

## VIII.7 California Hydrogen Infrastructure Project

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Working Partners/Subcontractors:

- University of California, Irvine (UCI)
- National Fuel Cell Research Center (NFCRC)

Project Start Date: August 1, 2005

Project End Date: December 31, 2010

### Contribution to Achievement of DOE Technology Validation Milestones

This project will contribute to achievement of the following DOE technology validation milestones from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- **Milestone 23:** Total of 10 stations constructed with advanced sensor systems and operating procedures. (1Q, 2008).

### Accomplishments

- Continued operation of permanent station (350 and 700 bar gaseous hydrogen) opened at UCI.
- Completed deployment of mobile station (HF-150) operational in Long Beach, CA.
- Deployment of NDC trailer.
- Continued development of hydrogen pipeline fueling station in Torrance, CA.



### Objectives

- Demonstrate a cost-effective infrastructure model in California for possible nationwide implementation:
  - Design, construct and operate seven hydrogen fueling stations.
  - Collect and report infrastructure data.
  - Document permitting requirements and experiences.
  - Validate expected performance, cost, reliability, maintenance, and environmental impacts.
- Implement a variety of new technologies with the objective of lowering costs of delivered H<sub>2</sub>:
  - New Delivery Concept (NDC).
  - High-pressure/high-purity clean-up equipment.

### Technical Barriers

This project addresses the following technical barriers from the Technology Validation section (3.6.4) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (C) Hydrogen Refueling Infrastructure

### Introduction

Air Products and Chemicals, Inc. is leading a comprehensive, multiyear project to demonstrate a hydrogen infrastructure in California. The specific primary objective of the project is to demonstrate a model of a “real-world” retail hydrogen infrastructure and acquire sufficient data within the project to assess the feasibility of achieving the nation’s hydrogen infrastructure goals. The project will help to advance hydrogen station technology, including the vehicle-to-station fueling interface, through consumer experiences and feedback. By encompassing a variety of fuel cell vehicles, customer profiles and fueling experiences, this project is obtaining a complete portrait of *real market needs*. The project is also opening its stations to other qualified vehicle providers at the appropriate time to promote widespread use and gain even broader public understanding of a hydrogen infrastructure. The project is engaging major energy companies to provide a fueling experience similar to traditional gasoline station sites to foster public acceptance of hydrogen.

### Approach

Work over the course of the project was focused in multiple areas. With respect to the equipment needed, technical design specifications were written, reviewed, and finalized. Both safety and operational

considerations were a part of this review. After finalizing individual equipment designs, complete station designs were started including process flow diagrams and systems safety reviews. Material quotes were obtained, and in some cases, depending on the project status and the lead time, equipment was placed on order and fabrication was started. Consideration was given for expected vehicle usage and station capacity, standard features needed, and the ability to upgrade the station at a later date.

In parallel with work on the equipment, discussions were started with various vehicle manufacturers to identify vehicle demand (short and long term needs). Discussions included identifying potential areas most suited for hydrogen fueling stations, with focus on safe, convenient, fast-fills. These potential areas were then compared and overlaid with suitable sites from various energy companies and other potential station operators. Work continues to match vehicle needs with suitable fueling station locations. Once a specific site has been identified, the necessary agreements can be completed with the station operator and expected station users.

Detailed work can begin on the site drawings, permits, safety procedures and training needs. Once stations are brought online, infrastructure data will be collected and reported to DOE using Air Products' enterprise remote access monitoring system. Feedback from station operators will be incorporated to improve the station user's fueling experience.

## Results

The first of the hydrogen fueling stations within the California Hydrogen Infrastructure Project continued operation at the NFCRC at UCI. The capability for fueling vehicles with gaseous hydrogen at 350 bar, involving the installation of a 1,500 gallon horizontal liquid hydrogen tank, 2 kg/hr compressor skid, storage for 50 kg of hydrogen, and a dual dispenser for both 350 and 700 bar hydrogen was brought onstream in August of 2006. The 700 bar system, including the installation of a booster compressor, was commissioned in February of 2007. Based on a 50% compressor on-stream factor, the station has the capacity to dispense 24 kg/day or approximately 6 cars per day. When starting with full storage, 4-5 cars can be filled in succession. The station continues to see increasing use over time, with operation exceeding 75% of rated capacity on most days as additional hydrogen-fueled vehicles are being deployed in the Irvine area. A photograph of the dispensing system is provided in Figure 1.

The HF-150 (shown in Figure 2) is ideal for small fleet fueling and offers the advantages of being a highly reliable, cost-effective, and automated fueling system that can be easily installed. The HF-150 maintains about 150 kg of gaseous hydrogen at 6,600 psig. It can



FIGURE 1. UCI 350/700 Bar Gaseous Hydrogen Dispenser



FIGURE 2. Air Products HF-150 Hydrogen Fueler

dispense approximately 80 to 90 kg before needing to be refilled. Air Products completed the deployment of an HF-150 mobile fueler at the facilities of Long Beach Gas & Oil at 2400 E. Spring Street. Discussions continued regarding a second HF-150 deployment with the U.S. Forest Service in Placerville, CA.

The world's first fueling station supplied by a hydrogen pipeline is being developed to demonstrate a low-cost, reliable supply of hydrogen. A site in the Torrance, CA area in proximity to an existing Air Products hydrogen pipeline is being considered. A 4 kg/hr compressor skid and a total of 50 kg of high-pressure hydrogen storage are being provided. Hydrogen purification technology will be deployed for the first time in this application to demonstrate the production of an ultra-pure hydrogen stream from the industrial-grade pipeline supply. A dual dispenser for both 350 and 700 bar hydrogen is being provided. Based on a 50% compressor on-stream factor, the station will have the capacity to dispense 48 kg/day or approximately 12 cars per day. When starting with full storage, six cars can be filled in succession. The design of the station is intended

to provide the ability to double storage capacity in the future. The agreement with the station operator has been executed, and detailed mechanical and electrical designs have been completed. The station operator has begun the process to secure the necessary permits to allow for station construction to commence.

The NDC trailer is a new method of hydrogen distribution capable of supplying low-, medium-, and high-pressure systems using a single liquid hydrogen trailer (Figure 3). The NDC trailer provides a tenfold increase in the amount of transported hydrogen compared with traditional tube trailers. This delivery system can be utilized to supply existing merchant bulk hydrogen and liquid hydrogen supply chains as well as hydrogen fueling stations, resulting in greater equipment utilization. Delivery pressures as high as 8,000 psig are achieved, and no utilities are required from the receiving stations. The trailer was deployed to California in April 2008.



FIGURE 3. Air Products NDC Trailer

Air Products was selected under California Air Resources Board Solicitation 06-618, “Establish Demonstration Hydrogen Refueling Stations,” to install a renewable-based hydrogen fueling station and cleanup system for anaerobic digester gas at Orange County Sanitation District (OCSD) in Fountain Valley, CA. Hydrogen will be produced utilizing the Hydrogen Energy Station concept being developed under a second DOE project (Cooperative Agreement No. DE-FC36-01GO11087). Figure 4 shows the integration of the hydrogen energy station with the existing water treatment facility at OCSD. Modifications to the Cooperative Agreement are being developed to include a no-cost time extension and to modify the statement of work for the procurement and installation of a hydrogen fueling station (sized at 100 kilograms per day) and of a gas cleanup skid to remove contaminant species such as sulfur from the anaerobic digester gas that will be fed to the hydrogen energy station.

## Conclusions and Future Directions

Planned future work includes:

- UCI Fueling Station – continue operation of gaseous dispensers.
- Torrance Pipeline Fueling Station – Following approval of permits, install and commission both 350 and 700 bar systems.
- Fountain Valley Renewable Station – Acquire necessary permits, install and commission both 350 and 700 bar systems.
- Hydrogen Fuelers (HF-150) – Work to finalize second deployment in northern California.
- Infrastructure data acquisition, analysis and delivery – report data to DOE.

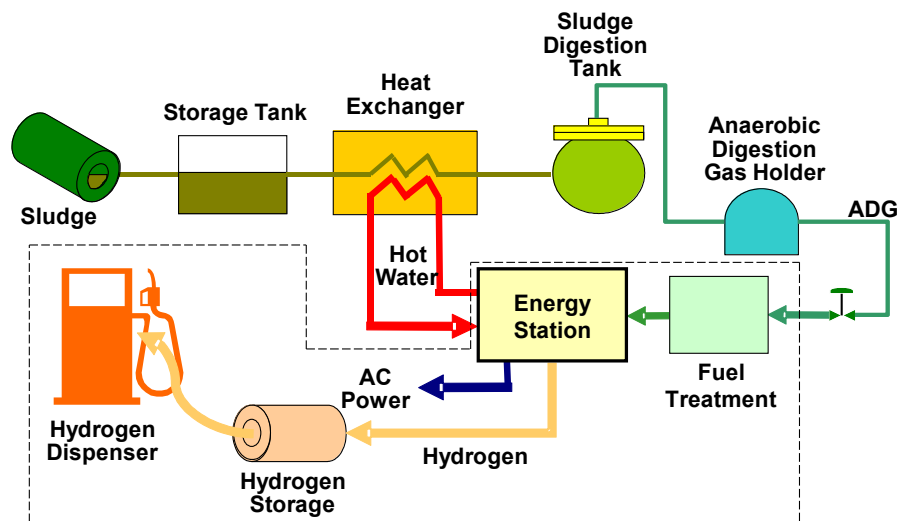


FIGURE 4. Fountain Valley Renewable Hydrogen Station Flow Diagram

### **FY 2009 Publications/Presentations**

1. A presentation regarding the overall project status was given at the DOE Annual Merit Review Meeting (May 2009).