VII.6 California Hydrogen Infrastructure Project

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Contract Number: DE-FC36-05GO85026

Working Partners/Subcontractors:
- University of California, Irvine (UCI), Irvine, CA
- National Fuel Cell Research Center (NFCRC), Irvine, CA

Project Start Date: August 1, 2005
Project End Date: December 31, 2011

Fiscal Year (FY) 2011 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_2:

- 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 Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

(C) Hydrogen Refueling Infrastructure

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 Fuel Cell 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).

FY 2011 Accomplishments

- Completed construction of, and vehicle test fills, at the hydrogen pipeline fueling station (350 and 700 bar dispensing) in Torrance, CA.
- Completed 9-month deployment of 350 bar mobile station (HF-150) in Placerville, CA.
- Completed construction of and began initial vehicle test fills at the hydrogen pipeline fueling station (350 and 700 bar dispensing) in Fountain Valley, CA.

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' eRAM 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 six cars per day. The station continues to see high usage, with daily throughput often reaching 50 kg/day. A proposal by Air Products to expand the station to 100 kg/day capacity was selected for support by the California Energy Commission. A photograph of the dispensing system is provided in Figure 1.

The world's first fueling station supplied by a hydrogen pipeline completed construction in early 2011 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 was developed by Shell Hydrogen. A 4 kg/hr compressor skid and a total of 100 kg of 7,777 psig storage and 20 kg of 15,000 psig storage have been provided. This station dispenses hydrogen according to SAE TIR-J2601. Hydrogen purification technology has been deployed for the first time in this application to demonstrate the production of an ultra-pure hydrogen stream from the

Photo by Lorin Humphries

FIGURE 1. UCI 350/700 Bar Hydrogen Fueling Station

industrial-grade pipeline supply. Two dual dispensers for both 350 and 700 bar hydrogen have been installed, and four vehicles can be filled simultaneously. 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. A photograph of the completed dispenser area is provided in Figure 2. Vehicle test fills were completed in March 2011, and a station opening ceremony was planned for May 2011.

The HF-150 (shown in Figure 3) 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 dispense approximately 80 to 90 kg before needing to be refilled. In December 2010, Air Products completed a 9-month deployment of an HF-150 mobile fueler at the District Office of the U.S. Forest Service in Placerville, CA.

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 in Fountain Valley, CA. Under this project, hydrogen will be produced utilizing the Hydrogen Energy Station concept being developed under a second DOE project (Cooperative Agreement No. DE-FC36-01GO11087). The statement of work for this project was modified to include the procurement and installation of a

FIGURE 2. Torrance, CA Hydrogen Pipeline Fueling Station

FIGURE 3. Air Products HF-150 Hydrogen Fueler – Placerville, CA

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. The fueling station includes compression, storage, and dispensing of hydrogen at 350 and 700 bar according to SAE TIR-J2601. Construction of the fueling station was completed in November 2010, and hydrogen produced from natural gas by the Hydrogen Energy Station was sent to the storage tubes in the fueling

FIGURE 4. Fountain Valley Renewable Hydrogen Station

station on 25 February 2011. Initial test fills of vehicles were performed in March 2011. A photograph of the fueling station area, with the dispenser in the foreground and the balance of fueling station equipment in the background, is provided in Figure 4. Delivery of the clean-up system for the anaerobic digester gas is expected in May 2011, after which production of renewable hydrogen for use in the fueling station is expected to begin in June 2011.

Conclusions and Future Directions

Planned future work includes:

- UCI Fueling Station – continue operation of both 350 and 700 bar systems.
- Torrance Pipeline Fueling Station – continue operation of both 350 and 700 bar systems.
- Fountain Valley Renewable Station – begin operation of (1) clean-up system for anaerobic digester gas and (2) 350 and 700 bar systems.
- Infrastructure Data Acquisition, Analysis and Delivery – report data to DOE.

FY 2011 Publications/Presentations

1. A presentation regarding the overall project status was given at the DOE Annual Merit Review Meeting (May 2011).