

## VII.5 California Hydrogen Infrastructure Project\*

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Contract Number: DE-FC36-05GO85026

Working Partners/Subcontractors:

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

Project Start Date: August 1, 2005

Project End Date: September 30, 2008

\*Congressionally directed project

- (C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

### 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
- First 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)
- Hydrogen-Based Unit (HBU)
- High pressure/high purity clean up equipment

### Technical Barriers

This project addresses the following technical barriers from the Technology Validation section (3.5.4) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

### 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. When starting with full storage, four to five cars can be filled in succession. The station continues to see increasing use over time as additional hydrogen-fueled vehicles are being deployed in the Irvine area. A photograph of the gaseous dispensing system is provided in Figure 1. A liquid



FIGURE 1. UCI 350/700 Bar Gaseous Hydrogen Dispenser

hydrogen dispensing project was cancelled during the past year.

Air Products installed an HF-150 mobile fueler at the facilities of Long Beach Gas & Oil at 2400 E. Spring Street. 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 dispense approximately 80 to 90 kg before needing to be refilled. Discussions regarding a second HF-150 deployment in northern California were started, and a potential station operator has been identified.

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 800 psig 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



FIGURE 2. Air Products HF-150 Hydrogen Fueler at Long Beach Gas & Oil

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 dispensing capacity in the future.

Two new technologies have been deployed under this project. 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. Individual process components have been tested, and the first of the NDC trailers is under fabrication. The trailer was deployed to California in April 2008.

The HBU (patents pending) is a new approach to reduce costs associated with stationary fueling stations. The HBU requires minimal space and can be located remotely from storage (including underground). No compression is required, as the NDC trailer delivers the hydrogen at the desired pressure (up to 7,000 psig). The design capacity of the HBU is 150 to 200 kg of hydrogen. Fabrication of the first HBU was completed in April 2007, and a photograph is provided in Figure 4. Discussions with potential station operators are continuing.



**FIGURE 3.** Air Products New Delivery Concept Trailer



**FIGURE 4.** Air Products Hydrogen Based Unit

## Conclusions and Future Directions

Planned future work includes:

- UCI Fueling Station – Continue operation of gaseous dispensers.
- Torrance Pipeline Fueling Station – Complete agreement with station operator, then install and commission both 350 and 700 bar systems.
- Hydrogen Fuelers (HF-150) – Continue operation at Long Beach, and work to finalize second deployment in northern California.
- NDC – Begin long-term operation of NDC #1.
- HBU – Identify location and station operator for HBU #1.
- Infrastructure Data Acquisition, Analysis and Delivery – Report Data to DOE.

## FY 2008 Publications/Presentations

1. A presentation regarding the overall project status was given at the DOE Annual Merit Review Meeting (June 2008).