IX.2 Hydrogen Codes and Standards

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Compressed Gas Association (CGA), Chantilly, VA
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Kelvin Hecht, Hartford, CT
International Code Council (ICC), Chicago, IL
National Fire Protection Association (NFPA), Quincy, MA
National Hydrogen Association (NHA), Washington, DC
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Start Date: 1995
Projected End Date: 2015

Objectives

- Facilitate creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications.
- Coordinate and conduct research and development (R&D) needed to establish sound technical requirements for standards, codes, and regulations for hydrogen components and systems.
- Provide technical resources to harmonize development of international standards among the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), and Working Party on Pollution and Energy (GRPE).

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Codes and Standards section (3.6) of the Hydrogen, Fuel Cells & Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- A. Limited Government Influence on Model Codes
- B. Competition between Standard Development Organizations (SDO) and Model Code Development Organizations (CDO).
- C. Limited State Funds for New Codes
- D. Large Number of Local Government Jurisdictions (approximately 44,000)
- E. Lack of Consistency in Training of Officials

- F. Limited DOE Role in the Development of International Standards
- G. Inadequate Representation at International Forums
- H. International Competitiveness
- I. Conflicts between Domestic and International Standards
- J. Lack of National Consensus on Codes and Standards
- K. Lack of Sustained Domestic Industry Support at International Technical Committees
- L. Competitiveness in Sales of Published Standards
- M. Jurisdictional Legacy Issues
- N. Insufficient Technical Data to Revise National Fire Protection Association (NFPA) 55 Standards
- O. Affordable Insurance is Not Available
- P. Large Footprint Requirements for Hydrogen Fueling Stations
- Q. Parking and Other Access Restrictions.

Technical Approach

- Support and facilitate the timely and efficient incorporation of hydrogen safety issues into existing and proposed codes and/or standards promulgated by organizations such as the International Code Council (ICC), NFPA, the Society of Automotive Engineers (SAE), and ISO.
- Support and encourage technical and operational consistency among and across the codes and standards developed by different organizations.
- Identify critical gaps and deficiencies in codes and standards and formulate recommendations for addressing them.
- Familiarize building code officials, fire safety officials, local/state/federal policy makers, and other strategic stakeholders with hydrogen technologies and the related codes and standards.
- Develop licensing agreement through American National Standards Institute (ANSI) for Web-based access to standards.
- Develop training modules and conduct workshops with ICC and NFPA.
- Create an international template to help develop a unified national agenda and to help support consistent representation of technical experts from industry and government at key global venues.
- Work with key agencies and industry in other countries to harmonize standards, codes, and regulations in all major market areas for hydrogen technologies.
- Develop preliminary, near-term specifications and long-term R&D plans for hydrogen fuel quality for proton exchange membrane (PEM) fuel cells in road vehicles
- Develop an R&D plan for validating requirements in key codes and standards and for testing critical components against these requirements.
- Develop an R&D plan for an integrated engineering systems approach to hydrogen safety.

Accomplishments

- National Template for standards, codes, and regulations for hydrogen vehicles and facilities, for on-site hydrogen generation, and for stationary and portable fuel cells accepted by all key SDOs and CDOs.
- Continued to develop key standards to implement National Template:
  - ANSI completed negotiations with all key SDOs and CDOs on posting and viewing hydrogen standards and model codes from a Hydrogen Portal on ANSI's national standards network and incorporated codes and standards matrix and database into the Hydrogen Portal.

  - American Society of Mechanical Engineers is developing technical requirements for hydrogen piping and composite transportable containers and coordinating work on metallic containers with Sandia National Laboratories.
  - Compressed Gas Association (CGA), Administrator for the U.S. Technical Advisory Group (TAG) of ISO TC197, developed a Web site to manage TAG activity, including accessing drafts of documents, accessing comments, and voting. Discussion is under way with CGA to make the Web site available to other U.S. TAGs, such as that for IEC TC105.
  - CSA America is developing a process through which requirements included in initial drafts of three standards (HPRD1, Pressure Relief Devices for Compressed Hydrogen Vehicle Fuel Containers; HGV2, Hydrogen Vehicle Fuel Containers; and HGV4, Hydrogen Dispensing Systems) can be made more performance-based and, where appropriate, harmonized with the requirements of the Federal Motor Vehicle Safety Standards.
  - ICC incorporated additional provisions for hydrogen applications (underground storage of liquid hydrogen and canopy-top storage of gaseous hydrogen) in the 2006 edition of ICC model codes that will help reduce the footprint of hydrogen fueling stations.
  - NFPA is reviewing hydrogen safety requirements into two critical standards, NFPA 52 (Vehicle Fuel Systems) and NFPA 55 (Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders and Tanks).
  - Underwriters Laboratories (UL) completed draft standards UL 2264 (Standard for Gaseous Hydrogen Generation Appliances) and UL 2266 (Fuel Cell Power Systems for Use with Telecommunications Systems).
- Established (with U.S. Fuel Cell Council [USFCC] and NHA) a single national committee, the National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee, to consolidate hydrogen and fuel cell codes and standards coordination.
- Initiated collaborative R&D between the United States and Japan on hydrogen safety, codes, and standards through DOE.
- Led U.S. and Canadian team of experts from industry, government, and academia to establish an agreement with Japan and the European Union on development of hydrogen fuel quality specifications for PEM fuel cell road vehicles under ISO.
- Coordinated DOE efforts to create a unified international R&D program to obtain the data needed to create an international standard based on modifications to the Technical Specification for hydrogen fuel quality developed under ISO.
- Helped to develop baseline fuel quality testing at the University of Hawaii and worked with General Motors, UTC Fuel Cells, and Ballard to obtain single-cell PEM test hardware and technical expertise for baseline testing.
- Worked with the Codes and Standards Tech Team of the FreedomCAR and Fuel Partnership (FCFP) to prepare a RD&D Roadmap and to coordinate efforts on R&D for fuel quality, integrated safety engineering, risk assessment, and detection and mitigation of hydrogen hazards.
- Participated in the peer review of the Codes and Standards Tech Team by the National Academy of Sciences (NAS).
- Conducted and hosted (with Sandia/California) a workshop to address risk assessment activities, methodologies, and data requirements and to gather input from experts in risk assessment, the hydrogen and fuel cell industries, automotive original equipment manufacturers (OEMs), and the insurance industry on how risk assessment can help to set priorities for R&D in hydrogen safety and codes and standards.

Future Directions

- Initiate R&D for integrated engineering approaches to hydrogen safety.
- Initiate comprehensive R&D and testing to develop data for international hydrogen fuel quality standards.
- Refine overall codes and standards coordination through the consolidated National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee, with more emphasis on harmonization of requirements in international standards and Global Technical Regulations.
- Create a centralized, publicly accessible web-based data center for one-stop technical assistance on hydrogen codes and standards, including a directory of primary contacts for information and technical assistance.
- Develop and sustain full participation of industry experts in preparation of and negotiations on international standards and Global Technical Regulations for hydrogen technologies.
- Convene annual safety, codes, and standards review with industry and provide annual status report.

Introduction

Codes and standards are critical to establishing a market-receptive environment for commercializing hydrogen-based products and systems, and their development and promulgation are essential if hydrogen is to become a significant energy carrier and fuel. With the help of key stakeholders, the DOE Hydrogen, Fuel Cells, & Infrastructure Technologies (HFCIT) Program and NREL are coordinating a collaborative national effort to prepare, review, and promulgate hydrogen codes and standards needed to expedite hydrogen infrastructure development.

DOE's Hydrogen Codes and Standards goals are to facilitate the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications and to provide technical resources to harmonize the development of international standards. NREL assists DOE and the Codes and Standards Tech Team of the FCFP with implementing its Codes and Standards R&D Roadmap. NREL coordinates and conducts the R&D needed to establish sound technical requirements for standards, codes, and regulations for hydrogen components and systems. Key R&D areas supported by NREL include integrated engineering approaches to hydrogen safety and comprehensive R&D and testing to develop data for international hydrogen fuel quality standards.

NREL continues to coordinate and provide overall management of domestic codes and standards activities on behalf of DOE and the FCFP Codes and Standards Tech Team. NREL also helps DOE and the Tech Team create a unified agenda for hydrogen standards, codes, and regulations that will enable the United States to present an industry and government consensus position at critical international negotiations on global hydrogen standards and regulations.

Approach

The federal government has an indirect and relatively limited role in the voluntary, consensus process through which codes and standards are developed in the United States (Barrier A). Because of the importance of establishing a harmonized set of standards on which model codes and regulations can be based, DOE, primarily through NREL, has devoted considerable effort to facilitating and coordinating this consensus process. This effort has been enhanced through the recent creation of a single entity, the National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee, by DOE, NREL, NHA, and USFCC. The committee conducts monthly conference calls to update participants on current activities and to discuss key issues. In addition, the committee meets quarterly to coordinate codes and standards development efforts and prevent duplication of efforts, identify critical deficiencies and gaps in hydrogen codes and standards development efforts that could have an adverse impact on market acceptance, determine a collaborative strategy and action plan to address critical gaps and deficiencies, and identify specific opportunities for organizations to work together in developing codes and standards.

Through the Codes and Standards Tech Team, DOE and its industry partners have established an RD&D Roadmap for a substantial and verified database of scientific information on the properties and behavior of hydrogen and on the performance characteristics of new hydrogen technology applications to enable the development of effective codes and standards for emerging hydrogen applications. This information will be made available to appropriate SDOs, CDOs, local and state authorities, and industrial entities to enable the development of safe, performance-based technical codes and standards that will accommodate eventual changes in technology, minimizing the need to develop new codes and standards as technology evolves.

Results

Key results in domestic codes and standards included the acceptance by all key SDOs and CDOs of the National Template for hydrogen standards, codes, and regulations and continued development of key standards to implement the National Template. For example, ICC incorporated additional provisions in its 2006 edition of model codes for hydrogen applications (underground storage of liquid hydrogen and canopy-top storage of gaseous hydrogen) that will help reduce the footprint of hydrogen fueling stations, and ANSI completed negotiations with all key SDOs and CDOs on posting and downloading hydrogen standards and model codes from the Hydrogen Portal on ANSI's national standards network.

In international codes and standards, key results included agreement among the United States, Canada, Japan, and the European Union to develop hydrogen fuel quality specifications for PEM fuel cell road vehicles under ISO and to create a collaborative R&D program to obtain the data needed to prepare an international standard based on modifications to the Technical Specification as better data become available. Working Group 12 of ISO TC197 made substantial progress during fiscal year (FY) 2005 on drafting the Technical Specification.

Key results in R&D included preparation of an RD&D Roadmap by the Codes and Standards Tech Team and a workshop to gather input from experts in risk assessment, the hydrogen and fuel cell industries, automotive OEMs, and the insurance industry on risk assessment activities, methodologies, and data requirements, and on how risk assessment can help to set priorities for R&D in hydrogen safety and codes and standards.

Conclusions

NREL continued to support DOE's growing and increasingly important program element to coordinate the development and promulgation of hydrogen codes and standards by:

- Helping develop and integrate a comprehensive R&D Roadmap with the Codes and Standards Tech Team
- Initiating R&D collaboration with Japan on hydrogen safety, codes, and standards, beginning with hydrogen fuel quality
- Coordinating the participation and input of the United States and Canadian industry in developing a Technical Specification for hydrogen fuel quality under ISO
- Continuing to implement the National Template for hydrogen codes and standards
- Creating the National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee with NHA and USFCC to consolidate domestic and international codes and standards activities in the United States and Canada

FY 2005 Publications/Presentations

1. Presentation on the ANSI Hydrogen Codes and Standards Portal at the New York State Building Officials Conference, Albany, NY, October 2004
2. Presentation at the Fuel Cell Testing and Standardisation Network (FCTESTNET) conference and to the international workshop on codes and standards, Ulm, Germany, October 2004
3. Presentation at the meetings of the U.S. TAGs for ISO TC 197 and IEC TC 105, Troy, MI, December 2004
4. Presentation at the NHA workshop during the Fuel Cell Seminar, San Antonio, TX, November 2004
5. Presentation on fuel quality, ISO TC 197 WG12, San Francisco, CA, January 2005
6. Presentation on hydrogen codes and standards, Steering Committee of the California Fuel Cell Partnership, Huntington Beach, CA, January 2005

7. Presentations on fuel quality and international standards and regulations, NHA National Codes and Standards Workshop, Washington, DC, March 2005
8. Hydrogen Fuel Quality Specifications for PEM Fuel Cells: An Overview of DOE Activities, National Hydrogen Association, Washington, DC, March 2005
9. Presentation and paper on codes and standards, Hydrogen, Fuel Cells and Infrastructure Technologies Program, 2005 Merit Review and Peer Evaluation, Washington, DC, May 2005
10. Risk Assessment for Hydrogen Codes and Standards, accepted for presentation at the first International Conference on Hydrogen Safety in Pisa, Italy, September 2005.