

X.1 Hydrogen Safety: First Responder Education

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Subcontractors:

- *Volpentest Hazardous Materials Management and Emergency Response (HAMMER) Training and Education Center, Richland, WA
- **California Fuel Cell Partnership (CaFCP), Sacramento, CA

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.
- Launch an in-depth, one-day course for first responders utilizing DOE's mobile hydrogen fuel cell vehicle (FCV) prop.
- Continue to update the awareness-level course first launched in Fiscal Year 2007.
- Disseminate first responder hydrogen safety educational materials at appropriate conferences.

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
- (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 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)

In addition, the following milestones were met in previous years:

- **Milestone 1:** Develop "Awareness-Level" information package for first responders (4Q, 2006)
- **Milestone 3:** Develop "prop-course" using hands-on training devices for first responders (4Q, 2008)

Accomplishments

- **Improved the Awareness-Level Course:** Developed a new video *The Characteristics of Hydrogen* that compares the properties and characteristics of hydrogen with those of conventional fuels that are familiar to first responders. Created narrated transcript so viewers can listen to course content instead of reading it. Revised quiz questions and answers, and added a certificate of completion for users who take the quiz. Launched new Web site on the PNNL server. Distributed compact disk (CD) version of course to users who request copies via the Web site.
- **Conducted Effective Outreach Activities:** Distributed CDs and print versions of the awareness-level course, as well as posters and *Firehouse* article reprints 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:** Developed course modules in the form of PowerPoint slides and notes pages. Developed a more in-depth study guide to

accompany the slides. Packaged the slides, notes pages, study guide, Web-based awareness-level course CD, and *The Characteristics of Hydrogen* digital video disk (DVD) into a course binder that is distributed to all students. Curriculum was completed and reviewed by DOE. First pilot course held on December 2, 2008 for technical reviewers from several national laboratories. Second pilot course held for industry representatives on March 10, 2009. Curriculum was revised slightly after each pilot course. First “real” courses held on June 16, 2009 and August 18, 2009 for first responders from across the country.



Introduction

Safety in all aspects of a future hydrogen infrastructure is a top priority, and safety concerns influence all DOE hydrogen projects. 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 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 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 awareness-level Web-based course developed in FY 2006-2007. A more advanced course and materials to facilitate education were developed in FY 2008 and FY 2009, complementing the development of a FCV prop (developed under PNNL's companion Hydrogen Safety Project). In addition, PNNL has implemented outreach efforts to key stakeholder groups in order 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 Panel, other national laboratories, HAMMER, CaFCP), to develop 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 2009 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 first responders 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, but who would not be expected to take further action. The target audiences in this group include firefighters, police, and emergency medical technicians. The introductory online course 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 and FY 2009, PNNL and HAMMER reformatted the training, added an oral transcript and a new video on hydrogen properties and behavior, included new material on stationary sources and codes, revised quiz questions and answers, added a certificate of completion, and made other minor modifications. The course was finalized in February 2009.
- **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 also distributed through the EERE Information Center.
- **Complete development of 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 utilizes a one-of-a-kind hydrogen burn prop that simulates a 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 hydrogen FCVs and stationary applications. Pilot courses were held first to get feedback on improving the

curriculum, and then actual first responder classes were held in the summer of 2009.

Results

Web-based course: The introductory course was revised during FY 2008, although the basic content remained the same as the earlier version. For each topic, a separate module provides basic information and sometimes videos or animations to further explain particular points.

Since the initial version of the online course was launched in January 2007, there have been more than 12,000 unique visitors to the Web site. The site is still averaging 300-500 unique visitors each month from almost every state and many foreign countries. 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.

Outreach: To distribute information and raise awareness about hydrogen safety and about the DOE-sponsored courses, HAMMER staff participated in two major first-responder conferences in FY 2009 to raise awareness about hydrogen safety and the DOE-sponsored courses:

- Fire Department Instructor's Conference, April 2009, Indianapolis
- Fire Rescue International, August 2009, Dallas

Booths were set up to display and disseminate posters, announcements of course offerings, hydrogen safety literature, and awareness-level course CDs. Also, HAMMER conducted live flame prop demonstrations at the Fire Department Instructor's Conference.

Prop course: Based on guidance from subject matter experts in industry and the national labs, as well as local

first responders who attended the pilot courses, the prop course was developed in several modules:

- Introduction and Course Overview
- Hydrogen and Fuel Cell Basics
- Hydrogen Vehicles
- Stationary Facilities
- Emergency Response
- Classroom Exercise: Incident Scenarios
- Quiz
- Hands-On Exercise with FCV Prop

The course uses existing, vetted materials as much as possible. Information on technical issues (e.g., the components of a FCV) is integrated with instruction on the appropriate safety-related emergency responses. The focus of the curriculum is on teaching first responders what is the same and what is different about hydrogen and FCVs as compared to conventional fuels and vehicles. We distribute a course evaluation form at the beginning of each class to request feedback from participants that will help us improve the course content and delivery. Based on feedback from both pilots and the first "real" class sessions, we conclude that first responders are comfortable with hydrogen as an energy carrier. In fact, many of them stated that they feel it is safer than gasoline. PNNL is pursuing official endorsement of this curriculum through the National Fire Academy's State Fire Training Course Endorsement Program.

The FCV prop (shown in Figure 1) demonstrates potential conditions that could be encountered during the control and suppression of a FCV fire. The prop has been integrated into the "Hydrogen Emergency Response: Training for First Responders" course developed by PNNL and HAMMER for DOE. The figure shows a team of firefighters responding to a multi-vehicle accident involving a hydrogen FCV and two conventional vehicles.



FIGURE 1. FCV Prop Training Exercise

Conclusions and Future Directions

The introductory Web-based course 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 they 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. PNNL will work with DOE to give the prop-based course at HAMMER and other locations in FY 2010. 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.

FY 2009 Publications/Presentations

1. Placet, M. *Hydrogen Safety: First Responder Education*, PNNL-SA-65774, 2009 U.S. DOE Hydrogen Program and Vehicle Technologies Program Review and Peer Evaluation, Arlington, VA, May 21, 2009.