IX.2 Hydrogen Safety: First Responder Education

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Project Start Date: October 1, 2004
Project End Date: Project continuation and direction determined annually by DOE

Objectives

- Support the successful implementation of hydrogen and fuel cell demonstration projects and market transformation by providing technically-accurate and objective information about hydrogen to first responders.
- Develop and disseminate first-responder hydrogen safety educational materials, including an update of the awareness-level course (first launched in Fiscal Year 2007) and a more in-depth, one-day course that includes hands-on training.

Technical Barriers

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

(A) Lack of Readily Available, Objective, and Technically Accurate Information

(B) Mixed Messages

(C) Disconnect Between Hydrogen Information and Dissemination Networks

(D) Lack of Educated Trainers and Training Opportunities

Contribution to Achievement of DOE Education Milestones

This project will contribute to achievement of the following DOE milestones from the Education section of the HFCIT Program Multi-Year Research, Development and Demonstration Plan:

- **Milestone 3:** Develop "prop-course" using hands-on training devices for first responders. (4Q, 2008)
- **Milestone 4:** Update awareness-level information package for first responders (4Q, 2009)
- **Milestone 6:** Update "prop-course" for first responders. (4Q, 2011)
- **Milestone 7:** Update "Awareness-Level" information package for first responders. (4Q, 2012)
- **Milestone 9:** Update "prop-course" for first responders. (4Q, 2014)
- **Milestone 10:** Update "Awareness-Level" information package for first responders. (4Q, 2015)

Accomplishments

- **Improved the Awareness-Level Course:** Developed a new video on hydrogen properties. Created oral voiceover of transcript, so viewers can listen instead of read. Added randomly-generated quiz questions. Addressed a few technical questions raised by industry experts. Included a certificate of completion. Launched new site, hosted on PNNL Web-server.
- **Conducted Effective Outreach Activities:** Distributed CD and print versions of the Awareness-Level Course, as well as posters and *Firehouse* article (re-prints) about the course, through the DOE Energy Efficiency and Renewable Energy (EERE) Information Center. Hosted booths at key first responder conferences.
- **Developed Prop-Based Course:** Formed steering committee from industry and other technical organizations and held meeting to design course. Conducted interviews with fire training centers. Developed course content, which will be reviewed and finalized.

Introduction

Safety in all aspects of a future hydrogen infrastructure is a top priority, and safety concerns influence all of the DOE hydrogen efforts. Despite the most concerted effort, however, no energy system

can be made 100% risk-free. Therefore, for any fuel, a suitably trained emergency response force is also an essential component of a viable infrastructure. HFCIT has identified training of emergency response personnel as a high priority, not only because these personnel need to understand how to deal with a hydrogen-related emergency situation, but also because firefighters and other emergency workers are influential in their communities and can be a positive force in the introduction of hydrogen and fuel cells into local markets.

This HFCIT project is employing the Occupational Safety and Health Administration and National Fire Protection Association frameworks for hazardous materials emergency response training to develop a tiered hydrogen safety education program for emergency responders. The overall first-responder education program will be developed over a number of years. The effort started with development and distribution of the First Responder Awareness-Level Web-based course developed in FY 2006-2007. More advanced courses and materials to facilitate education have been accomplished in FY 2008, complementing the development of a fuel cell vehicle prop (developed under another companion project). In addition, PNNL will develop and implement plans for outreach to key stakeholder groups, to facilitate delivering the training to a broad audience.

Approach

PNNL works with experts in hydrogen safety and first responder training (e.g., the PNNL Hydrogen Safety Review Panel, as well as experts at other national laboratories and external groups), to develop the hydrogen safety course materials. Draft materials are prepared and undergo considerable review and revision before being released. PNNL (with subcontractor support, as needed) works with DOE to develop plans for making stakeholder groups aware of training opportunities, and to provide "live" training when appropriate.

Specific tasks in FY 2008 included the following:

- **Update the Web-based first responder "Awareness-Level" hydrogen safety course.** The *Introduction to Hydrogen Safety for First Responders* course is designed for fire, law enforcement, and emergency medical personnel who may be called to or witness an accidental release of compressed or liquid hydrogen and must initiate an emergency response by notifying other responding authorities of the release, but who would not be expected to take further action beyond this notification. The target audiences in this group include fire fighters, police, emergency medical technicians, and others. The introductory course, designed to be completed in 1-2 hours, consists of a combination of presentation slides with videos and animations for illustrating key points, such as relevant aspects of hydrogen behavior, along with narration to enhance the learning experience. The Web-based format lends itself to use with a wide variety of media; in addition to the course being made available over the Internet, it is also being distributed on CD and pdf (printed hard copy). In FY 2008, PNNL and HAMMER reformatted the training, added an oral transcript and a new video on hydrogen properties, included new material on stationary sources and codes, added randomly-generated quiz questions and a certificate of completion, and made other minor modifications.
- **Awareness-Level outreach.** PNNL and HAMMER supported efforts to distribute information about the *Introduction to Hydrogen Safety for First Responders* course to its target audiences. HAMMER staff attending several conferences (with a booth to demonstrate the course). CDs, flyers and posters containing course material were distributed through the EERE Information Center.
- **Complete development of a more detailed prop-based course on hydrogen safety.** While all first responders should understand the fundamentals of hydrogen safety provided in the introductory course, most emergency personnel in regions with hydrogen demonstrations or emerging hydrogen infrastructure should aspire to a more in-depth level of understanding. An 8-hour course that involves use of a prop (simulating a fuel cell vehicle, FCV) has been developed to help first responders gain hands-on experience with personal protective equipment, monitoring and detection equipment, and the basic control, containment, and confinement operations associated with a FCV.

Results

The introductory course was revised during FY 2008, although the basic content remained the same as the earlier version. Figure 1 provides a screen-shot of the opening page of course, which shows the topics covered in it. For each topic, a separate module in the course provides basic information and sometimes videos or animations to further explain particular points.

Some statistics about the introductory course usage are as follows:

- Total unique visitors from April 1, 2007 to March 31, 2008 (old version) = 3,964 (total since January 24, 2007 launch = 6,192).
- About 1,700 repeat visitors (April 1, 2007 to March 31, 2008).
- Visitors from almost every state and many foreign countries (from Argentina to Venezuela).

FIGURE 1. Awareness-Level Course (The screen shot of the introductory slide shows the topics covered in the course.)

- Many government, industry and university viewers.

Typical viewers include the fire prevention/protection community, firefighters, fire department education coordinators, fire marshals, fire plan examiners/inspectors, code officials, law enforcement officials, and representatives from industry, universities, the military, and non-profit organizations.

Feedback on the course has been quite positive. For example, one firefighter sent the following input during in 2008: "Very informative presentation for the fire service! Good Job!" Many similar complements were received.

To distribute information and raise awareness about hydrogen safety and about the DOE-sponsored courses, HAMMER and DOE staff participated in the following conferences in FY 2008:

- Fire Department Instructor's Conference, April 8-12, Indianapolis
- Firehouse Expo, July 24-29, Baltimore
- Fire Rescue International, August 14-16, Denver

Several key activities were undertaken to plan the more in-depth prop-based course, including (1) interviews of ten directors at selected regional firefighter training centers in CA, CT, FL, MI, NY, SC, and TX, and (2) the formation of a steering committee to help plan the course.

The key questions asked in the interviews and a summary of the answers is as follows:

- Do they send people to offsite training?

  Most said yes, for specialty training
- Have they had training on alternative vehicles?

  60% said no; some had training on hybrid auto extrication, compressed natural gas, liquefied natural gas
- Are they familiar with DOE Hydrogen Program?

  70% said no
- Would they be interested in Hydrogen/FCV training?

  100% said yes
- Are they willing to host live prop-based training at their facility?

  Almost all said yes
- Would they be interested in sending someone to a train-the-trainer course?

  Almost all said yes

The steering committee for the course met in October 2007 to review preliminary plans for the course and offer suggestions. The steering committee is comprised of:

- Original equipment manufacturers – Ford and General Motors; Plug Power
- Energy companies – Shell and Chevron
- Hydrogen/FCV organizations – California Fuel Cell Partnership and NextEnergy
- Firefighting organizations – Washington Fire Training Academy and local Washington State fire departments
- Experts from Los Alamos, Sandia and Lawrence Livermore National Labs

Some of the key recommendations made by the steering committee include:

- Eight-hour course is appropriate, including five hours in the classroom and three hours of hands-on training with the mobile FCV prop (Figure 2).
- Use existing, vetted materials as much as possible
- Integrate, within each module, information on technical issues (e.g., the components of a FCV) with instruction on the appropriate safety-related emergency responses.
- Teach first responders what is the same and different about hydrogen and FCVs, compared to conventional fuels and vehicles.

FIGURE 2. FCV Simulator Prop (The FCV simulator prop demonstrates potential conditions that could be encountered during the control and suppression of a FCV fire. The prop is being integrated into a training course, Hydrogen Safety for First Responders, being developed by PNNL and the Volpentest HAMMER Training and Education Center for the U.S. Department of Energy. The photo shows a propane flame that simulates a compartment fire.)

Based on this guidance, the course was developed in several modules:

- Introduction and Course Overview
- Hydrogen and Fuel Cell Basics
- Hydrogen-Fueled Vehicle Systems
- Hydrogen-Related Stationary Facilities
- Standard Operating Procedures
- Practical Exercise
- Quiz
- Hands-On Exercise with FCV Prop

The course is almost ready for review at the time this report is being written.

PNNL and HAMMER will work with the Washington State Fire Marshal's office to pursue official endorsement through the National Fire Academy's State Fire Training Course Endorsement Program (or another endorsing organization).

Conclusions and Future Directions

The introductory course aimed at first responders has been quite successful, based on the usage recorded and feedback received. The course is fulfilling a need expressed by the first responder community to receive more information about hydrogen and fuel cells, so firefighters and others will be prepared in the rare event of a hydrogen-related emergency. The in-depth prop-based course builds on that success and is expected to be very useful in giving first responders a hands-on experience with simulated FCV incidents.

In future years, PNNL will continue to update the awareness-level and prop-based courses, as our knowledge about hydrogen safety improves. PNNL will work with DOE to give the prop-based course at HAMMER and other locations in FY 2009. PNNL will also work with DOE to determine what, if any, additional types of educational courses are warranted, and to develop and implement plans to provide education to specific groups including fire fighters, police, emergency medical technicians, and others.

FY 2008 Publications/Presentations

1. M. Placet, C. Cooper, and A. Ruiz, *Building Public Safety Consensus, The DOE Hydrogen Program: Education Activities*, 2007 Hydrogen Codes and Standards Conference, Next Energy Center, November 2007.

2. A. Ruiz and C. Cooper, *Building Public Safety Consensus, The DOE Hydrogen Program: Education Activities*, The 2nd International Conference on Hydrogen Safety, San Sebastián, Spain, September 2007.