Final Action Report

Hydrogen Fueling Station (HFS) Permitting Workshop for Fire Safety and Building Code Officials

NREL/NEXTENERGY/NASFM

September 17-18, 2008
NextEnergy Center
Detroit, MI

Prepared by

The National Association of State Fire Marshals

with the assistance of

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Davidson Code Concepts, LLC

October 8, 2008

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Executive Summary

SECTION 1

1. Executive Summary

The overall objective of the workshop was to present background material on the hydrogen economy, baseline information on the use of hydrogen as a motor fuel and as a back up power supply fuel along with safety and emergency response considerations. The focus would then be turned to providing an overview of the Michigan hydrogen installation rules and permitting process.

To summarize the project:

- The workshop was hosted as a stand alone activity.
- The workshop built on the previous workshops via teleconference coordination and discussion.
- Participants included building code, fire code and other code officials as identified by the State of Michigan from Michigan state and local enforcing agencies participated.
- An overview of hydrogen as compared to other fuel gases was provided along with safety and emergency response information.
- A thorough overview of the Michigan hydrogen regulations was provided to participants.
- A tour of NextEnergy's hydrogen motor fuel and stationary hydrogen fuel cell installations was provided.
- A wrap up summary discussion session was facilitated.
- Several code issues were identified dealing with an understanding of how to apply the Michigan hydrogen regulations along side other duly adopted codes and standards enforced by other state and local AHJs.
- Participants were overwhelmingly positive in their post workshop review comments.

The goals of the project were met. Participants were provided with a better understanding of how to apply the Michigan hydrogen codes and referenced standards to a hydrogen motor-fueling facility or stationary hydrogen fuel cell permit application and they indicated they had an increased level of comfort with the topic. In addition, feed back from the participants provided guidance on content to include in future workshops along with areas within the existing Michigan code language that may need modification to clarify applicability.

Workshop Sponsors

The National Association of State Fire Marshals

US Department of Energy

National Renewable Energy Laboratory

NextEnergy Center

State of Michigan DEQ

Plug Power, Inc.

General Motors

Workshop Code Expert Facilitators

Davidson Code Concepts, LLC

Project Development

SECTION 2

2. Project Development

The success of any project rests on establishing clear goals, assigning responsibilities, setting timelines for completion of assignments, and verifying follow through.

The development phase of the project presents its own challenges through the involvement of agencies and firms with office locations scattered around the country and individuals that are highly mobile on a day to day basis. Face to face meetings during the planning and development phase would be limited and alternate means of communications was a necessity.

Project development was accomplished via teleconferences and effective use of electronic communications such as e-mail exchange of messages and documents.

The initial project planning began in earnest mid-July, 2008 with preliminary email exchanges locking in on the dates of the workshop based upon coordination with the NextEnergy Hydrogen Codes & Standards Conference.

The initial project teleconference occurred on August 7th, 2008 involving representatives of NREL, NASFM, NextEnergy Center, State of Michigan DEQ and industry. The discussion was guided by the draft agenda:

NextEnergy Center, Detroit, MI
September 17th and 18th, 2008

AGENDA

DAY ONE: WEDNESDAY, SEPTEMBER 17, 2008

Registration/Breakfast

Welcome

Workshop Background and Objectives

Hydrogen Fuel and Fuel Cells Overview

Hydrogen Safety

Emergency Response and Safety Systems

Hydrogen Fueling Stations and Transportation

Hydrogen Fuel Cells for Back-up Power at Wireless Telecommunication Sites
Paul Buehler, Plug Power and *Mike Maxwell (or Mark Cohen), ReliOn*

State of Michigan Permitting Program

Overview
Michigan Regulations
Permit Application
Permitting Hydrogen Facilities & Responsibilities

DAY TWO: THURSDAY, SEPTEMBER 18, 2008

8:00 a.m. – 8:30 a.m.	**Continental Breakfast**
8:30 a.m. – 9:45 a.m.	**State of Michigan Permitting Program Continued**
9:45 a.m. – 10:30 a.m.	**Tour?**
10:30 a.m. – Noon	**Summary Discussions**
Noon – 12:15 p.m.	**Adjourn Workshop** *Antonio Ruiz, U.S. Department of Energy*

And a suggested list of agencies to target:

List of Attendees
Ryan at NextEnergy has provided the link http://www.nextenergy.org/h2permittingofficials/home.asp?cityID=0 for contact information for permitting officials.
Andrea provided the following locations from which officials should be invited:

Dearborn
Southfield
Detroit
Grand Rapids
Taylor
Bay City
Wixam
Michigan Tech
Lawrence Tech
Wayne State
University of Michigan
Telecom industry attendees
GM & Ford attendees

As a result of this teleconference the following parameters were identified and discussed.

- The overall objective of the workshop is to present background on the hydrogen fuel economy, the technology involved and safety. The program will include presentation and discussion of the Michigan hydrogen regulations and permitting process.

- The fire and building code officials will be invited by NASFM. Criteria for invitation will be based upon names and jurisdictions provided by Michigan state level officials.

- A tour of the hydrogen motor fuel and stationary hydrogen fuel cell installations located at the NextEnergy Center will be provided along with a hydrogen fueled vehicle provide by GM.

- Time will be provided for open discussion during a summary session at the end of the program.

Follow up teleconferences were spent fine tuning the schedule and arranging for speakers for the agreed to topics. A logistics update was provide by NASFM during each teleconference.

The Workshop

SECTION 3

3. The Workshop

The agenda for the workshop was as follows:

Permitting Hydrogen Fueling Stations and Hydrogen Fuel Cell Backup Power for Wireless Telecommunication Sites Workshop

NextEnergy Center, Detriot, MI
September 17th and 18th, 2008

AGENDA

DAY ONE: WEDNESDAY, SEPTEMBER 17, 2008

8:00 a.m. – 8:30 a.m.	**Registration/Breakfast**
8:30 a.m. – 8:45 a.m.	**Welcome** *Andrea Zajac, State of Michigan Department of Environmental Quality (DEQ)*
8:45 a.m. – 9:05 a.m.	**Workshop Background and Objectives** *Antonio Ruiz, US Department of Transportation*
9:05 a.m. – 9:15 a.m.	**Workshop Structure, Introductions and Agenda** *Jim Narva, NASFM*
9:15 a.m. – 10:15 a.m.	**Hydrogen Fuel and Fuel Cells Overview** *Tony Androsky, USFCC*
10:15 a.m. – 10:30 a.m.	**Break**
10:30 a.m. – 11:00 a.m.	**Hydrogen Safety** *Ryan Smith, Next Energy*
11:00 a.m. – 11:15 a.m.	**Emergency Response and Safety Systems** *Jim Narva, NASFM*
11:15 a.m. – Noon	**Hydrogen Fueling Stations and Transportation** *Kelly Jezierski, NextEnergy and Joe Mercurio, GM*
Noon – 1:00 p.m.	**Lunch**
1:00 p.m. – 1:45 p.m.	**Hydrogen Fuel Cells for Back-up Power at Wireless Telecommunication Sites** *Paul Buehler, Plug Power*
1:45 p.m. – 2:00 p.m.	**Break**
2:00 p.m. – 4:00 p.m.	**Overview and Discussion of the State of Michigan Permitting Program** *Andrea Zajac and Marcia Poxson, DEQ* ▪ What's Regulated, What's Not

- Michigan Regulations
- Permit Application
- Permitting Hydrogen Facilities & Responsibilities

DAY TWO: THURSDAY, SEPTEMBER 18, 2008

8:00 a.m. – 8:30 a.m.	**Continental Breakfast**
8:30 a.m. – 9:45 a.m.	**Overview and Discussion of the State of Michigan Permitting Program Continued** *Andrea Zajac and Marcia Poxson, DEQ*
9:45 a.m. – 10:30 a.m.	**Tour NextEnergy**
10:30 a.m. – Noon	**Summary Discussions**
Noon – 12:15 p.m.	**Adjourn Workshop** *Carl Rivkin, NREL*

The primary goals of the workshop were

- Provide the participants with background on hydrogen such as its chemical properties and uses with comparisons to other flammable gases.
- Familiarize participants with examples of hydrogen motor fueling station projects and telecommunication back up power installations that have been implemented in the United States.
- Provide a background on hydrogen safety as it relates to the installations along with information for emergency responders.
- Provide a thorough overview of the Michigan hydrogen regulations and their relationship to projects located within the jurisdictions of the attendees.
- Provide a tour of the NextEnergy Center hydrogen motor fueling and stationary fuel cell installations.
- Provide participants with the opportunity for open discussion of the material covered during the program.
- Raise the comfort level of the code official should they be presented with an application to construct a hydrogen motor fueling station or hydrogen fueled back up power source in their jurisdiction.

Recommendations: Relationship of DEQ Code to Michigan Building and Fire Codes

SECTION 4

4. Recommendations:

- The state hydrogen code needs to be updated to use the current NFPA standards by reference instead of the outdated standards currently used and/or to use the International Building Code as adopted by the State of Michigan along with the International Fire Code (which includes references to the latest NFPA standards).

- The state hydrogen code has a Hazard Analysis requirement to be conducted and submitted for the hydrogen installations. This requirement should be removed since it is similar to a fault tree analysis which very few if any professionals can properly apply to the number of parts that make up a hydrogen storage and/or dispensing system.

- The State DEQ, State Building Code Officials, State Fire Marshal and Local Fire Marshals need to write an MOU outlining agreed to duties in providing for the plan review, permitting, inspection and approval of hydrogen facilities including maintenance inspections.

    - A good example of this would be the construction of canopy top hydrogen storage system which includes structural issues, electric wiring, fire suppression systems, etc., not all of which would be reviewed by the State DEQ.

Summary

SECTION 5

5. Summary

The workshop was a success both from the standpoint of providing local and state code officials and inspectors with an understanding of how to apply the various codes and standards as modified by the Michigan hydrogen regulations to an application to build a hydrogen motor-fuel station or a back up power installation for a telecommunications site, and in having the codes and standards methodically applied to a project in a manner that identified areas of concern that needed to be addressed. For code officials to feel comfortable dealing with these types of applications they need to believe they have an adequate knowledge of the issues involved and they need to be assured that the existing codes and standards adequately address safety in an effective manner.

For the workshop to have been the success it was, all involved in the preparation had to perform their functions in an effective and timely manner. The management of the invitations, travel and accommodations for those attending, and scheduling of the facility for meeting rooms and refreshments are as important as the information gathering, material preparation and presentation of the workshop itself.

A failure of any one component, whether it was the lack of a room, missing or inaccurate piece of information, or the functioning of the workshop itself affects the experience of the participant and their assessment of the workshop as a whole.

When a team is assembled and contracted to develop and present a workshop it must include and agency or organization that has a proven track record organizing an event that includes travel, accommodations and leasing of conference space. When the participants arrive for the workshop everything must be organized and ready to go. Technical assistance must be available before and during the activity to address any audio visual equipment issues that come up.

The team must include firms, individuals or agencies familiar with the targeted topic to provide valid information and resources for use in the workshop. To be effective the information must be current, technically accurate and in a form that allows it to be understood and have a professional appearance.

And the team must include experienced educational presenters to develop the material and present or facilitate the workshop. Many otherwise well prepared presentations have failed when the presenter did not have the ability to communicate effectively with the audience.

The code officials that were invited to attend this workshop were identified as potential attendees by State of Michigan officials based upon future growth of the hydrogen economy in that state. The mix of backgrounds of the attendees generated considerable discussion during the summary discussion session and provided the basis for an increased level of cooperation and coordination between state and local officials moving forward.

Appendices
A-L

APPENDICES

Permitting Hydrogen Fueling Stations and Hydrogen Fuel Cell Backup Power for Wireless Telecommunication Sites Workshop

NextEnergy Center, Detriot, MI
September 17th and 18th, 2008

FINAL ATTENDANCE LIST

Name	Title	Company
Andrea Zajac	Chief, Storage Tank Unit	State of Michigan Department of Environmental Quality
Anthony Androsky	Deputy Executive Director	USFCC
Antonio Ruiz		US Department of Energy
Carl Rivkin	Senior Project Leader II	NREL
Chrishawn Morgan-Price		NASFM
Christopher Conklin	Waste & Hazmat Inspector	State of Michigan Department of Environmental Quality
Don Bloom	Inspector	State of Michigan Department of Environmental Quality
Donald Forsyth	Building Plan Examiner	State of Michigan Department of Environmental Quality
Douglas Kutzura	Inspector	State of Michigan Department of Environmental Quality
Douglas Pentziew	HazMat Storage Inspector	State of Michigan - DEQ
Eric Davis	Fire Prevention Inspector	Detroit Fire Department/Fire Marshal Division
Gary Miles	Waste & Hazmat Inspector	State of Michigan Department of Environmental Quality
Geoff Bromaghim	Administrative Assistant	National Hydrogen Association
Jeffrey Oldenburg	Fire Marshal	City of Dearborn
Jerry Arnold	Waste & Hazmat Inspector	State of Michigan Department of Environmental Quality

Jim Narva		NASFM
Joe McElvaney	Consultant	The DiCristina Group
Joe Mercurio	Manager – Fuel Cell Field Service Integration	General Motors
Kyle Gibeault	Program Coordinator	National Hydrogen Association
Marcia Poxson	Engineer	Michigan Department of Environmental Quality
Mark Johns	Inspector	State of Michigan Department of Environmental Quality
Matt Budrow	Inspector	DEQ-WHMD
Melanie Caton	Project Leader	NREL
Michael Charbonneau	HazMat and Storage Inspector	State of Michigan Department of Environmental Quality
Michael DeWyse	HazMat Inspector	State of Michigan Department of Environmental Quality
Michael McKinley	Hazardous Materials Storage Inspector	State of Michigan Department of Environmental Quality
Michael Thompson	Senior Analyst	Sentech, Inc.
Paul Buehler		Plug Power
Rob Creamer	Chief Inspector/Manager	City of Dearborn - Department of Building Safety
Ryan Smith		NextEnergy
Steve Matthison	Senior Engineer	Honda R&D Americas, Inc.
Tony SanFlippo	Deputy Director	Bureau of Fire Services

Permitting Hydrogen Installations Workshop

September 17, 2008
Detroit, Michigan

Antonio Ruiz
Technology Development Manager
U.S. Department of Energy
Hydrogen Program

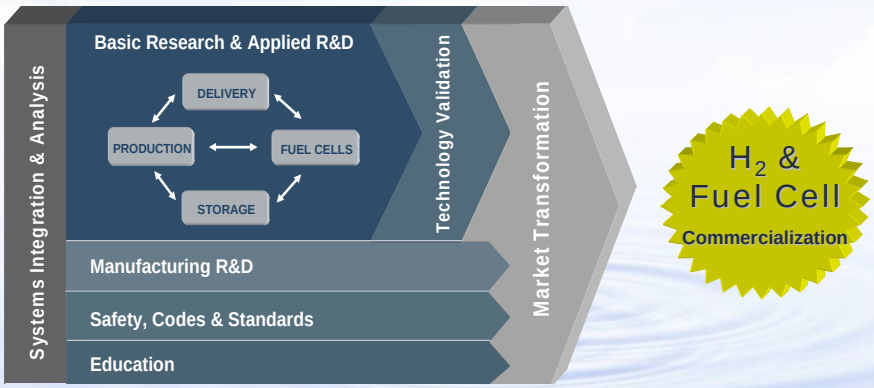
Hydrogen Program Mission

The Hydrogen Program's mission is to reduce oil use and carbon emissions in the transportation sector, and to enable clean, reliable energy for stationary and portable power generation.

The Program aims to accomplish this mission by researching, developing, and validating hydrogen and fuel cell technologies and by overcoming the non-technical barriers to their commercialization.

Hydrogen Program Activities

The DOE Hydrogen Program integrates diverse activities to address the wide range of barriers facing the commercialization of hydrogen and fuel cells



EERE Hydrogen Technologies Budget: FY 2004 – FY 2009

Activity	Funding *($ in thousands)*					
	FY 2004 Approp.	FY 2005 Approp.	FY 2006 Approp.	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request
Hydrogen Production & Delivery	10,083	13,303	8,391	33,702	39,636	0
Hydrogen Storage R&D	13,628	22,418	26,040	33,728	43,501	59,200
Fuel Cell Stack Component R&D	24,551	31,702	30,710	37,100	43,600	62,700
Technology Validation	15,648	26,098	33,301	39,413	29,727	15,000*
Transportation Fuel Cell Systems	7,317	7,300	1,050	7,324	7,927	6,600
Distributed Energy Fuel Cell Systems	7,249	6,753	939	7,257	7,630	10,000
Fuel Processor R&D	14,442	9,469	637	3,952	2,973	0
Safety, Codes & Standards	5,755	5,801	4,595	13,492	15,854	12,500*
Education	2,417	0	481	1,978	3,865	4,000*
Systems Analysis	1,429	3,157	4,787	9,637	11,395	7,713
Manufacturing R&D	0	0	0	1,928	4,954	0
Technical/Program Mgt. Support	395	535	0	0	0	0
Congressionally Directed Activities	41,967	40,236	42,520	0	0	0
TOTAL	144,881	166,772	153,451	189,511	211,062	177,713

* Transferred to Vehicle Technologies in FY 2009

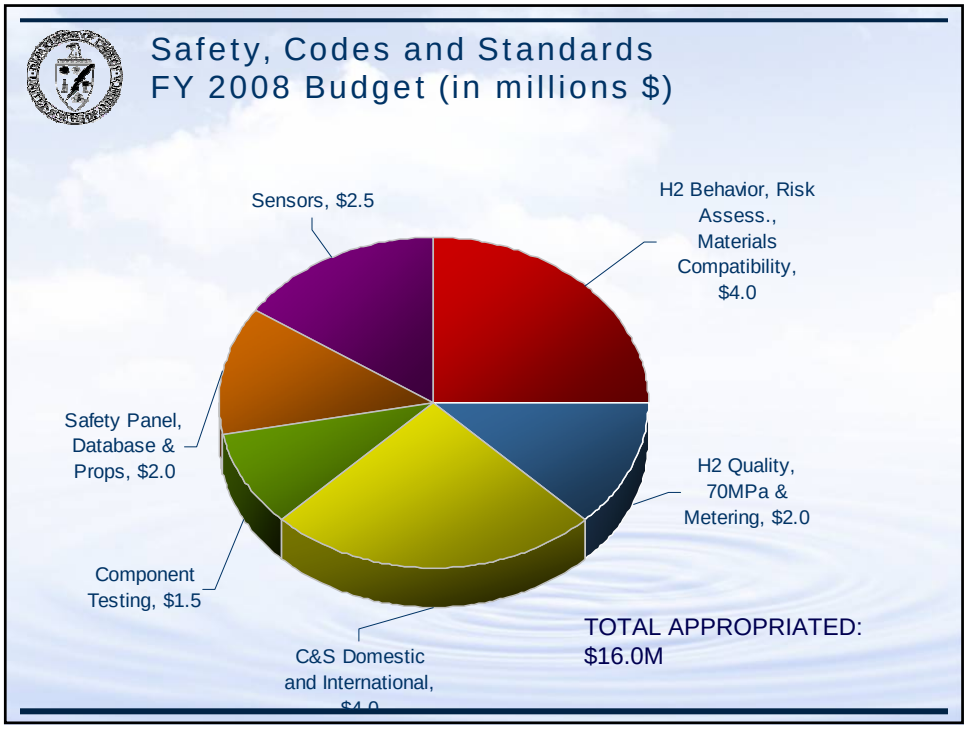
Hydrogen Fuel Initiative Budget: FY 2004 – FY 2009

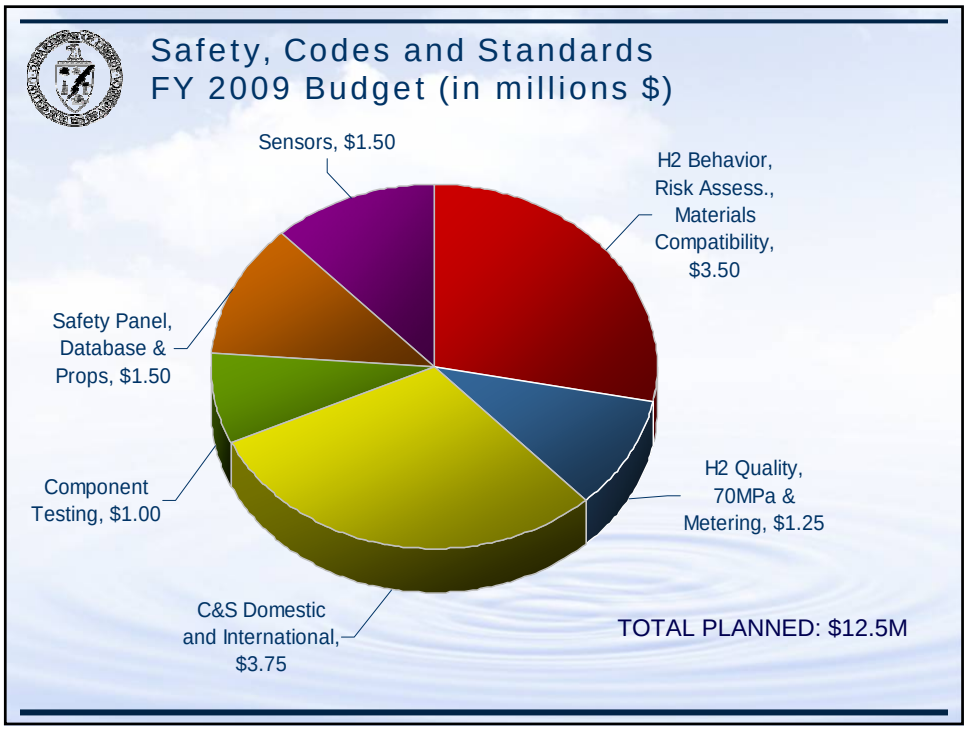
	Funding *($ in thousands)*					
	FY 2004 Approp.	FY 2005 Approp.	FY 2006 Approp.	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request
HYDROGEN FUEL INITIATIVE						
EERE Hydrogen	144,881	166,772	153,451	189,511	211,062	177,713*
Fossil Energy (FE)	4,879	16,518	21,036	21,513	21,773	11,430
Nuclear Energy (NE)	6,201	8,682	24,057	18,855	9,909	16,600
Science (SC)	0	29,183	32,500	36,388	36,388	60,400
DOE Hydrogen TOTAL	**155,961**	**221,155**	**231,044**	**266,267**	**279,132**	**266,143**
Department of Transportation	555	549	1,411	1,420	1,425	1,425
Hydrogen Fuel Initiative TOTAL	**156,516**	**221,704**	**232,455**	**267,687**	**280,557**	**267,568**

*** Includes $146,213,000 in Hydrogen Technology and $31,500,000 in Vehicle Technologies**

Safety, Codes and Standards Sub-program Objectives

- Establish requirements for hydrogen codes and standards based on scientific data, modeling, and analysis
- Implement consensus national agenda on domestic and international codes and standards for hydrogen systems in commercial, residential, and transportation applications
- Facilitate permitting of retail hydrogen fueling stations and fuel cell installations for backup power in the US through education and outreach to state/local code officials
  - need efficient, cost-effective permitting process based on collaboration among code officials, industry, and other key stakeholders


Safety, Codes and Standards
FY 2008 Budget (in millions $)
Sensors, $2.5
H2 Behavior, Risk Assess., Materials Compatibility, $4.0
Safety Panel, Database & Props, $2.0
H2 Quality, 70MPa & Metering, $2.0
Component Testing, $1.5
C&S Domestic and International,
TOTAL APPROPRIATED: $16.0M


Safety, Codes and Standards
FY 2009 Budget (in millions $)
Sensors, $1.50
H2 Behavior, Risk Assess., Materials Compatibility, $3.50
Safety Panel, Database & Props, $1.50
H2 Quality, 70MPa & Metering, $1.25
Component Testing, $1.00
C&S Domestic and International, $3.75
TOTAL PLANNED: $12.5M

Background: HFS Permitting Workshop

- First Workshop – Sacramento, February 1, 2007
  - Invited fire/building code officials, HFS developers from states where HFS located or likely to be located
  - Perspectives of hydrogen fueling station (HFS) developers and code officials on permitting experience (case studies)
    - Shared lessons learned
      - Shell Benning Road HFS (Washington, DC, Office of Fire Marshall)
      - NextEnergy energy station (Michigan Dept. Environmental Quality)
      - Chevron AC Transit HFS (Oakland Fire Prevention Bureau)
- Key issues and barriers to timely and cost-effective permitting of HFS identified
- Recommendations to DOE on how it can facilitate permitting process for HFS
- Feedback on proposed DOE initiative

Background: HFS Permitting

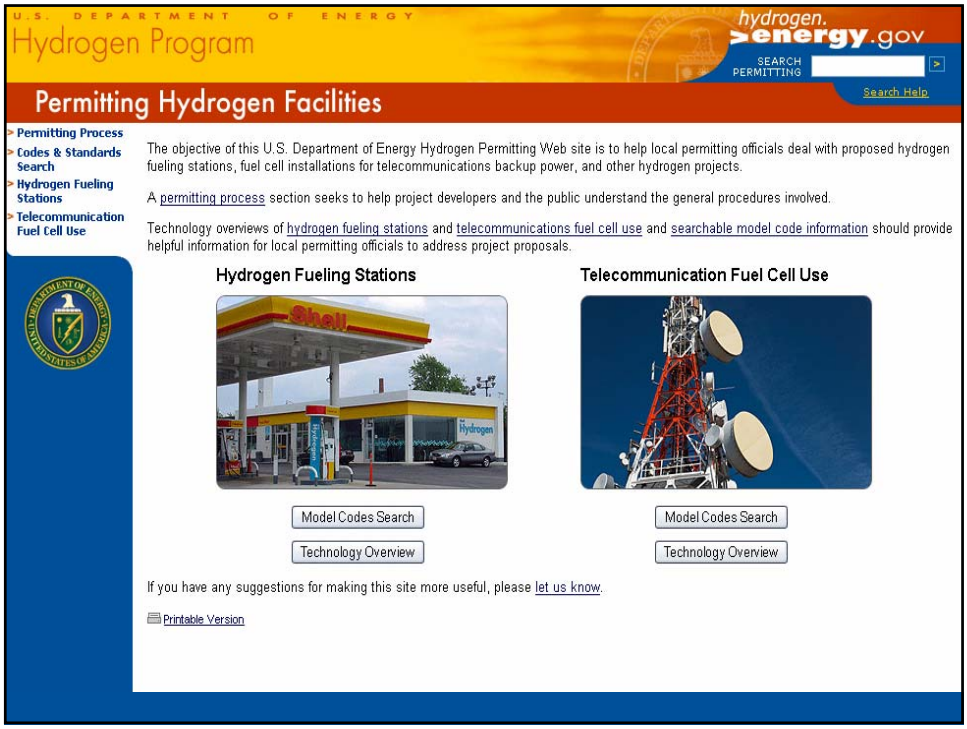
- Key Recommendations to DOE
  - Develop Information Repository for HFS with validated,"3rd party" data and information
  - Identify applicable codes & standards (specific safety requirements) and make them more accessible to permitting officials
  - Develop detailed Process Flowchart for permitting HFS
  - Develop Template for code officials to navigate permitting process
  - Note best practices for application of codes and standards for HFS
  - Develop fact sheets on hydrogen technologies/HFS equipment for permitting officials
  - Develop permitting pathway from "behind the fence" stations to retail stations
- Proceedings/presentations posted on NHA website (www.hydrogenandfuelcellsafety.info)

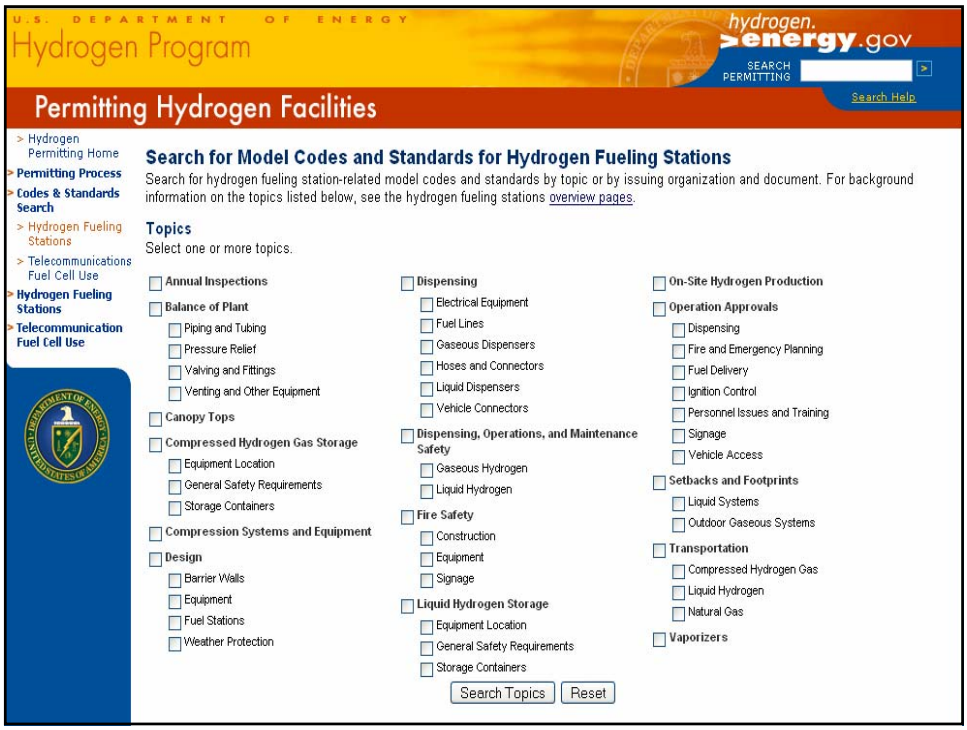
Permitting H_2 Fueling Stations and Fuel Cell Installations: DOE Initiative

- Information Toolkit
  - Fact sheet(s)
    - basic information on hydrogen and FC installations (examples, codes/standards typically used, information sources)
  - Network chart
    - contact list of code officials whose jurisdictions have issued permits for hydrogen and FC installations
  - Flowchart of permitting requirements
    - web-based map to "navigate" requirements with database of key standards and codes
  - Permitting Compendium
    - web-based information source and database
- Education-outreach workshops for code officials
  - National workshops with NASFM
    - vet case studies, C&S permitting process, information tools
  - Workshops in key regions
    - locations where industry will focus H_2 infrastructure development and hydrogen vehicle and fuel cell deployment

Permitting Workshop

- Objectives
  - Invite key fire and building code officials
    - present case studies
      - H2 stations and fuel cell installations permitted/permitting underway
      - codes/standards applied
    - review and discussion by permitting officials of case studies
    - recommendations to DOE on facilitating permitting process
  - Show information repository concept
    - web-based tools to "navigate" requirements with database of key standards and codes
    - recommendations to DOE on initiative and other steps


U.S. DEPARTMENT OF ENERGY
Hydrogen Program
hydrogen.energy.gov
SEARCH PERMITTING
Search Help
Permitting Hydrogen Facilities
Permitting Process
Codes & Standards Search
Hydrogen Fueling Stations
Telecommunication Fuel Cell Use
The objective of this U.S. Department of Energy Hydrogen Permitting Web site is to help local permitting officials deal with proposed hydrogen fueling stations, fuel cell installations for telecommunications backup power, and other hydrogen projects.
A permitting process section seeks to help project developers and the public understand the general procedures involved.
Technology overviews of hydrogen fueling stations and telecommunications fuel cell use and searchable model code information should provide helpful information for local permitting officials to address project proposals.
Hydrogen Fueling Stations
Telecommunication Fuel Cell Use
Model Codes Search
Technology Overview
Model Codes Search
Technology Overview
If you have any suggestions for making this site more useful, please let us know.
Printable Version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Hydrogen Program
hydrogen.energy.gov
SEARCH PERMITTING
Search Help
Permitting Hydrogen Facilities
Hydrogen Permitting Home
Permitting Process
Codes & Standards Search
Hydrogen Fueling Stations
Telecommunications Fuel Cell Use
Hydrogen Fueling Stations
Telecommunication Fuel Cell Use
Search for Model Codes and Standards for Hydrogen Fueling Stations
Search for hydrogen fueling station-related model codes and standards by topic or by issuing organization and document. For background information on the topics listed below, see the hydrogen fueling stations overview pages.
Topics
Select one or more topics.
Annual Inspections
Balance of Plant
Piping and Tubing
Pressure Relief
Valving and Fittings
Venting and Other Equipment
Canopy Tops
Compressed Hydrogen Gas Storage
Equipment Location
General Safety Requirements
Storage Containers
Compression Systems and Equipment
Design
Barrier Walls
Equipment
Fuel Stations
Weather Protection
Dispensing
Electrical Equipment
Fuel Lines
Gaseous Dispensers
Hoses and Connectors
Liquid Dispensers
Vehicle Connectors
Dispensing, Operations, and Maintenance Safety
Gaseous Hydrogen
Liquid Hydrogen
Fire Safety
Construction
Equipment
Signage
Liquid Hydrogen Storage
Equipment Location
General Safety Requirements
Storage Containers
On-Site Hydrogen Production
Operation Approvals
Dispensing
Fire and Emergency Planning
Fuel Delivery
Ignition Control
Personnel Issues and Training
Signage
Vehicle Access
Setbacks and Footprints
Liquid Systems
Outdoor Gaseous Systems
Transportation
Compressed Hydrogen Gas
Liquid Hydrogen
Natural Gas
Vaporizers
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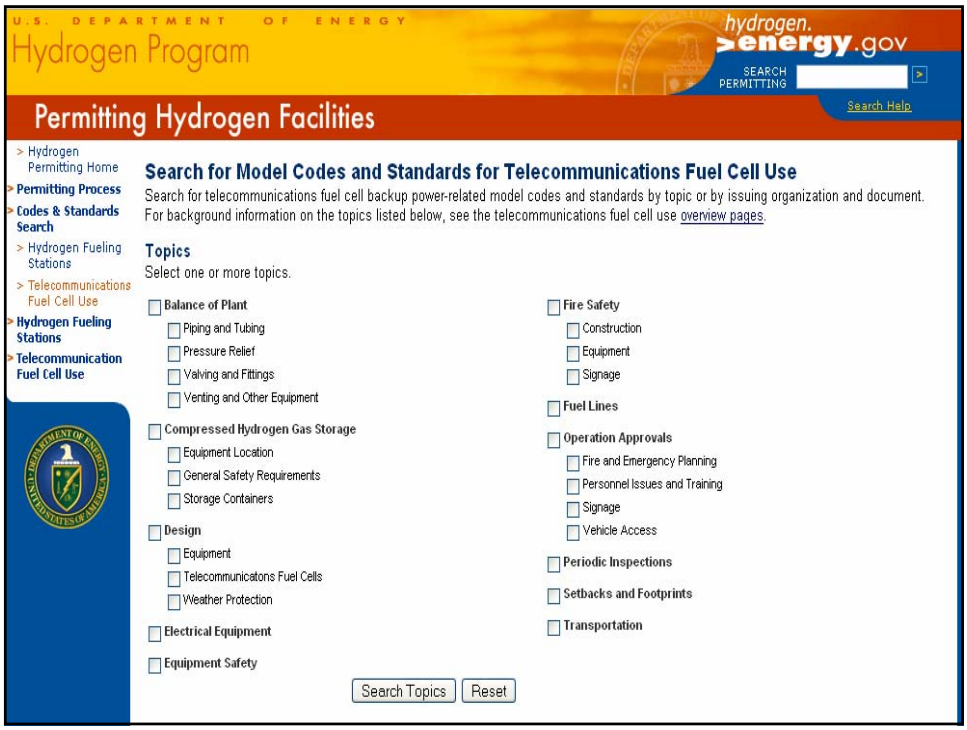
Permitting Hydrogen Facilities
> Hydrogen Permitting Home
> Permitting Process
> Codes & Standards Search
> Hydrogen Fueling Stations
> Delivery
> On-Site Production
> Storage & Compression
> Dispensing
> Design Standards
> Operation Standards
> Case Studies
> Related Links
> Contacts
> Telecommunication Fuel Cell Use
Hydrogen Fueling Stations
Public-use hydrogen fueling stations are very much like gasoline ones. In fact, sometimes, hydrogen and gasoline cars can be fueled at the same station. These stations offer self-service pumps, convenience stores, and other services in high-traffic locations.
Many future hydrogen fueling stations will be expansions of existing fueling stations. These facilities will offer hydrogen pumps in addition to gasoline or natural gas pumps. Other hydrogen fueling stations will be "standalone" operations. These stations will be designed and constructed to offer only hydrogen fueling. The design requirements of add-on and standalone stations may differ and should be considered in station design and permitting.
Like other fueling stations, hydrogen stations must be designed, constructed, and operated in accordance with the properties of the fuel they offer. Because of the unique properties of hydrogen, some special equipment, site, and safety considerations are necessary.
As permitting officials and developers become familiar with the basic properties, uses, and safety considerations of hydrogen, they will better understand the construction and safety considerations of hydrogen fueling stations and related codes and standards. Learn more about hydrogen basics.
Also affecting the design and permitting of hydrogen fueling stations are the methods used for hydrogen acquisition, storage, compression, and dispensing. Learn more about:
• Hydrogen delivery
• On-site hydrogen production
• Hydrogen storage and compression
• Hydrogen dispensing
• Design Standards
• Operation Standards
• Case Studies
• Related Links
• Contacts
Shell
This fueling station in Washington, D.C., provides drivers with both hydrogen and gasoline fuels
Printable Version
Contact Us | Security & Privacy | Hydrogen Program Home | USA.gov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> Hydrogen Permitting Home
> Permitting Process
> Codes & Standards Search
> Hydrogen Fueling Stations
> Telecommunications Fuel Cell Use
> Hydrogen Fueling Stations
> Telecommunication Fuel Cell Use
Search for Model Codes and Standards for Telecommunications Fuel Cell Use
Search for telecommunications fuel cell backup power-related model codes and standards by topic or by issuing organization and document.
For background information on the topics listed below, see the telecommunications fuel cell use overview pages.
Topics
Select one or more topics.
Balance of Plant
Piping and Tubing
Pressure Relief
Valving and Fittings
Venting and Other Equipment
Compressed Hydrogen Gas Storage
Equipment Location
General Safety Requirements
Storage Containers
Design
Equipment
Telecommunicatons Fuel Cells
Weather Protection
Electrical Equipment
Equipment Safety
Fire Safety
Construction
Equipment
Signage
Fuel Lines
Operation Approvals
Fire and Emergency Planning
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hydrogen.energy.gov
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Permitting Hydrogen Facilities

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- **Permitting Process**
- **Codes & Standards Search**
- **Hydrogen Fueling Stations**
- **Telecommunication Fuel Cell Use**
  - Telecommunications Technology
  - Backup Power
  - Fuel Cell Advantages
  - Fuel Cell Operation
  - Fuel Cell Maintenance
  - Design Standards
  - Operation Standards
  - Case Studies
  - Related Links
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Using Fuel Cells for Backup Power for Telecommunications Facilities

The telecommunications industry has expanded rapidly as mobile telephones, computers, and high-speed Internet have become more common. The number of cell phone towers and other telecommunications facilities has increased dramatically. This expansion has introduced new industry challenges, particularly service reliability. To prevent outages, most telecommunications providers install some form of backup power to keep their towers, equipment, and networks operational.

Historically, the electric power grid provided primary power, and batteries and generators provided backup. Many telecommunications providers are now, however, turning to fuel cells for backup power because of important advantages they offer.

To support efficient permitting and safe operation of fuel cell backup power systems at telecommunication sites, the U.S. Department of Energy is working with code organizations, local permitting officials, national laboratories, and industry experts to support the development of model codes and standards, and to provide up-to-date information to permitting officials.

The telecommunications industry uses an extensive network of cell phone towers and other field facilities to transmit phone calls and other services. All of these facilities require highly reliable electrical power supplies. Fuel cells provide highly effective backup to power these facilities in event of electrical grid power outages.

Learn more about:

- Telecommunications Technology
- Backup Power for Telecommunications
- Fuel Cell Advantages
- Fuel Cell Operation
- Fuel Cell Maintenance
- Design Standards
- Operation Standards
- Case Studies
- Related Links
- Contacts

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Permitting Hydrogen Facilities

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- **Telecommunication Fuel Cell Use**

Permitting Process

The permitting process for fueling stations, telecommunication backup power fuel cells and other hydrogen projects includes a number of steps, issues, codes, and standards that must be addressed by developers, permitting officials, fire safety officials, and other authorities.

The permitting process is designed to improve safety by reducing:

- The probability of an unintentional release of hydrogen
- The consequences of an accident if there is an unintentional hydrogen release
- The severity of a hydrogen-related fire.

Preliminary project preparation considerations include zoning, site selection, and garnering community support. Construction approval permits may address facility design, equipment, and construction requirements. Operation approvals may include a variety of permits, some ongoing on annual or other recurring bases. Although the major steps of the process are listed sequentially here, they may vary significantly by project. Some projects may include more steps, and there may be overlap among the steps, depending on the procedures used by the local permitting authority. In addition, the steps may vary based on the type of hydrogen project being developed. For example, the addition of hydrogen fuel to an existing fueling station or fuel cells to an existing telecommunications facility may have different zoning and site selection steps than a new standalone hydrogen fueling station or telecommunications tower. Similarly, fueling stations that produce hydrogen on-site and stations that have hydrogen delivered may have different processes and requirements.

- Project Considerations
- Construction Approval
- Operation Approvals

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Hydrogen Information and Education Tools

PROGRAM HIGHLIGHTS

- Introduction to Hydrogen Safety for First Responders
  - 6700 users since Jan 07' launch
- Online Safety Best Practices Manual
  - Lessons learned from project site visits, submitted safety plans, and extensive literature
- Hands-on "prop course"
  - Designed to realistically and safely simulate an actual fuel cell vehicle emergency response event.
- Hydrogen Safety Bibliographic Database
  - Contains over 500 documents related to hydrogen safety
- Introduction to Hydrogen for Code Officials
  - Provide readily-accessible "Hydrogen 101" information focused on the specific needs of code officials.

Technology Validation

Technologies are validated & progress evaluated through learning demonstrations (four teams in 50/50 cost-shared projects)

DOE Vehicle/Infrastructure Demonstration

Verified performance in 122 fuel cell vehicles and 16 hydrogen stations:

- ***EFFICIENCY: 53 – 58%*** *(>2x higher than gasoline internal combustion engines)*
- ***RANGE: 103 – 190 miles***
- ***FUEL CELL SYSTEM DURABILITY:***
  - ***1900 hours, projected (~57,000 miles)***
  - ***1200 hours, actual (~36,000 miles)***

Demonstrated Fuel Cost: $3/gge, from natural gas

DOT is demonstrating fuel cell buses and providing data to DOE for analysis

Eight buses in California, Massachusetts, New York, South Carolina, and Washington, DC

Additional Safety Information Tools

h2incidents.org

h2bestpractices.org

hydrogen.energy.gov

For More Information

www.hydrogen.energy.gov

Antonio Ruiz
antonio.ruiz@ee.doe.gov
(202) 586-0729

US Fuel Cell Council

Hydrogen

Properties – Generation – Distribution - Uses

PRESENTATION FOR

US BUILDING OFFICIALS

US CODE OFFICIALS

US FIRE MARSHALS

1

Hydrogen Facts

US Fuel Cell Council

- Hydrogen (H) is the first element in the periodic table of elements. It consists of one proton and one electron.
- Molecular hydrogen (H_2) is a small, simple molecule consisting of two protons and two electrons.
- Hydrogen is not commonly found in its pure form on Earth since it readily combines with other elements.

2

Anthony Androsky
US Fuel Cell Council

Hydrogen Properties

US Fuel Cell Council

Physical Constants

H_2 Molecular weight	2
Density (70°F, 1 atm)	0.00521 lbm/ft^3
Specific Gravity (70°F, 1 atm)	0.0696 (~$^1/_{14}$ of air)
Boiling point	-423°F (~37 R)
Melting point	-435°F (~25 R)
Energy Content	
(Lower Heating Value at 70°F, 1 atm)	51,555 Btu/lbm
	268.6 Btu/ft^3

Sources: CGA G-5, Hydrogen, 6th Edition; 2005

3

Hydrogen Properties

US Fuel Cell Council

Hydrogen has some interesting physical properties:

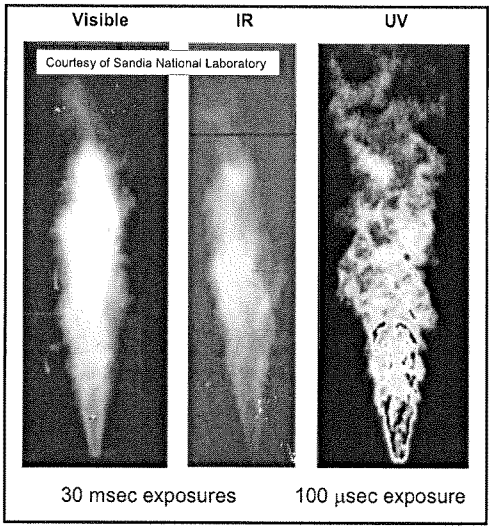
- Non-toxic
- Asphyxiant
- Odorless and Tasteless
- *Burns with a pale-blue, almost-invisible flame (DOE)*
- Burning hydrogen produces no carbon dioxide, particulate, or sulfur emissions. It can produce nitrous oxide (NOX) emissions under some conditions. (DOE)

4

Hydrogen Properties

US Fuel Cell Council

- A pure hydrogen flame is a pale blue color and is difficult to see in sunlight.
- Impurities in the air reacting with the hydrogen may make the flame more visible



5

Hydrogen Properties

US Fuel Cell Council

Some Hydrogen properties present a challenge:

- Easily ignited
- Wide flammability and explosive ranges
- Permeable through many materials
- Hydrogen can cause embrittlement of some metals.
- Some polymers are not compatible with hydrogen.
- *Low energy content (by volume)*
- *Low emissivity ("almost invisible flame" and low radiant heat transfer)*

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Hydrogen Properties

US Fuel Cell Council

	Hydrogen (4 / 0 / 0)	Natural Gas (4 / 1 / 0)	Gasoline (3 / 1 / 0)
Color	No	No	Yes
Toxicity	None	Some	High
Odor	Odorless	Mercaptan	Yes
Buoyancy Relative to Air	14X Lighter	2X Lighter	3.75X **Heavier**
Diffusivity Relative to Gasoline	~20X Gasoline	~5x Gasoline	0.2cm3/sec
Energy by Weight	2.8X > Gasoline	~1.2X > Gasoline	43 MJ/kg
Energy by Volume	4X to 10X< Gasoline	1.5X < Gasoline	120 MJ/Gallon

Hydrogen Properties

US Fuel Cell Council

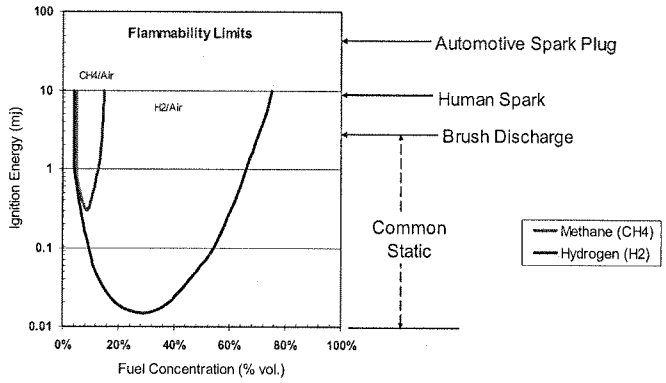
	Hydrogen (4 / 0 / 0)	Natural Gas (4 / 1 / 0)	Gasoline (3 / 1 / 0)
Flammability in air (LFL – UFL)	4.1% - 74%	5.3% - 15%	1.4% - 7.6%
Explosive limits in air (LEL – UEL)	18.3% - 59%	5.7% - 14%	1.4% - 3.3%
Fuel/Air Stoichiometry (complete combustion)	29%	9%	2%
Auto Ignition Temperature (F)	968	1166	437
Flame temperature (F)	3700	3400	4000
Radiant Heat Transfer From Flame	1/10 Gasoline	~ Gasoline	Gasoline

Anthony Androsky
US Fuel Cell Council

Hydrogen Properties

US Fuel Cell Council

Ignition Energy as a function of Mixture



Air Products Presentation dates 1998 June 12, p. 12

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Hydrogen Properties

US Fuel Cell Council

Sources for information on hydrogen properties used in slides 9-12:

- Bulletin 503, US Bureau of Mines, Limits of Flammability of Gases and Vapor; Coward and Jones 1952
- Bulletin 627, US Bureau of Mines, Flammability Characteristics of Combustible of Gases and Vapor; Zabetakis,1965
- CGA G-5, Hydrogen, 6th Edition, 2005
- Engineering Manual, 2nd Edition; Robert. H. Perry, 1967
- NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas; 1997
- NASA NSS 1740.16, Safety Standard for Hydrogen and Hydrogen Systems

12

Hydrogen Generation

US Fuel Cell Council

- Hydrogen can be generated at a central plant or locally at the point of use. It can be generated by a number of methods. Some of these methods include:
  - Reforming of Hydrocarbon Fuels
  - Splitting of water using electricity (electrolysis)
  - Gasification of fossil fuels (e.g. coal)
- The most common method of generating hydrogen is steam methane reforming (SMR) of natural gas. Steam methane reforming accounts for 95% of the hydrogen produced in the U.S. (DOE).
- The most common methods for the local point-of-use generation of hydrogen are:
  - Steam methane reforming
  - Electrolysis

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Transport to Site

US Fuel Cell Council

Hydrogen can be generated on-site (distributed generation) or at a remote location (central generation) and transported.

- Hydrogen generated on-site for use on-site is typically stored as a compressed gas since liquefaction is not needed and liquefaction is costly.
- Hydrogen generated off-site may be delivered as a liquid or as a gas depending upon the economies of transportation and liquefaction. Delivery is typically based on the method of storage.

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On-site Storage

US Fuel Cell Council

Liquid Storage

- Hydrogen is stored at very low temperatures (–) 423°F
- Each major component typically has isolation valves.
- Each major component with significant inventory has a pressure actuated safety relief valve.

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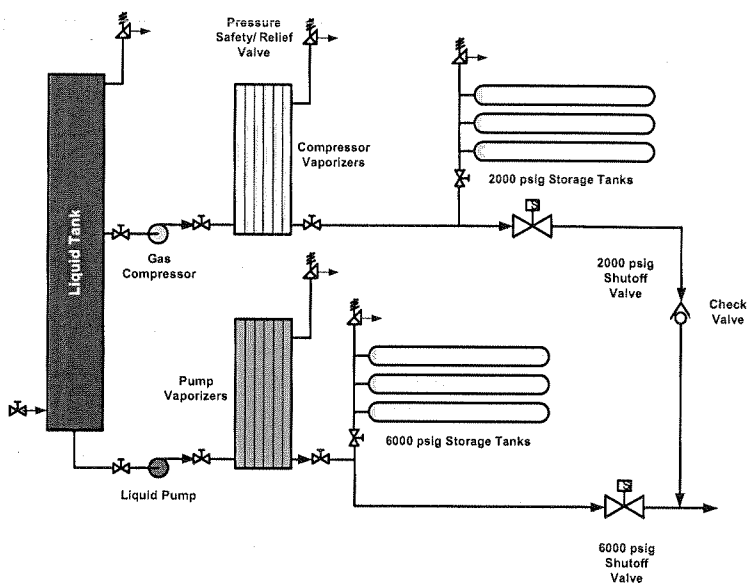
On-Site Storage

US Fuel Cell Council



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On-site Storage

US Fuel Cell Council

Liquid Storage

- Major components are typically designed per the ASME Boiler and Pressure Vessel Code
- Piping is designed per the appropriate ASME piping code (B31.1, B31.3, B31.12). The decision to use a particular design standard is made based on prior experience and precedent within the particular industry doing the design. All of these standards provide conservative designs that are practically interchangeable.
- NFPA 55 (was NFPA 50B) or the International Fire Code Chapter 34 is usually followed for liquid storage sites.

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On-site Storage

US Fuel Cell Council

Liquid Storage

- The Compressed Gas Association has a number of well written guidelines and recommended practices. Examples include:
  - CGA G5.4 - Hydrogen Piping Systems at Customer Sites
  - CGA G5.5 - Hydrogen Vent Systems
  - CGA H3 - Cryogenic Hydrogen Storage

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On-site Storage

US Fuel Cell Council

Gaseous Storage.

- Each major component typically has isolation valves.
- Each major component with relatively large inventory typically has a pressure actuated safety relief valve.
- Several pressure stages may exist.

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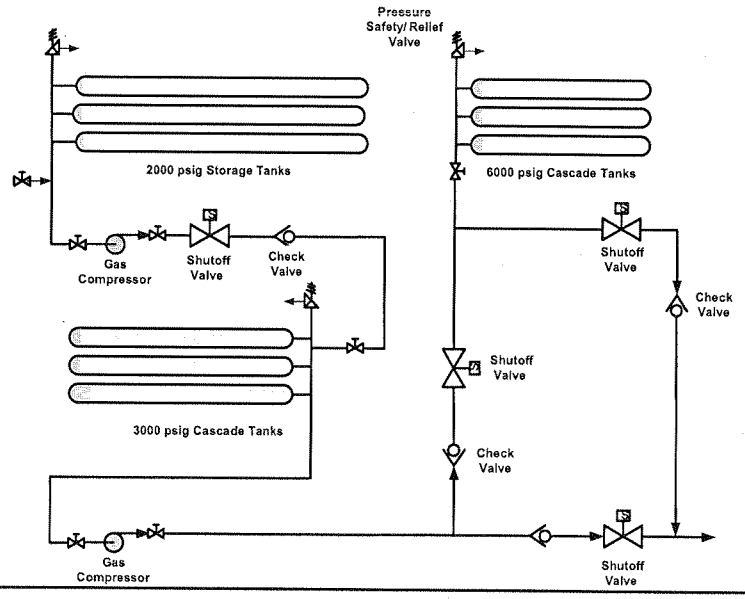
On-Site Storage

US Fuel Cell Council



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On-site Storage

US Fuel Cell Council

Gaseous Storage.

- Major components are typically designed per the ASME Boiler and Pressure Vessel Code
- Piping is designed per the appropriate ASME piping code (B31.1, B31.3, B31.12). The decision to use a particular design standard is made based on prior experience and precedent within the particular industry doing the design. All of these standards provide conservative designs that are practically interchangeable.
- NFPA 55 (was NFPA 50A) or the International Fire Code Chapter 35 is usually followed for gaseous storage sites.

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On-site Storage

US Fuel Cell Council

Gaseous Storage.

- The Compressed Gas Association has a number of well written guidelines and recommended practices. Examples include:
  - CGA G5.4 - Hydrogen Piping Systems at Customer Sites
  - CGA G5.5 - Hydrogen Vent Systems
  - CGA G5.6 - Hydrogen Pipeline Systems

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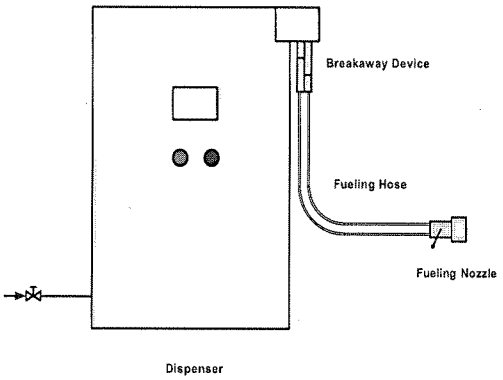
US Fuel Cell Council

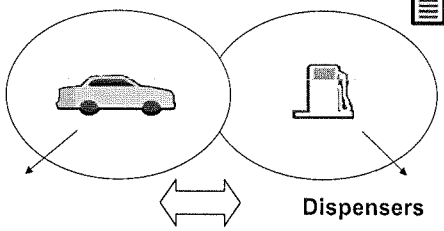
Dispenser

A dispenser system consists of four major components:



- Dispenser
- Breakaway Device
- Fueling Hose
- Fueling Nozzle

US Fuel Cell Council



Vehicles

- SAE J2578 – Vehicle Safety
- SAE J2600: 35 MPa Receptacle
- SAE J2601 Draft: – Communication & Targets
- SAE J2799: 70MPa Nozzle Report
- SAE J2719 & ISO/TS 14687-2:2008: Hydrogen Quality

Dispensers

- CSA HGV 4.1 Draft – Hydrogen Dispensers
- SAE J2600: 35 MPa Nozzle
- CSA HGV 4.3: Draft – Dispenser Communication via SAE J2601
- HGV 4.2 Draft – Hose and Hose Assemblies
- SAE J2719 & ISO/TS 14687-2:2008: Hydrogen Quality
- HGV4.4 Draft– Breakaway Devices
- Local and State Regulations:
  - Dispenser Accuracy, Grounding, PRV Setting, Permits

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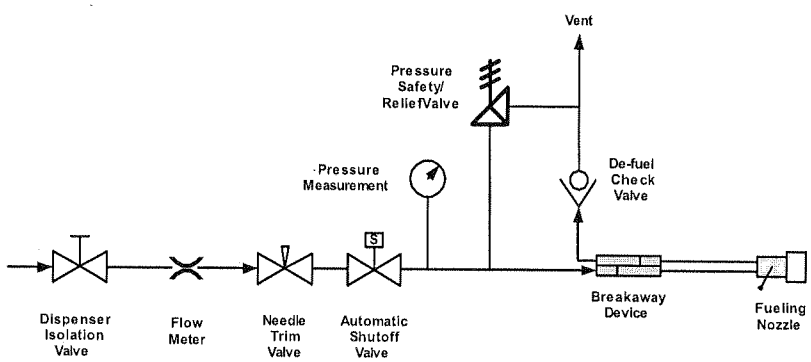
Dispenser

US Fuel Cell Council



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Vehicle Storage

US Fuel Cell Council

SAE and CSA are presently addressing storage on the vehicle. Storage is at 350 bar (5000 psi) or 700 bar (10,000 psi).

The storage system is relatively simple.

- Check Valve(s)
- Tank
- Shut off Valve
- Temperature Activated Pressure Relief Valve (PRD)

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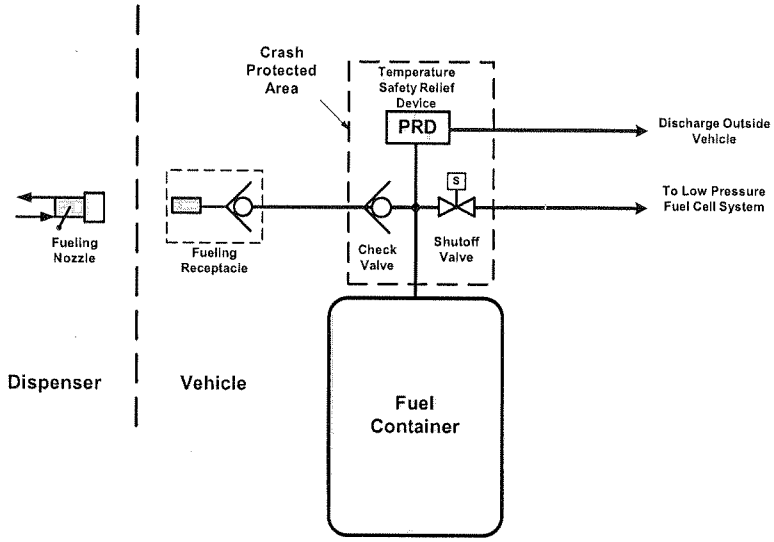
Dispenser

US Fuel Cell Council



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Hydrogen Fueling Stations

US Fuel Cell Council

Designed using one or more of the following:

- NFPA 52
- International Fire Code Chapter 22
- ASME Boiler and Pressure Vessel Code
- ASME B31.1, B31.3, B31.12
- NFPA 55

Storage may be liquid or gaseous hydrogen.

Dispensing can be liquid or gaseous.

Permitting guidance can be found here:
http://www.hydrogen.energy.gov/fueling_stations/permitting_process.cfm

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Fueling Stations

US Fuel Cell Council

Hydrogen Fueling Station in Oakland, California
Courtesy of Chevron

Hydrogen Fueling Station in Washington, DC
Courtesy of General Motors

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Fuel Cells

US Fuel Cell Council

What is a fuel cell?

A fuel cell generates electricity efficiently and cleanly without combustion. A chemical reaction between a fuel supply and oxygen produces direct current electricity inside the fuel cell. The fuel cell will stop running when the fuel supply is depleted or shut off.

Fuel cells on the space shuttle use bottled oxygen and hydrogen as fuel and make water for the astronauts to drink. For our systems, oxygen from the air is used.

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Fuel Cells

US Fuel Cell Council

What parts make up a fuel cell?

A fuel cell, like a battery, is a string of cells. Each cell consists of:

- an anode electrode
- an anode fuel distributor
- an electrolyte
- a cathode electrode
- a cathode fuel distributor
- a heat removal device

A fuel cell needs fuel to run. Fuel can be provided in many ways, and is fed to the fuel cell in order for the chemical reaction to take place, which provides electricity.

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Fuel Cell Technologies

Type	Efficiency	Operating Temp.
Solid Oxide	45-65%	~1500°F (~800°C)
Molten Carbonate	50%	~1200°F (~650°C)
Phosphoric Acid	40%	~400°F (~200°C)
Alkaline	50-60%	~180°F (~ 80°C)
Direct Methanol	40%	Up to180°F (80°C)
Proton Exchange Membrane (PEM)	40%	Up to 240°F (120°C)

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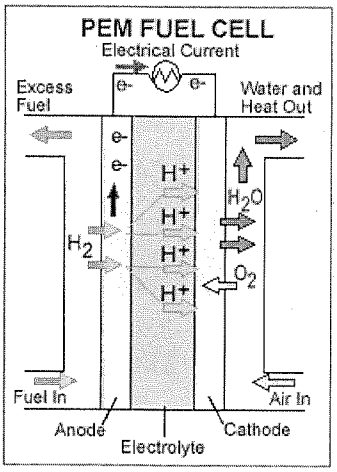
PEM Fuel Cells

US Fuel Cell Council

PEM cells are being commercialized and typically operate between ambient room temperature and 250°F (120°C).



Courtesy of DOE

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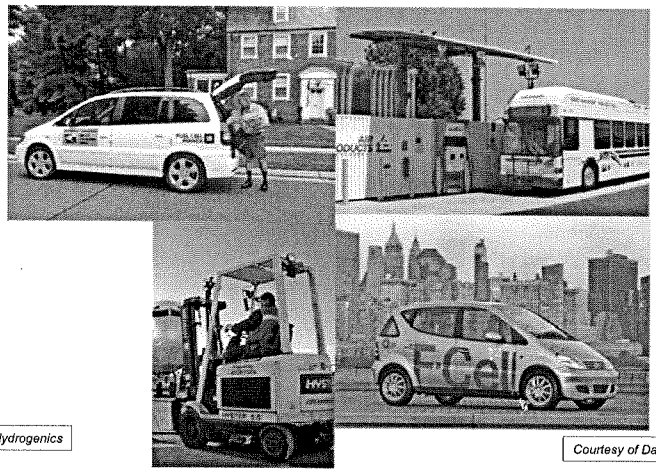
Fuel Cell Vehicles

Courtesy of General Motors and US Postal Service

Courtesy of Ballard



Courtesy of Hydrogenics

Courtesy of DaimlerChrysler

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Anthony Androsky
US Fuel Cell Council

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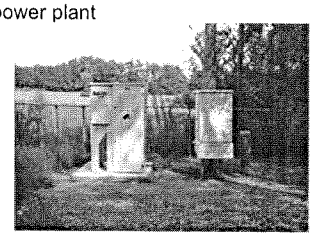
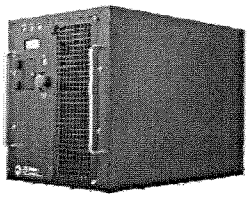
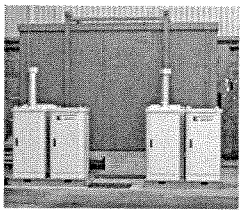
Light Commercial/Backup Utilizing H2 Storage

Outdoor installation of power plant and fuel supply
Courtesy of Plug Power





Indoor Rack mounted installation of power plant without fuel supply
Courtesy of UTC Power



Telecommunications backup power
Courtesy of RelOn

Extended run backup power for telecommunications
Courtesy of IdaTech

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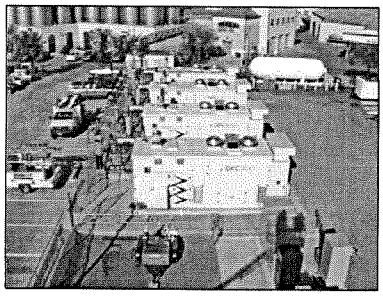
24 x 7 Reliable Large Industrial Scale Fuel Cell Power

Sierra Nevada Brewery
Chico, California
Courtesy of FuelCell Energy



- 1MW (250kW x 4) Net Output
- Runs on a blend of digester gas and natural gas
- Connected in parallel with electric grid
- Provides 95% of the electrical requirements for the brewery
- Heat recovery provides about 65% of the hot water/steam requirements

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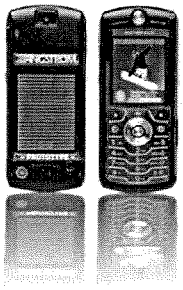
US Fuel Cell Council

Micro / Portable Applications



Angstrom Power Cell Phones
Courtesy of Angstrom Power

Jadoo Power System
Courtesy of Jadoo Power

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US Fuel Cell Council

Installation

What product standards exist for fuel cells?

- Stationary Fuel Cells are built and listed to ANSI/CSA FC1.
- Portable Fuel Cells have been listed to ANSI/CSA FC3.
- Micro Fuel Cells have been listed to UL 2265A and UL 2265C.
- International Civil Aviation Organization Technical Instructions and the relevant country regulations for aircraft passenger carry-on. require certification to IEC 62282-6-1.
- Fork Truck Fuel Cells are built and listed to UL 2267.
- International product standards are also published.

Refer to the following websites for details and status:

- www.usfcc.com/about/standards.html
- www.hydrogen.gov/regulations
- www.fuelcellstandards.com
- www1.eere.energy.gov/hydrogenandfuelcells/

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Installation

US Fuel Cell Council

What model code requirements exist for fuel cells?

In all cases, the regulations in force at the installation site and the local building officials have the final say on all requirements.

For model codes, the ICC uses the rule set from NFPA (harmonized between both) as indicated by IMC-2006 Section 924. This section indicates that the fuel cell is to be tested to ANSI FC-1 and installed to NFPA 853.

NFPA 853 specifically deals with physical positioning, fuel safety, ventilation, exhaust and fire protection. The electrical connections are addressed by reference to NFPA 70 article 692. H2 storage is addressed by reference to NFPA 55.

Air intake and ventilation exhausts are addressed by ANSI FC-1 (for small units) or NFPA 211 (for large custom installations) and NFPA 853.

More information is available from the National Association of State Fire Marshals www.nasfmhydrogen.com/ and www. Fuelcellstandards.com

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US Fuel Cell Council

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Hydrogen Safety

Ryan Smith
Project Engineer, NextEnergy Center

September 17th, 2008

NEXTENERGY
Economic Security through Energy Diversity

Today's Presentation

- Introduction
- NextEnergy Overview
- Hydrogen in Michigan
- Hydrogen Stations
- Hydrogen (H2) Overview
- Fuel Cell Vehicles & Safety Systems
- Questions?

NEXTENERGY
Economic Security through Energy Diversity

NextEnergy Overview

Who we are:

Non-profit corporation dedicated to the advancement of the alternative energy industry in Michigan.

Mission:

To enable the commercialization of energy technologies that positively contribute to economic competitiveness, energy security, and the environment.

NEXTENERGY
Economic Security through Energy Diversity

NextEnergy Center

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Ryan Smith
NextEnergy

NextEnergy Client Services Model

New Venture Support	Supplier Diversification Services	Industry Services
Capital Raising	Customer Acquisition	Technology / Supply Chain Acquisition
Business Incubation / Acceleration	Networking and Events	Alternative Fuel Infrastructure Support

Collaborative R & D Program Management
- Deployment / Demonstration Projects - Systems Development/Testing/Validation

NEXTENERGY
Economic Security through Energy Diversity

Hydrogen Fueling Stations…… in Michigan

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NextEnergy

Hydrogen Fueling Stations…. around the world

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Hydrogen Fleet Demo Program

- NextEnergy has partnered with Chrysler, Ford, and General Motors to deliver part of the Dept. of Energy Hydrogen Fleet Demonstration and Validation Program
- Elements include the development of permitting databases and first responder & permitting official education

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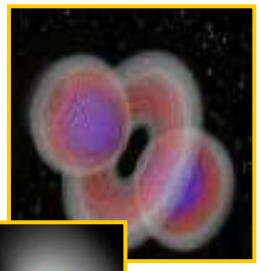
NextEnergy

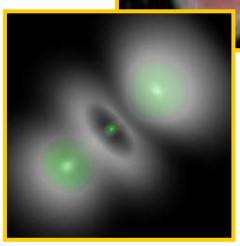
Hydrogen (H2) Overview

- Properties and characteristics
- Uses today
- Transportation
- Vehicle storage systems

Courtesy of California Fuel Cell Partnership

Hydrogen Properties & Characteristics



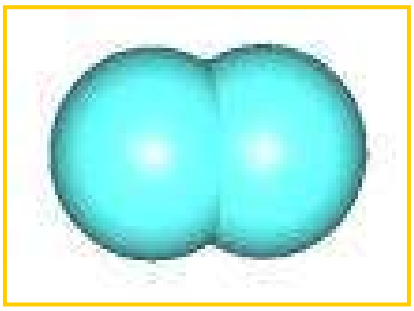


- H2 makes up 75% of the universe
- H2 is the lightest element and the molecules have a Vapor Density of 0.069
- H2 is _14_ times lighter than air?

Courtesy of California Fuel Cell Partnership

Hydrogen Properties & Characteristics

- *1 Kilogram of H_2* has the same energy as *1 Gallon of Gasoline*
- On a mass basis, H_2 has 2.8 times more energy than gasoline



Courtesy of California Fuel Cell Partnership

Hydrogen Properties & Characteristics

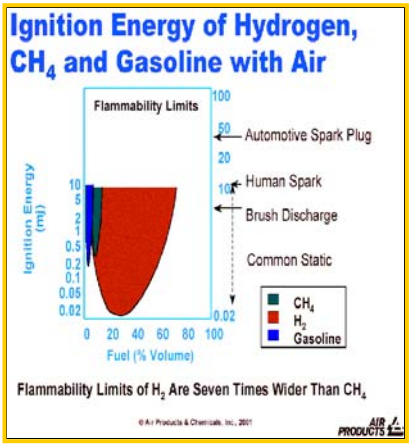
- Colorless
- Odorless
- Tasteless
- Non-corrosive
- Flammable gas
- Burns with a pale blue flame

Courtesy of California Fuel Cell Partnership

Hydrogen Properties & Characteristics

For H_2 to ignite or explode:

- The % of fuel in the air by volume must reach limits
  - *Flammability Limit* (4% LFL to 75% UFL)
  - *Explosive Limit* (18% LEL to 59% UEL)
  - FL ~7X wider than others
- Comparison with Gasoline:
  - ignition energy: (0.02mJ static vs 0.24 for gasoline)
  - auto ignition temperature H_2 858 F vs 501 to 744 F for gasoline



Courtesy of California Fuel Cell Partnership

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Comparison of properties

	Hydrogen	Natural Gas	Gasoline
Color/Toxicity	None / No	None / No	Yes / Yes
Odor	Odorless	Mercaptan	Yes
Buoyancy (relative, AIR = 1)	0.07 (14X lighter than air)	0.55 (2X lighter than air)	3.75 (heavier than air)
Energy by Wt MJ/ (2.2 lbs or 1 kg)	120	50	43
Flammability Limit (vol % in air)	4.1 (LFL) 75 (UFL)	5.3 (LFL) 15 (UFL)	1.0 (LFL) 7.8 (UFL)
Energy by Vol MJ/ (1 gal or 3.8 L) Liq	32 (-423 F)	78 (-259 F)	120 (75F)

Courtesy of California Fuel Cell Partnership

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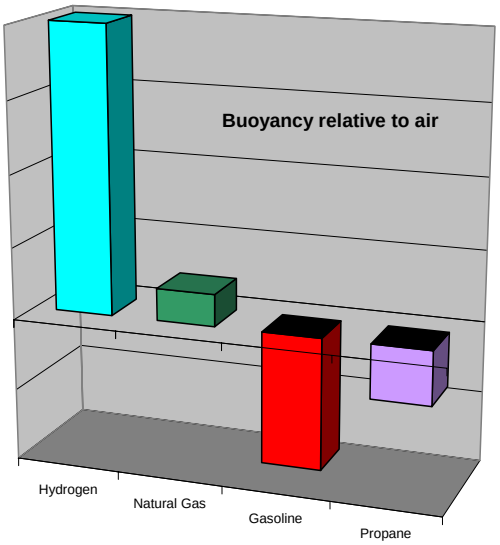
How fast does it rise?



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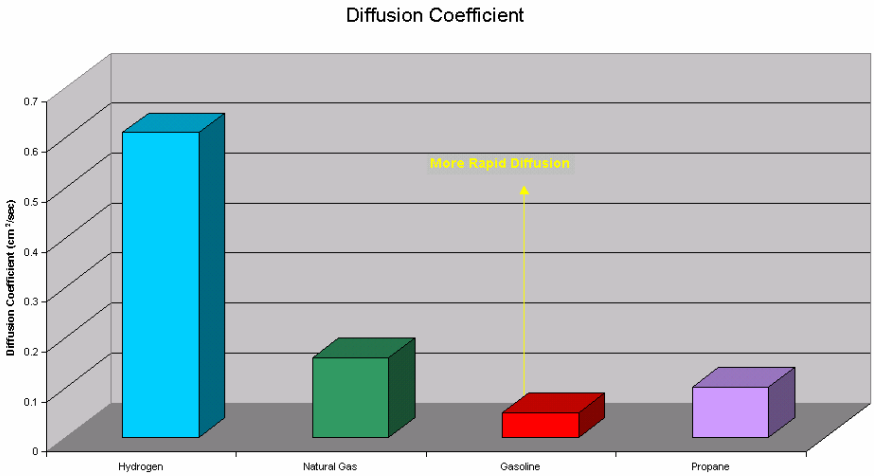
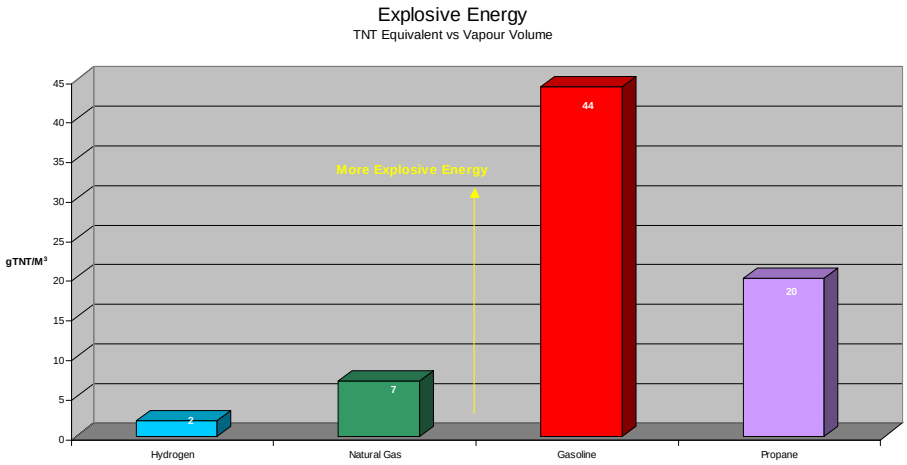
How fast does it disperse?



Ryan Smith
NextEnergy

What is its energy content?



Compressed H_2 Storage Tanks

- Carbon-fiber composite materials absorb five times the crash energy of steel
- All vessels have integrated pressure and / or temperature release devices (PRDs and TRDs)
- Others tanks have attached relief devices
- Tank Testing Requirements:
  - Bonfire
  - Drop
  - Gun Fire
  - Etc.

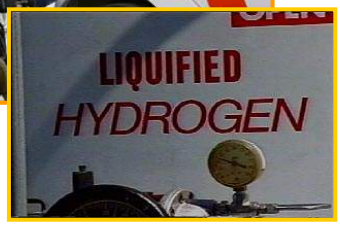
Courtesy of California Fuel Cell Partnership

Compressed H_2 Storage Tanks

Courtesy of California Fuel Cell Partnership

Liquefied H_2 Storage Tanks

- Liquefied Hydrogen (LH_2) stored at -423°F (-253°C)
- LH_2 poses a frostbite hazard
- Wear gloves & protective clothing when handling



Courtesy of California Fuel Cell Partnership

Gaseous Hydrogen Fueling

- In Michigan, all fueling stations for vehicles utilize compressed gaseous Hydrogen (not liquefied)
- Protective clothing is not required
- Fueling experience similar to that for compressed natural gas vehicles

Other Available Resources

- **National Hydrogen Association**
  www.hydrogensafety.info
- **DOE Permitter's Guide for Hydrogen Stations**
  www.pnl.gov/fuelcells/permit_guide.stm
- **CA Hydrogen Highway Network**
  www.hydrogenhighway.ca.gov
- **California Energy Commission**
  www.energy.ca.gov
- **ANSI Hydrogen Codes & Standards Portal**
  hcsp.ansi.org

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QUESTIONS?

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Ryan Smith
NextEnergy

Hydrogen Education for Code Officials Workshop

Hydrogen Emergency Response

Jim Narva
National Association of State Fire Marshals (NASFM)

Hydrogen Facts

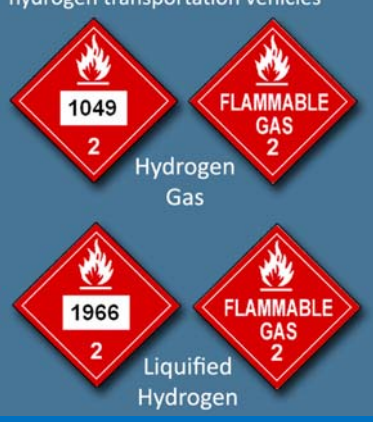
- Colorless and odorless
- Non-toxic, non-corrosive, and non-poisonous
- One gallon of liquid will expand to 848 gallons of gas
- 14 times lighter than air
- Diffuse quickly into atmosphere (vaporizes)

Hydrogen / Gasoline / Natural Gas

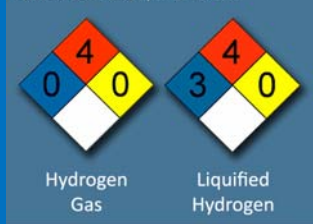
Properties	Hydrogen	Gasoline	Natural Gas
Flammable Limits	4%-74%	1.4%-7.6%	4%-15%
Flash Point	Not Applicable (gas)	-45°F	Not Applicable (gas)
Ignition Temp.	752°F	853°F	1100°F

Hazardous Marking Information Systems

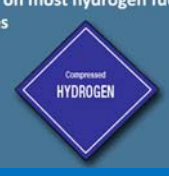
Department of Transportation Hazmat Placards
Posted on compressed and liquid hydrogen transportation vehicles



Warning Signage
NFPA Hazard Rating Placards: Posted on stationary hydrogen storage facilities, tanks, cylinders etc.



Posted on most hydrogen fuel cell vehicles



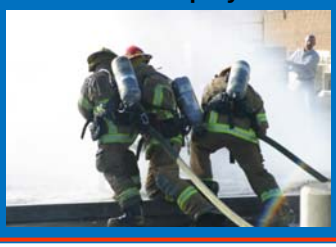
Jim Narva
NASFM

Extinguishing Materials

Carbon Dioxide

Dry Chemical

Water Spray



Detecting Hydrogen

- Hydrogen Gas
  - Sound of a high pressure gas leak
  - Air monitors with hydrogen detection capabilities
- Liquid Hydrogen
  - Cloud of condensed water vapor

Jim Narva
NASFM

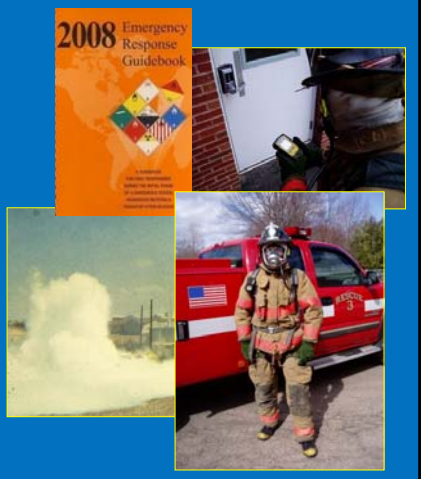
Hydrogen Fire

- Flames are invisible
- Thermal imaging camera
- Use a broom
  - Broom will ignite when it contacts a flame
  - Hydrogen has a very limited radiating heat.
  - The broom allows you to sense the flames before its too late

Thermal Imaging Camera

If a leak is detected . . .

- Evacuate the immediate area of all non-essential personnel (for a large spill evacuate ½ mile downwind)
- Wear Appropriate PPE
- Shut off the hydrogen source immediately and vent all hydrogen to a safe outside location
- Increase indoor ventilation
- Remove all possible ignition sources
- Combustible Gas Indicators



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NASFM

In case of a fire . . .

- Evacuate all non-essential personnel in a 1 mile radius
- Shut off the hydrogen source
- Let the fire burn itself out (if the flame is extinguished, it may reignite and cause greater damage
- Use Detection Equipment

Training Resources

- US Department of Energy – www.hydrogen.energy.gov/firstresponders.html

Jim Narva
NASFM

A Special Thanks to ….

Much of the facts and information in this program came from the Connecticut Hydrogen Fuel Cell Coalition and the Connecticut Fire Academy

Hydrogen Education for Code Officials Workshop

Hydrogen Emergency Response

Thank You

Jim Narva
NASFM

NextEnergy's Alternative Fuels Platform (AFP)

Dave McLean
Chief Operating Officer

Kelly Jezierski
Sr. Project Engineer

September 17, 2008

NEXTENERGY
Economic Security through Energy Diversity

Today's Presentation

1. Introduction – NextEnergy Center
2. H_2 Station Background & Objectives
3. Timeline of AFP
4. Site Schematics & Safety Features
   - Alternative Fuels Platform (AFP)
   - Microgrid Pavillion (MGP)
5. Questions & Answers

NEXTENERGY
Economic Security through Energy Diversity

Introduction to NextEnergy

Who we are:
Non-profit corporation dedicated to the advancement of the alternative energy industry in Michigan.

Mission:
To enable the commercialization of energy technologies that positively contribute to ***economic competitiveness, energy security, and the environment***.

- Advanced power trains, distributed generation, renewable energy, clean fuels (biofuels)
- Automotive, stationary, and portable applications

Website: ***www.nextenergy.org***

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Economic Security through Energy Diversity

Intro - NextEnergy Infrastructure

- NextEnergy Center (NEC)
  - Offices, Auditorium, Training Rooms (25,000 sq. ft.)
  - Laboratories (8 suites / 20,000 sq. ft.)
- Stationary Microgrid Power Pavilion
- Alternative Fuels Platform
  - Hydrogen
  - Biofuels
- Energy Diversity: a variety of fuels on site

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NEC Layout

R & D Labs

Office, Exhibition, & Conference Facilities

Alternative Fuels Platform (AFP)

Stationary MicroGrid Power Pavilion (MGP)

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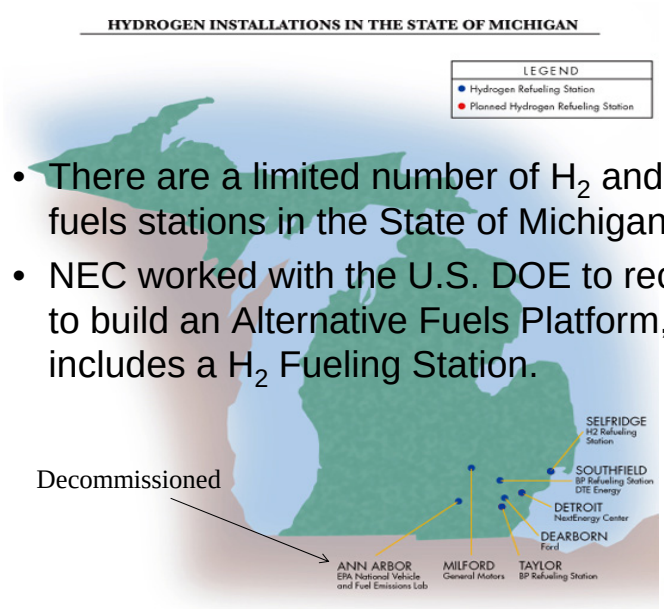
NEC AFP



- There are a limited number of H_2 and alternative fuels stations in the State of Michigan.
- NEC worked with the U.S. DOE to receive funding to build an Alternative Fuels Platform, which includes a H_2 Fueling Station.

Decommissioned

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Project Objectives

1. Support the DOE ***"Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project"*** in greater Detroit.
2. Integrate, within a core urban environment, critical hydrogen infrastructure components and systems for multi-use operations.
3. Optimize integrated, system-based solutions to advance H_2 infrastructure for vehicular and stationary distributed power generation use.
4. Provide a flexible "test" platform to advance the development and validation of commercial-type on-site generation technologies.

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NEC Microgrid & H_2 Fueling Facility Overview

The NextEnergy Hydrogen Fueling Facility & Microgrid Power Pavillion construction was divided into 5 phases:

Phase 1 was completed in June 2005 and provides GH_2 to the NextEnergy MicroGrid Pavilion (MGP).

- The MGP consists of 8 test bays that are supported by interconnections for both fuel delivery and power generation.
- It is interconnected to the local electric utility grid and can operate in a grid connected mode, a grid parallel mode and an islanded mode.
- The test bays are designed to accommodate the demonstration and testing of pre-commercial distributed generation technologies.

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AFP Timeline: Phase 1

Fall 2003	Fall 2004	8-Mar-05	15-Mar-05
1st H_2 Community Outreach Hosted by NEC	Phase 1 Started	Documentation to MDEQ: Notice of Proposed Installation of H2 Storage Tank	Installation Approved by MDEQ (NFPA 50B)

April - June 2005: Construction of AFP (Phase 1)

21-Apr-05	15-Jun-05	17-Jun-05
Installation Approved by MDEQ (NFPA 50A)	H2 Available to MGP	U.S. DOE H2 Safety Panel & NEC Meeting to Discuss Project

29-Jun-05	27-Jul-05	3-Aug-05	28-Sep-05	Sept. 29, 2005
NEC Submitted Report with Recommendations to U.S. DOE Based on Previous H2 Safety Panel Review Team Discussions	U.S. DOE H2 Safety Panel Team's 1st Site Visit to NEC for AFP Safety Review *(Included Overview & Status of Phase 2)*	NEC Submitted 2 Sealed Engineering "As Built" Design Drawings to City of Detroit	City Inspected AFP and Approved Permits	Grand Opening of NEC AFP (Phase 1)

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NEC Microgrid & H_2 Fueling Facility Overview

Phase 2 was opened on October 23, 2006.

- Phase 2 was dedicated to the development of the Vehicle Fueling Station.
- NEC incorporated a Gas & Flame Detection system into the station design, as required by the new requirements under NFPA 52
- The station building permits remained outstanding until the City of Detroit satisfied itself as to the system's operation, including the tie-in to the NextEnergy facility fire monitoring system.
- These permits were cleared in January 2007.

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AFP Timeline: Phase 2

5-Jan-06	6-Jan-06	11-Jan-06	27-Jan-06
NEC Applied for AFP City of Detroit Permit	Documentation to MDEQ: Notice of Proposed Installation of H2 Storage Tank for Phase II	Installation Approved by MDEQ for Phase II (NFPA 50A and 52)	City of Detroit Approved Building Permit for Phase II of AFP

17-May-06	17-May-06	26-Jun-06	September 2006	
NEC Applied for Revised City Permit to Show Changes to Elec. Fire Protection *(to Comply with NFPA 52)*	NEC Received Phase II City Building Permit - *Revised to Show Changes to Elec. to Comply with NFPA 52*	NEC Hosts H2 Orientation & AFP Review for EFR's and AHJ's	Gas & Flame Detection System in Place on AFP & MGP	*City of Detroit Requested a "Seq. of Operation" & Witness Test Before Issuing COA and Compliance*

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NEC Microgrid & H_2 Fueling Facility Overview

Phases 3 and 4 were constructed concurrently and included:

- The build out of the ground storage system associated electrical and mechanical control and protection systems.
- The ability to store and deliver liquid alternative fuels.
- The development of 5 test bays that accommodate alternative energy equipment for testing.
- Demonstration and the delivery of 1 methanol-to-hydrogen reformer.

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AFP Timeline: Phases 3 & 4

5-Jan-06	18-Jan-06	Mar-06
NEC Applied for City of Detroit Permit for AFP	U.S. DOE Project Safety Review of NEC MGP & AFP Conducted	Safety Evaluation Report Drafted for Phase 3/4 *(Based on DOE Safety Review Results)*

19-Dec-06	8-Feb-07	3-Apr-08
City of Detroit Permit for Phase 3/4 Issued to NEC	City of Detroit COA and Compliance for AFP Phase II Received *(Revised, as per 17-May-06 Permit)*	City of Detroit Issued COA and Compliance for Phase 3/4 AFP

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NEC Microgrid & H_2 Fueling Facility Overview

Phase 5 was originally to include the delivery of the next generation ("beta") methanol-to-H_2 reformer from the same equipment manufacturer as used in Phases 3/4.

- This equipment was originally scheduled for installation in March 2008, but was deferred to FY09Q3.
- Phase 5 is currently being reevaluated by the DOE in favor of a 70 MPa Residential Hydrogen Fueling Appliance (RHFA).
  - The Steering Committee believes an RHFA is more useful than the development of the next generation methanol-to-H_2 reformer.
  - The DOE has given the NEC 70 MPa RHFA Project Proposal positive feedback, so far, for Phase 1 of this 5-phase subprogram.

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AFP Timeline: *Phase 5

Jun-08	Sept.-08	Oct.-08	3-Oct-08
NEC Phase 5 Proposal Proposal Submitted to U.S. DOE (5 Sub-parts to Phase 5)	NEC Distributes RFP's to Bidders for Sub-phase 1 (70 MPa RHFA Feasibility Study) Work	Anticipate Official U.S. DOE Approval for Sub-phases 1 & 2a (70 Mpa RHFA Work)	Proposals Due to NEC for Sub-phase 1 - 70 MPa RHFA Feasibility Study Work

12-Nov-08	17-Apr-09	May-09	June-09	Dec-09
Sub-phase 1 - 70 MPa RHFA Feasibility Study Work Begins	Sub-phase 1 RHFA Feasibility Study Work Complete	NEC Sends Out RFP for Sub-phase 2a - Alpha Design of 70 MPa RHFA	Alpha Design Work Begins	Alpha Design Work Complete

*These dates/events are subject to change, pending official U.S. DOE approval of NEC's 70 MPa RHFA Project Proposal.

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AFP Timeline: *Phase 5

Jan-2010	Jan-2011	Feb-2011	Aug-2011
Alpha Fabrication (Sub-phase 2b) Work Begins	Alpha Fabrication Work Complete	Sub-phase 3 - Alpha 3rd Party Testing Begins	Alpha 3rd Party Testing Complete

Sept.-2011	April-2012	May-2012	Dec-2012
Sub-phase 4 - Beta 70 MPa RHFA Design & Fabrication Begins	Sub-phase 4 - Beta 70 MPa RHFA Design & Fabrication Complete	Sub-phase 5 - Beta 3rd Party Certification & Limited Durability Testing Begins	Beta 3rd Party Certification & Limited Durability Testing / 70 MPa RHFA Work Complete

*These dates/events are subject to change, pending official U.S. DOE approval of NEC's 70 MPa RHFA Project Proposal.

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Hydrogen Station Overview

- System design as safe or safer than gas stations – some now incorporated into existing retail sites
- Some codes and standards exist, more coming
- If no codified guidance → intensive engineering analysis applied
- More real-world experience will support code developments

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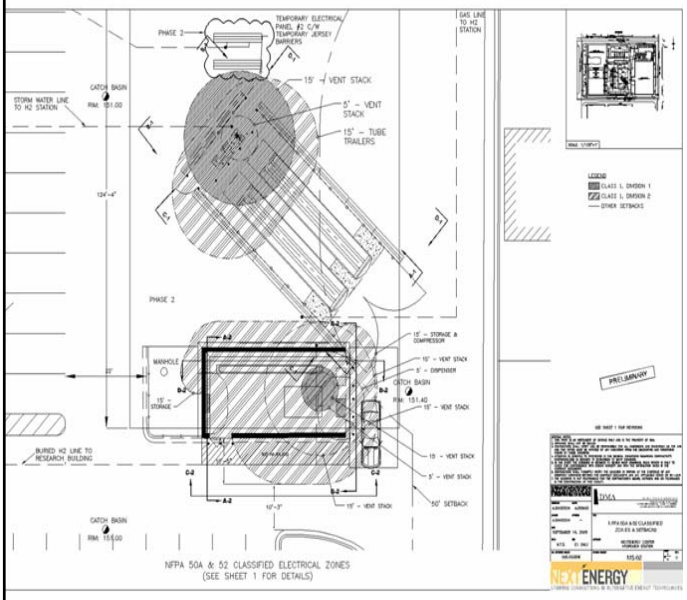
AFP Design & Code Application



NextEnergy Center: Classified Zones

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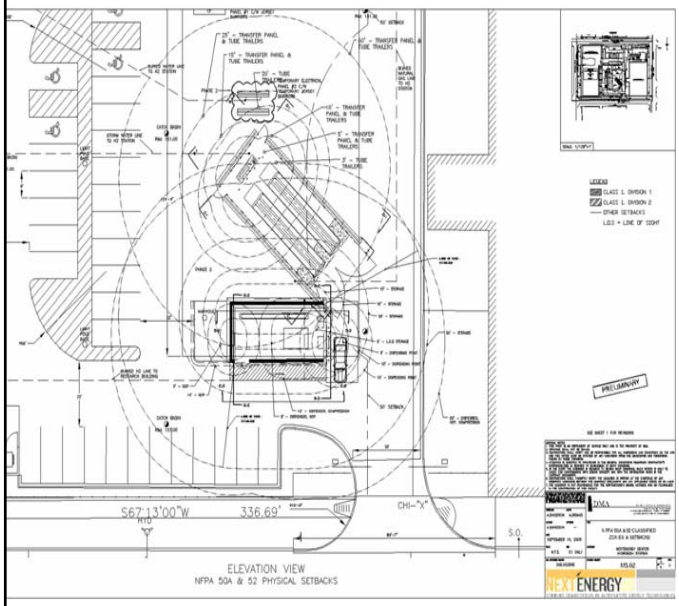
AFP Design & Code Application



NextEnergy Center: Classified Zones

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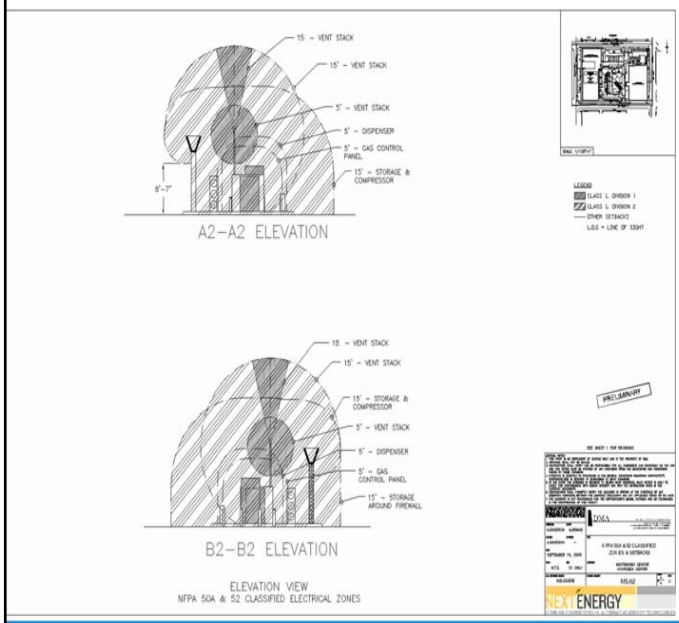
AFP Design & Code Application



NextEnergy Center: Classified Zones

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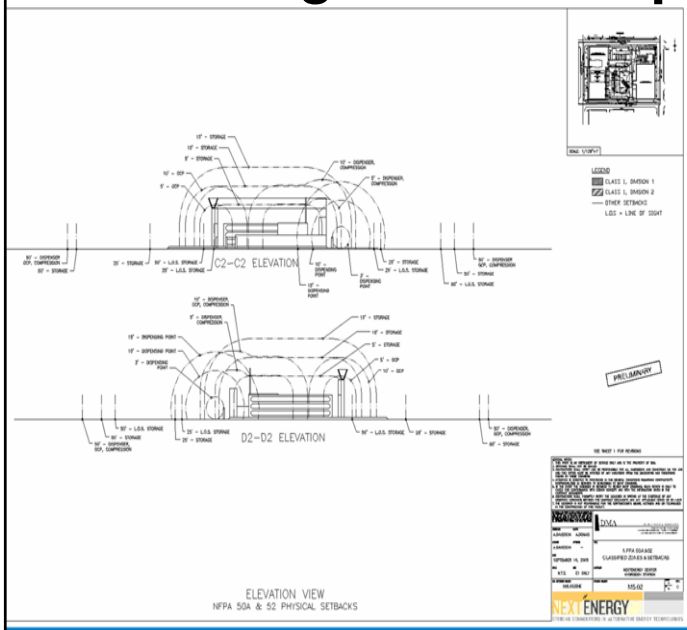
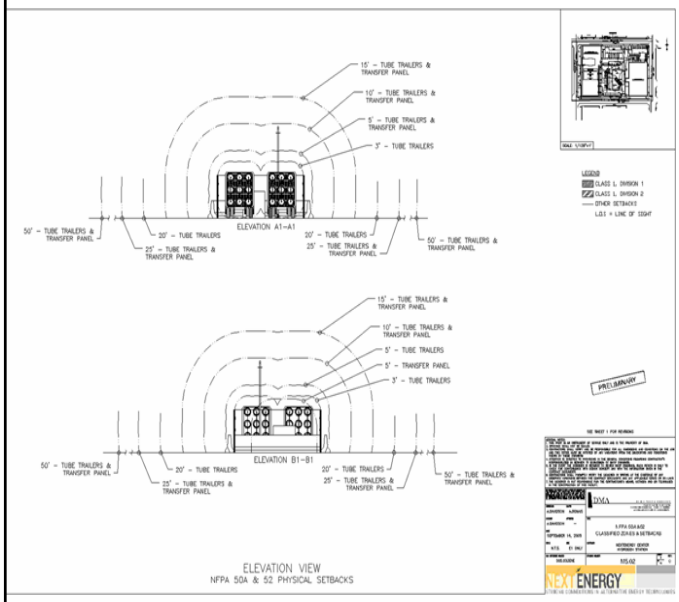
AFP Design & Code Application



NextEnergy Center: Physical Setbacks

AFP Design & Code Application



NextEnergy Center: Physical Setbacks

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MGP Basement

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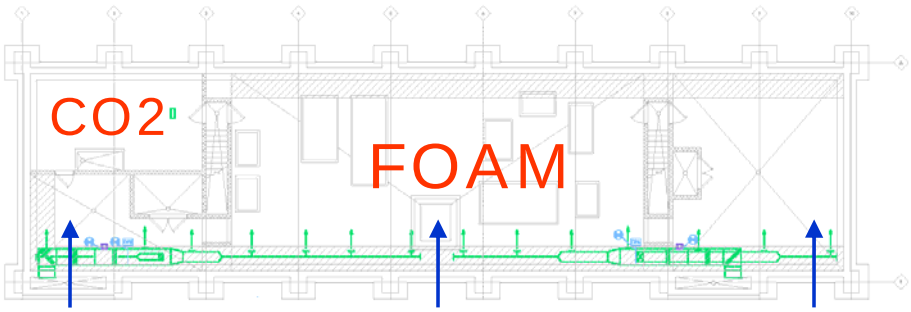
Basement Floor Plan



H2 & Natural Gas Sensors

Hydrocarbon Gas Sensor

Natural Gas Sensor

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MGP Safety Features

- Unmanned
- Locked
  - Access controlled by work permit system
- CO_2 system in electrical control room
- Foam system in general basement space
- Fire detection system
- Natural gas detection system (Q2/07)
- Hydrogen & Hydrocarbon gas detection systems (Q2/07)
- Ventilation failure detection system (Q2/07)
- E-stops top / bottom of stairs
- Fire pull stations bottom of stairs

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Alternative Fuels Platform

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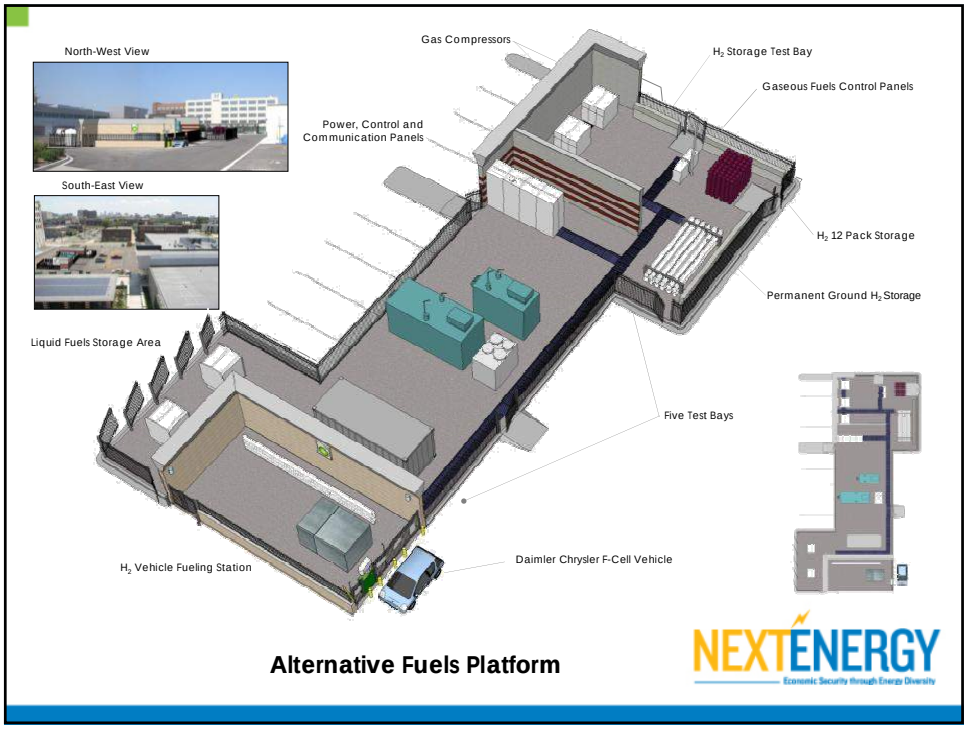

AFP Safety Features

- Unmanned
- Locked-access controlled by work permit system
- Gas & flame detection system in VFS
- E-stops throughout
- Fire pull stations throughout
- Multiple Local Annunciation
- NFPA 704 placards

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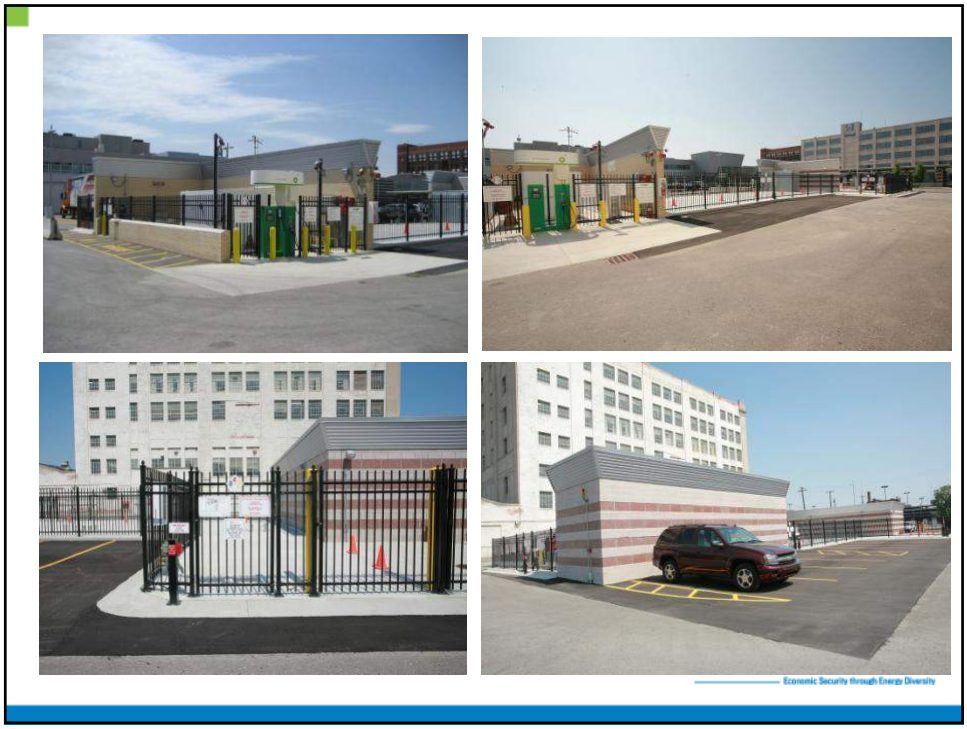
Hydrogen Fueling Stations and Tran*sportation*



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Emergency Egress Gates

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Vehicle Fueling Station

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Using the Vehicle Fueling Station

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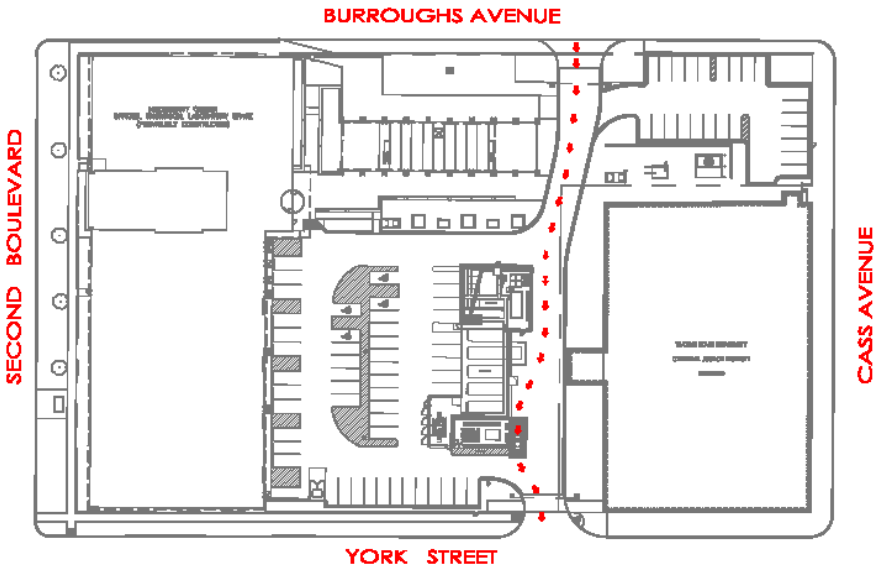
Traffic Route to the Station



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Burroughs Avenue Entrance

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Burroughs Ave Gate Control

NEC will issue a proximity card or access code to users who need facility access

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AFP Alarm Beacon at VFS

Green

Means

OK!

GFDS Alarm Beacon at VFS

See No Evil

Hear No Evil

OK!

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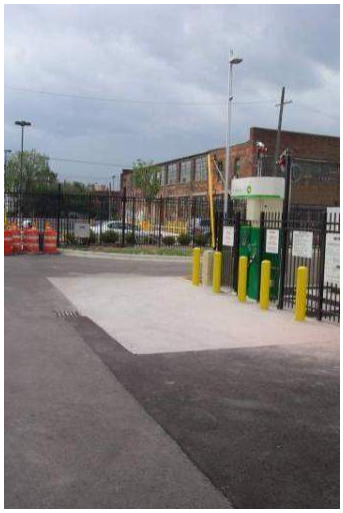
VFS – Low Ohm Pad



All 4 tires on the concrete!

Sign – No Smoking

There's hydrogen at 6300 psig in there!

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NextEnergy

Sign – Authorized Personnel

No Parking –

unless you're refueling of course!

Drop Down Gate – Down Position

Down when refueling

Kelly Jezierski
NextEnergy

Drop Down Gate – Up Position

Up before you leave

NEXTENERGY
Economic Security through Energy Diversity

York Street Exit

Gates open and close automatically

NEXTENERGY
Economic Security through Energy Diversity

Kelly Jezierski
NextEnergy

Abnormal Conditions

NEXTENERGY
Economic Security through Energy Diversity

Kelly Jezierski
NextEnergy

Fire Alarm Opens Gates

NEXTENERGY
Economic Security through Energy Diversity

Master E-Stop & Fire Pull Station

NEXTENERGY
Economic Security through Energy Diversity

Kelly Jezierski
NextEnergy

E-Stop / Fire Alarm Pull Station North Limit of AFP

NEXTENERGY
Economic Security through Energy Diversity

E-Stop / Fire Alarm Pull Station at Forklift Access Gate

NEXTENERGY
Economic Security through Energy Diversity

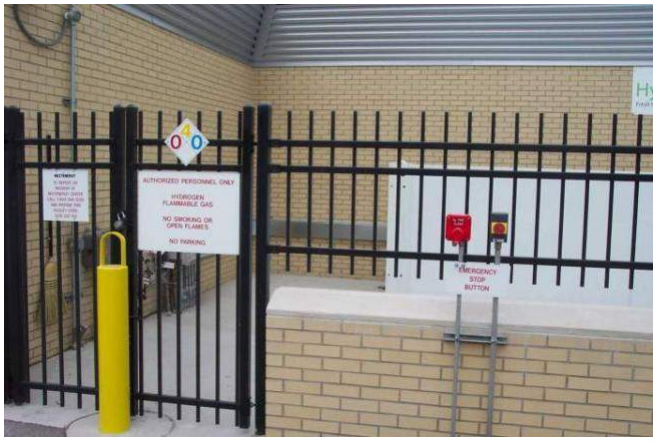
Kelly Jezierski
NextEnergy

E-Stop Dispenser

To be used if you can reach this E-Stop without putting yourself in harms way

NEXTENERGY
Economic Security through Energy Diversity

E-Stop / Fire Alarm Pull Station at South Wall VFS



To be used if using the E-Stop at the dispenser would put you in harms way

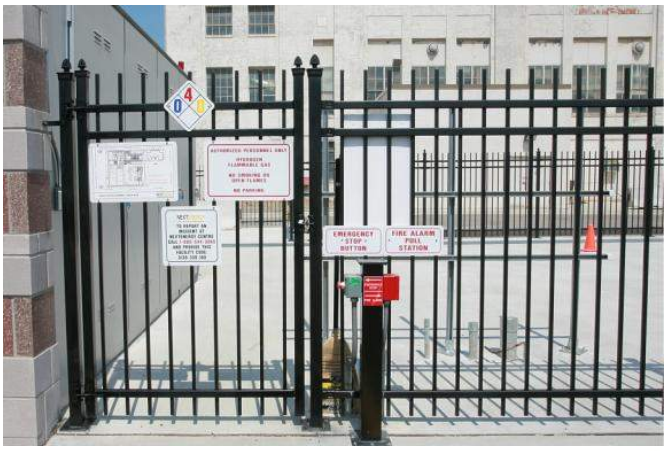
NEXTENERGY
Economic Security through Energy Diversity

Kelly Jezierski
NextEnergy

E-Stop / Fire Alarm Pull Station Northwest Corner LFS

NEXTENERGY
Economic Security through Energy Diversity

E-Stop / Fire Alarm Pull Station at PCC Panel



NEXTENERGY
Economic Security through Energy Diversity

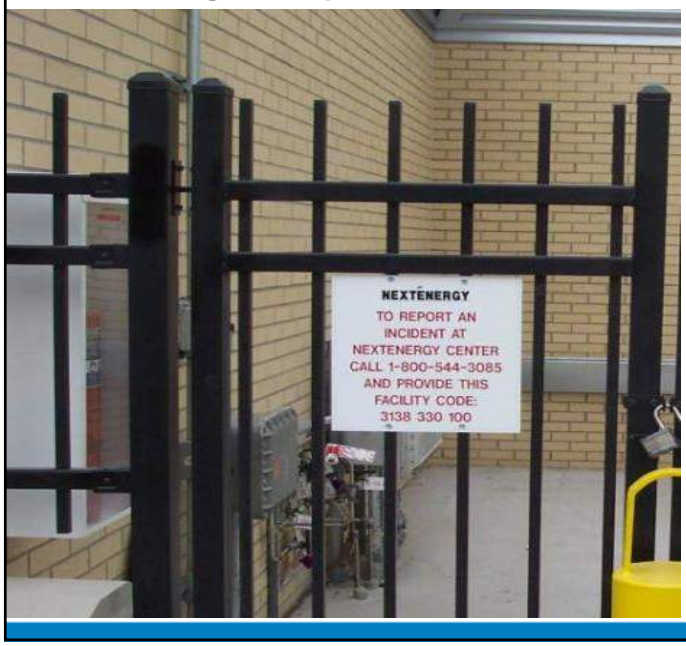
Kelly Jezierski
NextEnergy

E-Stops MGP
(at top and bottom of each stairwell)

MGP Fire Panel

Kelly Jezierski
NextEnergy

Emergency Phone Numbers Sign



NEXTENERGY
Economic Security through Energy Diversity

Fire Extinguishers

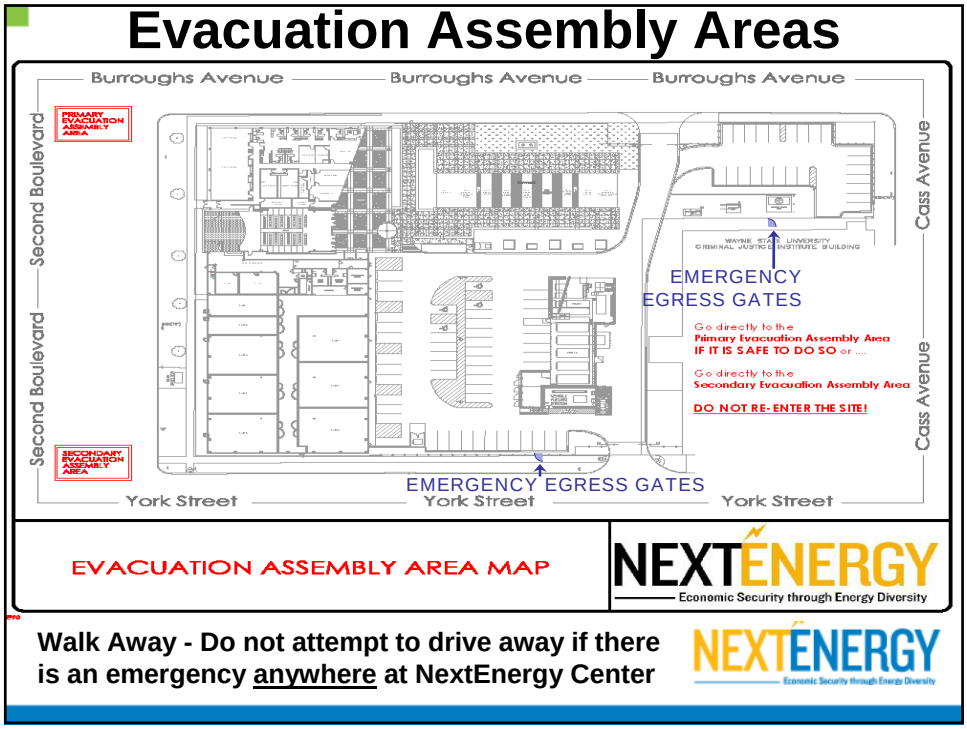
For use with non-hydrogen fires only!

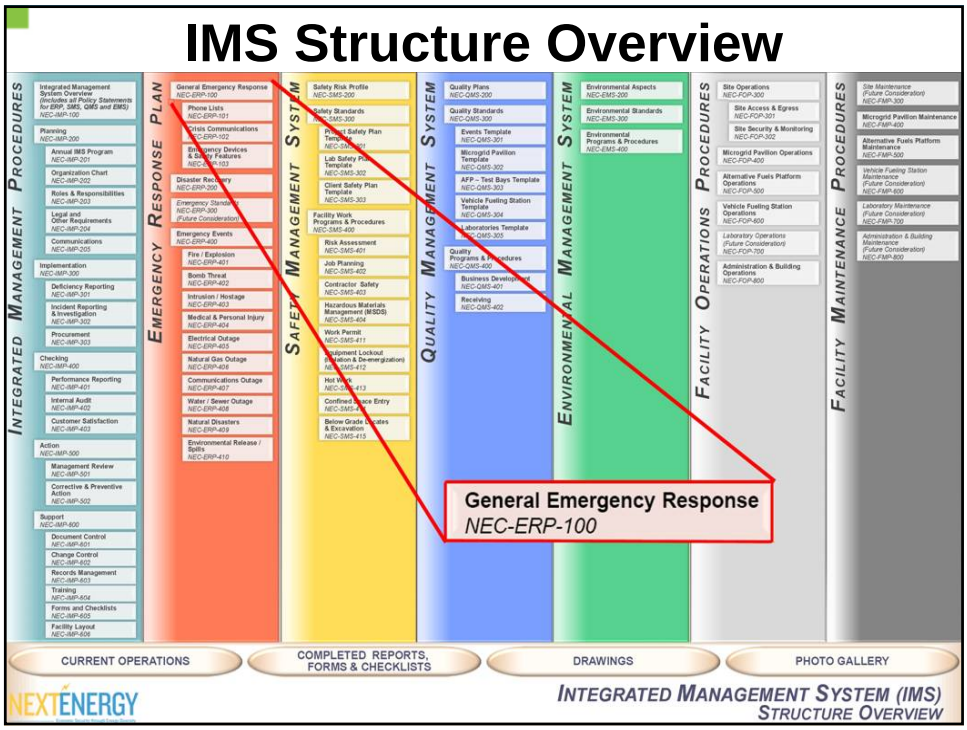
If in doubt, don't put it out!

NEXTENERGY
Economic Security through Energy Diversity

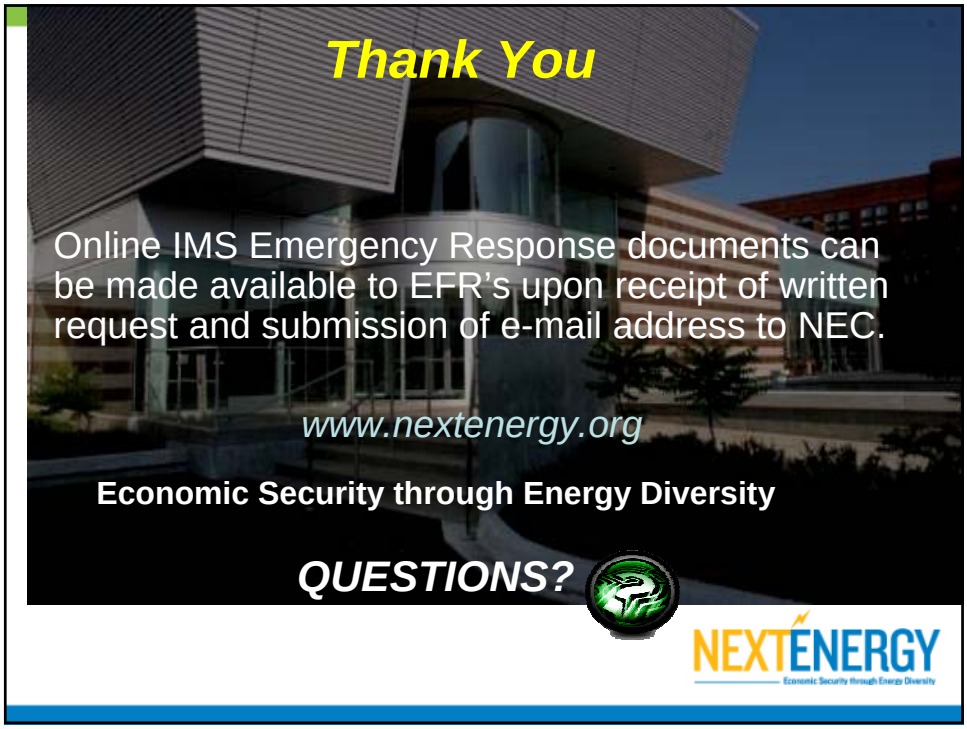
Kelly Jezierski
NextEnergy

Hydrogen Fueling Stations and Transportation





Kelly Jezierski
NextEnergy



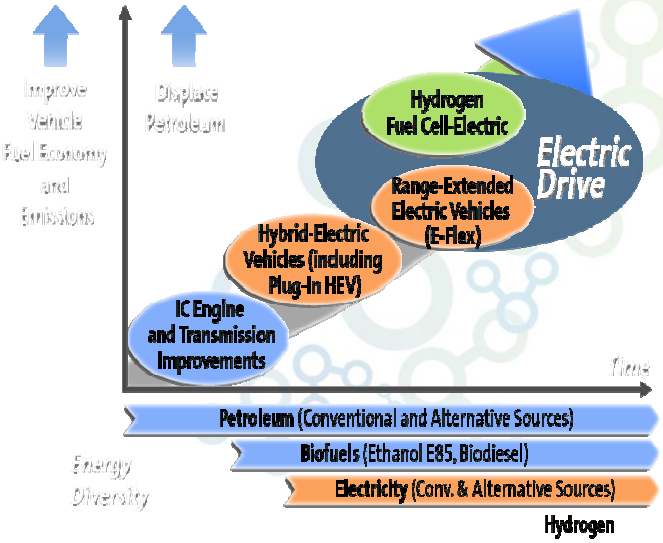
Kelly Jezierski
NextEnergy

Chevrolet Equinox Fuel Cell Electric Vehicle and Project Driveway

EQUINOX FUEL CELL

Joe Mercurio
Manager – Fuel Cell Field Service Integration

GM's Advanced Propulsion Technology Strategy



Joes Mercurio
General Motors

Project Driveway Program Overview

Equinox Fuel Cell is a fully-functional, distinctively-styled, 4-passenger crossover, with all the safety features of the 5-star production Equinox

- 110 Equinox Fuel Cell Vehicles fielded globally
  - Deployment plan based on 110 vehicles globally
- U.S. deployments in three locations
  - California (LA, Sacramento)
  - Greater New York City metro area
  - Washington D.C.
  - Other global deployments planned for Germany, China, Korea, Japan
- Deployment began in Sept. 2007 & runs through end of 2011
- U.S. deployment includes five target driver groups
  - Media, Public Policy, Celebrities/Influentials, B2B and mainstream driver
  - 3 to 30-month deployments, depending on driver group
- Comprehensive feedback on all elements of customer experience

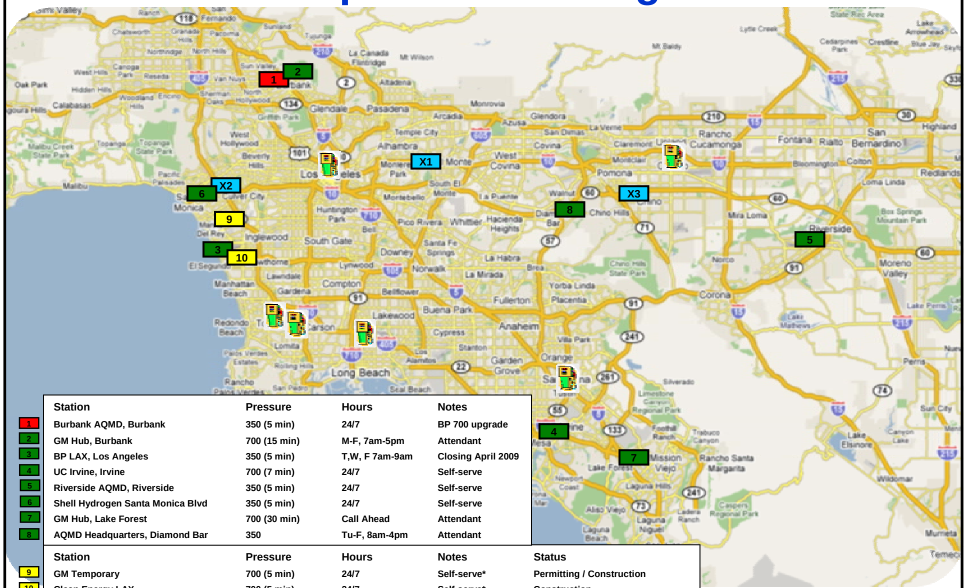
3

Project Driveway: Hydrogen Infrastructure Overview

GM Confidential 4

Joes Mercurio
General Motors

Metropolitan Los Angeles



	Station	Pressure	Hours	Notes
1	Burbank AQMD, Burbank	350 (5 min)	24/7	BP 700 upgrade
2	GM Hub, Burbank	700 (15 min)	M-F, 7am-5pm	Attendant
3	BP LAX, Los Angeles	350 (5 min)	T,W, F 7am-9am	Closing April 2009
4	UC Irvine, Irvine	700 (7 min)	24/7	Self-serve
5	Riverside AQMD, Riverside	350 (5 min)	24/7	Self-serve
6	Shell Hydrogen Santa Monica Blvd	350 (5 min)	24/7	Self-serve
7	GM Hub, Lake Forest	700 (30 min)	Call Ahead	Attendant
8	AQMD Headquarters, Diamond Bar	350	Tu-F, 8am-4pm	Attendant

	Station	Pressure	Hours	Notes	Status
9	GM Temporary	700 (5 min)	24/7	Self-serve*	Permitting / Construction
10	Clean Energy LAX	700 (5 min)	24/7	Self-serve*	Construction
X1	Rosemead Chevron	350 (5 min)			Access/Liability terms
X2	Santa Monica AQMD	350 (5 min)			Access terms
X3	Chino Chevron	350 (5 min)			Access/Liability terms

Hydrogen Infrastructure

- Comprehensive Program extends from vehicles to fueling to facilities
  - Holistic integration of Project Driveway with stakeholders allows for data transfer
    Result: Technology/market benefits when experienced is shared—City Officials, FR's, Industry, etc.

- Station access and accessibility barriers remain a concern
  - Select operators will not provide access/provide impracticable liability terms
    Result: Limits an already small network and adds pressure on accessible stations
  - In most cases, market/retail-like execution is missing (*but transitioning*)
    - Select stations: Require personal protective equipment, call-ahead/9-5 hours, training events
    Results: Drivers wearing Nomex, no weekend access, on-going appt coordination

"Real-world" effect on participants/drivers communicated to GM.
Example: After a station operator transitioned from supervised fills to 24/7 access, the amount of fueling (miles driven) nearly doubled each week.

Joes Mercurio
General Motors

Hydrogen Infrastructure

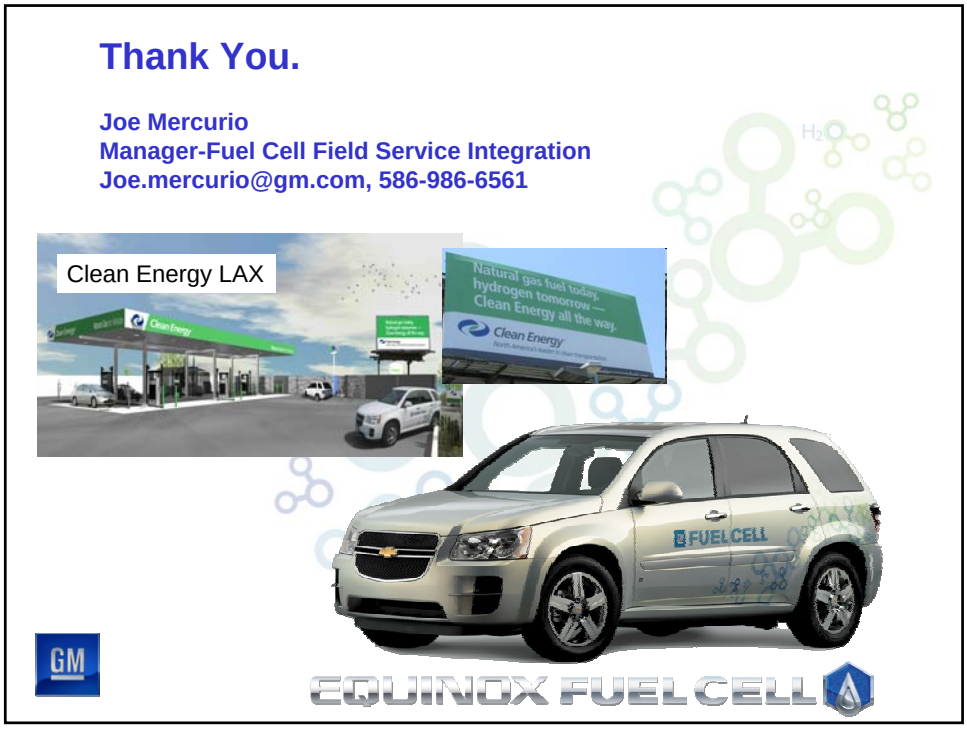
- Continuous effort to provide infrastructure support for vehicles
  - Constant balance of existing fuel supply, GM deployment, & additional OEM demand
    Result: Necessary to design stations for growth
  - With limited stations, the importance of each station rises
    Result: Station unavailability is arduous
- GM Experience: Fueling equipment to augment existing infrastructure
  - GM is managing the installation and operation of multiple fueling (700bar) systems
    - Permitting and Construction continues to be an unpredictable process
      Result: 8-Month vs. 6-Week permitting phases
  - Burbank Example: Engaged City officials early on regarding Facility and Fueling
    - Permitting focused on collaboration between GM and City's needs
      Result: World class facility (H2/Fire Detection System) and 700bar Fueling ,
      Result: City officials are knowledgeable advocates
  - Los Angeles Example: Clear plan defined for integration of fueling into existing station
    - Collaboration with organizations who understood process, leverage points, dialog with officials
      Result: Permitting time reduced dramatically , No surprises for either side, state-of-the-art fueling facility
  - Additional experiences in Los Angeles and New York areas

Station permitting/installation does not need to be cumbersome for either party. Significant learning for City stakeholders as well as GM (industry).

Plans for Michigan

- Plans in place to gain access to two existing hydrogen fueling stations for the Projece Driveway vehicles
  - NextEnergy in Detroit – 350 Bar system
    October 2008
  - DTE in Southfield – 350 Bar system
    November 2008

Joes Mercurio
General Motors



Joes Mercurio
General Motors

Applying Codes and Standards Systematically

P.J. Buehler – Plug Power

September 17 – 18, 2008

Where We Stand Today

- We now have a path through the I-Codes.
  - Available to all.
  - Endorsed by HELP and SBCC.
  - Linked on Plug Power, HELP and SBCC websites.
    - http://www.nasfmhydrogen.com/documents/I-CodePathFuelCell.pdf
    - http://www.saferbuildings.org/docs/training/I-CodePathFuelCell.pdf

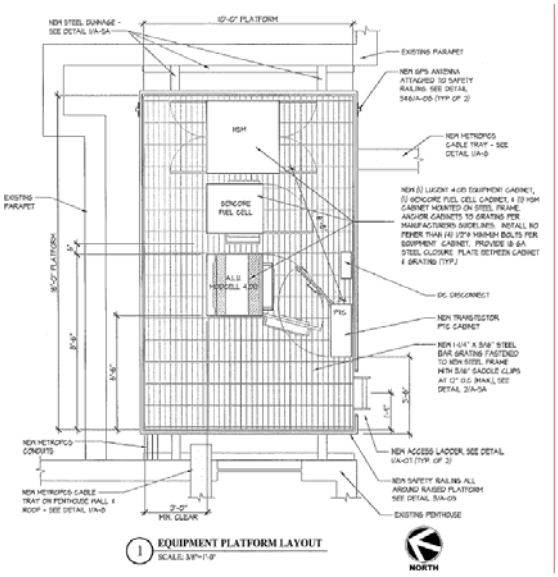
Applying Codes and Standards Systematically

Progress with AHJs

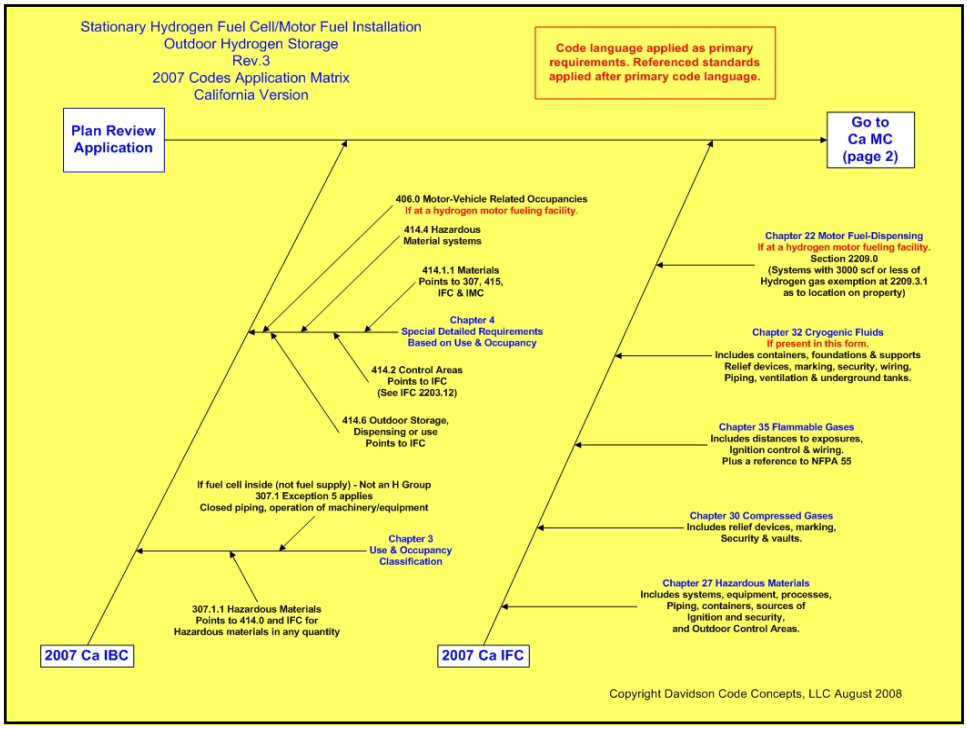
- Clear and concise rules have allowed for painless permitting since June 2007.
  - Massachusetts
  - New York
  - California
  - Rhode Island
  - New Hampshire
  - New Mexico
  - North Carolina
  - Houston, Texas

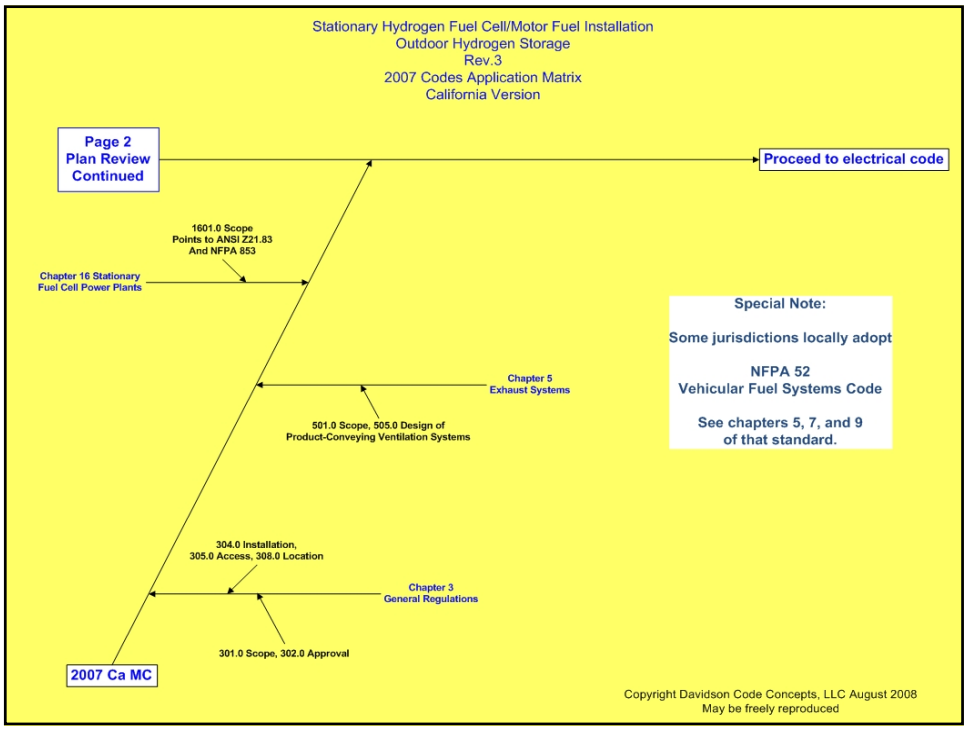
New Opportunities

- New York City



Applying Codes and Standards Systematically





Applying Codes and Standards Systematically

Referenced Standards?

- NFPA 853 Standard for the Installation of Stationary Fuel Cell Power Systems
- NFPA 55 Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks
- ANSI/CSA America FC 1

Others

- NFPA 70 NEC
- NFPA 54 ANSI Z223.1–2006 National Fuel Gas Code

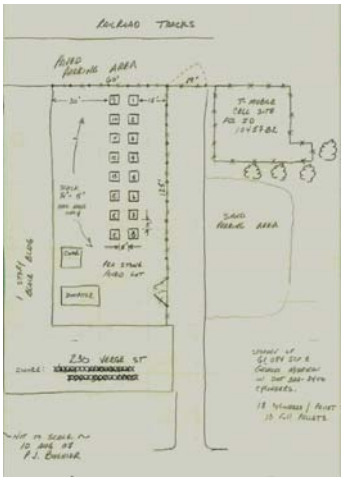
How It's Done

- Engineer follows published codes in the design process.
  - Then applies referenced standards.
- Engineer submits plans which meet the setback distances relevant to that jurisdiction.
- AHJ has an easier time reviewing the permit.
  - Has path through the codes showing relevant distances.
  - Can easily match design with codes.
- Permit is issued quickly or on the spot!

Applying Codes and Standards Systematically

Designs Which Were Approved Quickly

No permit required. Electrical inspection at completion of work for power and grounding.



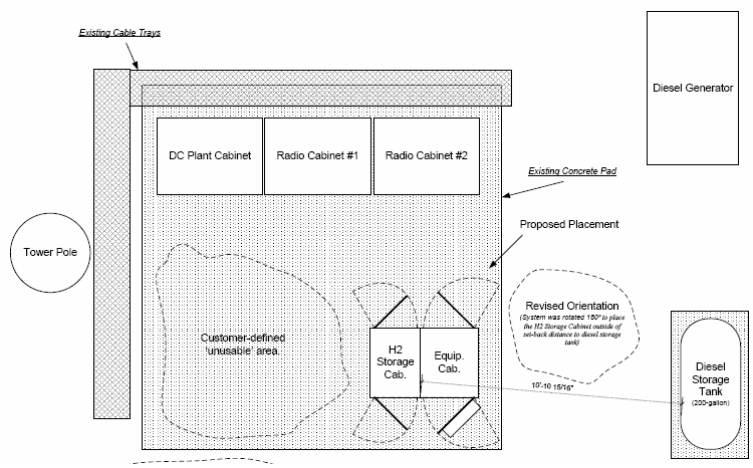
Permit issued “on-the-spot”.

How It’s Done (the hard way)

- Original site plan oriented the fuel cell cabinet and fuel storage cabinet to so the fuel cell front panels faced the outside of the pad
- This plan was rejected by the AHJ because the fuel storage cabinet violated the setback distance to an existing diesel storage tank
- The plan was modified by simply re-orienting the cabinets by 180°, placing the fuel storage cabinet outside of the required setback
- The plan was approved.
- Knowledge of setbacks would have saved 1 week off the siting schedule with a trivial re-orientation

Applying Codes and Standards Systematically

Minor change in orientation solves siting restriction



Don't Even Think About it Here!
(Yes, this is a real proposed location)

Applying Codes and Standards Systematically

Listed and approved fuel consuming appliances

A stationary hydrogen fuel cell is a listed and approved fuel consuming appliance

Questions?

WHAT'S REGULATED, WHAT'S NOT

Michigan Hydrogen Rules

For Storage and Handling

LIQUEFIED

- No minimum or maximum size
- ALL liquid H_2 systems must file application
  - $203 per container application fee
- All liquid H_2 systems must comply with Part 3 of these rules
- Annual per container fee of $61.50 per year

Marcia Poxson
Michigan DEQ

GASEOUS

- Rules do not apply to:
  - Individual gaseous systems under 400 scf
    - Except where separation between these systems is less than 5 feet.
  - Flow thru process container
  - Vehicle capacity is not part of facility quantity

GASEOUS

- Container is defined as 26,000 scf or increment thereof
- Fee Schedule:
  - Calculated per 26,000 scf or increment thereof
  - Application fee is based on $203 per container
  - Annual fee of $61.50 per container

Michigan's Hydrogen Rules

Department of Environmental Quality

Andrea Zajac
Michigan DEQ

Michigan Fire Prevention Code

- A township, city, village, or county shall not adopt or enforce an ordinance or resolution that is inconsistent with this act.
- "Inconsistent" means a rule or ordinance that is more permissive than the provisions of this act, or is more restrictive, or requires more action, equipment, permits, or prevents or obstructs compliance with the provisions of the act.

Michigan's Basics

- NFPA 50A – 1999 Edition
- NFPA 50B – 1999 Edition
- Additions & Amendments from NFPA 52, 55, DOE Documents, and Michigan specific language.
- Application form that follows the rules and cites pertinent sections as needed.

Title of Rules

- Storage & Handling of Gaseous and Liquefied Hydrogen
  - Part 2 covers gaseous guidelines
  - Part 3 covers liquefied guidelines
    - Parts of liquefied systems being gaseous fall under Part 2 guidelines

Rule Layout by Chapter

- 1. General Information.
- 2. Design of Hydrogen Systems.
- 3. Location of Hydrogen Systems.
- 4. Design Considerations at Specific Locations.
- 5. Operation and Maintenance.
- 6. Fire Protection.
- 7. Dispensing Systems.

Additions & Amendments

- Crash Protection Parameters. 2-1.5
- Systems and all system components shall be listed or approved. 2-1
- Temporary Installations. 2-13
- Set Backs from Public Assemblage. 3-2.2-
- Cargo Transport Loading/Unloading. 3-2.3
- Vaults for Gaseous Aboveground Containers. 3-3
- Gaseous/Liquid Attended Fast Filling. 7-2

Additions & Amendments

- Gaseous Vehicle Fueling Appliances in Nonresidential Occupancies. 4-7
- Gaseous Residential Fueling Facility. 4-9
- Cathodic Protection Maintenance. 5-4
- Operational Requirements for Full-Service, Attended Self-Service and Self-Service Dispensing Facilities. 7-3, 7-4
- Emergency Shutoff Devices. 7-6

First Responders

- An emergency plan shall be prepared and updated wherever gaseous or liquefied H2 are produced, handled, stored, or used...5-6
- A list of personnel or site operating authority who are designated and trained to be liaison personnel for the fire department and responsible for aiding the emergency responders in pre-emergency planning.5-6(f)

Installation Application - 30 days

- (a) A plot map showing all of the following w/in 100 ft. of any portion of the container system:
  - (i) The location of the following:
    - (A) Buildings.
    - (B) Public roadways.
    - (C) Railroad mainlines.
    - (D) Public sidewalks.
    - (E) Overhead power lines.
  - (ii) The proposed location of the dispenser station.
  - (iii) The location of property lines.

Installation Application – 30 days

- (iv) The locations of existing ASTs and USTs storing FL/CL, and flammable, compressed or liquid gases.
- (v) The location of the point of transfer in relationship to all of the following:
  - (A) The container.
  - (B) Buildings.
  - (C) Public ways.
  - (D) Outdoor places of public assembly.
  - (E) Driveways
  - (F) Main line railroad centerlines.
  - (G) The line of adjoining property that may be built upon.
  - (H) ASTs and USTs storing FL/CL and flammable, compressed or liquefied gases.

Installation Application – 30 days

- (b) The construction material, the dimensions and the capacity of each container.
- (c) The type of container venting and pressure relief.
- (d) The compressor(s) size (psig and scfm).
- (e) Container appurtenances, mfg/part no.
- (f) A piping diagram showing sizes, valves, pressure relief and fittings, and control devices.

Recommendations

- Contact the regulating authority up-front to establish a working relationship.
- Determine what information/fees /forms and time frame are needed for the permitting process.
- Coordinate with local electrical/building inspector(s) to ensure all certificates are issued prior to final inspection.

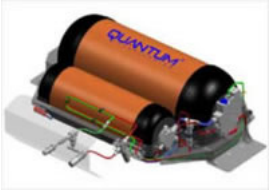
Questions

- Storage Tank Unit
- Department of Environmental Quality
  - Andrea Zajac, Chief
  - 517-335-7294
  - zajaca@michigan.gov
    - Marcia Poxson, Engineer
    - 517-373-3290
    - poxsonm@michigan.gov

HYDROGEN FACILITY PLAN REVIEW APPLICATION OVERVIEW

Gaseous, Liquefied,
Dispensing, Residential Fueling

- Submit application at least 30 days prior to installation
- Include:
  - Application fee of $203/container
  - Site map



APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

FACILITY NAME	NEW ASSIGNED CONTAINER NUMBER(S)	**FACILITY ID NUMBER**
OWNER NAME	OWNER ADDRESS	AREA CODE & TELEPHONE NUMBER ( ) --
SUBMITTER'S NAME/COMPANY	STREET ADDRESS	AREA CODE & TELEPHONE NUMBER ( ) --

Facility Application

SECTION I **The following section applies to container installations of the H2 Rules.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**CONTAINER LOCATION:** Section 3-2.2 & Table 3-2.2: To buildings, property lines, roadways, railways, adjacent flammable or combustible liquid and LPG tanks. Away from overhead power lines.	_____	5.	**CONTAINER SUPPORTS/ FOUNDATIONS:** Section 2-1.2:Firm foundation of noncombustible material, substantial supports. Foundation/supports in contact with cryogenic fluid must withstand temperature effects.	_____

(Continued from Page 1)

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
9.	**CONTAINER VALVES** Part 2, Section 2-4.8 Independent fill line must have backflow check valve as close as practical to container to prevent uncontrolled/accidental release.	_____	15.	**OVERFILL PROTECTION** Part 3, Section 2-1.8: Approved means to prevent overfill of container.	_____

SECTION II The following section applies to hydrogen motor vehicle fueling.

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**TYPE OF DISPENSING STATION**: Attended, Unattended, self-service, inside building, marina service station.	_____	7.	**HAZARD ANALYSIS:** Section 7-2: Emergency plan designed by a qualified H_2 engineer.	_____

SECTION III **The following section applies to indoor hydrogen motor vehicle fueling, must have prior approval from department.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**VENTILATION** Section 4-2: Vent to outdoors, inlet within 18" of floor on exterior wall, outlet at high point in exterior wall or roof.	_____	5.	**SIGNS** Section 4-3.8: At access doors, "No Smoking, Non-Odorized Flammable Gas, No Open Flames", 1" red letters on white background.	_____

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY – WASTE AND HAZARDOUS MATERIALS DIVISION
P O Box 30241 Lansing, MI 48909-7741

APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

This information is required under Act 207 of the Public Acts of 1941, as amended, being Section 29.5c of the Michigan Compiled Laws Annotated

INSTRUCTIONS: The item numbers are referenced in the attached typical installation of a Hydrogen Storage Tank. The system must be in compliance with the Storage and Handling of Liquefied and Gaseous Hydrogen (H2) Rules, 2007 AACS R 29.7001 et seq. The manufacturer and part number must be indicated next to the appropriate item. For emergency generator containers please see Part 5 of the FL/CL Rules for additional requirements. Please direct any questions to the Storage Tank Unit at 517-335-7211 or e-mail at DEQ-STD-TANKS@michigan.gov. For detailed instructions, see Page 7.

FACILITY NAME	NEW ASSIGNED CONTAINER NUMBER(S)		**FACILITY ID NUMBER**
FACILITY STREET ADDRESS (PO BOX NOT ACCEPTABLE)	CONTACT PERSON, TRAINED		AREA CODE & TELEPHONE NUMBER ( ) --
CITY	COUNTY	STATE MI	ZIP CODE
OWNER NAME	OWNER ADDRESS		AREA CODE & TELEPHONE NUMBER ( ) --
CITY	STATE		ZIP CODE
SUBMITTER'S NAME/COMPANY	STREET ADDRESS		AREA CODE & TELEPHONE NUMBER ( ) --
CITY	STATE		ZIP CODE

SECTION I **The following section applies to container installations of the H2 Rules.**

SECTION I **The following section applies to <u>container</u> installations of the H2 Rules.**

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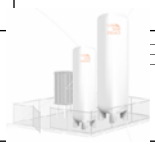
1.	**CONTAINER LOCATION:** Section 3-2.2 & Table 3-2.2: To buildings, property lines, roadways, railways, adjacent flammable or combustible liquid and LPG tanks. Away from overhead power lines.		5.	**CONTAINER SUPPORTS/ FOUNDATIONS:** Section 2-1.2:Firm foundation of noncombustible material, substantial supports. Foundation/supports in contact with cryogenic fluid must withstand temperature effects.	
2.	**CONTAINER DESIGN/ CONSTRUCTION:** Section 2-1: Title 49 CFR, and ASME standards; Dimension & capacity. Underground: ASME vacuum jacket; burial depth, Back fill material.	 	6.	**PIPE SUPPORTS:** Part 2, Section 2-3.1.2: Constructed of non-combustible material. Part 3, Section 2-3.4: Protection from cryogenic exposure.	
3.	**CORROSION PROTECTION:** Section 2-1.2: Container must be protected against corrosion. Section 2-1.8: Composite containers must be protected from UV radiation. Section 5: Underground containers must be protected from corrosion.		7.	**HOSE/PIPING MATERIAL:** Section 2.3: No cast-iron, no aluminum with liquid H_2, protected against corrosion, suitable for pressures & temperatures, supported and protected against corrosion & physical damage, must conform to ASME B31.3 Marked with product and flow direction. Section 2-3.10: Underground must be at proper depth, & vacuum jacketed.	
4.	**COMPRESSOR, GAS PROCESSING EQUIPMENT** Part 2, Section 1-8.1, 2-7.1 & Part 3, Section 1-5.1, 2-9.1: Size of compressor, psig and scfm. Listed and approved. Section 2-10 Gauge on each discharge.		8.	**NORMAL VENTS:** Section 2.2: Steel aboveground. Relieve excessive internal pressure. Terminate outdoors. Sign warning not to spray water in vent opening. Vents terminate outdoors.	

Page 1

(Continued on Page 2) EQP5240 (4/08)

APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

(Continued from Page 1)

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
9.	**CONTAINER VALVES** Part 2, Section 2-4.8 Independent fill line must have backflow check valve as close as practical to container to prevent uncontrolled/accidental release.		15.	**OVERFILL PROTECTION** Part 3, Section 2-1.8: Approved means to prevent overfill of container.	
10.	**PRESSURE RELIEF:** Section 2-2, 7-2.8: Installed per ASME standards. Arranged to discharge upward & unobstructed. Designed & located to prevent moisture and freezing. Gaseous service shall not have manual relief.		16.	**Anchorage** Section 2-1.2: Anchorage in areas subject to buoyant forces; each container shall be safeguarded against movement by anchoring or other secure means.	
11.	**MARKING:** Section 6-3.1: Area shall be marked "No Open Flames" "Nonodorized Flammable Gas." Storage site shall be fenced & posted "Liquefied Hydrogen Flammable Gas No Smoking – No Open Flames," or according to NFPA 704.		17.	**UNLOADING/ LOADING RISER LOCATION:** Section 3-2.3: Fixed piping, between riser & container and master shutoff and check valves. Separation per Table 3-2.2. Section 2-3.8: Backflow check valve at container Section 2-7: Static protection. Section 5-1: ESD in pipe transfer within 10' of hose/arm for lines 3" or more diameter.	
12.	**FIRE PROTECTION AND IDENTIFICATION:** Part 2, Section 2-5, & Part 3, Section 2-1.3: Labeled 3" letters, "Gaseous Hydrogen-Flammable Gas," "Liquefied Hydrogen-Flammable Gas".		18.	**VACUUM/LIQUID LEVEL MONITORING:** Part 3, Section 2-1.9: Means to indicate vacuum degradation within the vacuum jacket of underground container.	
13.	**PHYSICAL PROTECTION:** Sections 2-1.5 & 2-1.6: Guard posts must be in accordance with section specifications, or other means to protect system from vehicular damage. Section 2-4.3: Protect system against tampering. Section 3-1.9: Aboveground system must be fenced & posted.		19.	**EMERGENCY SHUTOFF VALVES:** Section 2-4: Auto-fire valve located at building where pipe enters, & in piping to equipment. Section 3-2.3: Emergency shutoff. Manually operated in path of egress Part 3, Section 2-2.12: Not between pressure relief and device or containers unless locking type. Section 2-4.4: Auto shutoff in liquid withdrawl line as close as practical to container.	
14.	**VAPORIZER:** Part 3, Section 2-6: Anchored, low temperature shutoff in discharge piping, relief valve on heated vaporizer. Monitor outlet temperatures.		20.	**CANOPY:** Section 4-5: The lowest elevation of the roof or canopy shall not be less than 4 feet (1.8 meters) from the top of the container. Vent(s) extended through the roof or canopy. Constructed to not allow vapors to accumulate under the canopy or roof. Constructed of noncombustible materials.	

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APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

SECTION II **The following section applies to hydrogen motor vehicle fueling.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**TYPE OF DISPENSING STATION**: Attended, Unattended, self-service, inside building, marina service station.		7.	**HAZARD ANALYSIS:** Section 7-2: Emergency plan designed by a qualified H_2 engineer.	
2.	**LOCATION OF DISPENSER:** Sections 3-4 & 7-2: Minimum 10 feet from property lines, building, 20 feet from fixed source of ignition, not under power line. Within 100 feet of emergency shutoff switch. In clear view of attendant.			**EMERGENCY BREAKAWAY DEVICE:** Section 3-5 & 5-1: Installed on each hose that dispenses a liquid into motor vehicles. Designed to retain liquid on both sides of the breakaway point.	
3.	**DISPENSING DEVICE:** Section 7-12: Must be listed and identify product dispensed. Section 7-2.5: Equipped to allow control of flow. Device in liquid service to prevent internal or external icing. Section 3-4: Protect against collision. Securely bolt in place.			**FIRE EXTINGUISHER:** Part 2, Section 6-4 & Part 3, Section 6-3: At least one listed 40-BC or two 20-BC within 75 feet of dispensers, fill pipes, and dispensing area.	
4.	**BONDING:** Part 2, Section 5-5 & Part 3, Section 5-4: Static protection between dispenser and vehicle. Transfer surface must be concrete with resistivity not exceeding API-RP 2003, or connection is in continuous metallic contact.		10.	**PHYSICAL PROTECTION:** Section 3-4 & 7-2.2: Secure against unauthorized use and vehicular collision. Section 7-2.3: check valve or pressure regulating valve under the dispenser.	
5.	**EMERGENCY SHUTOFF DEVICE:** Section 7-6: ESD or electric disconnect must be at least 10 feet and not more than 100 feet from dispensing area, along means of egress. Shall shut down all pumps & compressors, fuel supply, transfer equipment.		11.	**SIGNS:** Section 7-2: Warning signs posted: "No Smoking," "No Open Flames," "Stop Motor." "No filling of portable containers in or on a motor vehicle. Non-Odorized Flammable Gas, Cryogenic Liquid or Cold Gas, in 3" red letters on white background. Remain in attendance outside of the vehicle in view of the nozzle." Section 5-1.9: Dispensing instructions posted.	
6.	**DISPENSING NOZZLE:** Section 7-2: Automatic stop flow at temperature-corrected pressure. Shall prevent escape of H_2. Section 5-1.8: Must have interlock or self-closing ends.				

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APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

(In addition to requirements from Page 3)

SECTION III **The following section applies to indoor hydrogen motor vehicle fueling, must have prior approval from department.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**VENTILATION** Section 4-2: Vent to outdoors, inlet within 18" of floor on exterior wall, outlet at high point in exterior wall or roof.		5.	**SIGNS** Section 4-3.8: At access doors, "No Smoking, Non-Odorized Flammable Gas, No Open Flames", 1" red letters on white background.	
2.	**ROOM CONSTRUCTION** Section 4-3.1: At least 2 hour fire rating with at least one exterior wall.		6.	**DETECTION SYSTEM** Section 4-3.9: Dispenser must have gas/leak/fire detection system.	
3.	**AUTO VALVE** Section 4-6.1: Auto valve between storage & dispensing which closes when ESD is activated or loss of power.		7.	**MANUAL SHUTOFF VALVE** Section 4-6.2: Manual shutoff valve must be upstream of breakaway unless dispenser has self-closing valve. Valve must close when power is cutoff or ESD activated.	
4.	**SPACING** Section 4-7.6: Spacing between vehicle fueling appliances must be at least 3'. No manifolding.		8.	**STATIC PROTECTION** Section 4-8.2: Must be in place at load/unload riser location.	

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY – WASTE AND HAZARDOUS MATERIALS DIVISION
P O Box 30241 Lansing, MI 48909-7741

APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

This information is required under Act 207 of the Public Acts of 1941, as amended, being Section 29.5c of the Michigan Compiled Laws Annotated

INSTRUCTIONS: The item numbers are referenced in the attached typical installation of a Hydrogen Storage Tank. The system must be in compliance with the Storage and Handling of Liquefied and Gaseous Hydrogen (H2) Rules, 2007 AACS R 29.7001 et seq. The manufacturer and part number must be indicated next to the appropriate item. For emergency generator containers please see Part 5 of the FL/CL Rules for additional requirements. Please direct any questions to the Storage Tank Unit at 517-335-7211 or e-mail at DEQ-STD-TANKS@michigan.gov. For detailed instructions, see Page 7.

FACILITY NAME	NEW ASSIGNED CONTAINER NUMBER(S)		**FACILITY ID NUMBER**
FACILITY STREET ADDRESS (PO BOX NOT ACCEPTABLE)	CONTACT PERSON, TRAINED		AREA CODE & TELEPHONE NUMBER ( ) --
CITY	COUNTY	STATE MI	ZIP CODE
OWNER NAME	OWNER ADDRESS		AREA CODE & TELEPHONE NUMBER ( ) --
CITY	STATE		ZIP CODE
SUBMITTER'S NAME/COMPANY	STREET ADDRESS		AREA CODE & TELEPHONE NUMBER ( ) --
CITY	STATE		ZIP CODE

SECTION I **The following section applies to container installations of the H2 Rules.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**CONTAINER LOCATION:** Section 3-2.2 & Table 3-2.2: To buildings, property lines, roadways, railways, adjacent flammable or combustible liquid and LPG tanks. Away from overhead power lines.		5.	**CONTAINER SUPPORTS/ FOUNDATIONS:** Section 2-1.2:Firm foundation of noncombustible material, substantial supports. Foundation/supports in contact with cryogenic fluid must withstand temperature effects.	
2.	**CONTAINER DESIGN/ CONSTRUCTION:** Section 2-1: Title 49 CFR, and ASME standards; Dimension & capacity. Underground: ASME vacuum jacket; burial depth, Back fill material.		6.	**PIPE SUPPORTS:** Part 2, Section 2-3.1.2: Constructed of non-combustible material. Part 3, Section 2-3.4: Protection from cryogenic exposure.	
3.	**CORROSION PROTECTION:** Section 2-1.2: Container must be protected against corrosion. Section 2-1.8: Composite containers must be protected from UV radiation. Section 5: Underground containers must be protected from corrosion.		7.	**HOSE/PIPING MATERIAL:** Section 2.3: No cast-iron, no aluminum with liquid H_2, protected against corrosion, suitable for pressures & temperatures, supported and protected against corrosion & physical damage, must conform to ASME B31.3 Marked with product and flow direction. Section 2-3.10: Underground must be at proper depth, & vacuum jacketed.	
4.	**COMPRESSOR, GAS PROCESSING EQUIPMENT** Part 2, Section 1-8.1, 2-7.1 & Part 3, Section 1-5.1, 2-9.1: Size of compressor, psig and scfm. Listed and approved. Section 2-10 Gauge on each discharge.		8.	**NORMAL VENTS:** Section 2.2: Steel aboveground. Relieve excessive internal pressure. Terminate outdoors. Sign warning not to spray water in vent opening. Vents terminate outdoors.	

(Continued on Page 2)

APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

(Continued from Page 1)

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
9.	**CONTAINER VALVES** Part 2, Section 2-4.8 Independent fill line must have backflow check valve as close as practical to container to prevent uncontrolled/accidental release.		15.	**OVERFILL PROTECTION** Part 3, Section 2-1.8: Approved means to prevent overfill of container.	
10.	**PRESSURE RELIEF:** Section 2-2, 7-2.8: Installed per ASME standards. Arranged to discharge upward & unobstructed. Designed & located to prevent moisture and freezing. Gaseous service shall not have manual relief.		16.	**Anchorage** Section 2-1.2: Anchorage in areas subject to buoyant forces; each container shall be safeguarded against movement by anchoring or other secure means.	
11.	**MARKING:** Section 6-3.1: Area shall be marked “No Open Flames” “Nonodorized Flammable Gas.” Storage site shall be fenced & posted “Liquefied Hydrogen Flammable Gas No Smoking – No Open Flames,” or according to NFPA 704.		17.	**UNLOADING/ LOADING RISER LOCATION:** Section 3-2.3: Fixed piping, between riser & container and master shutoff and check valves. Separation per Table 3-2.2. Section 2-3.8: Backflow check valve at container Section 2-7: Static protection. Section 5-1: ESD in pipe transfer within 10’ of hose/arm for lines 3” or more diameter.	
12.	**FIRE PROTECTION AND IDENTIFICATION:** Part 2, Section 2-5, & Part 3, Section 2-1.3: Labeled 3” letters, "Gaseous Hydrogen-Flammable Gas,” “Liquefied Hydrogen-Flammable Gas”.		18.	**VACUUM/LIQUID LEVEL MONITORING:** Part 3, Section 2-1.9: Means to indicate vacuum degradation within the vacuum jacket of underground container.	
13.	**PHYSICAL PROTECTION:** Sections 2-1.5 & 2-1.6: Guard posts must be in accordance with section specifications, or other means to protect system from vehicular damage. Section 2-4.3: Protect system against tampering. Section 3-1.9: Aboveground system must be fenced & posted.		19.	**EMERGENCY SHUTOFF VALVES:** Section 2-4: Auto-fire valve located at building where pipe enters, & in piping to equipment. Section 3-2.3: Emergency shutoff. Manually operated in path of egress Part 3, Section 2-2.12: Not between pressure relief and device or containers unless locking type. Section 2-4.4: Auto shutoff in liquid withdrawl line as close as practical to container.	
14.	**VAPORIZER:** Part 3, Section 2-6: Anchored, low temperature shutoff in discharge piping, relief valve on heated vaporizer. Monitor outlet temperatures.		20.	**CANOPY:** Section 4-5: The lowest elevation of the roof or canopy shall not be less than 4 feet (1.8 meters) from the top of the container. Vent(s) extended through the roof or canopy. Constructed to not allow vapors to accumulate under the canopy or roof. Constructed of noncombustible materials.	

APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

SECTION II **The following section applies to hydrogen <u>motor vehicle fueling</u>.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**TYPE OF DISPENSING STATION**: Attended, Unattended, self-service, inside building, marina service station.		7.	**HAZARD ANALYSIS:** Section 7-2: Emergency plan designed by a qualified H_2 engineer.	
2.	**LOCATION OF DISPENSER:** Sections 3-4 & 7-2: Minimum 10 feet from property lines, building, 20 feet from fixed source of ignition, not under power line. Within 100 feet of emergency shutoff switch. Protected from collision, secured in place. In clear view of attendant.		8.	**EMERGENCY BREAKAWAY DEVICE:** Section 3-5 & 5-1: Installed on each hose that dispenses a liquid into motor vehicles. Designed to retain liquid on both sides of the breakaway point.	
3.	**DISPENSING DEVICE:** Section 2-12: Must be listed and identified as to product it dispenses. Section 7-2.5: Equipped to allow control of flow. Section 3-4: Protect against collision. Securely bolt in place.		9.	**FIRE EXTINGUISHER:** Part 2, Section 6-4 & Part 3, Section 6-3: At least one listed 40-BC or two 20-BC within 75 feet of dispensers, fill pipes, and dispensing area.	
4.	**BONDING:** Part 2, Section 5-5 & Part 3, Section 5-4: Static protection between dispenser and vehicle. Transfer surface must be concrete with resistivity not exceeding API-RP 2003, or connection is in continuous metallic contact.		10.	**PHYSICAL PROTECTION:** Section 3-4 & 7-2.2: Secure against unauthorized use and vehicular collision. Section 7-2.3: check valve or pressure regulating valve under the dispenser. Device in liquid service to prevent internal/external icing.	
5.	**EMERGENCY SHUTOFF DEVICE:** Section 7-6: ESD or electric disconnect must be at least 10 feet and not more than 100 feet from dispensing area, along means of egress. Shall shut down all pumps & compressors, fuel supply, transfer equipment.		11.	**SIGNS:** Section 7-2: Warning signs posted: "No Smoking," "No Open Flames," "Stop Motor." "No filling of portable containers in or on a motor vehicle. Non-Odorized Flammable Gas, Cryogenic Liquid or Cold Gas, in 3" red letters on white background. Remain in attendance outside of the vehicle in view of the nozzle." Section 5-1.9: Dispensing instructions posted.	
6.	**DISPENSING NOZZLE:** Section 7-2: Automatic stop flow at temperature-corrected pressure. Shall prevent escape of H_2. Section 5-1.8: Must have interlock or self-closing ends.				

APPLICATION FOR INSTALLATION OF HYDROGEN STORAGE SYSTEMS

(In addition to requirements from Page 3)

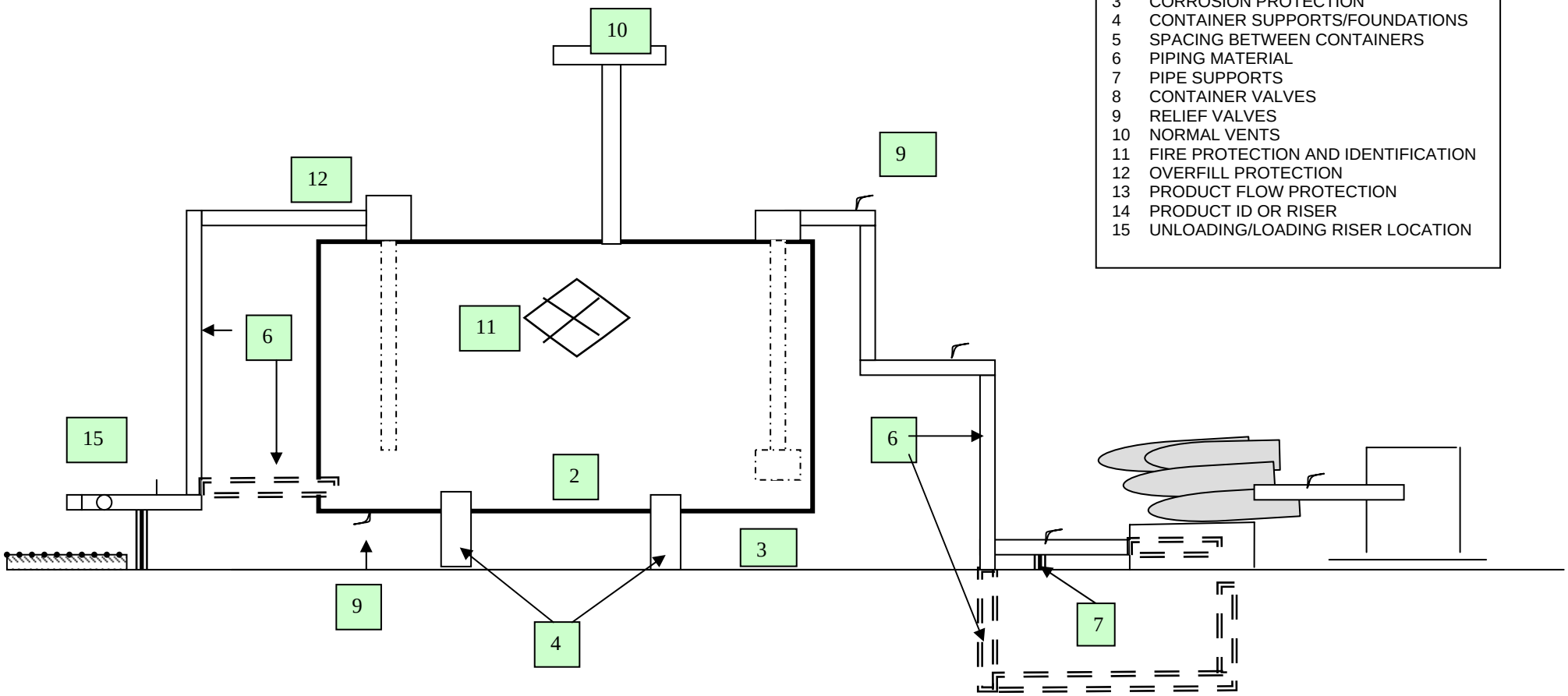
SECTION III **The following section applies to <u>indoor</u> hydrogen motor vehicle fueling, must have prior approval from department.**

ITEM	DESCRIPTION	MANUFACTURER & PART NO.	ITEM	DESCRIPTION	MANUFACTURER & PART NO.
1.	**VENTILATION** Section 4-2: Vent to outdoors, inlet within 18" of floor on exterior wall, outlet at high point in exterior wall or roof.	_____ _____ _____ _____	5.	**SIGNS** Section 4-3.8: At access doors, "No Smoking, Non-Odorized Flammable Gas, No Open Flames", 1" red letters on white background.	_____ _____ _____ _____
2.	**ROOM CONSTRUCTION** Section 4-3.1: At least 2 hour fire rating with at least one exterior wall.	_____ _____ _____ _____	6.	**DETECTION SYSTEM** Section 4-3.9: Dispenser must have gas/leak/fire detection system.	_____ _____ _____ _____
3.	**AUTO VALVE** Section 4-6.1: Auto valve between storage & dispensing which closes when ESD is activated or loss of power.	_____ _____ _____ _____ _____ _____	7.	**MANUAL SHUTOFF VALVE** Section 4-6.2: Manual shutoff valve must be upstream of breakaway unless dispenser has self-closing valve. Valve must close when power is cutoff or ESD activated.	_____ _____ _____ _____ _____
4.	**SPACING** Section 4-7.6: Spacing between vehicle fueling appliances must be at least 3'. No manifolding.	_____ _____ _____	8.	**STATIC PROTECTION** Section 4-8.2: Must be in place at load/unload riser location.	_____ _____ _____

TYPICAL INSTALLATION OF

HYDROGEN STORAGE SYSTEM

(Numbers corresponds to the item numbers on the application)



PART I – ITEMS

1. CONTAINER LOCATION
2 CONTAINER DESIGN/CONSTRUCTION
3 CORROSION PROTECTION
4 CONTAINER SUPPORTS/FOUNDATIONS
5 SPACING BETWEEN CONTAINERS
6 PIPING MATERIAL
7 PIPE SUPPORTS
8 CONTAINER VALVES
9 RELIEF VALVES
10 NORMAL VENTS
11 FIRE PROTECTION AND IDENTIFICATION
12 OVERFILL PROTECTION
13 PRODUCT FLOW PROTECTION
14 PRODUCT ID OR RISER
15 UNLOADING/LOADING RISER LOCATION

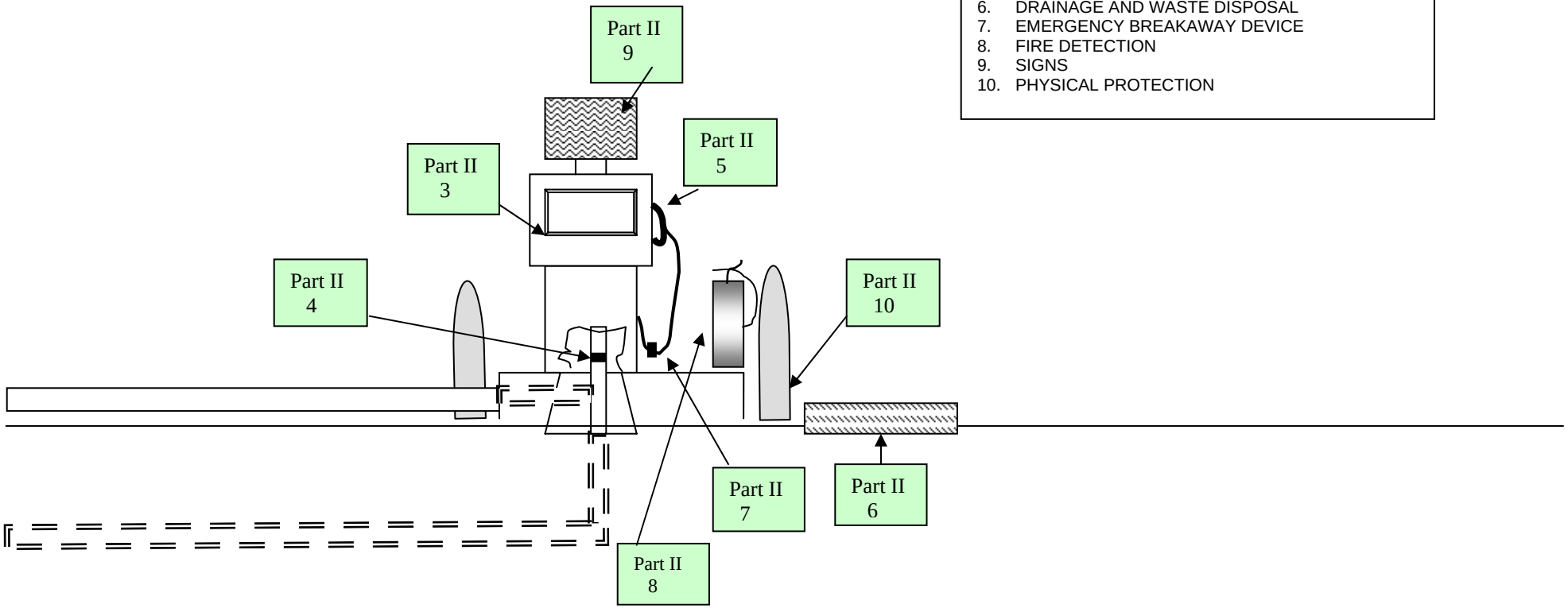
TYPICAL INSTALLATION OF

HYDROGEN DISPENSING SYSTEM

(Numbers corresponds to the item numbers on the application)

PART II – ITEMS

1. TYPE OF FACILITY
2. LOCATION OF DISPENSER
3. DISPENSING DEVICE
4. EMERGENCY SHEAR/FIRE VALVE
5. DISPENSING NOZZLE
6. DRAINAGE AND WASTE DISPOSAL
7. EMERGENCY BREAKAWAY DEVICE
8. FIRE DETECTION
9. SIGNS
10. PHYSICAL PROTECTION



A plan review must be completed on any hydrogen storage container system of 400 scf or more, where less than 400 scf systems are less than 5 feet apart, or any container filling location. A request for plan review must include:

1) Size of proposed container(s). The material of construction, the dimension, and the **capacity** of each container.
2) Type of venting, pressure relief, and compressor size.
3) A completed parts and materials list for each container with vent manufacturer, model number and flow rate (gpm, SCFH) as appropriate.
4) A plot map showing all of the following information within 100 feet of the proposed system:
   a) Location of **buildings**, public **roadways**, railroad mainlines, public sidewalks, and **property lines**.
   b) Overhead power lines.
   c) **Proposed** location of the **container**(s) and **loading/unloading** risers.
   d) Location of all **existing** tanks, above and under ground, storing flammable/combustible liquids or gases.
   e) Location of all fuel dispensers and canopy footings.
4) A separate piping diagram for each container with pipe, vent and valve specification identified on the diagram. Include manufacturer and model numbers where appropriate.
5) Section II shall be completed for motor fueling facilities.
6) Each installation of 26,000 scf gaseous storage capacity, or increment thereof, shall be considered a container.
7) A plan review fee of $203 (checks made payable to the State of Michigan) **per** container.

   Send the application to:

   DEQ OFFICE OF FINANCIAL MANAGEMENT
   REVENUE CONTROL UNIT
   PO BOX 30657
   LANSING, MI 48909

8) Physical address for overnight deliveries:

   MDEQ-WHMD
   Revenue Control Unit 5th Floor
   Constitution Hall
   525 West Allegan
   Lansing, Michigan 48933

The facility cannot be operated without approval from the Waste and Hazardous Materials Division. If you have any additional questions concerning this matter, please contact the Storage Tank Unit at 517-335-7211, or e-mail DEQ-STD-TANKS@michigan.gov.

Statewide Jurisdiction List
Bureau of Construction Codes

The **Statewide Jurisdiction List** is a listing of all units of government within the state. There are three levels of jurisdiction (state, county, local) for each of the four code disciplines (building, electrical, mechanical, and plumbing).

If COUNTY is indicated, that unit of government receives code enforcement services from a county enforcing agency.

If LOCAL (city, township, or village) is indicated, that unit of government has their own program.

If STATE is indicated, the Bureau of Construction Codes is responsible for code enforcement in that unit of government.

The Statewide Jurisdiction List is updated after every Construction Code Commission meeting to show changes; i.e. units of government which have newly assumed responsibility or those who have returned responsibility to the state or county level. The date each change takes effect will appear directly below the level of jurisdiction.

Occasionally, local units of government request assistance from the Bureau of Construction Codes for plan review and/or permit and inspection services. The assistance may be for a certain period of time or for an entire project. The Statewide Jurisdiction List reflects temporary assistance within a local jurisdiction with an asterisk and provides a link to the Report of Assistance to Local Enforcing Agencies for detailed information regarding the assistance.

This list was compiled to assist contractors and homeowners securing permits and requesting inspections. Code questions, requests for permits, or requests for inspections should be directed to the appropriate enforcing agency. Questions for state issued permits, inspections, or code interpretations should be directed to the respective division within the Bureau of Construction Codes.

Permitting Hydrogen Facilities & Responsibilities

By
Andrea Zajac
MDEQ- WHMD

Emergency Plan

- Shall be prepared and updated wherever gaseous and liquefied hydrogen are produced, handled, stored, or used and include the following:
- Type of emergency equipment available.
- Testing & maintenance programs for the emergency equipment.
- Hazard identification labeling for each storage location.
- Location of posted emergency procedures.
- A MSDS for the gaseous or liquefied hydrogen stored or used on site.

Emergency Plan cont.

- A list of people who are designated and trained to be a liaison personnel for the local fire department and who are responsible for, but shall not be limited to, the following:
- Aiding the emergency responders in pre-emergency planning.
- Identifying the location of the hydrogen stored and used.
- Assessing the MSDS's.
- Knowledge of the site emergency procedures.

Emergency Plan cont.

- A list of types and quantities of gaseous and liquefied hydrogen found within the facility.

Container Failure

- When an unexpected discharge due to primary container failure is discovered, the DEQ and the local fire department, shall be immediately notified, and the container shall be repaired or be removed from service.

Hazard Analysis

- A hazard analysis shall be conducted on every hydrogen fueling system installation by a qualified engineer(s) with proven expertise in hydrogen fueling systems and installations.
- The hazard analysis shall include the following: fire protection measures, fire protection and suppression systems, detection systems, and ventilation.

Hazard Analysis

- At a minimum, the hazard analysis shall include consideration of potential failures in hoses, nozzles, dispensing equipment, as well as failures for maintenance and service.

Hazard Analysis

- Method used for hazard analysis shall be 1 or combination of several of the following recognized procedures: hazard and operability studies (HAZOPS), failure mode effects and criticality analysis (FMECA), preliminary hazards analysis (PHA), fault tree analysis (FTA), and event tree analysis (ETA). Other analysis methods, when used, shall ensure same level of system safety as provided by any of the recognized procedures or acceptable to the DEQ.

Hazard Analysis

- Standard designs that have been analyzed by recognized procedure need not be studied each and every time such installation occurs. Site-specific elements that are unique to the installation shall be reviewed in concert with the analysis performed on the standard system to ensure that the standard design has not been altered in a way that would negatively effect the hazard analysis.

Hazard Analysis

- These hazard analyses shall be available for review at final inspection, prior to the installation being placed into service, shall be maintained on site, and be available to the DEQ upon request.

HAZOP – HAZard OPerability

- A structured technique in which a multi-discipline team perform a systematic study of a process using guide words to discover how deviations from the design intent can occur in equipment actions, or materials, and whether the consequences of these can result in a hazard.
- The results of the HAZOP analysis are the team's recommendations, which include identification of hazards and recommendations for changes in design, procedures, etc. to improve the safety of the system. Deviations during normal startup, shutdown, and maintenance operations are discussed by the team and are included in the HAZOP.

Failure Mode Effects and Criticality Analysis (FMECA)

- This is developed by studying the failure that might affect the system components under consideration. When the failure modes are identified, it is necessary to recognize the associated causes as well as the consequences in the component itself and in the system on the whole, corrective actions have to be suggested to eliminate or reduce the potential occurrence.

Failure Mode Effects and Criticality Analysis (FMECA)

- In general the FMECA process follows a standard procedure, as detailed below:
- Identify top-level hazards/events.
- Identify related equipment/components/processes.
- Identify potential failures.
- Identify design safety.
- Identify corrective actions.

Failure Mode Effects and Criticality Analysis (FMECA)

- The FMECA may be performed via two different approaches. The hardware, or component, analysis is the identification and analysis of ramifications of component failures. This method is a bottoms-up approach, wherein failures are initiated on the subsystem level. The functional approach is a top-down method, starting at the system level. This is suitable when specific components have not yet been chosen. Either approach is acceptable; both may be best in some cases.

Preliminary Hazard Analysis (PHA)

- A PHA is the first step of the safety process. Develop a list which describes the potential hazards of the system. The potential safety risk associated with each hazard is then evaluated by assessing the likelihood and severity of incidents that could result from the hazard. By identifying the potential risk associated with each hazard, PHA allows to assess the safety proposed conceptual design, and to focus engineering activities on eliminating or mitigating potential safety problems.

Preliminary Hazard Analysis (PHA)

- The next step in addressing hazards is to define hazard controls. Hazard controls are any design feature implemented to satisfy safety requirements. An individual hazard control may help satisfy requirements, or it may address only a single requirement.

Fault Tree Analysis (FTA)

- FTA is a deductive (top-down) method used for identification and analysis of conditions and factors the can result in the occurrence of a specific failure or undesirable event (i.e. container failure). It starts with an undesirable top event and isolates possible causes at each successive lower level of the hierarchy in order to establish the prime causes. FTA is very powerful in the sense that is forces the designers to consider all the causes of unacceptable top events.

Fault Tree Analysis (FTA)

- The level of detail addressed in a FTA is generally determined by the amount of data available, and the desire resolution of the model. FTA are generally developed and evaluated using available software packages, which can produce the diagrams, lists of contributing events, and evaluate the likelihood of occurrence of the top event and contributing events.

Event Tree Analysis (ETA)

- This method is an inductive approach used to identify and quantify a set of possible outcomes. The analysis starts with an initiating event or initial condition and includes the identification of a set of success and failure events that are combined to produce various outcomes. This method identifies the spectrum and severity of possible outcomes and determines their likelihood. A discussion and worked example can be found in *Guidelines for Hazard Evaluation Procedures*, *Second Edition with Worked Examples,* Center for Chemical Process Safety, American Institute of Chemical Engineers, 1992.

NREL National Renewable Energy Laboratory
A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Innovation for Our Energy Future
1617 COLE BLVD.
GOLDEN, CO 80401-3393
(303) 275-3000

Permitting Hydrogen Fueling Stations And the use of Stationary Hydrogen Fuel Cell as Back-up Power for Telecommunications Sites Workshop

September 17 - 18, 2008

Evaluation Form Results

Rating: 1 being the lowest, 5 being the highest

The workshop was what you expected?

1	2	3	4	5
		12%	50%	38%

Participation in the workshop increased your comfort level should you have to review an application for a hydrogen fueling station?

1	2	3	4	5
		38%	31%	31%

The workshop increased your understanding of how to apply the various codes and standards when reviewing a hydrogen fueling station?

1	2	3	4	5
	6%	19%	31%	44%

Would you recommend that your peers attend a similar workshop?

1	2	3	4	5
		6%	19%	75%

What did you like about the workshop?

- Having no experience with hydrogen it all had value
- Increased knowledge of use & components
- The presenters
- The information received helps in the inspection process
- Good forum for transfer/sharing of information
- The facilities and variety of presenters
- Interaction between state and local authorities
- Good speakers and subjects
- Small attendance
- The group discussion
- Given the topic it was the best it could be
- Like the safety program; Plug Power's presentation on problems encountered was interesting

What didn't you like about the workshop?

- Not all of the processes for inspection/AHJ were finalized and thought through
- Some confusion at the state level
- The last presentation
- Duplication of information from differing entities
- Following the rule portion was hard to follow; an outline of the rules would have made following easier

What improvements, if any, would you recommend to the workshop?

- Hands on portion with the equipment
- Provide clarifications about the breakdown of authority between local & state officials
- Additional NFPA Codes; having a binder with the appropriate codes would be beneficial
- Provide more detail about application of the building and fire codes
- Increase the magnification on the visual presentation material to make it easier to read
- Increased detail on the permitting process and involvement of local building and fire officials
- Rope off the back rows of seats to encourage more interaction
- More pictures of equipment and sites.

What target audience do you believe should be included in a future workshops?

- 1st Responders
- Owners/installers/Operators
- Building and Fire Code Officials
- More local code officials
- Plan reviewers
- Zoning Officials
- News Media