

NFPA 52 and 55 brief review

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C&S Workshop

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Outline



- Hydrogen Properties
- Code vs. Standard
- Development process in US
- Regulatory enforcement
- NFPA & I-codes (HIPOC)
- Safety considerations
- NFPA 52
- NFPA 55 separations distances
- H-CNG & NFPA 52



Properties – Hydrogen

Flammable Range	4 - 74% by vol. in air
Detonable Range	18.3 – 59% by vol. in air

- Wide flammability range
- Invisible flame (visible at night)
- Importance of ventilation
 - Hydrogen can only detonate with a degree of confinement
- Siting requirements
 - away from ignition sources

Properties - H₂ is very light!



Specific Gravity **0.070 (air = 1)**

- **Light Weight (Low Density)**
- **Tendency to dissipate before large energy accumulation**
- **Extremely Buoyant, Rises rapidly to the upper atmosphere**
- **Upward flame propagation with small radiant heat emission from flame**
- **Easy to leak, quickly dilutes and dissipates**

Properties comparison

	H ₂	NG	Petrol
1. Color	none	none	yes
2. Toxicity	no	no	yes
3. Odor	odorless	mercaptan	yes
4. Density (air=1)	0.07	0.424	liquid
5. Environment- Leak Impact - Fuel	none none	none CO ₂ / NO _x	C _n H _n CO ₂ / NO _x
6. Diffusion Coefficient - cm ³ /s	0.61	0.15	liquid
7. Flame Temperature - °C	2318	2148	
8. Flammability Range - in air	4% - 75%	5.3%-15%	1.4% -7.6%
9. Ignition energy - milli Joules	0.02	0.29	0.20
10. Auto Ignition Temp. - °C	520	<500*	440
11. Heat Value - kJ/kg	119,972	50,020	42,847
12. Energy Density - MJ/Nm ³	10.783	35.882	104.4

Courtesy: Air Products and Chemicals, Inc.

Codes and Standards



● What's a Standard

- a document with technical requirements and recommended practices
 - Developing Organizations
 - SAE, CSA, CGA, ASME
 - Mostly **Component level** documents are standards
 - Dispensing nozzle, break away device, storage tank ..
 - Few **System level** standards are developed
 - CSA standard for Dispensers
 - Incorporates valves, instrumentation, relief system, hose, nozzle etc...
- standards are used for listing (e.g. UL) and certification

Codes and Standard



● What's a Code

- a standard which covers a broad range of subjects and / or that can be adopted directly into law without needing other standards
 - NFPA (National Fire Protection Association)
 - I-Codes (International Codes Council)
- Broader scope
- Normal operating conditions

● Codes usually refer to standards

● Code setting bodies (NA): NFPA and ICC

● DOT (US & TC) regulations

NFPA codes for Hydrogen Installations



- **1: Uniform Fire Code**
 - general fire code for hydrogen system siting
- **2: Hydrogen Technologies Code (new)**
 - code for all hydrogen activities
- **52: Vehicular Fuel Systems Code**
 - covers hydrogen and natural gas for fuel
- **55: Compressed Gas and Cryogenic Fluids**
 - gas and liquid hydrogen supply systems (along with others)
- **70: National Electric Code**
 - electrical requirements
- **5000: Building Construction and Safety Code**
 - building requirements for hydrogen storage

ICC (*International Code Council*) *codes for Hydrogen Installation*



- **IFC: International Fire Code**
 - gas and liquid hydrogen supply systems
- **IFGC: International Fuel Gas Code**
 - hydrogen used as a fuel gas
- **IBC: International Building Code**
 - building requirements for hydrogen storage
- **IMC: International Mechanical Code**
 - piping requirements

US DOE's efforts for Harmonization



- Hydrogen Industry Panel on Codes (HIPOC)
- Objectives
 - Review current codes and standards
 - storage, dispensing, use and handling of H₂
 - in and around fixed-facility applications
 - Develop or facilitate industry-sponsored proposals
 - revise or otherwise harmonize the appropriate, reasonable and enforceable model health and safety provisions
 - *International Codes and NFPA*

US DOE's efforts for Harmonization



- **HIPOC Roster**
 - Fire Safety/Prevention
 - Highway Codes
 - Industrial Gas/Hydrogen Fuel
 - Energy Company
 - OEM vehicles/Fuel Cell
 - Academia
 - Installation Codes - state
 - NFPA 2
 - NFPA 52
 - NFPA 55
- **Balanced representation**

NFPA Process



- Start cycle day 1
- Proposal closing day 128
- Report on proposals (ROP) meeting day 216
- ROP published day 335
- Comments closing day 405
- Report on comments (ROC) meeting day 468
- ROC published day 580
- Technical session day 680
- Appeals closing day 704
- Document published day 734

Fueling System Safety Features



- **Compressors**
 - Multiple safety shutdowns
 - Isolation valves
 - Material selection critical
- **Piping systems**
 - Austenitic steel construction
 - Seamless tubing (preferred)
- **Storage**
 - ASME compliant
- **Importance of safe venting**
 - All venting is outdoors to safe location
 - elevated vent stack

Dispenser Safety Features



- **Special attention on dispenser**
 - End use application
 - Limited access to trained personnel
 - On screen instructions on dispenser
 - Deviations will abort fill
- **Multiple “Layers of Safety” to build redundancy**
- **Builds on historical hydrogen use for other applications**



Dispenser Safety Features

- Non-interchangeable nozzles
- Special design nozzles per SAE J2600
 - Double block and bleed, unlike industrial connections
 - Cannot be opened unless connected
- Multiple shutdown features
- Self-sealing break away joints
 - For vehicle pull-away/accident
- Vehicle and station electrically bonded
 - through nozzle
- Vehicle grounded through parking surface



Dispenser Safety Features

- Piping pressure monitored continuously
- At start of fill, leak check of entire dispenser
- Instrumentation check
- Leak check after connection, prior to fill
- Hose break detection during fill
- Gas Detection in cabinet
- Gas Detection in fueling area
- Flame Detection in fueling area
- All safeguards will stop fill

NFPA 55



- Risk informed Separation distance
 - Study completed by Sandia National Labs
 - [SAND2009-0874.pdf](#)
- NFPA 55 2009 edition
- [Risk Informed Approach NFPA 55 Chapter 10.pdf](#)

Installation code integration



- NFPA 52 2010 edition
- [NFPA 52 F08 2-10-09 draft \[1\].pdf](#)

NFPA 52



- HCNG chapters in 2012 edition
- Draft available
- Chapter 40A.doc

Thank you

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