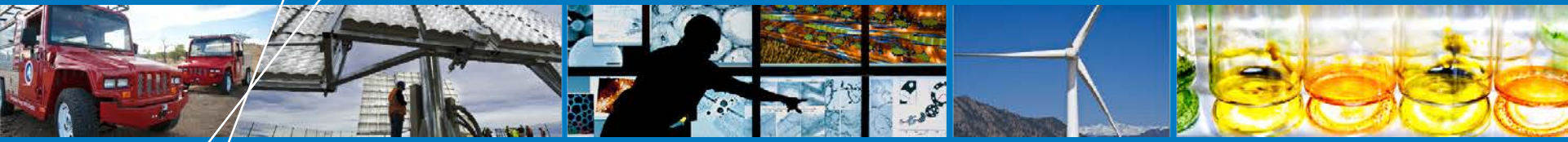
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Fuel Cell Technologies National Codes and Standards Development and Outreach



2013 DOE Annual Merit Review

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National Renewable Energy Laboratory

May 14, 2013

Project ID # SCS001

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Overview

TIMELINE

- Start date: **October 1, 2002**
- End date: **10/2013***

*Project continuation and direction determined annually by DOE

BARRIERS

- Insufficient synchronization of national codes and standards
- Safety data and information: limited access and availability
- Lack of hydrogen knowledge by AHJs
- Enabling national and international markets requires consistent RCS
- Insufficient technical data to revise standards

BUDGET

- Funding received in FY12: **$750K**
- Funding planned for FY13: **$550K***

** $300K outreach and $250K development*

PARTNERS

- National H2/Fuel Cells Codes and Standards Coordinating Committee, SDOs, FCHEA, CaFCP, CARB, AHJs, compressed gas and sensor industry
- US Drive C&S Technical Team

Relevance/Objectives

- **Relevance**
  - Hydrogen can be safely deployed if Regulations, Codes and Standards (RCS) are followed and interested parties have safety information
- **Objectives**
  - Support code development for the safe use of hydrogen in commercial, residential, and transportation applications with a major emphasis on infrastructure hydrogen fuel cell vehicle technologies
  - Advance hydrogen safety by collaboration and coordination with stakeholders
  - Facilitate the safe deployment of hydrogen technologies by working to incorporate safety data into codes and standards projects and hydrogen technology deployment projects
  - Distribute hydrogen safety information through the most effective channels, including websites, NREL technical reports, webinars, and in-person presentations required to reach key audiences such as project developers and code officials
  - *Conduct research and development (R&D) needed to establish sound technical requirements for the safe use of alternative fuels with a major emphasis on hydrogen and fuel cell technologies*
    - *Note that there are two NREL presentations (SCS002 and SCS021) on research supporting safety, codes and standards development*

Approach

The following methods will ensure that NREL effectively coordinates code development and distributes safety, codes and standards information for technology deployment:

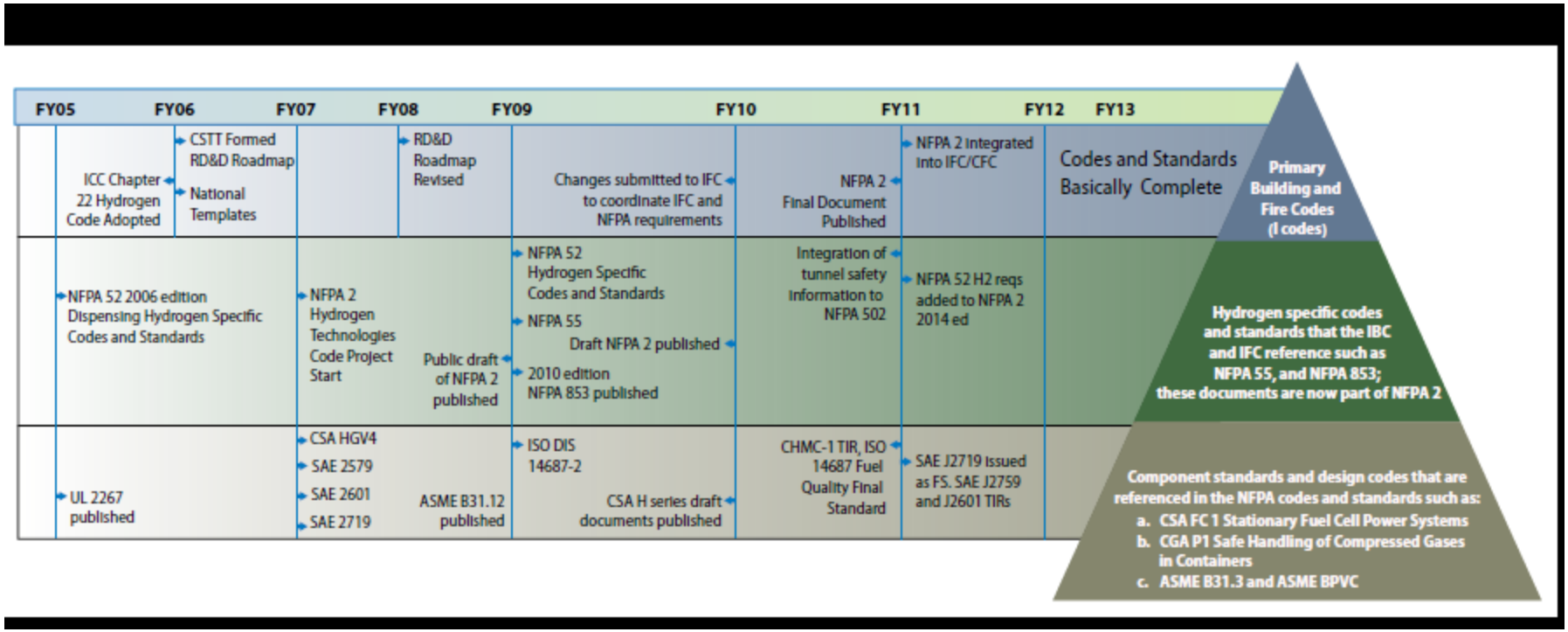
- **Codes and standards coordination and development for deployment**
  - NREL has identified work areas where resources can be used effectively to develop codes and standards
  - Code coordination: NREL has supported the coordination of the International Code Council (ICC) and National Fire Codes (NFC) and the California Fire Code
  - Direct technical committee involvement is key element of approach- H2 Committee
  - Coordination committees: C&S Tech Team, National Codes and Standards Coordinating Committee, Sensor Task Group
  - Technical studies such as NREL's gap analyses and NREL technology validation data help establish priorities:
    - Technology validation data, http://www.nrel.gov/hydrogen/media/demo/source/sunburst.html
    - Blake, C.; Buttner, W.; Rivkin, C. (2010). Vehicle Codes and Standards: Overview and Gap Analysis. 193 pp.; NREL Report No. TP-560-47336.
- **Information to support technology deployment**
  - Permitting presentations and webinars, third party safety review, codes and standards compliance templates, and Web-based information compendium
  - Review technology validation data to identify key areas of concern for safe deployment of hydrogen technologies

Key Collaborations

- Industry- industrial gas companies, OEMs, component manufacturers
- National laboratories- Sandia National Laboratory (component, codes and standards issues), Pacific Northwest National Laboratory (outreach, safety issues)
- Regional deployment support groups- California Fuel Cell Partnership
- Enforcing authorities- worked with authorities in key jurisdictions where to deployment is planned

Technical Accomplishments and Progress

- **Timeline showing development of key C&S**
- **Pyramid showing hierarchy of infrastructure C&S**



Technical Accomplishment- Key Codes and Standards are in Place for Deployment

- **Progress**
  - Key RCS for hydrogen technologies infrastructure deployment are complete
  - Key documents:
    - NFPA 2 Hydrogen Technologies Code
    - International Fire Code (IFC) – addresses hydrogen applications
    - International Building Code (IBC) – general construction requirements
    - ASME B31.12 Hydrogen Pipelines and Piping Code – hydrogen piping design
    - ASME Boiler and Pressure Vessel Code (BPV) Section XIII Pressure Vessels
    - CGA S-1.1-3 Pressure Relief for hydrogen storage systems
    - National Electric Code (NEC) for classified electrical areas
    - SAE J2719 Fuel Quality
- **Path forward/key focus areas**
  - Focus on improving component safety for hydrogen technologies deployment with special focus on infrastructure safety
  - Outreach/education for project developers, code officials, and other interested parties to support deployment with special focus on infrastructure

Codes and Standards- Outstanding Issues

- **There is still significant RCS work but much of it will be most effectively accomplished by industry and other interested parties**
- **NREL role- continue work to coordinate codes and standards on a smaller scale with special focus on:**
  - Taking information from deployment projects, such as NREL safety data, back to code development committees
  - Resolving infrastructure codes and standards issues
  - Working with code development committees to ensure research products are incorporated into codes and standards

Technical Accomplishment – Codes and Standards Coordination Committees

- **Accomplishment**
  - NREL provided broad coordination of codes and standards development by:
    - Supporting CSTT (Codes and Standards Tech Team) – develop and maintain the "2020" plan for defining and tracking C&S work required for deployment of hydrogen fuel cell vehicles
    - Managing the National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee (NHA, USFCC) – (group has monthly meetings that serve as a forum for the C&S development community to share information)
    - Running Hydrogen Sensor Task Group monthly meetings
    - Acting as liaison between codes and standards development committees to assist in coordination between fire codes and standards development projects
- **Significance**
  - Coordination makes the code development process more efficient, reduces redundancy, and helps committees focus on priority issues

Technical Accomplishment – *RCS Coordination and Development through FCHEA

- **Accomplishment**
- **NREL subcontract with the Fuel Cell and Hydrogen Energy Association (FCHEA) is focused on the areas of RCS with the greatest impact on deployment.**
  - Maintains Regulatory Affairs matrix
  - Administers monthly NHFCCSCC meetings
  - Distributes information on RCS at FCHEA web site
  - http://www.hydrogenandfuelcellsafety.info/reviewDocs.asp
  - Provides a forum for interested parties to participate in the RCS development processes

- **Significance**
  - Coordination makes the code development process more efficient, reduces redundancy, and helps committees focus on priority issues

***Fuel Cell and Hydrogen Energy Association (FCHEA) work is funded through a project not shown on the funding slide**

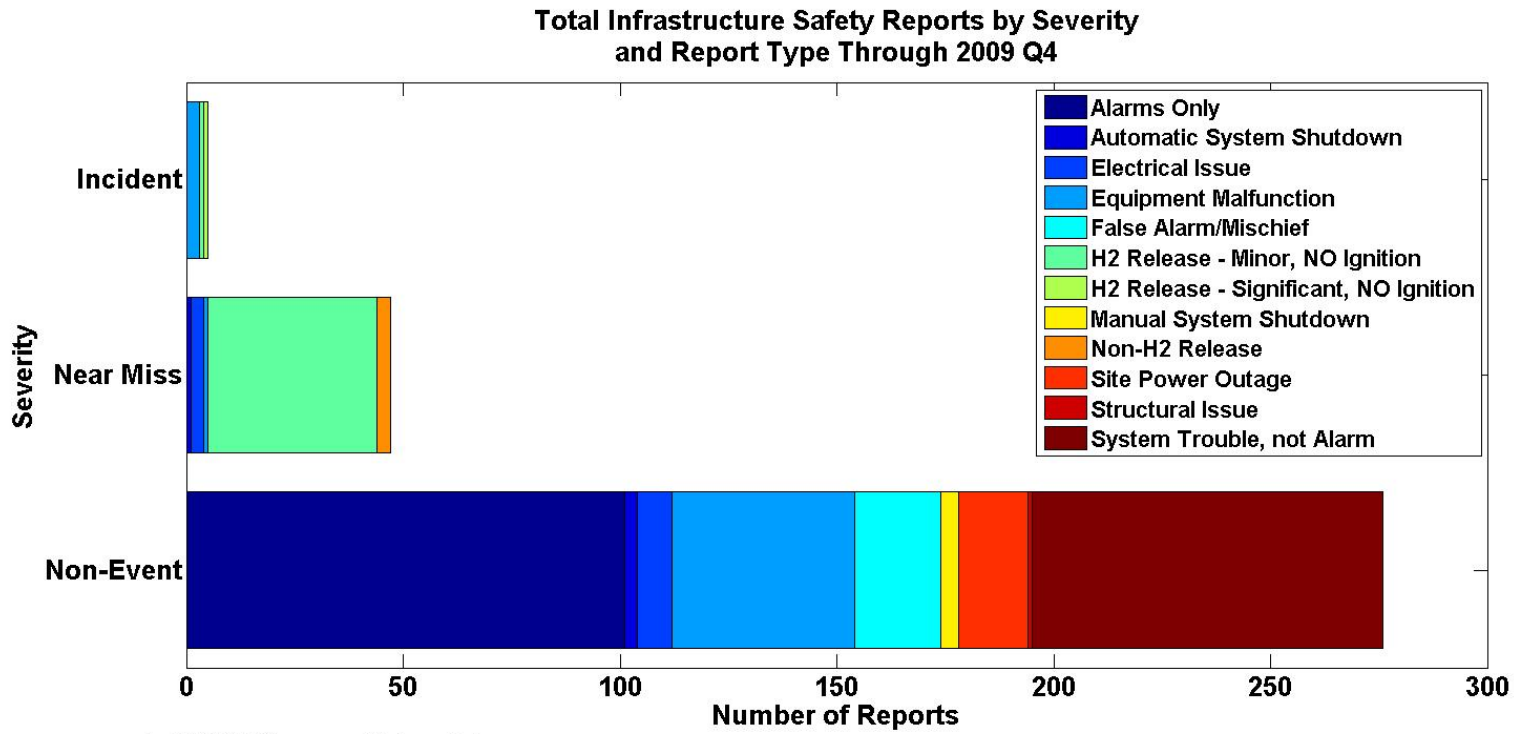
Technical Accomplishment – NREL has Implemented the 2020 Vehicle Deployment Plan

- **Accomplishment**
  - NREL accomplishments dictated by the 2020 Plan (Plan that identifies the Regulations, Codes and Standards (RCS) required to deploy hydrogen fuel cell vehicles on a commercial basis by 2020 developed by the Codes and Standards Tech Team) include:
    - Integrated NFPA 2 Hydrogen Technologies Code into the International Fire Code (IFC)
    - Supported codes and standards application in California through support of the California Fuel Cell Partnership (CaFCP)
    - Supported the development of key standards such as SAE J2601
- **Significance**
  - Achieving plan objectives will allow vehicle deployment

Technical Accomplishment – Coordination of Key Fire Codes

- **Accomplishment**
  - NREL worked to have references to NFPA 2 Hydrogen Technologies Code placed in the Fire Codes (The International Fire Code (IFC) and the Uniform Fire Code (UFC))
- **Significance**
  - NFPA 2 is a comprehensive hydrogen technologies code; 1st edition issued in 2011
  - The International Fire Code (IFC) and the Uniform Fire Code (UFC) are the two primary fire codes used in the United States
  - References to NFPA 2 Hydrogen Technologies Code in these Fire Codes will make NFPA 2 effectively the national hydrogen code for the United States
  - A national hydrogen code will create a greater level of standardization in hydrogen requirements
  - **This increased standardization will make it easier for project developers to write permit applications and code officials to review these applications**

Technical Accomplishment – Safety Review of Technology Validation Data



An INCIDENT is an event that results in:

- a lost time accident and/or injury to personnel
- damage/unplanned downtime for project equipment, facilities or property
- impact to the public or environment
- any hydrogen release that unintentionally ignites or is sufficient to sustain a flame if ignited
- release of any volatile, hydrogen containing compound (other than the hydrocarbons used as common fuels)

A NEAR-MISS is:

- an event that under slightly different circumstances could have become an incident
- unplanned H2 release insufficient to sustain a flame

NREL CDP20
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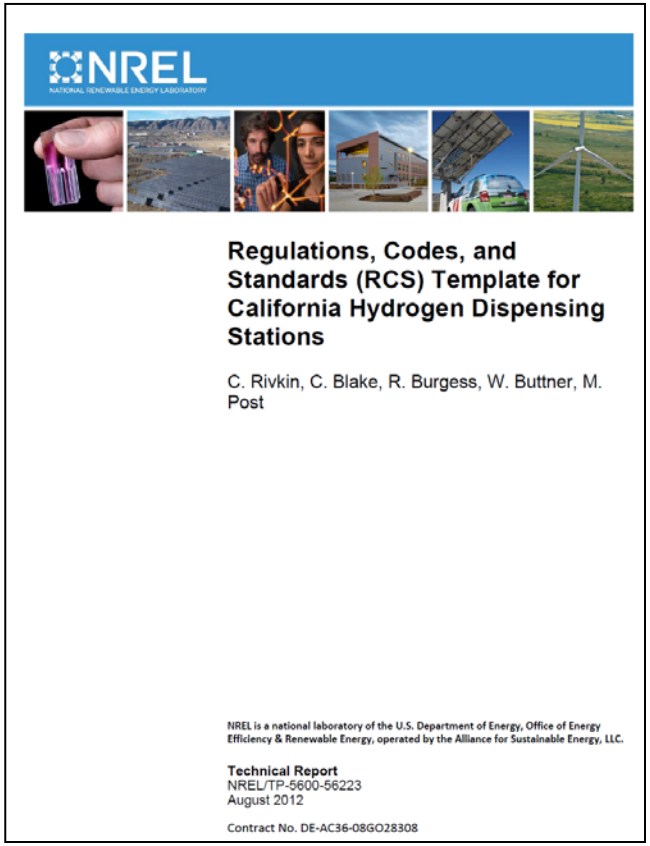
Technical Accomplishment – Safety Review of Technology Validation Data

- **Accomplishment**
  - Review leads to several key findings:
    - Component safety issues need to be better understood
    - Safety analyses may be fed back into the codes and standards development process
    - Data help give code officials and other interested parties a picture of hydrogen deployment safety and can be used in outreach efforts
- **Significance**
  - Analyzing technology validation safety data will help solve critical safety problems required to be addressed to deploy hydrogen technologies

NREL Technical Report for Dispensing Stations

Accomplishment – Published report

http://www.nrel.gov/publications/



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Regulations, Codes, and Standards (RCS) Template for California Hydrogen Dispensing Stations

C. Rivkin, C. Blake, R. Burgess, W. Buttner, M. Post

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Technical Report
NREL/TP-5600-56223
August 2012

Contract No. DE-AC36-08GO28308

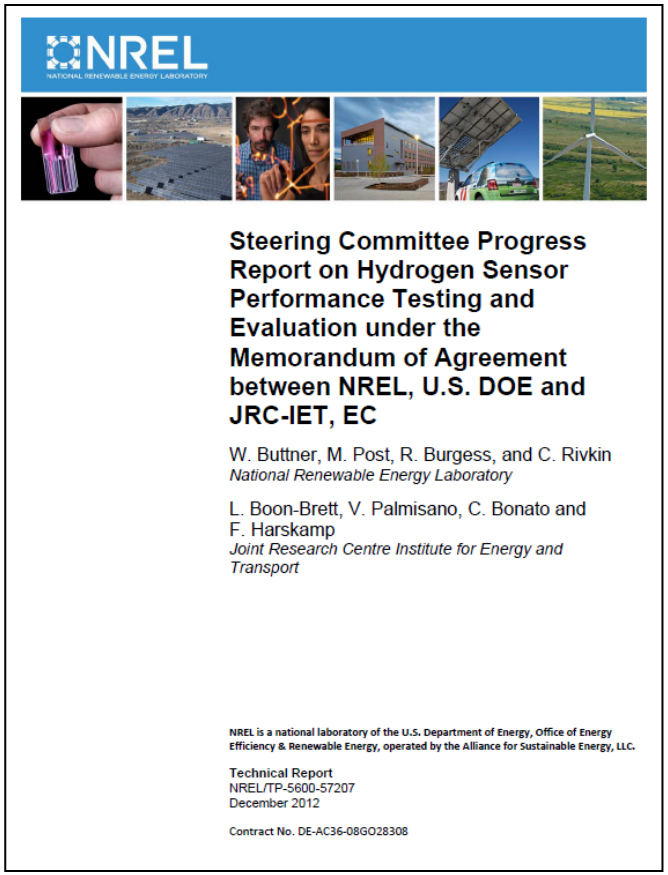
Significance – Report provides information on the following topics:

- RCS for hydrogen fueling stations
- California Fire Code and other California-specific requirements
- Permitting procedures
- Template of permit requirements for a hydrogen fueling station

NREL Technical Report: NREL, U.S. DOE, and JRC-IET, EC

Accomplishment – Published report

http://www.nrel.gov/publications/



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Steering Committee Progress Report on Hydrogen Sensor Performance Testing and Evaluation under the Memorandum of Agreement between NREL, U.S. DOE and JRC-IET, EC

W. Buttner, M. Post, R. Burgess, and C. Rivkin
National Renewable Energy Laboratory

L. Boon-Brett, V. Palmisano, C. Bonato and F. Harskamp
Joint Research Centre Institute for Energy and Transport

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Technical Report
NREL/TP-5600-57207
December 2012

Contract No. DE-AC36-08GO28308

Significance – Report provides information on the following topics:

- 2.1.1.1 Sintercom
- 2.1.1.2 Oxygen dependence
- 2.1.1.3 Sensor miniaturization
- 2.1.1.4 Interferent and poisons
- 2.1.1.5 Hydrogen measurement via oxygen displacement
- 2.1.1.6 Hydrogen sensor use in fuel cell electric vehicles
- 2.1.1.7 Performance feedback to hydrogen sensor manufacturer

Information Compendium / Update RCS References

Vehicle and Infrastructure Citations

Hydrogen Vehicle and Infrastructure Codes and Standards Citations

- This document lists codes and standards typically used for U.S. hydrogen vehicle and infrastructure projects. To determine which codes and standards apply to a specific project, identify the codes and standards currently in effect within the jurisdiction where the project will be located. Some jurisdictions also have unique ordinances or regulations that could apply.
- Learn about codes and standards basics at www.afdc.energy.gov/afdc/codes_standards_basics.html.
- Find hydrogen vehicle and infrastructure codes and standards in these categories:
  - Annual Inspections
  - Balance of Plant
  - Canopy Tops
  - Compressed Hydrogen Gas Storage
  - Compression Systems and Equipment
  - Design
  - Dispensing
  - Dispensing, Operations, and Maintenance Safety
  - Fire Safety
  - Liquid Hydrogen Storage
  - On-Site Hydrogen Production
  - Operation Approvals
  - Setbacks and Footprints

Stationary Fuel Cell Citations

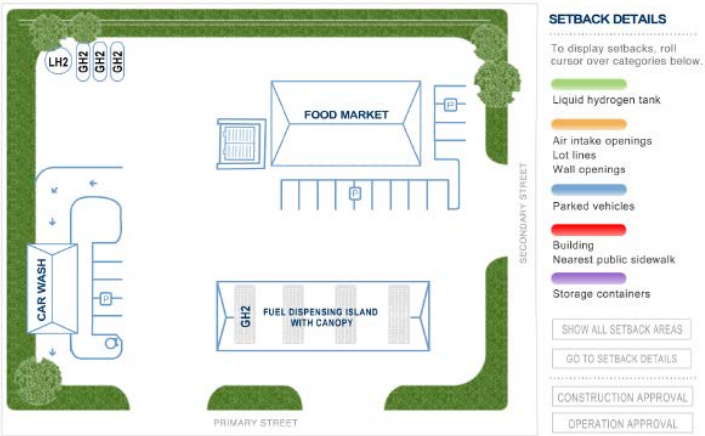
Stationary and Portable Fuel Cell Systems Codes and Standards Citations

- This document lists codes and standards typically used for stationary and portable fuel cell systems projects. To determine which codes and standards apply to a specific project, you need to identify the codes and standards currently in effect within the jurisdiction where the project will be located. Some jurisdictions also have unique applicable ordinances or regulations.
- Learn about codes and standards basics at www.afdc.energy.gov/afdc/codes_standards_basics.html.
- Find stationary and portable fuel cell systems codes and standards in these categories:
  - Balance of Plant
  - Compressed Hydrogen Gas Storage
  - Design
  - Electrical Equipment
  - Equipment Safety
  - Fire Safety
  - Fuel Lines
  - Operation Approvals
  - Periodic Inspections
  - Setbacks and Footprints
  - Transportation

Information Compendium / Update RCS References

Accomplishment

- Update the codes and standards reference material for both stationary fuel cells and infrastructure for fuel cell vehicles



Significance

- Easy access to commonly applied codes and standards references facilitates permit development
- Learn about codes and standards basics at www.afdc.energy.gov/afdc/codes_standards_basics.html.

NREL Hydrogen Safety Handbook

Accomplishment – Publication

- **NREL Hydrogen Safety Handbook**
  - Handbook will be an NREL technical report that can be downloaded as a single PDF
  - Table of Contents
    - Basic Properties of Hydrogen
    - Established Hydrogen Technology Applications
    - Emerging Hydrogen Technology Applications
    - Basic Hydrogen Safety
    - Regulations Codes and Standards for Hydrogen Technologies
    - Permitting Procedures
    - Reference Materials
    - Projected completion 9/11

Significance – Will help project developers and code officials develop and review permits

- Single PDF will be easily accessible
- Will be published as NREL technical report
- Includes information that will help project developers and code officials not familiar with hydrogen technologies

Milestones

FY 2013 Milestones

	Milestones	Completion Date
7.1.1	Action plans for key codes and standards complete	12/12
7.1.1	Publish the 2020 Plan of applicable codes and standards required to deploy hydrogen fuel cell vehicles on a commercial basis. CPS57458	9/13
7.1.1	Support the promulgation of the complete codes and standards required to deploy hydrogen and fuel cell technologies, with an emphasis on vehicle applications, by 2020. CPS 52251	9/13
7.1.2	Action items on key projects requiring coordination identified	11/12
7.2.1	FY13 Sensor Test Plan Complete	12/12
7.3.1	Mid-Year Deployment Evaluation	03/13
7.3.2	Sensor Field Deployment Objectives Documented	01/13
7.4.1	Subcontracting Plan Complete	11/12
7.5.1	Component testing plan complete	12/12

Summary

- Codes and Standards
- Codes and standards development support will continue at a reduced level through direct support of standards development organizations and participation on or operation of coordination committees
- Ongoing coordination of the fire codes and key hydrogen codes and standards is a priority
- Outreach
- Deployment support will be focused on infrastructure at locations with project activity and concrete deployment plans, for example jurisdictions in California
- These goals can only be accomplished through collaborations with key stakeholders at all levels
- NREL will continue to support deployment of hydrogen and fuel cell technologies through programs such as the technical reports, webinars, safety reviews, and the Web-based information compendium

Proposed Future Work

Codes and Standards Coordination

- **Continue work to coordinate codes and standards on a smaller scale with special focus on taking information from deployment projects back to code development committees**
- **Resolve infrastructure codes and standards issues**

Outreach

- **Continue to publish NREL technical reports, deliver webinars, and provide Web-based information on key safety issues required to support hydrogen technologies deployment**
- **Assist code officials, project developers, and other interested parties in use of new codes and standards and safety information through outreach activities, with special focus on key jurisdictions such as California**
- **Work with interested parties to provide information to assist in infrastructure deployment**