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Hydrogen Safety Panel and Hydrogen Safety Knowledge Tools

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Hydrogen Program Annual Merit Review and Peer Evaluation Meeting
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SCS019

PNNL Hydrogen Safety Program

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Hydrogen Safety Panel

- Identify Safety-Related Technical Data Gaps
- Review Safety Plans and Project Designs
- Perform Safety Evaluation Site Visits
- Provide Technical Oversight for Other Program Areas

Safety Knowledge Tools

- H_2incidents.org
- H_2bestpractices.org
- Hydrogen Tools Mobile Application

Hydrogen Safety Training

- Hydrogen Emergency Response Training for First Responders
- Maintain Live-Fire Burn Prop

International Collaborations

- IEA HIA Task 31 Experts Group
- IAHySafe Member

Overview

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Timeline

- First Panel meeting: December 11, 2003
- Continuing

Budget

- Funding received in FY12 = $625K
  - Hydrogen Safety Panel: $500K
  - Safety Knowledge Tools: $125K
- Planned funding for FY13 = $500K
  - Hydrogen Safety Panel: $450K
  - Safety Knowledge Tools: $50K

Barriers addressed[1]

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

G. Insufficient technical data to revise standards

Partners

- Panel member organizations

[1]Technical Plan – Hydrogen Safety, Codes and Standards, Section 3.7, Multi-Year Research, Development and Demonstration Plan, July 2012.

Hydrogen Safety Panel/Vision

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Safety practices, incorporating a wealth of historical experience with new knowledge and insights gained, are in place. Continuous and priority attention is being given to safety in all aspects of hydrogen and fuel cell technologies: research, development and demonstration; design and manufacturing; deployment and operations.

Name	Affiliation
Nick Barilo, Program Manager*	Pacific Northwest National Laboratory
Bill Fort, Chair	Consultant
Addison Bain	Consultant
David Farese	Air Products and Chemicals
Larry Fluer*	Fluer, Inc.
Donald Frikken	Becht Engineering
Aaron Harris	Sandia National Laboratories
Richard Kallman*	City of Santa Fe Springs, CA
Miguel Maes	NASA-JSC White Sands Test Facility
Glenn Scheffler	GWS Solutions of Tolland
Andrew J. Sherman	Mescoat Inc.
Ian Sutherland	General Motors R&D
Steven Weiner*	Pacific Northwest National Laboratory
Robert Zalosh	Firexplo

* Changes in Panel membership/responsibility

Objectives

Hydrogen Safety Panel (HSP)

- Provide expertise and recommendations to DOE and assist with identifying safety-related technical data gaps, best practices and lessons learned.
- Help DOE integrate safety planning into funded projects to ensure that all projects address and incorporate hydrogen and related safety practices.

Safety Knowledge Tools

- 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.
- Capture vast and growing knowledge base of hydrogen experience and make it publicly available to the “hydrogen community” and stakeholders.

Approach

Priority attention to safety and enhanced visibility

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- Ensuring project safety
  - Conduct ongoing safety assessments of DOE projects through safety plan reviews and site visits
  - Utilize Panel expertise to develop and maintain safety guidance tools; address technical safety gaps and make recommendations to DOE
- Hydrogen Safety Panel Meetings
  - Utilize meetings to engage other hydrogen and fuel cell technology stakeholders
- Safety Knowledge Tools
  - Use multiple approaches for new safety event records and best practices content
  - Bring greater visibility to the safety knowledge tools

Accomplishments: Hydrogen Safety Panel

Accomplishments Since FY12 AMR
Hydrogen Safety Panel

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- Completed ARRA work and issued final report, "Hydrogen Safety Panel Review of Fuel Cell Projects"
  - Industrial trucks (refueling and operations)
  - Backup power
  - Hydrogen safety checklist (outdoor storage for indoor use)
- Contributed to Hawaii Natural Energy Institute (HNEI) hydrogen production and fuel station projects
  - Piping and instrumentation diagram review
  - Onsite detailed design reviews
  - Reviewed HNEI's certification study
- Contributed to IEA Hydrogen Implementing Agreement Task 31
  - Lead Knowledge Analysis, Dissemination and Use subtask
  - Authored "Advancing the Hydrogen Safety Knowledge Base"
  - Contributed to Hydrogen Safety Stakeholder Workshop

Accomplishments

Learnings from fuel cell deployment reviews

- Project Integration
  - A thorough and integrated approach to project safety planning needs to involve all parties.
- Hazard Analysis
  - Safety vulnerability analysis needs to comprehensively consider all potential incident scenarios introduced by hydrogen/fuel cell deployment and equipment operations and exposures.
- Requirements
  - Practices in technology development phases don't necessarily translate to safe or code compliant configurations for deployment.
  - Safety issues associated with the modular design approach for refueling equipment need to be better understood by both manufacturers and code developers for safe and economical deployments.
- Certification
  - The role and scope of third-party certification of hydrogen and fuel cell systems need to be clarified to facilitate their commercialization.
    - What is covered and do certifications support or replace AHJ approval?

Accomplishments
What have we learned about our review process

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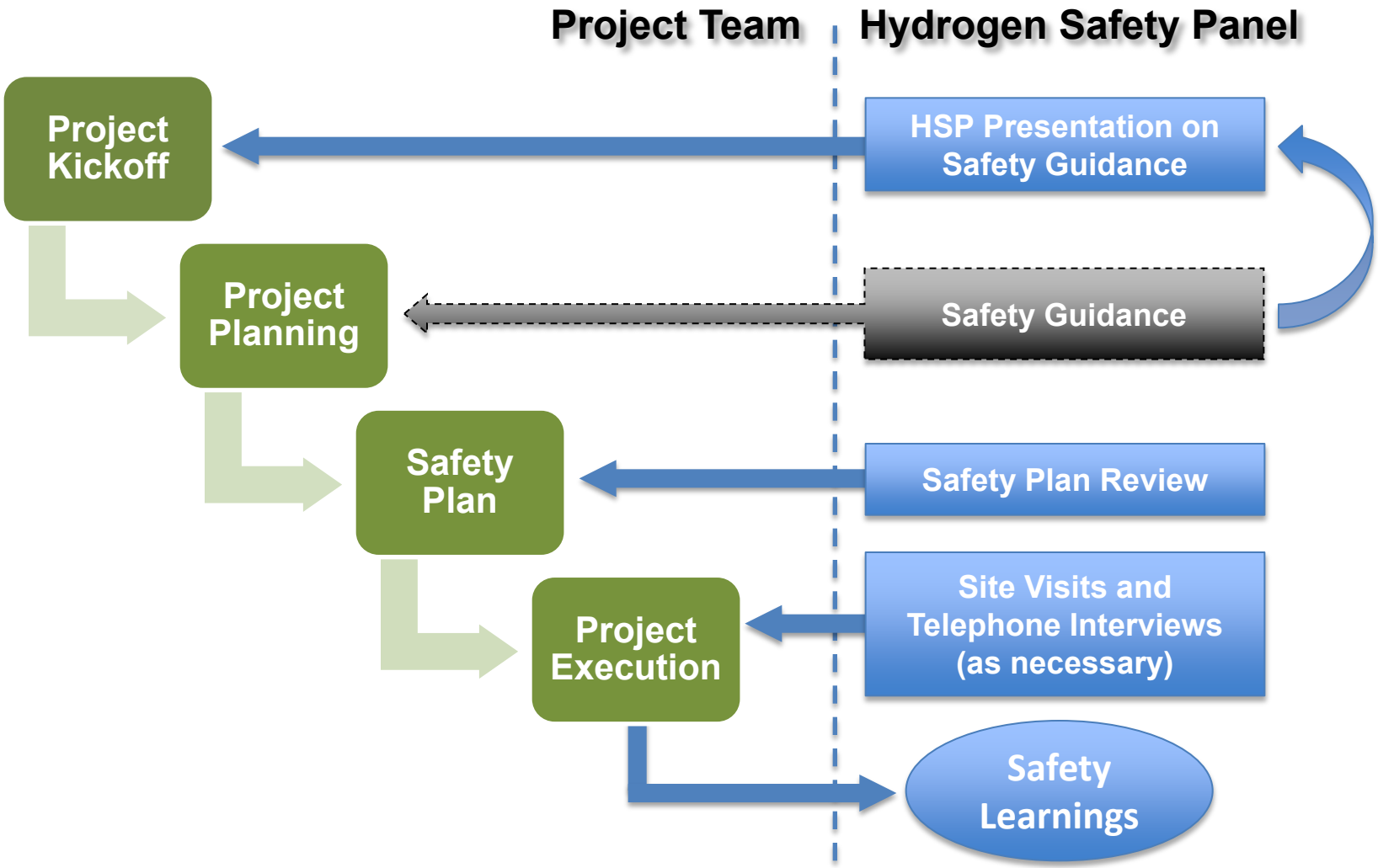
Deployment projects require a new review approach…

- **Timing for HSP involvement affects the benefit**
  - HSP review and site visits were provided after equipment was operational
  - It is difficult and costly to implement recommendations affecting equipment and configuration
  - Projects resist input when it occurs after the completion of design or construction activities
- **Benefits of early involvement realized in four HNEI projects:**
  - Helped the projects understand and evaluate the safety issues and code requirements
  - Significant design changes were made based on input from the HSP
  - Project management and stakeholders have greater confidence in approving the final configuration

"I believe getting the HSP involved early in the project contributes to a much safer outcome by putting many sets of highly qualified eyes on the project. In fact it would have been useful to get the HSP involved even earlier in the design process - perhaps at the preliminary design review." Mitch Ewan, HNEI

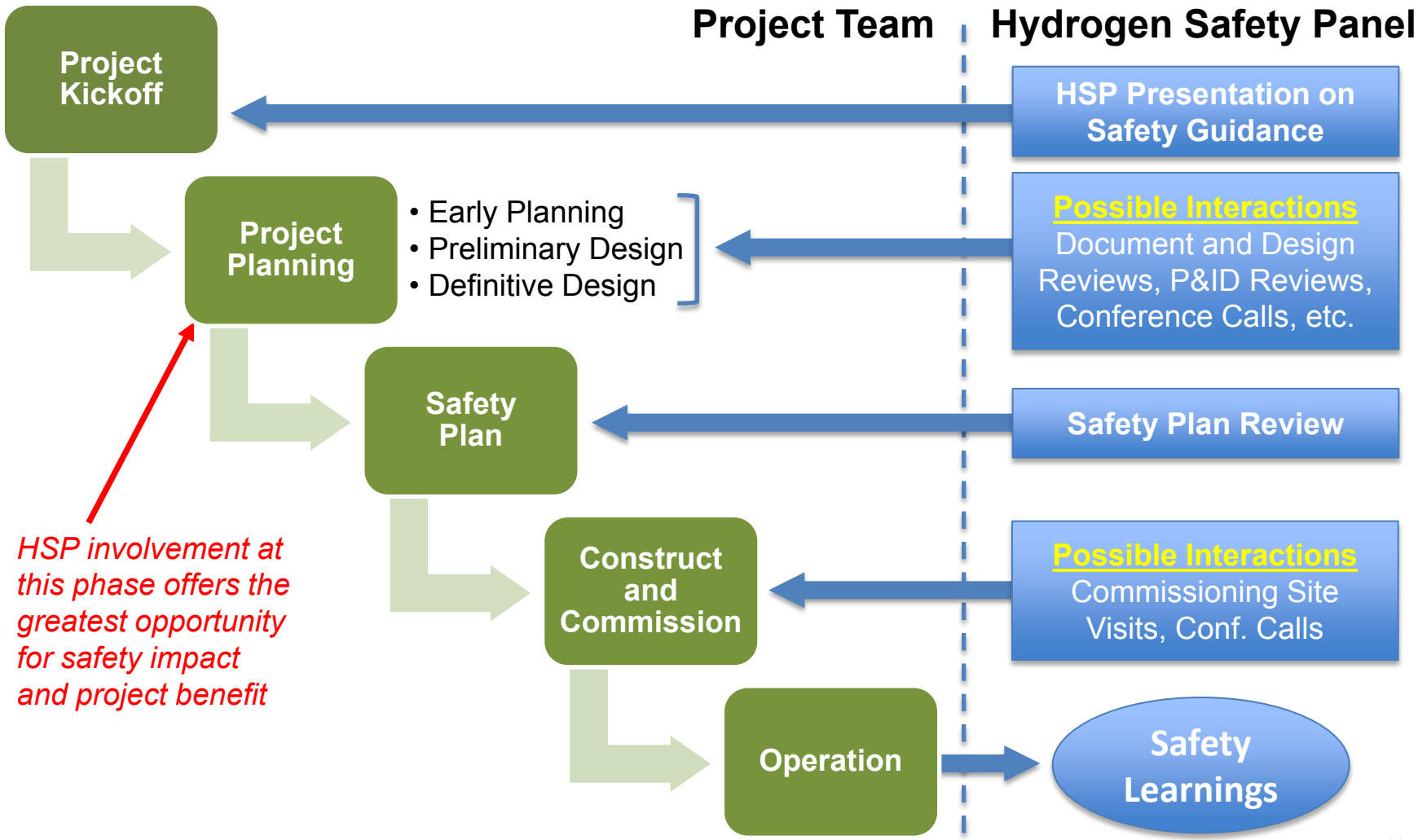
Hydrogen Safety Panel

Reviews for development projects



Hydrogen Safety Panel

Reviews for deployment projects



18th Hydrogen Safety Panel Meeting
Honolulu, HI, February 4-7, 2013

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- Focused Attention on Hydrogen Safety
  - The concurrent timing of the HSP meeting, first responder training and visits to other facilities was beneficial for bringing focused attention to hydrogen and fuel cell technologies in Hawaii
- Stakeholder/AHJ Interaction
  - A first-of-its-kind Panel meeting with local stakeholders and AHJs discussed commercial deployment of hydrogen technologies and future energy landscape in Hawaii. Outcome: initiative to create a local hydrogen stakeholder network
- Visit to the HNEI Hawaii Sustainable Energy Research Facility
  - Informal tour and discussion regarding safety practices resulted in their consideration of several laboratory and equipment enhancements
- Panel Addressing Technical Gaps
  - Third party certification of hydrogen and fuel cell equipment and systems
  - Cabinets, enclosures and containers used for hydrogen applications

Hydrogen Safety Panel Scorecard

- 325 safety plans reviewed
- 48 safety reviews conducted
- 18 Panel meetings held
  - *18th Meeting, Honolulu, HI, February 4-7, 2013*
- 16 follow-up interviews conducted
  - *>85% of safety review recommendations voluntarily completed or in progress*
- 6 “good example” safety plans provided
- 6 “white paper” recommendations submitted
- 3 incident investigations completed
- …and numerous contributions to the hydrogen safety literature

Proposed Future Work
Hydrogen Safety Panel

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- Remainder FY2013
  - Continue early project engagements and safety plan reviews
  - Continue Panel work on:
    - Third party certifications
    - Cabinets, enclosures and containers used for hydrogen applications
    - Input to the NFPA 2/55 committees
  - Manuscripts and presentations for the International Conference on Hydrogen Safety (ICHS)
- FY2014
  - Promote and ensure safety throughout the FCT project portfolio utilizing the early engagement approach
  - Utilize Panel resources to address safety knowledge gaps through white papers, recommendations to DOE, manuscripts, presentations and technical oversight of the Safety Knowledge Tools

Accomplishments: Safety Knowledge Tools

Accomplishments

Discovering New Ways to Share Safety Knowledge

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- **First mobile app being developed for the Fuel Cell Technologies Office**
  - 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
- **New safety knowledge content**
  - 6 safety events added to H_2incidents.org (207 total)
  - H_2bestpractices.org updated to include the safety checklist developed by the HSP

Accomplishments

Reaching out with Safety Knowledge Tools

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H_2incidents.org

Year	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
2012	19,635	2,347

H_2bestpractices.org

Year	Visitors	Max Visitors in 1 month
2008	703	93
2009	1,029	113
2010	1,373	166
2011	1,373	167
2012	1,658	188

Total Visits for 2012

- H_2incidents.org - 28,684
- H_2bestpractices.org - 5,009

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.

Proposed Future Work

Focusing on visibility and integration

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- Remainder FY2013
  - Release the iPad and iPhone mobile app to the Apple App Store
  - Participate in DOE proposed webinars on safety knowledge tools
  - Perform website maintenance to address technical and security issues
  - Present "Deployment of Hydrogen Fuel Cells – Safety Considerations and Resources" at the National Fire Protection Association Conference and Expo
- FY2014
  - Add new records to H_2incidents.org
  - Add new modules to mobile app (training tools, permitting tool, bibliography, etc.)
  - Deploy the mobile app on Android devices
  - Combine H_2incidents.org and H_2bestpractices.org into one website with additional features

Collaborations
Hydrogen Safety Panel and Safety Knowledge Tools

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- International Energy Agency Hydrogen Implementing Agreement Task 31 (Hydrogen Safety)
  - Barilo, Weiner, Farese and Fort contributed to the Hydrogen Safety Stakeholder Workshop in Bethesda, MD, in October 2012
  - Weiner lead author for, “Advancing the Hydrogen Safety Knowledge Base”
- International Conference on Hydrogen Safety (ICHS)
- Hawaii Natural Energy Institute (18th Hydrogen Safety Panel meeting)
- Forix, LLC (mobile application developer)
- NFPA Conference and Expo

Summary

Hydrogen Safety Panel

- Safety planning is a critical step!
- The HSP's early engagement of projects can be beneficial for the safe deployment of these technologies
- Learnings from the Panel's specific project involvement can benefit the FCT program more broadly
- Additional Panel meetings (two per year) allow engagement with local developers, users and other stakeholders

Safety Knowledge Tools

- New and improved tools warrant increased DOE investment
  - Reaching out to new stakeholders and users is essential for enabling a safe transition to commercialization of hydrogen and fuel cell technologies
  - To remain vital and useful, databases and websites require a concerted effort beyond general maintenance. The content must be current, relevant to the community being served and valuable to the user.
- The mobile application offers a platform for bringing a variety of hydrogen tools to the public

"I think that the industry should regard the HSP as a very valuable knowledge resource and not as a hindrance or something that has to be endured to "check off a box". I also recommend the HSP be given a much higher profile in the program and be adequately funded to be able to execute its mandate." Mitch Ewan, HNEI

Thank you

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- U.S. Department of Energy
  - Fuel Cell Technologies Office (Sunita Satyapal, Program Manager; Ned Stetson, Antonio Ruiz, Nha Nguyen and Will James, Safety Codes and Standards Team)
- All of my colleagues at Pacific Northwest National Laboratory, the Hydrogen Safety Panel and other collaborators