VIII.0 Safety, Codes & Standards Program Overview

INTRODUCTION

The Safety, Codes and Standards program identifies and performs high priority research and development (R&D) to provide an experimentally validated and fundamental understanding of the relevant physics, critical data, and safety information needed to define the requirements for technically sound and defensible codes and standards. In Fiscal Year (FY) 2013, the program continued to identify and evaluate safety and risk management measures that can be used to define the requirements and close the gaps in codes and standards in a timely manner.

Communication and collaboration among codes and standards stakeholders (e.g., government, industry, codes and standards development organizations, universities, and national laboratories) is emphasized in order to maximize the impact of the program's efforts and activities in harmonizing domestic and international regulations, codes, and standards (RCS).

Internationally, efforts continue through the testing activities of the Regulations, Codes and Standards Working Group (RCSWG) of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE). Domestically, the program utilizes the expertise of the Hydrogen Safety Panel (HSP) to disseminate relevant information and implement safe practices pertaining to the operation, handling, and use of hydrogen and fuel cell technologies. The HSP, with over 400 years of combined member experience in the hydrogen industry, provides recommendations on the safe conduct of project work as well as lessons learned and best practices that can be of broad benefit to the industry. The program continues to share current safety information and knowledge with the community.

In addition, extensive external stakeholder input—from the fire-protection community, academia, automobile manufacturers, and energy, insurance, and aerospace sectors—is used to create and enhance safety knowledge tools for emergency responders and authorities having jurisdiction. The program works to enable the continual availability of safety knowledge tools, distributed online or in-person in order to reach the largest number of personnel possible.

GOALS

The program's key goals are to provide the validated scientific and technical basis required for the development of codes and standards, to promulgate safety practices and procedures to allow for the safe deployment of hydrogen and fuel cell technologies, and to ensure that best safety practices are followed by Fuel Cell Technologies Office-funded projects.

OBJECTIVES[1]

The program's key objectives are to:

- Develop and validate test measurement protocols and methods to support and facilitate international harmonization of codes and standards for high-pressure tanks.
- Conduct materials R&D to provide the technical underpinning to enable fault-tolerant system designs for use with hydrogen infrastructure rollout by 2015.
- Conduct a quantitative risk assessment (QRA) study to address indoor refueling requirements to be adopted by code developing organizations (e.g., National Fire Protection Association [NFPA] and International Code Council [ICC]) by 2015.
- 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.
- Ensure that best safety practices underlie research, technology development, and market deployment activities supported through Office-funded projects.
- Develop and enable widespread sharing of safety-related information resources and lessons-learned with first responders, authorities having jurisdiction, and other key stakeholders.

[1] Note: Targets and milestones were recently revised; therefore, individual project progress reports may reference prior targets.

FY 2013 STATUS

The program continues to support R&D to provide the technical basis for codes and standards development, with projects in a wide range of areas including fuel specification, separation distances, materials and components compatibility, and hydrogen sensor technologies. Utilizing the results from these R&D activities, the program continues to actively participate in discussions with standards development organizations such as the NFPA, ICC, SAE International, the CSA Group, and the International Organization for Standardization (ISO) to promote domestic and international collaboration and harmonization of RCS.

The following websites provide additional, up-to-date information relevant to the status of the program's activities:

- Technical Reference for Hydrogen Compatibility of Materials (www.ca.sandia.gov/matlsTechRef/)
- Hydrogen Incident Reporting and Lessons Learned Database (www.h2incidents.org/)
- Hydrogen Bibliographic Database (www.hydrogen.energy.gov/biblio_database.html)
- Hydrogen Safety Best Practices Manual (www.h2bestpractices.org/)
- Hydrogen Safety Training for Researchers (www-training.llnl.gov/training/hc/HS5094DOEW/index.html)
- Introduction to Hydrogen for Code Officials (www.hydrogen.energy.gov/training/code_official_training/)
- Hydrogen Safety for First Responders (www.hydrogen.energy.gov/firstresponders.html)

FY 2013 KEY ACCOMPLISHMENTS

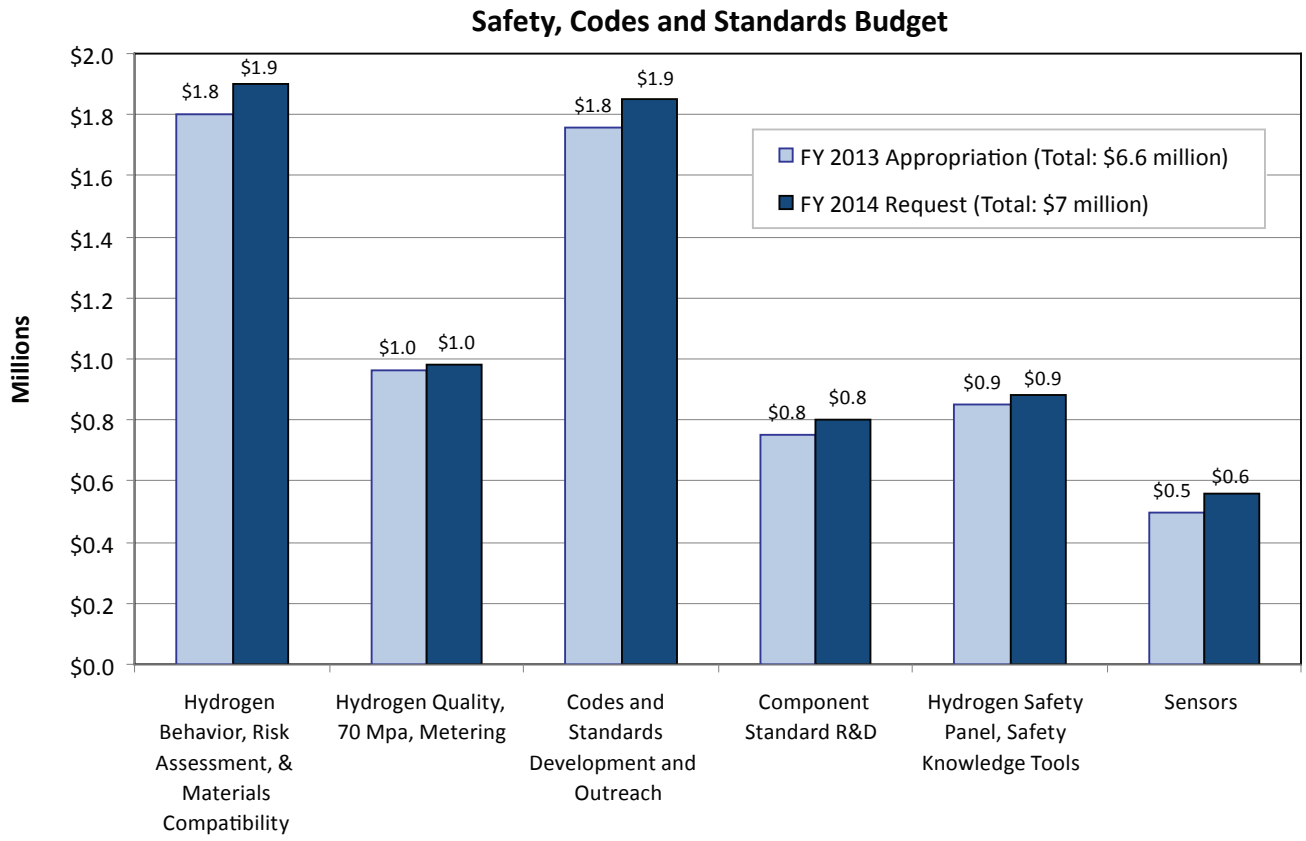
The program continued to make progress in several areas, including the following:

- International and Domestic Regulations, Codes, and Standards Harmonization
  - Submitted the Global Technical Regulation on hydrogen-fuelled vehicles to the United Nations Economic Commission for Europe Working Party 29 (UN ECE WP.29). Accepted in June 2013, this regulation was led by the U.S. Department of Transportation National Highway Transportation Safety Administration and will serve as the technical underpinning for the United States Federal Motor Vehicle Safety Standard.
  - Performed hydraulic cycle tests (up to 35 MPa) with the IPHE working group using a harmonized test measurement protocol which was established for consistent results independent of the test facility. Testing was conducted by the United States and China under the RCSWG and lessons learned were implemented in a revised test method protocol for a second tank, which will be completed in FY 2014.
  - Provided a science-based approach for the development of an ISO (14687-2) standard for hydrogen fuel quality, which was published by ISO in December 2012. This standard is now harmonized with the SAE International domestic standard on fuel quality (SAE J2719).
  - Supported the standardization of SAE J2579, *Standard for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles*, which was published by SAE in March of 2013.
- Hydrogen Behavior, Risk Assessment, and Materials Compatibility (Sandia National Laboratories [SNL])
  - Developed integrated algorithms for conducting QRA for gaseous hydrogen facilities and vehicles that are applied to identified risk drivers and associated consequences, including further reducing separation distances.
  - Identified ignition and jet light-up boundaries of jet flames for circular unintended releases with increased confidence and initiated a study on non-circular releases.
  - Updated *Technical Reference for Hydrogen Compatibility of Materials* (SAND2012-7321) and developed datasets for fatigue crack growth of materials in gaseous hydrogen.
- Hydrogen Quality (Los Alamos National Laboratory, LANL)
  - Determined that low-loaded anodes (0.03 mg-Pt/cm^2) have a ≈100 mV loss at 1 A/cm^2 when exposed to 100 ppm CO for 50 hours and ≈200 mV loss when exposed to 4 ppb of H_2S for 50 hours at steady state.
- Codes and Standards Development and Outreach (National Renewable Energy Laboratory, NREL)

  - Published a technical report *Regulations, Codes, and Standards (RCS) Template for California Hydrogen Dispensing Stations* to help the deployment and commercialization of hydrogen infrastructure.
  - Supported the referencing of the NFPA 2 Hydrogen Technologies Code chapter in the International Fire Code and Uniform Fire code in order to create a national hydrogen code.
- Component Testing (NREL)
  - Completed the validation testing of Hydrogen Pressure Relief Device 1 Phase, which includes modified test protocols that include worst case conditions during cycling tests.
- Hydrogen Safety Panel, Databases, Props, and First Responders (Pacific Northwest National Laboratory, PNNL)
  - Developed the first mobile app for the Fuel Cell Technologies Office with the following features:
    - Integrates H_2incidents.org and H_2bestpractices.org into a single, searchable, iPad and iPhone application.
    - Includes safety planning guidance and checklist features.
    - Access to all tools (except H_2incidents.org) available without a data connection.
  - Added six new safety event records from national laboratories, universities, and private-sector firms in the United States and other countries since the 2012 Annual Merit Review and Peer Evaluation Meeting, for a total of 207 records currently in the database.
  - Updated H_2bestpractices.org to include the safety checklist for outdoor storage with an indoor use, which was developed by the HSP.
  - Developed training material for first responders and code officials, bringing the total educated to over 25,000 first responders to date (online and in-person)
- Sensors
  - Developed, optimized, and characterized working electrode and electrolyte layers grown using electron beam (e-beam) evaporation methods, demonstrating a significant reduction in sensor manufacturing time that suggest decreases in projected manufacturing costs. (LANL and Lawrence Livermore National Laboratory)
  - Completed a review on the use of oxygen sensors to correlate changes in oxygen concentration to hydrogen levels, which are recommended in the current text of the Global Technical Regulation. (NREL)

BUDGET

The program received an appropriation of $6.6 million in FY 2013. This allowed for sustained progress in key R&D and codes and standards development work. The President's FY 2014 budget request includes $7.0 million for Safety, Codes and Standards, which will ensure continuity in key R&D and focus areas as shown below.



FY 2014 PLANS

The Safety, Codes and Standards program will continue to work with codes and standards organizations to develop technical information and performance data to enhance hydrogen-specific codes and standards. To address these needs, the program will continue to support a rigorous technical R&D program—including assessment of materials compatibility for component designs and high-pressure tank cycle testing—and continue to promote a QRA approach to identify risks and establish protocols to mitigate those risks. Future work will also focus on the permitting of hydrogen fueling stations and early market applications and testing, measurement, and verification of hydrogen fuel specifications.

The program will also continue to promote the domestic and international harmonization of test protocols for qualification and certification as well as the harmonization of RCS for hydrogen fuel quality and other key international standards. This will be enabled by working with the appropriate domestic and international organizations such as the NFPA, ICC, SAE International, CSA Standards, and the ISO. The program will also continue to participate in IPHE's Regulations, Codes and Standards Working Group and the International Energy Agency's Hydrogen Implementing Agreement, both of which are engaged in hydrogen safety work.

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