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

INTRODUCTION

The Safety, Codes and Standards (SCS) sub-program identifies research and development (R&D) needs and performs high-priority 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 facilitate and enable the widespread deployment and commercialization of hydrogen and fuel cell technologies. In FY 2014, 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 SCS 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, Federal government, industry, national labs, and trade associations is emphasized in order to maximize the impact of the sub-program's efforts and activities in international RCS development.

GOALS

The SCS 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:

- 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 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 DOE-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.

FY 2014 TECHNOLOGY STATUS AND ACCOMPLISHMENTS

The SCS sub-program has made significant progress related to infrastructure codes such as supporting the integration of the NFPA 2: Hydrogen Technologies Code into the International Fire Code and the publication of several component standards related to hydrogen dispensers (i.e., CSA HGV 4.1, 4.2, 4.4, 4.5, and 4.6). In FY 2014, the CSA Compressed Hydrogen Materials Compatibility (CHMC1) standard for metals was also published, establishing a test method for evaluating material compatibility in compressed hydrogen applications. In addition, the international testing of Type IV tanks—conducted by the RCS Working Group of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) determined that temperature increases in tanks are system dependent and that temperature increases on a per cycle basis are independent of cycle rate. Lastly for codes and standards support, sub-program efforts supported the standardization and publication of two SAE International standards: J2799 Standard

for 70 MPa Compressed Hydrogen Surface Vehicle Fuelling Connection Device and Optional Vehicle to Station Communications and J2601 Standard Fueling Protocols for Light-Duty Gaseous Hydrogen Surface Vehicles.

The SCS sub-program continues to utilize 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 sub-program-funded projects. The Safety Panel, with over 400 years of combined experience in the hydrogen industry, provides recommendations on the safe conduct of Federally-funded project work as well as lessons-learned and best practices that can be of broad benefit to the sub-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. For FY 2014, the sub-program's training for code officials and first responders has reached more than 30,000 through our on-line and classroom training.

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 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 sub-program's activities:

- Technical Reference for Hydrogen Compatibility of Materials (www.ca.sandia.gov/matlsTechRef/)
- Hydrogen Lessons Learned Database (www.h2tools.org/lessons, formerly 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)
- H2 Tools (http://h2tools.org/)

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

Hydrogen Behavior, Risk Assessment, and Materials Compatibility:

- Developed a metric to evaluate hydrogen codes and standards and benchmarked sub-program activity to show progress in enabling technology development. (Sandia National Laboratories, SNL)
- Completed an initial test matrix to measure for fatigue life of stainless steel 21Cr-6Ni-9Mn in 103 MPa hydrogen gas, satisfying the need to quantitatively evaluate methods published in the CSA CHMC1 standard and to generate qualification data for lower-cost stainless steels. (SNL)
- Finalized design requirements for the variable-temperature testing in a hydrogen gas system. (SNL)
- Organized and held a workshop on codes and standards quantitative risk assessment to build stakeholder awareness of risk and identify barriers limiting industry use of quantitative risk assessment approaches and tools. (SNL)

Hydrogen Quality:

- Improved sensitivity of analyzer using different electrode configurations, demonstrated a proof of concept for hydrogen sulfide (H_2S) analyzer using a platinum black electrode with an observed response to 10 ppb H_2S, and demonstrated clean-up techniques following H_2S exposure. (Los Alamos National Laboratory, LANL)

Coordination of Codes and Standards Development, Domestic and International:

- Developed new permitting and codes and standards training modules for hydrogen technologies deployment and presented in-person training sessions for deployment of hydrogen infrastructure in key jurisdictions including Huntington Beach, California and Culver City, California. (National Renewable Energy Laboratory, NREL)

Component Testing:

- Designed and built apparatus for high-pressure hydrogen component- and system-level testing to understand root cause failure modes and provide guidance for best practices. Test planning will take place in FY 2015. (NREL)
- Published peer review report "Pressure Relief Devices for High-Pressure Gaseous Storage Systems: Applicability to Hydrogen Technology" to provide information on best practices for hydrogen component design and selection. (NREL)

Hydrogen Safety Panel, Databases, Props, and First Responders:

- Released a first-of-its kind iPad/iPhone app to enhance utility and integration of the safety knowledge tools with other safety planning resources. Since May 2014, there have been more than 940 downloads of the app. (Pacific Northwest National Laboratory, PNNL)
- Developed training material for first responders and code officials, having educated over 30,000 first responders and code officials to-date (online and in-person). (PNNL)
- Participated in 13 project reviews (including safety plan and design review activities) for projects in fuel cell and hydrogen storage R&D. (PNNL)

Hydrogen Sensors:

- Completed an initial study in collaboration with the Joint Research Council quantifying the impact of potential chemical interferences, as identified in the ISO 26140 standard on hydrogen sensors, using major hydrogen sensor platform types. This included an impact assessment of selected sensor poisons on various platform types. (NREL)
- Researched and quantified the sensor requirements for preparing existing repair facilities to accommodate hydrogen vehicles. (NREL)
- Identified hydrogen refueling test sites for real-world sensor validation of solid-state electrochemical sensors to promote commercialization of the sensor. (LANL)

Hydrogen Fueling Infrastructure Research and Station Technology (H2FIRST):

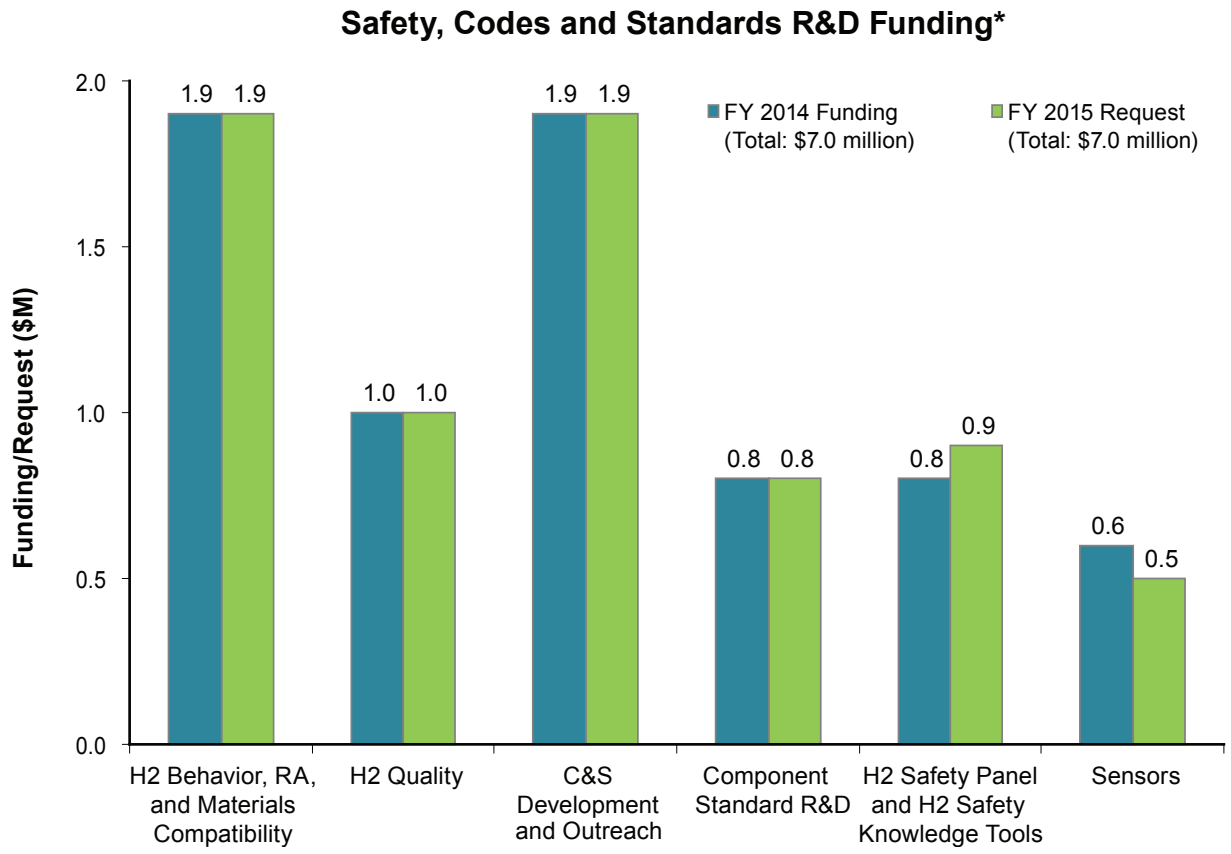
- In coordination with the Technology Validation and Delivery sub-programs, the office established the H2FIRST project with significant input from the SCS sub-program. Current H2FIRST projects are focusing on station acceptance/qualification, reference station design, and fuel contamination detectors. (NREL and SNL)

Other Workshops and Reports:

- Convened industry experts for the Hydrogen Contamination Detector workshop at SAE International offices in Troy, Michigan. Participants such as fuel suppliers, component manufacturers, national labs, and automakers discussed near-term performance requirements, long-term R&D needs, and proposed solutions which will be detailed in a forthcoming workshop report.
- Published the report "Safety, Codes and Standards for Hydrogen Installations: Metrics Development and Benchmarking" to inform the siting and deployment of hydrogen refueling stations. This report describes the development and benchmarking of a metric specific to hydrogen codes relevant for hydrogen refueling stations: "number of fueling stations that can readily accept hydrogen." (SNL)
- Held the 2nd International Workshop on Hydrogen Infrastructure and Transportation at Toyota's headquarters in Torrance, California. Participants from the U.S., Europe, Germany, Scandinavia, and Japan gathered to communicate progress, share experiences and best practices, and identify solutions on key issues facing hydrogen refueling infrastructure which will be detailed in a forthcoming workshop report.

BUDGET

The SCS sub-program received an appropriation of $7.0 million in FY 2014. This allowed for sustained progress in key R&D and codes and standards development work. The FY 2015 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.



* Subject to appropriations, project go/no-go decisions, and competitive selections. Exact amounts will be determined based on research and development progress in each area.

FY 2015 PLANS

The SCS sub-program will continue to work with codes and standards development organizations to develop technical information and performance data to enhance hydrogen-specific codes and standards. To address these needs, the sub-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 performance-based quantitative risk assessment approach to assess risks and establish protocols to identify and mitigate risk. Future work will also focus on facilitating the permitting of hydrogen fueling stations and early market applications and testing, measurement, and verification of hydrogen fuel specifications.

The sub-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 Group, and ISO. The sub-program will also continue to participate in IPHE's RCS Working Group and the International Energy Agency's Hydrogen Implementing Agreement, both of which are engaged in hydrogen safety work.

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