Implementation Topic Team Report

Codes & Standards, Insurance & Liability

California 2010 Hydrogen Highway Network

January 5, 2005

The Implementation Topic Team Report was a collaborative effort by many people, some of whom contributed focused sections or passages involving specialized areas of expertise. The participation of and contributions from individuals represent neither an endorsement of the Report and its findings or recommendations, nor a verification of a review of the Report, by the individuals or the organizations they represent.

Table of Contents

Executive Summary v
Implementation Team Organizational Structure ix
Acknowledgements xiii
Recommendations xv
Codes and Standards for the Hydrogen Highway xv
Insurance & Liability xxi
1. California Codes and Standards: The Process Today 1-1
1.1 National Model Building Codes and Fire Codes 1-1
1.2 California Codes and Standards 1-4
1.3 Local Codes and Standards within California 1-7
1.4 California Laws and Regulations Relating to Hydrogen Fueling Stations 1-8
1.5 Permitting Process for Hydrogen Fueling Stations 1-11
2. Individual Elements of Hydrogen Fueling Stations 2-1
2.1 On-Site Hydrogen Production & Linkage to Hydrogen Infrastructure 2-1
2.2 Pressure Vessels for Station Storage of Hydrogen 2-17
2.3 Vehicle Interface 2-27
2.4 Energy Stations (On-Site Power Generation) 2-33
2.5 Clearance Distances 2-33
2.6 Alternative Approval — Field Certification 2-34
3. Risk Assessment & Management 3-1
3.1 Insurance & Liability 3-1
3.2 Public Safety and Risk Assessment 3-3
4. Onroad Regulations for Hydrogen Vehicles 4-1
5. Conclusion 5-1
6. Glossary 6-1

Executive Summary

The California Hydrogen Highway Implementation Topic Team (Team) is one of five teams supporting the development of a Blueprint to deploy a hydrogen energy transportation infrastructure in the State of California by the year 2010. The Team has responsibility for determining public safety assurance recommendations in the siting of hydrogen fueling stations. This includes codes and standards related to fire, life, and safety; regulations; permitting; insurance; and liability.

The Team focused on elements of hydrogen use that are not effectively covered by current codes, standards or insurance practices. The primary target for discussion was hydrogen vehicle refueling stations available for public use. This included fuel delivery to the site, fuel storage, and fuel dispensing to vehicles. Hydrogen fueling stations could also include on-site hydrogen production or convert hydrogen for electrical power generation for on-site or grid-connected use. Off-site hydrogen production and its transport to fueling stations are already supported by existing codes and standards. Onboard vehicle standards and local land use regulations were not in the scope of work for this team.

The Team developed specific recommendations that pertain to:

- A State-wide uniform process for permitting and regulatory approvals of hydrogen stations based on consistent implementation of regulations, codes, and standards for fire, life, and safety;
- Education of legislators, municipal officials, permitting officials, the first-responder community, and the insurance industry on the safe use of hydrogen; and
- Policies to mitigate early-adopters' insurance risk.

In developing its recommendations, the Team sought to accommodate the needs of public and private stakeholders, permitting and regulatory officials, codes and standards development organizations, and industry.

The recommendations suggested apply to uniform standards, permits and procedures for fire code, life safety, and design and do not in any way impact the local land use permitting authority of the host jurisdiction.

The recommendations are presented in two main categories:

1. Recommendations for streamlining the process of implementing and enforcing codes & standards: Roles of Authorities Having Jurisdiction (AHJ); and
2. Recommendations for management of insurance, liability, and public safety.

Recommendations for Streamlining the Process of Implementing and Enforcing Codes & Standards: Roles of Authorities Having Jurisdiction (AHJ).

The primary recommendations in this area are designed to clearly identify relevant AHJs and their role in order to facilitate the permitting and installation of hydrogen fueling stations. Key recommendations include:

1. The State legislature should classify hydrogen as a transportation fuel similar to other hydrocarbon fuels.

2. The Governor or State legislature should designate the State Fire Marshal as the lead coordinating AHJ for the Hydrogen Highway.

3. The Governor should instruct the Building Standards Commission to initiate annual Code Cycle Review beginning mid-July 2005.

4. Local jurisdictions should appoint a lead coordinating AHJ for the Hydrogen Highway

5. Existing standards should be referenced while the State's codes and standards are being developed or revised.

6. The Governor or State legislature should assign the State Fire Marshal responsibility for developing and overseeing uniform application of three templates (Templates) for:

    1. AHJ responsibilities;
    2. Permitting/approval process; and
    3. Design and safety requirements for hydrogen refueling stations.

7. Provide the State Fire Marshal and designated lead local AHJs means to recoup the costs of their new responsibilities

While these are the key recommendations of the Implementation Team, numbers 2 and 6 should be considered the most essential in terms of having the greatest effect on developing a uniform body of hydrogen codes and standards and maximizing the efficiency of the permitting process.

Recommendations for Management of Insurance, Liability, and Public Safety:

1. AHJs should be responsible for including comprehensive risk management provisions in the recommended "Handbook for Hydrogen Fueling in the California Hydrogen Highway" (Template 3)

2. The State Fire Marshal and local AHJs should take advantage of training offered by the U.S. Department of Energy's (DOE) HAMMER (Hazardous Materials Management & Emergency Response) facility and the U.S. Department of Transportation's (US DOT) Transportation Safety Institute.

3. All entities planning to build hydrogen fueling stations should include specific elements related to risk assessment and risk management in their permitting submittals.

4. The State should create a system to record and investigate safety-related incidents and a database of experience available for insurance industry reference.

5. The State should mitigate the insurance uncertainty associated with lack of long-term experience by taking three actions:

    1. Create an insurance pool for partial coverage of deductibles;
    2. Temporarily limit liability for adverse events that occur even though requirements of permits and approvals (such as maintenance, training, and inspections) were followed;
    3. Set requirements for station installers/operators for self-insurance and liability limits.

Detailed discussions of these recommendations are articulated in the Recommendations Section. More specific recommendations for each sub-topic related to fueling stations and risk management can be found in the Sections.

Implementation Team Organizational Structure

Mission Statement: The mission of the California Hydrogen Highway Implementation team is to facilitate the timely, safe, and effective deployment of a hydrogen energy infrastructure for transportation and stationary power applications in California by 2010. This mission will be accomplished through support of the development and uniform implementation of regulations, codes, and standards. In addition, the effective education of legislative officials, permitting officials, the first responder community, and the insurance industry will be supported as a key element in meeting this mission goal.

The Implementation Team will serve as a body of experts that interacts with and seeks to accommodate the needs of public and private stakeholders, permitting officials, codes and standards development organizations, and industry. The Team will also analyze pertinent information and make recommendations to the California Hydrogen Highway Blueprint team to achieve the goal of infrastructure deployment by 2010.

Scope of Work: The scope covers, as applicable:

- The systems that produce gaseous hydrogen on-site and/or generate electricity, trailer and pipeline delivery; and

- The systems that store and dispense gaseous hydrogen, liquid hydrogen, and/or hydrogen blends from the point of supply at the fuelling station property to the filling connector installed onboard the land vehicle and/or an external or internal electrical grid. Other forms of hydrogen storage should be accommodated as those technologies approach commercial readiness.

Approach: The Team developed its recommendations in two categories:

1. Streamlining the process of implementing codes & standards: identification and roles of authorities having jurisdiction (AHJ)
2. Risk management, including insurance and liability

Structure: The Team was structured into sub-teams accordingly. The sub-teams and Topic Team members and their affiliations are listed below.

The Team's co-chairs were:

- **William Chernicoff**, Hydrogen Engineer, Research and Special Programs Administration, United States Department of Transportation
- **Christine Sloane**, Global Leader for Hydrogen & Fuel Cell Codes & Standards, General Motors Corporation
- **Andrei Tchouvelev**, Vice-President of Codes & Standards, Stuart Energy Systems

The Team Manager was **Rick Margolin**, *Assistant Director, Energy Independence Now Coalition*

Work Breakdown into Topic Subteams

CA Government Structure & Process	Fueling Station Elements	Risk Management
• Authorities and Model Codes	• Interface to Infrastructure: utilities and hydrogen • Pressure Vessels for Hydrogen Storage • Interface to Vehicle • Power generation • Clearance distances • Field Certification	• Insurance and Liability • Public Safety Response

Sub-team Leaders

- Authorities and Model Codes: **Patrick McCoy**, *Associate Mechanical Engineer/Energy Services Specialist, Division of the State Architect, Department of General Services*
- Interface to Infrastructure: **Lance DeLaura**, *National Codes & Standards and Emerging Technologies Manager, Sempra Utilities*, and **Mark Pedersen***, Regional Product Engineer, Air Products & Chemicals*
- Pressure Vessels: **Ron Eickelman** and **Neel Sirosh**, *Director of Advanced Technologies, Quantum Technologies*
- Interface to Vehicle: **Marshall Miller**, *Research Engineer, Institute of Transportation Studies, University of California-Davis* and **Jesse Schneider**, *Senior Mechanical Engineer, DaimlerChrysler/California Fuel Cell Partnership InterOperability Team Lead*
- Power Generation: **William Chernicoff**
- Clearance Distances: **Jay Keller**, *Hydrogen Program and Department Manager, Sandia National Laboratory* and **Chris Moen**, *Manager – Fluid and Thermal Science, Sandia National Laboratory*
- Field Certification: **Gary Howard**, *Director – Product Safety and Compliance, Stuart Energy*
- Insurance and Liability: **Gary Pope**, *Director of Marketing – Southwest Region, Hughes Associates*
- Public Safety Response: **Marshall Miller**

Implementation Topic Team Members

- **Gerhard Achtelik**, *Zero Emission Vehicle Programs – Regulations, California Air Resources Board*

- **Panama Bartholomy**, *Division of the State Architect, California Department of General Services*
- **H.I. Bud Beebe**, *Regulatory Affairs Coordinator, Advanced, Renewable & Distributed Generation Technologies, Sacramento Municipal Utility District*
- **Robert Boyd**, *Project Development Manager – Hydrogen Energy, Global Business Development, The BOC Group*
- **Herbert F. Burnett**, *President, Burnett & Burnette*
- **Joseph Cohen**, *Development Engineer, Air Products & Chemicals*
- **Donald Cook**, *Principal Safety Engineer, Pressure Vessel Unit, California Department of Occupational Safety & Health*
- **Gary Dixon**, *Special Technologies Project Manager, South Coast Air Quality Management District*
- **Gerry Eisenberg**, *Director, Pressure Technology Codes & Standards, ASME*
- **Anthony Estrada**, *Senior Program Manager, Clean Air Transportation Group, Pacific Gas & Electric Company*
- **Spencer Grieco**¸ *Vice President – Standards, CSA America*
- **Adam Gromis**, *Program Specialist, California Fuel Cell Partnership*
- **Jennifer Henderson**, *Program Manager, Alternative Energy Applications, CSA America*
- **Nettie Hoag**, *Deputy for Policy, California Department of Insurance Policy*
- **Gary Howard**, *Stuart Energy*
- **Harry Jones**, *Underwriters Laboratory*
- **Tom Joseph**, *Engineering Manager, Air Products & Chemicals*
- **John Koehr**, *Director, Codes & Standards Technology Institute, ASME International*
- **Carl Marbery**, *Senior Technical Staff, International Codes Council*
- **Janet McLean**, *Communications & Technology Industry Group – Western Canada, Marsh Associates*
- **Darren Meyers**, *Contracts Manager, International Codes Council*
- **Shane Michael**, *Civil Engineer, California Air Resources Board*
- **Neal Mulligan**, *Chief Operating Officer, Collier Technologies*
- **Dan Najera**, *Deputy State Fire Marshal, California Office of the State Fire Marshal*
- **Frank Niezbetowsky**, *Society of Automotive Engineers*
- **Dan Rabun**, *California Hydrogen Fuel Business Manager, Air Products & Chemicals*
- **Carl H. Rivkin**, *Senior Chemical Engineer, Hydrogen Coordinating Group, National Fire Protection Association (NFPA)*
- **Chris San Marchi**, *Sandia National Laboratory*
- **Brian Sisco**, *Technical Specialist – EV Infrastructure, Electric Transportation, Southern California Edison*
- **Brad Smith**, *Project Manager, Shell Hydrogen*
- **Ry Smith**, *Manager, Hydrogen Village Project, Fuel Cells Canada*
- **Jack Woycheese**, *Vice President – International Business Development, Hughes Associates, Inc.*

Acknowledgements

The Implementation Topic Team would like to acknowledge the assistance and input received from the following groups and individuals:

- Office of the State Fire Marshal
  - Rubin Grijalva, State Fire Marshal
  - Nancy Wolfe, Assistant State Fire Marshal
  - Leslie Haberek, Office of the State Fire Marshal
- Don Johnson, California Environmental Protection Agency
- Local Government Agencies and Associations
  - Carl Baust, Orange County Fire Authority
  - Dennis Berry, California County Planning Directors Association
  - Laura Blaul, CalChiefs and Orange County Fire Authority
  - Yvonne Hunter, League of California Cities
  - Kurt Latipow, City of Ukiah
  - Jennifer Lewis, League of California Cities
  - Danielle Stefani, Livermore-Pleasanton Fire Department
  - Don Williams, City of Fontana
- California Air Resources Board
  - Rose Castro, California Air Resources Board – Aftermarket Parts
  - Tom Chang, California Air Resources Board – Onroad Certification
  - Leslie Croll, California Air Resources Board – Fuels
  - Jae Do, California Air Resources Board – Aftermarket Parts
  - Duc Nguyen, California Air Resources Board – Onroad Certification
  - Gary Yee, California Air Resources Board
  - Andrew Yoon, California Air Resources Board – Onroad Certification
- CSA America
  - Julie Cairns, CSA America
  - Spencer Grieco, CSA America
  - Steve Kazubski, CSA America
  - Ken Loewenthal, CSA America
- A.Y. Ahmed, Air Products
- Naveen Berry, South Coast Air Quality Management District
- Andreas Fernandez, General Motors/Opel
- Alan Mace, IdaTech
- Russel Moy, Georgetown University
- Rajwinder Sadeh, Santa Clara Valley Transportation Agency
- Kent Whitfield, Underwriters Laboratories

Recommendations

The Team's recommendations are divided into two main categories. In the area of codes & standards, recommendations are presented to streamline the siting and permitting processes for fueling stations and to smooth the application of existing procedures and regulations to hydrogen use as a transportation fuel. With regard to insurance and liability, the recommendations identify policies to offset the initial insurance risk attributable to the absence of a track record of experience with hydrogen technologies in public domain.

Codes and Standards for the Hydrogen Highway

Codes and standards are currently under development for the safe commercial use of those elements of the Hydrogen Highway for which the underlying technology is sufficiently mature to serve as the basis for standardization. Most model codes and standards are expected to be completed in 2005-6 for hydrogen distribution to a fueling station involving over-the-road and pipeline delivery; for on-site production involving natural gas reformation and electrolysis; and for the storage and dispensing of gaseous and liquid hydrogen at fueling stations. However, significant research is still needed to develop the necessary legacy data to finalize these codes and standards. Federal expectations suggest data generation to complete by 2010, and finalized codes and standards by 2015.

Finalized standards are based, in large part, on lengthy experience with hydrogen's production, distribution, and use in industry. As new approaches and technologies for producing, distributing, and storing hydrogen are developed, standards for safe commercial use will need to be created by the standards development organizations. For example, new standards will be sought for underground storage of gaseous hydrogen, and for high pressure hydrogen storage vessels made from light-weight composite materials that would enable retrofit of existing fueling stations with storage above fueling island canopies.

These standards and model codes will then be available for adoption by regulatory agencies with additions and modifications as required to accommodate local circumstances (see Section 1). Training guidelines will then be required for the responsible authorities having jurisdiction (AHJ), as well as commercial sector parties responsible for the design, installation, and use of the facilities. (See Section 1 for details on California procedures for establishment of codes and regulations, AHJ roles and training.)

Codes and standards for the dispensing equipment (the "pump") used by the public at fueling stations will develop over the next several years as onboard "tank" technology continues to evolve. A key challenge for the Hydrogen Highway will be to enable the rapid incorporation of these advances into its system of codes, standards and regulations. Several storage media are under development, each with unique fueling

requirements. Consequently, in order to encourage timely deployment of technology advances in onboard storage, the Hydrogen Highway should provide for frequent adoption of new codes and established fueling practices. Permitting should proactively account for expected near-term technology advances. For example, a likely early transition will be from the initial installation of dispensing to vehicular 350-bar compressed hydrogen storage tanks to the dispensing of higher pressure hydrogen into 700-bar vehicular storage tanks.

The recommendations suggested in this report apply to uniform standards, permits and procedures for fire code, life safety, and design for hydrogen refueling applications. The Implementation Team does not offer recommendations which would impact local land use permitting authorities of host jurisdictions.

Recommendation: Legislature Should Classify Hydrogen as a Transportation Fuel Similar to Other Hydrocarbon Fuels

This action would facilitate a permitting/regulatory-approval process parallel to gasoline, diesel, and natural gas usage in transportation. Revisions to the Business & Professions Code (underlined text) should include:

1. Section 13401 Chapter 14: Petroleum and Hydrogen Fuels

2. Section 13401 (h) "*Engine fuel"* means any liquid or gaseous matter used for the generation of power in an internal combustion engine or fuel cell.

3. Section 13401 (i) "*Motor vehicle fuel"* means any product intended for consumption in an internal combustion engine or fuel cell.

4. Section 13401 (r) "*Hydrogen"* means a fuel composed of the chemical hydrogen intended for consumption in an internal combustion engine or fuel cell.

This would enable section 13650 (Service Stations) to accommodate hydrogen as a vehicle fuel and accommodate use of hydrogen in fuel cell vehicles.

Recommendation: Designate the State Fire Marshal as the Lead Coordinating AHJ for the Hydrogen Highway

The Governor or legislature should designate the State Fire Marshal (SFM) as the lead coordinating authority for AHJs relevant to the Hydrogen Highway. The State Fire Marshal should coordinate the selection of model codes for fire, life, and safety for hydrogen use in transportation; coordinate State AHJs to resolve conflicting requirements in those model codes and to accommodate California requirements; and coordinate the submission of the resultant model code package to the California Building Standards Commission for adoption into the California Code of Regulations, Title 24.

The SFM is encouraged to monitor plans that identify locations and jurisdictions where hydrogen fueling stations would be placed in order to organize educational sessions

with local AHJs. The SFM would provide AHJs with educational demonstrations of hydrogen handling equipment, including emergency response equipment, and vehicles operating on hydrogen.

Recommendation: Instruct the Building Standards Commission to Initiate Annual Code Cycle Review Beginning Mid-July, 2005

The Governor should instruct the Building Standards Commission to initiate an annual hydrogen code review cycle to begin mid-July, 2005. This will allow the State Fire Marshal, working in conjunction with the local fire marshals and AHJs, to develop and adopt the necessary codes, standards, and regulations rather than waiting for codes and standards to be adopted at the state level. This will also provide additional time needed to develop appropriate regulations, and provide the local AHJs an opportunity to develop the necessary amendment packages for adoption and submittal to the Building Standards Commission.

Recommendation: Local Jurisdictions Should Appoint a Lead Coordinating AHJ for the Hydrogen Highway

In order to facilitate consistency in application of local codes and standards, to provide "one-stop shopping" for permit applicants, and to enable applicants to understand local variations in regulations, governing bodies of local jurisdictions should appoint a lead local AHJ (presumably the local fire marshal). The appointment should be made by the city council or county board of supervisors. This local lead AHJ would be responsible for coordinating the fire and life safety permits of its peer local AHJs, and be expected to know which permits are required within the jurisdiction to develop a hydrogen station. Though this lead coordinating local AHJ would not coordinate issuance of land use permits, it should be prepared to assist the applicant in understanding (to the extent practicable) the local land use permitting process. An applicant would still be obligated to meet the regulations of all relevant local AHJs, and would still be required to apply for each department's permit; however, the applicant would receive and submit all of a jurisdiction's permits to the lead AHJ. This will create a single-point of contact between the applicant and the local AHJs. The lead local AHJ would also be responsible for ensuring timely action and for facilitating resolution of any jurisdictional disputes should they arise.

Recommendation: Reference Existing Standards

While anticipating the adoption of newly developed, revised, or modified model building and fire codes for hydrogen stations, it is recommended that AHJs, through the permitting process, utilize by reference and as allowable under current law, the existing International Code Council (ICC) and/or National Fire Protection Association (NFPA) hydrogen codes. The State Fire Marshal and relevant state agencies should develop, and make available, the necessary resources to affect this recommendation and ensure consistent use of appropriate codes and standards. One manner in which this might be facilitated would be for the Office of the State Fire Marshall to monitor pending changes in hydrogen-related codes and provide feedback, as appropriate, to the principal code and standard development organizations (e.g., ICC and NFPA).

Recommendation: Establish the Three Templates & Implement Statewide

Two categories of State action can speed the effective deployment of hydrogen codes and standards for fire, life, and safety: 1) training of AHJs and commercial sector deployers, and 2) statewide consistency of processes and requirements through AHJ-enforced templates. To accomplish this, three Templates should be established throughout the State:

1. Identification and Responsibilities of AHJs;
2. Requirements for Permits and Approvals;
3. Guideline for Design of a Hydrogen Fueling Station.

- **Template 1: Identification & Responsibilities of Authorities**
  - Streamlined definition of AHJs roles and responsibilities to be upheld consistently across the State
  - Education of identified AHJs
  - Appeal process used to achieve consistent implementation
  - Adoption of codes and standards linked to a national pattern
- **Template 2: Requirements for Permits and Approvals**
  - One-stop shopping: single local AHJ to coordinate issuance of permits
  - Handbook identifying all requirements
  - Education of AHJs and applicants on expectations in Handbook
- **Template 3: Guideline for Design of a Hydrogen Fueling Station**
  - Fueling station layout – equipment and separation requirements
  - Identification of information submittals required for permits
  - Guide to nationally recommended practices

First Template to be Implemented Statewide:
Identification & Responsibilities of Authorities Having Jurisdiction

Identification of the State Fire Marshal as the authority with fire and public safety responsibility to implement the Hydrogen Highway will be critical. This will ensure that the SFM is mandated the responsibility, not only for the adoption of appropriate State-level codes and standards, but for the requisite training of local AHJs with regard to those requirements. The criteria for identification of key AHJs at the State level should be replicated in local and regional jurisdictions so that lines of responsibility are consistent. The adoption of codes and standards should be consistent, wherever possible, with the emergence of national patterns for code adoption. In this way, learning experiences nationwide can inform the limited experience of California prior to 2010.

The training of local and State-level AHJs should include education in hydrogen safety and emergency response. Training modules should be prepared at the State level using State resources for training in local and regional jurisdictions. The State should

explore options to incentivize completion and maintenance of up-to-date hydrogen training and certification. For example, hydrogen training could be added to the curriculum of required hazardous materials training for AHJs and first responders. It will also be important to provide sufficiently frequent training opportunities to accommodate expected personnel turnover.

The SFM should coordinate the action of State AHJs in the establishment of training requirements for fire, emergency response, building requirements, and environmental requirements. Similarly, the local fire marshal, or equivalent official, should be designated with the responsibility for maintaining a coordinated permitting and approval process as well as for coordinating and training local AHJs. Additionally, the SFM should provide oversight of local jurisdictions to ensure proper interpretation and execution of State-approved requirements.

State-initiated education of AHJs with regard to hydrogen issues and requirements should be the primary method to ensure consistent implementation Statewide.

Finally, a clarified appeals process should be provided. If a developer or owner believes that the local AHJ is incorrectly applying a building or fire code or regulation, or is misinterpreting an existing code or regulation, or is referencing an inappropriate code or standard because the code or regulation does not yet exist for application in question, the developer may utilize local appeal processes. If local appeal processes fail to resolve the conflict, appealing to the SFM should ensure that the situation is resolved.

Second Template to be Implemented Statewide:
Requirements for Permits and Approvals

A Handbook for Implementation of the California Hydrogen Highway should be created under the supervision of the State Fire Marshal, working with other State-level AHJs, to identify all relevant codes, standards, and requirements, including local modifications. Standards and requirements would be collaboratively prepared with local AHJs such that, should a commercial party meet the requirements listed in the Handbook, that party would qualify for the required permits and approvals to install and operate the facility under consideration; that is, there would be no later-discovered surprises with unexpected requirements.

The Handbook should inform facilities installers of the comprehensive requirements for permits and approvals, and the procedures and expectations for obtaining them, including response time. The local fire marshal, or equivalent official, should be designated with responsibility to oversee a coordinated and timely process for reviewing information and issuing permits and approvals when requirements are met.

Third Template to be Implemented Statewide:
Guideline for Design of a Hydrogen Fueling Station

Computer-based templates are being created by several regional, state, and federal agencies such as the South Coast Air Quality Management District and the United

States Department of Energy (DOE). These templates are for use in developing fueling station footprints for equipment positioning, projected equipment requirements, referencing guidelines, codes and standards of national professional technical organizations, and regulatory requirements of individual States. The local- and State-level AHJs with responsibility for the California Hydrogen Highway are encouraged to examine these materials for completeness and accuracy and to ensure that they have informed the relevant template author of local requirements for inclusion in the template. This tool will serve as a valuable reference for AHJs in evaluating compliance of proposed facilities. The templates will also be a valuable design reference for commercial activity.

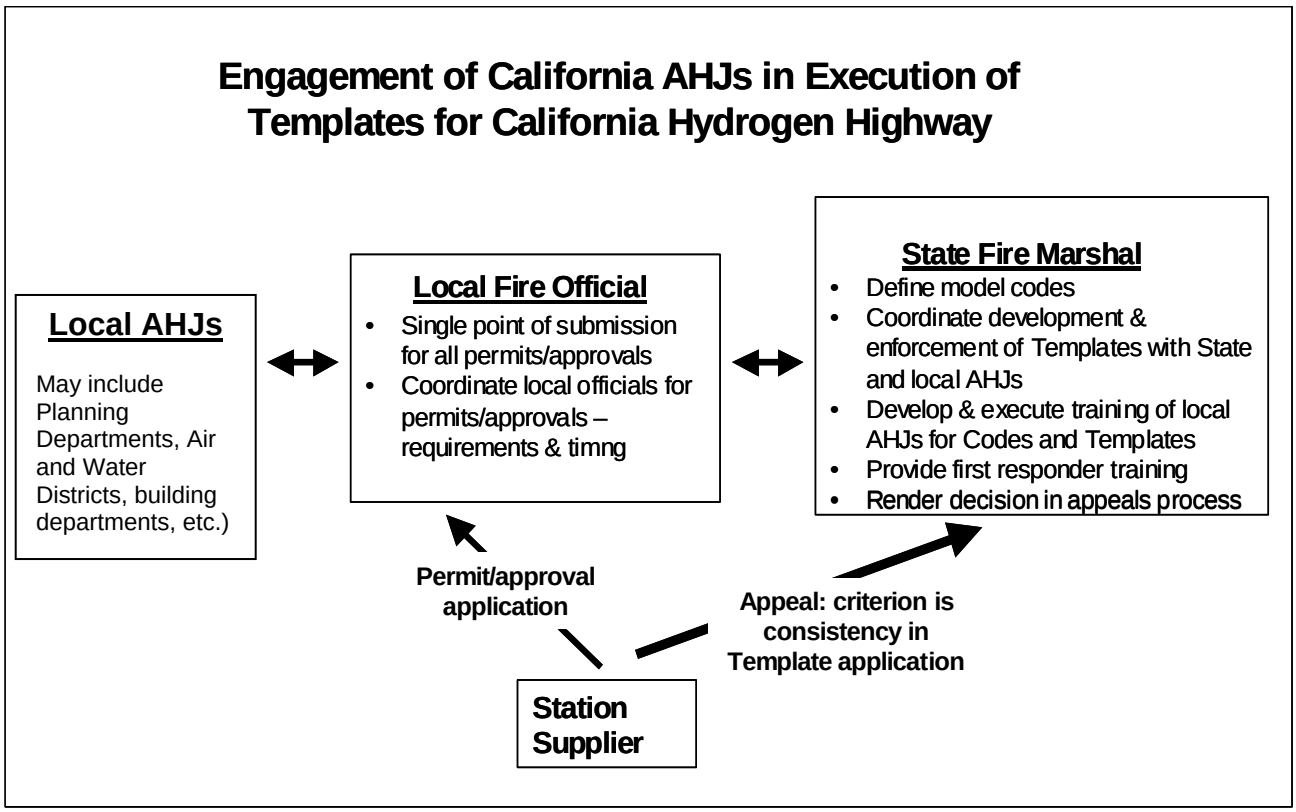
Recommendation: Provide the State Fire Marshal and lead local AHJs Means to Recoup the Costs of Their New Responsibilities

The legislature should appropriate funds to the Office of the State Fire Marshal and lead local AHJs so that they may have the resources needed to effectively execute the added responsibilities recommended herein. Local AHJs should be allowed to charge applicants a fee for submittal and review of documents. Fees should be commensurate with the cost the local lead AHJ will incur to coordinate and process permits for the installation of the hydrogen station.

The ideal result of these recommendations will be to facilitate identification of all relevant AHJs to each other and to permit applicants. The AHJs will be uniformly trained to efficiently apply State requirements. Also, the applicants will benefit from a well-coordinated approval process wherein the applicants will submit all materials identified in the Handbook for Implementation of the California Hydrogen Highway at one time and to one lead local AHJ.

The benefit will be the avoidance of time lost due to projects being reworked to accommodate requirements not recognized at the start (6-12 month experience in current process). Another benefit will be circumventing the cost of reworking project plans and designs ($50,000-$100,000 in individual projects to date). By having AHJs educated in the safe use of hydrogen, and both knowledgeable and confident in the approval process, the AHJs will be in a position to assist the public in understanding the fuel and its safe handling, and thereby, serve as public educators to mitigate undue public apprehension that results in delayed implementation.

An example of how these recommendations will achieve the mentioned benefits can be seen in the case of the Santa Clara Valley Transportation Authority's (VTA) efforts to install a hydrogen refueling station for the VTA's hydrogen bus fleet. VTA had been following the permitting procedures of Santa Clara County, who issued installation permits for the VTA facility. However, county officials did not feel they had the proper knowledge of hydrogen systems to perform annual safety inspections, and therefore deferred responsibility for annual inspections to the city of San Jose. By designating the State Fire Marshal with responsibility for training and education, AHJs will have sufficient knowledge to permit and inspect hydrogen facilities.



This figure illustrates the leadership responsibilities of the SFM in the coordination of State and local AHJs in defining State-level model codes and regulations for hydrogen use as a fuel, and in the development of the Templates. In some jurisdictions, another agency besides the local fire marshal may be the lead coordinating local AHJ. It is expected that local AHJs will be engaged as appropriate in the development of these Templates.

Insurance & Liability

Insurance is based on the assessment of risk, which includes the probability of an adverse event and the impact (i.e., injury, loss of life or property damage, and cost). Risk is managed primarily through reference to standards and codes for safe installation, maintenance and use of equipment and facilities. Some requirements reduce the likelihood of an adverse event, while others reduce the impact.

Recommendation: AHJs should be responsible for inclusion of comprehensive risk management provisions in the recommended Handbook for Hydrogen Fueling in the California Hydrogen Highway

Risk is managed by authorities who:

1. Review risk assessment and approve risk management plans for proposed facilities to ensure that a comprehensive approach has been implemented;

2. Inspect the construction of a facility;
3. Periodically inspect functioning facilities to verify required maintenance and compliance;
4. Investigate all adverse events to remedy its cause, disseminate lessons learned to other facilities, and maintain a database serving as a clearinghouse for the insurance industry;
5. Ensure that training of facility operators is current; and
6. Ensure that emergency responder training is comprehensive and current.

Recommendation: The SFM and Local AHJs Should Take Advantage of Training Offered at the US DOE's HAMMER Facility and the US DOT's Transportation Safety Institute

The SFM and local AHJs should take advantage of training offered at the US DOE's Hazardous Materials Management & Emergency Response (HAMMER) facility and that offered by the US DOT's Transportation Safety Institute. This training will aid development of emergency response guidelines and training modules for California AHJs and emergency responders. The OFSM should oversee the training of AHJs and emergency responders throughout the State to ensure a rapid and safe implementation of the Hydrogen Highway and to ensure consistent high quality practices are initiated throughout the State.

Recommendation: All entities planning to build hydrogen fueling stations should include specific elements related to risk assessment and risk management in their permitting submittals

Specific elements pertaining to risk assessment and management should be included in applications for permits of a hydrogen fueling station. These elements include:

- Site Quantitative Risk Assessment
- HazOp
- Emergency Response Plans
- Control Recovery Register
- Proof of Insurance
- First Responder Training Plans
- Operation Inspections

Recommendation: The State should create a system to record and investigate safety-related incidents and a database of experience available for insurance industry reference

A formal assessment of financial risk by the insurance industry (e.g., likelihood and cost of adverse events) is traditionally established based on historical records of frequency and cost impact of an adverse event. The insurance industry then establishes premiums to cover its financial risk. For a new type of activity, insurance may be difficult or expensive to purchase. Insurers generally charge high fees, limit coverage and/or require high deductibles for covering extraordinary situations where historical

experience is thin. These circumstances may present a prohibitive barrier to the installation of fueling stations for smaller size companies. The state should facilitate the collection of the necessary body of statistics and analysis underwriters need to offer rates commensurate with the true risk factors associated with the use of hydrogen in transportation applications.

This recommendation will help provide the insurance industry the necessary body of statistics and analysis needed to provide insurance rates on par with the true risk factors associated with the use of hydrogen in transportation applications.

There are two approaches to insuring a facility in the early years when robust experience statistics are still lacking. First, the facility installer could self-insure. In such cases, it is recommended that the AHJ affirm that the installer/operator has implemented a comprehensive risk management plan and has the financial resources to cover liabilities. A second approach would be for the State to mitigate the insurance uncertainty associated with the lack of long-term experience. This is justified since installation/operation of hydrogen fueling stations is considered to be in the public interest.

Recommendation: State Mitigate the Insurance Uncertainty Associated With Lack of Long-term Experience By Taking Three Actions:

1. Create an insurance pool for partial coverage of deductibles;
2. Temporarily limit liability for adverse events that occur where requirements of permits and approvals (such as maintenance, training and inspections) were followed; and
3. Set requirements for self-insurance and liability limits for station installers and/or operators.

Additional specific detailed recommendations for each sub-topic related to a fueling station and risk management are presented in the following Sections.

1. California Codes and Standards: The Process Today

1.1 National Model Building Codes and Fire Codes

National Codes and Standards

Model building and fire codes are largely dependent on the standards development process. Standards Development Organizations (SDOs) are organizations that represent technical and engineering disciplines. These disciplines encompass most facets of modern manufacturing, design, installation, construction, operation, and maintenance, and are applied in projects from residential home construction to automobile manufacturing to the operation of large central power generating facilities.

The following is a list of some of the prominent SDOs and CDOs that have relevance for the Hydrogen Highway:

- API American Petroleum Institute
- ASME American Society of Mechanical Engineers
- ASTM American Society of Testing and Materials
- CGA Compressed Gas Association
- CSA CSA America
- ICC International Codes Council
- ISO International Standards Organization
- IEC International Electrotechnical Commission
- IEEE Institute of Electrical and Electronic Engineers
- NFPA National Fire Protection Association (Note: NFPA develops both standards and model codes)
- NIST National Institute of Standards and Testing
- SAE Society of Automotive Engineers
- UL Underwriters Laboratory

This list is by no means exhaustive, but merely represents a sample group of SDO/CDOs. Some are accredited by the American National Standards Institute (ANSI) and create national standards for their respective industries and markets. This particular list represents the key SDOs that are involved in the establishment of appropriate standards for hydrogen energy stations, including hydrogen refueling.

Standards can be generally defined as a set of criteria and/or requirements by which an object or process is measured and/or described. For example, the nozzle that dispenses gasoline to an automobile conforms to a standard that is universally applied to gasoline refueling stations to ensure interoperability among different vehicles.

The SDOs are professional organizations that typically represent a particular industry (e.g., Society of Automotive Engineers) or a particular technical and/or engineering discipline (e.g., American Society of Mechanical Engineers). SDOs review and update

standards on a regular basis. Standards are published for reference and potential adoption into regulations. The request for action can be initiated by an entity that has need of a new or revised standard. The typical process for updating or establishing new standards is as follows:

1. Initiate standards action through request submittal.
2. Perform necessary and appropriate technical work through research and analysis.
3. Draft updated standard (or new standard) based upon outcome of technical work.
4. Distribute to appropriate committees and working groups for review and comment.
5. Achieve consensus and obtain required approvals to move forward.
6. Conduct public review process for additional review and comment.
7. Achieve consensus and obtain approval from supervisory board.
8. Obtain ANSI approval of finalized standard.
9. Publish for adoption into model codes and regulations as appropriate and applicable.

Code Development Organizations (CDOs) are voluntary professional organizations that develop, publish, and own the copyrights to the model codes under their purview. These model codes are typically categorized into the following areas (including but not limited to):

- Building Codes
- Mechanical Codes
- Plumbing Codes
- Electrical Codes
- Fire Codes
- Fuel Gas Codes

These codes establish the minimum standards by which buildings and structures are designed, built and constructed. Codes are revised periodically to reflect new practices and requirements and to revise the standards that are referenced to be the latest technical standards.

Two prominent CDOs that are active in the development of model codes in the United States are the National Fire Protection Association (NFPA) and the International Code Council (ICC). The ICC has copyright ownership to the International Building Code (IBC), the International Fire Code (IFC), International Mechanical Code, International Fuel Gas Code and International Electrical Code, to name a few. The NFPA has copyright ownership to a Fire Code (NFPA 1/Uniform Fire Code), the National Electric Code, and a Building Code (represented as NFPA 5000), to name a few.

The typical process for updating or establishing new codes is as follows:

1. Initiate code action through request submittal.
2. Publication, review, and public discussion by the appropriate technical committee.
3. Public hearings and voting by the technical committees to either move the code change forward, modify, or reject.
4. Publication, review, and public discussion by the larger assembly or entire association.

5. Public hearings and voting by the larger assembly or entire association to either recommend code change for approval, modify, or reject.
6. Authorizing body (e.g. Standards Council for NFPA, Governmental Member Representatives for ICC) finalizes and publishes new codes for adoption by public and governmental AHJs.

The NFPA incorporates a process for amending and creating documents that very closely mirrors the process for amending and creating state and federal regulations. State and federal agencies use a process that typically has two basic steps: an NPRM (Notice of Proposed Rule Making), a period where comments are reviewed, and FR (Final Rule). NFPA uses the ROP (Report on Proposals) where public proposals have been solicited and reviewed by the technical committee responsible for the document being revised or created, a public comment period on proposals, and ROC (Report on Comments) where public comments are reviewed. All ROP and ROC material is published on the NFPA web site for public access and anyone can submit proposals and comments. NFPA technical committee meetings may be attended by the public. For the NFPA process, the primary facilitator is the Technical Committee, with additional oversight by the Technical Correlating Committee. Final action is taken by the Standards Council who ultimately issues the codes and standards,

NFPA publishes codes, standards, and recommended practices that cover both broad subject matter areas and fairly specific areas. All NFPA documents are ANSI approved. An example of a code that covers a broad subject matter is the National Electric Code, and a standard that covers a broad subject matter is the NFPA 13 Sprinkler Standard. An example of a code that has a relatively narrow focus is the NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages and a standard that has relatively narrow focus is NFPA 50A Standard for Gaseous Hydrogen Storage Systems at Consumer Sites.

In comparison, the ICC process relies predominantly on public hearings – two per 18-month cycle. Established Code Committees facilitate the process based on submitted code changes and public hearings. As with the NFPA process, anyone can submit a code change proposal or comments. The appropriate Code Committee votes on the proposed code change during the publicly held Code Development Hearing. The outcome of this vote can be challenged by ICC Assembly Action of all voting members or a challenge issued following publication of the positions taken by the Code Committee. A second public hearing is held until the Final Action Hearing, where the ICC Governmental Members vote on the final determination of the proposed code provisions. Typically the governmental members are building and fire code officials representing jurisdictions with enforcement authority.

Revision cycles for codes and standards are dependent on each SDO’s revision policy and protocol.

There is a connection between codes and standards, since codes reference standards from a foundational perspective (as well as referencing other codes). However, this does not mean that the revision schedules between the SDOs and CDOs are linked, and cycle conflicts can cause delays in updating and revising codes and standards.

The revision cycle for two prominent CDOs is as follows:

Revision Cycle		
	NFPA	**ICC**
Number of Codes	320 Codes and Standards	14 Codes
Comments	255 committees process the codes and standards.	References Standards within its codes.
Revision Cycle	2 year running process, continuously running, staggered by 6 months. Revision cycles vary between 3 to 5 years.	18-month process. New edition printed every 3 years, supplemental printed every 18 months.
Comments	Approximately 30 documents are considered at each spring and fall meeting.	All codes are on the same revision cycle and are discussed and voted on at the same location.

Federal Agencies and Departments are generally required to consider SDO technical standards where applicable in formulating regulations.

1.2 California Codes and Standards

California law is established in 29 Codes. The Website for viewing the codes is www.leginfo.ca.gov/calaw.html . The authority for the promulgation, adoption, and enforcement of California Building Standards resides in California State Law, as articulated in the California Building Standards Law. Only legislation can affect changes in code. Agencies having responsibility to develop and enforce requirements and regulations to interpret and implement the Codes are identified in the Codes.

The regulations that are adopted by the agencies identified in the State-legislated Codes are the means of implementing these Codes. The agencies created the regulations that are assembled in the California Code of Regulations, which has 28 Titles. The most pertinent titles of the CCR that relate to the installation and operation of a hydrogen refueling station would be:

- Title 4, Divisions 8 and 9, dealing with Weights and Measures;
- Title 8, Division 1, dealing with the Division of Occupational Safety and Health;
- Title 13, Division 3, dealing with the California Air Resources Board; and,
- Title 24, California Building Standards.

Title 24 includes provisions for building and fire codes that serve as minimal requirements throughout the State of California and have applicability to the Hydrogen Highway. In particular, Title 24 has twelve parts. Parts most relevant to the Hydrogen Highway are:

- Part 2, California Building Code, is based on the adoption of the 1997 edition of the Uniform Building Code.
- Part 3, California Electrical Code, is based on the adoption of the 1999 edition of the National Electrical Code (some articles of the 1999 edition have been superseded by the 2002 edition of the National Electrical Code – awaiting publishing and effective dates).
- Part 4, California Mechanical Code, is based on adoption of the 2000 edition of the Uniform Mechanical Code.
- Part 5, California Plumbing Code, is based on the adoption of the 2000 edition of the Uniform Plumbing Code.
- Part 9, California Fire Code, is based on the adoption of the 2000 edition of the Uniform Fire Code.

It should be noted here that the regulatory enforcement of the California Building Standards (and other applicable regulations) at the local level (city, county or fire district) is governed primarily by Health and Safety Code Sections 17958 and 18941.5.

State agencies develop mandatory codes and regulations, in general using a three step process: 1) issuance of Notice of Proposed Rule Making (NPRM), 2) a period where public comments are received reviewed, and 3) Final Rule (FR) making. These codes and regulations typically incorporate SDO/CDO model codes and standards. Therefore, California regulatory agencies and departments have reason to participate in the activities of the key SDOs and CDOs in developing technical standards for the various business sectors and areas of public safety as pertinent to their authority and jurisdiction for the California Hydrogen Highway.

The California Building Standards Commission (CBSC) is charged with reviewing and approving building standards proposed for adoption by relevant state regulatory agencies. The Office of Administrative Law (OAL) is the final approving authority prior to filing the CBSC approved regulation or standard with the Secretary of State. Regulations adopted by the CBSC and relating to applications under the Health and Safety Code are included in the California Code of Regulations, and are often set forth in the California Business and Professions Code. The CBSC is comprised of two bodies: the Coordinating Council and the Code Advisory Committees.

The Coordinating Council (state AHJs) submits recommendations for building and fire codes and regulations. The Coordinating Council is comprised of representatives appointed by the directors of the following state agencies: Health Services, Office of Statewide Health Planning and Development (OSHPD), Housing and Community Development (HCD), Industrial Relations, State Fire Marshal (SFM), California Energy Commission, and General Services.

Through a rulemaking process (which typically occurs on an as-needed basis) the Coordinating Council reviews and checks regulations being proposed by any of the individual proposing agencies. Coordination is required to ensure that regulations do not conflict with one another, with statute or mandates of enforcement agencies.

The Code Advisory Committees advise the CBSC on proposed building standards by annually reviewing the technical merit of building standards as proposed by regulatory state agencies, and submit recommendations to the CBSC. There are five Code Advisory Committees: the Accessibility Committee; the Plumbing, Electrical, Mechanical, and Energy Committee; the Building, Fire and Other Committee; Structural Design/Lateral Forces Committee; and the Health Facilities Committee. The CBSC appoints members to these committees and represent the public, building design professionals, the building and construction industry, local building officials, fire officials, and other affected parties.

Some of the state agencies that provide input into the Coordinating Council include:

- CalOSHA California Occupational Safety and Health Agency
- Weights & Measures Unit within the Department of Food and Ag
- CalEPA California Environmental Protection Agency
- DOSH Department of Occupational Safety and Health
- CPUC California Public Utilities Commission
- ARB California Air Resources Board
- CEC California Electrical Commission

From an industry perspective, the adoption and promulgation of new codes and/or regulations can be conducted in one of two ways: through the passage of enabling legislation, or by petitioning the state agency responsible for the respective codes and regulations.

The State codes can be amended for application in local jurisdictions, which can add more, but not less, restrictive provisions according to specific criteria (geological, topographical or meteorological). Modifications can be challenged by appeal to the responsible State AHJ. Enforcement responsibilities are generally delegated to local government authorities who have cognizance of local additions to the State requirements.

CCR Title 24, Part 1, provides for any member of the public to submit an appeal to the CBSC due to being adversely affected by any regulation, rule, omission, interpretation, decision, or practice by a state regulatory agency or local agency having jurisdiction, pursuant to Health and Safety Code Section 18945. Appeals must be submitted within six months of when the adverse act occurred (adverse act being as listed above). The appellant must have previously exhausted the appeals process (see petition process above) of the state regulatory agency or local agency having jurisdiction. In cases of the offending party being identified as a local agency, the CBSC currently may not administer the resolution of the appeal if the local agency does not agree to have the CBSC resolve the matter and the matter does not have statewide implications.

It is a recommendation of this California Hydrogen Highway team to modify this situation so that the Office of the State Fire Marshal is the final decision point on appeals relative to execution of the Hydrogen Highway Templates, and those rulings prevail with local AHJs. This situation already exists in the case of State-owned or occupied buildings

where the State Fire Marshal's judgment currently prevails (Health and Safety Code, Section 13108 (d)).

The California Code of Regulations currently contains the Uniform Building Code (1997 edition) and the Uniform Fire Code (2000 edition), both of which are in the process of being revised. The revision process has not been concluded in part because of changes in key personnel at the California Building Standards Commission and other key State agencies during the revision process. When the revised national codes are completed and identified to be the basis of the California codes, then it will be critically important to examine those elements pertaining to the California Hydrogen Highway and draft amendments, as needed, to resolve any discrepancies between those national codes and to include adjustments that may be required for application in California.

1.3 Local Codes and Standards within California

Building standards adopted and promulgated at the state level establish a statewide minimum level of fire/life/safety standards and protections. Local governmental administrative and enforcement agencies (local AHJs) may exceed these minimums through the passage of local ordinances, but must maintain the minimum building standards as established by the state. Local governmental administrative and enforcement agencies may amend state adopted building standards if deemed necessary, although each modification must be justified based on one of three applicable criteria: geological, topographical, or meteorological (Health and Safety Code Sections 18941.5 and 17958.7). Modifications must be filed with the CBSC. The CBSC will not review or question the express findings of the local governmental authority for the three applicable criteria that necessitate the submitted amendments. The CBSC will reject local governmental amendment filings that propose adopting model codes not incorporated in the California Building Standards, nor filings that amend model codes currently incorporated in the California Building Standards.

Local governmental amendments to the California Building Standards that affect CCR Title 9, California Fire Code, are handled in a similar fashion. A difference may be that, depending on the governmental structure, a local fire authority may be a fire protection district where their board is deemed to be the "governing" body and is responsible for determining the express findings that necessitate the amendments to CCR Title 9 (Health and Safety Section 13869.7). The fire protection district board must submit these amendments to the local governmental authority and receive their comments, after which the local governmental authority will approve the amendments through the passage of local ordinance (adopting ordinance). These amendments must then be filed with the CBSC to become effective and operative.

Two prominent local AHJs that would be involved in the siting, design, construction and operation of a hydrogen energy station for transportation and stationary applications are the local planning and building/permitting officials, and the local fire marshal or official. In some smaller jurisdictions, the local fire official acts as the building official or vice versa. In some jurisdictions, depending on the type of permit being issued, the local legislative body may be required to take some level of action in order for the permit to be approved.

In the event that a developer or owner believes that the local AHJ is incorrectly applying a building or fire code or regulation, or is misinterpreting an existing code or regulation, or is referencing an inappropriate code or standard in the event that a specific code or regulation does not exist for the particular application, an appeals process exists to allow for the developer or builder to submit their complaint or grievance to the appropriate state AHJ.

1.4 California Laws and Regulations Relating to Hydrogen Fueling Stations

The following tables list the currently applicable California laws and regulations that pertain to the siting, construction, installation and operation of a hydrogen refueling station. This comprehensive list of applicable regulations is separated into five categories, with a sixth category referencing the regulation governing Utility Interconnections for a hydrogen energy station configured as a distributed generation installation. The five categories listed are: Overall Siting, Setbacks, and the Built Environment; Subsystem and Assemblies; Fuel Storage, Piping, and Handling; Environmental Impact; and Fueling Interface Dispenser and Access. The tables themselves denote the particular California Regulation, the Application of the regulation, the responsible State Agency, the Authority Having Jurisdiction, the Enforcement aspect of the application regulation, the Model Code or Civil Law Referenced, the Locally Recognized Standard, and any Additional California Statutory Requirements.

California Regulation	Application	State Agency(s)	Authority Having Jurisdiction	Enforcement	Model Code or Civil Law Referenced	Locally Recognized Standards[1]	Additional CA Statutory Requirements
	Overall Siting, Setbacks, and the Built Environment						
Title 24, Part 2 (1 & 2) – California Building Code	Seismic standards, materials selection, and energy efficiency of commercial structures	OSFM[2], DSA, OSHPD, HCD	Local fire department (sometimes building)	Permitted and reviewed prior to construction	1997 Uniform Building Code		
Title 24, Part 9 Article 52 - Motor Vehicle Fuel Dispensing Stations	Complete installation, equipment assemblies, individual appliances, and setbacks	OSFM, DSA, OSHPD, HCD	Local fire chief	Permitted and reviewed prior to construction (CFC Section 105, Permit m.3)	2000 Uniform Fire Code (UFC)	NFPA 30A NFPA 52 NFPA 50A/B	*5201.5.1 protection of dispensers installed at grade with provisions for point-of-sale device access in accordance with ADA.
Title 24, Part 9, (California Fire Code 2001) Article 29 – Repair Garages, Section 2903 - Repair Garages for Natural Gas and Hydrogen-Fueled Vehicle	Provided here for reference.	OSFM, DSA, OSHPD, HCD	Local fire chief	Permitted and reviewed prior to construction (CFC Section 105.8, Permit r.3)	2000 Uniform Fire Code (UFC)	NFPA 88B	
Title 8, Division 1, Chapter 4 – Division of Industrial Safety, Subchapter 7 - General Industry Safety Orders (especially Article 138,	Minimum standards for safety orders for all places of employment in California including special provisions for certain employment environments,	DOSH	CalOSHA (& DOSH Pressure Vessel Unit in cases of hydrogen storage)	Same as above for all Title 8, Division 1 enforcement	*ASME BPV Code, B31.3 **Various NFPA (inc. NFPA 50, 496) ***API	Note - DOSH/ CalOSHA authority may supercede local authority at places of employment,	Same as above for all Title 8, Division 1 variances

[1] Nationally recognized standards, like NFPA standards, may be used in subject areas not regulated by Title 24, Part 9 (See CFC Section 101.3).
[2] See list of acronyms used at bottom.

"Hydrogen", Sections 5465-5498)	applications, and equipment (including signage, setbacks, materials, design, etc.)				Standard 620 ****CGA Pamphlet S-1 *****Some UL	in some areas	
California Regulation	**Application**	**State Agency(s)**	**Authority Having Jurisdiction**	**Enforcement**	**Model Code or Civil Law Referenced**	**Locally Recognized Standards**	**Additional CA Statutory Requirements**
	Subsystems and Assemblies						
Title 24, Part 3 – California Electrical Code	Wiring, lighting in classified areas	OSFM, DSA, OSHPD, HCD	Local building & fire departments	Permitted and reviewed prior to construction	1999 National Electrical Code (NFPA 70)		
Title 24, Part 4 – California Mechanical Code	Heating, ventilation, and cooling systems (and other heating appliances)	OSFM, DSA, OSHPD, HCD	Local building & fire departments	Permitted and reviewed prior to construction	2000 Uniform Mechanical Code of IAPMO		
Title 8, Division 1, Chapter 4 – Division of Industrial Safety, Subchapters 4 & 5 – for Construction and Electrical Safety Orders	Construction and electrical safety minimum state standards for places of employment	DOSH	CalOSHA	Same as above for all Title 8, Division 1 enforcement	*NFPA (inc. NFPA 30, 70) **Some UL	See note above for Title 8, Division 1	Same as above for all Title 8, Division 1 variances
	Fuel Storage, Piping, and Handling						
Title 24, Part 9 Article 74 - Compressed Gases	Handling, storage, dispensing of compressed hydrogen	OSFM, DSA, OSHPD, HCD	Local fire chief	Permitted and reviewed prior to construction (CFC Section 105, Permit c.7)	2000 Uniform Fire Code (UFC)	NFPA 50A	
Title 24, Part 9 Article 75 - Cryogenic Fluids	Handling, storage, dispensing of cryogenic liquid hydrogen	OSFM, DSA, OSHPD, HCD	Local fire chief	Permitted and reviewed prior to construction (CFC Section 105, Permit c.9)	2000 Uniform Fire Code (UFC)	NFPA 50B	
Title 24, Part 9 Article 80 - Hazardous Materials	Handling, storage, dispensing of hydrogen	OSFM, DSA, OSHPD,	Local fire chief	Permitted and reviewed prior to construction (CFC Section 105,	2000 Uniform Fire Code (UFC)		*California Health and Safety Code* Requirements for
		HCD		Permit h.1)			HMMP and HMIS (see below) **8003.1.4.2 – No emergency ventilation system shutoff required for exhaust systems venting flammable gases completely exhausted to outside air
California Regulation	**Application**	**State Agency(s)**	**Authority Having Jurisdiction**	**Enforcement**	**Model Code or Civil Law Referenced**	**Locally Recognized Standards**	**Additional CA Statutory Requirements**
	Fuel Storage, Piping, and Handling (continued)						
Title 8, Division 1, Chapter 4 – Division of Industrial Safety, Subchapter 1 – Unfired Pressure Vessel Safety Orders (especially Section 460)	High pressure or cryogenic storage and piping requirements for the human interactive employee working environment; Hydrogen storage and piping	DOSH	CalOSHA (& DOSH Pressure Vessel Unit)	Compliance incumbent upon employer/owner, CalOSHA will inspect if found to be out of compliance	*ASME BPV Code, B31.3 **NFPA 58, NFPA Pamphlet 59A ***Some UL	See note above for Title 8, Division 1	Title 8, Division 1, Chapter 3.3 & 3.5 – Occupational Safety and Health Appeals & Standards Boards – for temporary and permanent variances
Title 8, Division 1, Chapter 4 – Division of Industrial Safety, Subchapter 2 – Boiler and Fired Pressure Vessel Safety Orders	Any boiler or fired pressure vessels in the human interactive working environment	DOSH	CalOSHA (& DOSH Pressure Vessel Unit)	Same as above for all Title 8, Division 1 enforcement	*ASME BPV Code, ASME B31.3	See note above for Title 8, Division 1	Same as above for all Title 8, Division 1 variances
Title 19, Division 2, Chapter 4 – Hazardous Material Release	Any storage, use, or handling of hazardous materials	OES, UPS	*Local Fire Dept. **Local CUPA	*Annual resubmission **Requirements include an HMBP with HMMP,	*California Health and Safety Code		

Reporting, Inventory, and Response Plans Especially Section 2720				HPIS and emergency response plan	(Chapter 6.95, Article 1) **Also CFC Article 80		
California Regulation	**Application**	**State Agency(s)**	**Authority Having Jurisdiction**	**Enforcement**	**Model Code or Civil Law Referenced**	**Locally Recognized Standards**	**Additional CA Statutory Requirements**
	Fuel Storage, Piping, and Handling (continued)						
Title 19, Division 2, Chapter 4.5 – California Accidental Release Prevention (CalARP) Program Detailed Analysis	Hydrogen storage greater than 10,000 pounds (4,536 kg or 16,879 gallons, specific gravity for LH2 = .071)	OES, UPS	*Local Fire Dept. **Local CUPA	*Annual resubmission **Requires include a RMP and PHA	Federal Risk Management Program		
	Environmental Impact						
Title 14, Division6, Chapter 3 – Guidelines for Implementation of the California Environmental Quality Act	Environmental impact (especially reformation stations) – air emissions, power consumption	Resources Agency	Local planning departments, local AQMD often involved	Required in local permitting process (could result in conditional approval or EIR)	Unique to California Law		
California Health and Safety Code, Section 40000 – APCD/AQMD authority to permit stationary sources	APCD's/AQMD's have authority in California to regulate and permit stationary sources contributing to criteria pollutants in pursuit of each district's Attainment Plan.		Local APCD or AQMD	Permits and programs may vary between APCD's/AQMD's.	Federal Clean Air Act		
Title 17, Division 1, Chapter 1.8, Article 3 - Distributed Generation Certification Program	Distributed generation emissions sources below local AQMD deminimus for permitting	CARB	CARB	BACT requirement, only listed technologies accepted	California State Senate Bill 1298		

California Regulation	**Application**	**State Agency(s)**	**Authority Having Jurisdiction**	**Enforcement**	**Model Code or Civil Law Referenced**	**Locally Recognized Standards**	**Additional CA Statutory Requirements**
	Fueling Interface, Dispenser, and Access						
Title 4, Division 9	*Mass Flow Meters for CNG (Section 337) **Cryogenic materials metering (Section 334) ***Article 2.2 – Electric Watt-hour metering for sub-metering only (attached for reference only) ****General Code 1.10 for device identification and all areas unaddressed by the individual codes	W&M (under Dept. of Agriculture)	Periodic inspections supposed to be carried out by county officials (typically under local agricultural Commissioner)	*Proactive: lists for type approved devices and installations (under NIST) **Periodic inspection following installation ***Annual inspection for cryogenic meters	*National Conference on Weights and Measures (NCWM) Publication 14 **National Institute of Standards and Testing (NIST) Handbook 44		*An CA listed Authorized Service Agency can place the device in service directly upon installation
California Business and Professions Code, Chapter 14 – Weights & Measures, Petroleum Products (starting at 13400)	Provided here for reference only: W&M has purview of quality verification of all vehicle fuels used in spark-fired or compression engines	W&M (under Dept. of Agriculture)	W&M	Random surveys of fuel stations or inspections conducted upon complaint	ASTM and SAE standards for fuel quality testing		
California Business and Professions Code Section 13660 (some references in Title 24, see CFC/Article 52 above)	User assistance for refueling service, signage requirements, and	DAS	*Local officials (varies) **US Department of Justice (at federal level in case of non-compliance)	*Local officials (on a building permit checklist for instance), county sealers **Department of Fair Employment and Housing (DFEH) [if notified of non-compliance]	*American Disabilities Act (ADA) **American Disabilities Act Access Guidelines (ADAAG) [Federal Building Code]		*Threshold for service (DMV placard), signage requirements, and local enforcement. ** Unruh Civil Rights Act (Civil Code Section 54 Government Code 11.135)

California Regulation	Application	State Agency(s)	Authority Having Jurisdiction	Enforcement	Model Code or Civil Law Referenced	Locally Recognized Standards	Additional CA Statutory Requirements
	Fueling Interface, Dispenser, and Access (continued)						
Title 13, Division 3, Chapter 5, Article 3 – Specifications for Alternative Motor Vehicles Fuels, Section 2292.7: Specifications for Hydrogen	Specifications and test methods for hydrogen fuel	CARB	Local AQMD				
	Utilities Connection						
Rule 21 for most California utilities agencies	Distributed generation grid output	PUC	*Local utilities agency **PUC in matters of dispute	Local utilities agency requirement for electricity application	IEEE and UL standards referenced		

Acronyms:

OSFM – Office of the State Fire Marshal	NFPA – National Fire Protection Agency	DOSH – Department of Occupational Safety & Health
DSA – Department of the State Architect	DAS – Disability Access Section	CalOSHA – California Occupational Safety & Health Agency
W&M – Weights and Measures	PHA – Process Hazard Analysis	HMMP – Hazardous Materials Management Plan
AQMD – Air Quality Management District	EIR – Environmental Impact Report	OSHPD – Office of Statewide Health, Planning & Development
UPS – Unified Program Section	O/M – Operations and Maintenance	ASME – American Society of Mechanical Engineers
DMV – Department of Motor Vehicles	OES – Office of Emergency Services	NIST – National Institute of Standards and Testing
BACT – Best Available Control Technology	RMP – Risk Management Plan	HMIS – Hazardous Materials Inventory Statement
PUC – Public Utilities Commission	UL – Underwriter Laboratories	IEEE – Institute of Electrical and Electronics Engineers
APCD – Air Pollution Control District	CARB – California Air Resources Board	HCD – Housing and Community Development
HMBP – Hazardous Materials Business Plan	CFC – California Fire Code	CUPA – Certified Unified Program Agency
IAPMO – International Association of Plumbing and Mechanical Officials		

Sections remaining in earlier draft form.

(The above matrix provided by Adam Gromis, California Fuel Cell Partnership)

Current Status of Model Building Code and Fire Code Adoption

The currently applicable codes as referenced by the California Building Standards (CCR Title 24) are listed as follows:

California Building Code	Uniform Building Code	1997 edition
California Electric Code	National Electric Code	1999 edition
California Mechanical Code	Uniform Mechanical Code	2000 edition
California Plumbing Code	Uniform Plumbing Code	2000 edition
California Fire Code	Uniform Fire Code	2000 edition

These codes comprise the bulk of the 2001 Triennial Edition of CCR Title 24, which became effective November 2, 2002, and are currently in effect. The 2004 triennial review cycle has not been completed.

1.5 Permitting Process for Hydrogen Fueling Stations

The permitting and regulatory approval process is comprised of a series of reviews by local permitting and regulatory agencies. The process is designed to ensure that a hydrogen fueling station meets all required and applicable municipal (city, county, or city and county) and state regulations, codes and standards. Permitting and regulatory agencies enforce the municipal and state regulations, codes and standards by regulating the design, construction, quality of materials, and use of all buildings and structures under their authority and jurisdiction.

The design of a hydrogen fueling station for transportation and stationary applications includes five basic elements:

1. Fuel Supply and Storage
2. General Station Siting Issues
3. Fueling Station Piping and Equipment
4. Fire Protection
5. Operations and Maintenance.

The construction of a hydrogen fueling station includes five elements:

1. Selection and preparation of the site
2. Permitting process
3. Siting of system and equipment
4. Storage system
5. Dispensing system.

Completion of the design and construction of a hydrogen fueling station (with or without stationary power generation) requires that all of these elements be managed with authorities having jurisdiction. The process varies considerably between local jurisdictions within California in terms of the technical requirements and in terms of the number and identify of the local authorities that have jurisdiction.

The permitting process involves three generic areas of approvals and permits:

1. Environmental Impact (CEQA, AQMD)
2. Local Requirements (zoning, ordinances, regional planning)
3. Building Construction & Use (design review, inspections)

Permitting Sequence

The following chart generally represents the overall sequence of permits needed to establish a hydrogen refueling station:

Phase	Permit Element	Permit	Authorizing Body
Design	Siting Zoning Ordinance Setback Requirements Separation Distances Access Compliance Hydrogen Transport/Delivery	Applicable Approvals	Local Planning Agency
	Environmental	Compliance	CEQA

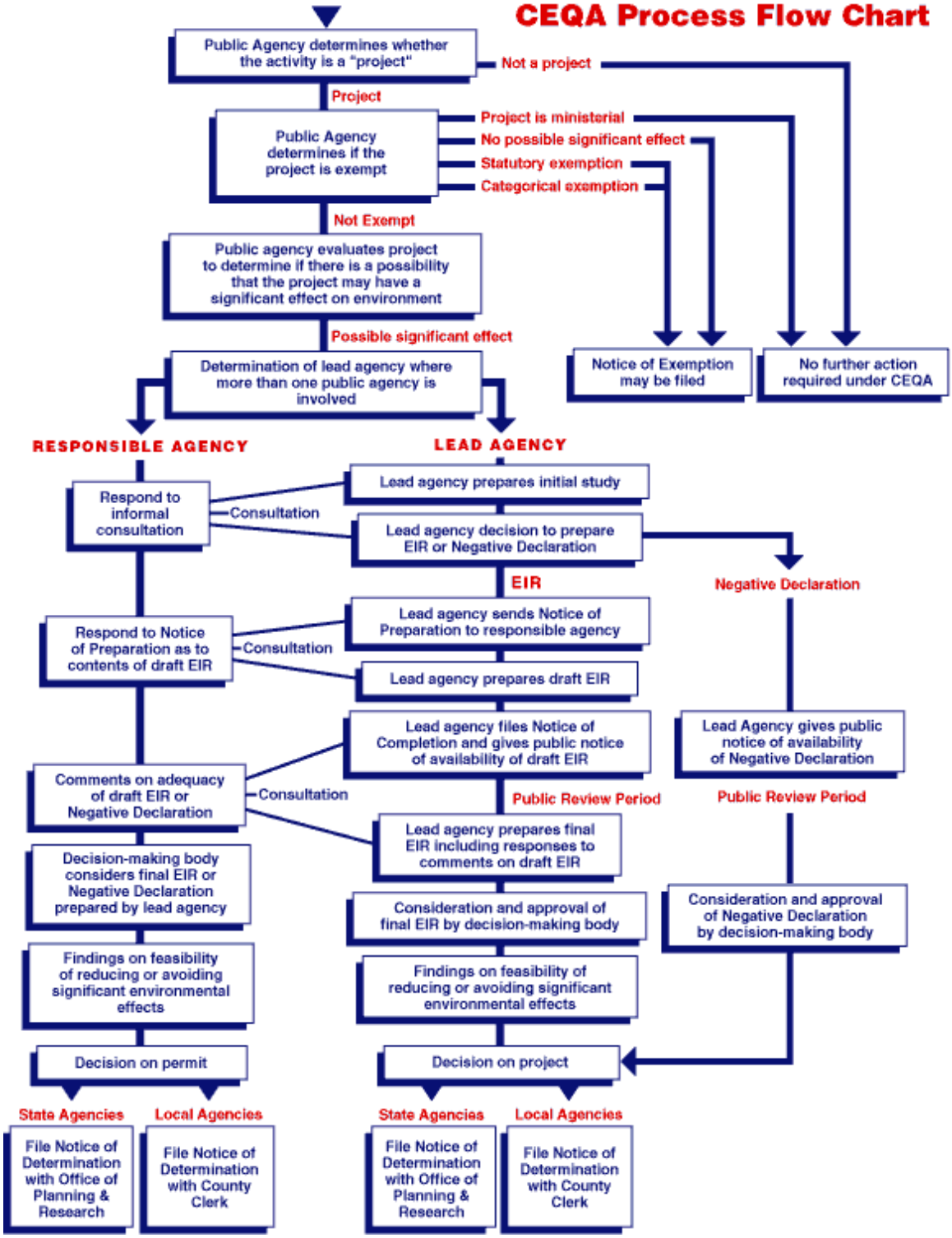
Phase	Permit Element	Permit	Authorizing Body
Construction Plans and Documents	Emissions	Permit to Construct	AQMD
	Structural Mechanical Electrical Plumbing Fuel Gas Architectural	Applicable Permits and Approvals	Building Department
	Fire/Life/Safety	Applicable Permits and Approvals	Fire Department
Construction/Installation	Applicable Inspections		Building Department Fire Department CalOSHA Health Department
Approvals		Permit to Operate	AQMD Fire Department CUPA Weights and Measures
Operations		Periodic Inspections Permit Renewals	

Environmental Impact

Two regulatory agencies provide oversight of the environmental requirements and authorization to proceed with the design, construction, and operation of the proposed building or structure. The California Air Resources Board (ARB) develops and promulgates regulations that control atmospheric emissions from any equipment or operation. The Air Quality Management Districts (AQMDs) enforce these regulations at the local level, and can enact stricter regulations as approved by local ordinance.

In addition to these two agencies, the California Environmental Quality Act (CEQA) process must be undertaken for permitting. The CEQA requires an assessment regarding the impact of a project on the environment, including how the project will comply with environmental regulations in mitigating these impacts.

California Environmental Quality Act: The CEQA process was put into effect in 1970 for the purpose of monitoring land use and development through the permitting process. The process begins with an evaluation of the proposed project to determine the potential environmental effects. A lead agency must then be identified as the responsible entity which will review the applicant's project information and either approve or deny the permit.



From: http://ceres.ca.gov/images/CEQA_process_chart.gif
California Environmental Resources Evaluation System Web Site
California Resources Agency, State of California

The CEQA permitting process is composed of three main parts: the pre-application phase, the application phase, and the review phase. The flow chart as shown on the next page provides an overview of the CEQA permitting process.

The primary objective of the pre-application phase is to identify the appropriate permitting agencies, determine the lead agency, and ensure that there is enough relevant project related information to proceed with the determination of the degree of environmental analysis that will be required by the permitting agencies. All relevant permitting agencies other than the lead agency are referred to as the responsible agency.

The application phase consists of the submittal of the necessary permit application forms along with a detailed project description to the lead and responsible agencies. Each agency will review the application to determine completeness of filing. The lead agency will then determine during the review phase whether or not the proposed project is subject to CEQA. The lead agency may file a Notice of Exemption if the project is not covered by CEQA, or prepare an Initial Study to determine whether or not the project may have significant adverse effects on the environment. If the Initial Study indicates that the project will not have a significant effect on the environment, the lead agency will issue a Negative Declaration. If the Initial Study shows that the project may have one or more adverse environmental effects, the applicant would be given the opportunity to modify the project in order to avoid or reduce the impacts to a level of non-significance. If such changes are made in the project, a mitigated Negative Declaration may be adopted. Otherwise, the lead agency will circulate a Notice of Preparation which will initiate the development of an Environmental Impact Report (EIR).

Assuming that the environmentally adverse effects can be properly mitigated below a level of significance, and that other factors merit the approval of the project, the lead agency will certify the EIR and approve the mitigation monitoring program and the permit, and file a Notice of Determination.

Air Pollution Regulations: Each regional Air Quality Management District (AQMD) in California is authorized by the Health and Safety Code to issue permits for stationary sources that emit pollutants into the atmosphere. There are two permits that are issued by each AQMD: Permit to Construct and a Permit to Operate. The permit process is described below.

AQMD Permit to Construct: This permitting process should occur during the design phase, and consists of the following elements:

- Determine if equipment/project is classified as a minor, moderate, or major source as it relates to the emissions of air pollutants.
  - Sources emitting more than 10 tons per year of an identified hazardous pollutant or 25 tons of a combination of pollutants are classified as major sources. Major sources are required to obtain Title V operating permits.
- Complete Permit to Construct application and submit to AQMD with fee.
  - Business related information (Applicant Information).
  - Equipment and process related information.

  - Emissions related information.
  - CEQA documentation.
- AQMD Review to determine compliance with AQMD rules, regulations, and policies.
  - Review period typically 49 to 60 days, depending on equipment and process.
- Issuance of Permit to Construct.

AQMD Permit to Operate:

- AQMD inspection to verify compliance with Permit to Construct. Confirm equipment/project operates in compliance with AQMD rules, regulations and policies.
  - Applicant is required to notify the AQMD prior to initial start-up date of the source. Initial start-up period may last for 60 days, during which the AQMD will evaluate the source for compliance.
- Issuance of Permit to Operate.
  - Permits are valid for one year and must be renewed annually.

Recommendations for Environmental Impact

For the purposes of addressing environmentally related issues and permitting, it is recommended that hydrogen-related information be made available so that the AHJs that participate in the CEQA process have the ability to conduct timely and accurate assessments of hydrogen refueling stations. This information can be disseminated directly through available channels for getting information to the appropriate organizations, or by establishing a Web-based clearinghouse that these particular AHJs can access. *The recommendation is to establish environmental permitting guidelines that pertain to hydrogen as a fuel, and to make the necessary information available to AHJs that will assist in the permitting process.*

A further recommendation regarding environmental issues is to motivate and assist the California Air Resources Board to establish regulations pertaining to the use of hydrogen as a fuel. The California Environmental Protection Agency (CalEPA), in coordination with other relevant state agencies, should develop statewide guidance (i.e. template) for the application or non-application of CEQA/NEPA to hydrogen fueling stations to be utilized by local lead agencies. These resources should address the various types of fueling station technologies and configurations, and where legally possible, streamline, reduce, or eliminate the CEQA/NEPA process with regard to hydrogen fueling station application.

Plan Review and Building Permits

There are two basic phases to the construction process: plan review and construction/equipment inspection. For a motor fuel dispensing facility, a third phase can also be considered regarding operations and maintenance, including training and safety plans. This additional consideration is primarily due to the nature of a motor fuel (in this case hydrogen) dispensing facility and the fact that these facilities retain on site hazardous materials and substances and chemical products.

The plan review phase of the permitting process begins with the submittal of the appropriate documents and applicable fees to the coordinating permitting agency, typically the building and/or planning department of most municipal jurisdictions. At this stage of the permitting process the applicant should have addressed zoning ordinance requirements, setback requirements, emergency access and required fireflow water supply, separation distances in accordance with the applicable codes and standards, and the method of transport of hydrogen to the site (assuming that hydrogen isn't being generated on site). There are four items that are typically required by most jurisdictions to initialize this phase, and these would include: 1) assessor tax parcel number (evidence of legal lot), 2) full legal description, 3) site plan drawn to scale, and 4) estimate of the cost of the proposed project.

The primary activity in the plan review phase is the review of the building and equipment plans, which can be further delineated into several major permitting categories, with each major permitting category further segmented into sub-categories. The four major permitting categories are: site, building, fire, and environmental. A fifth major category that is related to the permitting of a hydrogen motor fuel dispensing facility is the performance of a Failure Mode and Effect Analysis (FMEA) and Hazard and Operability Study (HAZOP The following is a listing of the sub-categories for each major permitting category:

Elements of Review of the Project Plan

Major Category:	**Site**	**Building**	**Fire**	**Environmental**
Subcategories:	• Demolition • Grading • Excavation • Foundation • Street Use	• Structural • Mechanical • Electrical • Plumbing • Fuel Gas • Architectural	• Fire Protection • Fire Safety Plan and Operating Permit • Equipment • Dispensing • Storage • Access & Water	• CEQA • AQMD • Water • Waste

The plans and information submitted for review follow the identified permitting categories as listed in the preceding table. The following is a list of plans typically submitted for obtaining approval to proceed to construction:

1. Site Plan
2. Specifications (equipment)
3. Soils Report
4. Architectural Plans
5. Structural Plans
6. Structural Calculations
7. Life Safety Plans
8. Mechanical Plans
9. Plumbing Plans
10. Fuel Gas Plans
11. Electrical Plans
12. Fire Protection System Plans
13. Fire Protection System Calcs

In addition to the above listed plans and information, the installation of a hydrogen energy station may require submittal of California Code of Regulations Title 24 Part 6 compliance information (energy efficient designs meeting minimum energy standards in accordance with the published regulations). Other information required for submittal may include Access Compliance (in accordance with American Disability Act regulations), and proof of Workers Compensation Insurance. Finally, a State Industrial Safety permit may be required which may require additional information to be submitted for review.

In California, the local Air Quality Management District is an AHJ that regulates emissions from a variety of sources, including motor fuel dispensing facilities. For the installation of a hydrogen energy station, a Permit to Operate most likely will be required to be issued from the local AQMD, as well as an Authority to Construct prior to commencement of construction. Depending on the jurisdiction, approval from the AQMD may be required prior to initiating the plan review phase of the permitting process.

In larger jurisdictions, the plan review process may require the involvement of several municipal regulatory departments. The Planning Department determines the appropriateness of the installation of the project based on the general plan and local governmental policies and regulations. The Building and Fire Departments handle the bulk of the plan review and inspection responsibilities for the design and installation of building, structure or facility. The Public Works Department will review the submitted plans and information for street use permits, water and sewer interconnections, and other aspects of the utilization of city services for the construction and operation of the building, structure or facility.

Additional regulatory, code and standard oversight can come from other departments and agencies such as CalOSHA and the Public Health Department. If the building, structure or facility is being constructed in a redevelopment zone, the Redevelopment Agency may require a review of the plans. Also, depending on the nature of the building, structure or facility being constructed, public and neighborhood notifications may be required. In smaller jurisdictions, many of these functions may be handled by fewer departments, agencies and personnel.

For the installation of a hydrogen energy station that will generate electricity and operate in parallel with the local utility grid, the local utility has the regulatory authority to review the interconnection plans, approve to interconnect, inspect the installation, and test the interconnection prior to final approval. Interconnection requirements are typically published in the utility's tariff. In California, for the three large Investor Owned Utilities (IOUs), Rule 21 is the applicable tariff regulation for interconnecting customer owned on site generation.

Construction Inspection

The construction inspection phase is typically coordinated with the construction schedule. As each major milestone in the project is reached, the construction manager schedules an appointment with the inspector to obtain approval for the installation of a

particular aspect of the project. The inspector is the field person who ensures that the construction project is being installed as designed and follows the applicable regulations, codes and standards.

Additional Permitting Considerations

Permits may require review and approval from the city council or county board of supervisors, depending on the appropriate jurisdiction. This could add an additional step to the permitting cycle, which would then begin with review and approval by the local governmental planning commission, followed by approval from the local legislative agency (city council, county board of supervisors, etc.), before then proceeding to the approval and permitting process for construction. It should be noted that a conventional fueling station (gasoline, diesel) generally takes 12 to 14 months to get approval for construction.

Other permits that need to be considered or may be required by the local AHJs include: burglar or security alarm permit, air tanks permit, industrial activities storm water general permit, underground storage tank permit, hazardous materials license, hazardous waste generator permit, and on-site hazardous waste treatment permit, as well as the typical business related permits.

Permitting Flow Chart

The permitting flow chart generally can be broken down into five basic processes:

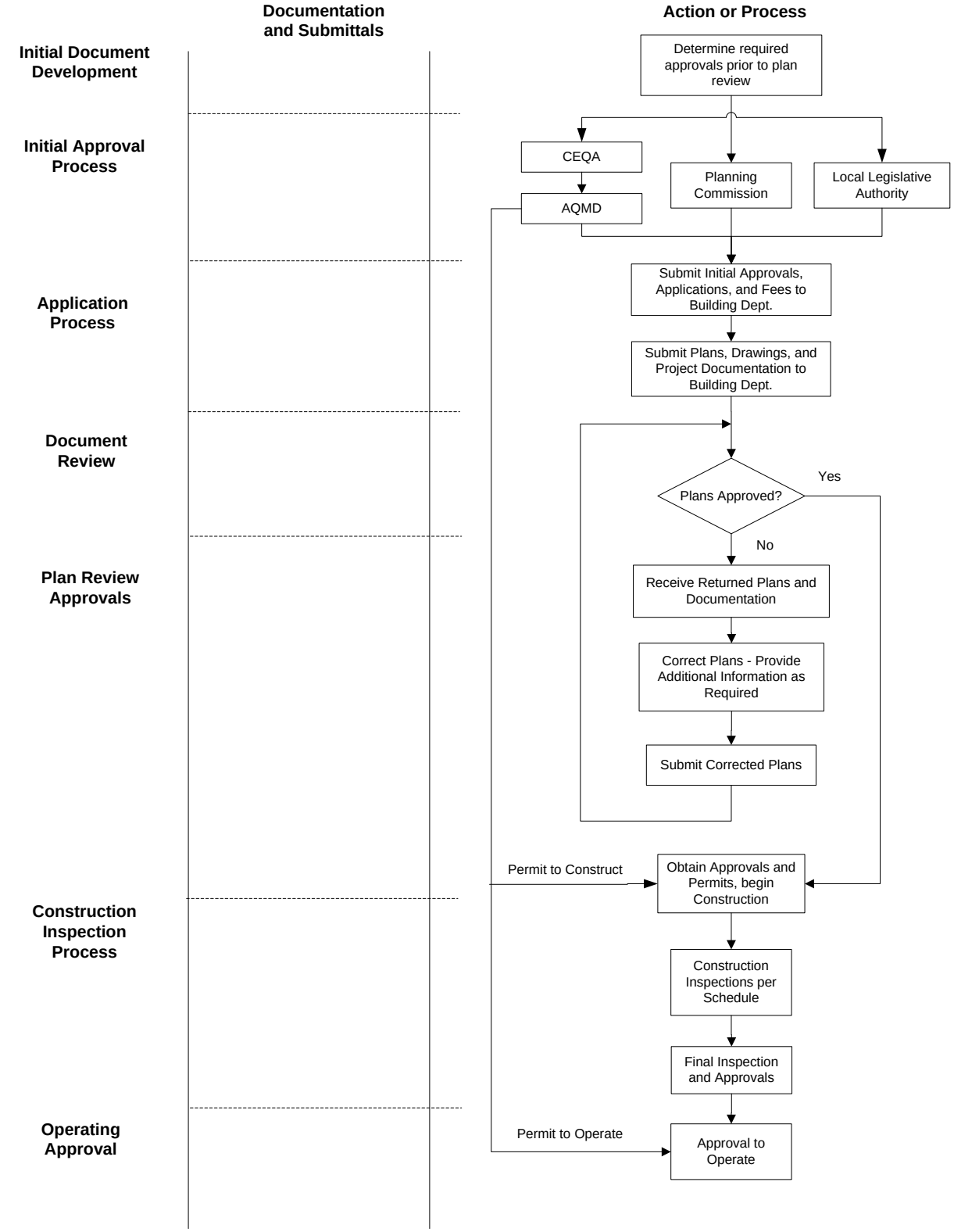
1. Application Process
2. Document Review Process
3. Approval Process
4. Construction Inspection Process
5. Operating Approval Process

This list doesn't necessarily imply a linear order and progression for the overall permitting process, since some tasks and activities can be conducted in a parallel manner, while others are on a critical path and must follow one after the other.

Recommendation

It is recommended that CalEPA coordinate semi-annual meetings with representatives from all California state agencies with any possible regulatory purview over hydrogen applications. These meetings should also include appropriate representatives from the United States Departments of Energy and Transportation (DOE and DOT) hydrogen and fuel cells programs to best coordinate state efforts to develop a technical and regulatory environment which supports the Governor's CA H2 Net program. Activities would include but not be limited to:

Permitting Flow Chart



1. Review of current status of California regulations, and available national and international codes and standards;
2. Assessment of California programs supporting the CA H2 Net, and current relevant national programs;
3. And other activities necessary to furthering the California and federal government objectives to operate hydrogen-powered vehicles and hydrogen fueling infrastructure.

2. Individual Elements of Hydrogen Fueling Stations

2.1 On-Site Hydrogen Production & Linkage to Hydrogen Infrastructure

Hydrogen Fueling Station Type	Grounding Grid / Rods	Phone Line or Internet	Low Voltage (Signal)	Medium Voltage single phase (120 / 240 VAC)	High Voltage 3 phase (480 and above)	General Utility Water	DI Water (Filtered)	Fire Protection /Fire Hydrants	Natural Gas by Pipeline (Low Pressure)	Natural Gas by Pipeline (High Pressure)	Storm Drains	Sewer Drains	Collection (i.e. drains which cannot go directly to sewer)	Air Intake (cooling only)	Air intake (combustion)	Venting H2	Venting O2	Venting Exhaust (ex. CO, CO2, NOx)	Venting air (Not HVAC)	Compressed Air (CA)	Instrument Nitrogen	Pipeline Right of way	Property Land Issues	Road Access/ Traffic	Aesthetics/ special zoning requirements
Onsite Production	R	O > R	R	R	R	R	N/A	TBD	R	TBD	TBD	TBD	TBD												
Onsite Reforming	R	O > R	R	R	R	TBD > R	N/A >R	TBD	R	TBD	TBD	TBD	TBD	TBD	R	R	NA	R	TBD	O	O	R	TBD	O	Site Specific
Onsite Electrolyzer	R	O > R	R	R	TBD	R	N/A >R	TBD	TBD > N/A	N/A	TBD	TBD	TBD	TBD	NA	R	R	NA	TBD	O	O	N/A	TBD	O	Site Specific
Delivered Hydrogen																									
Gaseous tube trailer	R	O > R	R	R	O > R	O	N/A	TBD	N/A	N/A	TBD > N/A	TBD	TBD	NA	NA	R	NA	NA	NA	O	O	N/A	TBD	R	Site Specific
Liquid Tanker	R	O > R	R	R	R	O > R	N/A	TBD	N/A	N/A	TBD > N/A	TBD	TBD	NA	NA	R	NA	NA	NA	O	O	N/A	TBD	R	Site Specific
H2 Pipeline	R	O	R	R	O > R	O	N/A	TBD	N/A	N/A	TBD > N/A	TBD	TBD	NA	NA	R	NA	NA	NA	O	O	R	TBD	O	Site Specific

Legend: R=Required, O=Optional, N/A=Not Applicable, TBD=To Be Determined

Red=H2 Specific
Green=Not H2 Specific

Notes: Responses for Columns E, F, G, K, & L reflect likely technical requirements based on assumptions regarding possible station designs.
These assumptions should be checked against available data from existing H2 stations constructed here in CA and elsewhere.

Low pressure natural gas service at the Liquid Tanker or even the H2 pipeline might be needed depending on the need for heating equipment at the delivery site.

Delivered Hydrogen — Trailer, Tanker, Pipeline

California Regulation[1]	Application	State Agency(s)	Authority Having Jurisdiction	Enforcement	Laws, Codes, or Standards Referenced	Locally Recognized Standards[2]	Additional CA Statutory Requirements
Grounding, Grid, Rods	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						
					All grounding must meet NFPA 70, National Electrical Code®,		
Low Voltage Signal	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						
					"Points where connections are regularly made and disconnected 1 Within 3 ft (1 m) of connection- Class 1 Division 1 Between 3 ft (1 m) and 25 ft (7.6 m) of connection- Class I Division 2"		

[1] This table is intended to refer to current, as of July 2004, California laws, statutes, or regulations and is in no way intended to be seen as a gap analysis.

[2] Nationally recognized standards, like NFPA standards, may be used in subject areas not addressed by Title 24, Part 9 (See CFC Section 101.3).

Medium Voltage Single Phase	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Title 24 Part 9 Fire Code	Equipment & Piping Compressed gases	SFM	Local Fire Chief	Permit, Review & Inspection	NFPA 70, 52 ASME, ASTM,	Local City Code	
Title 24 Part 3 Electrical Code	Electric Power	SFM	Local Bldg Dept	Permit,Review & inspection	NEC, NFPA 70, NFPA52 NEMA, IEEE, UL	Local City Code	
Title 24 Part 9, compressed gases, cryogenic fluids and hazardous materials	Handling, storage and dispensing of H2	SFM	Local Fire Chief	Inspection	Uniform Fire Code NFPA 54, UL	Cocal Ordinances	

High Voltage Three Phase	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Title 24 Part 9 Fire Code	Equipment & Piping Compressed gases	SFM	Local Fire Chief	Permit, Review & Inspection	NFPA 70, 52 ASME, ASTM,	Local City Code	
Title 24 Part 3 Electrical Code	Electric Power	SFM	Local Bldg Dept	Permit,Review & inspection	NEC, NFPA 70, NFPA52 NEMA, IEEE, UL	Local City Code	
Title 24 Part 2	Seismic Standards	SFM	Local Bldg Dept Local Fire Chief	Local Bldg Dept inspection	UBC, ASME, ASTM	Local City Code	
Title 24 Part 9, compressed gases, cryogenic fluids and hazardous materials	Handling, storage and dispensing of H2	SFM	Local Fire Chief	Inspection	Uniform Fire Code, NFPA54, UL	Cocal Ordinances	

Instrument Air / Instrument Nitrogen	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						
TBD	Siting for Air Compressor - Set back distances would need to be followed with respect to the air intake for the compressor and the electrical components /classification.	SFM	Local Fire Chief / HAZMAT	Permitted and reviewed prior to construction	Uniform Fire Code (UFC)	NFPA 50[a] NFPA 50B UFC CFC	

On first pass no specific or unique issues pertaining to hydrogen or hydrogen fueling stations were identified other than the item listed above. Good engineering practice, local codes, national recognized standards, etc. should all be followed, but the fact that this is a H2 station should not create any changes in the design, construction, installation, or operation of the station relating to this item. As additional people review the document and new things come to light, this section will be updated.

Instrument or Compressed Air (CA) – Used for valve actuation/air operated valves, electrical panel purge, etc. (CA should not to be used for purging of piping or equipment in hydrogen service. An inert gas such as nitrogen must be used for this.) Assumed source is an air compressor. Typical pressure is 100 to 150 psig.

Instrument N2 – Used for valve actuation/air operated valves, electrical panel purge, piping/equipment purging, etc. Assumed source could be from a liquid nitrogen system, membrane/generator, etc. Typical pressure is 100 to 150 psig.

H2 Gas Pipeline	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						

Property / Land Use / Environmental	***Delivered Hydrogen – Trailer, Tanker, Pipeline***						
California Environmental Quality Act (CEQA)	Project size and location will determine if this applies. Obviously the bigger the project the greater the likelihood of triggering CEQA	Various	Often times if there is a state agency involved, they will take the lead on evaluating the possible CEQA impact. If there is no agency directly involved in the project, then typically it's the agency that's issuing a statewide permit (air pollution, water pollution, etc.) to the project.		Refer to the web site http://ceres.ca.gov/ceqa/	N/A	a) Negative Declaration if it finds no "significant" impacts; b) Mitigated Negative Declaration if it finds "significant" impacts but revises the project to avoid or mitigate those significant impacts; c) Environmental Impact Report (EIR) if it finds "significant" impacts.
California Accidental Release Program (CalARP). (California's answer to RMP)	Applies if storage of 10,000 pounds or more of hydrogen at the site.	CAL EPA?			Refer to website http://www.oes.ca.gov		Includes: Safety information, Hazard review, Operating procedures, Training, Maintenance, Compliance audits, and Incident investigation.
EPA,Risk Management Plan (RMP)	Applies if storage of 10,000 pounds or more of hydrogen at the site.		Federal EPA				
OSHA,Process Safety Management (PSM)	Applies if storage of 10,000 pounds or more of hydrogen at the site.		Federal OSHA				

Road Access to the site / Traffic	Delivered Hydrogen – Trailer, Tanker, Pipeline						
	Transporting of flammable liquids or gases – Local regulated roads and bridges.						
	Transporting of flammable liquids or gases – State regulated roads, highways, bridges, tunnels.			California Highway Patrol (CHP)	DOT		
	Assume that delivery vehicle must be on private property when off loading product. Can not be parked on a public street during off loading.						

California Code of Regulations Title 21 Section 1402.1(b) states that tank vehicles which are placarded "Flammable" under Department of Transportation (DOT) Regulations whether loaded or empty are not permitted on the Bay Bridge for example. "FLAMMABLE" is the proper placard for vehicles transporting materials with a hazard class of 3. Liquid Hydrogen has a hazard class of 2.1, the proper placard is “Flammable Gas”. Therefore, it is believed that transporting liquid hydrogen across the Bay Bridge is permitted according to these regulations. This is probably an area where help and clarification is needed.

Aesthetics / Special Zoning Requirements	Delivered Hydrogen – Trailer, Tanker, Pipeline						

It is believed that this issue will vary quite a bit from city to city, as well as the specific location that the station is at (for example if the area is zoned for commercial, light-industrial, heavy-industrial, etc.). Some cities have specific height restrictions; require screening to hide the equipment, noise restrictions if close to residential areas, etc. These issues are not specific to hydrogen only. This would apply to any industrials tanks, equipment, etc.

When the revised codes such as NFPA and IFC are published they will address underground storage of liquid hydrogen storage tanks as well as gaseous storage and equipment installation on the top of canopies.

On first pass no specific or unique issues pertaining to hydrogen or hydrogen fueling stations were identified. Good engineering practice, local codes, national recognized standards, etc. should all be followed, but the fact that this is a H2 station should not create any changes in the design, construction, installation, or operation of the station relating to this item. As additional people review the document and new things come to light, this section will be updated.

Onsite Production, Reformer, Electrolyzer

California Regulation[3]	Application	State Agency(s)	Authority Having Jurisdiction	Enforcement	Laws, Codes, or Standards Referenced	Locally Recognized Standards[4]	Additional CA Statutory Requirements
Grounding, Grid, Rods	***On Site Production, Reformer, Electrolyzer***						
					All grounding must meet NFPA 70, National Electrical Code®,		

[3] This table is intended to refer to current, as of July 2004, California laws, statutes, or regulations and is in no way intended to be seen as a gap analysis.

[4] Nationally recognized standards, like NFPA standards, may be used in subject areas not addressed by Title 24, Part 9 (See CFC Section 101.3).

Low Voltage Signal	***On Site Production – Reforming, Electrolyzer***						
					"Points where connections are regularly made and disconnected 1 Within 3 ft (1 m) of connec-tion- Class 1 Division 1 Between 3 ft (1 m) and 25 ft (7.6 m) of connection- Class I Division 2"		

Medium Voltage Single Phase	***On Site Production, Reformer, Electrolyzer***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Title 24 Part 9 Fire Code	Equipment & Piping Compressed gases	SFM	Local Fire Chief	Permit, Review & Inspection	NFPA 70, 52 ASME, ASTM,	Local City Code	
Title 24 Part 3 Electrical Code	Electric Power	SFM	Local Bldg Dept	Permit,Review & inspection	NEC, NFPA 70, NFPA52 NEMA, IEEE, UL	Local City Code	
Title 24 Part 2	Seismic Standards	SFM	Local Bldg Dept Local Fire Chief	Local Bldg Dept inspection	UBC, ASME, ASTM	Local City Code	
Title 24 Part 9, compressed gases, cryogenic fluids and hazardous materials	Handling, storage and dispensing of H2	SFM	Local Fire Chief	Inspection	Uniform Fire Code NFPA 54, UL	Cocal Ordinances	

High Voltage Three Phase	***On Site Production, Reformer, Electrolyzer***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Title 24 Part 9 Fire Code	Equipment & Piping Compressed gases	SFM	Local Fire Chief	Permit, Review & Inspection	NFPA 70, 52 ASME, ASTM,	Local City Code	
Title 24 Part 3 Electrical Code	Electric Power	SFM	Local Bldg Dept	Permit,Review & inspection	NEC, NFPA 70, NFPA52 NEMA, IEEE, UL	Local City Code	
Title 24 Part 2	Seismic Standards	SFM	Local Bldg Dept Local Fire Chief	Local Bldg Dept inspection	UBC, ASME, ASTM	Local City Code	
Title 24 Part 9, compressed gases, cryogenic fluids and hazardous materials	Handling, storage and dispensing of H2	SFM	Local Fire Chief	Inspection	Uniform Fire Code, NFPA54, UL	Cocal Ordinances	

General Utility	***On Site Production - Reforming , Electrolyzer***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Calif Vehicle Code	Transport			Local Gov, Police, CHP	DOT, EPA		
Title 24 Part 2	Seismic Standards	SFM	Local Bldg Dept Local Fire Chief	Local Bldg Dept inspection	UBC, ASME, ASTM	Local City Code	
Calif Environ Quality Act -CEQA	EIR		Local Planning Dept	Permitting Process		Local City Planning Guidelines	

Low Pressure Gas Pipieline	***On Site Production, Reformer, Electrolyzer***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Title24 Part 2 Structural	Structural -seismic		Local Bldg Dept	Permit & Review	UBC, ASME, ASTM, MSS		
Title 24 Part 4 Mechanical Code	Piping/HVAC/equipment		Local Bldg Dept	Permit & Review	UMC, NFPA, HI, ASME, SBI, UL, FM, ANSI	Local City Code	
Title 24 Part 5 Plumbing Code	Piping		Local Bldg Dept	Permit & Review	UPC, NFPA, ASME, UL, ANSI	Local City Code	
Title 24 Part 9 Fire Code	Equipment & Piping Compressed gases	SFM	Local Fire Chief	Permit & Review	NFPA 70, 52, 54, ANSI, ASTM, ASME, UL	Local City Code	
Calif Environ Quality Act -CEQA	EIR		Local Planning Dept	Permitting Process		Local City Planning Guidelines	

High Pressure Gas Pipeline	***On Site Production, Reformer, Electrolyzer***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Title24 Part 2 Structural	Structural -seismic		Local Bldg Dept	Permit & Review	UBC, ASME, ASTM, MSS		
Title 24 Part 4 Mechanical Code	Piping/HVAC/equipment		Local Bldg Dept	Permit & Review	UMC, NFPA, HI, ASME, SBI, UL, FM, ANSI	Local City Code	
Title 24 Part 5 Plumbing Code	Piping		Local Bldg Dept	Permit & Review	UPC, NFPA, ASME, UL, ANSI	Local City Code	
Title 24 Part 9 Fire Code	Equipment & Piping Compressed gases	SFM	Local Fire Chief	Permit & Review	NFPA 70, 52, 54, ANSI, ASTM, ASME, UL	Local City Code	
Calif Environ Quality Act -CEQA	EIR		Local Planning Dept	Permitting Process		Local City Planning Guidelines	

Instrument Air / Instrument Nitrogen	***On Site Production, Reformer, Electrolyzer***						
TBD	Siting for Air Compressor - Set back distances would need to be followed with respect to the air intake for the compressor and the electrical components /classification.	SFM	Local Fire Chief / HAZMAT	Permitted and reviewed prior to construction	Uniform Fire Code (UFC)	NFPA 50[a] NFPA 50B UFC CFC	

On first pass no specific or unique issues pertaining to hydrogen or hydrogen fueling stations were identified other than the item listed above. Good engineering practice, local codes, national recognized standards, etc. should all be followed, but

the fact that this is a H2 station should not create any changes in the design, construction, installation, or operation of the station relating to this item. As additional people review the document and new things come to light, this section will be updated.

Instrument or Compressed Air (CA) – Used for valve actuation/air operated valves, electrical panel purge, etc. (CA should not to be used for purging of piping or equipment in hydrogen service. An inert gas such as nitrogen must be used for this.) Assumed source is an air compressor. Typical pressure is 100 to 150 psig.

Instrument N2 – Used for valve actuation/air operated valves, electrical panel purge, piping/equipment purging, etc. Assumed source could be from a liquid nitrogen system, membrane/generator, etc. Typical pressure is 100 to 150 psig.

H2 Gas Pipeline	***On Site Production, Reformer, Electrolyzer***						

Property / Land Use / Environmental	***On Site Production, Reformer, Electrolyzer***						
California Environmental Quality Act (CEQA)	Project size and location will determine if this applies. Obviously the bigger the project the greater the likelihood of triggering CEQA	Various	Often times if there is a state agency involved, they will take the lead on evaluating the possible CEQA impact. If there is no agency directly involved in the project, then typically it's the agency that's issuing a statewide permit (air pollution, water pollution, etc.) to the project.		Refer to the web site http://ceres.ca.gov/ceqa/	N/A	a) Negative Declaration if it finds no "significant" impacts; b) Mitigated Negative Declaration if it finds "significant" impacts but revises the project to avoid or mitigate those significant impacts; c) Environmental Impact Report (EIR) if it finds "significant"

							impacts.
California Accidental Release Program (CalARP). (California's answer to RMP)	Applies if storage of 10,000 pounds or more of hydrogen at the site.	CAL EPA?			Refer to website http://www.oes.ca.gov		Includes: Safety information, Hazard review, Operating procedures, Training, Maintenance, Compliance audits, and Incident investigation.
EPA,Risk Management Plan (RMP)	Applies if storage of 10,000 pounds or more of hydrogen at the site.		Federal EPA				
OSHA,Process Safety Management (PSM)	Applies if storage of 10,000 pounds or more of hydrogen at the site.		Federal OSHA				

Road Access, Traffic	***On Site Production, Reformer, Electrolyzer***						
Health & Safety Code	Handling of H2	Public Health Dept	Public Health Dept	Public Health Dept			
Calif Vehicle Code	Transport			Local Gov, Police, CHP	DOT, EPA		
Calif Environ Quality Act -CEQA	EIR		Local Planning Dept	Permitting Process		Local City Planning Guidelines	
	Transporting of flammable liquids or gases – Local regulated roads and bridges.						
	Transporting of flammable liquids or gases – State regulated roads, highways, bridges, tunnels.			California Highway Patrol (CHP)	DOT		
	Assume that delivery vehicle must be on private property when off loading product. Cannot be parked on a public street during off loading.						

California Code of Regulations Title 21 Section 1402.1(b) states that tank vehicles which are placarded "Flammable" under Department of Transportation (DOT) Regulations whether loaded or empty are not permitted on the Bay Bridge for example. "FLAMMABLE" is the proper placard for vehicles transporting materials with a hazard class of 3. Liquid Hydrogen has a hazard class of 2.1, the proper placard is “Flammable Gas”. Therefore, it is believed that transporting liquid hydrogen across the Bay Bridge is permitted according to these regulations. This is probably an area where help and clarification will be needed.

Aesthetics / Special Zoning Requirements	*On Site Production, Reformer, Electrolyzer*						

It is believed that this will vary quite a bit from city to city, as well as the specific location that the station is at (for example if the area is zoned for commercial, light-industrial, heavy-industrial, etc.). Some cities have specific height restrictions, require screening to hide the equipment, noise restrictions if close to residential areas, etc. These issues are not specific to hydrogen only. This would apply to any industrials tanks, equipment, etc.

When the revised codes such as NFPA and IFC are published they will address underground storage of liquid hydrogen storage tanks as well as gaseous storage and equipment installation on the top of canopies.

On first pass no specific or unique issues pertaining to hydrogen or hydrogen fueling stations were identified. Good engineering practice, local codes, national recognized standards, etc. should all be followed, but the fact that this is a H2 station should not create any changes in the design, construction, installation, or operation of the station relating to this item. As additional people review the document and new things come to light, this section will be updated.

Acronyms:

SFM – Office of the State Fire Marshal
NFPA – National Fire Protection Agency
DOSH – Department of Occupational Safety & Health
DSA – Department of the State Architect
DAS – Disability Access Section
CalOSHA – California Occupational Safety & Health Agency
W&M – Weights and Measures
PHA – Process Hazard Analysis
HMMP – Hazardous Materials Management Plan
AQMD – Air Quality Management District
EIR – Environmental Impact Report
OSHPD – Office of Statewide Health, Planning & Development
UPS – Unified Program Section
O/M – Operations and Maintenance
ASME – American Society of Mechanical Engineers
DMV – Department of Motor Vehicles
OES – Office of Emergency Services
NIST – National Institute of Standards and Testing
BACT – Best Available Control Technology
RMP – Risk Management Plan
HMIS – Hazardous Materials Inventory Statement
PUC – Public Utilities Commission
UL – Underwriter Laboratories
IEEE – Institute of Electrical and Electronics Engineers
APCD – Air Pollution Control District
ARB – California Air Resources Board
HCD – Housing and Community Development
HMBP – Hazardous Materials Business Plan
CFC – California Fire Code
CUPA – Certified Unified Program Agency
IAPMO – International Association of Plumbing and Mechanical Officials

2.2 Pressure Vessels for Station Storage of Hydrogen

The term ‘pressure vessel’, within the present scope, refers to the “system that stores gaseous hydrogen and/or liquid hydrogen from the point of supply at the fuelling station property, to the filling connector installed on-board the land vehicle and/or an external or internal electric grid”. Pressure vessel can be a high-pressure gaseous storage system, liquid hydrogen system or a metal hydride system. This section includes an overview of the relevant codes and standards for fuel station pressure vessels, identifies gaps and provides recommendations.

Overview

Pressure vessels used in California for the storage of alternative fuels are required meet the requirements of the American Society of Mechanical Engineers (ASME) Code, utilizing the appropriate section (e.g. ASME Section VIII), unless specifically accepted by the Division of Occupational Safety & Health (DOSH) Pressure Vessel Unit, of the California Department of Industrial Relations.

In April 2004, ASME set up a Boiler and Pressure Vessel (BPV) Project Team on Hydrogen Tanks to undertake the necessary standards development in support of the hydrogen infrastructure. ASME has determined that (1) BPV Code Section VIII Division 1 is suitable for stationary liquid hydrogen vessels (2) provisions for higher strength materials and alternative construction techniques that are appropriate for high pressure hydrogen storage, up to 15,000 psi, are to be introduced in BPV Code Section VIII (Division TBD), upon consultation with existing hydrogen storage standards including on-board fuel-storage storage standards (3) provisions to address metal hydride expansion loadings in vessel design are to be introduced in BPV Code Section VIII Division 1. ASME is considering a “Code Case” approach, which is a relatively fast-track process (approximately 2 years) to establish alternatives to the published rules in Section VIII, to such that large volume ground storage tanks for up to 15,000-psi hydrogen storage become feasible.

ASME standards currently facilitate H2 ground storage at 5,000 to 6,000 psi but become virtually impractical at the 12,000 to 15,000 psi level that is required for the 10,000 psi on-board storage which is necessary to support the range requirement of FC vehicles. While specific codes and standards for up to 15,000 psi hydrogen ground storage tanks are being developed in the US, Canada and various EU members are allowing on-board hydrogen storage tanks to be used with time limitations in ground storage applications. On-board hydrogen tanks, which can be designed and validated for limited life and specific service in the vehicle environment, differ from ASME vessels in terms of fatigue life, burst margin and requirement for periodic inspections. Codes and standards that govern on-board hydrogen tanks should be performance-based, rather than the prescriptive approach taken by ASME.

ASME Codes

Background

The American Society of Mechanical Engineers (ASME) was formed in 1880 to project a national role for mechanical engineers. In 1883, a paper was presented at the annual meeting on the need to adopt a set of rules for conducting boiler tests, which would be generally accepted among engineers as a standard code of practice. As a result, a test code was published in 1884, which became the first ASME standard. In 1911, ASME recommended the establishment of an organization to coordinate the development of voluntary standards in the U.S.A. and, subsequently, ANSI was established in 1918.

Today, ASME is a non-profit educational and technical organization with more than 125,000 members worldwide, most of which are practicing engineers. The ASME Board of Governors has delegated the codes and standards activity to a 22-member Council on Codes and Standards, which directs all aspects of the program. Under the council are 10 boards made up of ASME members and other interested parties. Six of those boards are supervisory boards that in turn have committees, each responsible for a specific area of standard development. After a standard has been considered and reconsidered at many meetings and through many drafts, it is sent to the consensus committee, representing all interests, which votes on the standard. It is then made available for public comment and must be approved by the appropriate ASME supervisory board.

ASME Boiler and Pressure Vessel Code has the following sections:

- Section I. Power Boilers
- Section II. Materials
- Section III. Rules for Construction of Nuclear Facility Components
- Section IV. Heating Boilers
- Section V. Nondestructive Examination
- Section VI. Recommended Rules for the Care and Operation of Heating Boilers
- Section VII. Recommended Guidelines for the Care of Power Boilers
- Section VIII. *Pressure Vessels*
  - Division 1
  - Division 2
  - Division 3
- Section IX. Welding and Brazing Qualifications
- Section X. *Fiber-Reinforced Plastic Pressure Vessels*
- Section XI. Rules for In-service Inspection of Nuclear Power Plant Components
- Section XII. Rules for Construction and Continued Service of Transport Tanks

ASME Section VIII ‘Pressure Vessels’ is perhaps the most universally recognized pressure vessel code. In general, various federal and state laws require that pressure vessels of metal construction used in industrial systems meet the design and fabrication requirements in ASME Section VIII. A new edition of the ASME Boiler and Pressure Vessel Code is published every three years. The 2004 Code is the latest version.

ASME BPV Code, Section VIII, Division 1 ‘Design and Fabrication of Pressure Vessels’ provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures exceeding 15 psig. Specific requirements apply to several classes of material used in pressure vessel construction, and also to fabrication methods such as welding, forging and brazing. It contains mandatory and non-mandatory appendices detailing supplementary design criteria, nondestructive examination and inspection acceptance standards. Storage vessels are typically made in accordance with Appendix 22.

ASME BPV Code, Section VIII, Division 2 ‘Alternative Rules’ provides an alternative to the minimum requirements for pressure vessels under Division 1 rules. In comparison the Division 1, Division 2 requirements on materials, design, and nondestructive examination are more rigorous; however, higher design stress intensify values are permitted. Division 2 rules cover only vessels to be installed in a fixed location for a specific service where operation and maintenance control is retained during the useful life of the vessel by the user who prepares or causes to be prepared the design specifications.

ASME BPV Code, Section VIII, Division 3 ‘Alternative Rules for Construction of High Pressure Vessels’ provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures at very high pressures. Division 3 rules cover vessels intended for a specific service and installed in a fixed location or relocated from work site to work site between pressurizations. The user, who prepares the design specifications, retains the operation and maintenance controls during the useful life of the vessel.

ASME Section X “Fiber-Reinforced Plastic Pressure Vessels” was initially adopted in 1977. It is a design-based standard for fiberglass pressure vessels. Pressure vessels must burst at five (5) times their rated operating service pressure, after being cycled to design pressure 3,000 times at minimum design temperature and 30,000 times at maximum design temperature. For filament wound pressure vessels with polar boss openings, this maximum service pressure is 3,000 psi. Carbon fibers and aramid fibers were added later, however, using the same requirements as glass (i.e. factor of safety of 5). Designs are fully-wrap, generally with non-metallic liners. Applications are stationary and there is no limitation on service life and there is no prescription of in-service inspections. The only qualification tests are cycle and burst tests.

Status

In 2003, ASME Boiler and Pressure Vessels (BPV) board has established a committee to study the requirements for rules for hydrogen storage and transport tanks to be used in hydrogen infrastructure applications. The committee recommendations, which were made public in April 2004, include the following:

(1) Develop Code requirements to accommodate new high strength steels and high-strength aluminum for the construction of relatively lightweight vessels for ASME BPV Code Section VIII Division 1 construction.

(2) Obtain data on hydrogen embrittlement threshold stress intensity factor K_{IH} as a function of the material strength and hydrogen pressure for metallic vessels and non-Aluminum liners used with composite vessels. Use these data in developing BPV Code rules for new construction [BPV Code Section VIII Division 1] as well as post-construction guidelines for inspection of cracking and also periodic in-service inspection and testing of these vessels [Post-Construction Committee].

(3) Develop requirements for composite vessels, for pressures up to 15,000 psig MAWP (maximum allowable working pressure) for ASME BPV Code Section VIII Division 1 construction using guidance from ASME Code Case 2390, DOT standards FRP-1 (Basic requirements for Fiber Reinforced Plastic Type 3FC Composite Cylinders), FRP-2 (Basic requirements for Fiber Reinforced Plastic Type 3HW Composite Cylinders), and CFFC (Basic requirements for Fully Wrapped Carbon Fiber Reinforced Aluminum Lined Cylinders), CSA NGV-2 (Metal or Polymer Lined Cylinders with or without Composite Wrap). These requirements could be developed for a Code case, a mandatory Appendix or a separate standard that references the appropriate Code Sections.

For liquid hydrogen, it was recommended that the present ASME BPV Code Section VIII Division 1 and Section XII are suitable, and no code change is required. Also, it was recommended that a non-mandatory appendix will be developed for BPV Section VIII Division 1 that will include a method to address metal hydride expansion loadings and compatibility issues between the metal hydrides and the vessel material.

A Boiler and Pressure Vessels (BPV) Hydrogen Project Team was established in April 2004, with the task of drafting the requirements for ground storage, transportation and portable hydrogen tanks. The team met in September ’04 to discuss approaches for developing an ASME code for hydrogen ground storage tanks up to 15,000 psi for refueling infrastructure. At this meeting, the project team agreed that existing ASME Section VIII BPV Code specifications might be inadequate for high-pressure (up to 15,000 psi) hydrogen storage. For example, steel tanks made using the ASME provisions may be limited to about 6 in. in diameter, due to (a) the 135-ksi strength-limit driven by hydrogen embrittlement and (b) the limit of 1.5 in. steel wall thickness to ensure uniformity in heat treatment. However, large diameter (> 20 in.) 15,000 psi composite pressure vessels can be designed and built following the provisions of newer, state-of-the-art, hydrogen tank standards (e.g. CSA/ANSI NGV2, CSA B51, ECE/EIHP) for vehicular applications.

The project team is now evaluating two methods to introduce new requirements within the scope of ASME codes:

(1) "Code Case" route – code cases specify a set of design/material prescriptions and performance requirements for a specific application. Code Case is tied to an ASME section, but not officially part of that section. Advantages include expediency (mandated fast movement through ASME oversight committees; 2 yrs from start to finish vs. 4 years of more for regular ASME code modifications) and lack of ANSI (public) review. Disadvantage include the risk of a state not recognizing the legal validity of a 'code case'

(2) Assimilation into an existing standard, such as a mandatory appendix of Section VIII.

ASME may attempt both approaches in parallel. Code Case 2390, associated with BPV Section VIII Division 3, currently allows composite reinforced pressure vessels (limited to 3,625 psi), and is expected to be used as a template for the hydrogen ground storage tank code case. It appears that certain trends within ASME may help to expedite the process of gaining recognition for high strength material tanks for ground storage. For example, ASME board is now recommending various project teams to consider a performance-based approach as opposed to the traditional approach based on stringent design prescriptions. Performance-approach is more conducive to introduce innovative technologies.

A subcommittee has been formed to draft ASME guidelines for stationary tanks. Next ASME Hydrogen Project meeting will be in San Francisco in December 2004.

NFPA Standards

Background

National Fire Protection Association (NFPA) is an international nonprofit membership organization founded in 1986. Today NFPA has more than 75,000 members representing nearly 100 nations. NFPA influences every building, process, service, design, and installation in the United States, as well as many of those used in other countries. NFPA develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks. NFPA is accredited by ANSI, and uses an ANSI-approved consensus process. NFPA codes and standards have no legal enforceability. However, NFPA uses enforceable language to enable AHJs to reference the NFPA documents in legal provisions.

The first edition of NFPA 52 was published in 1984 to address fire safety of natural gas vehicular fuel systems. NFPA 52 is being revised to comprehend fueling and maintenance facilities for hydrogen-fueled vehicles. Revisions are expected to be completed in 2005. The current draft NFPA 52 references ASME's Boiler Pressure Vessel Code.

Status

NFPA has set up "Hydrogen Coordinating Group", outside of the normal NFPA code committee structure, to allow wide participation in the development of hydrogen standards. Current status of NFPA 52 is as follows:

1. NFPA 52 Draft with hydrogen provisions, has been completed
2. NFPA "Vehicle Alternative Fuels Technical Committee" voted to proceed with the changes, in March 2004
3. Public comments on the changes were due by October 1st, 2004

4. The Vehicle Alternative Fuels Technical Committee will review the comments November 9-11, 2004 at NFPA meeting in Las Vegas
5. Results of committee decisions will be published by April '05
6. NFPA Standards Council "floor vote" in July '05
7. NFPA 52 publication by August/September '05

U.S. DOT Regulations

The DOT Research and Special Programs Administration (RSPA) administers a comprehensive hazardous materials safety program to "protect the American people from the risks to life, health, property and the environment when these goods are transported by water, air, highway and rail". Through the Office of Hazardous Materials Safety (HAZMAT), they develop safety regulations and standards for the transportation of hazardous materials including their classification, handling and packaging. The following DOT-RSPA specifications are authorized for the transportation of compressed hydrogen (UN 1049, Division 2.1):

Cylinders:	DOT Specifications 3, 3A, 3AA (steel) and 3AL (aluminum): water capacity not over 1,000 pounds; *service pressure* at least 150 psig (typically 2,000 to 3,600 psig). (49 CFR 178.36; 178.37; 178.46).
	DOT Specification 4B, 4BA and 4BW (steel): water capacity not over 1,000 pounds; *service pressure* 150 to 500 psig (typically 240 psig). 49 CFR 178.50; 178.51; 178.61
	Composite cylinders (steel and aluminum liners wrapped with fiberglass or carbon) manufactured under DOT exemptions: water capacity not over 200 pounds; *service pressure* 900 to 5,000 psig (typically 2,000 to 4,500 psig). FRP-1 & 2; CFFC.
Tube Trailers:	DOT Specifications 3AX and 3AAX (steel): water capacity greater than 1,000 pounds; *service pressure* greater than 500 psig (typically 2,000 to 3,600 psig). 49 CFR 178.36; 178.37.
Tank Car Tanks:	DOT Specification 107A (steel): similar in size to tube trailers; gas pressure at 130 F must be less than 70% of *test pressure.* 49 CFR 179.400.
Portable Tanks:	DOT Specification UN portable tanks. Portable tanks manufactured under DOT exemptions based on DOT Specification MC-338 (see cargo tank above). 49 CFR 178.274.

The FRP-1 code was developed in the 1970s by the Compressed Gas Association and used by DOT RSPA to grant exemptions for full-wrap (with metal liner) transportable cylinders such as firemen's backpack and aircraft escape slide pressure vessels. This code prescribes a burst safety factor of 3.33, since it was originally developed for glass fiber. Aramid fiber was added later at the same burst factor. Performance tests include bonfire, gunfire, and 10,000 operating and 30 proof-pressure cycles.

The FRP-2 code was developed in the 1980s by the Compressed Gas Association and used by DOT RSPA to grant exemptions for glass hoop wrapped aluminum tanks. The burst factor is 2.5. Aramid fibers and steel liners were included later. Performance tests are similar to those in FRP-1.

DOT CFFC, "Basic Requirements for Fully Wrapped Carbon-Fiber Reinforced Aluminum Liner Cylinders", was developed by RSPA to grant exemptions for carbon fiber full wrap of aluminum liners with 3.4 factor of safety. This code is very design restrictive and performance tests are similar to those in FRP-1.

DOT compliance is required for mobile fueling systems that are transporting hydrogen. DOT requirements do not supercede the local AHJ requirements when a mobile fueling unit is parked as part of a fueling station and used as a stationary device.

Canadian Experience

Canada has opted to allow vehicle cylinders for use in ground service based on the following rationale:

(1) Experience with compressed natural gas filling stations over the last 20+ years has demonstrated that service conditions are far less severe than in vehicle applications
(2) Ground storage is not exposed to extreme temperatures, vibration, pressure cycle amplitudes, chemical exposure, or the increased risk of impact damage and fire exposure associated with vehicle operations
(3) Studies of pressure amplitudes experienced at CNG stations, fracture mechanics analyses, and pressure cycle testing of cylinders to failure under different pressure amplitudes have demonstrated that the fatigue conditions in ground storage are approximately an order of magnitude less severe than that in vehicle service.

Recommendations

The Division of Occupational Safety and Health (DOSH) is the state agency mandated to protect employees working in the state of California in compliance with Title 8 of the CCR (T8CCR). In particular, the Pressure Vessel Unit of the DOSH provides operating permits for the installation and use of steam boilers, air tanks, and LPG tanks, and provides inspection services for other types of pressure vessels that do not require permits.

It is recommended that T8CCR regulations be enforced at the local level during the normal permitting process in order to avoid problems developing after installation has been completed. In this regard, it is recommended that the Governor or Legislature should direct DOSH to incorporate rulemaking language in Title 8CCR requiring a permit with the California Division of Industrial Safety for the use or cause of use of hydrogen storage vessels, similar to that already in place for LP-gas systems. Additionally, funding should be allocated to DOSH and CalOSHA to appropriately support the execution, review, and enforcement of these permits.

It is also recommended that DOSH should consider new code adoption, to apply to relevant sections of California Code of Regulations Titles 8 and 24 that address applications involving hydrogen as a transportation fuel. This process should include coordination with the Office of the State Fire Marshal and the California Building Standards Commission to appropriately ensure complimentary code selection and regulatory development.

Further recommendations are summarized in the table below.

Gap Analysis & Recommendations

Hydrogen Ground Storage Requirement	Gap Analysis	Recommendation
Storage up to 6,000 psi	Current ASME BPV Code Section VIII Division 1 Appendix 22 supports intermediate pressure ground storage tanks	No action necessary
Storage up to 15,000 psi	Tanks of limited capacity (typically 6 inches in diameter) can be fabricated using current ASME BPV Code Section VIII Division 2. High capacity ground storage tanks of larger diameters are not feasible under the current ASME provisions due to (a) the 135-ksi strength-limit driven by hydrogen embrittlement and (b) the limit of 1.5 in. steel wall thickness to ensure uniformity in heat treatment. However, large diameter (> 20 in.) 15,000 psi composite pressure vessels can be designed and built following the provisions of newer, state-of-the-art, hydrogen tank standards (e.g. CSA/ANSI NGV2, CSA B51, ECE/EIHP) for vehicular applications.	Request ASME to expedite the development of a Code Case for hydrogen storage tanks, in association with ASME BPV Code Section VIII Division 1. Request CalOSHA to consider an interim approach, as is currently accepted in Canada and Europe for time-limited use.
Liquid Storage	Current ASME BPV Code Section VIII Division 1 is suitable for stationary liquid hydrogen vessels	No action necessary
Metal Hydride Storage	Current ASME BPV Code provisions do not address compatibility of hydride material and the vessel wall and also additional loading from hydride expansion	Request ASME to expedite the on-going enhancement to ASME BPV Code Section VIII Division 1 to address metal hydride storage

STATE OF CALIFORNIA Arnold Schwarzenegger, *Governor*

DEPARTMENT OF INDUSTRIAL RELATIONS
Division of Occupational Safety & Health
Pressure Vessel Unit
1515 Clay Street, Suite 1302
Oakland CA 94612-1402
Tel: (510) 622-3066 Fax: (510) 622-3063

August 2, 2004

To: All Interested Parties

Subject: Alternative Fuel Regulations

Our office has received numerous inquires from employers as to what the regulations are for the use of various alternative fuels, such as: compressed natural gas (CNG); liquefied natural gas (LNG); compressed hydrogen (H2); liquefied hydrogen (LH2); and liquefied petroleum gas (LPG). This letter will attempt to provide clarification.

The Division of Occupational Safety & Health (DOSH) is the state agency mandated to protect employees working in California. DOSH has a number of units that assist in this goal. The two that are most applicable are the CalOSHA Enforcement Unit and the Pressure Vessel Unit. The CalOSHA Enforcement Unit is typically referred to, as simply CalOSHA and most employers and employees are aware of its role in ensuring a safe working environment through investigating accidents and complaints. The Pressure Vessel Unit provides operating permits to employers using steam boilers, air tanks, and LPG tanks and supplying inspection services for other types of pressure vessels that do not require permits.

Employers are required to maintain their workplaces in compliance with the California Code of Regulations Title 8 (T8CCR). Copies of T8CCR may be purchased through Barclays at (800) 888-3600 or viewed on-line at http://www.dir.ca.gov/samples/search/query.htm. The Unfired Pressure Vessel Safety Orders are found in T8CCR Division 1, Chapter 4, Subchapter 1 and provide the regulations for CNG & LNG (Article 7), LPG (Article 5), and the Design and Construction of Pressure Vessels for other than Compressed Air, LPG, NH3, and Natural Gas (Article 2). Hydrogen regulations can be found in T8CCR Division 1, Chapter 4, Subchapter 7 Article 138. The scope section of each subchapter will determine the applicability of those regulations to your installation and the subchapters may also refer to other sections or standards that may apply.

While only LPG tank installations are the only alternative fuel that requires a permit to operate issued by the Pressure Vessel Unit, employers are still required to have their natural gas and hydrogen systems in compliance with the appropriate sections of T8CCR. The Pressure Vessel Unit can assist employers in complying with T8CCR by providing a consultation and on-site inspection at the employer's request, the results of which may be documented and supplied to the employer for their records.

There is also an acceptance process for those installations that do not strictly conform to T8CCR. The employer may petition the CalOSHA Standards Board to be granted a permanent variance from T8CCR by demonstrating that their installation is as safe or safer than one that complies with T8CCR. The variance process allows an employer to present information to the Standards Board at a formal hearing, after which, a decision will be made whether to grant the permanent variance or not. Application procedures will be supplied by the Standards Board, which may be contacted at (916) 274-5721.

A few technical questions have popped up consistently that need to be addressed. First, a change in Article 7 Section 527(c) in February 2003 required that LNG facilities use a methane gas detection system instead of odorization of the natural gas. The detection system shall be in the vicinity of the transfer operation and the vessel into which the gas was delivered and shall have both an audible and visible alarm device that signals when the methane airborne concentration exceeds 20% of the lower explosive limit. Another issue concerns the filling of LNG tanks. Article 7 Section 528(c) states that "To provide for the expansion of LNG with temperature, the tanks shall not be filled beyond the level specified by the tank manufacturer and in no case more than 90 percent." Article 7 Section 541(a)(6) requires that all CNG and LNG safety relief devices be tested annually. And finally, all pressure vessels used for the storage of these alternative fuels are required to be manufactured in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Code, utilizing the appropriate section, unless specifically accepted by the DOSH Pressure Vessel Unit as equivalent to the ASME Code.

It is hoped that this information provides you with additional guidance as to what the current regulations are for the use of these alternative fuels in places of employment in our state. Please feel free to contact this office if you need further assistance or would like to have a consultation with one of our engineers. Our goal is to assist you in providing a safe working environment for your employees and to reduce the risk of an accident at your facility.

Sincerely;

Donald C. Cook

Donald C. Cook
Principal Safety Engineer

2.3 Vehicle Interface

The Vehicle Interface consists of the dispensing unit that moves the fuel to the vehicle from its storage tank in the refueling station. It includes the refueling nozzle, hoses, valves, pumps, compressors and safety devices such as pressure relief devices and breakaway connections for nozzle hoses. It includes provisions for fuel quality including chemical composition, temperature, flow rate and pressure at the point of presentation to the vehicle.

Three forms of hydrogen refueling are encompassed in the following assessment: compressed gaseous hydrogen, liquid hydrogen, and blends of CNG and hydrogen. While the primary focus of initial hydrogen infrastructure deployment is expected to be compressed hydrogen to coincide with the majority of vehicles projected to be available for refueling in the early years prior to 2010, some vehicles using liquid hydrogen are also expected to be deployed. It is expected that fuel cell powered vehicles will operate on "pure" (>>99%) hydrogen fuel, while vehicles with internal combustion engines (ICEs) tuned to operate on hydrogen blends may also be deployed. The dispenser equipment used for these three types of hydrogen refueling will be different and distinct.

There are few codes and standards that cover hydrogen vehicle interface. Standard Development Organizations (SDOs) such as SAE, ASTM, CSA America and ISO are working on draft standards. Since the technology is not yet in the commercial phase, it has been premature to formalize codes and standards.

However, there are a number of evolving guidelines and station test devices that have been developed and demonstrated by individual parties and coordinated programs (e.g., the California Fuel Cell Partnership) which could be used in the interim for guidance.

Gaseous Hydrogen Vehicle Interface Recommendations:

1) State of California should recommend that the California Air Resources Board changes the language on California Code of Regulations 13; ARB Division 3, Chapter 5, Article 3 #2292.7 (specifies a composition of hydrogen fuel) to clarify that it does not apply to fuel cell vehicles.

2) State of California should recommend that California Bureau of Weights and Measures work with NIST to develop methods to measure hydrogen composition, mass flow rate, temperature and pressure to support retail sale. It is anticipated that the methods developed will be demonstrated at the California Fuel Cell Partnership.

3) Hydrogen Dispensers: Prior to 2010 as the onboard storage technologies are evolving and the corresponding technology for dispensers is also evolving, best practices based on documented safety evaluation should be considered where SDO standards have not yet been developed. For compressed storage dispensers, CSA/ HGV standards augmented to consider compatibility of

component materials with hydrogen at the applicable pressure range can be used.

4) The State of California should be prepared to periodically inspect dispensers installed in fueling stations as is typically performed with conventional fuel dispensers.

Liquid Hydrogen Vehicle Interface Recommendations:

1) Vehicle Interface: Utilize a best practice available at the California Fuel Cell Partnership from industry members (BMW/GM) until such time that a nationally recognized hydrogen quality standard is available.

2) State of California should recommend that California Bureau of Weights and Measures should work with NIST to develop measurement protocols

Hydrogen-Compressed Natural Gas (HCNG) Interface Recommendations:

Standards for HCNG fuel blends would require definition of the upper limit hydrogen percentage and pressure so that material constraints could be specified. Given the diversity of localized fleet applications that use HCNG blends (e.g., bus fleets), it is not foreseen by this Team that such a limit will be specified in the near term in California. Therefore, uniform standards for HCNG blends in California were not addressed by this Team.

However, to enable accelerated use of these blended fuels, the State of California could recommend that the NIST and the California Bureau of Weights and Measures investigate methods and standards to measure HCNG fuel fill rate limitations and HCNG fuel percentages.

An additional recommendation would be for the State to request CSA America and the US DOE work together to research issues relevant to codes and standards for HCNG fueling stations.

Background

These recommendations are based on an analysis of the current status of codes and standards and gaps requiring action. That analysis follows.

The current status of the Standards Development Organizations (SDOs) in developing standards and codes for the hydrogen fueling station is summarized in the following tables. The recommended action for the State of California is to monitor the progress of the SDOs carefully so that California State-level AHJs can be assured of the comprehensive nature of the standards and codes in assuring safety and so that the State-level AHJs will be able to propose amendments in the process of adopting the codes for use in California to accommodate local requirements.

Since hydrogen storage technologies applied onboard vehicles are expected to advance considerably in the period up to 2010, technologies for fueling vehicles will be advancing complementarily. As formal codes and standards for the use of fuel nozzles and dispensing units evolve, provisions under State Code to introducing new technologies using codes for the application of the technologies in similar situations or comprehensive data-driven formal risk management assessments can be used to demonstrate safety for implementation during the period that SDOs formalize codes and standards.

H2 Highway: **C&S for Compressed H2** vehicle refueling interface *(DRAFT)*

Status: 8/11/04

Draft Standards		Applicable Released Standards		Recommendations:
		Gap Analysis Key:		
			= Gap requiring additional supporting documents for interim	
			= Gap which can utilize current release C&S until update is available	
			= No Gap: Applicable C&S already released	
CSA America				
CSA America HGV 4.1-	Compressed Hydrogen Dispensers			Utilize CaFCP* Fueling Interface Guideline/ STA until HGV Standards are Released
CSA America HGV 4.2-	Hoses and Hose Assemblies for Gaseous Hydrogen Vehicles and Dispensing Systems	**CSA America NGV 4.2-**	Hoses and Hose Assemblies for Gaseous Natural Gas Vehicles and Dispensing Systems	Components chosen must be Hydrogen compatible @ applicable pressure range
CSA America HGV 4.3-	Temperature Compensation Systems for Gaseous Hydrogen Vehicle Fueling Stations			Utilize CaFCP* Fueling Interface Guideline/ STA until HGV Standards are Released
CSA America HGV 4.4-	Breakaway Devices for Hoses Used in Compressed Hydrogen Vehicle Fueling Stations	**CSA America CNG 4.4-**	Breakaway Devices for Hoses Used in Compressed Natural Gas Vehicle Fueling Stations	Components chosen must be Hydrogen compatible @ applicable pressure range
CSA America HGV 4.5-	Priority and Sequencing Equipment for Gaseous Hydrogen Dispensing Systems	**CSA America CNG 4.5-**	Priority and Sequencing Equipment for Gaseous Natural Gas Dispensing Systems	Components chosen must be Hydrogen compatible @ applicable pressure range
CSA America HGV 4.6-	Manually Operated Valves Used in Gaseous Hydrogen Vehicle Fueling Stations	**CSA America CNG 4.6-**	Manually Operated Valves Used in Gaseous Natural Gas Vehicle Fueling Stations	Components chosen must be Hydrogen compatible @ applicable pressure range
CSA America HGV 4.7-	Standard for Automatic Pressure Operated Valves for Use in Gaseous Hydrogen Vehicle Fueling Stations	**CSA America CNG 4.7-**	Standard for Automatic Pressure Operated Valves for Use in Gaseous Natural Gas Vehicle Fueling Stations	Components chosen must be Hydrogen compatible @ applicable pressure range
CSA America HGV 4.8-	Hydrogen Gas Vehicle Fueling Station Compressor	**CSA America CNG 4.8-**	Natural Gas Gas Vehicle Fueling Station Compressor ***	Components chosen must be Hydrogen compatible @ applicable P & T range
CSA America HGV 2	Hydrogen Gas Vehicle Fueling Container	**CSA America CNG 2**	Natural Gas Gas Vehicle Fueling Container	Components chosen must be Hydrogen compatible @ applicable P & T range
CSA America PRD-1/ HGV	Pressure Relief Devices for Hydrogen Gas Vehicle (HGV) Fuel Containers	**CSA America PRD-1/ CNG**	Pressure Relief Devices for Natural Gas Gas Vehicle (CNG) Fuel Containers	Components chosen must be Hydrogen compatible @ applicable Temperature range
CSA America FC 5/ UL 2264	Hydrogen Generators Utilizing Fuel Processing Technologies			
Society of Automotive Engineers International				
SAE J2601	Performance requirements for the communications and refueling algorithms of a automotive gaseous and liquid hydrogen dispensers			Utilize CaFCP* Fueling Interface Guideline/ STA until SAE Standards are Released
SAE J2579	Recommended Practice for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles	**SAE J2578**	Recommended Practice for General Fuel Cell Vehicle Safety	
SAE JXXXX	Hydrogen Quality Guideline for Automotive Applications (Standard number has not yet been issued)			Utilize CaFCP* H2 Quality Guideline & HQSA (H2 Quality Sampling Adapter) until SAE is published
SAE J2600	Metal Hydride Nozzles to be added by to the J2600. 700 Bar Completion	**SAE J2600**	COMPRESSED HYDROGEN SURFACE VEHICLE REFUELLING CONNECTION DEVICES (Metal Hydride Nozzles not covered)	Recommendation for Metal Hydride Nozzle direction to come from SAE working group
National Fire Protection Association				
NFPA 52**	Vehicular Fuel System Code 2005 (incoporates NFPA 57 as well)- CNG, LNG, LH2,CH2	**NFPA 50A**	Standard for Gaseous Hydrogen Systems at Consumer Sites	
NFPA 55	Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, cylinders, Equipment and Tanks (will also incorporate NFPA 50A & 50B)	**NFPA 50B**	Standard for Liquified Hydrogen Systems at Consumer Sites	
		NFPA 70	National Electrical Code Handbook	
International Codes Council (does not apply to CA)			**Does not apply to CA- Informational Only**	
ICC Model Building Code	Fuel Gas Code: Ch. 7 Gaseous H2 Systems, 632.1; 705; Mechanical Code: 924.1; FIRE CODE: General, 2209, 2211, 3204, 3205 (to be updated)	**ICC Model Building Code**	Fuel Gas Code: Ch. 7 Gaseous H2 Systems, 632.1; 705; Mechanical Code: 924.1; FIRE CODE: General, 2209, 2211, 3204, 3205	
American Standards and Testing Methods				
ASTM D03.14	Subcommittee for C&S on hydrogen and fuel cell vehicles (ASTM V3)- Standard Test methods and guidelines for gaseous (CNG,LNG,CH2) fuels		Various released standards for H2 impurity constituants	Utilize CaFCP* H2 Quality Guideline & HQSA (H2 Quality Sampling Adapter) until SAE is published
California Weights & Measures/ NIST				
		CA B&P Code Division 5	Fuel quality and performance (sections 13440, 13450) ASTM standard not available. Does not have juristiction over fuel cell vehicles.	Recommendation: CaFCP H2 Quality Guideline until SAE/ASTM document is ready
		CA B&P Code Division 5	Measurement of dispensed fuel (sections 12020, 12500, 12500.5, 12500.10, 12510) No standards for H2 for CA Weights and Measures. NIST standards and test procedures not available for hydrogen or blends.	Recommendation: CaFCP STA to be utlized in the interim in coordination with CA W&M / NIST. It is important to represent the spectrum of vehicle to insure safe, representative refueling.
California Air Resources Board (CARB)				
TBD	ARB not currently pursuing C&S regarding H2 Quality,etc. (awaiting industry lead)		Nothing applicable for H2 FCV (existing ICE engine standard would not be appropriate for FCV & ICE sharing station)	Utilize CaFCP* H2 Quality Guideline & HQSA (H2 Quality Sampling Adapter) until SAE is published
ISO (International Standards Organization)-not CA			**Does not apply to CA- Informational Only**	
TC-197	Hydrogen Quality Standard under ammendment in WG 12			

* CaFCP Guidelines are planned to be approved internally at the end of October in the "Station Implementation Resource". CaFCP partner buyoff is required.
** Current standards for Hydrogen IC vehicles which cannot be utilized for H2 stations which have FCV (concerns of ICE values may degrades fuel cells / safety)
STA = hydrogen Station Test Apparatus
HQSA = Hydrogen Quality Sampling Adapter
*** Some further investigation necessary
**** NFPA 52 to be ballotted in October

Critical Recommendations:

State of California should recommend that the California Air Resources Board changes the language on 2292.7 to incude "not including fuel cell vehicles"- next to Motor vehicles before the implementation of the H2 highway.

State of California should recommend that bureau of weights and measures to work with NIST and the California Fuel Cell Partnership to develop safe methodology for reviewing Hydrogen dispensers. The CaFCP has developed a hydrogen Station Test Apparatus (STA) in order to simulate vehicle fills to test station dispensers as well as a hydrogen quality sampling adapter for taking H2 quality samples off of the station dispenser.

H2 Highway: C&S for Hydrogen- CNG (HCNG) "Blend" vehicle refueling interface (DRAFT)

Status: 8/10/04

Draft Standards		Applicable Released Standards		Recommendations:
			Gap Analysis Key:	
			= Gap requiring additional supporting documents for interim	
			= Gap which can utilize current release C&S until update is available	
			= No Gap: Applicable C&S already released	
CSA America				
CSA America NGV 4.1-	Compressed Natural Gas Dispensers	**CSA America NGV 4.1-**	Compressed Natural Gas Dispensers	
CSA America NGV 4.2-	Hoses and Hose Assemblies for Gaseous Natural Gas Vehicles and Dispensing Systems	**CSA America NGV 4.2-**	Hoses and Hose Assemblies for Gaseous Natural Gas Vehicles and Dispensing Systems	Components chosen must be both H2 & CNG compatible
CSA America CNG 4.3-	Temperature Compensation Systems for Gaseous Natural Gas Vehicle Fueling Stations	**CSA America CNG 4.3-**	Temperature Compensation Systems for Gaseous Natural Gas Vehicle Fueling Stations	Standard should be established for the type and format of fuel HCNG
CSA America CNG 4.4-	Breakaway Devices for Hoses Used in Compressed Natural Gas Vehicle Fueling Stations	**CSA America CNG 4.4-**	Breakaway Devices for Hoses Used in Compressed Natural Gas Vehicle Fueling Stations	Components chosen must be both H2 & CNG compatible
CSA America CNG 4.5-	Priority and Sequencing Equipment for Gaseous Natural Gas Dispensing Systems	**CSA America CNG 4.5-**	Priority and Sequencing Equipment for Gaseous Natural Gas Dispensing Systems	
CSA America CNG 4.6-	Manually Operated Valves Used in Gaseous Natural Gas Vehicle Fueling Stations	**CSA America CNG 4.6-**	Manually Operated Valves Used in Gaseous Natural Gas Vehicle Fueling Stations	Components chosen must be both H2 & CNG compatible
CSA America CNG 4.7-	Standard for Automatic Pressure Operated Valves for Use in Gaseous Natural Gas Vehicle Fueling Stations	**CSA America CNG 4.7-**	Standard for Automatic Pressure Operated Valves for Use in Gaseous Natural Gas Vehicle Fueling Stations	Components chosen must be both H2 & CNG compatible
CSA America CNG 4.8-	Natural Gas Gas Vehicle Fueling Station Compressor	**CSA America CNG 4.8-**	Natural Gas Gas Vehicle Fueling Station Compressor	Components chosen must be both H2 & CNG compatible
CSA America CNG 2	Natural Gas Gas Vehicle Fueling Container	**CSA America CNG 2**	Natural Gas Gas Vehicle Fueling Container	Components chosen must be both H2 & CNG compatible
CSA America PRD-1/ CNG	Pressure Relief Devices for Natural Gas Gas Vehicle (CNG) Fuel Containers	**CSA America PRD-1/ CNG**	Pressure Relief Devices for Natural Gas Gas Vehicle (CNG) Fuel Containers	Components chosen must be both H2 & CNG compatible
CSA America FC 5/ UL 2264	Natural Gas Generators Utilizing Fuel Processing Technologies	**CSA America FC 5/ UL 2264**	Natural Gas Generators Utilizing Fuel Processing Technologies	Components chosen must be both H2 & CNG compatible
				CSA to provide a recommended nozzle geometry
CSA America PRD-1/ CNG	Pressure Relief Devices for Natural Gas Gas Vehicle (CNG) Fuel Containers	**CSA America PRD-1/ CNG**	Pressure Relief Devices for Natural Gas Gas Vehicle (CNG) Fuel Containers	Components chosen must be both H2 & CNG compatible
Society of Automotive Engineers International				
	No Standards for HCNG fuels		No Standards for HCNG fuels	
National Fire Protection Association				
NFPA 52	Vehicular Fuel System Code 2005 (incoporates NFPA 57 as well)- CNG, LNG, LH2,CH2. Present draft considers HCNGs with < 20% H2 equivalent to NG. (need to look at 30% HCNGs).	**NFPA 50A**	Standard for Gaseous Hydrogen Systems at Consumer Sites	NFPA 52 should be updated to include HCNG blend fuels above the percentage for natural gas. MM to give comments directly to NFPA
NFPA 55	Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, cylinders, Equipment and Tanks (will also incorporate NFPA 50A & 50B)	**NFPA 52**	Vehicular Fuel System Code 2005 (incoporates NFPA 57 as well) CNG, LNG, LH2,CH2. Present draft considers HCNGs with < 20% H2 equivalent to NG. (need to look at 30% HCNGs).	
		NFPA 70	National Electrical Code Handbook	
International Codes Council (do not apply to CA)				
				Requested Feedback from ICC
American Standards and Testing Methods				
	A means should be established to confirm and monitor that the stated HCNG rate is being achieved.		Various released standards for natural gas impurity constituants	Request Feedback from ASTM
California Weights & Measures/ NIST				
		CA B&P Code Division 5	Fuel quality and performance (sections 13440, 13450) ASTM standard not available.	Current Standards Not Applicable to HCNG Fuels. Fills involving both H2 & NG require fill rate limitation (CNG fills generally do not). The fill rate for HCNG blend fuels may require fill rate limitation. We require a rationale for determining the flow rate limit and a means to verify and monitor it ***Collect Data for developing of Weights & Measure Protocols***. See below.
		CA B&P Code Division 5	Advertising signage (sections 13531, 13532) Only applicable to fuels intended for ICE vehicles	
		CA B&P Code Division 5	Dispenser labelling (sections 13470, 13480) Only applicable to fuels intended for ICE vehciles	
		CA B&P Code Division 5	Measurement of dispensed fuel (sections 12020, 12500, 12500.5, 12500.10, 12510) No standards for H2 for CA Weights and Measures. NIST standards and test procedures not available for hydrogen or HCNGs.	
California Air Resources Board (CARB)				
	TBD			Not Applicable to HCNG Fuels. Collect Data.
ASME				
		B 31.3	Code on Process Piping	Components chosen must be both H2 & CNG compatible
ISO (International Standards Organization)-not CA			**Does not apply to CA- Informational Only**	
TC-197	Work item 15869- Land vehicle filling connectors 20012 Gaseous H2 and hydrogen HCNGs- fueling stations			

Critical Recommendations:

Recommend to the state that it catalyzed the CSA America and relevant SDOs and the US DOE to craft a standard for HCNG % guidelines.
Issue 1: It is necessary to determine the maximum % of H2 below which could be considered natural gas.
Issue 2: Also recommend that the state encourage to the SDOs develop a standard % range of H2 blend into CNG

State of California: Recommend that the state find appropriate groups to develop an interim percentage range HCNG standard while encouraging SDOs to develop a more perminant % range standard. In addition, it is recognized that ISO TC 197 Working group has completed draft standards for HCNG blend fuels. It is recommended to set up an official contact in order to see if it is possible to utilize these draft standards in California.

State of California should recommend that bureau of weights and measures adopt methods and standards to measure HCNG fuel fill rate limitations and HCNG fuel percentages.

H2 Highway: C&S for **Liquid H2 vehicle** refueling interface *(DRAFT)*

Status: 8/09/04

Draft Standards		Applicable Released Standards		Recommendations:
		Gap Analysis Key:		
			= Gap requiring additional supporting documents for interim	
			= Gap which can utilize current release C&S until update is available	
			= No Gap: Applicable C&S already released	
CSA America				
	CSA is not currently doing work in LH2			
Society of Automotive Engineers International				
SAE J2600	LH2 Nozzle addition			Utilize BMW/ GM LH2 Fueling Interface Protocoll until SAE Standard Published
SAE J2601	Performance requirements for the communications and refueling algorithms of a automotive gaseous and liquid hydrogen dispensers			Utilize BMW/ GM LH2 Fueling Interface Protocoll until SAE Standard Published
SAE J2579	Recommended Practice for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles	**SAE J2578**	Recommended Practice for General Fuel Cell Vehicle Safety	
SAE JXXXX	Hydrogen Quality Guideline for Automotive Applications (Standard number has not yet been issued)			Utilize released LH2 Guideline
National Fire Protection Association				
NFPA 52	Vehicular Fuel System Code 2005 (incoporates NFPA 57 as well)- CNG, LNG, LH2,CH2			
NFPA 55	Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, cylinders, Equipment and Tanks (will also incorporate NFPA 50A & 50B)	**NFPA 50B**	Standard for Liquified Hydrogen Systems at Consumer Sites	
		NFPA 70	National Electrical Code Handbook	
International Codes Council (do not apply to CA)				
ICC Model Building Code	Fuel Gas Code; Ch. 7 Liquid H2 Systems:	**ICC Model Building Code**	Fuel Gas Code; Ch. 7 Liquid H2 Systems:	
American Standards and Testing Methods				
ASTM D03.14	Subcommittee for C&S on hydrogen and fuel cell vehicles (ASTM V3)- Standard Test methods and guidelines for gaseous (CNG,LNG,CH2) fuels		Various released standards for H2 impurity constituants	
California Weights & Measures/ NIST				
TBD	Both California & NIST working on standard for weights & measures		Nothing applicable for H2 FCV	Collect Data for developing of Weights & Measure Protocols
California Air Resources Board (CARB)				
TBD	ARB not currently pursuing C&S regarding H2 Quality,etc.		Nothing applicable for H2 FCV	Coordinate with weights and measures
ISO (International Standards Organization)-not CA				
TC-197	Hydrogen Quality Standard			

Critical Recommendations:

State of California should recommend that bureu of weights and measures should investigate and develop measurement protocols

State of California should recommend that ARB to coordinate with Weights and Measures/ NIST

2.4 Energy Stations (On-Site Power Generation)

Energy Station Concept

The end goal of the California Hydrogen Highway is to develop an economically viable fueling infrastructure for the hydrogen vehicles that California expects to develop by 2010. Hydrogen fueling stations can be as simple as dispensing systems for stored hydrogen or more complex systems that produce hydrogen onsite to dispense as vehicle fuel. One station concept, the "energy station", would include the production of hydrogen on-site and use of that hydrogen for both vehicle fueling and for distributed generation of electrical power in a stationary fuel cell or ICE.

An "energy station" would be classified as a "fueling station" if the power produced is consumed solely onsite. A "distributed generation" designation would apply if the energy station's electrical power is sent to the electrical grid beyond the facility. If it is a fueling station, then codes and standards for fueling stations will be applicable. Grid connectivity and provision of onsite-generated electrical power to the grid will be subject to the same standards and codes that apply to other distributed generation technologies connecting to the grid. Hence, no new standards and codes for the onsite use of onsite-generated electricity or export of that electricity to the grid are expected to be required.

2.5 Clearance Distances

Several SDOs and CDOs are working with the federal government, state governments, and industry to develop codes and standards that would provide a basis for assurance of public safety and for permitting hydrogen-fueling stations. Consequently, the relevant codes and standards are evolving and subject to further change. The third Template recommended by this Team (Guideline for Design of a Hydrogen Fueling Station) should provide guidance on clearance distances to those who need to install hydrogen fueling stations.

It is also recommended that the State of California develop and collaborate with the U.S. DOE Hydrogen - Fuel Cells and Infrastructure Technologies Office that is developing permitting templates and supporting R&D to provide comprehensive and sufficient information as the basis for codes and standards for a hydrogen fuel infrastructure and hydrogen-fueled vehicles. Templates of codes, standards and regulations developed by the South Coast Air Quality Management District (SCAQMD) for a number of South Coast regions should be coordinated with the U.S. DOE umbrella activity.

The DOE is developing software that shows the layout of a typical fueling station with the current setback requirements in the International Fire Code. The program allows the user to step through the ICC requirements that affect the footprint of a fueling station;, for example, the setbacks for dispensers, signs, and storage tanks. The next generation of this program will be linked to a flexible database that will, for example, contain setback requirements of the NFPA and other requirements of state and local authorities having jurisdiction that could affect station footprint. DOE plans to further develop the software and database to assist code officials and industry create a set of

footprints that can serve as starting points for locating hydrogen fueling stations in, for example, urban, suburban, and rural areas of California where stations may be located.

The California Hydrogen Highway network will provide a valuable opportunity for state and federal collaboration on hydrogen fueling infrastructure development not only in the implementation stage but also in its evolution. To that end, participants should provide information on performance, reliability, durability and any safety issues to the DOE program so that a statistically significant database can be assembled to competently guide broader deployment of hydrogen infrastructure with confidence in its safe and reliable performance.

2.6 Alternative Approval — Field Certification

This Section addresses the means to acquire field certification for the use of new hydrogen technologies before the existing codes, regulations and standards are revised to comprehend the new technology by approving its components for use with hydrogen. When components are approved for use by an SDO they may be considered to be "listed".[5] In some cases, however, the most common definition of "listing" refers to a Nationally Recognized Testing Laboratory (NRTL) performing detailed evaluation of the component and typically also providing a label.

California Code of Regulations - Hydrogen

The present California Code of Regulations (CCR) addresses commercial and industrial use of hydrogen, but not fueling stations. For reference, note that the only hydrogen systems that are currently considered in the CCR are found in TITLE 8. Industrial Relations (Division 1. Department of Industrial Relations, Chapter 4. Division of Industrial Safety, Subchapter 7. General Industry Safety Orders, Group 20 Flammable Liquids, Gases and Vapors, Article 138. Hydrogen)[6] This regulation is based on NFPA 50A.

Provision for the use of new technology and advancements that differ from code specifications if they are demonstrated to the AHJ as providing equivalent safety and compatible operation to meet the intent of the code can be found in:

- NFPA 52 (1.4 Alternative Provisions)
- ICC Fuel Gas Code (105.2 Alternative materials, methods and equipment)
- ICC Fire Code (104.9 Alternative materials and methods)

---

[5] **NFPA A.3.2.4 Listed.** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

[6] http://www.calregs.com/cgi-bin/om_isapi.dll?clientID=84815&advquery=hydrogen&infobase=ccr&record=%7B1D46F%7D&softpage=Document42&x=0&y=0&zz=

Nationally Recognized Testing Laboratories

NRTLs are qualified private organizations that meet the requirements of OSHA regulations under 29 CFR section 1910.7 to perform independent safety testing and product certification. OSHA makes this determination under its NRTL Program, which is part of OSHA's Directorate of Science, Technology and Medicine.

NRTLs may be based in the United States or in other countries. Currently, 16 NRTLs are established in the United States, and 2 NRTLs are foreign-based. A listing of current NRTLs is at http://www.osha-slc.gov/dts/otpca/nrtl/nrtllist.html.

Alternatives to NRTL Field Evaluations

In general, under 29 CFR Part 1910, products required to be approved must be NRTL approved. However, there are a few exceptions.

Most notably, for electrical products, there are two exceptions. If the electrical products are of a kind that no NRTL approves, then OSHA allows approval of the products by a Federal agency or by a State or local code authority that enforces NEC workplace safety provisions. The other exception concerns "custom-made equipment," which designates equipment designed, made for, and used by a particular customer (i.e., unique or one-of-a-kind items). In this case, the employer must demonstrate safety based on test data provided by the manufacturer. As can be seen, these exceptions are very narrow.

The "CE" mark is a generic marking allowed by the European Union (EU) to indicate that the product meets requirements in the EU for product safety and is unrelated to the requirements for product safety in the United States. OSHA must recognize a foreign testing and certification organization as an NRTL before its product certifications will be considered acceptable to OSHA, so a "CE" label does not imply NRTL validation.

Underwriter's Laboratory (UL) Field Evaluation Service evaluates installed products that have not been previously investigated by UL, or for a UL Listed product that has been modified in the field. Field evaluations are limited to the features and characteristics that can be evaluated at the installed site without damage to the product.

Recommendations

1. Prepare a list of registered NRTLs in the Handbook described in the second Template recommended by this Implementation Team, the Template for Requirements for Permit and Approvals
2. Educate local AHJs in means for permitting/approving equipment using the alternative approaches described in this Section.

3. Risk Assessment & Management

3.1 Insurance & Liability

Insurance is based on the assessment of risk, which includes the probability of an adverse event and the impact (i.e., injury, loss of life or property damage, and cost). Risk is managed primarily through reference to standards and codes for safe installation, maintenance and use of equipment and facilities. Some requirements reduce the likelihood of an adverse event, while others reduce the impact.

Risk is managed by authorities who:

1) Review risk assessment and risk management plans for proposed facilities to ensure that a comprehensive approach has been implemented
2) Inspect the construction of a facility
3) Inspect periodically to verify required maintenance
4) Investigate any adverse event to ensure remedy of its cause and dissemination of lessons learned to other similar facilities.
5) Ensure that training of facility operators is current; and
6) Ensure that training of emergency responders is comprehensive and kept current.

It is recommended that AHJs be responsible for inclusion of these provisions in the recommended Handbook for Hydrogen Fueling in the California Hydrogen Highway.

The SFM and local AHJs should take advantage of training offered at the US DOE's Hazardous Materials Management & Emergency Response (HAMMER) facility and that offered by the US DOT's Transportation Safety Institute. This training will aid development of emergency response guidelines and training modules for California AHJs and emergency responders. The OFSM should oversee the training of AHJs and emergency responders throughout the State to ensure a rapid and safe implementation of the Hydrogen Highway and to ensure consistent high quality practices are initiated throughout the State.

A formal assessment of financial risk by the insurance industry (e.g., likelihood and cost of adverse events) is traditionally established based on historical records of frequency and cost impact of an adverse event. The insurance industry then establishes premiums to cover its financial risk. For a new type of activity, insurance may be difficult or expensive to purchase. Insurers generally charge high fees, limit coverage and/or require high deductibles for covering extraordinary situations where historical experience is thin. These circumstances may present a prohibitive barrier to the installation of fueling stations for smaller size companies. The state should facilitate the collection of the necessary body of statistics and analysis underwriters need to offer rates commensurate with the true risk factors associated with the use of hydrogen in transportation applications. *It is, therefore, recommended that the State create a*

system to record and investigate safety-related incidents and a database of experience available for insurance industry reference.

There are two approaches to obtaining insurance in the early years when robust historical experience statistics are still lacking.

- **First, the facility owner could self-insure.** In that case, the AHJ must be empowered to ensure that the installer/operator has a comprehensive risk management plan and has financial resources to cover liabilities.

- **Secondly, since installation/operation of the fueling stations is in the public interest, the State could mitigate the insurance uncertainty associated with lack of long-term experience by taking two actions:**

    1. Create an insurance pool for partial coverage of deductibles

        Insurance pools are most often developed by state legislatures as a means of providing affordable health insurance to groups of individuals who cannot typically afford insurance or are considered to be uninsurable by the insurance industry. By "pooling" their resources and risk, customers can create a market that makes it more compelling for an underwriter to offer reasonably-priced policies for the clients' unique needs. Pooling hydrogen station providers may be an effective method of providing affordable insurance rates needed to develop the Hydrogen Highway Network.

        Creating an insurance pool for hydrogen station operators in California may require legislative action, and eligibility requirements may need to be defined. Pools are typically funded through member premiums combined with legislative appropriations. Some states have received grants to supplement funding as well. The pool can actively engage in educating insurance companies about the operation of hydrogen stations in order to assist in the development of reasonably priced policies.

        Pools are often used by state transit agencies to obtain coverage. Often times these groups will self-insure, but, in the health care industry, pools are typically underwritten by established health insurance companies.

        In California, there is an example of a pool which may be used as a model for hydrogen: The California Transit Insurance Pool (CalTIP). According to the CalTIP website[7], "CalTIP is a joint powers insurance authority organized under California law in 1987 in response to the lack of liability insurance coverage from the commercial insurance market. CalTIP combines the resources of public transit operators to minimize risk, increase buying power…provide stable, affordable insurance to its members." CalTIP self-insures its members rather than receiving coverage from a commercial underwriter.

[7] http://www.CalTIP.org

2. Temporarily limit liability, such as to actually incurred financial cost

   A temporary limitation of liability would help insurers provide interim rates at reasonable costs because they could better predict what levels of pay-outs they may need to make in the event of a hydrogen related incident. A temporary limitation of liability should be granted to hydrogen station providers who have satisfied AHJ permit requirements in their achievement of requisite risk management. Those requirements are:

   1. Developing risk management plans and submitting them to AHJs for approval.
   2. Constructing facilities that meet inspection requirements.
   3. Satisfying periodical inspections of equipment to verify required maintenance and compliance.
   4. Ensuring the training of facility operators is current

   This limitation of liability should apply to the transition period where commercial experience is acquired to develop the necessary body of statistics the insurance industry needs to offer reasonably priced insurance policies. This option should be phased out as the body of statistics needed by the insurance industry grows to a point whereby underwriters feel they have enough information to accurately price a policy. Thus, the Legislature should include sunset provisions in its establishment.

   A temporary limitation of liability would require legislative action.

3.2 Public Safety and Risk Assessment

To insure adequate risk assessment and management (RA/M*), it is recommended that all groups planning to build hydrogen fueling stations should include specific elements related to RA/M in their permitting submittals.* The table below lists these recommended elements, their purpose, and the group or agency that should review that element. In some cases the specific element may be new to the reviewing group; therefore, training and review tools should be provided to aide the process. In some cases the RA/M element is necessary only until proper codes and standards are in place for hydrogen fueling stations. We recommend dropping those elements when the appropriate C&S are adopted.

Additional RA/M Recommendations:

- Create an Emergency Strike Team to investigate hydrogen fueling station accidents and incidents. The Team would prepare reports that would be available to the hydrogen community. The reports would identify specific actions that would increase fueling station safety.
- Require certification of all hydrogen fueling station maintenance providers.
- Require annual maintenance inspections of critical fueling station hardware and systems. This requirement should be periodically revisited when more station data is available.

- All hydrogen stations that meet all applicable codes and standards should be classified as CEQA 70 – Categorically Exempt (CE).
- State should champion idea that hydrogen stations should be allowed wherever (and perhaps beyond) gasoline is allowed.

The second element of ensuring public safety is the preparation and training of emergency responders. It is recommended that the State take advantage of training offered at the US Department of Energy's HAMMER facility and by the US DOT, and work with the federal government in developing emergency response guidelines and training modules. The State Fire Marshal should oversee the training of AHJs and emergency responders throughout the State to ensure a rapid and safe implementation of the CA hydrogen Highway and to ensure consistent high quality practices are initiated throughout the State.

RA/M Element	Purpose	Reviewed By	Tools to Evaluate	Relax When
Site Quantitative Risk Assessment (QRA)	Measures selected site risk (hazard extent + frequency)	Fire Marshal's office (primary); Zoning (secondary)	Published State guidelines of acceptable risk; Training for reviewers	State adopts sufficient C&S (e.g. NFPA 52, NFPA 55, etc). Require if exceptions to C&S
HazOp	Detailed design review process to ensure safe design and operation	Fire Marshal's office (primary)	Node analysis tables/drawings; Training for reviewers	State adopts sufficient C&S (e.g. NFPA 52, NFPA 55, etc). Require if exceptions to C&S
Emergency Response Plan	Detailed plan for execution should an emergency incident occur	Fire Marshal's office (primary)	Training for reviewers; State standard elements	Continuous requirement
Control Recovery Register	Details overall project (site + equipment + operations) measures	Fire Marshal's office (primary)	Training for reviewers; State standard elements	State adopts sufficient C&S (e.g. NFPA 52, NFPA 55, etc). Require if exceptions to C&S
Insurance	Provides financial protection	State or local agency	State standards	Continuous requirement
First Responder Training	To mitigate impact from incidents that may occur	State or local agencies	State standards	Continuous requirement
Operation Inspections	To enforce safe operations and compliance to C&S	Fire Marshal's office; Weights/Msrs; other	Training; Standards; checklists	Continuous requirement

4. Onroad Regulations for Hydrogen Vehicles

Through consultations with the California Department of Transportation (CalTrans) and the California Fuel Cell Partnership, the Implementation Team found there are presently no restrictions which would prevent the use of hydrogen vehicles on public roads, over bridges, through tunnels, or parking in garages.

The biggest threat these vehicles could pose to public safety would be a hydrogen leak or burst storage tank. The threat of a hydrogen leak does not warrant restrictions on hydrogen vehicle usage in tunnels or parking garages because these structures have high air circulation rates and are already required to provide ventilation for carbon monoxide and other gasoline vehicle emissions. These ventilation methods are generally deemed to be sufficient to prevent the buildup of hydrogen and for hydrogen to be vented in the event of a leak. Specific, additional onroad regulations governing hydrogen storage tanks are unnecessary as codes, standards, and regulations are already well established and applied.

For more detailed information on the use of hydrogen vehicles in parking garages, the reader is encouraged to view the California Fuel Cell Partnership's "Support Facilities for Hydrogen-Fueled Vehicles: Conceptual Design and Cost Analysis Study"[8].

[8] http://www.cafcp.org/pdf/ResourceDocs/FacilitiesStudy08.2004.pdf

5. Conclusion

Critical to the development of the California Hydrogen Highway Network will be the State's development and adoption of a uniform set of hydrogen codes and standards; streamlining and improving the efficiency of permitting processes while taking steps to fully ensure public safety; the education of legislators, municipal officials, permitting officials, the first responder community, and the insurance industry on the safe use of hydrogen; and policies to mitigate early-adopters' insurance risk. The Implementation Topic Team, one of five teams contributing to the development of the Hydrogen Highway Blueprint Plan, evaluated the existing body of codes and standards and associated permitting processes to identify gaps, insufficiencies, inefficiencies, and/or areas of overlap which can be resolved. The Team also evaluated the regulatory and permitting process stream and the relationships and dependencies between the various components.

The result of the Implementation Team's work is a comprehensive set of recommendations designed to create an environment that would allow for the widespread deployment of hydrogen fueling stations in the State by the year 2010. Several of the recommendations will require State legislative action which should initiate in the next legislative cycle.

Clear identification of government authorities having jurisdiction (AHJs) and their permitting requirements will facilitate permitting of hydrogen fueling stations for applicants and for the authorities themselves. By designating the Office of the State Fire Marshal (SFM) as the lead agency for oversight of the codes and standards and permitting processes governing the Hydrogen Highway, the State can expect these processes to be made clear, uniform, streamlined, and consistent in their application. These advantages are to be reinforced when local jurisdictions designate a local AHJ with responsibility for coordinating Hydrogen Highway permitting and training activities within their area.

The use of three distinct templates should be implemented to help the SFM, AHJs, emergency first responders, and station developers to effectively and efficiently permit hydrogen fueling facilities. Those three templates are:

1. Identification and Responsibilities of Authorities Having Jurisdiction
2. Requirements for Permits and Approvals (a "handbook")
3. Guideline for Design of a Hydrogen Fueling Station

Helping station developers obtain affordable insurance should also be considered a priority. Since the cost of obtaining insurance today can be prohibitively high when real-world commercial experience is insufficient for reliable performance statistics, the State should consider creating insurance pools and temporarily limiting liability for early-phase hydrogen station developers.

The Implementation Team Report identifies many detailed recommended actions the State should consider in order to ensure hydrogen stations can be permitted and operational by 2010. The recommendations work together to create a regulatory environment where the state's body of codes and standards is uniform; authorities having jurisdiction and the process of permitting a station is clearly defined; comprehensive risk assessment and risk management measures are enacted; and insurance for early-phase hydrogen stations is affordable.

6. Glossary

Definitions

Authority Having Jurisdiction (AHJ) — The phrase “authority having jurisdiction” is used in code documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional government department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction. The AHJ typically assures compliance with a regulation, code or standard. In the absence of locally recognized codes a precedent is usually sought either from a similar application or a document used by another jurisdiction.

California Building Standards Commission (CBSC) — Charged with reviewing and approving building standards proposed for adoption by relevant state regulatory agencies. Composed of the Coordinating Council and the Code Advisory Committees

Code (Model Code) — Set of broad technical system requirements usually dealing with safety and/or performance of an overall system – established by professional Code Development Organizations (CDOs, e.g., ICC, NFPA) – non-mandatory. Model Codes incorporate by reference various standards. For example, the ICC Building Code incorporates standards published by 50 different organizations (ASTM, NFPA, UL, etc.). Stationary facilities are generally specified by codes and the equipment/process standards that individual codes reference. Comprehensive Model Codes may be adopted by regulatory agencies and, thereby, incorporated into law / regulation, and become mandatory.

Code Advisory Committees — Advises the California Building Standards Commission on proposed building standards by annually reviewing the technical merit of building standards as proposed by regulatory state agencies, and submit recommendations to the CBSC. There are five Code Advisory Committees: the Accessibility Committee; the Plumbing, Electrical, Mechanical, and Energy Committee; the Building, Fire and Other Committee; Structural Design/Lateral Forces Committee; and the Health Facilities Committee.

Coordinating Council — One of two bodies of the California Building Standards Commission. The Coordinating Council submits recommendations for building and fire codes and regulations, and is comprise of representatives of: Health Services, Office of

Statewide Planning and Development, Housing and Community Development, Industrial Relations, State Fire Marshal, California Energy Commission, and General Services.

Control Recovery Register — Provides overall project details such as information on site equipment and operations measures

Emergency Response Plan — Detailed plan of execution should an emergency incident occur

HazOp — Detailed design review process to ensure safe design and operation

Implementation Topic Team (Team) — One of five topic teams contributing to the development of the Blueprint Plan describing how California should develop a network of hydrogen fueling stations by 2010. The Implementation Team addresses issues related to hydrogen codes and standards, and insurance and liability.

Law or Legislative Act — Broad set of legal requirements with no technical details on the subject matter.

Model Codes — See "Code."

Office of the State Fire Marshal (SFM) — A division of the Department of Forestry and Fir Protection dedicated to fire prevention. Responsibilities include: regulation of occupied buildings; managing flammable substances; regulating liquid pipelines transporting hazardous materials; reviewing regulations and building standards; and educating and training officials in fire protection practices.

Regulation — Set of legal requirements to support a Legislative Act or Law. May incorporate reference to technical codes and standards – mandatory

Site Quantitative Risk Assessment (QRA) — A risk management/assessment procedure which measures selected site risk such as the extent and frequency of hazards

Standard — Set of technical requirements, usually dealing with safety and/or performance of equipment or the installation of equipment Mobile/portable products are generally specified by standards. Some standards may be incorporated into local or federal regulations, and thereby become mandatory.

Standards Development Organizations (SDOs) — organizations of professional, technical experts that establish professional, non-mandatory standards to insure safety, compatibility, performance measures, and other features of equipment and processes; e.g., IEEE, CSA America, CGA)

Templates — Guidelines and provisions set forth as recommendations by the Implementation Topic Team to help ensure uniform application of codes and standards for the purpose of facilitating the permitting and installation of hydrogen fueling stations in California.

Acronyms

AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
AQMD	Air Quality Management District
ASME	American Society of Mechanical Engineers
BPV	Boiler Pressure Vessel
C&S	Code(s) and Standard(s)
CalEPA	California Environmental Protection Agency
CalOSHA	California Occupational Safety and Hazard Agency
CalTrans	California Department of Transporation
ARB	California Air Resources Board
CBSC	California Building Standards Commission
CCR	California Code of Regulations
CDO	Code Development Organization
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CH2	Compressed Hydrogen Gas
CNG	Compressed Natural Gas
DOE	United States Department of Energy
DOSH	California Department of Industrial Relations' Division of Occupational Safety and Health
DOT	United States Department of Transportation
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
FCV	Fuel Cell Vehicle
FMEA	Failure Mode and Effect Analysis
FR	Final Rulemaking
HAMMER	US Department of Energy's Hazardous Materials Management & Emergency Response Facility
HAZMAT	Hazardous Materials Safety
HAZOPS	Hazard Operability Study(ies)
HCNG	Hydrogen/Natural Gas Blend
HICE	Hydrogen Internal Combustion Engine
ICC	International Code Council
ICE	Internal Combustion Engine
LH2	Liquefied Hydrogen
LNG	Liquefied Natural Gas
NEPA	National Environmental Protection Act
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Testing
NPRM	Notice of Proposed Rulemaking SFM
NRTL	Nationally Recognized Testing Laboratory
OAL	Office of Administrative Law
PUC	California Public Utilities Commission
QRA	Site Quantitative Risk Assessment
RA/M	Risk Assessment and Risk Management
ROC	Report on Comments

ROP	Report on Proposals
RSPA	US Department of Transportation Research and Special Programs Administration
SAE	Society of Automotive Engineers
SCAQMD	South Coast Air Quality Management District
SDO	Standard Development Organization
UFC	Uniform Fire Code
UL	Underwriters Laboratories
VTA	Santa Clara Valley Transportation Agency