

VI.A.3 Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

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Subcontractors/Partners:

The U.S. Army Tank Automotive Research, Development and Engineering Center, TARDEC - Selfridge, MI
Hyundai Motor Company (HMC) - Seoul, South Korea
Kia Motors Corporation (KMC) - Seoul, South Korea
Hyundai-KIA America Technical Center Inc. (HATCI) - Chino, California.
UTC Power (UTC) - South Windsor, CT.
Alameda Contra Costa Transit (ACT) - Oakland, CA.
Southern California Edison (SCE) - Rosemead, CA.

Start Date: January 15, 2004
Projected End Date: September 30, 2009

Objectives

Record, collect, report, and analyze data from fuel cell vehicles (FCVs) and hydrogen fueling operations

- Validate certain 2009 performance targets:
 - Fuel cell stack durability: >2,000 hours
 - Vehicle range: >250 miles
 - Hydrogen cost: <\$3.00/gge
- Demonstrate a variety of hydrogen generation technologies including:
 - Autothermal reformation of natural gas
 - Low pressure steam reformation of natural gas
 - High pressure steam reformation of natural gas
 - Electrolysis of water

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section (3.5.4.2) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) Vehicles
- (B) Storage
- (C) Hydrogen Refueling Infrastructure
- (D) Maintenance and Training Facilities
- (E) Codes and Standards
- (H) Hydrogen from Renewable Sources

Technical Targets

The Technology Validation Program element does not develop new component technologies, and therefore does not have technology targets. Instead, this Program element validates individual component technical targets developed within the other subprograms when integrated into a complex system, and reviews the future requirements for each component in such integrated systems.

2009 Performance Targets	Units	
Fuel Cell Stack Durability	Hours	2,000
Range	Miles	250
Hydrogen Cost at station; On-site Production	\$/kg of H2	3.00

Accomplishments

- Seven vehicles on the road
- Data collection and fleet monitoring system operational
- Autothermal reformer station operational
- Dual steam methane reformer station operational

Introduction

As a result of the President's Initiative, the DOE recently detailed a strategy that emphasizes co-developing hydrogen infrastructure in parallel with hydrogen fuel cell-powered vehicles. In the past, efforts to introduce new energy technologies in the

transportation sector have been thwarted by the classic “chicken and egg” dilemma of which comes first; in this case, hydrogen infrastructure or hydrogen vehicles. The Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation project will be an important first step towards achieving the above strategy because the selected consortia will develop a complete system solution(s) that will address all elements of infrastructure and vehicle development.

These goals will be accomplished by developing hydrogen infrastructures and operating hydrogen-powered vehicles at selected U.S. locations. The Technology Validation Program element provides selected consortia an opportunity to participate in a cost-share demonstration of hydrogen infrastructure and vehicle technologies.

Approach

Chevron Technology Ventures (CTV) and its project team of HMC, HATCI, UTC and the site hosts intend to operate a fully integrated fueling and fleet operation consisting of 32 FCVs, (including two different generations) with the aim of developing a database of operational experience under a wide variety of conditions including, for the stations, different technology and feed stocks, and for the vehicles, differing driving patterns and ambient temperatures. This data will also be collected in a manner that allows ‘consumer’ (including station operators, fuelers, drivers and maintenance workers) feedback to be recognized and incorporated into lessons learned.

Learning’s from the early phases of this project can be incorporated into later phases in a way that allows performance improving technologies to be tested in the most cost effective and efficacious manner.

Results

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 2: Demonstrate FCVs that achieve 50% higher fuel economy than gasoline vehicles.

Hyundai and UTC Fuel Cells worked together to manufacture and assemble the first seven of the 32 Hyundai-Kia fuel cell vehicles (FCVs) which will participate in the DOE demonstration project. These FCVs are based on UTC Fuel Cells PEM stack technology and Hyundai’s advanced drive systems and balance of plant. The introduction of the remainder of the vehicles is timed to coincide with the commissioning of the various hydrogen energy stations that CTV will build.

Collection of data and validation of increased fuel economy has begun. Procedures are developed and tested that allow the transfer and extraction of data that is provided to NREL. Data collection began in the third quarter 2005.

Milestone 3: Demonstrate (on a vehicle) compressed and cryogenic storage tanks achieving the 2005 energy and mass density targets. The compressed hydrogen storage tanks that are used in both the HMC Tuscon and KMC Sportage fuel cell vehicles have been designed to realize an energy density which allows extended range. Fleet operations started in the third quarter of 2005 provided data supporting the drive toward the 2005 energy and mass density targets.

This team is not planning on-board cryogenic storage tanks.

Milestone 5: Validate fuel cell demonstration vehicle range of ~200 miles and durability of ~1,000 hours. Hyundai has conducted baseline dynamometer testing at Quantum, Figure 1. DOE representatives witnessed the testing that included the Highway Fuel Economy Test (HWFET) and Urban Dynamometer Driving Schedule (UDDS). On road testing is in progress with seven vehicles. Vehicles have been tested in hot and high altitude environments, Figure 2.

Milestone 6: Validate vehicle refueling time of 5 minutes or less. Vehicles have been fueled following California Fuel Cell Partnership protocol 6.1.

Milestone 11: Validate cost of producing hydrogen in quantity of \$3.00/gge untaxed. CTV has demonstrated on-site hydrogen production technologies including autothermal reformation of natural gas and steam reformation of natural gas.



FIGURE 1. Vehicle Testing



FIGURE 2. Vehicle Road Testing

Milestone 12: Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures.

A hydrogen energy station has been installed at the Hyundai-Kia America Technical Center in Chino, California, Figure 3. This station demonstrates the on-site autothermal reformation of natural gas. This Chino site will serve as the commissioning site for all future project vehicles as well as also serving as one of the project's fleet operators. The station was designed to utilize state-of-the-art remote monitoring and operation systems and incorporates advanced hydrogen and fire sensors.

A hydrogen energy station has been installed at Alameda Contra Costa Transit in Oakland, California, Figure 4. This station is not part of the DOE project but the data from this station is being shared with the NREL. This station demonstrates the use of on-site low-pressure and high-pressure steam methane reforming.

Maintenance facilities are located at Chino, California. Employees have been trained for maintenance and repair of the vehicles. HATCI has participated in First Responder Training, Figure 5.

CTV intends to complete the construction of at least three additional hydrogen energy stations, one in each of the three climatic regions, hot, moderate and cold, including locations in Rosemead, California; Orlando, Florida; and Selfridge, Michigan.

Note: Data from this demonstration project is reported as part of the composite results presented in project report VI.G.1.

Conclusions and Future Directions

Seven FCVs have been deployed at two on-site hydrogen energy stations. We are targeting for eleven more vehicles and two more energy stations to be placed into operation in 2006.



FIGURE 3. Infrastructure, Chino Station



FIGURE 4. Infrastructure, Oakland Station



FIGURE 5. First Responder Training