Fuel Cell Technologies Office

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Safety, Codes and Standards Program Overview

HySafe R&D Prioritization Workshop

November 11, 2014

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U.S. Department of Energy

DOE Technical Strategy

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Successful commercialization of hydrogen technologies depends on a foundation of safety and standards development:

- Comprehensive system of codes and standards
- Cost-effective, reliable, safety technology
- Harmonized permitting and certification
- Accessible education and targeted training

Key C&S elements for commercial viability:

- Consistent/complete codes & standards (SDOs/CDOs)
- Technical criteria/guidance for safe, low-cost options
- Common/adopted certification (GTR effort)
- Saleable hydrogen (H_2 quality projects)
- Awareness and education for hydrogen safety

DOE Safety, C&S Activity Pyramid

Codes and Standards

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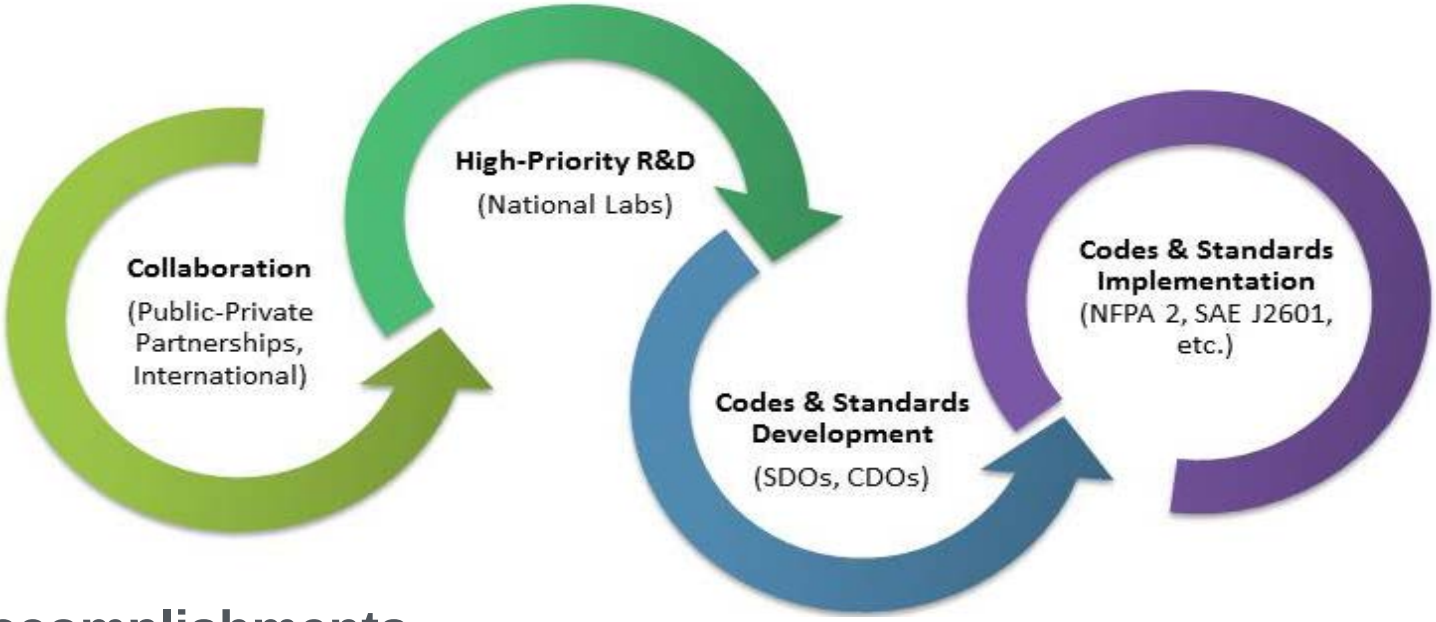
Objective: Support and facilitate development and promulgation of essential codes and standards by 2015 to enable widespread deployment and market entry of hydrogen and fuel cell technologies and completion of all essential domestic and international RCS by 2020



2014 Accomplishments

- NFPA 2 integrated into the IFC enables a domestic-wide codification for the deployment of hydrogen infrastructure
- GTR adopted by UNECE Working Party 29 becomes technical underpinning for the Federal Motor Vehicle Safety Standard (FMVSS)
- Refueling standard, SAE J2601, enables 3-5 minutes fast fill

Continuous C&S Approach

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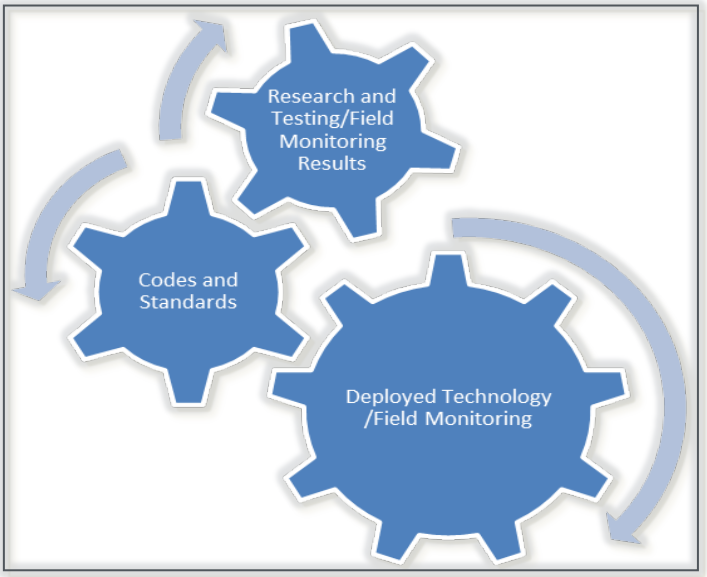
CCSI allows an integrated approach that builds on lessons learned from deployment to provide feedback to the C&S committees



- Examples of potential inputs or data gathering source(s):
  - Regular review (at least every 6 months) of NREL technology validation data to identify issues (NFCTEC)
  - Annual site visits to key hydrogen fueling stations provide information on Safety, Codes and Standards issues (e.g. – HSP or NREL)
  - Interviews with code officials and project developers to identify issues with actual code application (for example, requirements that are worded such that they are difficult to enforce and comply with)
  - Participation on technical committees to ensure that research and field data are effectively linked to code development

Accelerate Deployment of HRS

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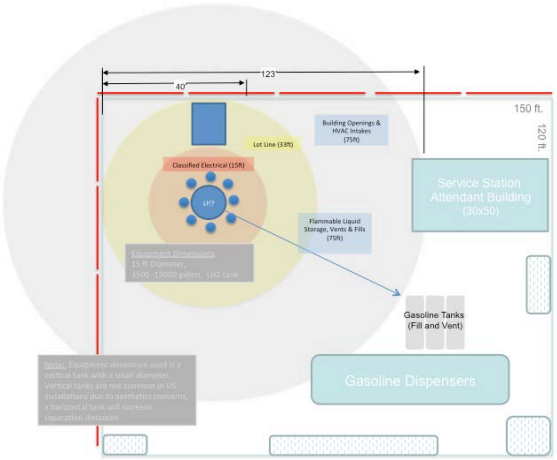
Initiate performance-based design and liquid release tasks to impact the deployment hydrogen fueling stations

Performance-Based Design (PBD)

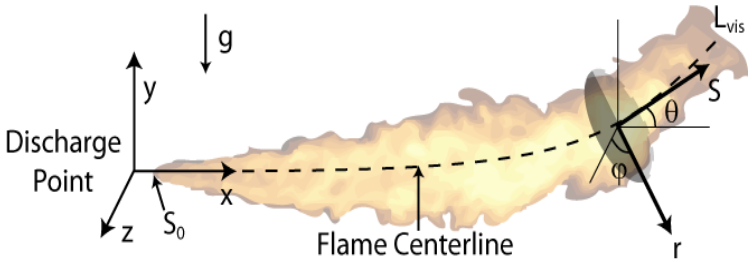
- Demonstrated the use of the QRA toolkit to develop and analyze a PBD
- A PBD Brief has been prepared for a representative refueling station



Demonstrating successful use of PBD option may significantly increase number of available sites - if industry can use PBD option in a cost-effective manner

Liquid Releases

- Current Separation distance are large and makes citing LH_2 stations difficult
- Leverage experience from gaseous hydrogen work
- Leverage industry through participation in NFPA 2/55



Develop work plan for liquid hydrogen releases and initiate **initial experiments in FY2015**

Established H_2FIRST Project–H_2 Fueling Infrastructure Research & Station Technology

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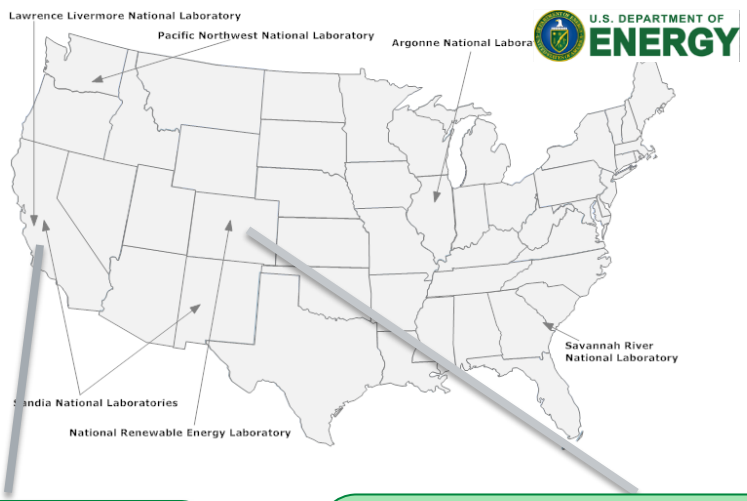
NREL and SNL Provide: H2FIRST in support of H2USA

Hydrogen Fueling Infrastructure Research and Station Technology

- Technical expertise – Hydrogen specific materials and systems
- Facilities - for technical collaboration and validation
- Objectivity – Independent and objective assessment

Leverage DOE National Lab Network



Project Teams:

- Station Qualification
- Dispenser Components Research
- Fuel Quality Sensor
- Station Component RD&D
- Reference Station Design

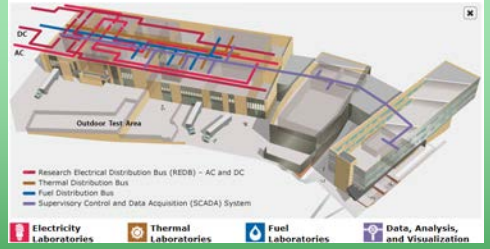
Sandia National Laboratories

Center for Infrastructure Research & Innovation

Ciri Center for Infrastructure Research and Innovation

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Energy Systems Integration Facility



Distributed Energy Resources Test Facility

Safety Program Support

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Leveraging expertise and resources from key domestic and international communities to deploy hydrogen and fuel cell technologies safely

Objectives

- Ensure that best safety practices underlie research, technology development, and market deployment activities supported through DOE-funded projects.
- Develop and enable widespread sharing of safety-related information resources and lessons learned with first responders, authorities having jurisdiction (AHJs), and other key stakeholders.

Hydrogen Safety Panel

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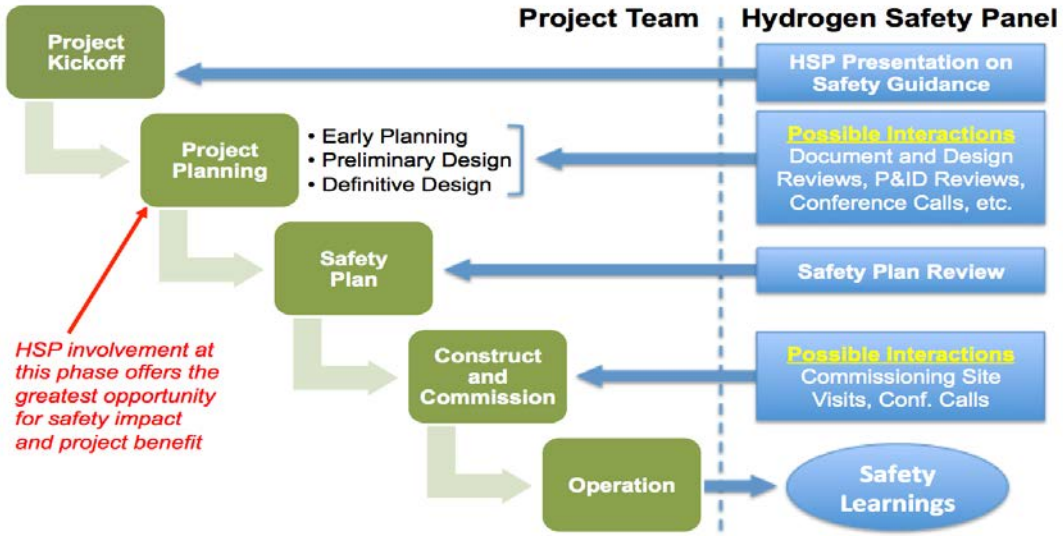
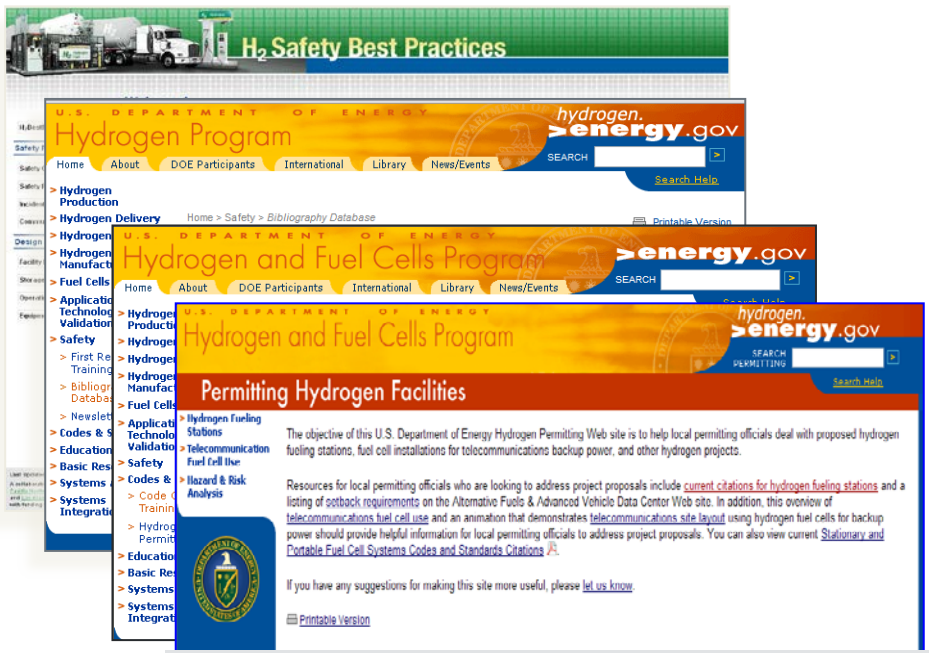
Earlier involvement by the HSP, managed by PNNL, offers great opportunity to impact projects



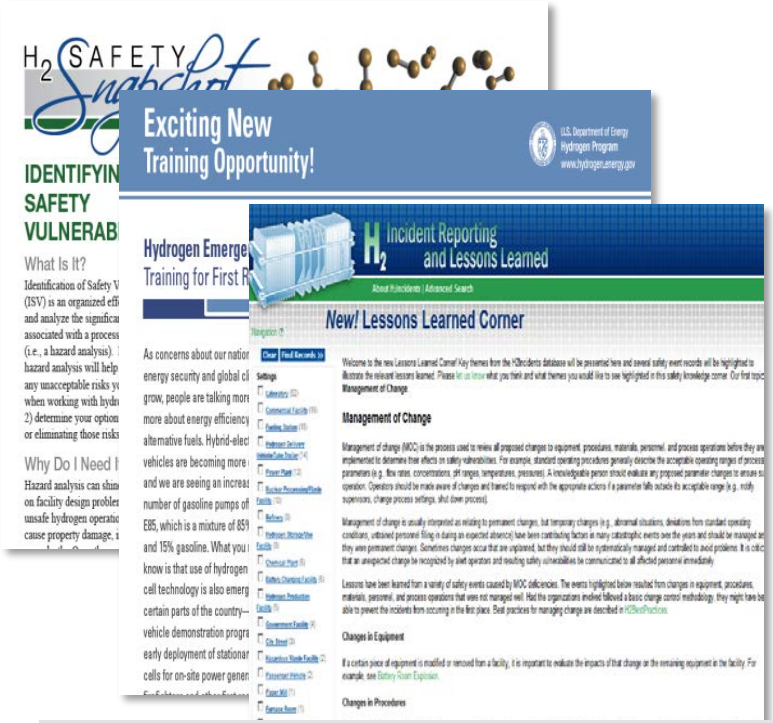
Authored a May/June 2014 *NFPA Journal*® article focusing on hydrogen safety which highlights the Hydrogen Safety Panel and DOE's Hydrogen Emergency Response Training for First Responders circulated to (70,000 individuals in 100 countries)

Activity	Since the 2013 AMR	Total for the Project Duration
Project Reviews (including safety plans, site visits reviewed, follow-up interviews and design review activities)	12 (includes 3 early project reviews)	395
Panel Meetings	2 (Washington, DC and Golden, CO)	20
White Papers & Recommendations (e.g., *Safety of Hydrogen Systems Installed in Outdoor Enclosures*)	1	7
Publications and Presentations (both projects combined total)	5	39

Safety Knowledge Resources



Hydrogen Safety Bibliographic Database
Permitting Hydrogen Facilities
Introduction to Hydrogen for Code Officials
Hydrogen Safety Best Practices Manual



H_2 Safety Snapshot bulletin
Introduction to Hydrogen Safety for First Responders
Hydrogen Incident Reporting Database

www.eere.energy.gov/hydrogenandfuelcells/codes/

SCS Training Totals and Impacts

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First responder training at PNNL is important to enable commercialization of fuel cell and hydrogen technologies

http://hydrogen.pnl.gov/FirstResponders/

- TOTAL First Responders Trained = 28,000+
- Emphasis within H2USA and the Market Support and Acceleration Working Group
- Works closely with the CaFCP to conduct training across California
- International Collaboration with FCH JU funded HyResponse project.

SCS Training Totals and Impacts

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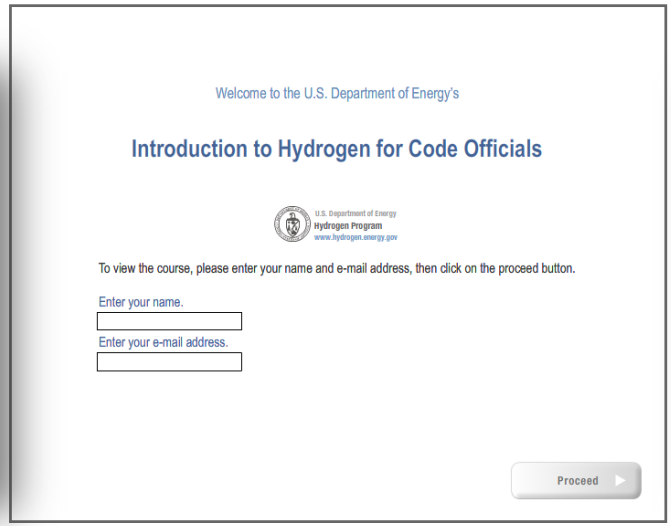
Code official training at NREL is an important outreach tool to enable commercialization of fuel cell and hydrogen technologies



http://www.hydrogen.energy.gov/training/code_official_training/

- TOTAL CODE OFFICIALS TRAINED = 1,200+
- Most recent training occurred on May 19th (Huntington Beach) and May 27th (Culver City) through the CEC and CaFCP
- Emphasis within H2USA and the Market Support and Acceleration Working Group

New Ways to Share Safety Knowledge

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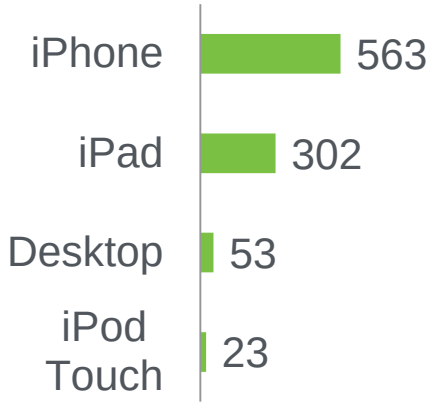
First mobile app developed for the Fuel Cell Technologies Office

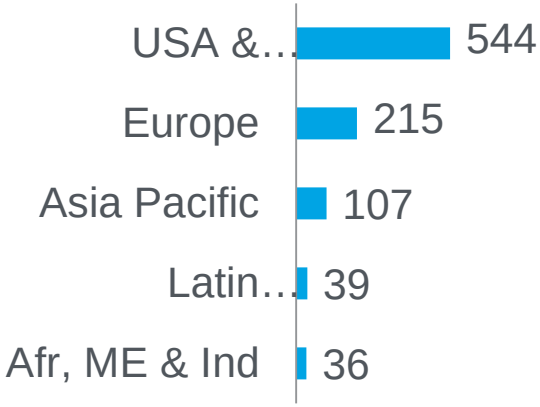
- Released in September 2013
- Integrates H_2incidents.org and H_2bestpractices.org into a single, searchable, iPad and iPhone application
- Features include safety planning guidance and checklists
- All tools (except H_2incidents.org) are available without a data connection

941
Downloads as of 05/2014

By Platform



By Territory



Hydrogen Tools

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A Transformative Step Towards Hydrogen Adoption

CENTRALIZED LOCATION — organizes current H_2 resources in one robust location—including **more than 20** existing tools, with plans for adding future content

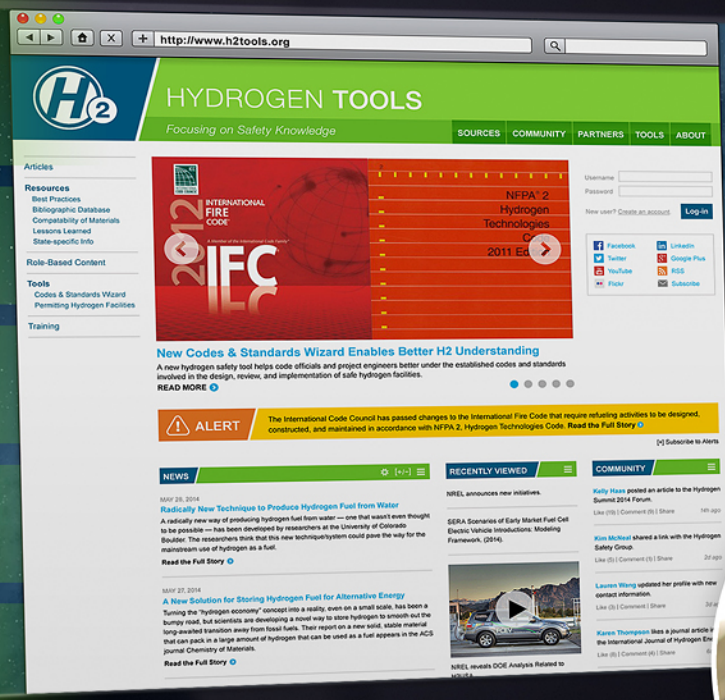
FOCUSED CONTENT — tailored to the specialized needs of H_2 user groups

CUSTOMIZABLE INTERFACE — allows content to display based on the H_2 user's role or interests

RESPONSIVE DESIGN — enables H_2 safety work across both desktop and mobile devices

TRUSTED COMMUNITIES — fostered through social networking around H_2 subject matter expertise

EXPANDABLE FORMAT — built with frequently requested future feature sets in mind



› **Credible** and **reliable** safety information from a **trustworthy** source

SCS Outreach (Webinars, Key reports, Workshop, etc)

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Webinars

1st Bilateral International Webinar – Jointly between U.S. and E.C. (in conjunction w/ICHS5)
What Can We Learn From Hydrogen Safety Event Databases? (Sept 10, 2013)
http://energy.gov/eere/fuelcells/downloads/what-can-we-learn-hydrogen-safety-event-databases

Hydrogen Compatibility of Materials (August 13, 2013)
http://energy.gov/eere/fuelcells/downloads/hydrogen-compatibility-materials

Key Reports

Polymers for Hydrogen Infrastructure and Vehicle Fuel Systems: Applications, Properties, and Gap Analysis (Sandia National Laboratory) – October 2013 (w/Delivery Program)

Rachael Barth, Kevin Simmons (PNNL), and Chris San Marchi

Safety, Codes and Standards for Hydrogen Installations: Hydrogen Fueling System Footprint Metric Development (Sandia National Laboratory) – April 2014

Aaron Harris, Daniel Dedrick, Chris LaFluer, and Chris San Marchi

Workshop

Hydrogen Quantitative Risk Assessment Workshop – co-hosted by SNL and IA HySafe

June 11-12, 2013 in Washington, D.C.

hySafe INTERNATIONAL ASSOCIATION FOR HYDROGEN SAFETY

Recent and Upcoming Activities

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Summary of activities and upcoming milestones

- Define the impact of fast fueling (SAE standard J2601) on hydrogen station requirements.
- Quantify the impact of liquid hydrogen release to help define reduced separation distances outlined in NFPA 2/55 from the current requirement of 75 feet from vents/openings.
- Develop a hydrogen fueling station template that includes the safety codes necessary for widespread commercialization of infrastructure
- Coordinate with State of California (CEC) to accelerate station deployment
- Determine fuel purity requirements and the impact of cleaners/degreasers for hydrogen components

FY 2014 | **FY 2015** | **FY 2016**

2Q 2014: Publishing of SAE J2601 *Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles*

1Q 2015: Publication of Codes and Standards, Safety peer-reviewed article to the International Journal of Hydrogen Energy

NFPA 2 adopted into the International Fire Code

1Q 2016: 6th Annual International Conference on Hydrogen Safety held in Japan

1Q 20162: 2nd Edition of NFPA 2 *Hydrogen Technologies Code published*

2Q 2016: United States adoption of Global Technical Regulation as the Federal Motor Vehicle Safety Standard (FMVSS).

Collaborations

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Safety, Codes and Standards

External Input

- Annual Merit Review & Peer Evaluation
- H_2 & Fuel Cell Technical Advisory Committee
- National Academies, GAO, etc.

International

- International Partnership for Hydrogen & Fuel Cells in the Economy
  - 17 countries & EC, 30 projects
- Independent Projects (EU, Japan, Korea, etc)

Federal Agencies

DOT NASA

- *Interagency coordination through staff-level Interagency Working Group (meets monthly)*
- *Assistant Secretary-level Interagency Task Force mandated by EPACT 2005.*

State & Regional Partnerships

- California Fuel Cell Partnership
- California Stationary Fuel Cell Collaborative
- SC H_2 & Fuel Cell Alliance
- Upper Midwest Hydrogen Initiative
- Ohio Fuel Coalition
- Connecticut Center for Advanced Technology

Industry Partnerships & Stakeholder Assn's.

- Tech Teams (USCAR, energy companies- U.S. DRIVE) – GM, Ford, DOT, CaFCP, Exxon
- Fuel Cell and Hydrogen Energy Association (FCHEA)
- H2USA
- Various CDOs & SDOs (SAE, NFPA, ISO, CSA, ICC, etc)

National Laboratories

Lawrence Livermore
Los Alamos
NREL
Oak Ridge
Pacific Northwest
Sandia
Savannah River

Contacts:

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http://energy.gov/eere/fuelcells/fuel-cell-technologies-office