National Renewable Energy Laboratory
Innovation for Our Energy Future

2010 DOE Fuel Cell Technologies National Codes and Standards Template

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Overview

Timeline

- Start date: Oct 1, 2002
- Percent complete: Ongoing,

Barriers

- Consensus - Achieving national agenda on codes & standards (A,B,D,L,J)
- Representation – Government & Industry support and DOE limited role (F,G,H,I,K)
- Technology Readiness – Jurisdictional issues related to available codes and existing set back distances (M,N,P)

Budget

- Funding received in FY09: $0.75M (Vehicle Technologies)
- Funding for FY010: $0.9M

Partners

- National H2/Fuel Cells Codes and Standards Coordinating, SDOs Committee (NHA, USFCC), CaFCP, CARB
- FreedomCAR-Fuel Partnership C&S Technical Team

Objectives

- Conduct research & development (R&D) needed to establish sound technical requirements for renewable energy codes & standards with a major emphasis on hydrogen and fuel cell technologies.
- Support code development for the safe use of renewable energy in commercial, residential, and transportation applications with a major emphasis on emerging fuel cell technologies.
- Advance renewable energy safety, code development, and market transformation issues by collaboration with appropriate stakeholders.
- Facilitate the safe deployment of renewable energy technologies

Approach

- The following approach will ensure that all codes and standards are in place to implement hydrogen and fuel cell technologies:
- Codes & Standards Coordination and Development
  - Code Development Support: SAE, NFPA, CSA America, ICC, CGA, ISO, IEC
  - Direct technical committee involvement is key element of approach
  - Coordination Committees: C&S Tech Team, HIPOC, NHFC4
- Collaboration
  - SNL, LANL, ORNL, ANL, PNNL, NASA, NIST, JRC, NHA, USFCC, CaFCP, CARB, SDO's, CDO's, Industry
- Support Technology Readiness/Market Transformation
  - Permitting workshops and web based information compendium

The DOE Safety, Codes and Standards Subprogram

- DOE has helped develop a national template of hydrogen and fuel cell codes and standards
- DOE performs research required to develop the codes and standards identified on the national template
- These codes and standards cover all hydrogen and fuel cell applications
- There is variation among jurisdictions but these codes and standards are used fairly consistently across the US

Technical Accomplishments

Highlights presented in following slides

- Used template to evaluate DOE participation in the Codes & Standards development process and support development of several key projects
- Performing Gap analysis of fuel cell technologies to make program recommendations
- Direct support of several Codes & Standards development of projects including:
    - a. NFPA 2 Hydrogen Technologies Code
    - b. Fuel quality standard
    - c. SAE Standards
    - d. CSA Component standards

National Template of Codes and Standards

National Template: Vehicle Systems & Refueling Facilities

STANDARDS DEVELOPMENT ORGANIZATIONS

LEAD STANDARDS DEVELOPMENT ORGANIZATIONS (SDOs)

Vehicles

CONTROLLING AUTHORITIES:
DOT/NHTS (crashworthiness)
EPA (emissions)

General FC Vehicle Safety: SAE
Fuel Cell Vehicle Systems: SAE
Fuel System Components: CSA
Containers: SAE
Reformers: SAE
Emissions: SAE
Recycling: SAE
Service/Repair: SAE

Fuel Delivery, Storage

CONTROLLING AUTHORITIES:
DOT/PHMSA (over-road transport, pipeline safety)

Composite Containers: ASME, CSA, G, NFPA
Pipelines: ASME, API, G, AGA
Equipment: ASME, API, G, AGA
Fuel Transfer: NFPA, API

Fueling, Service, Parking Facility

CONTROLLING AUTHORITIES:
State and Local Government (zoning, building permits)

Storage Tanks: ASME, CSA, G, NFPA, API
Piping: ASME, CSA, G, NFPA
Dispensers: CSA, UL, NFPA
On-site H_2 Production: CSA, UL, G, API
Codes for the Environment: ICC, NFPA

Interface

Fuel Specs: SAE, ASTM, API
Wts/Measures: NIST, API, ASME
Fueling: SAE, CSA
Sensors/Detectors: UL, NFPA, SAE, CSA
Connectors: SAE, CSA
Communications: SAE, UL, CSA, API, IEEE

National Template of Codes and Standards

National Template: Stationary & Portable Systems

STANDARDS DEVELOPMENT ORGANIZATIONS

LEAD STANDARDS DEVELOPMENT ORGANIZATIONS (SDOs)

Hydrogen Generator

CONTROLLING AUTHORITIES:
EPA (emissions)
DOT/PMHSA (pipeline)
OSHA, State and Local Gov't (zoning, building permits)

Electrolyzers:
UL, CSA

Reformers:
UL, CSA, API

Perform. Test Procedures:
ASME, CSA

Chemical Hydrides:
UL, CSA, NFPA

Portable Fuel Cells

CONTROLLING AUTHORITIES:
CPSC, DOT/PHMSA, OSHA, EPA (methanol)
State and Local Government (zoning, building permits)

Handheld Systems:
UL, CSA

Portable Systems:
CSA, UL, G

Handheld Fuel Containers:
UL, CSA, G

Portable Fuel Containers:
G, CSA, ASME

H_2 Fuel Specifications:
G, SAE

Perform. Test Procedures:
gti, ASME, CSA

Stationary Fuel Cells

CONTROLLING AUTHORITIES:
OSHA, State and Local Government (zoning, building permits)

H_2 ICEs:
UL, CSA

H_2 Fueled Turbines:
API, CSA, UL, ASME

FC Systems:
CSA, ASME, UL

FC Installation:
NFPA

FC Performance Test Procedures:
ASME, CSA, gti

Interface

Installation Piping:
ASME, CSA, G, NFPA, IC

Storage:
ASME, G, CSA, API, NFPA

Compressors Safety Cert.:
CSA, UL

Comp. Design, Perf. & Safety:
API

Sensors/Detectors:
UL, CSA, NFPA

Fuel specifications:
G, SAE, API, ASTM

Weights/Measures:
NIST, API, ASME

Dispensers:
NFPA, SAE, CSA, UL, API

Non-vehicle Dispensing:
G

Codes for Built Environ.:
IC, NFPA, G, ICC

Interconnection:
IEEE, UL, NFPA

Codes and Standards Gap Analysis

- NREL has produced a draft codes and standards gap analysis for stationary fuel cells
- Gap analysis identifies existing codes and standards and where there may be additional codes and standards work required to implement fuel cell technologies
- Issues identified include component standards for use in high and low pressure systems, qualification testing standards for plastic and composite materials, and coordination between model codes such as NFPA 853 and design codes such as ASME B31.12

Codes & Standards Development

- Manage codes and standards development assisting
  - Supporting CSTT (Codes & Standards Tech Team)
  - Co-chair of National Hydrogen and Fuel Cells Codes & Standards Coordinating Committee (NHA, USFCC)
  - Work on HIPOC (Hydrogen Industry Panel on Codes)
  - Technical support of Regulatory Logic contracts
  - Promoting National Template Implementation
- Direct Participation on Codes & Standards Committees
  - NFPA 2 Hydrogen Technologies Code
  - UL2267 Fuel cell powered forklifts
  - SAE J2579 – Onboard Hydrogen Storage –
  - SAE J2578 – General Fuel Cell Vehicle Safety –NFPA 2 – Hydrogen Technologies Code – Working on 2010 release cycle
  - ISO TS14687-2 – Hydrogen Fuel Quality – coordinate North American team of experts
  - ISO 20100- Hydrogen fuelling stations-serve on technical committee
  - CSA America H4 series of standards

NFPA 2 Hydrogen Technologies Codes

- NFPA 2 will be a comprehensive hydrogen technologies code
- NREL and Sandia have supported the development of this code through
  - analysis of data,
  - validation of CFD model for hydrogen releases
  - performance modeling analyses,
  - and acting as principal committee members

Fuel Quality R&D and Testing

- ISO Technical Specification (TS14687-2) published February 2008
  - guidelines for PEMFC road vehicles during initial demonstration phase
  - harmonized with SAE J2719 (Technical Information Report)
- International standard (ISO 14687-2) by late 2010 (target date)
  - standard requires sufficient data and adequate level of confidence in data to set allowable limits for non-hydrogen constituents
    - focus on “critical contaminants” that are technology and economic drivers
      - CO, He, S, NH3, PM, CH4, and other inerts
  - include technical annex explaining rationale and data/modeling used to derive limits
- Coordinated testing and modeling underway at national labs, universities in US, Asia, EC
  - North American team of experts represents U.S. and Canada at ISO
    - similar team effort underway at SAE
  - standardized sampling and analytical methodologies under development by ASTM
    - 70 MPa sampling apparatus developed and under testing

SAE Standards Development

NREL has supported the SAE work through:

-Tank testing

- Component testing

- Direct participation on the Fuel Cell technical committee

SAE Fuel Cell Technical Committee is responsible for the following documents:

- J1766 Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing
- J2572 Recommended Practice for Measuring Fuel Consumption and Range of Fuel Cell and Hybrid Fuel Cell Vehicles Fuelled by Compressed Gaseous Hydrogen
- J2574 Fuel Cell Vehicle Technology
- J2578 Recommended Practice for General Fuel Cell Vehicle Safety
- J2579 Fuel Cell Systems in Fuel Cell and other Hydrogen Technologies
- J2594 Recommended Practice to Design for Recycling Proton Exchange Membrane (Pem) Fuel Cell Systems
- J2600 Compressed Hydrogen Surface Vehicle Refueling Connection Devices
- J2615 Testing Performance of Fuel Cell Systems for Automotive Applications
- J2616 Testing Performance of the Fuel Processor Subsystem of an Automotive Fuel Cell System
- J2719 Information Report on the Development of a Hydrogen Quality Guideline for Fuel Cell Vehicles
  J2760 Pressure Terminology Used
  in Fuel Cells and Other Hydrogen Vehicle00

CSA Component Standards

DOE/NREL has supported the development of the CSA standards shown below through:

- Administrative support
- Providing data to validate standards
- Committee participation

- CSA Component Standards cover the following topics:
  - CSA America HGV 2 (draft) Fuel System Components for Hydrogen Gas Powered Vehicles
  - CSA America HGV 3.1 (draft) Hydrogen Gas Dispensing Systems
  - CSA America HGV 4.1 (TIR) Hoses for Hydrogen Gas Vehicles and Dispensing Systems
  - CSA America HGV 4.2 (TIR) Temperature Compensation Devices for Hydrogen Gas Dispensing Systems
  - CSA America HGV 4.3 (draft) Breakaway Devices for Hydrogen Gas Dispensing Hoses and Systems
  - CSA America HGV 4.4 (TIR) Priority and Sequencing Equipment for Hydrogen Gas Dispensing Systems
  - CSA America HGV 4.5 (TIR) Manually Operated Valves for Hydrogen Gas Dispensing Systems
  - CSA America HGV 4.6 (TIR) Automatic Valves for Use in Hydrogen Gas Vehicle Fueling Stations
  - CSA America HGV 4.7 (TIR) Hydrogen Gas Fueling Station Reciprocating Compressor Guidelines
  - CSA America HGV 4.8 (TIR) Pressure Relief Devices for Hydrogen Gas Vehicle (HGV) Containers
  - CSA America HPRD 1 (draft)

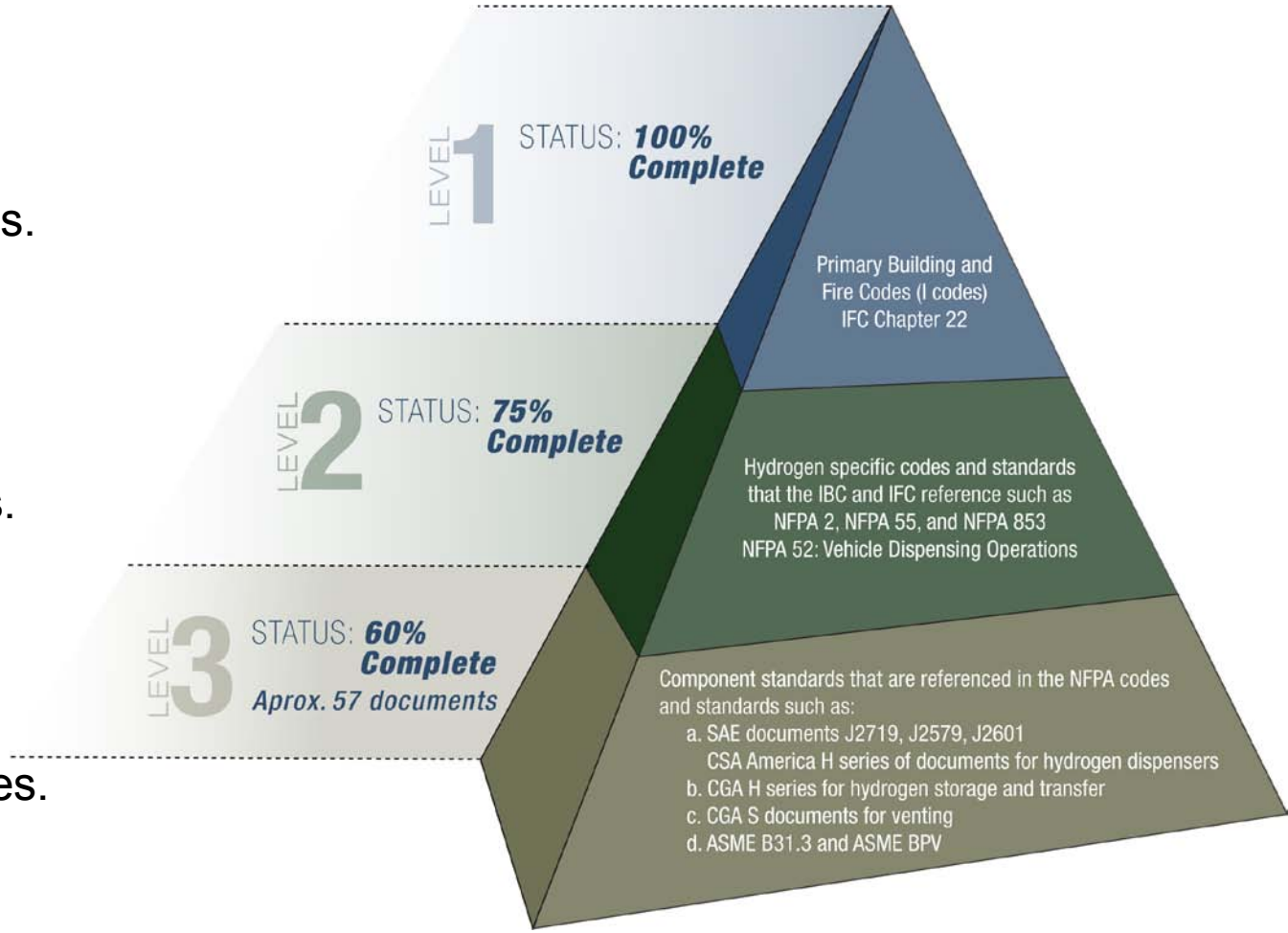
Current Status

Regulatory Hierarchy of H2 Codes & Standards

Level 1:
Building and fire codes directly adopted by jurisdictions.

Level 2:
Hydrogen specific codes referenced in building and fire codes.

Level 3:
Component standards referenced in hydrogen specific codes.



Example of Dispensing at Fueling Station

Hydrogen Behavior

- Physical properties
- Flammability and transport
- Material compatibility
- Detection

Hydrogen Fuel Infrastructure

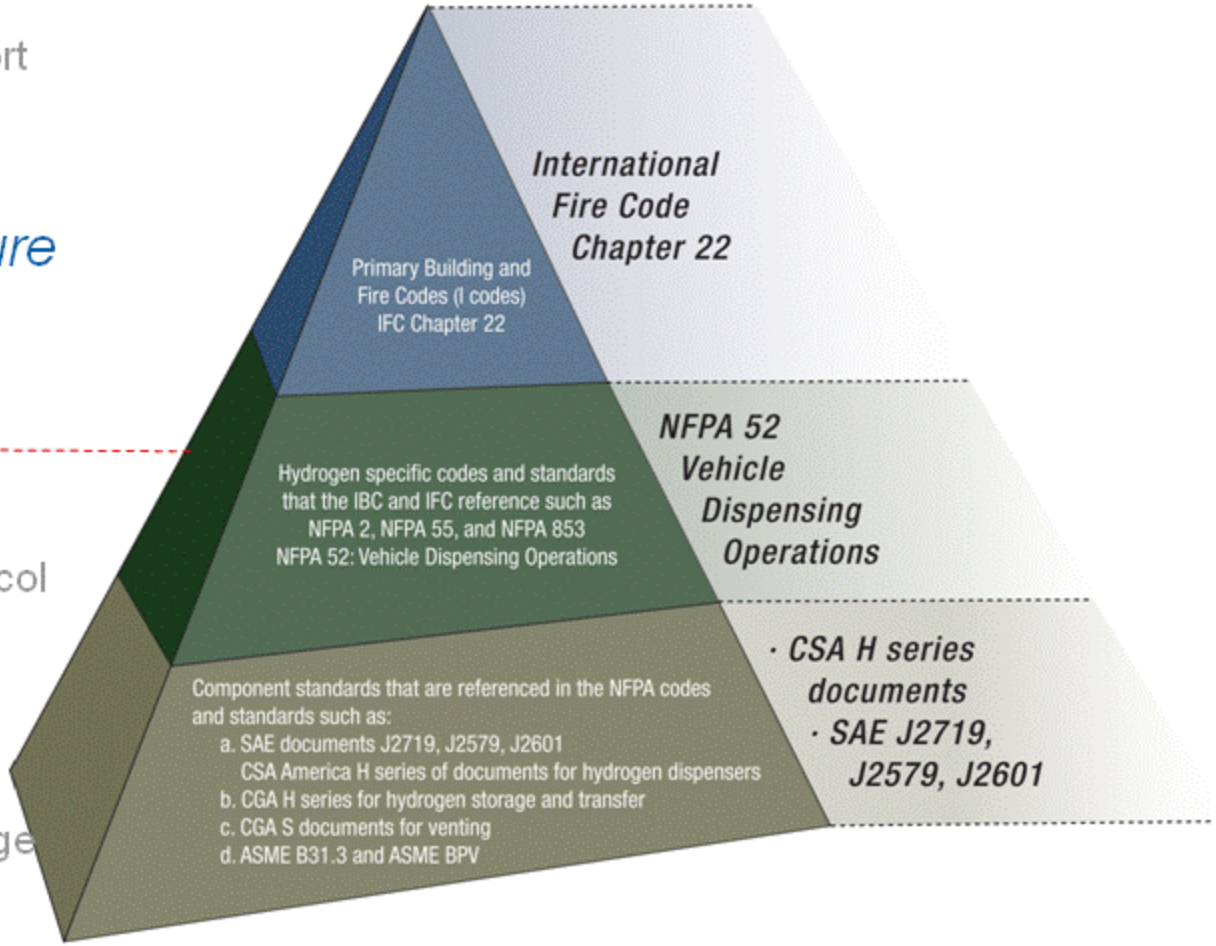
- Production
- Distribution and delivery
- Fueling station

Fuel-Vehicle Interface

- Fueling nozzle and protocol
- Fuel quality
- Cross-cutting issues

Hydrogen Vehicle

- Onboard hydrogen storage
- Onboard fuel handling
- Parking requirements



Future Work

- Component Testing
  - Support standard development with special emphasis on emerging fuel cell application standards
  - Continue work on high pressure component test work to support code development
  - Hydrogen safety sensor testing effort will continue with baseline testing of sensor technologies and will work toward standardization of test methods and sensor performance improvement
- Evaluation of indoor releases of hydrogen from indoor fueling operations and the operations of vehicles such as forklifts
- Fuel Quality- continue to coordinate the production and distribution of test data to assist in the development of a fuel quality standard for PEM vehicle fuel cells and stationary fuel cells
- Continue work with national and international codes & standards development through direct support of SDO and CDO organizations and collaboration with key stakeholders
- Assist code officials and project developers and other interested parties use new codes and standards such NFPA 2 through outreach activities

Summary

- Research and development efforts to support implementation of the template will be focused on component testing, hydrogen fuel quality testing, and hydrogen safety sensor testing
- Codes & standards development will continue through direct support of standards development organizations and participation on or operation of coordination committees
- These goals can only be accomplished through collaborations with key stakeholders at all levels
- NREL will continue to support technology readiness of renewable energy technologies through programs such as the workshops for permitting officials, safety reviews, and the web based information compendium