National Codes and Standards Development and Outreach

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Subcontractor:
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Project Start Date: October 1, 2002
Project End Date: Project continuation and direction determined annually by DOE

Overall Objectives

- Support the deployment of hydrogen technologies for hydrogen fuel cell vehicles and associated infrastructure, industrial trucks, and stationary fuel cell applications.
- Integrate safety research into codes and standards.
- Make critical safety information readily available through webinars, training sessions, safety reports, online training, and technical presentations.
- Inform key stakeholders of the safety, codes, and standards requirements for the safe use of hydrogen technologies.
- Work with potential infrastructure developers to accelerate the deployment of hydrogen fueling stations and other key infrastructure.
- Identify and resolve safety issues associated with hydrogen technologies infrastructure.
- Support the continuous improvement of codes and standards through incorporating research and field data into the code development process.

Fiscal Year (FY) 2018 Objectives

- Publish papers on the large-scale hydrogen systems and multi-fuel alternative fuel stations.
- Support the deployment efforts through participation in H2USA's Market Support and Acceleration Working Group.
- Support the development of the National Fire Protection Association (NFPA) 2 Hydrogen Technologies Code by chairing the Technical Committee on Hydrogen Technology, directing the various task groups formed under the committee.
- Support NFPA 502 Standard for Road Tunnels, Bridges, and other Limited Access Roadways by incorporating fire safety analysis into document annex.
- Develop outreach products for permitting hydrogen technologies including web-based regulations, codes, and standards (RCS) training materials.
- Implement continuous codes and standards improvement (CCSI) process by evaluating field data to determine codes and standards development priorities through an NREL technical report on safety research needs.
- Provide codes and standards information to critical stakeholders such as code officials through in-person training, updated online training, NREL technical reports posted on DOE websites, and development of relevant videos.
- Support the coordination of international and domestic hydrogen standards such as participating in International Organization for Standardization/Technical Committee 197 Hydrogen Technologies, hydrogen component development working groups, and domestic standards organizations such as the CSA Group.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Safety, Codes and Standards section of the Fuel Cell Technologies Office Multi-Year Research, Development, and

Demonstration Plan[1]: (A) Safety Data and Information: Limited Access and Availability

(D) Lack of Hydrogen Knowledge by AHJs

(F) Enabling National and International Markets Requires Consistent RCS

(G) Insufficient Technical Data to Revise Standards

(H) Insufficient Synchronization of National Codes and Standards

(I) Lack of Consistency in Training of Officials

(K) No Consistent Codification Plan and Process for Synchronization of R&D and Code Development

(L) Usage and Access Restrictions

Contribution to Achievement of DOE Hydrogen Safety, Codes and Standards Milestones

This project will contribute to achievement of the following DOE milestones from the Hydrogen Safety, Codes and Standards section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

- Milestone 4.6: Completion of standards for critical infrastructure components and systems. (4Q, 2014)
- Milestone 4.7: Complete risk mitigation analysis for advanced transportation infrastructure systems. (1Q, 2015)
- Milestone 4.8: Revision of NFPA 2 to incorporate advanced fueling and storage systems and specific requirements for infrastructure elements such as garages and vehicle maintenance facilities. (3Q, 2016)
- Milestone 4.9: Completion of GTR Phase 2. (1Q, 2017)

FY 2018 Accomplishments

- Implemented CCSI through several projects including:
  - Inter-Laboratory Research Integration Group (IRIG) assigned priorities to research and code development projects.
  - Successfully submitted code amendments in IRIG priority areas, as defined by the group rating projects, to NFPA 2, NFPA 55, and NFPA 502.
  - Led NFPA Hydrogen Technologies Technical Committee as committee chair in producing the 2020 edition of NFPA 2 Hydrogen Technologies Code.
  - Led the NFPA Standard Permit Task Group to develop permitting tools for hydrogen fueling stations and links in the annex of NFPA 2 to connect these tools to the code.
- Developed new permitting and codes and standards training tools for hydrogen technologies deployment that includes overview of NFPA 2 at H2Tools.org.
- Collaborated effectively with other DOE laboratories, including Sandia National Laboratories and Pacific Northwest National Laboratory, to develop training materials and code proposals. Proposals include annex material to NFPA 502 on hydrogen releases in tunnels, which was successfully moved to the final ballot stage in FY2018.
- Documented safety lessons learned on deployment of hydrogen projects through collaboration with NREL's Environmental, Health, and Safety group.

[1] https://www.energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22

INTRODUCTION

The fundamental purpose of this work is to support the safe deployment of hydrogen technologies. To achieve this objective, codes and standards must be in place to protect public safety and any significant safety issues must be resolved before deployment proceeds. The primary focus of this project is to identify research needs to support codes and standards development and integrating that research into the appropriate documents.

The work under this project has helped develop a national set of codes and standards to safely deploy hydrogen technologies. Additionally, key safety issues have been identified and are in the process of being resolved. Safety, codes, and standards information has been distributed to interested parties using a variety of techniques including webinars, NREL technical reports, workshops, in-person presentations, videos, online training tools, and web-based products.

APPROACH

The project approach involves integrating the efforts from as many key stakeholders as possible in codes and standards development and coordination and outreach activities to achieve maximum impact. These stakeholders include industry partners, standards development organizations, research organizations including other national laboratories, authorities having jurisdiction, local government in locations where projects will be deployed, and trade organizations involved in technology development and deployment.

RESULTS

NREL, at the direction of DOE, has helped develop a baseline set of codes and standards for the deployment of hydrogen technologies. This accomplishment helps meet several DOE milestones, including 4.4 and 4.8.

The next step in this codes and standards development process after the promulgation of the baseline set of codes and standards is monitoring the field performance of these documents, determining where modifications are required (including the research required to support these modifications), and supporting the implementation of those modifications. Examples of these modifications achieved in FY 2018 include adding allowances for using active safety measures for bulk liquefied hydrogen storage systems in NFPA 2 and the references to NREL work on hydrogen fueling system installation methods to reduce the probability of system fouling. This helps DOE meet milestone 4.5.

This modification process is illustrated in Figure 1. The process consists of evaluating field deployment of hydrogen technologies through use of NREL data and site visits, determining whether there are issues with codes and standards based on this information, and developing modified codes and standards requirements to resolve these issues. This process also integrates NREL (and other DOE laboratories) laboratory research activities involving hydrogen technologies safety by using this research to address codes and standards issues.

The CCSI process produced results in the following areas:

1. The NFPA Hydrogen Standard Permit Task Group submitted a public comment to include a permit for a hydrogen fueling station employing both bulk gaseous and liquid hydrogen storage, and this comment was accepted in the form of a pointer in the code to standard permit documents.
2. The NFPA Hydrogen Storage Task Group developed a public comment to differentiate between bulk liquid and bulk gaseous portions of hybrid storage systems so that the safety separation distances could be significantly reduced and allow for more options in hydrogen fueling station siting.

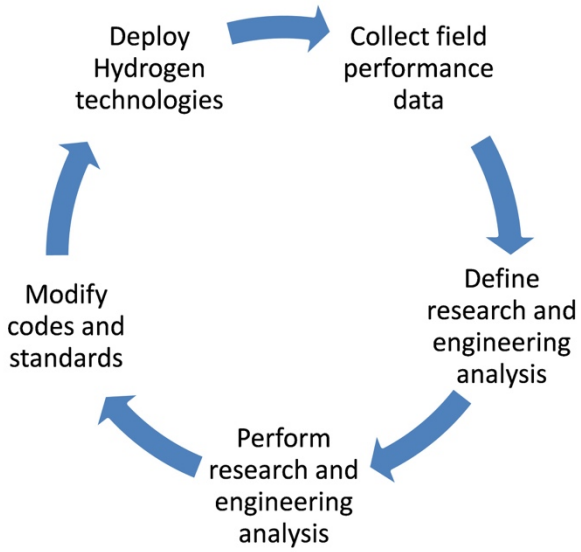

Figure 1. CCSI process

NREL completed codes and standards and permitting training tools such as the "NFPA 2 Hydrogen Technologies Code Overview" posted to the H2Tools.org website.

NREL supported the work of H2USA by participating as a member of the Market Support and Acceleration Working Group.

NREL has acted as Task Group Leader for the NFPA Hydrogen Storage Task Group and the Standard Permit Task Group, which will develop new requirements for bulk gaseous and liquefied hydrogen and associated safety mitigation measures for the next edition of NFPA 55/2. This supports DOE milestone 4.9.

CONCLUSIONS AND UPCOMING ACTIVITIES

Conclusions

- Codes and standards
    - The CCSI process is effective at modifying key codes to incorporate research results and define required research, such as characterization of liquid hydrogen releases.
    - Integration of DOE (and other) research into hydrogen codes and standards is a priority to ensure DOE safety research achieves the greatest possible impact on public safety by integration in widely used safety documents.
    - Ongoing coordination of the fire and building codes and key hydrogen codes and standards is a priority.
    - Field deployment information will help set codes and standards development priorities and improve the quality and relevance of codes as this information is incorporated through the American National Standards Institute-prescribed revision process.
    - Coordination of U.S. infrastructure codes and international standards is an increasing priority as infrastructure proceeds to commercial deployment

- Outreach
    - Outreach deployment support has been reduced to focus limited resources on IRIG (research integration) efforts.
    - Deployment support focused on infrastructure at locations with project activity and concrete deployment plans; for example, jurisdictions in California and the Northeast can be effective at moving projects forward, but this is a labor-intensive effort.
    - These goals can only be accomplished through collaborations with key stakeholders at all levels.
    - NREL supports the deployment of hydrogen and fuel cell technologies through programs such as technical reports, webinars, safety reviews, and the web-based information compendium. NREL has developed permitting tools that address the different needs of stakeholders and are readily accessible through various DOE websites including H2Tools.org. These Internet accessible tools have provided permitting support for all types of users from the infrequent user to more knowledgeable users.
    - NREL will use its status as a national research laboratory with independent status to provide safety information and to bring together safety officials from different jurisdictions.

Upcoming Activities

- Codes and standards
    - Focus on the IRIG project of integrating safety research into codes and standards. Key project areas will be station siting requirements, high-risk component safety, critical infrastructure such as tunnels and garages, and codes and standards streamlining to reflect higher levels of infrastructure deployment.
    - Support H2@Scale work by identifying gaps in safety knowledge and research required to fill these gaps, as well as coordinating this research where possible.
    - Continue work to coordinate codes and standards with special focus on taking information from deployment projects back to code development committees.
    - Resolve infrastructure codes and standards issues such as hydrogen setback distances in NFPA codes.
    - Continue coordination between NFPA codes and International Code Council codes, as well as International Organization for Standardization hydrogen component standards and domestic hydrogen component standards.
    - Support efforts to adopt NFPA 2 Hydrogen Technologies Codes (and other key codes), such as the work done by California's Office of the State Fire Marshal to adopt NFPA 2 earlier than adoption of the International Fire Code would dictate. This effort will begin focus on areas of deployment outside of California as the deployment process proceeds nationally.
    - Continue to incorporate research into codes through the CCSI process using the IRIG as the primary mechanism to achieve these incorporations.
    - Support efforts to develop standard permits and similar tools for hydrogen infrastructure projects to streamline project permitting efforts.

- 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 and the Northeast.
    - Utilize NREL hydrogen fueling station for training purposes such as videos on hydrogen fueling operations and maintenance.
    - Work with interested parties to provide information to assist in infrastructure deployment.
    - Provide in-person codes and standards training or consultation in key locations such as California, New York, Massachusetts, and other zero-emission vehicle states.

FY 2018 PUBLICATIONS/PRESENTATIONS

1. C. Rivkin. "Overview: NFPA 2 Hydrogen Technologies Code Requirements." H2tools.org. 2018.
2. C. Rivkin. "National Codes and Standards Development and Outreach." Presented at DOE Annual Merit Review, Washington, DC, June 2018.
3. C. Rivkin. "NFPA 2 National Hydrogen Code 2020 Edition Update." Presented at 2017 Fuel Cell Seminar, Long Beach, CA, November 2017.
4. C. Rivkin, R. Burgess, W. Buttner. "Regulations, Codes, and Standards (RCS) for Large Scale Hydrogen Installations." NREL/CP-5400-70929. Proceedings of the 7th International Conference on Hydrogen Safety (ICHS 2017), 11–13 September 2017, Hamburg, Germany (published July 2018).