Report to the Summit
Hydrogen in the International Codes

Setting the Standard for Building Safety™

Hydrogen & Fuel Cells Summit VIII
June 15th, 2004

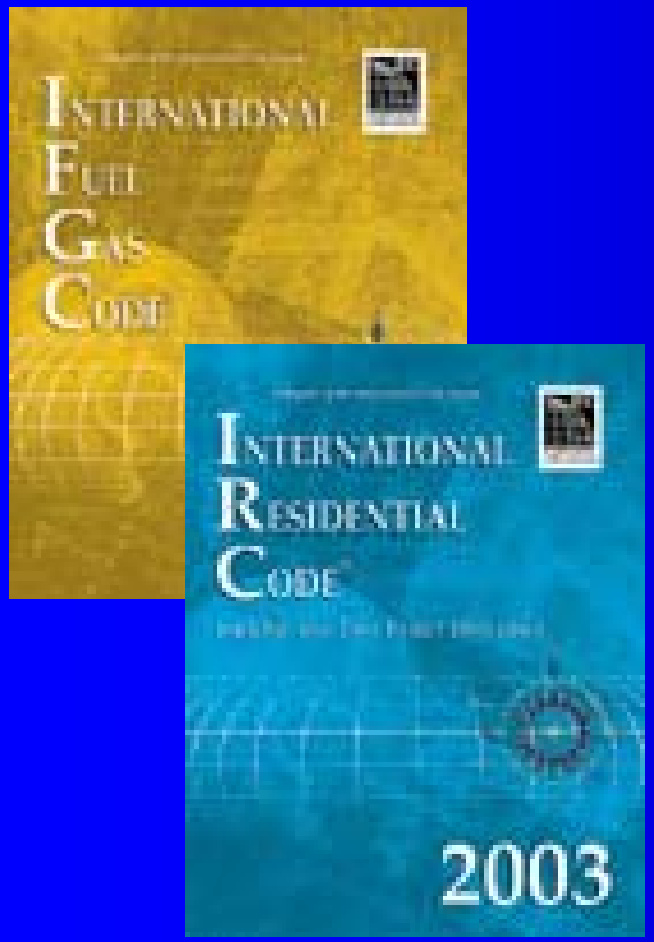
Ad Hoc Hydrogen Committee

- August 2000 - ICC charters AHC
- Objectives
  - Review C&S applicable to H2 in vehicular and portable
  - Determine adequacy of coverage in I-Codes
  - Propose changes, as necessary to I-Codes
- Effort for the 2003 I-Codes
  - Five Open Meetings (DC, Detroit, Portland, Golden, Houston)
  - Two 45-day public comment periods
  - Two public hearings in 2002 (Pittsburgh, Ft. Worth)
- 2003 Changes appear in 2003 (IBC, IFC, IRC, IMC, IFGC)
- 2003 ICC extends life of the AHC

2003 Fire Code

- §2209 Hydrogen motor fuel-dispensing and generation facilities
- T2209.3.1 Separation distances
- 2209.5 Venting of hydrogen gas
- §2211.8 Defueling of hydrogen from motor vehicle fuel storage containers
- Ch. 32 Cryogenic Fluids
- Ch. 35 Flammable Gases

2003 Fuel Gas & Residential



- §101.2.1 Scope adds Gaseous hydrogen
- §202 & IRC §202, Definitions
  - FUEL GAS includes hydrogen gas
  - STATIONARY FC Power Plant
  - PORTABLE FC APPLIANCE
- §633 Fuel Cells installed in acc. with
  - CSA FC1 and NFPA 853-2000
- Ch. 7 Gaseous Hydrogen Systems
  - General requirements; Piping, use and handling
  - Testing of piping; Location, operation and maintenance
- IRC §2401.1
  - Hydrogen gas systems regulated by IFGC

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2003 Building Code

- IBC T302.1.1 Incidental use areas and hydrogen cut-off rooms
- Fire barriers required
  - 1-hour in Groups B, F, H, M, S and U
  - 2-hour in Groups A, E, I and R

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Hydrogen Cut Off Room

- *"A room or space intended exclusively to house a gaseous hydrogen system."*
- Construction
  - One- or two-hour fire barriers as required by IBC
  - Self-closing openings interlocked with hydrogen system
  - Operable windows to building prohibited
- IMC ventilation for lighter-than-air vehicle fuels
  - Continuous exhaust to maintain <25 LFL
  - Rate not less than 1 cfm per 12 cu. ft. volume
- Equipped with flammable gas detection
- Explosion control as required by IFC Ch.9

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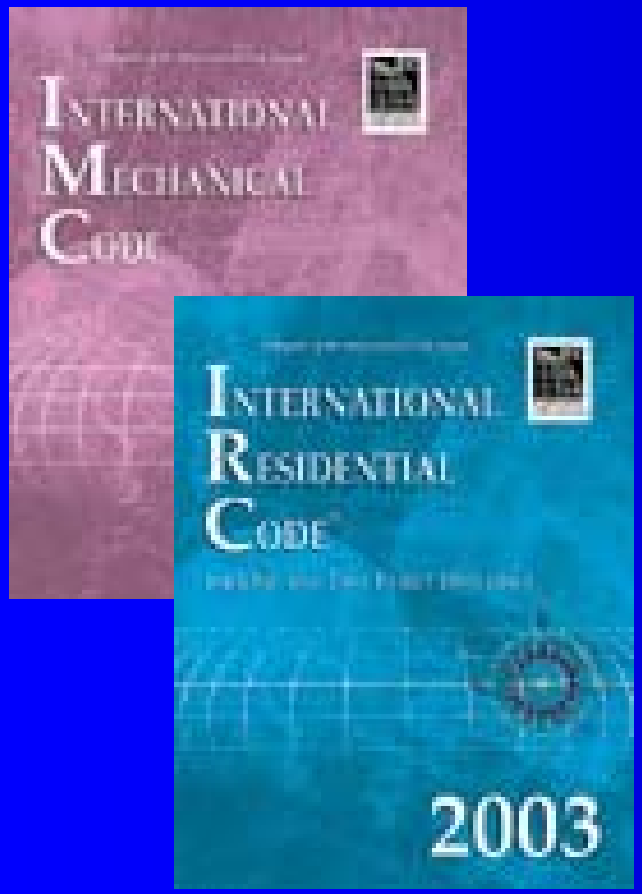
2003 Mechanical & Residential



- §202, Definitions
  - FUEL GAS
  - STATIONARY FC Power Plant
  - PORTABLE FC APPLIANCE
- §304.4 & IRC §M1307.4, Hydrogen generating and refueling operations
  - Natural ventilation
  - Mechanical ventilation in acc. w/ IMC
- §924 Fuel Cells in accordance w/
  - ANSI Z21.83 and NFPA 853

Natural Ventilation

Comparisons of Hydrogen Accumulation in Garage (1 SCFM at 20 min.)

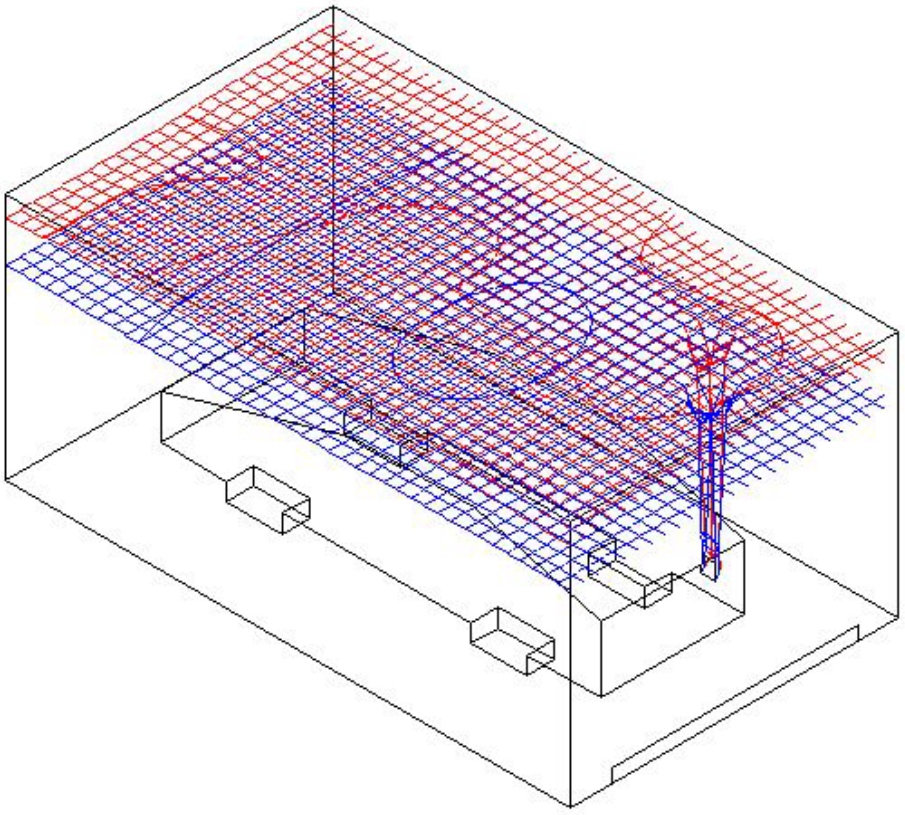


Figure C 1 - Unvented garage, 1 SCFM hydrogen leak for 20 minutes.
Blue: 0.82% hydrogen. Red: 4.1% hydrogen

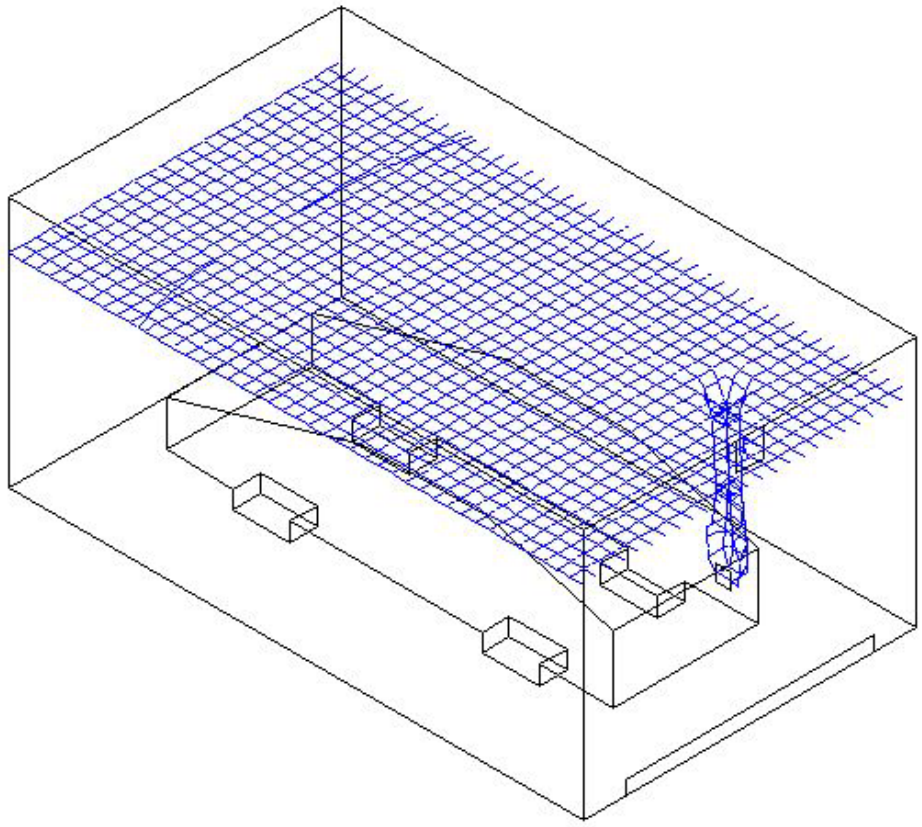


Figure C 1 - Vented garage, 1 SCFM hydrogen leak for 20 minutes.
Blue: 0.82% hydrogen. Red: 4.1% hydrogen

Natural Ventilation

Comparisons of Hydrogen Accumulation in Garage (4 SCFM at 20 min.)

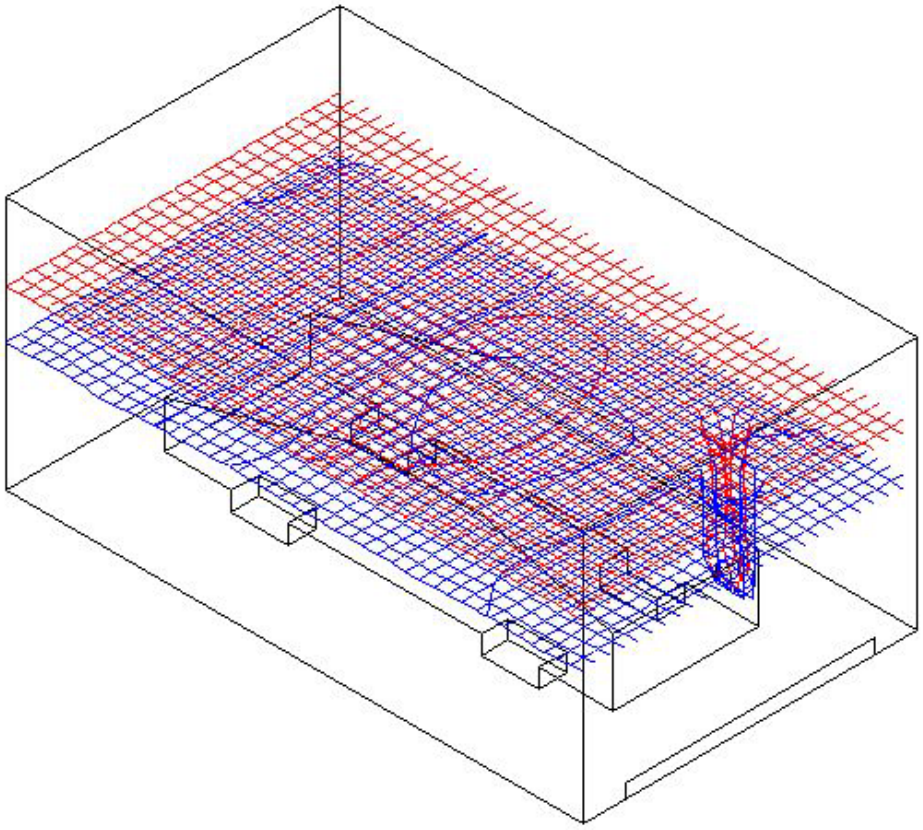


Figure C 1 - Unvented garage, 4 SCFM hydrogen leak for 20 minutes.
Blue: 0.82% hydrogen. Red: 4.1% hydrogen

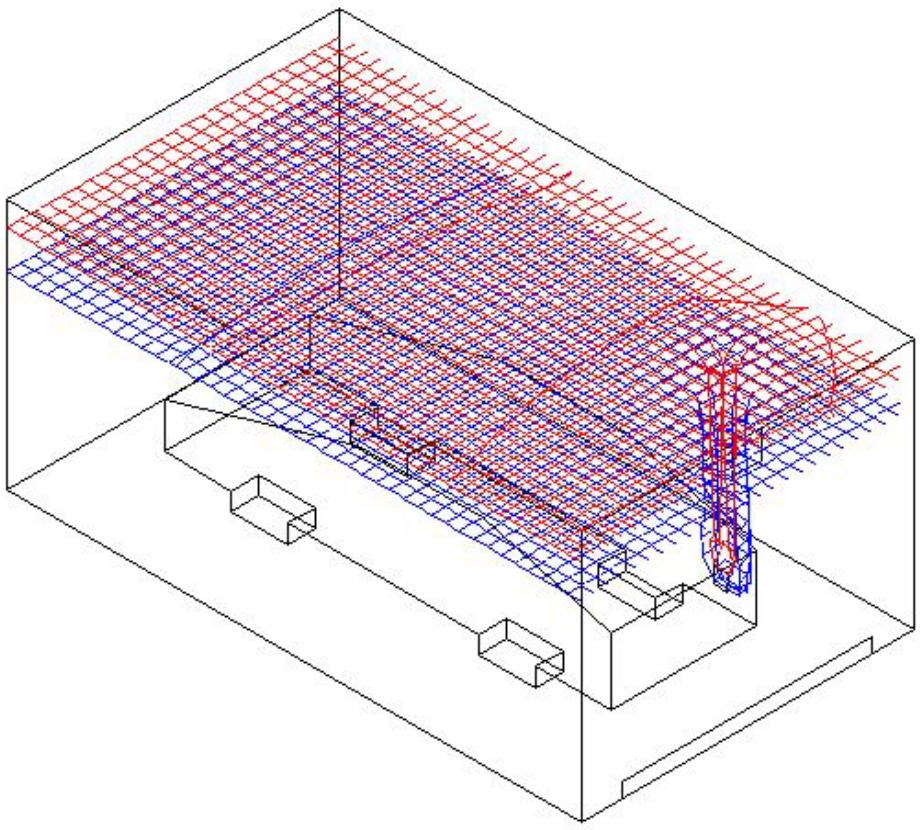
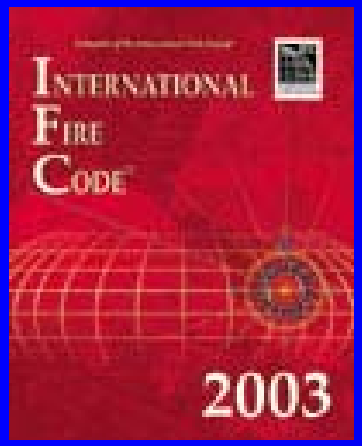


Figure C 1 - Vented garage, 4 SCFM hydrogen leak for 20 minutes.
Blue: 0.82% hydrogen. Red: 4.1% hydrogen

AHC Activities Sustained for 2003-04 Code Cycle

- Focus for the continued effort
  - Optimize/Economize refueling station footprint
  - Canopy-top & underground storage options
  - Testing, inspection and purging of H2 piping
  - Improvements to usability and enforceability
- Effort for the 2006 I-Codes
  - Three open meetings (Golden No. 1, Golden No. 2, W. Sacramento)
  - One open public comment period (AISI, CGA, API, Canadian TFCA)
  - Two public hearings in 2003/04 (Nashville, Overland Park, KS)
- Changes appear in 2004Supp. (IBC, IFC, IFGC)



Canopy-top Installations Approved *(F154-03/04)*

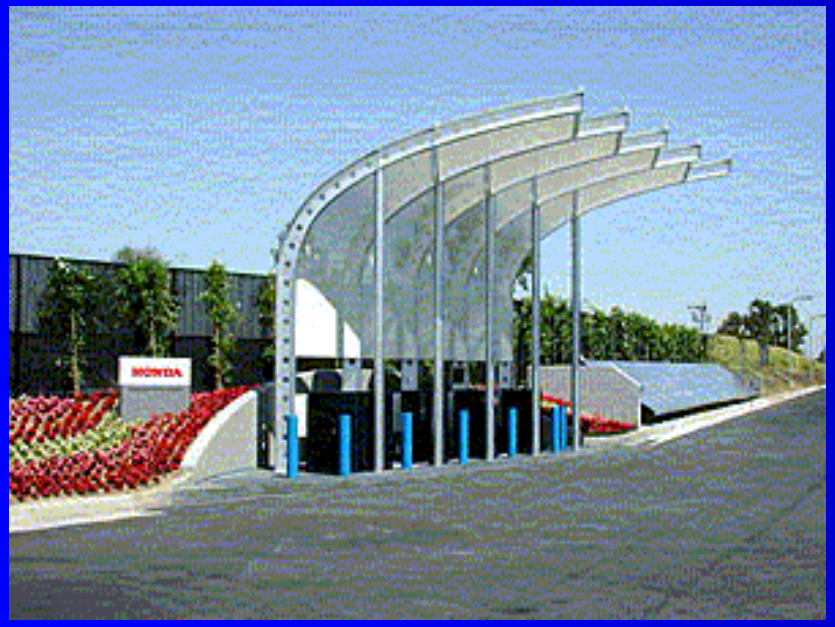


Photo courtesy of Sunline Transit Agency

- An OPTION to other on-site measures
- Locate high pressure tube bundle(s), compression equipment on canopy top
- Canopy shall be 2-hour construction
- Fuel dispensing areas underneath sprinklered as Extra Hazard Group 2
- Activities underneath limited to refueling operations only
- Canopy constructed to prevent accumulation of hydrogen gas

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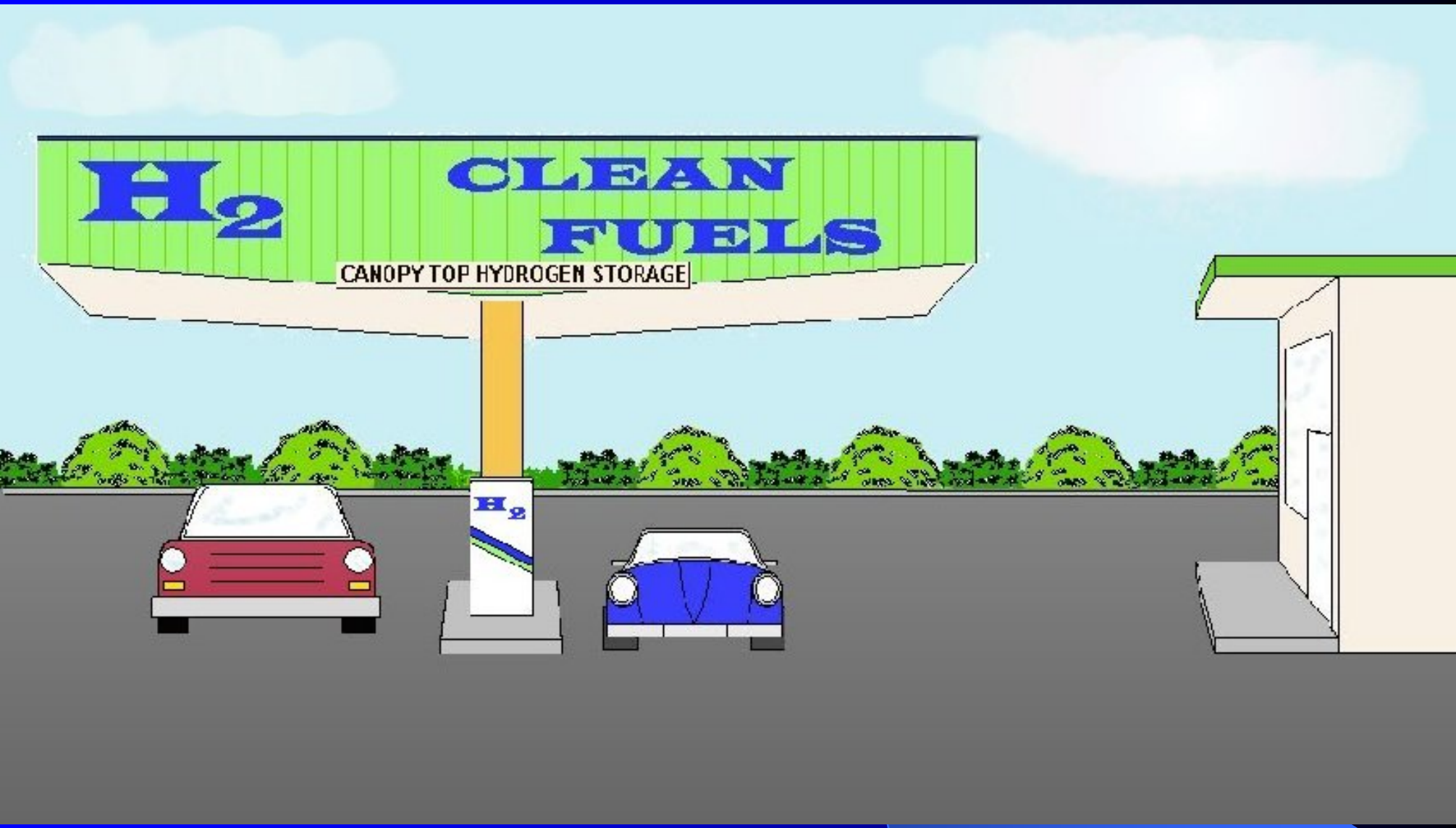
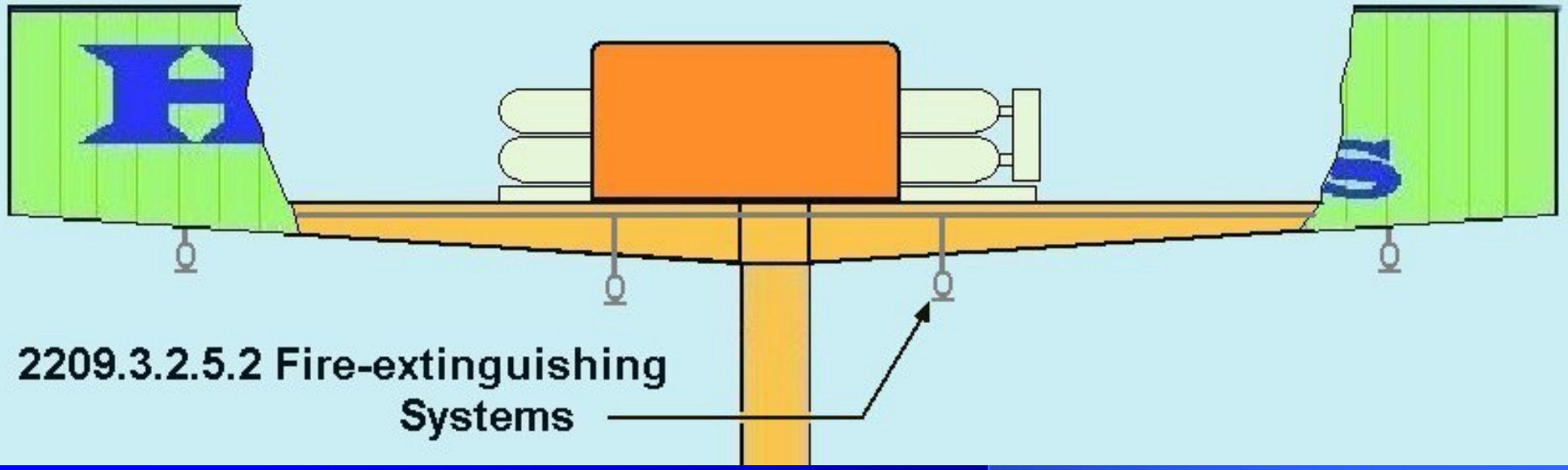


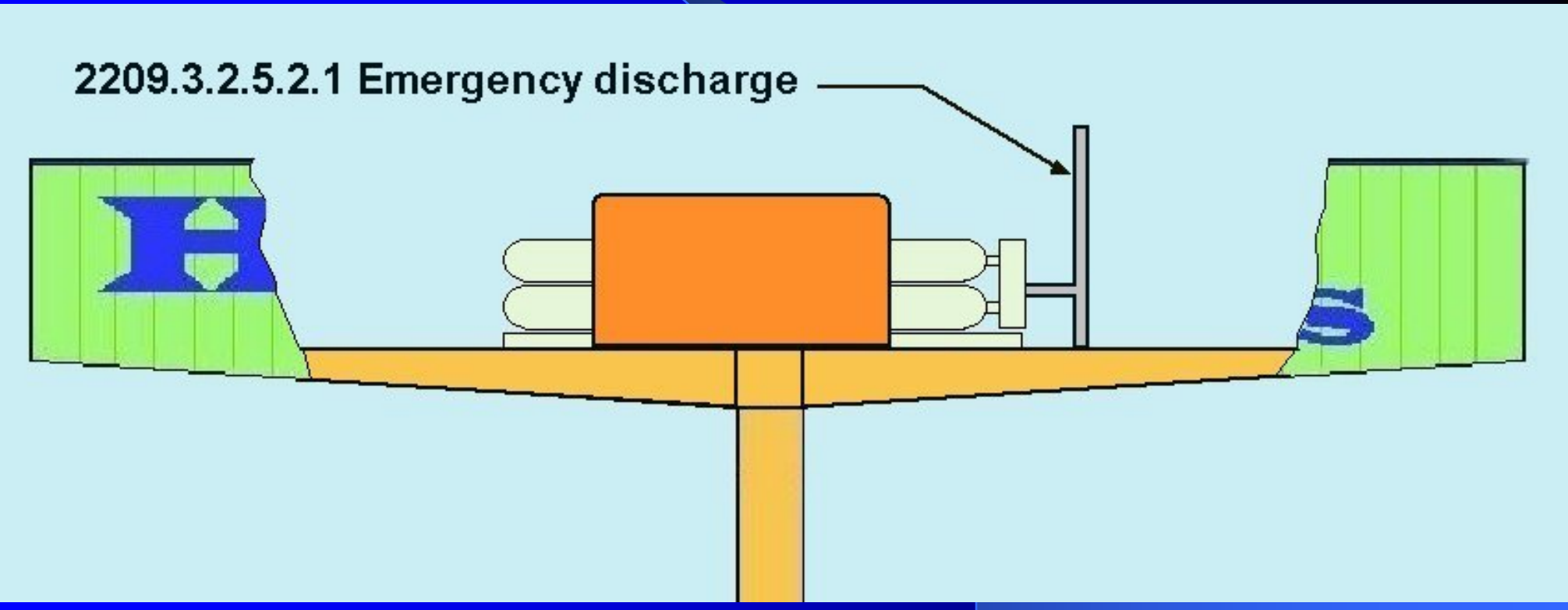
Renderings courtesy of Shell Hydrogen, Inc.

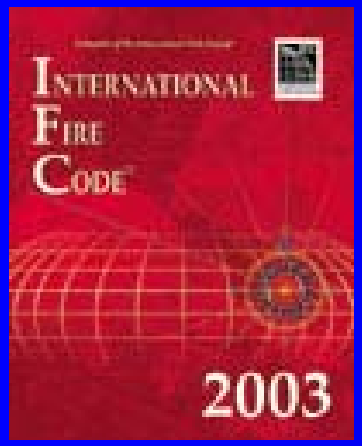
2209.3.2.5.2 Fire-extinguishing systems.

Fuel-dispensing areas under canopies shall be equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. The design of the sprinkler system shall not be less than that required for Extra Hazard Group 2 occupancies. Operation of the sprinkler system shall activate the emergency functions of Sections 2209.3.2.5.1 and 2209.3.2.5.2.

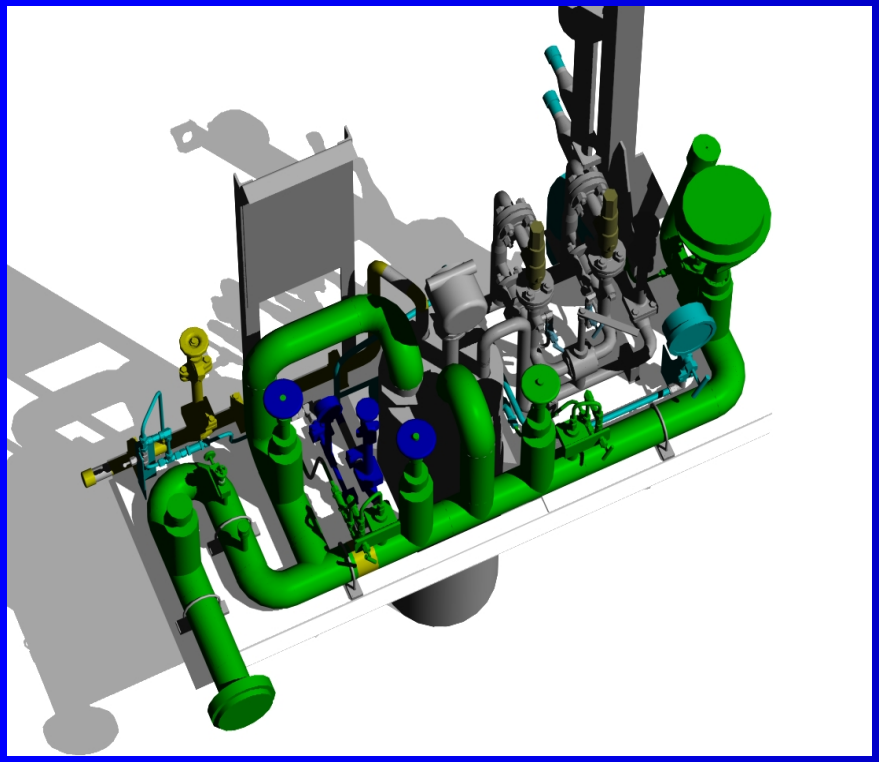


<u>2209.3.2.5.2.1 Emergency discharge</u>. Operation of the fire sprinkler system shall activate an automatic emergency discharge system, which will discharge the hydrogen gas from the equipment on the canopy-top through the vent pipe system.





Underground Storage Approved *(F155-03/04)*



Rendering courtesy of Air Products & Chemicals, Inc.

- Safety is paramount
- Tanks are double-wall (vacuum annulus)
- Placing tank below grade
  - Increases safety
  - Reduces security risk
  - Increases available space
  - Environmentally friendly
- 50,000 Similar tanks
  - LAr, LHe, LH_2 , LiN, LOx
  - 1000 LH_2 tanks alone

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Conventional LH2 Storage Tanks at Fuel Stations

Chicago (CTA), IL

City of Las Vegas, NV

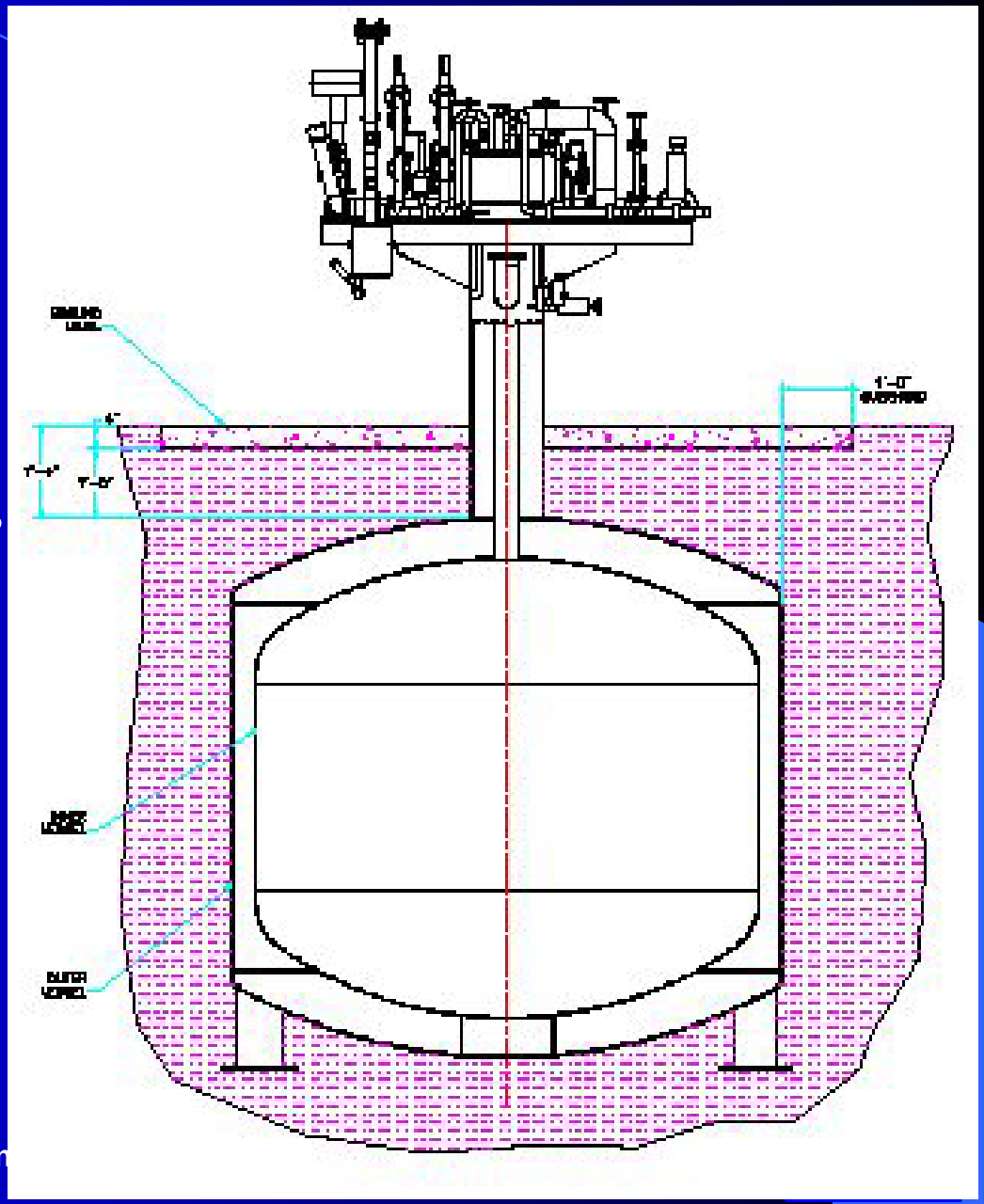
CaFCP, CA

Ann Arbor, MI

AIR PRODUCTS

Underground Storage

- Tank and Vacuum Jacket
  - ASME BPVC, Section VIII, Div. 1
  - Stainless steel or corrosion resistant
- Location requirements
  - Protected from other tanks/structures
  - Concrete cover and inert fill
- Anchorage and security
- Corrosion protection required
- Vacuum level monitoring
- Safe venting of unplanned release
- Overfill protection



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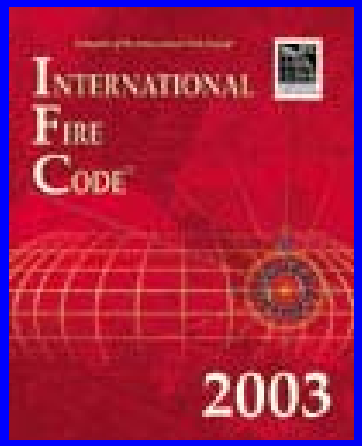
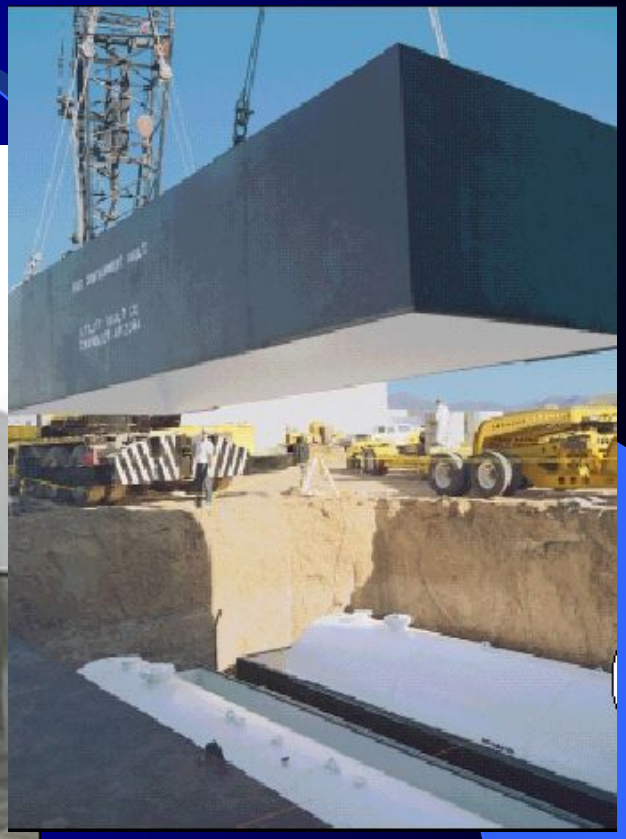


Above/Below Grade Vaults Approved *(F152 & F169-03/04)*



Photos courtesy of Shell Hydrogen and Oldcastle Precast

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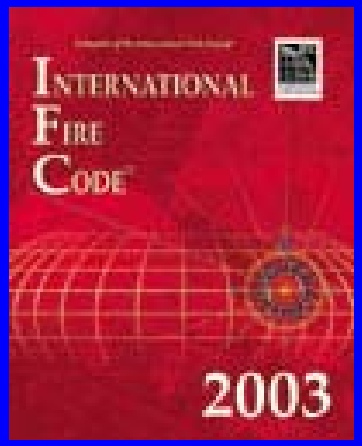

Metal Hydride Storage Approved *(F181-03/04)*

- Metal hydride storage systems for the storage of hydrogen gas contain solid material that might be flammable, suceptable to spontaneous combustion or water-reactive.
- Adds a definition to Ch. 35 Flammable Gases:
  - METAL HYDRIDE STORAGE SYSTEM. A system for the storage of hydrogen gas absorbed in solid material.
- Establishes hazard classification of system based on hydrogen stored without regard to metal hydride content.
- Systems must be listed for application and designed to prevent the removal of the metal hydride.

Hydrogen Piping Updates Approved *(FG47 & FG48-03/04)*

- §704.1.2.3 Design & Construction
  - Applicability to both piping and tubing
  - Adds Type 316L Stainless to austentitic 300 series
- §705 Testing, Inspection and Purging
  - Inspection methods clarified
  - Purging provisions added
- §705.2 Inspections, §705.3 Pressure Tests
  - ASME B31.3 recognized as practice
  - Hydrostatic or Pneumatic testing
  - Gauges and test medium specified

Photo courtesy of California Fuel Cell Partnership

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Is coverage of hydrogen in the I-Codes complete?

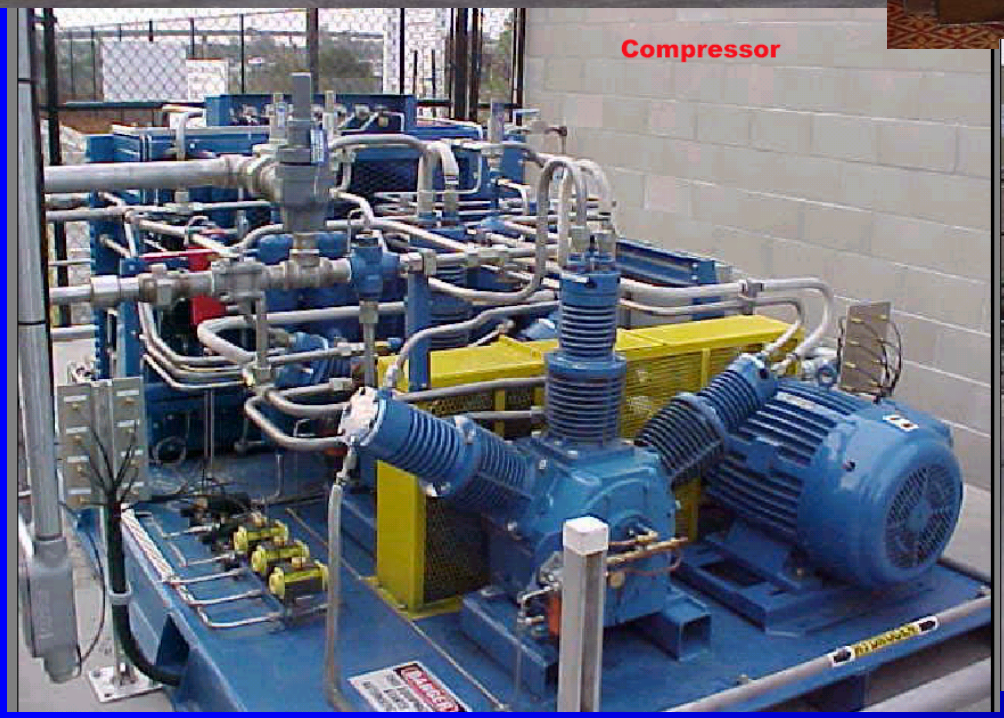
!! WHAT NEXT ??
AHC Effort 2004-05 Code Cycle

- Focus for the continued effort…**!!You tell me!!**
  - Optimize/Economize refueling station footprint
  - Separations validation research
  - Improvements to usability and enforcability
- Meeting #9 June 17-19, 2004 – DOE SummitVIII, Miami
  - SANDIA to present near “best-and-final” recommendations
  - Powered industrial trucks, indoor/outdoor hydrogen refueling
  - Receive input from interested/affected parties
  - Develop/discuss AHC proposals for 2004-05 cycle

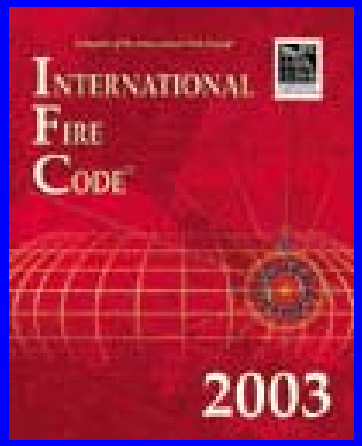

Ann Arbor, MI


AIR PRODUCTS
Hydrogen fuel


Fuel dispensers
Hydrogen Fueling Station
Hydrogen.
Fueling a cleaner future.
tell me more

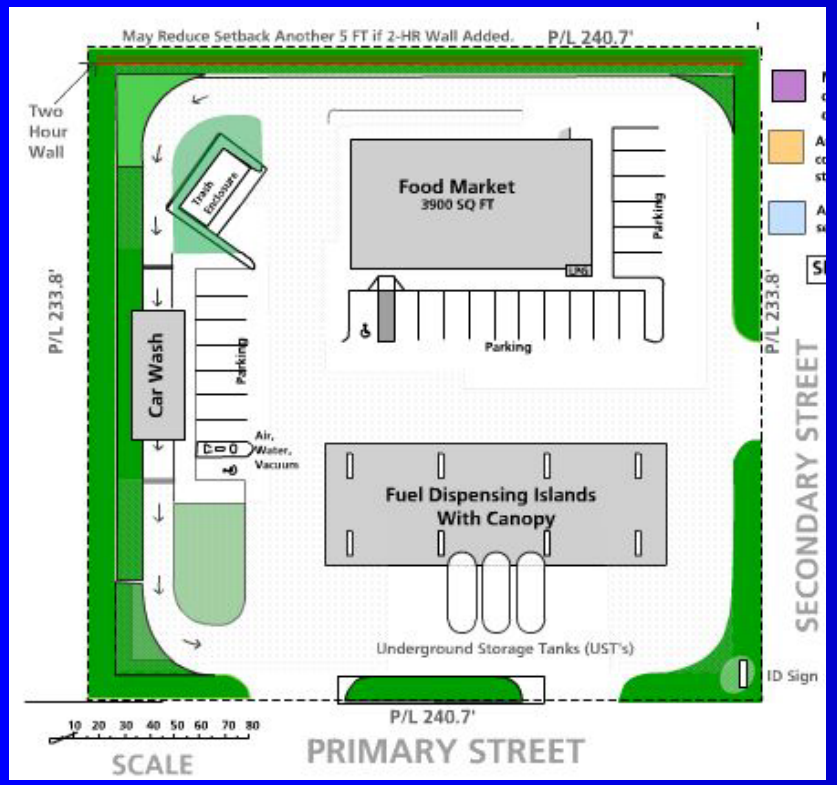

Compressor


Compressed H2 Storage



Separation Distances?

- Separation distances in T2209.3.1
- Improvements to terminology such as type of construction
- Ultimate goal use Laboratory Research
  - Validate or revise separation distances
  - Transitions “buoyant flow vs. jet flow”
  - Effects of a hydrogen fire on materials
  - Confirm flammability limits of H2
- Avoiding inadvertent exposure to flame at dispenser at instant of leak detection
  - “High-speed” flame detection interaction
- Emphasis on strong dispenser standard



!! Meetings !!
AHC Effort 2004-05 Code Cycle

- Mtg #9 – June 17-19, 2004
  - DOE FC Summit VIII, Miami, FL (June 14-17)
- Mtg #10 AHC (Release of Proposed Changes Monograph)– Jan. 2005
  - NREL Golden, CO
- ICC Public Hearing on Proposals – Feb. 21- Mar 2, 2005
  - Cincinnati, OH
- Mtg #11 AHC (To Draft Public Comments) – May, 2005
  - Chicago, IL (via ICC)
- Meeting #12 AHC (Release of FAA Monograph) – July 2005
  - NREL Golden, CO)
- Final Action Hearings – Sept. 27-30, 2005
  - Detroit, MI

'Will we see you in Cincinnati?' February, 2005 Thank You!

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Please consider us your resources to the ICC AHC

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