NHTSA Alternative Fuel Activities

Department of Energy Codes and Standards Activities

Nha Nguyen
U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Alternative Fuel Activities at NHTSA

Hydrogen:

- As part of the adoption process of GTR No. 13 on hydrogen fuel cell vehicles into federal Motor Safety Standard (FMVSS), NHTSA contracted a test lab to conduct a series of tank testing to validate the GTR test procedures. This work also allow NHTSA to evaluate the feasibility of the GTR performance requirements for compliance testing

Compressed Natural Gas (CNG):

- Evaluation of aged tanks: NASA conducted a series of tank testing to document in-service wear, damage, and residual life in CNG containers that have seen real world service, through nondestructive and destructive evaluation techniques

- Conducted CNG containers (3,600 psi) were evaluated using hydraulic performance durability test sequence and fire exposure in GTR.13. The purpose is to determine the feasibility of applying GTR requirements for CNG tanks.

Overview of Test Results of Hydrogen Tank Tests

Sample Assigned Tank Manufacturer No.	Type	NWP (MPa)	Vol (L)	Tested BPo (MPa)
1	IV	70	30-40	183.7
2	IV	70	70-80	173.3
3	III	70	20-30	257.1

GTR No. 13 Sections	Tests	Results for assigned tank manufacturer No.		
		1	2	3
5.1.1. Baseline				
5.1.1.1.	Baseline initial burst pressure	Pass	Pass	Pass
5.1.1.2.	Baseline initial pressure cycle life	Pass	Fail	Pass
5.1.2. Performance durability (sequential hydraulic tests)				
5.1.2.4.	Chemical exposure and Ambient temperature pressure cycling	Pass	Fail	Pass
5.1.2.5.	High temperature static pressure test	Pass	-	Pass
5.1.2.6.	Extreme temperature pressure cycling	Pass	-	Fail
5.1.2.7-8.	Residual proof pressure and burst	Pass	-	-
5.1.3. Expected on-road performance (sequential pneumatic tests)				
5.1.3.2.	Ambient and extreme temp gas pressure cycling	Pass	-	Pass
5.1.3.3.	Extreme temperature static pressure permeation	Pass	-	Pass
5.1.3.5.	Residual proof pressure and burst	Pass	-	Pass

Overview of Test Results of CNG Tank Hydraulic Tests

Test articles, rated for 11,250 cycles service life:

- Type-2 WireTough – steel with hoop-wrapped wire in epoxy
- Type-3 Luxfer – aluminum full wrap carbon in epoxy
- Large Type-4 Lincoln – plastic, full wrap carbon and glass in epoxy
- Small Type-4 Lincoln – plastic, full wrap carbon and glass in epoxy

GTR No. 13 Sections	Tests	Results for tank manufacturer No.			
		1 II	2 III	3 IV-93L	4 IV-32L
5.1.1. Baseline					
5.1.1.1.	Baseline initial burst pressure	Pass	Pass	Pass	Pass
5.1.2. Performance durability (sequential hydraulic tests)					
5.1.2.2.	Drop test (each tank in four drop orientations)	Pass	Pass	Pass	Pass
5.1.2.4.	Chemical exposure and Ambient temperature pressure cycling	Pass	Pass	Pass	Pass
5.1.2.5.	High temperature static pressure test	Pass	Pass	Pass	Pass
5.1.2.6.	Extreme temperature pressure cycling	Pass	Pass	Fail	Pass
5.1.2.7-8.	Residual proof pressure and burst	Pass	Pass	-	Pass
5.1.4. Test for service terminating performance in fire					
6.2.5.1.1. test procedure	On container assembly with a combination of solenoid, manual valve (s), TPRD (s) etc.	Fail	Pass	Fail	-

Overview of Evaluation of Aged CNG Containers

Test Articles:

- 23 Type-4 Brunswick (Lincoln) – Manufactured 1994, certified to ANSI/NGV2 for 15 years, 3000 psi SP.
- 2 Type-4 Lincoln – Manufactured in 2012. Certified to ANSI/NGV2, 3600 psi SP.
- 36 Type-2 Lucas – Manufactured 1998, certified to ANSI/NGV2 for 15 years and self-cert to FMVSS 304, which went into effect in 1995, 3000 psi SP.
- 7 Type-2 Pressed Steel – Manufactured 2002, certified to ANSI/NGV2-2000 for 15 years, 3600 psi SP.

Evaluation - Cylinders (subset) were subjected to various NDE techniques to include the following:

- Physical dimensions such as weight, length, various circumferences.
- Detailed external visual inspection)/high magnification photography
- Internal visual inspection
- Radiography, flash thermography, laser shearography (internal structure, heat transfer, non-visible flaws)
- Samples if interior and exterior contaminants
- NDE service and 1.25xSP pressure cycling with strain gauges to study vessel response and compare to expected response.

Results:

- Scuffing, paint transfers, missing labels, no inspection labels, mechanical damage to level 2 per CGA pamphlet, OEM manual, circumferential witness marks (shifting in brackets), rubber mounting ring, adhesive materials, liner blistering, and liner separation, compressor oil (up to half gallon), clay and sand (exterior).

Status

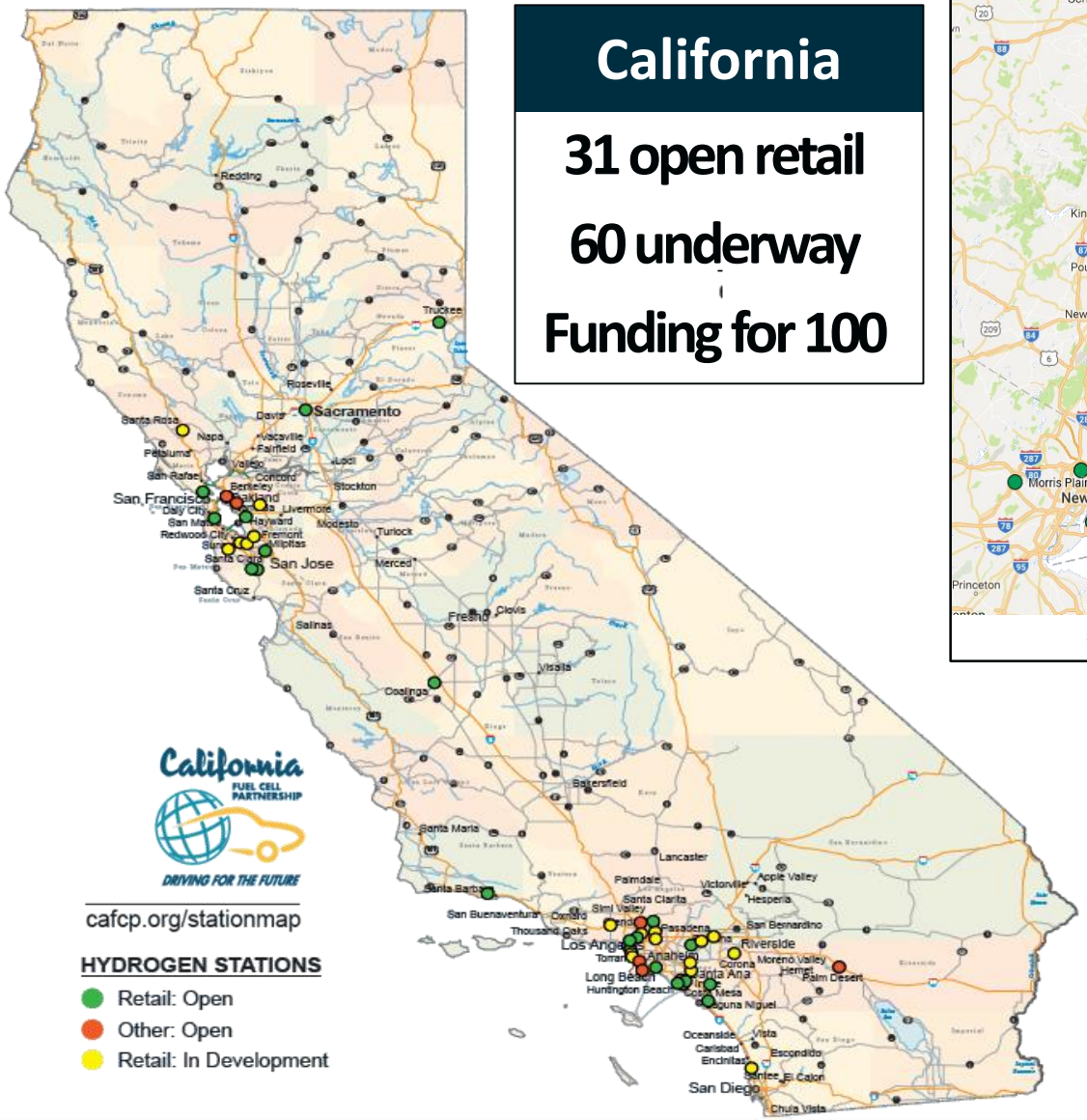
- Final rule published September 27, 2017, NHTSA incorporated additional safety requirements for in-use and post-crash into Federal Motor Vehicle Safety Standard (FMVSS) No. 305. Final rule was initiated in response to a petition from the Auto Alliance and Toyota

- NHTSA is working on the adoption of the rest of the GTR.13 including tank requirements

- NASA CNG tank test results reported in ESV Paper, ID# 15-0326, Failure Analysis of Compressed Natural Gas Containers for Automotive Use http://www-esv.nhtsa.dot.gov/Proceedings/24/files/24ESV-000326.PDF. We will publish photos and raw data for public access

- CNG tank test report is being reviewed and will be published soon

Hydrogen Stations in the U.S.

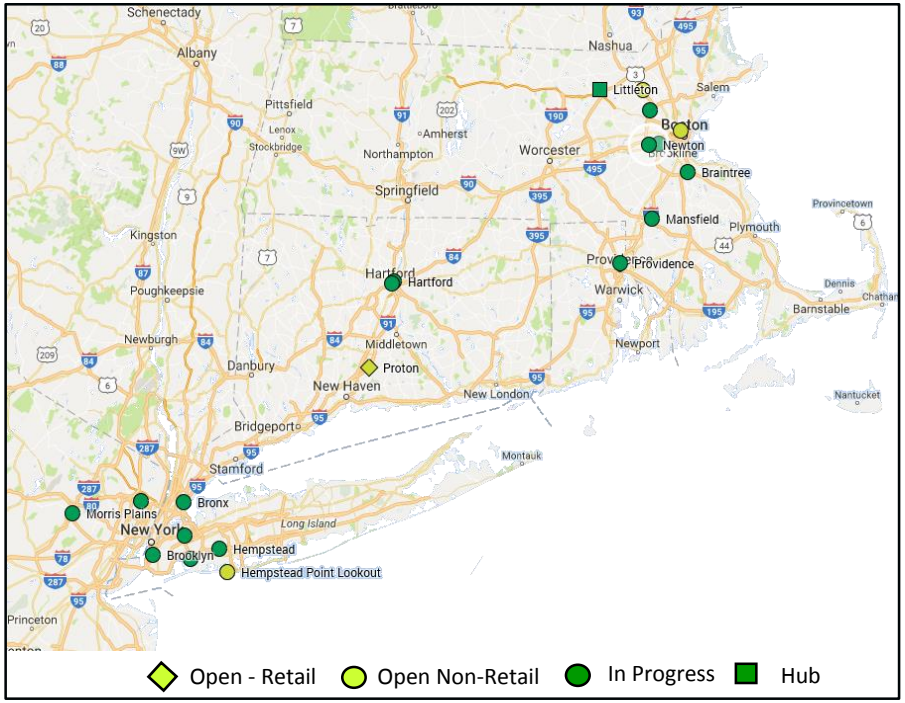


California

31 open retail

60 underway

Funding for 100



Northeast

Approx. 12 to 25 retail planned

Codes & Standards Goals & Objectives

Performing R&D needed to develop science-based codes and standards, thereby enabling the safe deployment of H_2 and fuel cell technologies

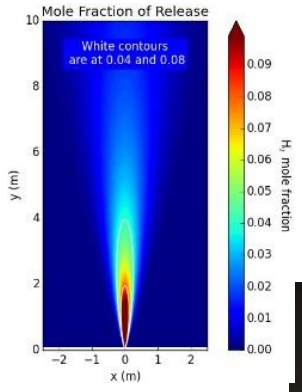
Codes & Standards

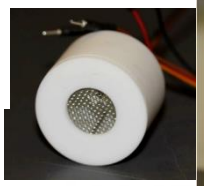
- Conduct **R&D to provide critical data** and information needed to define requirements in developing codes and standards.
- Support and facilitate development of **essential codes and standards** to **enable widespread deployment** of hydrogen and fuel cell technologies and completion of essential regulations, codes and standards (RCS).

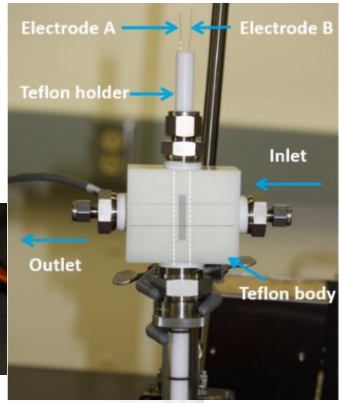
Safety

- Ensure that **best safety practices** underlie activities supported through DOE-funded projects.
- Enable **widespread sharing** of **safety-related information resources** and lessons learned with key stakeholders.

HyRAM
HYDROGEN RISK ASSESSMENT MODELS





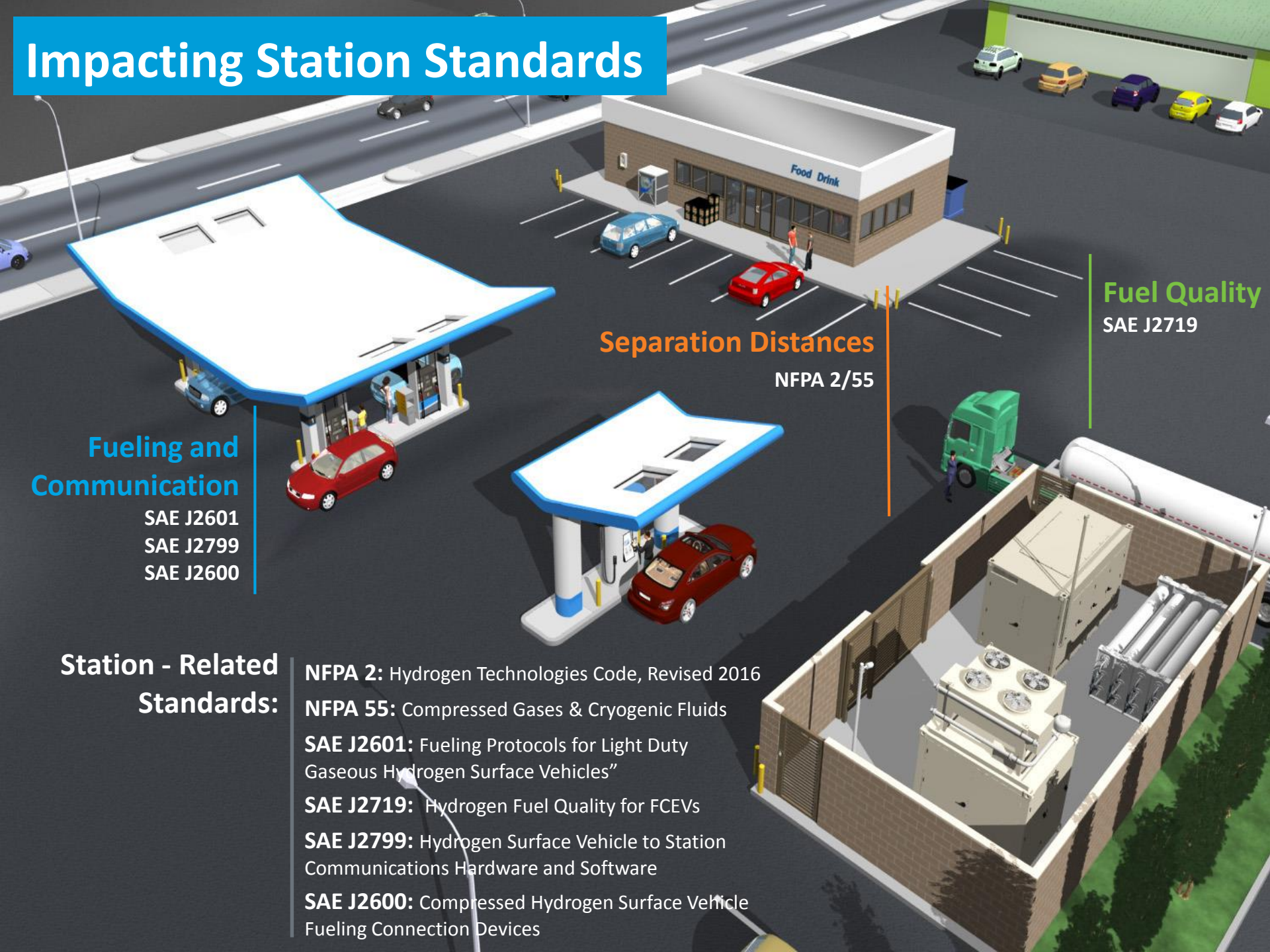


Current Strategy and Barriers

Focus areas	Barriers*	Objectives
Hydrogen Behavior	Insufficient data for code revision (e.g.-large station footprints)	R&D model development and verification to establish scientific basis for codes and standards revisions.
Risk Assessment	Usage and access restrictions; Limited reliability data	Develop tools on a scientific foundation which can be used for various hydrogen applications.
Materials Compatibility	Lack of information on new materials compatibility with H_2	Establish a foundational materials understanding, which will enable and support the C&S development.
Detection & Sensors	High cost and limited commercial availability of products	Develop H_2 contaminant detectors for fuel quality at H_2 station.
Outreach & Support	Limited access and understanding of safety data and information	Support critical stakeholders in understanding hydrogen safety best practices.

* From Safety, Codes and Standards MYRD&D (June 2015)

Impacting Station Standards



Fueling and Communication
SAE J2601
SAE J2799
SAE J2600

Separation Distances
NFPA 2/55

Fuel Quality
SAE J2719

Station - Related Standards:

NFPA 2: Hydrogen Technologies Code, Revised 2016

NFPA 55: Compressed Gases & Cryogenic Fluids

SAE J2601: Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles"

SAE J2719: Hydrogen Fuel Quality for FCEVs

SAE J2799: Hydrogen Surface Vehicle to Station Communications Hardware and Software

SAE J2600: Compressed Hydrogen Surface Vehicle Fueling Connection Devices

http://www.nhtsa.gov/

nha.nguyen@dot.gov

Questions