

---

## VIII.0 Safety, Codes & Standards Sub-Program Overview

### INTRODUCTION

The Safety, Codes and Standards sub-program supports research and development (R&D) to provide an experimentally validated fundamental understanding of the relevant physics, critical data, and safety information needed to define the requirements for technically sound and defensible codes and standards. This information is used to help facilitate and enable the widespread deployment and commercialization of hydrogen and fuel cell technologies. In Fiscal Year (FY) 2012, the sub-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.

The sub-program promotes collaboration among government, industry, codes and standards development organizations, universities, and national laboratories in an effort to harmonize regulations, codes, and standards (RCS), both internationally and domestically. Communication and collaboration among codes and standards stakeholders is emphasized in order to maximize the impact of the sub-program's efforts and activities in international RCS. The sub-program is leading a round-robin testing effort by the Regulations, Codes and Standards Working Group of the International Partnership for Hydrogen and Fuel Cells in the Economy, which aims to harmonize high-pressure tank-testing measurement protocols required for tank certification. In addition, in December 2011, a Global Technical Regulation on hydrogen-fueled vehicles was submitted to the United Nations Economic Commission for Europe Working Party 29 (UN ECE WP.29). This regulation will serve as the technical underpinning for the United States Federal Motor Vehicle Safety Standard.

The sub-program utilizes the expertise of the Hydrogen Safety Panel to disseminate relevant information and implement safe practices pertaining to the operation, handling, and use of hydrogen and fuel cell technologies in Program-funded projects. The Safety Panel 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 Program. The sub-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 sub-program has renewed its emphasis on ensuring the continual availability of safety knowledge tools, distributed via an array of media outlets to reach the largest number of safety personnel possible.

### GOALS

The sub-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 in Hydrogen and Fuel Cells Program activities.

### OBJECTIVES

The sub-program's key objectives are to:

- Facilitate the 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:

- Conduct R&D to provide critical data and information needed to define requirements in developing codes and standards.
- Develop and validate test-measurement protocols and methods to support and facilitate international harmonization of codes and standards for high-pressure tanks by 2013.
- Conduct materials R&D to provide the technical underpinning to enable fault-tolerant system designs in time to enable their use in the anticipated rollout of hydrogen fueling infrastructure in 2015.
- Conduct a quantitative risk assessment study to address indoor refueling requirements to be adopted by code developing organizations (e.g., National Fire Protection Association and International Code Council) by 2015.
- Develop safety-related information resources and lessons-learned and share these resources with first responders, authorities having jurisdiction, and other key stakeholders.
- Ensure that best safety practices are followed in all research, technology development, and market deployment activities supported by the Hydrogen and Fuel Cells Program.

## FY 2012 STATUS

The sub-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 sub-program continues to actively participate in discussions with standards development organizations such as the National Fire Protection Association, International Code Council, SAE International, CSA Group, and the International Organization for Standardization 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 sub-program's activities:

- Technical Reference for Hydrogen Compatibility of Materials ([www.ca.sandia.gov/matlsTechRef/](http://www.ca.sandia.gov/matlsTechRef/))
- Hydrogen Incident Reporting and Lessons Learned Database ([www.h2incidents.org/](http://www.h2incidents.org/))
- Hydrogen Bibliographic Database ([www.hydrogen.energy.gov/biblio\\_database.html](http://www.hydrogen.energy.gov/biblio_database.html))
- Hydrogen Safety Best Practices Manual ([www.h2bestpractices.org/](http://www.h2bestpractices.org/))
- Hydrogen Safety Training for Researchers (<https://www-training.llnl.gov/training/hc/HS5094DOEW/index.html>)
- Introduction to Hydrogen for Code Officials ([www.hydrogen.energy.gov/training/code\\_official\\_training/](http://www.hydrogen.energy.gov/training/code_official_training/))
- Hydrogen Safety for First Responders ([www.hydrogen.energy.gov/firstresponders.html](http://www.hydrogen.energy.gov/firstresponders.html))

## FY 2012 KEY ACCOMPLISHMENTS

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

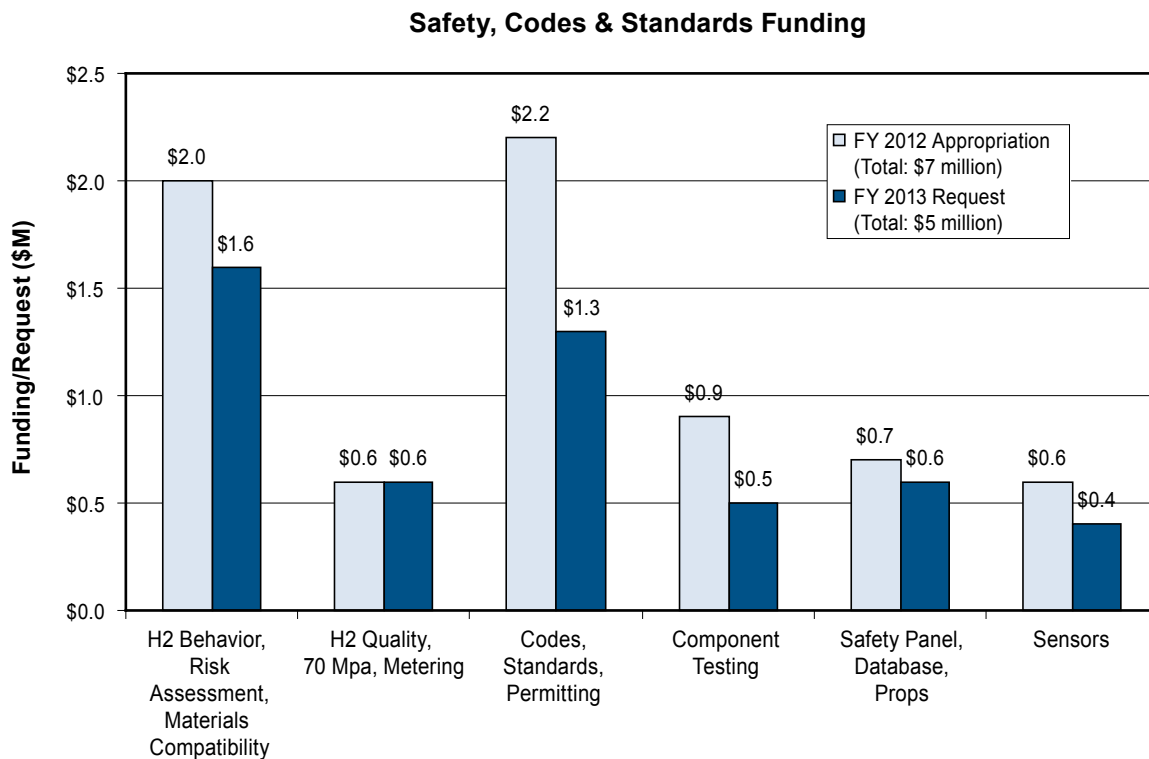
- *Hydrogen Behavior, Risk Assessment, and Materials Compatibility* (Sandia National Laboratories):
  - Published compressed-hydrogen materials compatibility (CHMC) testing and data application standard, CSA CHMC 1 Part 1, in May 2012.
  - Developed accelerated test methods for measurement of hydrogen-assisted fatigue crack growth; this accelerated test greatly reduces the cost barriers that prevent qualification of new materials in hydrogen service.
  - Compressed Hydrogen Powered Industrial Truck (HPIT) component standard, CSA HPIT 1, completed in September 2011; this standard will be the first to allow the development of design criteria for components for hydrogen storage systems.

- Developed test methods for evaluating the effectiveness of stainless steel welds in a hydrogen environment; this test methodology leverages past test methods and identifies methods for evaluating the hydrogen resistance of materials under actual use conditions, such as welding.
- Developed a method to measure flame light-up probability, which will be used to determine the overall hazard classification of a hydrogen release.
- *Hydrogen Quality* (Los Alamos National Laboratory):
  - Determined that an anode loading of 0.05 mg Pt/cm<sup>2</sup> can tolerate a CO concentration of at least 75 ppb and 100 ppb at 60°C and 80°C respectively.
  - Completed the validation of ASTM D7653-10-*Determination of Trace Gaseous Contaminants in Hydrogen Fuel by Fourier Transform Infrared (FTIR) Spectroscopy* for both ammonia (NH<sub>3</sub>) and water (H<sub>2</sub>O).
- *Coordination of Codes and Standards Development, Domestic and International* (National Renewable Energy Laboratory, NREL):
  - Developed a permit template for hydrogen dispensing stations, which will be used in California as the permitting template for hydrogen dispensing stations and will contain the basic codes and standards requirements, including those related to the California Risk Management Plan requirements.
  - Developed a fact sheet summarizing the requirements for siting stationary fuel cells and the associated hydrogen storage systems.
  - Developed and began implementing a plan for identifying and supporting the development of the codes and standards required for a wider deployment of hydrogen and fuel cell technologies, with a particular emphasis on fuel cell electric vehicles, by the year 2020.
- *Component Testing* (NREL):
  - Completed the validation testing of Hydrogen Pressure Relief Device 1 phase 1. Results were utilized to modify test protocols in order to provide a more representative set of worst case conditions during cycle testing.
- *Hydrogen Safety Panel, Databases, Props, and First Responders* (Pacific Northwest National Laboratory):
  - The Hydrogen Safety Panel reviewed 11 safety plans for projects in fuel cell and hydrogen storage R&D—results of these safety evaluations indicate that over 90% of report recommendations have been accepted.
  - Added 12 new safety event records from national laboratories, universities, and private-sector firms in the U.S. and other countries since the 2011 Annual Merit Review and Peer Evaluation Meeting, for a total of 206 records currently in the database.
  - Added 30 new links between safety event records and best practices databases.
  - Conducted two fire training classes at the Los Angeles City and County Fire Department, with approximately 300 first responders attending.
  - Received 200–300 unique visits per month through the Web-based first responders’ training awareness course; the course is registered on the TRAIN (Training-finder Real-time Affiliate Integrated Network) website, for broader dissemination to first responders (TRAIN is a central repository for public health training courses, and nearly 30,000 TRAIN users identify themselves as emergency responders.)
- *Hydrogen Sensors*:
  - Measured sensor long-term durability over a one-year period using 2% hydrogen exposures in a newly built long-term exposure chamber with environmental controls (NREL).

- Developed a more advanced sensor platform, with input from an industrial partner, to provide temperature-control capabilities for a low-cost, durable, and reliable hydrogen safety sensor (Los Alamos National Laboratory and Lawrence Livermore National Laboratory).

## BUDGET

The sub-program received an appropriation of \$7.0 million in FY 2012. This allowed for sustained progress in key R&D and codes and standards development work. The President's FY 2013 budget request includes \$5.0 million for Safety, Codes and Standards, which will ensure continuity in key R&D and focus areas as shown below.



## FY 2013 PLANS

The Safety, Codes and Standards sub-program will continue to work with codes and standards organizations to identify and address needs for the development of new hydrogen-specific codes and standards. To address these needs, the sub-program will continue to support its rigorous technical R&D program—including assessment of materials compatibility for component designs and high-pressure tank cycle testing—and continue to promote a quantitative risk assessment approach to ensure the development of technically sound codes and standards. The sub-program will also continue to promote the domestic and international harmonization of RCS by working with the appropriate domestic and international organizations such as the National Fire Protection Agency, International Code Council, SAE International, CSA Standards, and the International Standards Organization. The sub-program will continue to participate in International Partnership for Hydrogen and Fuel Cells in the Economy's Regulations, Codes and Standards Working Group and the IEA's Hydrogen Implementing Agreement, both of which are engaged in hydrogen safety work.

Antonio Ruiz

Safety, Codes & Standards Team Lead

Fuel Cell Technologies Program

Department of Energy

1000 Independence Ave., SW

Washington, D.C. 20585-0121

Phone: (202) 586-0729

Email: [Antonio.Ruiz@ee.doe.gov](mailto:Antonio.Ruiz@ee.doe.gov)