

APPLICATIONS ANALYSIS

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Abstract

The National Renewable Energy Laboratory (NREL) supports hydrogen technology development in several ways. First, NREL helps to establish codes and standards for hydrogen applications. Second, NREL provides technical coordination of Hydrogen Program activities in collaborative projects with other U.S. Department of Energy (DOE) offices, other federal agencies, especially the National Aeronautics and Space Administration (NASA) and the U.S. Department of Transportation (DOT), and state and local agencies. Third, NREL provides technical support to the DOE Hydrogen Technical Advisory Panel (HTAP), especially in the areas of scenario planning and fuel choice. This paper reviews recent activities by NREL to support hydrogen technology development.

Codes and Standards

In late 1997, NREL and the Hydrogen Research Institute (HRI) at the University of Quebec, under joint funding from the U.S. DOE and Natural Resources Canada (NRCan), assembled a panel of internationally recognized experts from industry, universities, and government agencies in the U.S. and Canada to prepare a sourcebook on hydrogen safety. The *Sourcebook for Hydrogen Applications* was published in both hard cover and CD-ROM format in 1998. The *Sourcebook* is a compilation of prevailing practices and applicable codes, standards, guidelines, and regulations for the safe use of hydrogen. Publication and distribution of the *Sourcebook* was sponsored jointly by the Canadian Hydrogen Association (NHA) and the National Hydrogen Association (CHA) through TISEC, Inc. (mail@tisecc.com)

The purpose of the *Sourcebook* is to serve as a reference to available information that developers can use to design, build, and operate safe hydrogen projects at a non-industrial scale. The *Sourcebook* is not intended to be a design handbook or an

interim surrogate for codes and standards that are being developed by working groups under the International Standards Organization (ISO). Information available in the *Sourcebook* will not obviate the need for detailed safety reviews of specific projects.

The *Sourcebook* has been received well by the hydrogen community. To date, over 100 copies have been sold. In 1999, HRI and NREL, again under the joint sponsorship of NRCAN and DOE, will focus on the safety concerns of key constituents and stakeholders in hydrogen safety, beginning with building and fire code officials and the insurance industry. The team will tailor the *Sourcebook*, perhaps in shorter, more focused versions, to address the safety concerns of specific user groups. HRI and NREL will work with key organizations of building and fire code officials in Canada and the U.S. to facilitate incorporation of hydrogen into model codes. NREL and HRI will also become more familiar with and involved in the processes and procedures of these organizations as they amend and modify existing model codes and standards related to building and fire safety.

The HRI-NREL team will address the longer-term issue of changing the prevailing public perception of hydrogen as being much more dangerous to use than other fuels. The team will develop a comprehensive approach for NRCAN and DOE to address hydrogen safety. Elements of this approach may include general publications, such as updates of the *Sourcebook*, more focused versions of the *Sourcebook* for key stakeholders, as well as an internet web page that contains general information on hydrogen and hydrogen safety for the public and technical information for safety experts and hydrogen project developers.

NREL also submitted proposed changes to the model International Building and Fire Codes to facilitate hydrogen use in vehicular and stationary applications and will participate in public hearings to follow-up on changes submitted to the model International Building and Fire Codes.

The danger of hydrogen in the mind of the public and in some technical communities is associated with fire, explosion, and even radioactivity. NREL's long-term goal is to establish the necessary codes and standards to facilitate hydrogen applications in the vehicular market. The process of adopting and promulgating codes and standards for even established technologies is time-consuming and process-intensive. To do this, NREL will work with all interested parties to remove the "danger" sign associated with hydrogen use by key constituent groups and by the general public

Technical Coordination

Hydrogen Aircraft

In 1998, NREL represented the Hydrogen Program and gave a presentation at NASA's Environmental Compatibility Workshop that focused on NASA's goals to reduce the environmental effects of aviation. Hydrogen-fueled aircraft may provide one approach to reducing aircraft emissions, and NREL helped to initiate a cooperative project between NASA and DOE by drafting a memorandum of understanding (MOU) between NASA and DOE on hydrogen RD&D. The MOU is under consideration by NASA.

In 1999, NREL plans to initiate scenario development and systems analysis of airframe, engine, and fuel infrastructure requirements for subsonic hydrogen aircraft in cooperation with NASA Glenn and NASA Langley. This activity may, however, be constrained by budget cuts in NASA's program for advanced subsonic aircraft development and its environment compatibility initiative.

Hydrogen Bus Technology Development

In March 1999, NREL initiated a coordinated hydrogen bus technology development program in California among DOE, the Federal Transit Administration of the U.S. Department of Transportation, the California Air Resource Board, the California Energy Commission, the South Coast Air Quality Management District, three transit agencies, and other groups with an interest in hydrogen buses. This initiative has resulted in the formation of the California Hydrogen Bus Coordination Committee. In April 1999, the State of California launched the California Fuel Cell Partnership with selected members of the automobile and petroleum industries. The Committee plans to work closely with the Partnership, especially on fuel infrastructure development for hydrogen buses.

NREL, working with the Committee and the Partnership, plans to put together a comprehensive technology development plan for hydrogen vehicles, beginning in California, that integrates codes and standards and insurance issues along with fuel choice, propulsion technology, vehicle platform, and fuel infrastructure development

Although initial reception by all parties involved has been positive, hydrogen technology development projects in the past have typically been one-of-a-kind projects promoted by a specific constituency or interest group. Coordination, let alone integration, of hydrogen bus development projects will be difficult, particularly in a state as large, diverse, and politically powerful as California.

Hydrogen Technical Advisory Panel Support

NREL provides technical support to the DOE's Hydrogen Technical Advisory Panel (HTAP), particularly in the areas of scenario planning and fuel choice. In 1999, NREL reviewed and summarized all major recent scenario analyses of future energy use and energy systems for the HTAP Scenario Development Committee as part of a process to develop preliminary hydrogen scenarios. The scenarios are intended to provide a long-term context for hydrogen RD&D investments by the federal government.

In 1998, NREL co-chaired and spoke at a session devoted to fuel choice at the Fuel Cell Seminar and organized and chaired the first SAE session devoted to fuels for fuel cells. In 1999, NREL conducted a session on fuel choice at the Spring HTAP meeting to illuminate technical and economic issues involved in fuel choice for fuel cell vehicles. At this session, leading scientists and analysts identified and assessed the key issues of fuel choice. NREL also helped the HTAP prepare a brief paper on fuel choice and a brief

statement showing the fruitful intersections of the DOE Hydrogen Program with other programs in DOE's Office of Energy Efficiency and Renewable Energy.

Fuel choice is an extremely complex issue with many technology options and many interest groups backing a specific option. In 1999, NREL plans to support the HTAP in preparing a definitive analysis and paper on fuel choice for fuel cell vehicles.