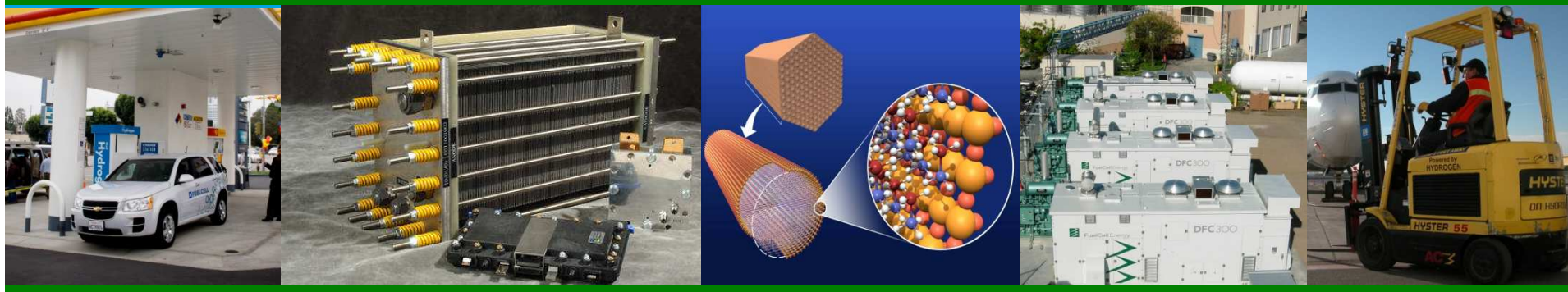




U.S. DEPARTMENT OF
ENERGY



What Can We Learn from Hydrogen Safety Event Databases?

Webinar Moderator:

Jay Keller

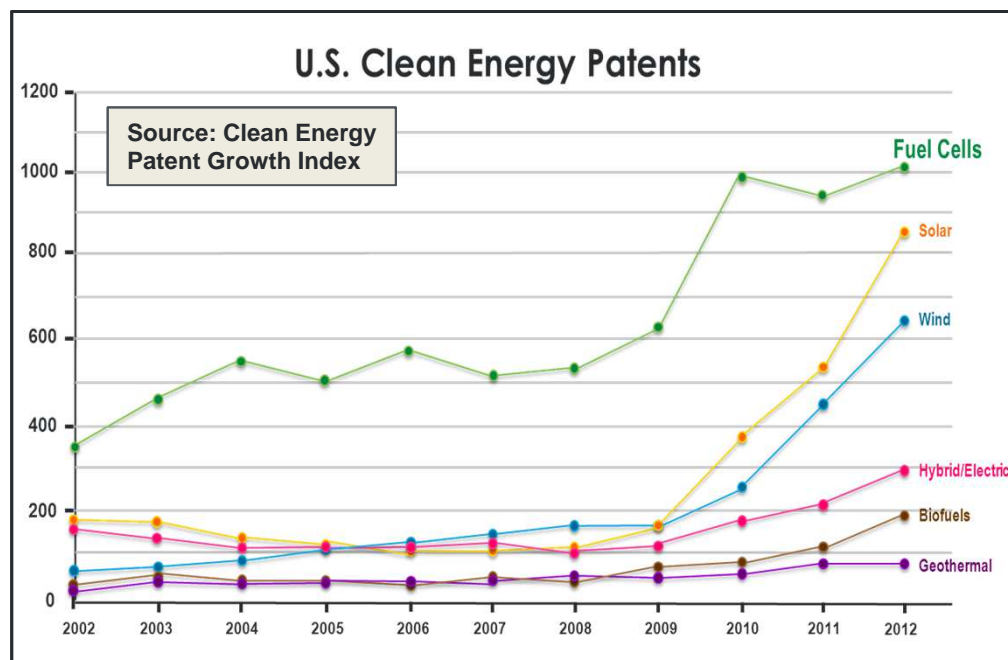
Consultant

U.S. DOE Fuel Cell Technologies Office
Safety, Codes and Standards

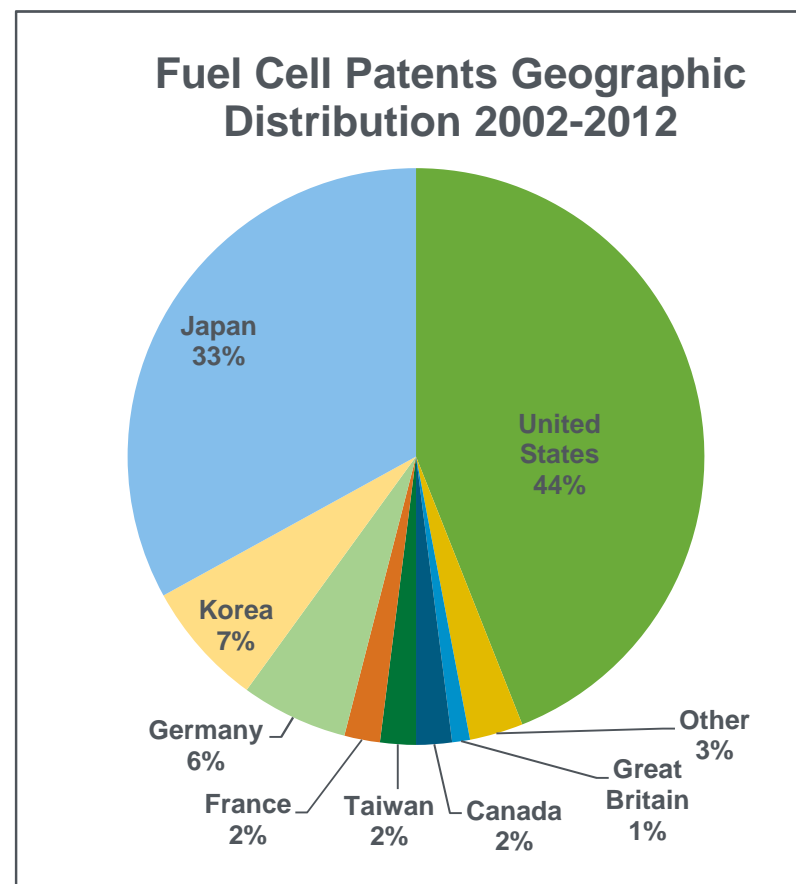
September 10, 2013

Overview

Fuel Cells – An Emerging Global Industry



Top 10 companies for fuel cell patents: GM, Honda, Toyota, Samsung, UTC Power, Nissan, Ballard, Panasonic, Plug Power, Delphi Technologies



- Clean Energy Patent Growth Index^[1] shows growth in all clean energy technology patents
- More than 1,000 fuel cell patents issued in 2012

[1] http://cepgi.typepad.com/heslin_rothenberg_farley_/2013/03/clean-energy-patent-growth-index-2011-year-in-review.html

Worldwide Commitment to FCEVs

Interest in fuel cells and hydrogen is global, with more than \$1 billion in public investment in RD&D annually. The world's leading automakers have committed to develop FCEVs.

Major Auto Manufacturers' Activities and Plans for FCEVs

	General Motors	<ul style="list-style-type: none"> >120 vehicles deployed since 2007 in Project Driveway 2012: Technology readiness goal for FC powertrain
	Toyota	<ul style="list-style-type: none"> 2010-2013: U.S. demo fleet of 100 vehicles "FCHV-adv" can achieve 431-mile range & 68 mpgge 2015: Commercialize cars at <\$100K
	Honda	<ul style="list-style-type: none"> Clarity FCX named "World Green Car of the Year"; EPA certified 72mpgge; leasing up to 200 vehicles 2015: Launch all-new fuel cell electric model sequentially in Japan, U.S. and Europe.
	Daimler	<ul style="list-style-type: none"> Plans for tens of thousands of FCEVs/year in 2015 – 2017 and hundreds of thousands a few years after Partnership with Linde to develop fueling stations. Moved up commercialization plans to 2014
	Hyundai-Kia	<ul style="list-style-type: none"> 2012-2013: 2000 FCEVs/year 2015: 10,000 FCEVs/year "Borrego" FCEV has achieved >340-mile range.
	Volkswagen	<ul style="list-style-type: none"> Expanded demo fleet to 24 FCEVs in CA Recently reconfirmed commitment to FCEVs
	SAIC (China)	<ul style="list-style-type: none"> SAIC Motor Company is planning 20-30 prototypes in 2013 and >1,000 FCEVs in 2015.
	Nissan	<ul style="list-style-type: none"> Commercial FCEVs planned for 2016. FCEVs are key part of "Nissan Green Program." Announced strategic partnership with Daimler on FCEVs.
	BMW	<ul style="list-style-type: none"> Fielding a fleet of "F-Cell" vehicles in the U.S. 40 currently leased with another 20 on the way.

Based on publicly available information during 2011 – 2012. Ford involved through Ballard-Daimler partnership (AFCC).

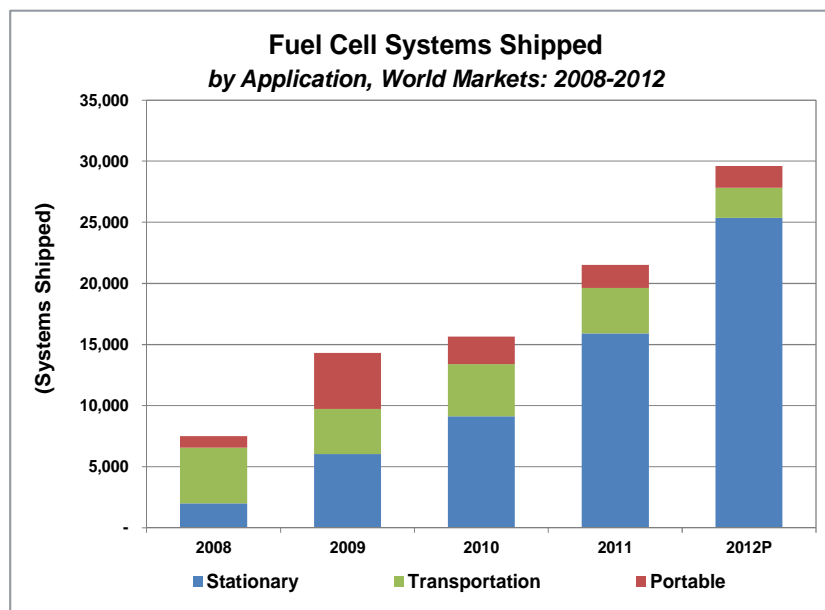
Market Growth & Potential

Fuel cell markets continue to grow

- ~30,000 units shipped in 2012 (~35% increase)
- 48% increase in global MWs shipped

Independent analyses show global markets could mature in the next 10–20 years, producing revenues of:

- \$14 – \$31 billion/year for stationary power
- \$11 billion/year for portable power
- \$18 – \$97 billion/year for transportation



Sources: Navigant Research, DOE Fuel Cells Market Report

Safety Information Portal

- Information Portal will serve as a central point for access to the hydrogen safety lessons learned and best practices information.
- IPHE will consolidate information into a single, global, open-source, searchable information resource.

Webinars

- Regular IPHE webinars will serve as another pathway to share information while utilizing the resources, knowledge and experience of IPHE members and partners.
- Webinars will cover topics of interest to the global hydrogen and fuel cell community.
 - ✓ **Safety information sharing**
 - ✓ H2 resource availability analysis (IEA HIA² Task 30) results
 - ✓ Status of infrastructure deployments
 - ✓ Policy Examples to Promote H2 and FCs
- Two webinars per year

¹IPHE – International Partnership for Hydrogen and Fuel Cells in the Economy

²IEA HIA – International Energy Agency Hydrogen Implementing Agreement

Webinar Objective: To Share U.S. and E.U. information as it pertains to Hydrogen Safety and Best Practices, Lessons Learned and Available Databases

- Each speaker up to 15 minutes for formal remarks
 - We will entertain panel discussion questions at the end of the formal presentations for 20 minutes
 - Webinar is being recorded and will be posted approximately 10 days after the webinar. This will be through the U.S. DOE Fuel Cell Technologies Office homepage.

www1.eere.energy.gov/hydrogenandfuelcells/webinar_archives_2013.html

- Safety Information helps guide R&D.
- It is critical to collect and disseminate relevant information.

Equipment	Total Incidents
Piping/Fitting/Valves	102
Hydrogen Storage	49
Vehicle & Fueling System	40
Safety Systems	25
Ventilation System	22
Laboratory Equipment	19
Pressure Relief Devices	16
Motive Power Systems	15
Heating Equipment	14
Electrical Equipment	14
Process Equipment	14
Batteries and Related Equipment	13

Database web address –
www.h2incidents.org

Examples:

Piping (36)
Valve (36)
Flexible Tubing (8)
Gasket (6)
Bolts (6)

Cross-Search Categories :

Settings
Damage and Injuries
Probable Causes
Contributing Factors

What Can We Learn from Hydrogen Safety Event Databases? *H2Incidents.org*

STEVEN C. WEINER

Battelle Washington Office
Washington, DC



The screenshot shows the homepage of the H2 Incident Reporting and Lessons Learned website. The header features the title "H₂ Incident Reporting and Lessons Learned" and a "Welcome!" message. The left sidebar contains a navigation menu with categories like "Latest Reports", "Equipment", "Damage and Injuries", and "Probable Causes", each with a list of sub-items and counts. The main content area includes sections for "What is H₂Incidents?", "How does H₂Incidents work?", and "Latest Reports". The "Latest Reports" section lists recent incidents such as "Hydrogen Gas Regulator Failure" and "Industrial Hydrogen Purifier Explosion". The "How does H₂Incidents work?" section explains the database's purpose and how users can access and submit reports. The "Latest Reports" section also includes a "New! Lessons Learned Corner" with a link to "Ventilation of Facilities where Hydrogen is Used".

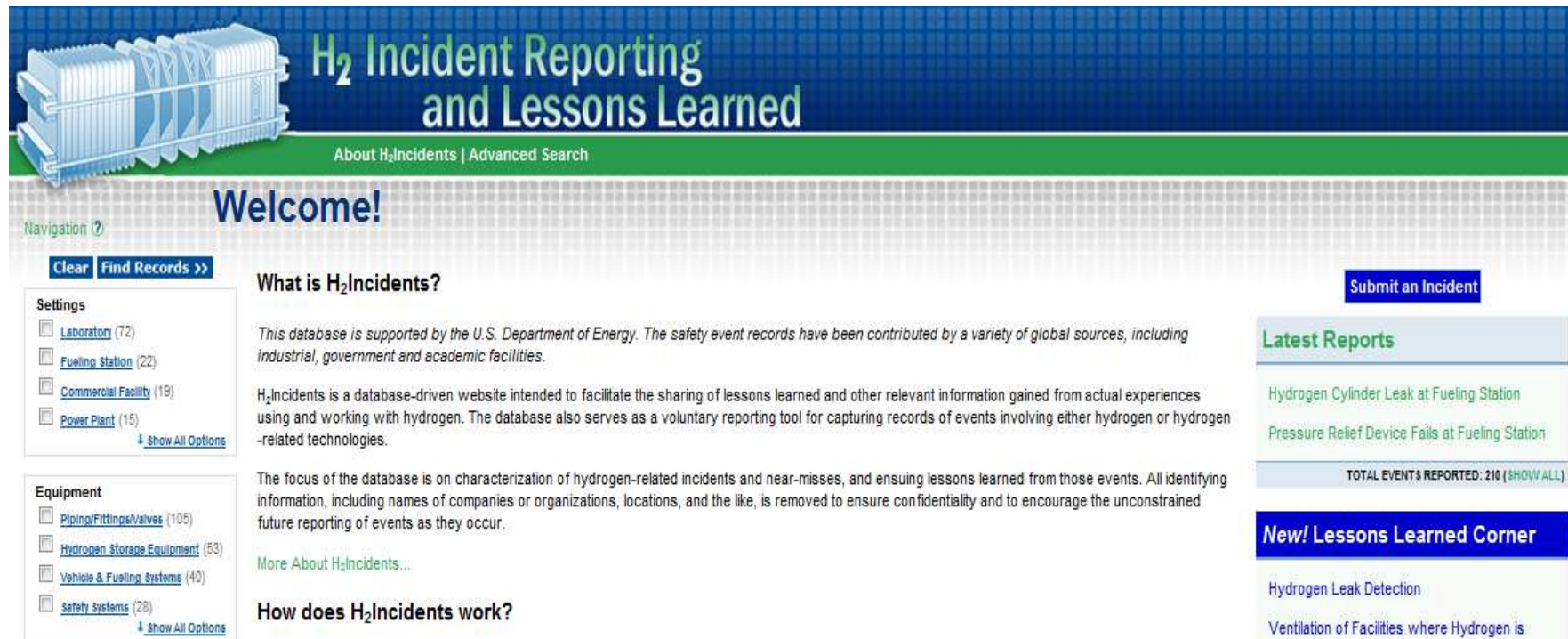
The Premise

“Hydrogen and fuel cell safety event information can serve as a rich and valuable resource if it is systematically collected, analyzed and used to enhance hydrogen safety knowledge. The sharing of lessons learned from safety events can serve to help prevent similar events from happening in the future...”

Ref: *Learning from Safety Events*, A Statement from the Hydrogen Safety Panel, January 17, 2012.

What is H2Incidents.org?

- ▶ Database-driven website to facilitate the sharing of lessons learned and other relevant information gained from actual experiences using and working with hydrogen.
- ▶ Focus on characterization of hydrogen-related incidents and near-misses, and ensuing lessons learned from those events.



The screenshot shows the homepage of the H2 Incident Reporting and Lessons Learned website. The header features a blue banner with the title "H₂ Incident Reporting and Lessons Learned" and a sub-header "About H₂Incidents | Advanced Search". Below the banner is a "Welcome!" message. The main content area is divided into several sections: "Navigation" with a "Clear" button and a "Find Records >>" button; "Settings" with a list of categories (Laboratory, Fueling Station, Commercial Facility, Power Plant) and a "Show All Options" link; "Equipment" with a list of categories (Piping/Fittings/Valves, Hydrogen Storage Equipment, Vehicle & Fueling Systems, Safety Systems) and a "Show All Options" link; "What is H₂Incidents?" with a paragraph about the database's support by the U.S. Department of Energy and its purpose; "How does H₂Incidents work?" with a link to "More About H₂Incidents..."; "Submit an Incident" button; "Latest Reports" with two entries: "Hydrogen Cylinder Leak at Fueling Station" and "Pressure Relief Device Fails at Fueling Station"; and "New! Lessons Learned Corner" with two entries: "Hydrogen Leak Detection" and "Ventilation of Facilities where Hydrogen is". A status bar at the bottom right indicates "TOTAL EVENTS REPORTED: 210 (SHOW ALL)".

- ▶ Launched in 2006 to store information and analysis of hydrogen-related safety events including describing the event, its setting and equipment, its characteristics, causes and contributing factors
 - 210 Safety event records to date
 - Voluntary reporting tool for capturing records of events involving hydrogen or hydrogen-related technologies.

- ▶ Key Attributes
 - Search Incidents
 - Enter Incidents
 - New Lessons Learned

The road to “H2incidents.org” began in Pisa....



Capturing the Event Focusing on Lessons Learned

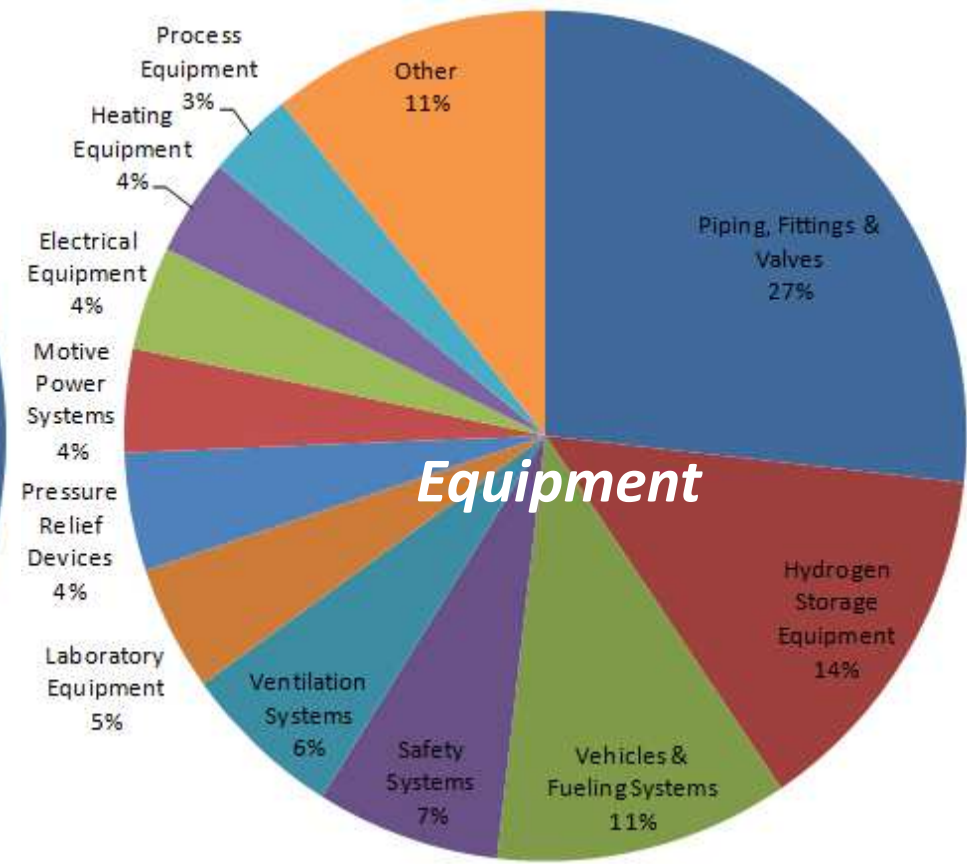
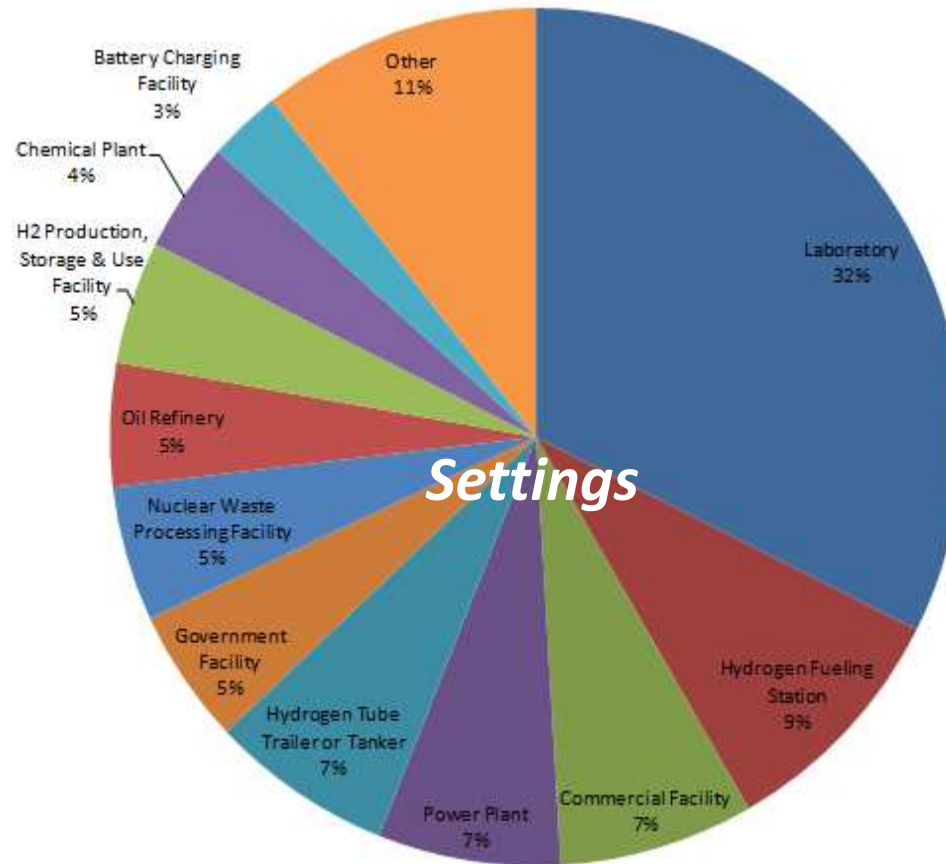
Each safety event record contains

- Description
- Severity (Was hydrogen released?
Was there ignition?)
- Setting
- Equipment
- Characteristics (High pressure?
Low temperature?)
- Damage and Injuries
- Probable Cause(s)
- Contributing Factors
- Lessons Learned/Suggestions for
Avoidance/Mitigation Steps Taken

Lessons learned content enhanced
by links to “H2best practices.org”



Two Looks at H2incidents.org



Search capabilities allow the user to seek information of interest.

Developing Safety Event Records

- ▶ Both incidents and near-miss records are sought
- ▶ Encourage self-submittal through an easy-to use online form
- ▶ Identify potential records through other means, e.g. media reports and other databases
- ▶ Work with “incident owners” and other submitters
 - Discuss, encourage and reach agreement for the submittal of a safety event record
 - Discuss, clarify and edit description, information and lessons learned.
 - Ensure anonymity in the safety event record itself
 - Obtain organizational approval for posting
- ▶ Provide expert review of safety event records by the Hydrogen Safety Panel and other subject matter experts.

H2incidents.org

Emphasizing Lessons Learned



H₂ Incident Reporting and Lessons Learned

About H₂Incidents | Advanced Search

Welcome!

Navigation ?

[Clear](#) [Find Records >>](#)

Settings

- ☐ [Laboratory](#) (72)
- ☐ [Fueling Station](#) (20)
- ☐ [Commercial Facility](#) (18)
- ☐ [Power Plant](#) (15)

[Show All Options](#)

Equipment

- ☐ [Piping/Fittings/Valves](#) (102)
- ☐ [Hydrogen Storage Equipment](#) (49)
- ☐ [Vehicle & Fueling Systems](#) (40)
- ☐ [Safety Systems](#) (25)

[Show All Options](#)

Damage and Injuries

- ☐ [Property Damage](#) (111)
- ☐ [None](#) (82)
- ☐ [Minor Injury](#) (27)
- ☐ [Lost Time Injury](#) (18)

[Show All Options](#)

Probable Causes

- ☐ [Equipment Failure](#) (83)
- ☐ [Human Error](#) (33)
- ☐ [Design Flaw](#) (28)

What is H₂Incidents?

This database is supported by the U.S. Department of Energy. The safety event records have been contributed by a variety of global sources, including industrial, government and academic facilities.

H₂Incidents is a database-driven website intended to facilitate the sharing of lessons learned and other relevant information gained from actual experiences using and working with hydrogen. The database also serves as a voluntary reporting tool for capturing records of events involving either hydrogen or hydrogen-related technologies.

The focus of the database is on characterization of hydrogen-related incidents and near-misses, and ensuing lessons learned from those events. All identifying information, including names of companies or organizations, locations, and the like, is removed to ensure confidentiality and to encourage the unconstrained future reporting of events as they occur.

[More About H₂Incidents...](#)

How does H₂Incidents work?

You can 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. By clicking on the "show all" text next to this number, you can view a [complete, alphabetical list of incidents](#).

To look for incidents related to specific details, you can use the left navigation. The five main headings—[Settings](#), [Equipment](#), [Damage and Injuries](#), [Probable Causes](#), [Contributing Factors](#)—will help you drill through the collection of incidents to find those that interest you. You can also view a graphical representation of the number of incidents associated with each of these main headings, simply click on the heading and then mouse over the chart to view a larger image. At any time, you can also use the [Advanced Search](#) form, found at the top of the page, for some more options to search the database.

If you have an incident you would like to include in the H₂Incidents database, please visit the [Submit an Incident](#) page. This page will ask for a wide range of information on your incident. Please enter as much of the information as possible. In order to protect your and your employer's identities, information that may distinguish an incident (your contact information, your company's name, the location of the incident, etc.) will not be displayed in the incident reports on H₂Incidents.

[Submit an Incident](#)

Latest Reports

- [Industrial Hydrogen Purifier Explosion](#)
- [Lithium Aluminum Hydride Laboratory Fire](#)

TOTAL EVENTS REPORTED: 207 ([SHOW ALL](#))

New! Lessons Learned Corner

- [Hydrogen Leak Detection](#)
- [Ventilation of Facilities where Hydrogen is Used](#)

[LESSONS LEARNED ARCHIVES](#)

Lessons Learned Corner Archives

- Hydrogen leak detection
- Ventilation of facilities where hydrogen is used
- 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

Linking H2incidents.org and H2bestpractices.org Enhancing the Value of Both



H₂ Incident Reporting and Lessons Learned
About H₂Incidents | Advanced Search

Welcome!

Navigation 

Clear **Find Records >>**

Settings

- ☐ Laboratory (72)
- ☐ Fueling Station (22)
- ☐ Commercial Facility (19)
- ☐ Power Plant (15)
- [Show All Options](#)

Equipment

- ☐ Piping/Fittings/Valves (105)
- ☐ Hydrogen Storage Equipment (53)
- ☐ Vehicle & Fueling Systems (40)
- ☐ Safety Systems (28)
- [Show All Options](#)

Damage and Injuries

- ☐ Property Damage (112)
- ☐ None (84)
- ☐ Minor Injury (27)
- ☐ Lost Time Injury (18)
- [Show All Options](#)

Probable Causes

- ☐ Equipment Failure (86)
- ☐ Human Error (33)
- ☐ Design Flaw (28)
- ☐ Failure to Follow Standard Operating Procedures (20)
- [Show All Options](#)

Contributing Factors

- ☐ Human Error (50)
- ☐ Situational Awareness (50)
- ☐ Change in Procedures, Equipment, or Materials (34)
- ☐ Training Issue (32)
- [Show All Options](#)

Clear **Find Records >>**

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Submit an Incident

Latest Reports

- Hydrogen Cylinder Leak at Fueling Station
- Pressure Relief Device Fails at Fueling Station

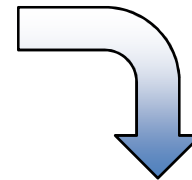
TOTAL EVENTS REPORTED: 210 [\(SHOW ALL\)](#)

New! Lessons Learned Corner

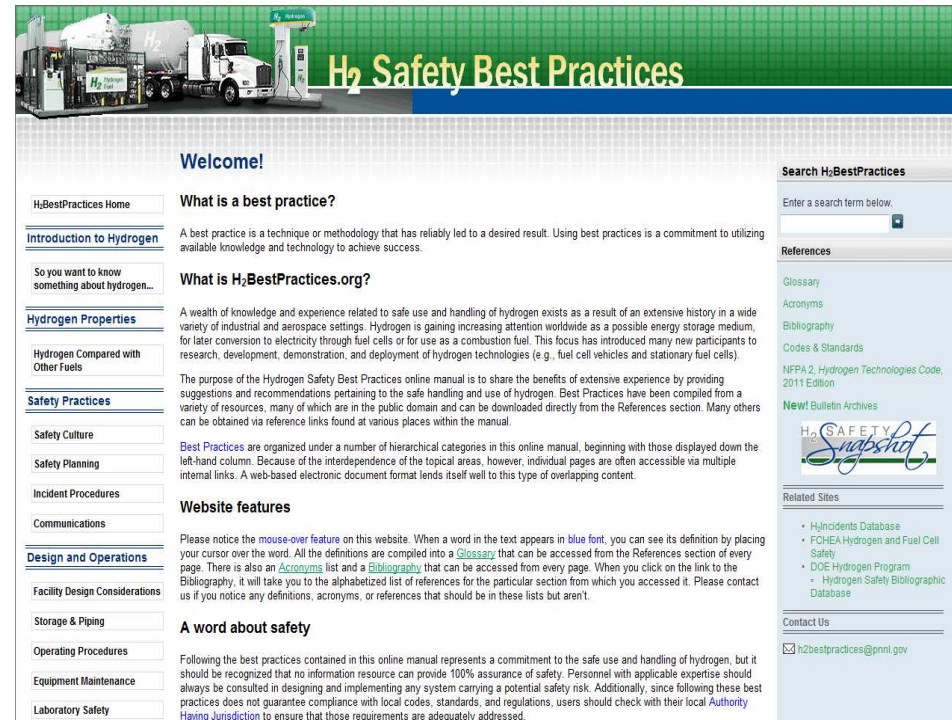
- Hydrogen Leak Detection
- Ventilation of Facilities where Hydrogen is Used

[LESSONS LEARNED ARCHIVES](#)

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



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



H₂ Safety Best Practices

Welcome!

What is a best practice?

A best practice is a technique or methodology that has reliably led to a desired result. Using best practices is a commitment to utilizing available knowledge and technology to achieve success.

What is H₂BestPractices.org?

A wealth of knowledge and experience related to safe use and handling of hydrogen exists as a result of an extensive history in a wide variety of industrial and aerospace settings. Hydrogen is gaining increasing attention worldwide as a possible energy storage medium, for later conversion to electricity through fuel cells or for use as a combustion fuel. This focus has introduced many new participants to research, development, demonstration, and deployment of hydrogen technologies (e.g., fuel cell vehicles and stationary fuel cells).

The purpose of the Hydrogen Safety Best Practices online manual is to share the benefits of extensive experience by providing suggestions and recommendations pertaining to the safe handling and use of hydrogen. Best Practices have been compiled from a variety of resources, many of which are in the public domain and can be downloaded directly from the References section. Many others can be obtained via reference links found at various places within the manual.

Best Practices are organized under a number of hierarchical categories in this online manual, beginning with those displayed down the left-hand column. Because of the interdependence of the topical areas, however, individual pages are often accessible via multiple internal links. A web-based electronic document format lends itself well to this type of overlapping content.

Website features

Please notice the **mouse-over** feature on this website. When a word in the text appears in **blue font**, you can see its definition by placing your cursor over the word. All the definitions are compiled into a **Glossary** that can be accessed from the References section of every page. There is also an **Acronyms** list and a **Bibliography** that can be accessed from every page. When you click on the link to the Bibliography, it will take you to the alphabetized list of references for the particular section from which you accessed it. Please contact us if you notice any definitions, acronyms, or references that should be in these lists but aren't.

A word about safety

Following the best practices contained in this online manual represents a commitment to the safe use and handling of hydrogen, but it should be recognized that no information resource can provide 100% assurance of safety. Personnel with applicable expertise should always be consulted in designing and implementing any system carrying a potential safety risk. Additionally, since following these best practices does not guarantee compliance with local codes, standards, and regulations, users should check with their local **Authority Having Jurisdiction** to ensure that those requirements are adequately addressed.

Search H₂BestPractices

Enter a search term below.

References

- Glossary
- Acronyms
- Bibliography
- Codes & Standards
- NFPA 2, Hydrogen Technologies Code, 2011 Edition

New! Bulletin Archives

H₂ SAFETY Snapshot

Related Sites

- H₂Incidents Database
- FCHEA Hydrogen and Fuel Cell Safety
- DOE Hydrogen Program
- Hydrogen Safety Bibliographic Database

Contact Us


h2bestpractices@pnnl.gov

Navigation

- [H₂BestPractices Home](#)
- [Introduction to Hydrogen](#)
- [So you want to know something about hydrogen...](#)
- [Hydrogen Properties](#)
- [Hydrogen Compared with Other Fuels](#)
- [Safety Practices](#)
- [Safety Culture](#)
- [Safety Planning](#)
- [Incident Procedures](#)
- [Communications](#)
- [Design and Operations](#)
- [Facility Design Considerations](#)
- [Storage & Piping](#)
- [Operating Procedures](#)
- [Equipment Maintenance](#)
- [Laboratory Safety](#)

Just one example....

- ▶ A recent event that is relevant to the focus on deployment of hydrogen and fuel cell technologies
- ▶ Root causes for PRD failure
 - Incompatible materials
 - Improper assembly
 - Over-hardening of inner assembly materials
- ▶ But there is usually something else one can learn from the incident
 - Timely communication during emergency events
 - Training of personnel focused on improving response time
 - Effective communication between employees, first responders and suppliers



H₂ Incident Reporting and Lessons Learned

About H₂ Incidents | Advanced Search

Incident Report

Navigation ? [Clear](#) [Find Records >>](#)

Settings

- ☐ Laboratory (72)
- ☐ Fueling Station (22)
- ☐ Commercial Facility (19)
- ☐ Power Plant (15)

[Show All Options](#)

Equipment

- ☐ Piping/Fittings/Valves (105)
- ☐ Hydrogen Storage Equipment (53)
- ☐ Vehicle & Fueling Systems (40)
- ☐ Safety Systems (28)

[Show All Options](#)

Damage and Injuries

- ☐ Property Damage (112)
- ☐ None (64)
- ☐ Minor Injury (27)
- ☐ Lost Time Injury (18)

[Show All Options](#)

Probable Causes

- ☐ Equipment Failure (86)
- ☐ Human Error (33)
- ☐ Design Flaw (28)
- ☐ Failure to Follow Standard Operating Procedures (20)

[Show All Options](#)

Pressure Relief Device Fails at Fueling Station

Incident Date: 2012

Severity: Incident	Was Hydrogen released? Yes	Was there Ignition? Yes
-------------------------------------	---	--

Ignition Source: Either static electricity or spark from escaping particle

Description

A pressure relief device (PRD) valve failed on a high-pressure storage tube at a hydrogen fueling station, causing the release of approximately 300 kilograms of hydrogen gas. The gas ignited at the exit of the vent pipe and burned for 2-1/2 hours until technicians were permitted by the local fire department to enter the station and stop the flow of gas. During this incident the fire department evacuated nearby businesses and an elementary school, closed adjacent streets, and ordered a high school to shelter in place.

There were no injuries and very little property damage. The corrugated roof on an adjacent canopy over a fueling dispenser was slightly singed by the escaping hydrogen flame, causing less than \$300 in damage.

The station's operating systems worked as they were designed to function in an emergency. All equipment and fuel supplies were completely isolated, and all storage vessels were well within acceptable and safe pressure and temperature limits prior to and throughout the incident.

After a thorough analysis of the incident was conducted, corrective actions were taken to replace PRD valves, heighten vent stacks, modify response procedures and improve communication protocols with first responders. A considerable amount of time was taken to review the station design, evaluate emergency action plans and procedures, meet with the public, train first responders, and conduct follow-up drills with employees and first responders. The station reopened nine months after the incident and has been fully operational since that time.

Setting

- Fueling Station
- Outside - paved parking lot

HYDROGEN TOOLS

...available now for your mobile devices!

- ▶ **First mobile app targeted for AHJs, end-users and other stakeholders**
 - Integrates H₂incidents.org, H₂bestpractices.org and other resources into a single, searchable iPad and iPhone application
 - Features include safety planning guidance and checklists

**Announced by the
U.S. Department of Energy
September 2013**



What More Can We Learn?

“...Informed analysis of leaks, fires and explosions, and equipment failure and ignition data derived from these safety events can facilitate the development of risk assessment models and help technical experts identify gaps in applicable codes and standards that can be addressed by a variety of means.”

Ref: Learning from Safety Events, A Statement from the Hydrogen Safety Panel, January 17, 2012.

Concluding Thoughts

- ▶ Safety knowledge tools such as “H2incidents.org” provide a powerful resource for conveying data, information and knowledge
- ▶ Content must be current, relevant to the community being served and valuable to the user
- ▶ Prompt and timely responses to user feedback and inquiries to h2incidents@pnnl.gov are important
- ▶ Progress is being made but there is more to be done!



Acknowledging....

- ▶ Fuel Cell Technologies Office (Sunita Satyapal, Director) and Staff, U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy
- ▶ All those who have contributed safety event information, knowledge and lessons learned to our database
- ▶ International Conference on Hydrogen Safety

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or

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Pacific Northwest National Laboratory
202-646-7870
sc.weiner@pnnl.gov

Related References

- ▶ Weiner, S.C., Kinzey, B.R., Dean, J., Davis, P.B. and Ruiz, A., “Incident Reporting: Learning from Experience,” PNNL-SA-56185, International Conference on Hydrogen Safety, San Sebastian, Spain, September 11-13, 2007.
- ▶ Weiner, S.C. and Blake, C.W., “Safety Knowledge Tools Enhanced by International Collaboration,” A White Paper of the International Energy Agency Hydrogen Implementing Agreement Task 19 – Hydrogen Safety, PNNL-19901, October 18, 2010.
- ▶ Weiner, S.C., Fassbender, L.L. and Quick, K.A., “Using Hydrogen Safety Best Practices and Learning from Safety Events,” PNNL-SA-70148, International Journal of Hydrogen Energy, Volume 36, Issue 3, February 2011, pp. 2729-2735.
- ▶ 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, Volume 38 (2013), pp 7583-7593.
- ▶ Weiner, S.C., “Advancing the Hydrogen Safety Knowledge Base,” PNNL-SA-91531, International Conference on Hydrogen Safety, Brussels, Belgium, September 9, 2013.



HIAD

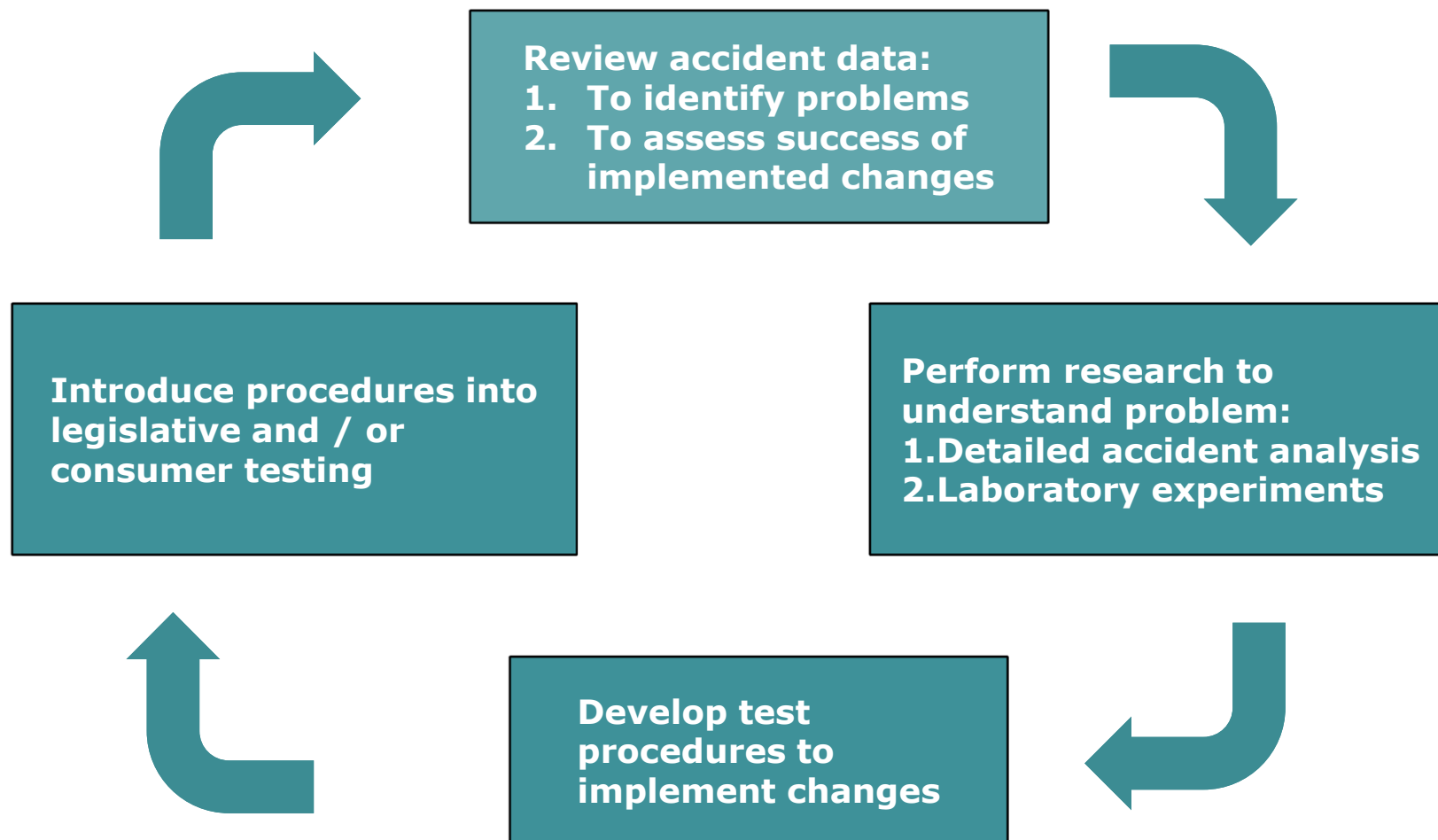
The EUROPEAN HYDROGEN INCIDENT & ACCIDENT DATABASE

P. Moretto & D. Baraldi

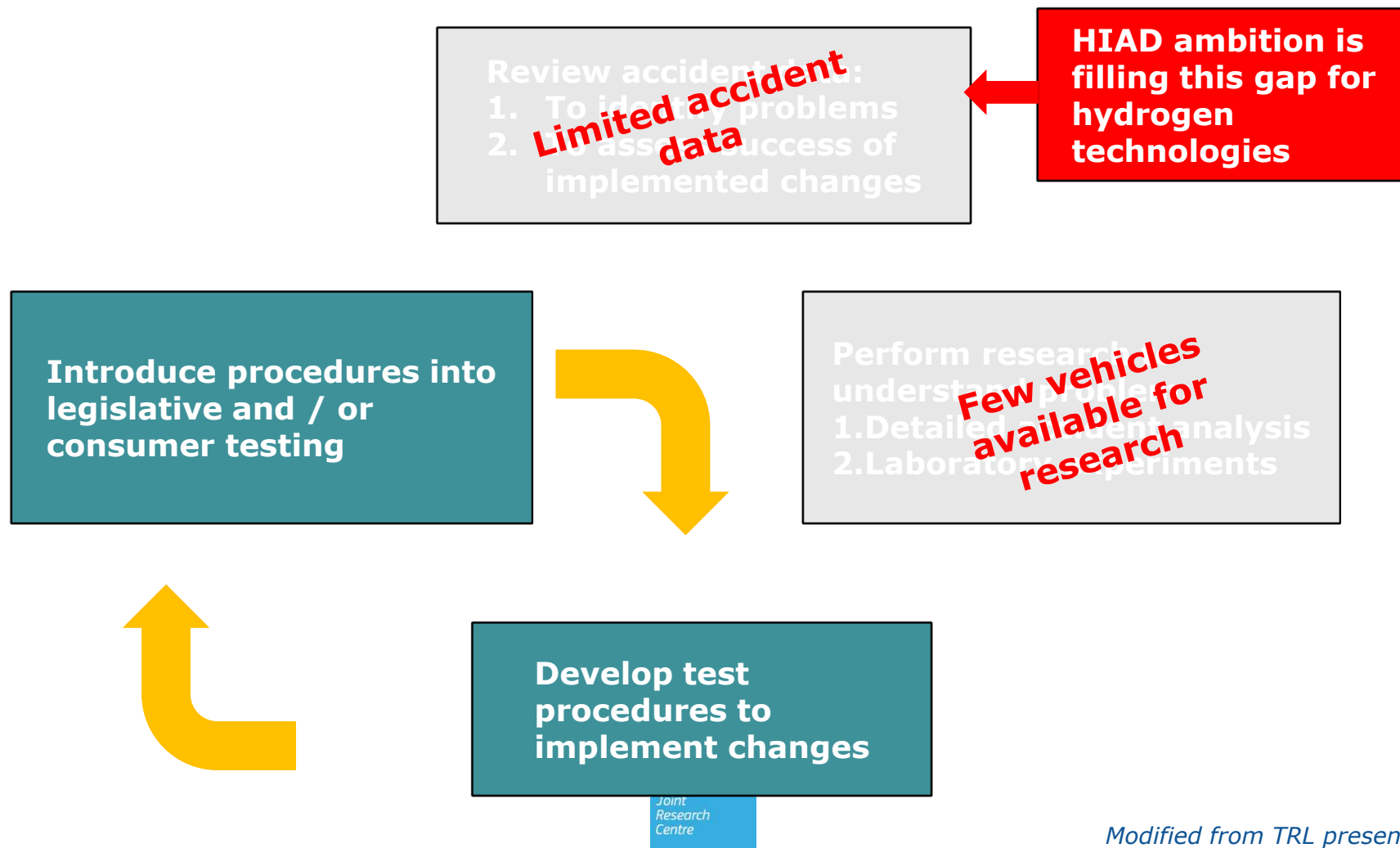
*Joint Research Centre - European Commission,
Institute for Energy and Transport*

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Typical (vehicle) safety research cycle



Safety research cycle for low carbon vehicles



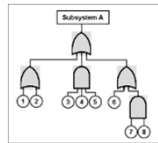
What is HIAD?

HIAD aims to be an repository of any accidental even related to hydrogen technology

- Originally designed to be a multi-task tool:



Open platform for lessons learned and risk communication



Data source of information to assist risk assessment approaches

- Fully operational with about 250 events published

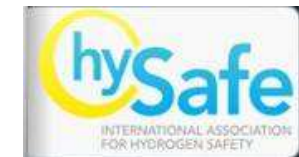


HIAD history

HIAD was originally developed in the European Network of Excellence for Hydrogen Safety (**HySafe** 2004-2009).



After the end of HySafe, the International Association for Hydrogen Safety **IA-HySafe** became the focal point for all hydrogen safety related issues. HIAD was further developed with an analysis module.

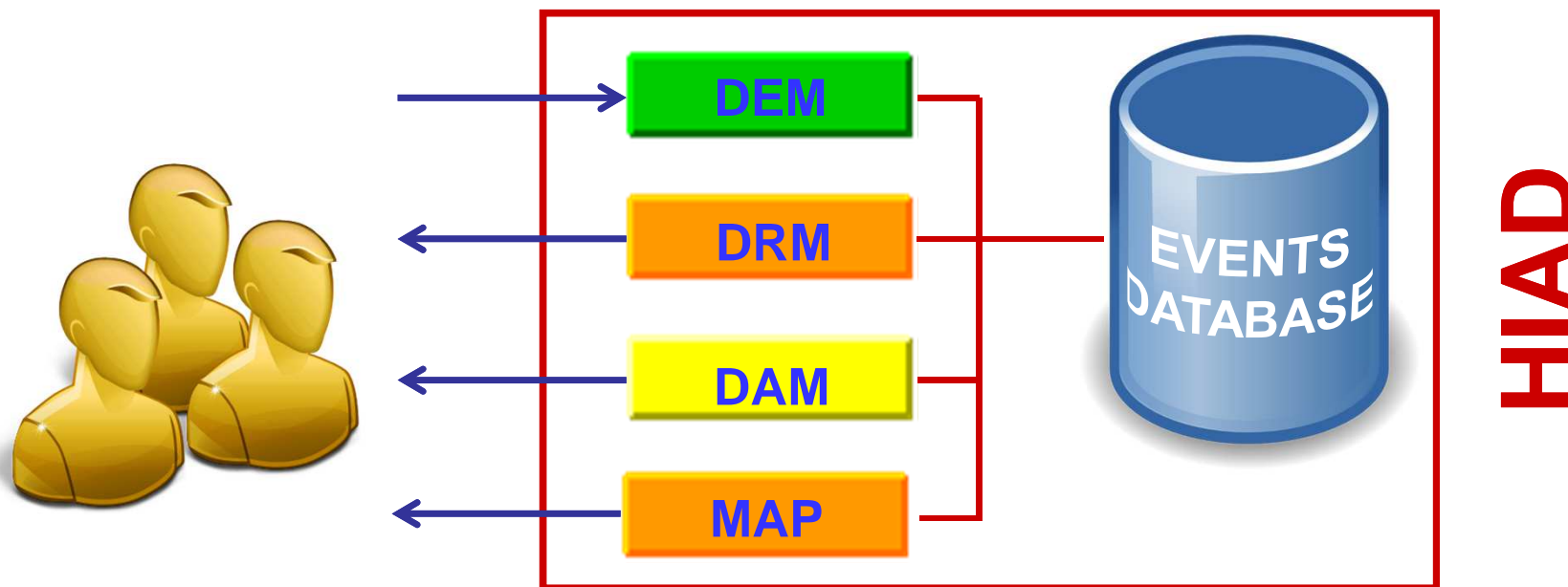


HIAD is maintained, updated and funded by the **Joint Research Centre**, and is available at <https://odin.jrc.ec.europa.eu/>.





HIAD Structure – 4 modules



DEM – Data Entry Module: Users can register as “event provider” and insert/update events directly on the database

DRM – Data Retrieval Module: Allows the user to access hydrogen events recorded on HIAD

DAM – Data Analysis Module: Is a tool for conducting online simple analyses of the data recorded into the database

MAP: a GIF based tool which links events to their geographical distribution

Event structure

Pre-event conditions: Date/time of event, Weather conditions, Geographical location, applications, Operation phase or mode.

Nature of event: Systems and components affected or involved, Chain of events, Causal relations, Relevant safety systems and emergency response, Release, fire and explosion specifications/details.

Consequences of event: Fatalities and injuries, Property, environment and economical loss and damage.

Post-event actions: Clean-up and restoration, Legal/legislation initiatives, Lessons learned, Investments made.

References: Hyperlinks/references to files and documents, web-sites, etc., Specification of attachments, e.g. maps, drawings, photos, etc.

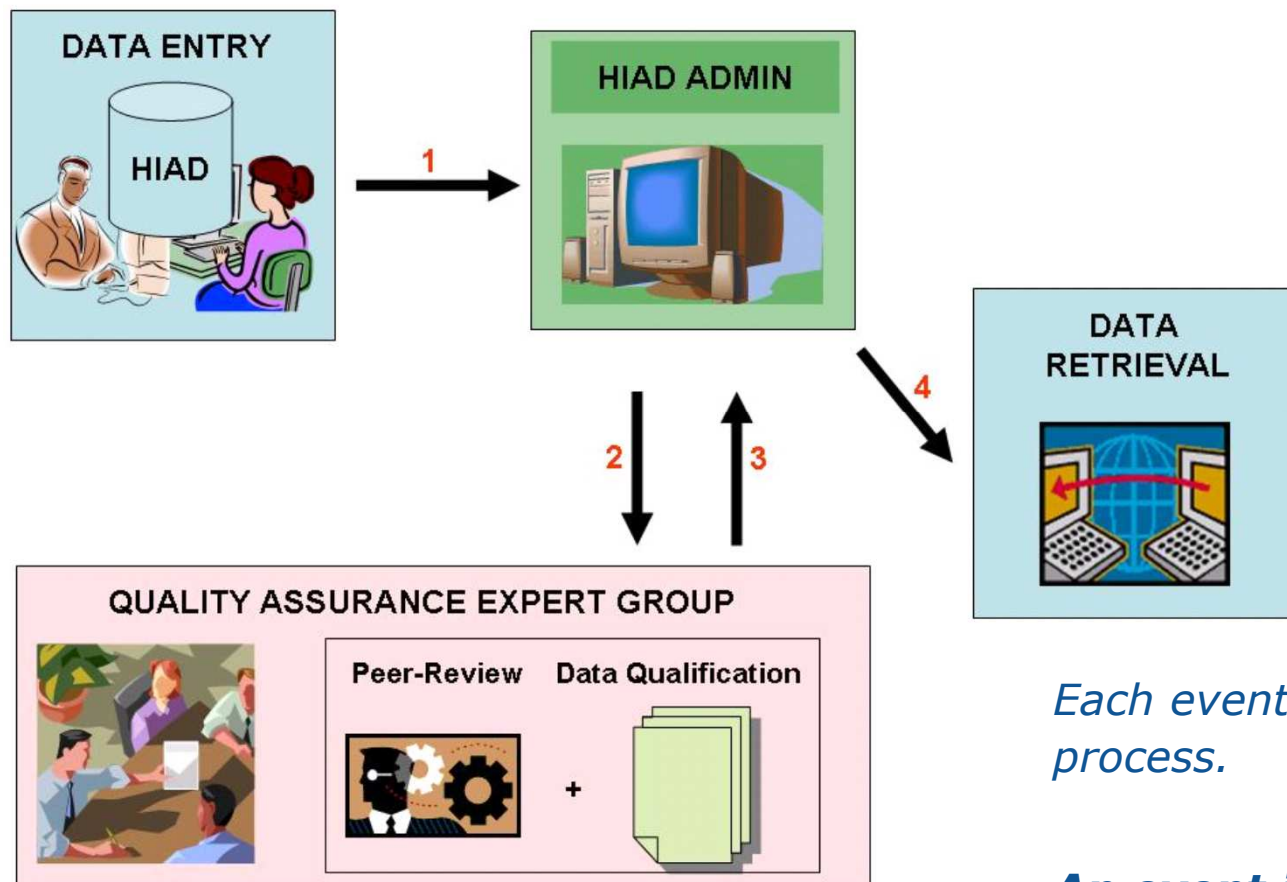
DEM = Data Entry Module Inputs

Users can enter events into HIAD in two ways:

- *Users can e-mail the event to JRC who can insert it on behalf of the users*
- *Alternatively users can register as "event provider" and insert/update events directly on the database, using the DEM.*

Only fields describing the dynamics of the event are mandatory. All other fields are not mandatory and the event can be introduced as a **completely anonymous event** without any information on location, company, etc.

Quality Assurance Process



Each event undergoes a QA process.

An event is published (visible) in HIAD only after QA process.



DAM = Data Analysis Module

Online analysis of the events

How to analyse:

In this module you can search for event versions based on up to 5 database information fields. The search result can be presented as a plain list or in a cross table based on 2 database fields.

Note: Not all combinations of search fields and cross table fields will give a reasonable output.

Step 1: Select and submit search fields and cross table fields.

Step 2: Add search values and criteria.

Step 1:

Other sets: **Tech. Info & People**

Other & Postevents

Subevent Details

Event	<input type="checkbox"/> City	i	Tech. info	<input type="checkbox"/> Application	i
	<input type="checkbox"/> Country	i		<input type="checkbox"/> Application chain	i
	<input type="checkbox"/> Street	i		<input type="checkbox"/> Application stage	i
	<input type="checkbox"/> State	i		<input type="checkbox"/> Storage medium	i
	<input type="checkbox"/> Year	i		<input type="checkbox"/> Storage quantity	i
Event Nature	<input type="checkbox"/> Systems involved	i		<input type="checkbox"/> Actual pressure (in storage medium)	i
	<input type="checkbox"/> Principal event	i		<input type="checkbox"/> Design pressure (of storage medium)	i
	<input type="checkbox"/> Event nature summary	i		<input type="checkbox"/> Type of location	i
Subevent	<input type="checkbox"/> Subevent type	i		<input type="checkbox"/> Location description	i
	<input type="checkbox"/> Emergency action	i		<input type="checkbox"/> Potential ignition source	i
	<input type="checkbox"/> Emergency evaluation	i		<input type="checkbox"/> Surroundings	i
Event scenario	<input type="checkbox"/> Presence of scenario	i		<input type="checkbox"/> Operational condition	i
	<input type="checkbox"/> Scenario known	i		<input type="checkbox"/> Operations phase	i
	<input type="checkbox"/> Scenario author	i		<input type="checkbox"/> Pre event summary	i
	<input type="checkbox"/> Year	i	i People Injuries	<input type="checkbox"/> Persons affected onsite	i
	<input type="checkbox"/> Date	i		<input type="checkbox"/> Persons affected rescued	i
	<input type="checkbox"/> Scenario analysis type	i		<input type="checkbox"/> Persons affected offsite	i
	<input type="checkbox"/> Established frequency (scenario)	i		<input type="checkbox"/> Persons at risk onsite	i
	<input type="checkbox"/> Scenario reference	i		<input type="checkbox"/> Persons at risk offsite	i
	<input type="checkbox"/> Scenario comments	i		<input type="checkbox"/> Total number of affected persons	i
Event weather	<input type="checkbox"/> Season of the year	i		<input type="checkbox"/> Total number of injured persons	i
	<input type="checkbox"/> Weather type	i		<input type="checkbox"/> Total number of fatalities	i
	<input type="checkbox"/> Wind direction	i		<input type="checkbox"/> Injury comments	i

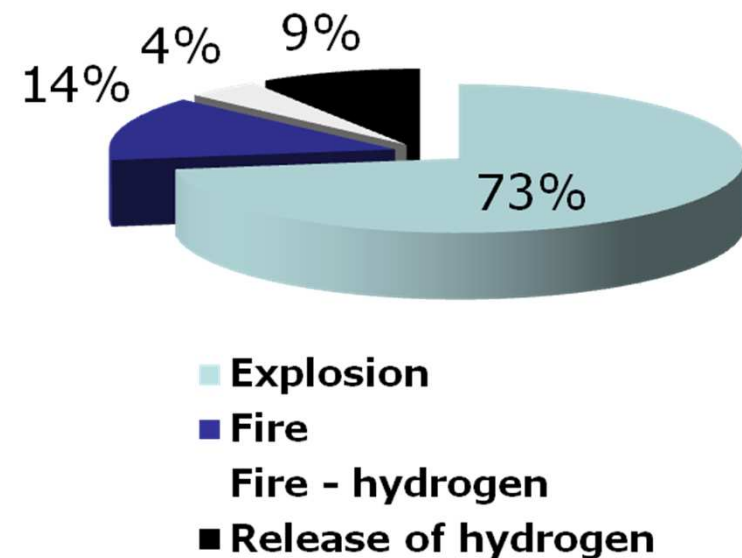


Data Analysis example: total number of involved people

Total number of affected persons -> Change

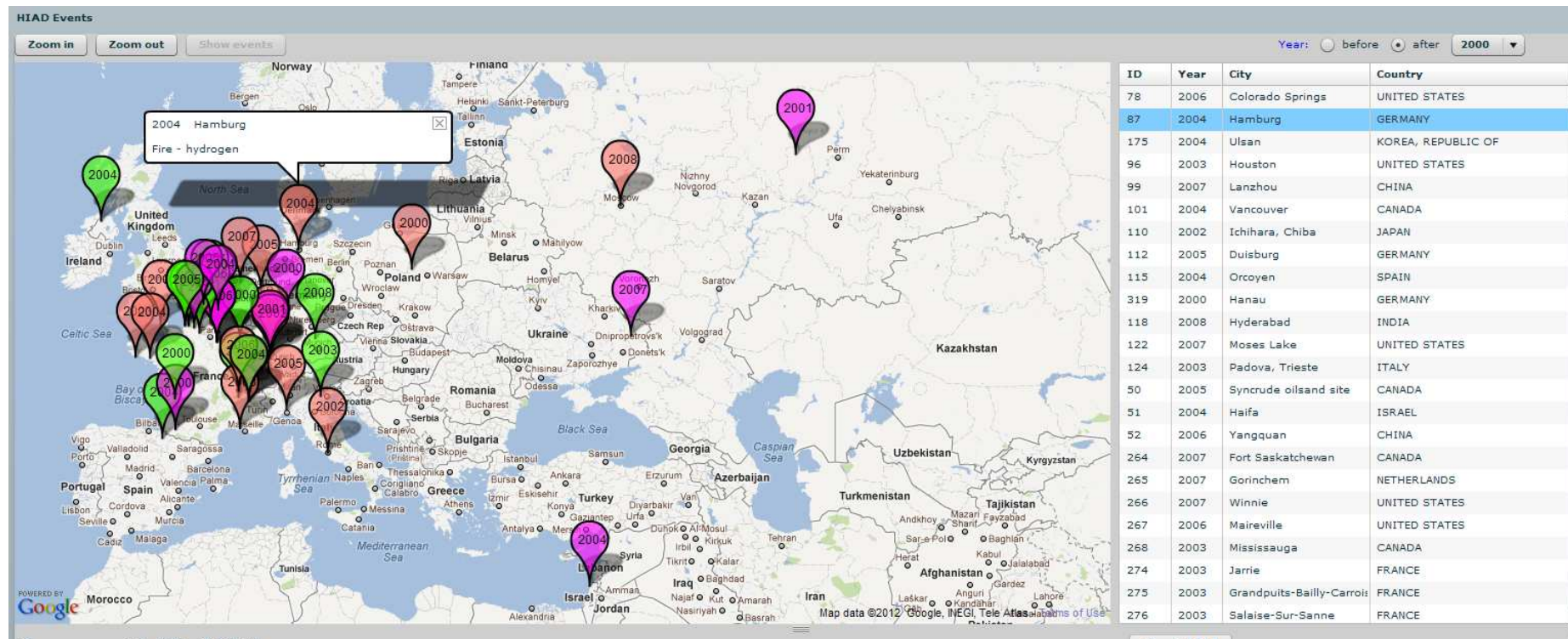
Year - Principal event	Burst of tank	Explosion	Fire	Fire - hydrogen	Pipe rupture	Release of hydrogen	Total
1985	0	2	0	0	0	0	2
1986	0	7	0	0	0	0	7
1987	0	8	0	0	0	0	8
1988	0	3	0	0	0	0	3
1989	0	124	15	7	0	0	146
1990	0	1	0	0	0	0	1
1991	0	26	0	0	0	70	96
1992	0	24	0	0	0	0	24
1993	0	4	0	4	0	0	8
1994	0	0	0	0	0	0	0
1995	0	24	0	0	0	0	24
1996	0	2	0	0	0	0	2
1997	0	73	4	0	0	0	77
1998	0	0	0	3	0	0	3
1999	0	53	0	1	0	0	54
2000	0	0	0	1	0	0	1
2001	0	21	7	4	0	0	32
2002	0	188	0	0	0	0	188
2003	0	2	0	0	0	0	2
2004	0	3	0	1	0	0	4
2005	0	23	0	0	0	0	23
2006	0	12	3	5	0	0	20
2007	0	1	88	9	0	3	101
2008	0	6	0	0	0	3	9
Total	0	607	117	35	0	76	835

Events 1985-2008: total number of involved people.





MAPS module



The screen shows you the HIAD events as they are scattered over the globe. Only events where the city or town is known are displayed. Events where only the country/continent is known are not displayed.

Lesson learned and improvement actions

A database such as HIAD is an essential reference and qualitative/quantitative tool for

- ☞ A structured dissemination of information
- ☞ An optimisation of safety for an emerging technology.

It will increase importance and expand usage with increasing technology deployment.

To this purpose, the experience with HIAD of the past years has generated improvement needs...

Lesson learned

Requirement 1 - commitment to reporting:

First responders or facility owners do not have as a duty a HIAD input.

Therefore a commitment to reporting also to HIAD should be required by licensing bodies. A 'distributed', European-wide network of data providers should be in place.

Requirement 2 - availability of accurate event reports:

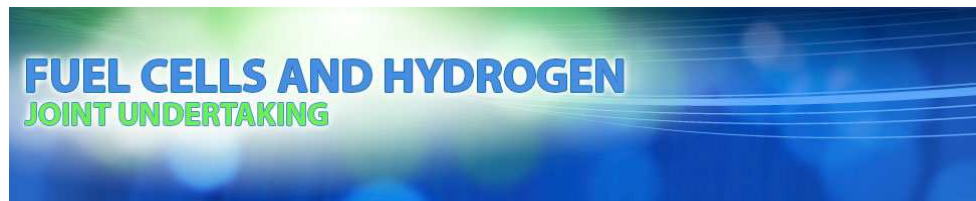
- 👉 Event description providers tend to input a minimal number of information, and many fields remain empty.
- 👉 Local journal articles almost never provide data with the required quality and resolution.

Therefore final internal accident reports should be made available for HIAD input (a very good example: the Emeryville accident report).



Improvement actions so far

1. Since 2013 all the European FCH JU projects, and especially the Demo projects are committed to report safety related events in HIAD



A similar commitment is wished also from commercial installations

2. The US and the European databases 'speak' to each others, and a small exchange of events has started

Improvement actions to come

Improve end-user usefulness

HIAD has been written for expert operators, not for end users; the level of details of the data expected/required must take into account the average availability of data.

Solution: restructuring of HIAD interface is planned for the coming 2 years



Improve quality assurance service

A broader and permanently available, quality assurance group is required, also for the interaction with the event provider.

Solution: not available at the moment; joining forces between databases could be a way forward.



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Thank You

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