

# **Final Action Report**

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

**March 12-13, 2008  
Buellton, CA**

**Prepared by**

**The National Association of State Fire Marshals**

with the assistance of

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Davidson Code Concepts, LLC**

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The DiCristina Group**

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# Executive Summary

## 1. Executive Summary

The overall objective of the workshop was to present “case studies” for a selected number of hydrogen motor-fueling station configurations and back-up power for telecommunication sites to an invited group of fire and building code officials that shows how existing codes and standards, or engineering solutions based on the latest codes (“alternative methods”), have been or can be applied to permit construction of a hydrogen motor-fueling station in a rigorous but timely manner. Additionally a goal was to have this group review and vet the permitting process, codes and standards, and engineering solutions exemplified by the case studies.

To summarize the project:

- The workshop would be hosted in conjunction with the Annual California Fire Prevention Institute.
- The workshop built on the previous Atlanta workshop via teleconference coordination and discussion.
- Twenty-three building & fire code officials primarily from southern California participated in the workshop.
- An overview of hydrogen as compared to other fuel gases was provided along with a logical path for applying codes and standards to hydrogen fuel projects.
- Participants were broken down into five teams.
- Each team was assigned a primary and a secondary plan involving a service station and a telecommunications site.
- Each team gave a verbal report on the results of their reviews which was followed by comments from any team that used the same plan for their review. General discussion followed.
- Several code issues were identified dealing with an understanding of how to apply the codes and standards and existing code language that presented roadblocks to effective application of the codes.
- 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 codes and referenced standards to a hydrogen motor-fueling facility 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 code language that may need modification to clarify technical requirements.

## **Workshop Sponsors**

**The National Association of State Fire Marshals**

**Shell Hydrogen, LLC**

**General Motors**

**Plug Power, Inc.**

**ReliOn, Inc.**

**National Renewable Energy Laboratory**

## **Workshop Facilitators**

**Davidson Code Concepts, LLC**

**The DiCristina Group, Inc.**

# Project Development

## 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 teleconference occurred on February 4<sup>th</sup>, 2008 involving representatives of NREL, NASFM and the CFPI. The discussion agenda was:

Workshop format: plenary (Day 1-am), breakouts (Day 2-am and pm), report outs (Day 2— late pm)

Invitees: fire code officials (So. CA), building code officials (So. CA), key officials (CA, national)

Speakers: welcome, workshop structure/purpose, energy companies, fuel cell companies, telecom industry

Invitation letters

Draft agenda

Logistics: breakout rooms, lodging, food, fees

Next steps: planning milestones, dates

Action items, next call

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

- The overall objective of the workshop is to present “case studies” for a selected number of HRS and back-up power for telecommunication site configurations to an invited group of California fire and building code officials that shows how existing codes and standards or engineering solutions based on the latest codes (“alternative methods”) have been or can be applied to permit HRS in a rigorous but timely manner and to have

this group review and vet the permitting process, codes and standards, and engineering solutions exemplified by the case studies.

- The fire and building code officials will be invited by NASFM. Criteria for invitation include previous experience permitting HFS, responsibility and authority within jurisdictions where HFS permit applications are likely, potential future location for an installation and “standing” within the community of fire and building code officials.
- The case studies can include existing, planned, and “hypothetical” installations. The case studies should demonstrate the logic and concept of the configurations and how safety is built into the design in relation to the existing site improvements.
- At the workshop, teams will be formed to review each case study. The teams will be asked to evaluate the application of codes and standards to the examples presented in each case study and reach a consensus on whether the codes and standards were selected and applied appropriately. Each team will review more than one case study to provide experience with both a HFS and a telecommunications site.
- Two key issues to address with the workshop is how the codes and standards apply and in which order, (which will deal with the logic and design principals); and we also want the site plan dimensional issues dealt with because they are the 'make or break' issues when attempting to site a hydrogen motor fuel station or back up power for telecommunications sites on an existing lot in an urban or suburban environment.

As a result of the second teleconference on February 14<sup>th</sup> a draft agenda was created for the workshop

Workshop on Permitting Hydrogen Fueling Stations and  
Hydrogen Fuel Cell Backup Power for Telecommunication Towers

Santa Ynez Valley Marriott  
Buellton, CA  
March 12-23, 2008

March 12 (Wednesday)

8:00	Continental breakfast	
8:30	Welcome	Penni Overstreet-Murphy, CFPI
8:35	Objectives, purpose of workshop	Antonio Ruiz, U.S. DOE
8:50	Agenda, structure of workshop	Jim Narva, NASFM
9:00	Hydrogen Fueling Stations	
	Case studies	Brad Smith, Shell Hydrogen

Codes and standards	Bob Davidson, Davidson Code Concepts
10:00 Break	
10:20 Hydrogen Fuel Cells for Back-up Power at Telecommunication Towers	
Case studies	TBD
Codes and standards	Sal DiCristina, DiCristina
11:20 Discussion	Bob Davidson, Sal DiCristina
11:50 Breakout session, group assignments	Jim Narva
12:00 Adjourn for Day 1	Antonio Ruiz

March 13 (Thursday)

8:00 Continental breakfast	
8:30 Convene breakout sessions	
Breakout 1	
Breakout 2	
Breakout 3	
10:30 Break	
10:50 Reconvene breakout sessions	
12:00 Lunch	
1:00 Reconvene breakout sessions	
3:00 Break	
3:30 Plenary session for report out	Breakout session chairs
4:30 Summary, next steps	Jim Narva
5:00 Adjourn workshop	Antonio Ruiz

Workshop material and resource development to be accomplished included:

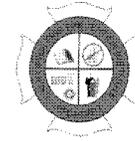
- Preparation of site plan for both HFS and telecommunication scenarios.
- Update of a Team Review Report Form.
- Update of a Participant Evaluation Form.
- Compilation of a list of code official invitees with a goal of thirty participants.
- Obtaining copies of relevant codes and standards for use by the teams.
- Printing and delivery of workshop materials.
- Development of individual presenter Power Point presentations.

All items were completed in a timely manner leading up to the day of the workshop.

# The Workshop

### 3. The Workshop

The agenda for the workshop was as follows:



**Workshop on Permitting Hydrogen Fueling Stations  
and Stationary Hydrogen Fuel Cells as Back-up Power for  
Wireless Telecommunications Facilities**

Santa Ynez Valley Marriott - Buellton, CA  
March 12-13, 2008



DAY ONE: WEDNESDAY, MARCH 12, 2008

- |                         |   |
|-------------------------|---|
| 8:00 a.m. - 8:30 a.m.   | <b>Continental breakfast</b>  |
| 8:30 a.m. - 8:35 a.m.   | <b>Welcome</b><br><i>Pemi Overstreet-Murphy, California Fire Prevention Institute</i>   |
| 8:35 a.m. - 8:50 a.m.   | <b>Objectives and Purpose of Workshop</b><br><i>Antonio Ruiz, U.S. Department of Energy</i>   |
| 8:50 a.m. - 9:15 a.m.   | <b>Introductions, Agenda, and Structure of Workshop</b><br><i>James Narva, National Association of State Fire Marshals</i>  |
| 9:15 a.m. - 10:15 a.m.  | <b>Hydrogen Fueling Stations</b> <ul style="list-style-type: none"><li>▪ Case studies - <i>Alex Keros, General Motors</i></li><li>▪ Codes and standards - <i>Bob Davidson, Davidson Code Concepts</i></li></ul>   |
| 10:15 a.m. - 10:30 a.m. | <b>Break</b>  |
| 10:30 a.m. - 11:30 a.m. | <b>Hydrogen Fuel Cells for Back-up Power at Wireless Telecommunication Sites</b> <ul style="list-style-type: none"><li>▪ Case studies - <i>Paul Buebler, Plug Power, and Mike Maxwell, ReliOn</i></li><li>▪ Codes and standards - <i>Sal DiCristina, DiCristina Group</i></li></ul> |
| 11:30 a.m. - 11:50 a.m. | <b>Q/A and Discussion</b><br><i>Bob Davidson and Sal DiCristina</i>   |
| 11:50 a.m. - 11:55 a.m. | <b>Breakout Sessions and Group Assignments</b><br><i>James Narva</i>  |
| 11:55 a.m. - 12:00 p.m. | <b>Adjourn for Day 1</b><br><i>Antonio Ruiz</i>   |
| 12:00 p.m.              | <b>Lunch</b>  |
| Afternoon of Day 1:     | <b>Exhibits</b>   |

**DAY TWO: THURSDAY, MARCH 13, 2008**

<b>8:00 a.m. – 8:30 a.m.</b>	<b>Continental breakfast with Screening of Permitting Website</b>
<b>8:30 a.m. – 10:30 a.m.</b>	<b>Convene Breakout Sessions</b> <ul style="list-style-type: none"><li>▪ Breakout 1</li><li>▪ Breakout 2</li><li>▪ Breakout 3</li><li>▪ Breakout 4</li><li>▪ Breakout 5</li></ul>
<b>10:30 a.m. – 10:50 a.m.</b>	<b>Break</b>
<b>10:50 a.m. – 12:00 p.m.</b>	<b>Reconvene Breakout Sessions</b>
<b>12:00 p.m.</b>	<b>Lunch</b>
<b>1:00 p.m. – 2:00 p.m.</b>	<b>Reconvene Breakout Sessions</b>
<b>2:00 p.m. – 2:30 p.m.</b>	<b>Break</b>
<b>2:30 p.m. – 4:00 p.m.</b>	<b>Plenary Session for Report Outs</b> <i>Bob Davidso, Breakout Session Chair</i>
<b>4:00 p.m. – 4:30 p.m.</b>	<b>Recommended Code Solutions</b> <i>Bob Davidson and Sal DiCristina</i>
<b>4:30 p.m. – 5:00 p.m.</b>	<b>Summary and Next Steps</b> <i>Jim Narva</i>
<b>5:00 p.m.</b>	<b>Adjourn workshop</b> <i>Antonio Ruiz</i>

The primary goals of the workshop were

- Familiarize participants with examples of hydrogen motor fueling station projects and telecommunication back up power installations that have been implemented in the United States.
- Familiarize participants with the codes and standards and the processes that have been utilized by local/state officials to permit the projects.
- Provide workshop participants with the opportunity to conduct “Virtual Permittings” of projects that have already been permitted to get a handle on how they would do the permitting, given available information about the projects and available codes and standards.
- Identify critical issues associated with the permitting process that need to be addressed by the Department of Energy, in order to facilitate the permitting process (i.e., make it efficient, both in terms of time and expense).
- Provide participants with the opportunity to articulate codes and standards gaps or conflicts (if any) that need to be addressed.
- Raise the comfort level of the code official should they be presented with an application to construct a hydrogen motor fueling station in their jurisdiction.

As an opening introduction to issues that can develop when applying codes and standards to projects utilizing hydrogen as an energy source, presentations were done on the use of stationary hydrogen fuel cells as a back up power supply at telecommunications equipment sites and on hydrogen as a motor fuel. The presentations were used as an avenue to identify the path a code official should take when applying the 2006 edition of the International Building Codes, (California version), along with related codes and standards.

For the breakout sessions the participants were broken down into 5 Teams. Each team was assigned one of the five scenarios as a primary review project and an additional scenario as a secondary review project. This ensured that there would be sufficient work for the allotted times and that there would be two individual reviews of each plan covering both HFS and telecommunication installations

A. The Teams were:

- |        |   |
|--------|---|
| Team 1 | Dan Chudy<br>Eric Binder<br>Tim Dunn<br>Ron Keefer<br>Paul Inouye<br>Mark Cohen<br>Chris Kraft                              |
| Team 2 | Henry Roe<br>Rochelle Maurer<br>Mark Latham<br>Jesse Martinez<br>Marnel Vanden Bossche<br>Conrad Cox<br>Rob Schroeder       |
| Team 3 | Michael McGivney<br>Brian Weidman<br>Richard Stillwagon<br>Patti Cline<br>Chuck Weber<br>Damien Quattlebaum<br>Mike Maxwell |
| Team 4 | Shane Walter<br>Adria Paesani<br>Ken Quick<br>Lee Caldwell<br>Neil Reitzell<br>James Ker                                    |
| Team 5 | Vince Tovey<br>Mark Gomez<br>Al Miller<br>Jeffrey Taylor<br>Greg Evans<br>Michael Miller                                    |

B. The resources provided to each team included the following:

A set each of:

- International Code Council I-Codes
  - International Building Code
  - International Fire Code
  - California Mechanical Code Material
  
- National Fire Protection Association
  - NFPA 52 Vehicular Fuel Systems Code 2006 edition
  - NFPA 54 ANSI Z223.1-2006 National Fuel Gas Code
  - NFPA 55 Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks 2006 edition

Along with:

- A set of Site Layout Plans
- Note Pad Easel, Review Report Forms, Evaluation Forms, Pens and Scales

C. The teams were instructed to address the following questions:

- Which codes and standards did you apply during your review and why were they applied?
- What codes or standards were needed but not supplied?
- What items shown on the plan were determined to be acceptable?
- What items shown on the plans were not found to be acceptable?
- What items or information, if any, was not provided on or with the plan and is needed to complete your review?

*(The teams were instructed to list relevant code references)*

And were advised that for the afternoon:

- When the plan review portion is completed everyone will return to this room and the team leaders will present their primary assignment reviews.
- The team assigned the same plan for the secondary review will be asked if they have anything to add.
- General discussion will then occur.

D. The Plans included various scenarios

- Combined Gasoline-Hydrogen Retail Station with Below-Grade Liquid H<sub>2</sub> Storage
- Combined Gasoline-Hydrogen Retail Station with Canopy-Top Electrolyzer and Above-Ground H<sub>2</sub> Storage
- Combined Gasoline-Hydrogen Retail Station with Ground-Mounted Electrolyzer
- Combined Gasoline-Hydrogen Retail Station with Ground-Mounted NG Reformer
- Combined Gasoline-Hydrogen Retail Station with Hydrogen Supplied by Pipeline
- Three roof top telecommunication site installations.
- Two at grade telecommunication site installations.

# The Workshop

#### 4. The Results

The manner in which the teams were selected ensured that individuals had diverse qualifications and were diverse from the standpoint of regional influences on application of codes and standards. The workshop would be the first time they had worked with each other applying the code (though many knew of each other through activities with the California Fire Prevention Officers Division).

Each of the teams began with a slightly disorganized or a shotgun approach to the plans with team's members picking up the different codes and standards and identifying issues to be addressed. It is a fairly common approach to dealing with hydrogen installations because most guidance documents simply list all of the codes and standards that may apply without providing a matrix of the path that should be followed to properly apply the technical requirements of the codes and standards. This approach also occurs because it is not uncommon to have a building code, fire code, mechanical code and/or electrical code official simultaneously reviewing their portions of an application to complete a review process.

However, within a short time team leaders and team members coalesced and agreed that the codes and standards needed to be applied in an orderly manner starting with the building code and followed by the fire code. The fuel gas code and referenced standards would be applied subsequent to these two documents. Once this decision was made the teams progressed through each applicable section of the building and fire code and followed paths to other referenced sections, codes and standards. This process was helped by the availability of the I-Code Path matrix that visual depicts the path through the various codes.

The difference in the scope of the scenarios provided each team with a slightly different experience. At least one team was completed quicker than other teams and suggested that better details on the plans should be provided including electrical plans. One of the teams required more time on their initial scenario and did not get to the secondary scenario. This experience matched what should be expected in real projects depending on the scope and complexity of the application.

The structured approach ultimately applied by the separate teams wherein sections of the building code were noted with a path to a reference led all of the teams to identify loop backs wherein the code language pointed to another code section, only to find the referenced code section pointed back to the starting point. Some of these issues were pointed out in the introductory presentations.

AS in the past workshop a common theme throughout the workshop from the initial presentations to the evaluation comments submitted by the participants concerned zoning issues. In many jurisdictions it is the zoning approval process that presents the biggest obstruction to the application process, particularly because in many

cases the zoning and planning boards reviewing the application do not have the technical building or fire code background necessary to understand the hazards or lack of hazards presented by a hydrogen motor fueling station.

Unfortunately zoning is a topic that is as varied as the individual jurisdiction involved and there are no state or national focal points that can be used to disseminate information and knowledge to zoning or planning board members or to provide for standard zoning ordinance language to apply to hydrogen installations such as the communication and code change process provided by the International Code Council and the National Fire Protection Association when addressing the codes and standards applied to the use of hydrogen. Some of the zoning issues had more to do with aesthetics than with the fact that hydrogen was to be present.

It was recommended to the code officials that an approach they can use when the zoning or planning board consults with them on this issue is to point out that the codes and standards provide for the safe construction and operation of hydrogen motor-fueling stations just as they do for flammable liquid motor-fuel stations.

Ultimately the teams did an excellent job of reviewing the assigned plans in a collaborative manner with the exception of one team. Only minimal guidance was provided by the workshop facilitators. Reporting of results was thorough and well documented by all five teams.

The issue with the breakdown of one of the teams was identified with the fact that the workshop was conducted in partnership with an annual conference and as a result there were other activities some of the workshop participants wanted to attend. It is recommended that in the future the workshops be stand alone activities to avoid distractions.

Each team's final analysis and presentation began with the International Building Code followed by the International Fire Code, California/NFPA Fuel Gas Code and referenced standards. Explanations were provided on how they made their decisions, why they made the decisions they did, and what path took them to the next section of the code or to a referenced standard.

At the end of the workshop each participant was asked to complete an evaluation form. The evaluation asked the participants to rank their responses to four questions concerning expectations, increase in comfort level, increased understanding and whether or not they would recommend others to attend a similar workshop. In addition they were asked to share what they liked or disliked about the workshop and to provide recommendations for improvements. *(A full listing of the responses and comments provided by the participants is in Appendix H.)*

The rankings provided by the participants were overwhelmingly positive and all those that commented responded that they would recommend participation in similar workshops to their peers. Privately, many of the participants expressed an interest in being invited to future workshops of this type on other code topics.

## Summary

## 5. Summary

The workshop was a success both from the standpoint of providing code officials with an understanding of how to apply the various codes and standards 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 an 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 all accomplished in their field of endeavor. All are knowledgeable about codes and standards, some are active in the code development process and all are recognized as leaders in their areas of the state. Some are instructors of codes and standards related training programs and courses. Because of their backgrounds they were a

challenging audience; one that requires a high content level and a high level of accuracy. They have the ability to immediately pick up on flaws, incorrect information or if a presenter is not being entirely open with their information.

Because the participants had such a high level of knowledge and experience, their positive response to the workshop and the information provided documents the quality and value of the workshop for the purpose of educating code officials on the topic of hydrogen motor-fuel stations and the safe use of hydrogen in general.

At the end of the workshop representatives of NREL, NASFM, and Industry held a short meeting to discuss the results of the workshop and begin planning for the next workshop. It was agreed that participant suggestions concerning providing background on hydrogen, detailed plans, broadening of the types of code enforcement disciplines invited and adding the National Electric Code as a resource would be implemented.

With implementation of the changes suggested by the participants the workshop will be an effective education tool that should be expanded to include presentation at the regional level in each state, starting with those that either have hydrogen motor-fuel station construction activities or will have those activities in the near future.

## List of Participants

**Hydrogen Workshop - Buellton, CA  
Registration  
March 12-13, 2008**

Registered	Category	Name	Title	Organization	Email
X	Building Official	Dan Chudy	Building Official	City of Riverside	<a href="mailto:dchudy@riversideca.gov">dchudy@riversideca.gov</a>
x	Building Official	Henry Roe	Building Official	County of San Bernardino	<a href="mailto:bjohnston@lusc.sbcounty.gov">bjohnston@lusc.sbcounty.gov</a>
X	Building Official	Michael McGivney	Building Inspector	City of Fillmore - Building & Safety	
X	Building Official	Shane Walter	Director, Building and Safety	City of Palmdale	<a href="mailto:swalter@cityofpalmdale.org">swalter@cityofpalmdale.org</a>
X	Fire Service	Adria Paesani	Deputy Fire Marshal	Fountain Valley Fire Department	<a href="mailto:adria.paesani@fountainvalley.org">adria.paesani@fountainvalley.org</a>
X	Fire Service	Brian Weidman	Fire Inspector	Long Beach Fire Department	<a href="mailto:brian_weidman@longbeach.gov">brian_weidman@longbeach.gov</a>
X	Fire Service	Eric Binder	Senior Fire Inspector/ Fire Investigator	Santa Monica Fire Department	<a href="mailto:Eric.Binder@SMGOV.NET">Eric.Binder@SMGOV.NET</a>
X	Fire Service	Jeffrey Taylor	Fire Inspector	Anaheim Fire Department	<a href="mailto:jeffreywtaylor@anaheim.net">jeffreywtaylor@anaheim.net</a>
X	Fire Service	Ken Quick	Fire Prevention Specialist	Culver City Fire Department	<a href="mailto:Kenneth.quick@culvercity.org">Kenneth.quick@culvercity.org</a>
X	Fire Service	Richard Stillwagon	Fire Inspector	Los Angeles County Fire Department	<a href="mailto:rstillwagon@fire.lacounty.gov">rstillwagon@fire.lacounty.gov</a>
X	Fire Service	Rochelle Maurer	Fire Inspector	Torrance Fire Department	<a href="mailto:RMAURER@TORRNET.COM">RMAURER@TORRNET.COM</a>
X	Fire Service	Tim Dunn	Plumbing & Mechanical Inspector	Ventura City Fire Department	<a href="mailto:tdunn@cityofventura.net">tdunn@cityofventura.net</a>
X	Fire Service	Vince Tovey	Electrical Inspector	Ventura City Fire Department	<a href="mailto:vtovey@cityofventura.net">vtovey@cityofventura.net</a>
X	Fire Service	Mark Gomez		Turlock Fire Department	<a href="mailto:mgomez@turlock.ca.us">mgomez@turlock.ca.us</a>
X	Fire Service	Ron Keefer		Menlo Park Fire District	<a href="mailto:ronkeef@menlofire.org">ronkeef@menlofire.org</a>
X	Fire Service	Mark Latham	Battalion Chief/ Fire Marshal	Sacinas Fire Department	<a href="mailto:marklat@ci.sacinas.ca.us">marklat@ci.sacinas.ca.us</a>
X	Fire Service	Patti Cline		Madera County Fire	<a href="mailto:pcline@madera-county.com">pcline@madera-county.com</a>
X	Fire Service	Lee Caldwell		Huntington Beach Fire	<a href="mailto:lcaldwell@surfcity-HB.org">lcaldwell@surfcity-HB.org</a>
X	Fire Service	Al Miller		Tulane County Fire	<a href="mailto:armiller@co.tulane.ca.us">armiller@co.tulane.ca.us</a>
X	Fire Service	Paul Inouye		Milpitas Fire	<a href="mailto:pinouye@ci.milpitas.ca.gov">pinouye@ci.milpitas.ca.gov</a>
X	Fire Service	Jesse Martinez		Santa Barbara County Fire Department	<a href="mailto:jesse.martinez@sbcfire.com">jesse.martinez@sbcfire.com</a>
X	Fire Service	Chuck Weber		Lakeside Fire	<a href="mailto:cweber@lakesidefire.com">cweber@lakesidefire.com</a>
X	Fire Service	Neil Reitzell	Fire Inspector II	Los Angeles County Fire Department	<a href="mailto:neil.reitzell@lacity.org">neil.reitzell@lacity.org</a>
X	Government Participant	Jim Ohi	Consultant, Hydrogen Technologies and Systems	NREL	
X	Government Participant	Melanie Caton	Project Leader	NREL	
X	Government Participant	Russell Hewett	Sr. Systems Analyst II	NREL	<a href="mailto:russell_hewett@nrel.gov">russell_hewett@nrel.gov</a>
X	Government Presenter	Antonio Ruiz	Technology Development Manager	U.S. Department of Energy	<a href="mailto:antoni.ruiz@ee.doe.gov">antoni.ruiz@ee.doe.gov</a>
X	Industry	Conrad Cox	Project Manager II	Sprint Nextel Corp.	<a href="mailto:conrad.cox@sprint.com">conrad.cox@sprint.com</a>
X	Industry	Damian Quattlebaum	Technical Program Project Manager	Sprint Nextel	<a href="mailto:damian.quattlebaum@sprint.com">damian.quattlebaum@sprint.com</a>
X	Industry	Greg Evans	Staff Member	Sandia National Lab	<a href="mailto:evans@sandia.gov">evans@sandia.gov</a>
X	Industry	James Ker	Product Marketing Manager	IdaTech, LLC	<a href="mailto:jker@idatech.com">jker@idatech.com</a>

**Hydrogen Workshop - Buellton, CA**  
**Registration**  
**March 12-13, 2008**

Registered	Category	Name	Title	Organization	Email
X	Industry	Mark Cohen	Product Manager	ReliOn, Inc.	<a href="mailto:mcohen@reliion-inc.com">mcohen@reliion-inc.com</a>
X	Industry	Michael Miller	West Region Facilities Manager	Sprint Nextel	<a href="mailto:michael.miller@sprint.com">michael.miller@sprint.com</a>
X	Industry	Rob Schroeder	Network Engineer II	Sprint Nextel - Power Engineer & Standards	<a href="mailto:rob.c.schroeder@sprint.com">rob.c.schroeder@sprint.com</a>
X	Industry	Alexander (Alex) Keros	Western Region Hydrogen Infrastructure	General Motors	<a href="mailto:alexander.keros@gm.com">alexander.keros@gm.com</a>
X	Industry	Chris Krafft	Engineering Dept. Head	Black & Veatch	<a href="mailto:krafftca@bv.com">krafftca@bv.com</a>
X	Industry	Paul Buehler	Technical Product Manager	Plug Power	<a href="mailto:paul_buehler@plugpower.com">paul_buehler@plugpower.com</a>
X	Industry	Mike Maxwell	Director of Application Engineering	ReliOn, Inc.	<a href="mailto:mmaxwell@reliion-inc.com">mmaxwell@reliion-inc.com</a>
X	STAFF	Chrishawn Morgan-Price		NASFM	
X	STAFF/Presenter	James Narva		NASFM	
X	STAFF/Presenter	Robert Davidson	Fire & Life Safety Consultant	Davidson Code Concepts, LLC	<a href="mailto:RJD@davidsoncodeconcepts.com">RJD@davidsoncodeconcepts.com</a>
X	STAFF/Presenter	Sal DiCristina		DiCristina Group	

# **NREL Presentation**

# Permitting Hydrogen Fueling Stations and Hydrogen Fuel Cells for Backup Power at Wireless Telecommunication Facilities

Permitting Hydrogen Fueling Stations and Hydrogen Fuel Cells for Backup Power at Wireless Telecommunication Facilities

DOE/NASFM/CFPI Workshop  
Buellton, California  
March 12 - 13, 2008

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



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### DOE Hydrogen Safety, Codes and Standards 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
  - priority for FreedomCAR and Fuel Partnership and Hydrogen Technical Advisory Committee
  - need efficient, cost-effective permitting process based on collaboration among code officials, industry, and other key stakeholders

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### Background: HFS Permitting 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

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

# Permitting Hydrogen Fueling Stations and Hydrogen Fuel Cells for Backup Power at Wireless Telecommunication Facilities



## 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](http://www.hydrogenandfuelcellsafety.info))

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## Permitting H2 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 and NCSBCS (planned)
    - vet case studies, C&S permitting process, information tools
  - Workshops in key regions
    - locations where industry will focus H<sub>2</sub> infrastructure development and hydrogen vehicle and fuel cell deployment

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## DOE/NASFM/CFPI Workshop

- Objectives
  - Invite key fire and building code officials
    - present case studies
      - H<sub>2</sub> 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
  
- Acknowledgements
  - CFPI, NASFM, Shell, GM, Sprint, Plug Power, ReliOn, Idatech, Black and Veatch
  - Bob Davidson, Sal DiCristina, Ken Kraus, Jim Narva, Chrishawn Morgan-Price, Penni Overstreet-Murphy

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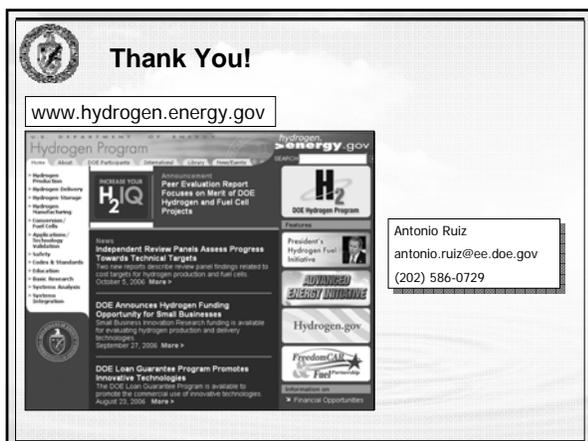
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# Permitting Hydrogen Fueling Stations and Hydrogen Fuel Cells for Backup Power at Wireless Telecommunication Facilities



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

**Telecommunications  
Presentation**

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**Applying Codes and Standards Systematically**

P.J. Buehler – Plug Power  
Mike Maxwell - ReliOn  
12 March 2008

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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>

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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

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**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

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**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!

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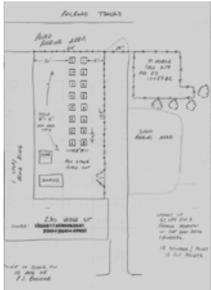
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**Designs Which Were Approved Quickly**



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



Permit issued "on-the-spot".

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### 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

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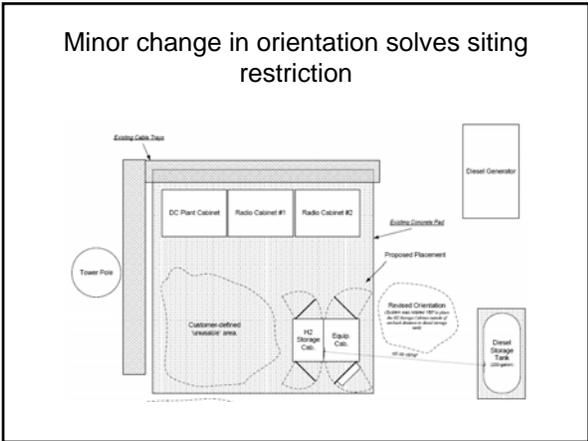
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### Don't Even Think About it Here! (Yes, this is a real proposed location)

The block contains two side-by-side photographs of a construction site. The left photo shows a dirt area with a utility pole, a car, and some equipment. The right photo shows a similar area with a utility pole, a car, and some equipment.

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Listed and approved fuel consuming appliances



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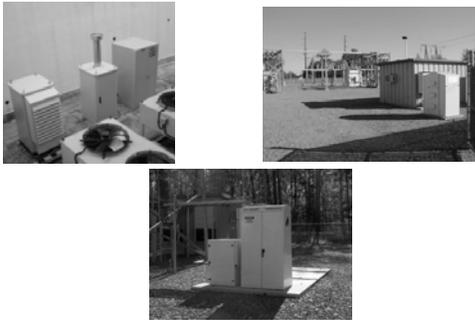
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A stationary hydrogen fuel cell is a listed and approved fuel consuming appliance



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Questions?

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**General Motors  
Presentation**

**Chevrolet Equinox Fuel Cell Electric Vehicle and Project Driveway**



**EQUINOX FUEL CELL**

Alex Keros  
Fuel Cell Activities- Western Region





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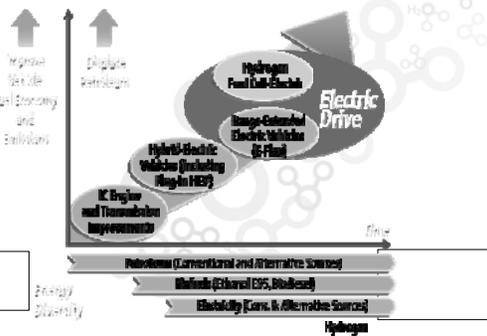
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**GM's Advanced Propulsion Technology Strategy**



Improve Mileage, Fuel Economy and Emissions

Deploy Globally

IC Engine and Transmission Improvements

Hybrid-Electric Vehicles (including Plug-in HEV)

Range-Extended Electric Vehicles (RE-VE)

Hydrogen Fuel Cell Electric Vehicle

Electric Drive

Petroleum (Conventional and Alternative Sources)

Ethanol (Ethanol EFS, BioEthanol)

Electricity (Coal, & Alternative Sources)

Hydrogen




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**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

GM Confidential 3

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**Project Driveway: Hydrogen Refueling Plan**

We currently face...

- **Limited network of 350bar, behind-the-fence applications**
  - Many locations include municipal and business lots
  - Many require call-ahead scheduling of fueling
  - Varying safety practices and differing Personal Protective Equipment requirements
- **Inconsistent access arrangements**
  - Access terms require significant negotiations
  - Usually do not provide access to all OEMs
  - Few locations publicly accessible 24/7
- **Time-consuming and unpredictable station approval and processes**
  - Varying methodologies for application of codes and standards to hydrogen infrastructure
  - Continuing need to educate local authorities on hydrogen and fuel cell vehicles

**Hydrogen Infrastructure continues to be challenging. Technical and commercial details must be addressed.**

GM Confidential 7

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**Project Driveway: Hydrogen Refueling Plan**

We currently need...

- **Retail-like refueling stations**
  - Geographically targeted regions where automakers want to put vehicles
  - 700bar fast-fill refueling
- **Access to key existing stations**
  - Access agreements w/ consistent principles or
  - Eliminate access agreements altogether
- **Expedient station approval and permitting process**
  - State-wide consistency and local adherence
  - Community support
- **Funding Support and Incentives**
  - Stations and upgrades
  - Liability coverage (funded liability pool, liability cap) or...
    - Full-service attendants to mitigate liability issues
  - Station operating costs/refueling costs

**Vehicles will be in customer's hands. Goal must be to promote a normal sense of driving / refueling.**

GM Confidential 8

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**Project Driveway: Hydrogen Refueling Plan**

Strategy

- **Underestimated infrastructure hurdles**
  - Current gap between existing and required fueling experience
  - Lead time required to execute infrastructure
  - Inability to keep pace with evolving vehicle programs
- **GM has purchased and plans to site temporary refuelers to supplement existing hydrogen refueling network in order to meet program needs**
  - Strategically selected locations in LA and NYC metro areas
  - GM owned and operated equipment
  - Permitting will be difficult and timing can be unpredictable
    - Working with Public Policy, local municipalities and Fire Marshalls
  - Goal is to provide more comfortable/convenient access
    - No PPE, safe surroundings, 24/7, simple training, etc.
- **Working with Shell Hydrogen and partners in LA and NYC areas to facilitate permitting, siting and operation of additional 700-bar sites**

GM Confidential 9

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**Davidson-DiCristina  
Breakout Session**

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**Team 1**

Dan Chudy  
Eric Binder  
Tim Dunn  
Ron Keefer  
Paul Inouye  
Mark Cohen  
Chris Kraft

**Team 2**

Henry Roe  
Rochelle Maurer  
Mark Latham  
Jesse Martinez  
Marnel Vanden Bossche  
Conrad Cox  
Rob Schroeder

**Team 3**

Michael McGivney  
Brian Weidman  
Richard Stillwagon  
Patti Cline  
Chuck Weber  
Damien Quattlebaum  
Mike Maxwell

**Team 4**

Shane Walter  
Adria Paesani  
Ken Quick  
Lee Caldwell  
Neil Reitzell  
James Ker

**Team 5**

Vince Tovey  
Mark Gomez  
Al Miller  
Jeffrey Taylor  
Greg Evans  
Michael Miller

# Hydrogen Background Material Presentation

# Permitting Hydrogen Fueling Stations

## What is Hydrogen/Team Breakout

March 11 – 12, 2008

Permitting Hydrogen Fueling Stations  
and the use of  
Stationary Hydrogen Fuel Cells as Back up Power for  
Telecommunications Antenna Sites Workshop

Santa Ynez Valley  
March 11 – 12, 2008  
Davidson Code Concepts, LLC  
&  
The DiCristina Group

NREL National Renewable Energy Laboratory  
1515 COLE BLVD.  
GOLDEN, CO 80401-2908  
(303) 271-3000

National Association of State Fire Marshals

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What is Hydrogen?

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Hydrogen is the lightest and most abundant element in the universe. It is present in water, nearly all organic compounds and in all living organisms. Hydrogen is able to react chemically with most other elements.

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Hydrogen is a flammable gas. It is the lightest gas known, having a specific gravity of 0.0695 (air = 1.0). Hydrogen diffuses rapidly in air and through porous materials.

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Hydrogen burns in air with a pale blue, almost invisible flame. At atmospheric pressure the ignition temperature of hydrogen air mixtures has been reported by the U.S. Bureau of Mines to be as low as 932°F (500°C).

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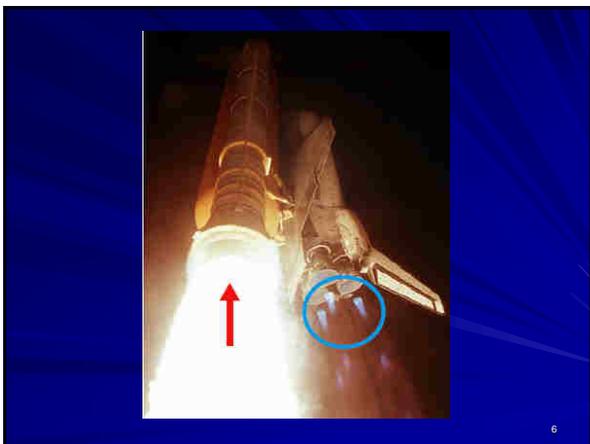
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- The flammable limits of hydrogen air mixtures depend on pressure, temperature, and water vapor content.
- At atmospheric pressure the flammable range is approximately 4 percent to 74 percent by volume of hydrogen in air.

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Hydrogen remains as a gas at high pressures. It is liquefied when it is cooled to its boiling point of -423°F ( -253°C).

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- Hydrogen is nontoxic, but can cause anoxia (asphyxiation) when it displaces the normal 21 percent oxygen in a confined area without adequate ventilation.
- Because hydrogen is colorless, odorless, and tasteless, its presence cannot be detected by the human senses.

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- Hydrogen fires are not normally extinguished until the supply of hydrogen has been shut off because of the danger of reignition or explosion.
- In the event of fire, large quantities of water have been sprayed on adjacent equipment to cool the equipment and prevent involvement in the fire.

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### History Lesson



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# Permitting Hydrogen Fueling Stations

## What is Hydrogen/Team Breakout

March 11 – 12, 2008



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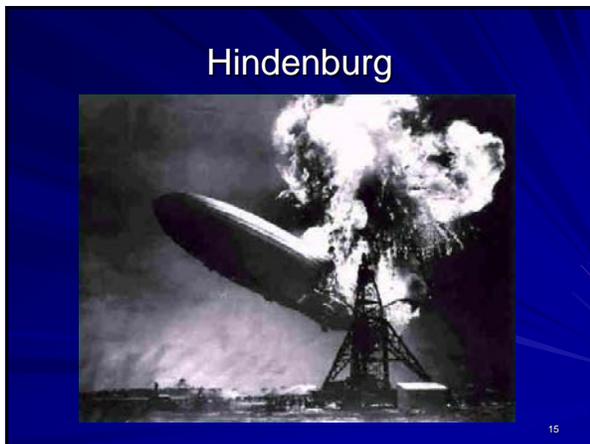
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### Hindenburg

The explosion of the luxury airship Hindenburg at Lakehurst, NJ, on May 6, 1937, serves as one of the most spectacular moments recorded by the media. Until very recently, it has aided in paralyzing the development of widespread hydrogen use as a fuel, due to concerns for safety (and viewing the fiery picture on prior slides, understandably so). But knowing the actual nature of the Hindenburg disaster, as well as knowing the behavior of hydrogen allows us to dispel this stigma associated with hydrogen.

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### The Facts

The bags of hydrogen that provided the lifting force for the Hindenburg were NOT the main contributor to the fire. The surface of the ship was coated with a combination of dark iron oxide and reflective aluminum paint. These components are extremely flammable and burn at a tremendously energetic rate once ignited. The skin of the airship was ignited by electrical discharge from the clouds while docking during an electrical storm. This reaction has been proven chemically for years, and was demonstrated with actual remnants of the Hindenburg sixty years later, which burned as vigorously as on the day of the disaster.

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The hydrogen burned quickly, safely, above the occupants. When the escaping hydrogen was ignited by the burning skin of the airship, it burned far above the airship, and was completely consumed within 60 seconds of the ignition. During this period of time, the airship descended to the ground from the 150 foot docking tower.

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Almost all deaths were caused by jumping or falling from the airship. Of the 35 deaths from the disaster, 33 were caused by jumping or falling. Only two deaths were caused by burning, and it is likely that those two were from proximity to the burning skin of the airship, or from the stores of diesel fuel that were ignited by the covering. Whereas the hydrogen burned within one minute of ignition, the diesel fires burned for up to ten hours after the ignition.

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Files examined at the Zeppelin Archive in Friedrichshafen, Germany, yielded final confirmation of Bain's theory. Several handwritten letters, when finally translated from German, corroborate what Bain uncovered. Wrote electrical engineer Otto Beyersdorff on 28 June 1937, "The actual cause of the fire was the extreme easy flammability of the covering material brought about by discharges of an electrostatic nature."

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The Hindenburg would have burned if it had been filled with inert helium gas. Even if the Hindenburg had not been lifted by hydrogen, the ignition of the covering would still have happened, and would then have set ablaze the diesel stores, resulting in the same disaster.

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**Lets get this out of the way!**  
**Hindenburg Disaster (Cont'd)**

- The covering was coated with cellulose nitrate or cellulose acetate -- both flammable materials. Furthermore, the cellulose material was impregnated with aluminum flakes to reflect sunlight. -- Dr. Addison Bain
- A similar fire took place when an airship with an acetate-aluminum skin burned in Georgia -- it was full of helium!
- "I guess the moral of the story is, don't paint your airship with rocket fuel." -- Dr. Addison Bain

Courtesy of Dr. Addison Bain and the National Hydrogen Association



Sandia National Laboratories

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### H<sub>2</sub> - LPG Comparison

Hydrogen - specific gravity of 0.0695  
LPG - vapor specific gravity of 1.5

Air = 1.0

Hydrogen - lighter than air  
LPG - heavier than air

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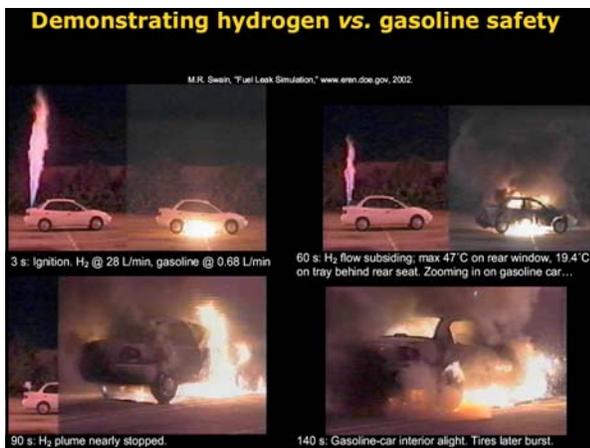
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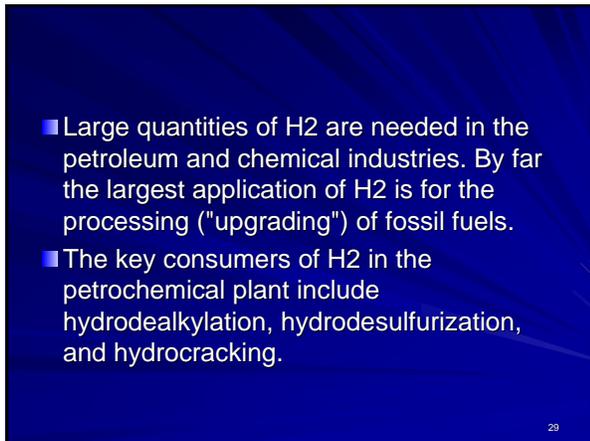
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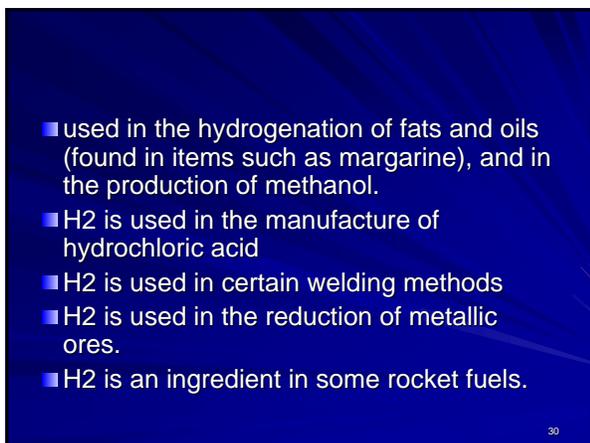
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- H<sub>2</sub> is used as the rotor coolant in electrical generators at power stations, because it has the highest thermal conductivity of any gas.
- Liquid H<sub>2</sub> is used in cryogenic research, including superconductivity studies.

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- Deuterium, an isotope of hydrogen (hydrogen 2), is used in nuclear fission applications as a moderator to slow neutrons, and in nuclear fusion reactions. Deuterium compounds have applications in chemistry and biology in studies of reaction isotope effects.
- Tritium (hydrogen 3), produced in nuclear reactors, is used in the production of hydrogen bombs, as an isotopic label in the biosciences, and as a radiation source in luminous paints.

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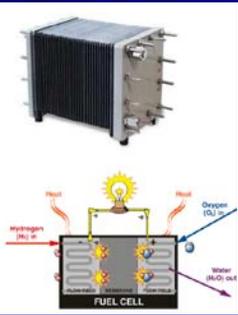
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### What is a Fuel Cell (FC)?

- A device that combines Hydrogen and Oxygen to produce electric power.
- Consists of an anode, a pair of catalysts, a electrolyte membrane and a cathode.



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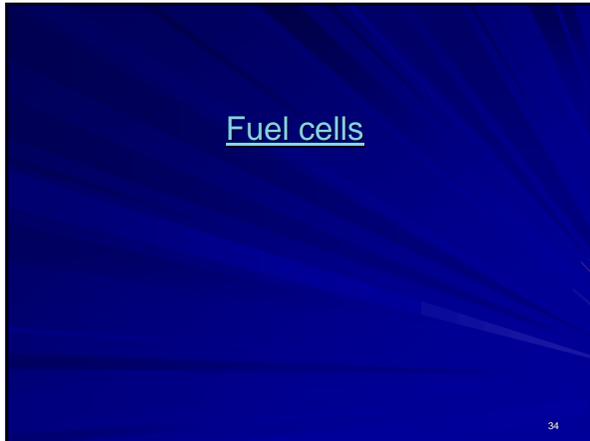
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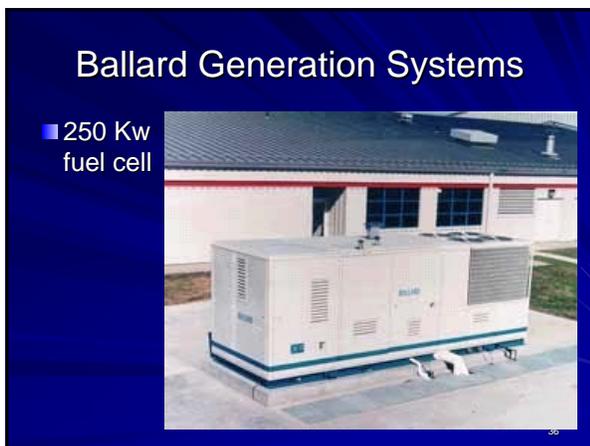
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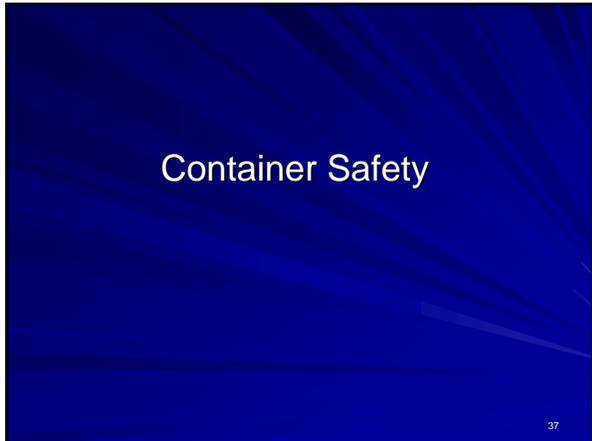
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### Compressed Gases are All Around Us

Applications	Service Pressures (psi)
Industrial gas	6,000
Fireman's breathing tank	4,500
Paintball propellant	4,500
Natural gas vehicle storage	3,600
Scuba tanks	3,300
Medical	3,000
Aircraft oxygen and emergency slides	3,000
Beverage	1,800
Nitrous Oxide (automotive)	1,200
Fire extinguishers	240

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**Plan Review**

5 Teams

2 - 3 scenarios each

Each group will be assigned a primary and a secondary plan to review

Resources provided...

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**Resources provided each team...**

- International Code Council | Codes
  - International Building Code
  - International Fire Code
  - International Fuel Gas Code
  - International Mechanical Code
- National Fire Protection Association
  - NFPA 54 ANSI Z223.1 2006 National Fuel Gas Code
  - NFPA 55 Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks 2006 edition
  - NFPA 853 2003 Standard for Stationary Hydrogen Fuel Cells
- Set of Plans
- Note Pad Easel, Review Report Forms, Evaluation Forms and Scales

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**Questions to address:**

- Which codes and standards do you apply and your review and why were they applied?
- What code standards were needed but not applied?
- What items on the plan were not found to be acceptable?
- What items or information, if any, was not provided on or with the plan and is needed to complete your review?

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### Completion

- When the plan review portion is completed everyone will return to this room and the team leaders will present their primary assignment reviews.
- The team assigned the same plan for the secondary review will be asked if they have anything to add.
- General discussion will then occur.

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### Teams

- Select a Team Leader  
The team leader will lead the discussion and will give an oral report of the results of the team review at the end of the workshop.

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### Breakout Session

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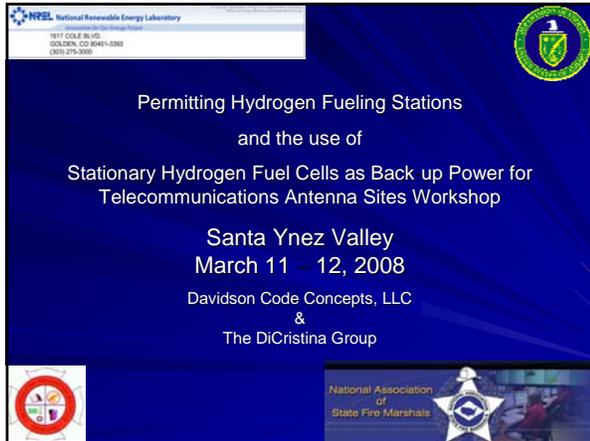
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**Breakout Session Reporting  
Presentation**



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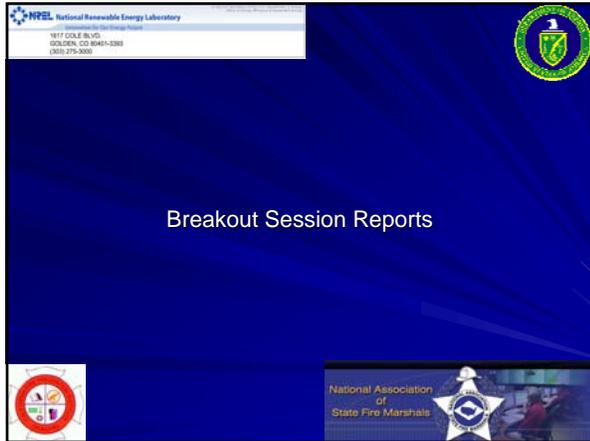
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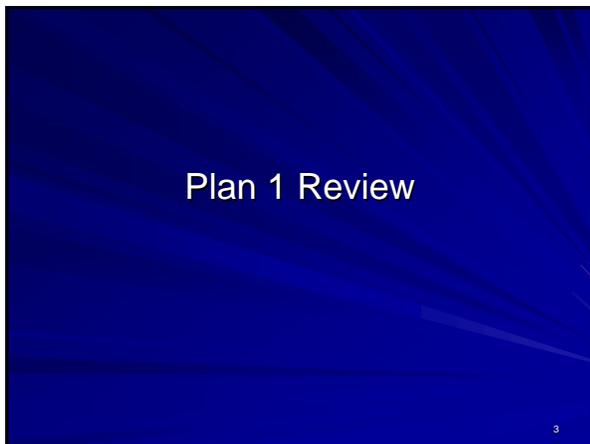
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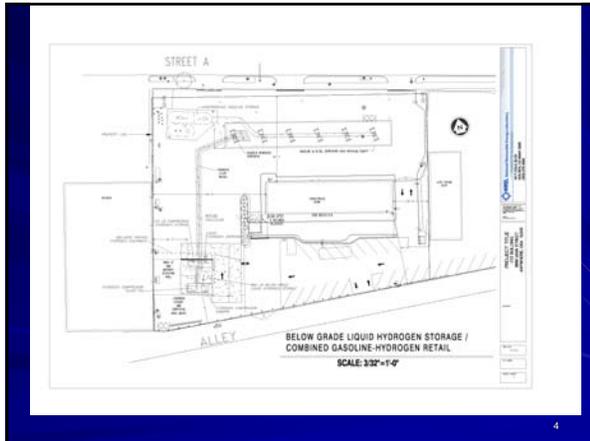
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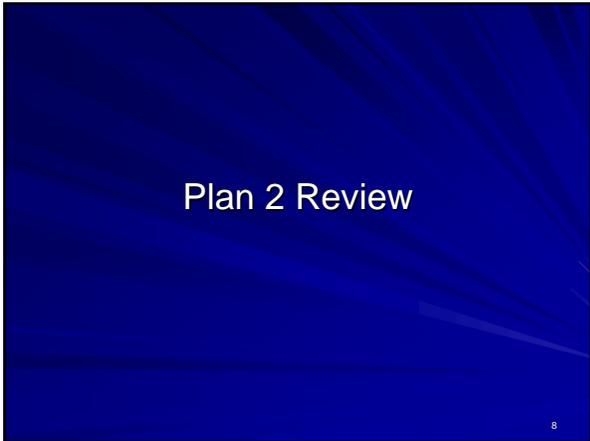
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Plan 2 Review

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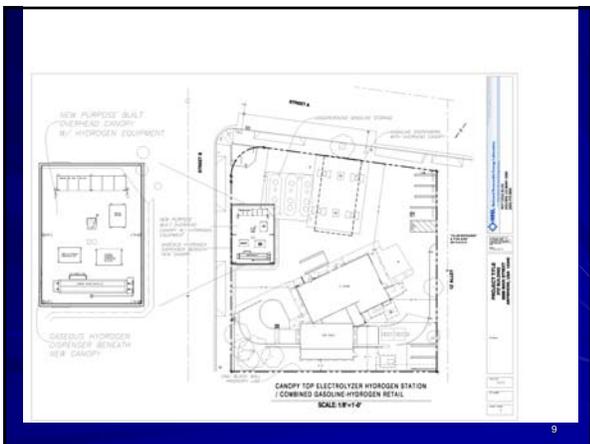
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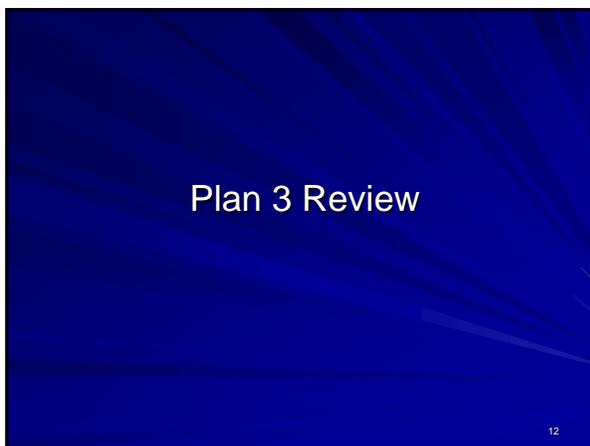
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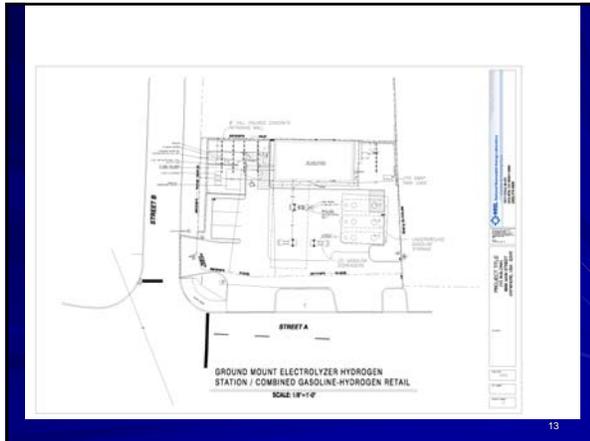
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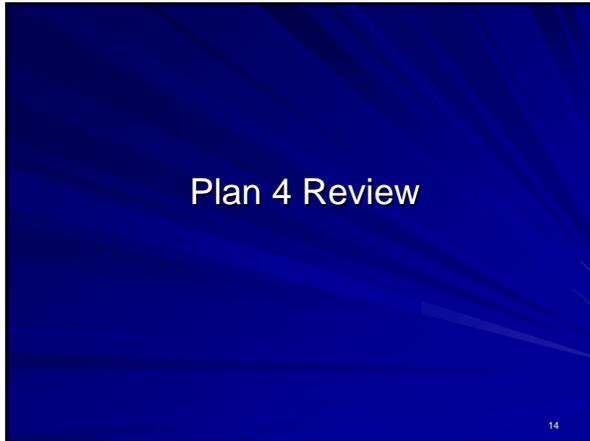
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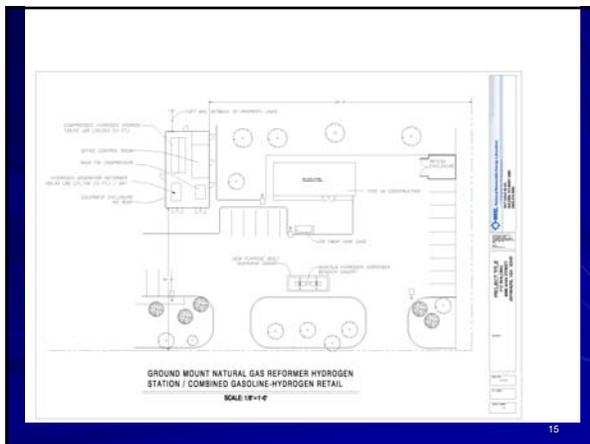
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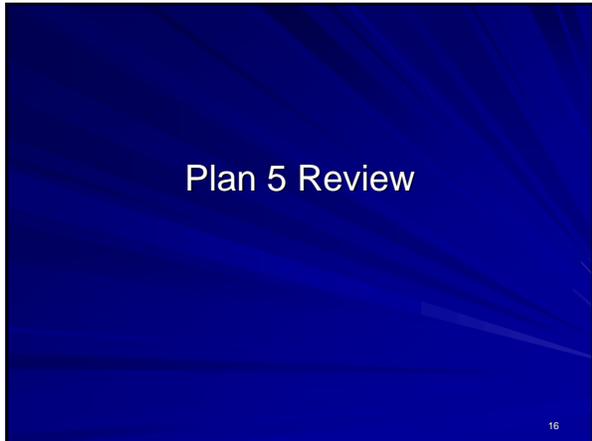
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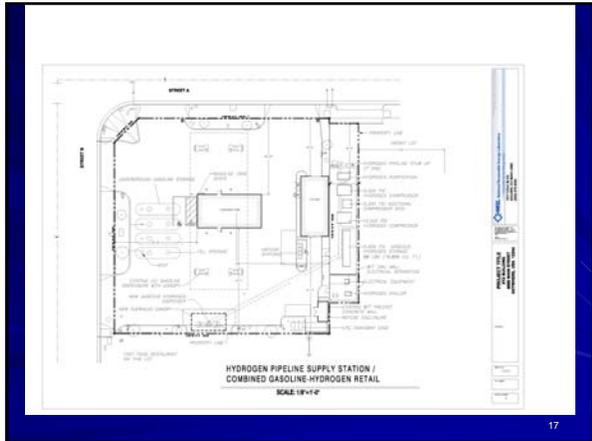
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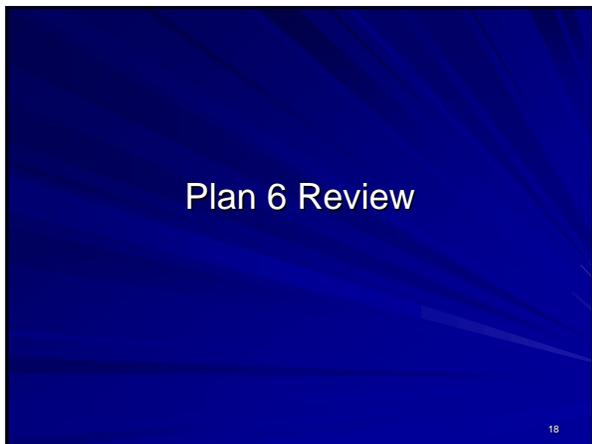
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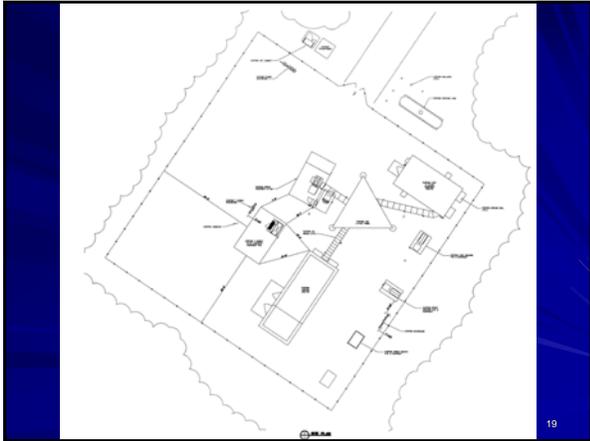
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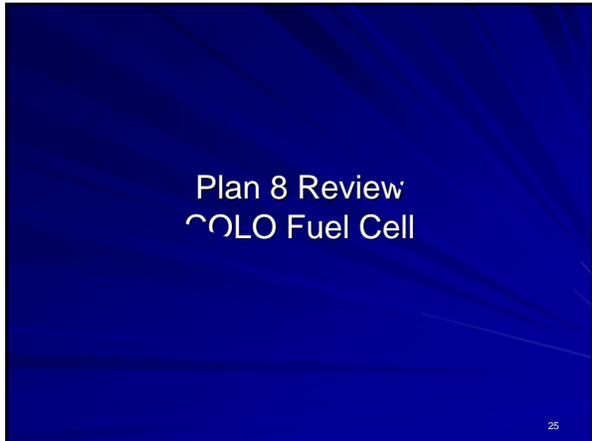
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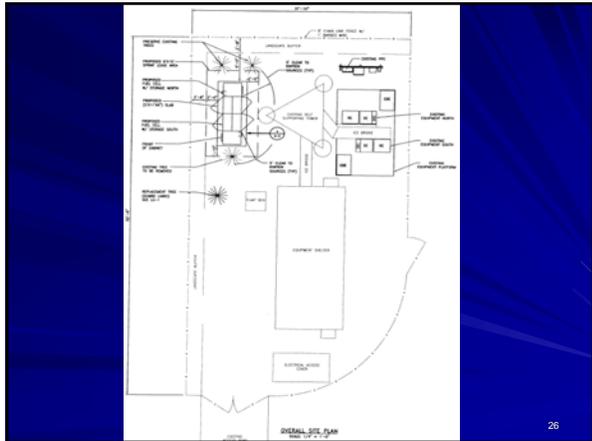
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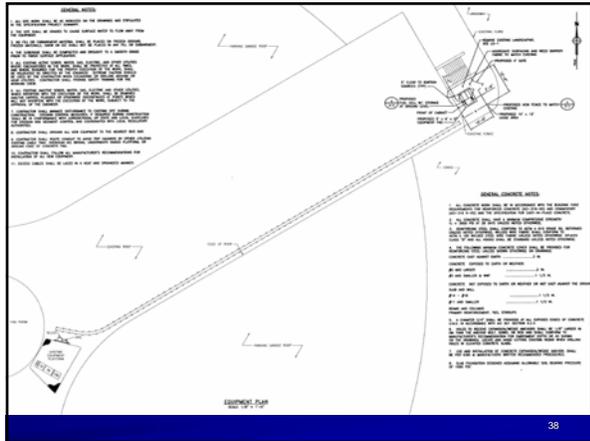
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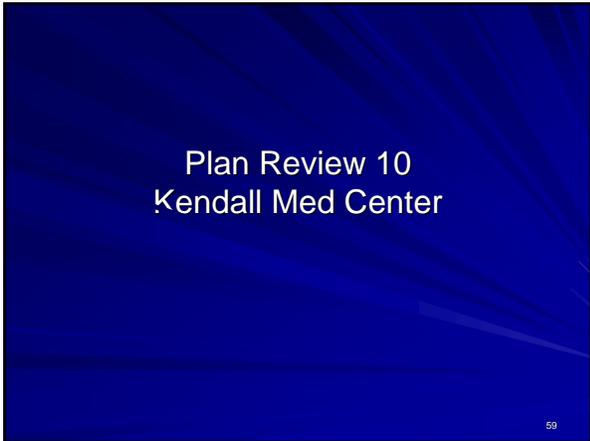
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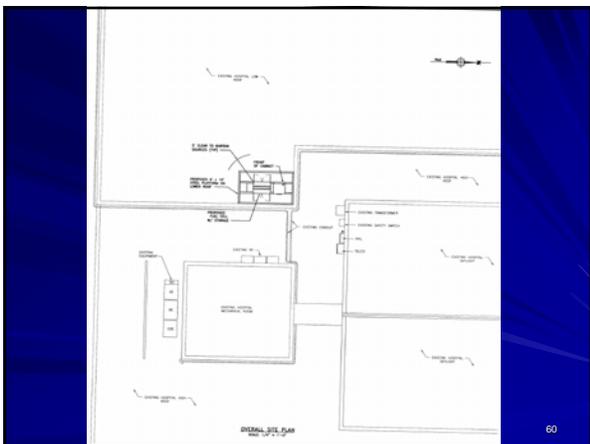
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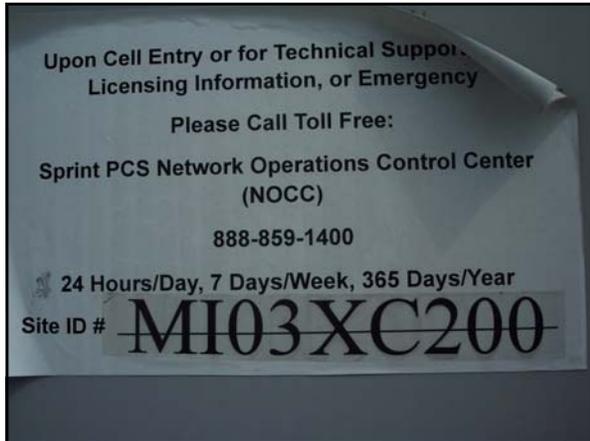
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# Review Report Form



**Permitting Hydrogen Fueling Stations  
and the use of  
Stationary Hydrogen Fuel Cells as Back-up Power for  
Telecommunications Antenna Sites Workshop**

**March 11 -12, 2008**

**Team Plan Review Reporting Form**

**Team #:** \_\_\_\_\_ **Plan #:** \_\_\_\_\_

**Which codes and standards did you apply during your review and why were they applied?**

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**What codes or standards were needed but not supplied?  
(Explain why they were needed.)**

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# Individual Evaluation Form



**Permitting Hydrogen Fueling Stations  
and the use of  
Stationary Hydrogen Fuel Cells as Back-up Power for  
Telecommunications Antenna Sites Workshop**

**March 12 – 13, 2008**

**Evaluation Form**

*Rating: 1 being the lowest, 5 being the highest*

**The workshop was what you expected?**

1  2  3  4  5

**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

**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

**Would you recommend that your peers attend a similar workshop?**

1  2  3  4  5

**What did you like about the workshop?**

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**What didn't you like about the workshop?**

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

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

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**If a similar workshop was offered in your state, would you be willing to assist as a facilitator?**

- Yes  No

**Optional**

**Name:** \_\_\_\_\_

**Phone #:** \_\_\_\_\_

## Evaluation Results



**Permitting Hydrogen Fueling Stations  
and the use of  
Stationary Hydrogen Fuel Cells as Back-up Power for  
Telecommunications Antenna Sites Workshop**

**March 12 & 13, 2008**

**Evaluation Results**

*Rating: 1 being the lowest, 5 being the highest*

**The workshop was what you expected?**

1	2	3	4	5
		8%	58%	33%

**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
			25%	75%

**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
			25%	75%

**Would you recommend that your peers attend a similar workshop?**

1	2	3	4	5
		8%		92%

## **What did you like about the workshop?**

- Interaction with other code officials.
- Integration of the plan review provided an understanding of the codes involved in a full plan check.
- The basic knowledge of hydrogen
- The variety of AHJ's and private industry participants.
- The hands on workgroup plan review was very effective.
- The code reference material and the group discussions.
- The great speakers and their patience.
- The varied case studies.
- Everything.
- The level of experience the speakers and the attendees had.

## **What didn't you like about the workshop?**

- The baseline knowledge of hydrogen was not at the beginning of the program.
- The process piping, electric line diagram and mechanical drawings were not included.
- It wasn't long enough.
- No copy of the National Electric Code.
- Need go-forward activities to resolve code and standard discrepancies.

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

- Additional time on time on the basics of hydrogen and the pros and cons.
- Provide copies of NFPA 70 and NFPA 52.
- Additional reference and background handouts for participants.
- Include more site examples.
- Images of the completed installations.
- Provide examples of equipment such as electrolyzers, reformers, hydrogen generator.
- Add hazmat and emergency response personnel to the mix.
- Provide full detailed and complete plan documents.
- Teach the code requirements instead of having participants apply the code.

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

- Building department, fire code official and telecommunications industry.
- Plan checkers.
- Engineering, environmental health and zoning officials.
- Industry personnel.
- Planners.
- Mechanical and electrical plan checkers.
- ICC Chapters.

**If a similar workshop was offered in your state, would you be willing to assist as a facilitator?**

Yes

Shane Walter  
Mark Coehn  
Adrian Paesani  
Brain Weidman  
Eric Binder  
Rochelle Maurer  
Chuck Weber  
Michael McGivney

# Hydrogen Storage Code Pathway Matrix



Stationary Hydrogen Fuel Cell/Motor Fuel Installation  
Outdoor Hydrogen Storage  
Rev.2  
2006 I-Codes Application Matrix

**Page 2  
Plan Review  
Continued**

**Proceed to electrical code**

