

Recommendations for Hydrogen Fire Safety Training

The purpose of the Fire and Safety Officials Hydrogen Safety Training Program activity is to support the scoping and future development of a training program for the target market, local fire and safety officials. These officials include first responders and code safety enforcement personnel. One of the most important conclusions of the work to date is that the fire safety community is interested in hydrogen and receptive to hydrogen safety training.

Specific recommendations for hydrogen fire safety training appear below. The recommendations are divided into the following categories: general; content; format; development, marketing and distribution.

General

- Create a comprehensive hydrogen training program, the “The Universal Hydrogen Safety Program” that will meet the needs of the local fire safety and code officials community which consists of: 1) the first responders, who deal with mitigation and suppression aspects of fire safety as well as hazardous materials; and 2) the code safety enforcement officials who deal with prevention and compliance. In addition, the program should address the needs of developers who design, engineer and build hydrogen fueling stations and related infrastructure. The comprehensive program is envisioned as a suite of training products organized in modules that can be assembled in training packages of differing durations. The products should include:
 - Learning material for first responders, both professional and volunteer, involved in fire safety, mitigation and suppression, beginning with the entry level and continuing up the chain of command
 - Learning material for safety code enforcement officials involved in plan review, architecture and engineering, inspection and installation
 - Guidelines for project developers subject to permitting and approval processes and community participation challenges
 - Facilitators’ guides for all products
 - PowerPoint presentations 1-1.5 hours in length for first responders and code safety enforcement officials
- Feature a “train the trainer” initiative(s) as a key component of the comprehensive program
- Incorporate “hands-on” learning for select parts of training
- Prepare a hydrogen safety component for the *Essentials of Firefighting* and appropriate modifications to *Hazardous Materials for First Responders* developed by the International Fire Service Training Association
- Prepare/revise hydrogen entries for the National Emergency Response Guidebook (NAERG) and the National Institute for Occupational Safety and Health (NIOSH) Pocket Guide.

- Partner and/or cooperate with appropriate entities in the fire safety and first responder network. This network consists of federal and state agencies and organizations, membership organizations and a union as well as codes and standards organizations. Collaborations could involve all phases of training from concept through development, assessment, piloting, approval and delivery. In partnering, leverage the core competencies and strengths of network members to maximize value-added and leverage political influence with members' constituencies.
- Cooperate with codemaking organizations to maximize the effectiveness of the program, its distribution and delivery.
- Utilize *Propane Emergencies* as an example of "best training practices" in sister fuel industries.
- Promote adoption and use of a standardized system of labeling and specifications for vehicles and equipment that utilize hydrogen to facilitate the rescue work of first responders while contributing to their safety and that of the general public.

Content

These recommendations focus on content for first responders and safety code enforcement officials:

- Cover physical and chemical properties of hydrogen.
- "Compare and contrast" hydrogen with other fuels, e.g., propane, CNG (compressed natural gas), LNG (liquefied natural gas), and LPG (liquefied petroleum gas), as a guide to hydrogen behavior and the real hydrogen issues
- Address hydrogen safety concerns (relative to combustion, releases, leaks, etc.)
- Reference relevant codes and standards and include them as learning objectives where appropriate. Among the codes and standards suggested for reference:
 - For first responders – use NFPA, including NFPA 1 Uniform Fire Code (UFC) and 29CFR1910.120, 40CFR Part 311, and the ICC International Fire Code
 - For fire code enforcement officials – NFPA and the ICC code families, including the International Fire Code and the International Fuel Gas Code
 - ASME boiler pressure code, CGA documents, ANZI 2183 (CSAFC1)
- Introduce pressure vessels and containers (bulk containers, intermodal/intermediate bulk containers, highway carriers, railroad cars, non-bulk containers) shapes and sizes for highway, roads, intermodal and fixed sites
- Explain risk analysis as a tool to systematically and objectively identify hazards and evaluate risks
 - Failure mode and effect analysis (FMEA)
 - Hazard and operability analysis (HAZOP)
 - Qualitative risk analysis (QRA)
- "What and how to" guide on gaseous and liquid hydrogen fire mitigation and suppression.

- Use case studies and scenario planning – actual and hypothetical situations that make the material fire-fighter and code-official friendly and familiar for training purposes
- Include Manufacturers’ information on specific hydrogen products and the general subject
- Introduce application of placards, labels, marking systems and lists – NFPA and DOT marking systems, UN Identification numbers
- Introduce use of documents for fixed facilities (e.g., material safety data sheets) and shipping papers by modes of transportation
- Explain use of local jurisdictions Standard Operating Procedures (SOPs) and Standard Operating Guidelines (Sags) for hydrogen applications
- Include Glossary of important terms
- Include emergency preparedness for catastrophic events that encompasses various functions and levels of responsibility
- Feature a hands-on learning component for select audiences
- Create guidelines for laying the groundwork for the permit approval process for hydrogen related projects
- Incorporate the results of national research on crucial topics such as flammability and separation distance validation. Likewise, incorporate the results of international efforts in hydrogen safety as applicable.

Format

- Develop and package program product(s) in modules that collectively comprise the comprehensive training program.
- Use a multi-media approach. Generally, design training for in-person delivery with CD-Rom and on-line back up.
- Enhance the multi-media approach with use of videos, especially to illustrate hardware and equipment, facilitate understanding of hydrogen behavior, and simulate conditions firefighters and hazardous materials specialists may encounter.
- Use actual equipment and props as a part of the training through “in-person” and multi-media training wherever possible. Videos may play an especially important role as a substitute for “hands-on” training, especially given the size of the population to be trained and the challenge of providing “hands-on training” nationwide.
- Support federal efforts to establish regional “hands-on” hydrogen training centers around the country.
- In response to market demand, scale comprehensive training program into 4, 8 and 24 hour segments.
- Use the four-five levels for first responders: Awareness, Operations, Technician, Specialist and Command to format modules. These categories coincide with the required levels of training associated with hazardous materials response. These

levels of training are defined in 29 CFR 1910.120 and National Fire Protection Association Standard 472.

- Where appropriate, adapt and interpret this system for use with code enforcement officials who deal with prevention.
- To enhance effectiveness of the training, follow the pedagogical principle of proceeding from the specific to the general, from concrete to the abstract wherever appropriate with all the products.
- Context matters. Format material to highlight such learning tools as case studies and scenario planning that mimic real life activities of firefighters and code enforcement officials. Use multiple tools: virtual as well as paper and pencil exercises.
- Couple a Facilitators Guide(s) with various products in the training program through interpretation of the facilitator's guide.

Development, Marketing and Distribution

- Use fire code and local code official network for various aspects of training development, including focus groups and training pilots as well as actual material development.
- Use existing training delivery mechanisms in the network for marketing and distribution.
- Aim to distribute the "Universal Hydrogen Program" directly to every fire department in the U.S. and other interested parties.
- Involve DOE directly in "train the trainer" initiatives.
- Have the products "certified" by appropriate entities in the fire safety community to increase the appeal of the training.
- Promote availability and use of the training, as well as "train the trainer" initiatives through existing network of government agencies, the fire safety and code official community and hydrogen groups.
- Maintain a website to access upgrades and suggestions to help trainers deliver program.