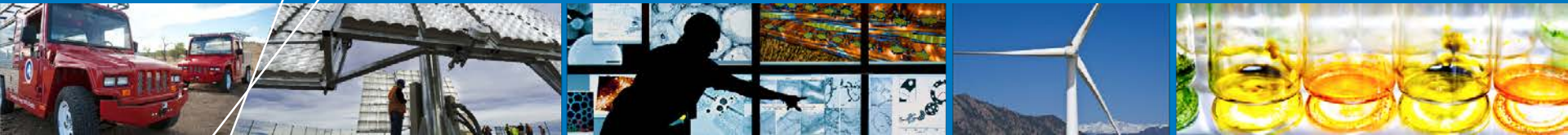


National Codes and Standards Deployment and Outreach



**Carl Rivkin, P.E. (PI), Robert Burgess, and
William Buttner
National Renewable Energy Laboratory
9 June 2015**

Project ID SCS001

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

Overview

Timeline

- **Project start date:** October 1, 2002
- **Project end date*:** September 30, 2015

*Project continuation and direction determined annually by DOE

Budget

- **FY14 DOE funding:** \$425,000
- **FY15 planned DOE funding:** \$275,000
 - Training and Outreach – \$150,000
 - Continuous Codes and Standards Improvement – \$125,000
- **Total DOE funds received to date:** \$700,000

Barriers

- **G. Insufficient Technical Data to Revise Standards**
- **F. Enabling National and International Markets Requires Consistent RCS**
- **A. Safety Data and Information: Limited Access and Availability**

Partners

- **Regional fire departments**
- **DOE national labs**
- **Regional hydrogen associations**
- **Industrial gas industry**
- **Station developers**
- **Standards development organizations**

Relevance

- **Objectives: Both projects further the deployment of hydrogen fuel cell technologies with particular focus on the infrastructure required to support fuel cell electric vehicles (FCEVs).**
- **Project impact:**
 - The Continuous Codes and Standards Improvement (CCSI) project supports technology deployment by modifying codes and standards to remove barriers to their effective application.
 - The Codes and Standards Outreach and Training project supports technology deployment by providing codes and standards information to project developers and code officials, making project permitting smoother and faster.
 - These impacts directly address DOE barriers to deployment (consistent codes and standards and having information readily available to users).
 - These projects have proven to be effective over the last year with furthering hydrogen fueling station deployment and addressing key code issues such as hydrogen storage setback distances.

Approach

- **Outreach and Training:**

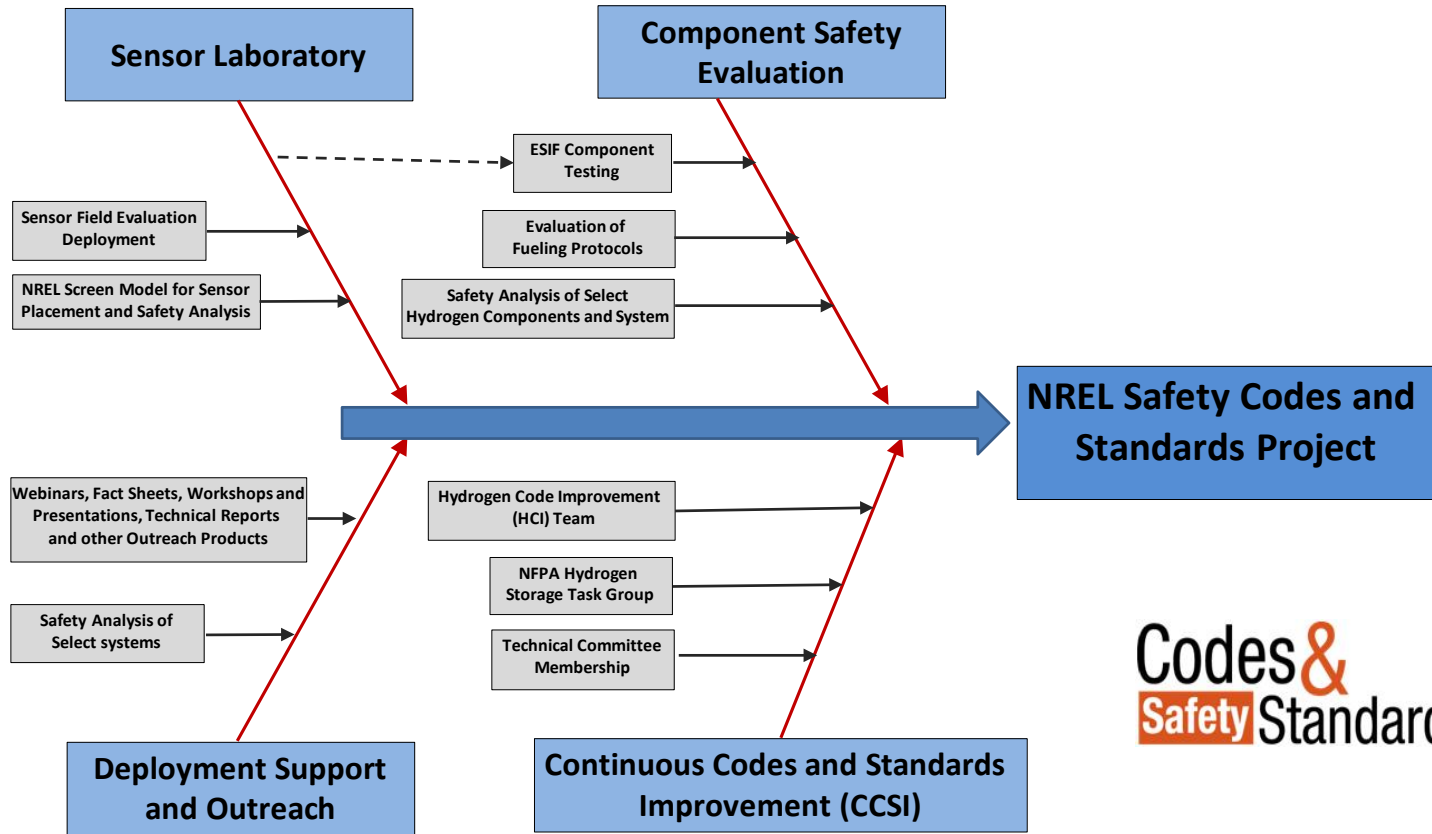
- Identify the users' needs at this stage of technology deployment, particularly code officials and project developers, and develop tools to make their jobs easier.
- Use extensive collaborations with interested parties to ensure information is effectively distributed to users.

- **CCSI:**

- Use NREL participation in Regulations, Codes, and Standards (RCS) technical committees (including ISO committees), H2USA, H2FIRST, and review of NREL field data to identify key RCS issues requiring action.
- Use a process that complements the ANSI process that all North American standards development organizations (SDOs) follow.
- Foster collaborations with industry, national laboratories, SDOs, project developers and other interested parties to identify code improvement issues.

Approach:

NREL Safety Codes and Standards Project Structure



Codes &
Safety Standards

Accomplishments and Progress: Outreach and Training Project

- **Hydrogen station permitting video**
- **Guide for Permitting Hydrogen Motor Fuel Dispensing Facilities**
- **Telecommunications Industry Association (TIA) stationary fuel cell guidance**
- **Codes and standards training**
- **Hydrogen Technologies Safety Guide**
- **H2USA Market Acceleration Working Group**
 - State and local jurisdiction code issues
 - Western Governors Association and National Association of State Legislators

Outreach and Training Accomplishments and Progress: Hydrogen Station Permitting Video

Excerpt from shooting outline

- *What is the viewer's problem?*
The viewer is presented with a project that is foreign to them. They don't know where to start or what to expect.
- *What is the viewer's solution?*
The solution is to watch this video, which will save hours of misdirection and frustration and provide a level of comfort and confidence.
- *What do you want the viewer to take away from this segment?*
You are not alone, and there are plenty of resources to make your job easier starting now by viewing of this video.

Progress

- Draft shooting outline complete
- Introduction, interviews, and fire department footage complete
- Fueling animation complete
- Station schematics drafted
- Final video to be completed 30 September 2015

Outreach and Training Accomplishments and Progress: Hydrogen Station Permitting Video

Modules

- Introduction
- Why stations are needed
- Background of hydrogen technologies
- Codes and standards for hydrogen stations
 - Bulk gaseous hydrogen delivered
 - On-site hydrogen production
 - Liquefied hydrogen
- Maintenance

Collaborators

- Orange County Fire Authority
- South Coast Air Quality Management District
- UC Irvine Fire Department
- First Element
- Linde

Outreach and Training Accomplishments and Progress: Hydrogen Station Permitting Video

Key points

- Contracts put in place in early 2015
- Draft shooting script complete March 2015
- Video should be complete by end of FY 2015
- Access through DOE website/hydrogen portal
- Can be amended to cover some topics in more detail or to incorporate technology updates

Carl Baust, P.E.

**Orange County Fire Authority
Fire Protection Engineer and
Primary Contributor**

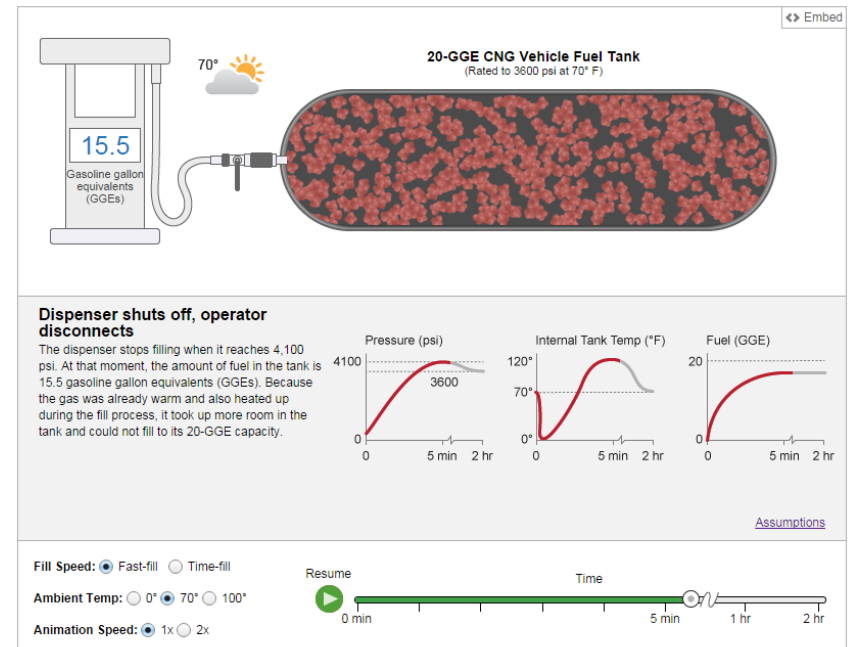


Outreach and Training Accomplishments and Progress: Hydrogen Station Permitting Video

Video components

- Expert interviews
- Code official narratives
- Safety inspector narratives
- Footage of stations
- Animation of hydrogen fueling
- Schematics of hydrogen fueling stations

Hydrogen fueling animation



Outreach and Training Accomplishments and Progress: Guide to Permitting Hydrogen Motor Fuel Dispensing Facilities

Table of contents

1.0 Introduction

- 1.1 Purpose
- 1.2 Background
- 1.3 Structure of This Guide

2.0 Hydrogen Motor Fuel Dispensing Facility Basics

3.0 Hydrogen Motor Fuel Dispensing Facility Requirements

- 3.1 Construction Requirements for Gaseous Hydrogen Storage
 - 3.1.1 Site Selection and System Siting
 - 3.1.2 Storage System
 - 3.1.3 Dispensing System
- 3.2 Construction Requirements for Liquefied Hydrogen Storage
- 3.3 Operating Requirements for a Hydrogen Motor Fuel Dispensing Facility

4.0 Codes and Standards Affecting Design, Installation, and Operation of a Hydrogen Motor Fuel Dispensing Facility

- 4.1 Overview
- 4.2 Codes and Standards Tables

5.0 Case Study

- 5.1 Project Description
- 5.2 Installation
 - 5.2.1 Hydrogen Receiving and Long-Term Storage System
 - 5.2.2 Hydrogen Transfer System
 - 5.2.3 Installation Operation

- 5.3 Codes and Standards
- 5.4 Additional Resources

6.0 Hydrogen Properties



Guide to Permitting Hydrogen Motor Fuel Dispensing Facilities

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NREL/TP- 5400-64042
April 2015

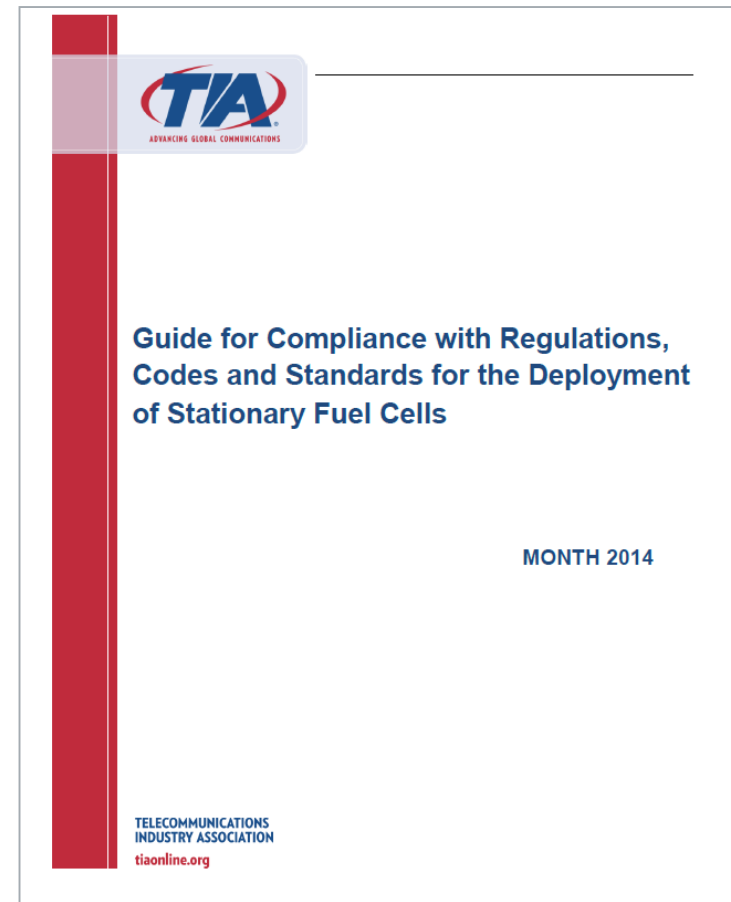
Contract No. DE-AC36-08G028308

Outreach and Training Accomplishments and Progress: Telecommunications Industry Association (TIA) Documents

Two documents

- Guide for Deployment of Stationary Fuel Cells (background information)
- Guide for Compliance with Regulations, Codes and Standards for the Deployment of Stationary Fuel Cells (summary of typical RCS)
- These guides do not contain any safety recommendations – they only attempt to summarize existing RCS
- They are similar to maps that attempt to guide the potential project developer through the existing RCS and provide background information on fuel cell technologies
- TIA is an ANSI-accredited SDO with extensive experience in document production

Draft of first volume



Outreach and Training Accomplishments and Progress: Codes and Standards Training

In-person/Web training

- Denver Fire Department, Denver, CO, 19 August 2014
- Hayward, CA, 9 December 2014 (collaboration with California Fuel Cell Partnership [CaFCP])
- H2USA Hydrogen Component Workshop, 22 April 2015
- Colorado Hydrogen Coalition, July 2015
- International Code Council, 29 September 2015 (collaboration with CaFCP and Pacific Northwest National Laboratory)

Feedback

- Strong attendance from fire officials in key jurisdictions
- Multiple requests for presentation material
- Follow-up questions from code officials on applying codes and standards to projects they are reviewing
- More in-depth codes and standards coverage for select audience



Outreach and Training Accomplishments and Progress: H2USA

- **Identified obstacles in existing transportation infrastructure to FCEV deployment**
- **Regional regulations restricting FCEV usage of tunnels and hydrogen transport over bridges**
 - Identify controlling authorities and process for regulatory change
 - Meet with controlling authorities to brief them on hazards of FCEVs and hydrogen transport
 - Propose regulatory changes
- **Held meetings with National Association of State Legislators (NASL) and Western Governors Association (WGA) to:**
 - Familiarize them with FCEVs and the required fueling infrastructure
 - Ride and drive a Toyota Highlander FCEV
 - Develop opportunities for expanding infrastructure through state incentives

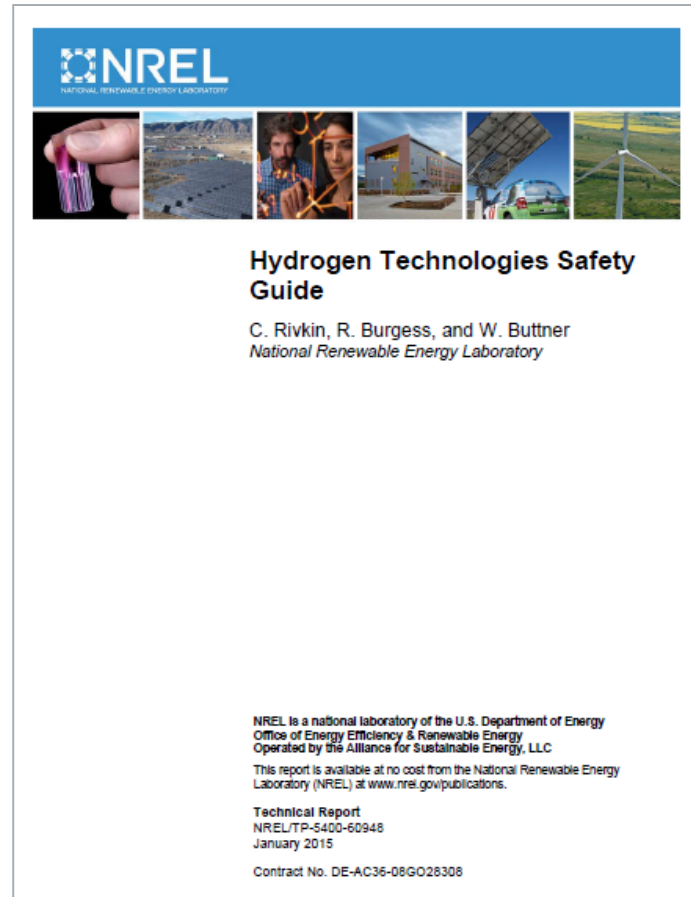
Outreach and Training Accomplishments and Progress: Hydrogen Technologies Safety Guide

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Published January 2015

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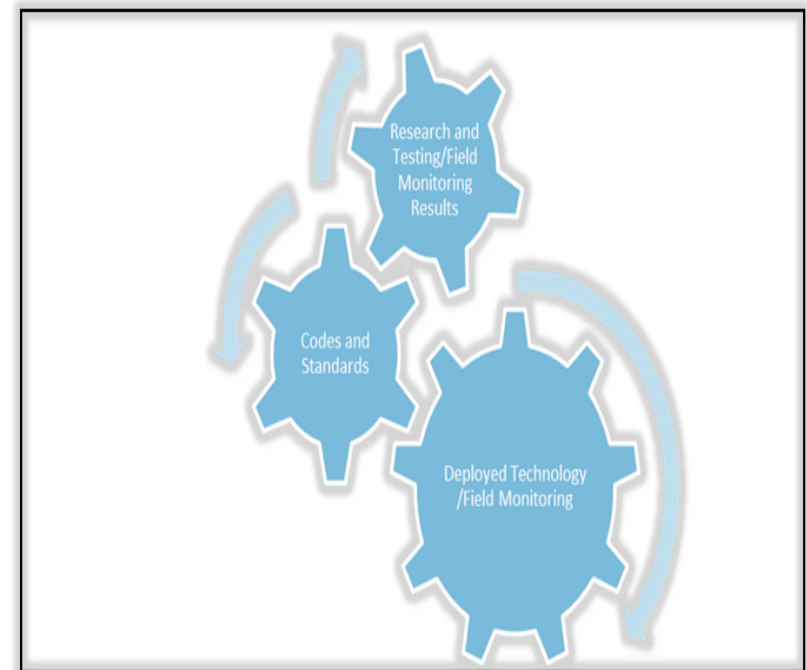


Accomplishments and Progress: Continuous Codes and Standards Improvement (CCSI) Project

CCSI projects

- NFPA Task Group
- Hydrogen Code Improvement (HCI) Team
- Member of several codes and standards technical committees
 - Principal Member of NFPA Industrial and Medical Gases Technical Committee
 - CGA Hydrogen Technology Committee
 - CSA Technical Subcommittee on Standards for Compressed Natural Gas (NGV) and Compressed Hydrogen Vehicle Fuel Containers
 - ASTM
 - SAE Fuel Cell Committee
- Review of ISO standards as a member of ISO T/C 197 WG 21, 22, and 23
- H2FIRST – validation testing for hydrogen component standards

The CCSI process



CCSI Accomplishments and Progress: NFPA Hydrogen Storage Task Group

Objectives

- Evaluate setback distances for bulk liquefied hydrogen storage found in NFPA 55 and develop setback distances based on a documented technical analysis
- Evaluate mitigation measures beyond current code requirements and develop a conversion tool to convert additional mitigation to reduced setback distances
- Task group scope has expanded on the mitigation measures to include gaseous hydrogen
- Setback distances for hydrogen storage determined to be a critical barrier to deployment

Progress

Project Plan Developed with Key Elements Defined
1. Representative system chosen using CGA P-28 Risk Management Plan (RMP) Analysis (complete)
2. Risk ranking of hazard scenarios identified in CGA P-28 performed to identify critical scenarios for air dispersion modeling (complete)
3. Liquid hydrogen release model undergoing validation
4. Leak frequency data from hydrogen storage systems will be used (data collection ongoing)
5. Risk threshold set to determine setback distances (complete – using same value as gaseous hydrogen storage)
6. Deploy HyRAM tool for developing risk informed setback distances and mitigation measures (tool in development)

CCSI Accomplishments and Progress: NFPA Task Group

**Key finding from risk analysis:
venting during transfer can
produce large discharges**



Project plan timeline

1. Identify release scenarios for modeling – 9 April 2015
2. Identify mitigation measures that could reduce the impact of these release scenarios – 3–4 June 2015
3. Identify additional inputs required to use the HyRAM tool for developing risk informed setback distances and mitigation measures – September 2015
4. Develop initial revised setback distances and mitigation measures for both gaseous and liquefied hydrogen storage – January 2016
5. Develop draft proposal to NFPA 55 for revised setback distances and mitigation measures – March 2016
6. Develop final proposals to NFPA 55 for revised setback distances and mitigation measures – July 2016

CCSI Accomplishments and Progress: Creation of Hydrogen Code Improvement (HCI) Team

Charter

- Purpose: Enact change (improvements) in hydrogen codes and standards. Identify areas where codes and standards related to hydrogen need improvement, especially related to hydrogen fuel cell vehicles and their related infrastructure, and take action to move the needed changes forward. Emphasis will be on top tier codes and standards with a specific emphasis on:
 - The International Code Set (I-Codes) International Fire Code, International Building Code, International Fuel Gas Code
 - NFPA 1 (top tier model fire code for “NFPA” states)
 - NFPA 2, 55
 - Local codes (e.g., California Fire Code, New York City Fire Code & Port Authority, City of Los Angeles).
- Actions will be in the form of developing, submitting, and supporting actionable code change proposals.

Representation

- Demonstrated successful experience with developing and getting code proposals approved.
- Documented experience with and understanding of the administrative process of:
 - NFPA Codes and Standards
 - ICC Codes
- Experience approving hydrogen and/or other hazardous material projects from a fire code perspective.
- Experience with top tier codes and how they work together. Experience with only hydrogen is not sufficient. Better to have both hydrogen specific code experience as well as overall fire code experience with an emphasis on hazardous materials.
- Hydrogen fuel station design experience.
- Hydrogen gas supplier experience.
- FCEV original equipment manufacturer experience.
- Available to perform needed tasks.

CCSI Accomplishments and Progress: Hydrogen Component Standards

Key hydrogen listing standards may require validation

- CSA HGV 4.1 Hydrogen Dispenser
- CSA HGV 4.2 Hoses
- CSA HGV 4.4 Breakaway Devices
- CSA HGV 4.6 Manual Valves for Use in Hydrogen Fueling Stations(s)
- CSA HGV 4.7 Automatic Valves for Use in Hydrogen Fueling Station(s)
- CSA HGV 4.8 Fueling Station Compressors
- CSA HGV 4.10 Fittings
- SAE J2600 and ISO 17268 for fueling nozzles
- CGA S-1.1 for PRDs for cylinders for compressed gases
- CGA S-1.3 for PRDs for stationary storage containers for compressed gases

Accomplishments

- NREL met with CSA 20 February 2015 to discuss possible test plans
- NREL presented issue to H2FIRST review panel 22 March 2015
- Prioritized standards according to earlier risk analysis on hydrogen fueling

Accomplishments and Progress:

Responses to Previous Year Reviewers' Comments

1. Why is the CCSI project focused on domestic codes and standards?

One of the main objectives of both projects is to support deployment of infrastructure in the United States. The built environment in the United States is controlled by building and fire codes that make very limited reference to ISO or other non-North American standards. If ISO documents are used as the basis for North American standards then they could be considered to be under the scope of this project.

2. Is there sufficient collaboration in the outreach and training products?

The NREL technical reports produced go through technical review by outside and internal reviewers. This review process has produced many helpful insights that have been incorporated into the final documents. The training video under development has the collaboration of an expert in the hydrogen permitting field as well as the input of several hydrogen experts, station developers, and industrial gas companies. The in-person training material is highly fluid, is tailored to specific audiences, and incorporates feedback from audiences. It is important to note that documents that are to be produced on a timeline will have a limited review process – this process cannot be open ended.

Collaborations: Outreach and Training Project

- **NREL collaborators:**

- Pacific Northwest National Laboratory – joint in-person training and co-authored outreach materials
- Sandia National Laboratories and Los Alamos National Laboratory – co-authored paper on history of codes and standards
- California Fuel Cell Partnership – joint in-person training
- Orange County Fire Authority – collaborated on hydrogen “Fueling Station Permitting” video
- Massachusetts Hydrogen Coalition – collaborated on H2USA outreach
- Colorado Hydrogen Coalition – collaborated on plan to support hydrogen deployment in Colorado
- Several fire departments including the fire departments in the Los Angeles metropolitan area and the Denver Fire Department collaborated on training –
- H2USA Market Acceleration Working Group – collaborated on development of outreach materials
- Western Governors Association – presented on resources available to support hydrogen infrastructure deployment
- National Conference of State Legislators – presented on resources available to support hydrogen infrastructure deployment
- Fuel Cell and Hydrogen Energy Association (FCHEA) – collaborated on webinar on listing hydrogen fueling system components
- Codes and standards development organizations such as the International Code Council – collaborated on in-person training and webinar on listing hydrogen fueling system components
- Hydrogen fueling station developers – supported hydrogen fueling station developers (such as First Element) by answering questions on compliance issues

Collaborations: CCSI Project

- **NREL collaborators:**
 - Sandia National Laboratories
 - Pacific Northwest National Laboratory
 - Standards development organizations including the following:
 - International Code Council, National Fire Protection Association, CSA, CGA, SAE, ISO, ASME, ASTM, UL
 - H2USA
 - H2FIRST
 - DOE Codes and Standards Tech Team
 - DOE Hydrogen Safety Panel
 - Hydrogen fueling project developers – First Element
 - Industrial gas industry – LH2 Task Group

Remaining Challenges and Barriers

CCSI

- Coordinating requirements in building and fire codes with hydrogen-specific codes and standards
- Implementing the analytical tools required to make technically substantiated code changes
- Obtaining data on component failure and leak frequency
- Validating test requirements in component listing standards
- Addressing regional infrastructure code issues

Training and Outreach

- Continuing to identify and reach out to key groups on both a regional and national basis
- Reducing large amounts of information into clear, intelligible training materials
- Identifying codes and standards and permitting issues that are creating difficulties for users

Proposed Future Work

CCSI

- Develop engineering-based setback distances for liquid hydrogen
- Develop mitigation measures to reduce setback distances for both liquid and gaseous hydrogen
- Address key coordination issues in building and fire codes
- Support component standard development and validation

Training and Outreach

- Continue to support H2USA outreach efforts
- Complete hydrogen station permitting video, permit manual, and TIA guidance documents, and distribute through DOE/Hydrogen Portal
- Continue focused in-person training in key geographic locations
- Develop interactive permitting tools

Summary

CCSI

- The NFPA Task Group has a solid plan to revise liquid hydrogen setback distances and develop a tool to convert mitigation measures for both liquid hydrogen and gaseous hydrogen into reduced setback distances.
- A Hydrogen Code Improvement (HCI) team has been formed that will translate codes and standards issues into high quality code and standards proposals.

Training and Outreach

- The hydrogen permitting video will be an effective tool to further infrastructure deployment.
- Permitting and safety documents will complement the permitting video.
- In-person training will get information to key geographical audiences.
- H2USA outreach and market acceleration efforts will get information to key groups across the United States and support code development activities.