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## VII.1 Safety, Codes and Standards Sub-Program Overview

### Introduction

The Safety, Codes and Standards sub-program assesses current practices and the status of technical standards development efforts, both nationally and internationally. It develops and implements the practices and procedures that will ensure safety in the operation, handling and use of hydrogen and hydrogen systems for all DOE-funded Hydrogen Program projects. It also facilitates the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications. Development of codes and standards also requires coordination of activities across government agencies (i.e., Department of Transportation and state government agencies), associations, corporate stakeholders, international stakeholders, and standards and code development organizations.

The safety activity involves a large degree of external stakeholder input. Expertise is gathered from hydrogen manufacturers, the energy industry, the insurance industry, fire protection, academia, aerospace, and others to provide the widest range of perspectives on safety possible. Input is obtained through involvement in a variety of activities, as detailed under the Technology Status section.

Communication is also a principal emphasis for maximizing the impact of all safety activities. All of the data and information obtained (of a non-confidential nature) through the safety activity are made widely available through public presentations and the release of a Best Practices Manual scheduled for 2008. Safety information materials aiming to enhance the knowledge of emergency responders and local authorities having jurisdiction are made available through various media to the greatest number of recipients possible. In addition, all planning efforts supporting future activities are conducted through open workshops to ensure the engagement of interested stakeholders.

### Goals

- Perform underlying research to enable codes and standards to be developed for the safe use of hydrogen in all applications. Facilitate the development and harmonization of international codes and standards.
- Develop and implement the practices and procedures that will ensure safety in the operation, handling and use of hydrogen and hydrogen systems for all DOE projects and utilize these practices and lessons learned to promote the safe use of hydrogen.

### Objectives

- Starting in 2004, integrate safety procedures into new DOE projects to ensure that they all incorporate hydrogen safety requirements.
- By 2007, develop a comprehensive safety plan in collaboration with industry that establishes Program safety policy and guidelines. DOE will utilize the Hydrogen Safety Panel's expertise and assistance in conducting safety evaluations and identifying areas of additional research.
- Develop a supporting research and development program to provide critical hydrogen behavior data and leak detection technologies. This data will support the establishment of setback distances in building codes.
- By 2007, facilitate the adoption of the most recently available model codes (e.g., International Code Council) in key regions; complete research and development on hydrogen release scenarios; and provide a sound basis for model code development and adoption.
- By 2007, support and facilitate the completion of the International Standards Organization specifications for gaseous hydrogen refueling (TS 20012) and standards for on-board liquid- (ISO 13985) and gaseous- or gaseous blend- (ISO 15869) hydrogen storage.
- By 2008, publish a hydrogen safety Best Practices Manual. The Manual will be a "living" document that will provide guidance for ensuring safety in DOE hydrogen projects, while serving as a model for all hydrogen projects and applications.

- Promote widespread sharing of safety-related information, procedures and lessons learned to first responders, authorities with jurisdiction and other stakeholders.
- By 2008, support and facilitate the drafting of the Hydrogen Technologies Code by the National Fire Protection Association (NFPA 2).
- By 2008, support and facilitate the completion of standards for bulk hydrogen storage (e.g., NFPA 55) with experimental data and input from Technology Validation Program element activities.
- By 2010, support and facilitate development of Global Technical Regulations for hydrogen vehicle systems under the United Nations Economic Commission for Europe, World Forum for Harmonization of Vehicle Regulations, and Working Party on Pollution and Energy Program (ECE-WP29/GRPE).
- By 2015, complete necessary codes and standards that support the commercialization of hydrogen technologies.

### FY 2006 Technology Status

The sub-program utilizes the expertise of the Pacific Northwest National Laboratory (PNNL) and its Hydrogen Safety Panel to evaluate the safety plans and practices of DOE-funded projects against a Panel-developed protocol. This activity provides suggestions on safety improvements and “lessons learned” that can be of broad benefit to the DOE Hydrogen Program. The Panel, its services, and its work products are assets to funded project teams who perform their own risk assessment and mitigation planning and are responsible for their own safe operating practices. In this manner, PNNL and its Panel help to disseminate hydrogen safety best practices throughout the DOE Hydrogen Program.

To help fill the void of publicly available hydrogen safety data, the sub-program has developed and published three online hydrogen safety information resources: the Hydrogen Incidents Database, the Safety Bibliographic Database, and a Technical Reference for Hydrogen Compatibility of Materials. The Hydrogen Incidents Database, developed by PNNL, catalogs all hydrogen incidents and near-misses at DOE-funded projects and elsewhere. This resource is available at <http://www.h2incidents.org>. The Safety Bibliographic Database, developed by the National Renewable Energy Laboratory, was established in response to a recommendation from the National Research Council.<sup>1</sup> The Safety Bibliographic Database contains over 400 publicly available hydrogen safety-related reports, papers, and presentations, allowing researchers, code officials, stakeholders to learn from others’ experiences, and is available at [http://www.hydrogen.energy.gov/biblio\\_database.html](http://www.hydrogen.energy.gov/biblio_database.html). The Technical Reference, developed by Sandia National Laboratory, contains a compilation of hydrogen-compatible materials and properties, which is available at <http://www.ca.sandia.gov/matlsTechRef/>.

Internationally, the sub-program has been involved in a number of activities that span both codes & standards and safety. DOE provides support for the International Partnership for a Hydrogen Economy (IPHE) and the International Energy Agency (IEA), both of which have been engaged in hydrogen safety work. In addition, through the Los Alamos National Laboratory, DOE continues to work with the Department of Transportation to support their role as U.S. representative to the UN GTR process.

### FY 2006 Accomplishments

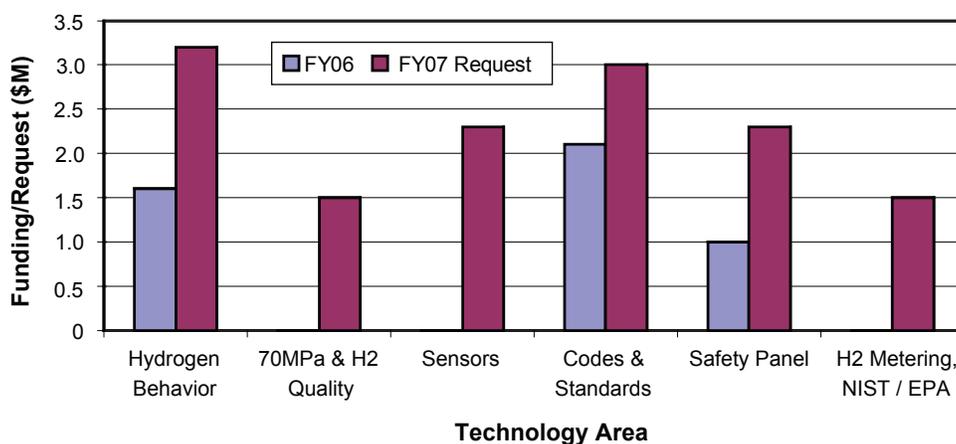
- The Hydrogen Safety Panel (11 members plus two direct support staff) held two Panel meetings, reviewed 60 safety plans, and conducted five site visits and telephone interviews.
- Engaged stakeholders in a Risk Assessment Workshop to identify risk assessment tools and data requirements, and to assess the viability of risk assessment work to support the code development process.
- Completed hydrogen effects on materials studies and published results on 10 of 15 materials classes; results are available at <http://www.ca.sandia.gov/matlsTechRef/>.
- Continued planning activities for R&D to support development of a hydrogen quality specification.

<sup>1</sup> National Research Council. *Review of the Research Program of the FreedomCAR and Fuel Partnership*. Washington, D.C.: The National Academies Press. 2005. p. 39.

- Developed safety information materials for emergency responders and authorities having jurisdiction with the Education subprogram and industry groups.
- Established a searchable, online Hydrogen Incidents Database ([www.h2incidents.org](http://www.h2incidents.org)) to catalog hydrogen related incidents (without attribution), including causes, severity, lessons learned and corrective action.
- Established an online Hydrogen Safety Bibliographic Database ([www.hydrogen.energy.gov/biblio\\_database.html](http://www.hydrogen.energy.gov/biblio_database.html)) with over 400 references to hydrogen safety related publications. All of the entries include abstracts and many are downloadable from the website.

## Budget

Work plans for FY 2006 were significantly curtailed due to budget constraints. The budget request for FY 2007 represents increased funding for all activities, allowing the restart of hydrogen sensor R&D; hydrogen behavior, hydrogen quality and risk assessment R&D that supports the codes and standards development process; and increased support for training and safety assurance.



## FY 2007 Plans

In FY 2007, the Hydrogen Safety Panel activity plans to conduct a total of 20-30 project reviews, including safety plan reviews for new project starts and site visits. The Safety Panel will also participate in guiding the development of a hydrogen safety Best Practices Manual to be published in 2008.

Continued development of a safety information program to aid in the training of first responders and authorities with jurisdiction will be sponsored by the Education sub-program, with training aids (“props”) sponsored by the Safety, Codes and Standards sub-program. Widespread sharing of data and information related to hydrogen safety will be continued through industry participation, publications, and a hydrogen safety Best Practices Manual. The hydrogen safety Best Practices website is expected to make its initial public debut early next fiscal year and will regularly compile safety-related information for the hydrogen community. A risk communication strategy will also be developed to guide officials on effective ways to communicate hydrogen risk information to the public in order to build and maintain public trust.

The hydrogen incidents database will be updated and maintained in FY 2007 to promote hydrogen safety through publishing details of hydrogen incidents and “lessons learned.” Future enhancements to the H2Incidents.org website will include graphical trend tools for displaying and reporting information. Cooperation with the European HySafe safety incidents database is also planned, as well as coordination with code organizations and other stakeholders. Establishment of a hydrogen incidents investigation team is planned; this team will be available to investigate hydrogen incidents and report on causes and lessons learned.

The Technical Reference for Hydrogen Compatibility of Materials is a living document that is evolving as data is collected from the literature and generated from materials testing. Sections on pressure vessel steels, pipeline steels and aluminum alloys will be added in the coming year. Additional content will be prioritized in cooperation with stakeholders (such as the American Society of Mechanical Engineers).

In FY 2007, the Codes and Standards effort will initiate R&D to support the development of a hydrogen quality standard. Working in cooperation with the Fuel Cell sub-program, this activity will initially focus on fuel cell hydrogen quality requirements. The sub-program will continue risk assessment activities and initiate component testing work that supports risk assessment and codes & standards development.



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