

X.8 Incorporation of Two Ford H₂ ICE Buses into the Shuttle Bus Fleet

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FY 2011 Accomplishments

- Worked with LLNL Operations and Business Offices/Facilities and Infrastructure Directorate and its Sandia counterparts to permit mobile H₂ refueling station at LLNL and H₂ bus use at the LLNL/SNL facilities.
- Collaborated with Air Products and Chemicals to bring mobile H₂ refueler to LLNL.
- Instituted refueling training and H₂ bus operation for drivers.
- Worked through insurance issues associated with on-site refueling and public ridership.
- Instituted H₂ shuttle bus service for LLNL and SNL and have executed several community outreach activities.
- Established means to monitor ridership, refueling, and vehicle operations.



Introduction

As part of the “Walk the Talk” initiative within DOE, whereby the use of hydrogen technology in the DOE complex is increased, DOE has asked LLNL and SNL to establish and manage a hydrogen bus (taxi service) project servicing SNL and LLNL in Livermore, California. Ford has made available a number of hydrogen buses (internal combustion engine [ICE], with high pressure storage of hydrogen) that seat 12 people, plus driver (or 7 plus one wheelchair and driver), have a range of 150 miles, and on-board storage of 30 kg of hydrogen at 5,000 psi. These vehicles achieve near-zero regulated emissions (below Super Ultra Low Emission Vehicle regulation for oxides of nitrogen) and no CO₂ emissions. In the past year, SNL and LLNL have partnered to lease two buses (one year lease) for the demonstration project. The buses have been serving the local LLNL/SNL staff community. They directly replaced two diesel buses that were in use, thereby achieving reductions in diesel emissions at the two sites.

The purpose of this project is to demonstrate hydrogen technologies and educate the community. As part of the community outreach goals, we have engaged the broader Tri-Valley area (cities of Livermore, Dublin, Pleasanton, San Ramon) and others on event support using the H₂ buses. We have also initiated educational activities with nearby Las Positas College. We also plan to coordinate with the Livermore community public transportation companies to enhance operations.

Approach

Our approach to this project was as follows. Prior to receiving the buses, extensive discussions were carried

Fiscal Year (FY) 2011 Objectives

- To promote the early market adoption of hydrogen technology.
- To displace diesel-fueled taxi vehicles at LLNL and SNL.
- To help promote public education on the benefits of hydrogen and fuel cell technology.

Technical Barriers

This project addresses the following technical barriers assigned to this project:

- (A) Non-technical issues preventing full commercialization of hydrogen and fuel cell systems.
- (B) Hydrogen storage.
- (C) Lack of hydrogen refueling infrastructure performance and availability data.
- (D) Maintenance and training facilities.

Technical Targets

- Promote the use of hydrogen technology to the public.
- Reduce diesel use at the LLNL and SNL sites.
- Gain extensive experience using H₂ buses by driving daily with high mileage use.

out with LLNL and SNL facilities management, and with the LLNL Site Manager for the Nuclear National Security Administration to secure “buy-in” for the project. With the project receiving strong acceptance and support, we leased the H₂ buses from the Ford Motor Company, followed by an initial certification of them in collaboration with Ford maintenance staff. During this certification phase, we designed appealing “wraps” for the bus to bring attention to their H₂ technology (Figure 1). There are no hydrogen stations currently operating in the Tri-Valley area, so we had to establish a mobile refueling station at the LLNL site using an Air Products Mobile Refueler, shown in Figure 2.

With reliable fueling established, the buses were integrated into the LLNL/Sandia taxi service, replacing two buses that were operated on diesel fuel. Thus, use of the H₂ buses led to a decrease in diesel fuel use at the two laboratories. Furthermore, the H₂ buses were used for educating the local public on the benefits of hydrogen and fuel cell technology. We managed frequent maintenance problems that arose with the buses, these problems being unrelated to the hydrogen technology (except for the need to replace a sensor, with the failure being detected with on-board diagnostics), and many involved traditional bus mechanical systems.



FIGURE 1. Final Design of “Wrap” for Bus



FIGURE 2. Air Products Mobile Refueler Servicing the Two H₂ Buses

Results

In November of 2010, the two H₂ buses were integrated into the LLNL/SNL fleet. The buses travel all over the LLNL and SNL sites, as well as to the local commuter train station, picking up LLNL and SNL employees and transporting them to our campuses. The typical ridership per shuttle bus is ~80-100 passengers/day with each H₂ bus traveling ~80-100 miles each day. The H₂ buses are “topped off” with hydrogen each day with ~13 kg of hydrogen. We have put on 8,757 miles on the buses in approximately six months of operation (up to June 30, 2011). The average number of miles driven by each bus is 730 miles per month. With regard to a fuel comparison, the average number of gallons of diesel used on our previous buses is 168 gallons per month (per bus), so that is our savings. It is our understanding that this level of use is among the highest for DOE facilities using such buses.

Both buses found extensive use in a number of community outreach activities. Two of these are described in a little more detail here. The first community event was a joint SNL/LLNL Celebration of Hydrogen Technology in downtown Livermore on February 22, 2011. This event was organized by the project and LLNL and SNL protocol and public relations personnel. Approximately 70 members of the public, media, local dignitaries and LLNL and SNL management and staff were on hand to see the two H₂ buses, along with the H₂ Fuel Cell Mobile Light, the cryo-compressed hydrogen vehicle from LLNL, and a number of posters on hydrogen research and development being conducted at the labs. Speakers included:

1. Ron Cochrane, Executive Officer from LLNL and Bob Carling, Director of the Transportation Energy Center from SNL.
2. John Garbak, DOE Technology Development Manager
3. John Marchand, Vice Mayor, City of Livermore
4. Alice Williams, Nuclear National Security Administration Site Manager

KPIX television (San Francisco) broadcast video from the celebration on their evening news, and press from two local newspapers attended as well. Representation from Congressmen Garamendi’s and McNerney’s offices and California State Assembly member Joan Buchanan were also in attendance. A picture from the event is shown in Figure 3. The public were given rides on the buses, and had a chance to talk with LLNL and SNL staff scientists about the hydrogen technology depicted in the posters.

In another community outreach event one of the H₂ buses was on display at the Expanding Your Horizons conference on Saturday February 26, 2011 at the Diablo Valley Community College, San Ramon campus, with rides given to attendees. The Expanding Your Horizons conference serves to:



FIGURE 3. Celebration of Hydrogen Technology in Downtown Livermore, February 22, 2011

- Increase the interest of young women in math and science through positive hands-on experience (over 300 present).
- Foster awareness in math- and science-related careers.
- Provide young women with opportunities to meet and interact with positive role models who are active in math- and science-related careers.

A picture of Expanding Your Horizons attendees in the H₂ bus is shown in Figure 4.

Other outreach events include the John Muir Birthday-Earth Day Celebration in Martinez, California on April 16, 2011. This event provided a shuttle service from the parking area to the event main gate. Over 1,000 people attended this event. In addition, lectures were given on hydrogen technology (fuel cells, hydrogen storage, H₂ bus, H₂ mobile light) to an environmental science class at Las Positas Community College in Livermore on April 12, 2011. One of the buses was also used at the SNL “Take Your Sons and Daughters to Work Day” on April 28, 2011. The buses were on display at the Bay Area American Chemical Society meeting in Oakland, California on April 30, 2011. The buses were also highlighted at the LLNL internal safety fair on June 22, 2011. Finally, the buses were on display at the opening of the Innovation for the Green Advanced Transportation Center in Livermore which is located near the laboratories on June 30, 2011. The opening



FIGURE 4. Students attending the the Expanding Your Horizons conference on Saturday February 26, 2011 at the Diablo Valley Community College, San Ramon campus, on-board the H₂ Bus.

was attended by 300 people, including Congressman John Garamendi. At all of these events we handed out brochures that explain the DOE Hydrogen Market Transformation sub-program and information about the buses. We were on hand to answer questions about the buses.

Conclusions and Future Directions

Two Ford H₂ buses were successfully integrated in the LLNL/SNL taxi fleet, and have been extensively used for transporting laboratory staff within the LLNL/SNL campuses, and also to a local commuter rail stop. To our knowledge, the LLNL/SNL buses have received the most use (highest number of miles driven, greatest number of refuelings) of any H₂ bus effort in the DOE program. Use is ongoing at this time. Future activities associated with the H₂ buses, until the end of FY 2011, include:

- Monitoring shuttle bus mileage, ridership, and vehicle operation.
- Maintaining the vehicles in collaboration with Ford.
- Conduct community outreach events.
- Curriculum development with Las Positas College and high school demonstrations.
- Annual Community Festivals/Antique Automobile Shows/farmers markets.