XII.9 Fuel Cell-Powered Lift Truck FedEx Freight Fleet Deployment

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Contract Number: DE-EE0000482

Subcontractors:
- Plug Power Inc., Latham, NY
- Air Products and Chemicals, Inc., Allentown, PA

Project Start Date: October 1, 2009
Project End Date: September 30, 2013

Objectives

The objectives of this project are to:

- Convert an entire fleet of 35 class-1 electric lift trucks to hydrogen fuel cells at the FedEx Freight facility in Springfield, MO.
- Demonstrate the safe and reliable operation of hydrogen-fueled material handling equipment (MHE).
- Demonstrate the economic benefits of conversion to hydrogen fuel cell-powered MHE.
- Demonstrate operator acceptance of hydrogen fuel cell-powered MHE.
- Provide a cost-effective and reliable hydrogen fuel supply.
- Spur further lift truck fleet conversions to hydrogen fuel cells.
- Establish a proving ground for hydrogen fuel cell-powered MHE.

Relevance to the American Recovery and Reinvestment Act (ARRA) of 2009 Goals

This project advances the goals of the ARRA of 2009 to create new jobs, save existing jobs, and spur economic activity and investment in long-term economic growth by:

- Creating jobs at Plug Power to design, build and commission the fuel cell power units.
- Creating jobs at Air Products to design, install and commission hydrogen storage and fueling equipment.
- Creating jobs at Air Products to deliver hydrogen to the FedEx Freight Springfield, MO facility.
- Training FedEx Freight lift truck operators in hydrogen safety, fueling procedures and fuel cell operation.
- Training FedEx Freight lift truck maintenance personnel to service fuel cells.
- Improving the overall economic efficiency of material handling operations.

This project advances the DOE Fuel Cell Technologies' ARRA project goals of accelerating the commercialization and deployment of fuel cells and fuel cell manufacturing, installation, maintenance, and support services by demonstrating:

- Safe and reliable operation of hydrogen storage and fueling equipment and fuel delivery.
- Reliable and efficient operation of hydrogen fuel cells.
- Economic and environmental advantages of fuel cells over batteries.
- Practical operation and maintenance of fuel cells.

Technical Barriers

This project addresses the following technical barriers to the use of fuel cell powered lift trucks:

- Repair frequency of hydrogen fuel cells.
- Cold weather operation of hydrogen fuel cells.
- Cold weather operation of hydrogen storage and fueling equipment.

Technical Targets and Milestones

The technical targets and milestones of this project include:

- Installing hydrogen storage and fueling equipment by May 2010.
- Developing a hydrogen safety plan by May 2010.
- Commissioning 35 class-1 power units by December 2009.
- Completing startup and training by June 2010.
- Starting operation and evaluation by July 2010.

Accomplishments

The accomplishments of this project include:

- Commissioning 35 GenDrive class-1 power units by December 2009.

- Commissioning hydrogen storage and fueling equipment by June 2010.
- Completing all fueling, operation and maintenance training by June 2010.
- Purchasing and commissioning an additional five GenDrive class-1 power units in December 2010 (without DOE funding).
- Determining that problems with air-actuated valves during cold-weather operation of the hydrogen storage and fueling system were caused by excessive moisture in the air supply.
- Modifying lift trucks to prevent drive-offs that damaged the hydrogen fueling hose.
- Logging over 48,000 hours of fuel cell operation by the end of July.
- Purchasing 18,300 kilograms of hydrogen by the end of July.
- Monitoring operating costs and reliability of 40 GenDrive power units (ongoing).
- Demonstrating 30-60% more operating hours per repair for fuel cells compared to propane lift trucks between July 2010 and February 2011.

Introduction

The purpose of this project is to demonstrate that hydrogen fuel cells are a safe and economical alternative to batteries for powering electric lift trucks. The primary barriers to widespread use of hydrogen fuel cells for material handling equipment are concerns about the safety of hydrogen storage and fueling equipment, operating costs for fuel and maintenance, and the long-term reliability of fuel cells.

Approach

This project evaluates the safety and economics of using hydrogen fuel cells to power a fleet of 35 class-1 electric lift trucks at the FedEx Freight facility in Springfield, MO. FedEx Freight supplies the lift trucks, Plug Power supplies the GenDrive fuel cell power units and Air Products supplies the hydrogen fuel and the hydrogen storage and fueling equipment. The fuel cell equipment is maintained by FedEx Freight personnel with assistance from Plug Power and Air Products personnel when necessary. Plug Power and Air Products also assisted FedEx Freight in developing a comprehensive hydrogen safety plan.

Previous FedEx Freight field trials with a limited number of GenDrive power units demonstrated productivity gains and improved performance compared to battery-powered lift trucks. The lift truck fleet conversion in Springfield is expected to demonstrate improved operational efficiencies and help the environment by reducing greenhouse gas emissions and the use of toxic battery materials. A successful demonstration of these advantages at the Springfield facility could lead to additional fleet conversions at other FedEx Freight facilities.

The Hydrogen Safety plan has been completed and reviewed. The changes to the safety plan are in the process of being made.

The National Environmental Policy Act forms were submitted to the DOE. There are no outstanding National Environmental Policy Act requirements. The project was granted a categorical exclusion determination prior to the project commencing.

Results

To date, this project has successfully demonstrated the safe and economical operation of 40 GenDrive class-1 power units and associated hydrogen storage and fueling equipment. The power units have accumulated over 48,000 hours of operation and consumed 18,300 kilograms of hydrogen.

A few problems occurred during cold-weather operation. Problems with air-actuated valves in the hydrogen storage and fueling system were caused by excessive moisture in the air supply. Problems with the power units were resolved by adding thermal insulation to sensitive components.

Fueling hoses were damaged on two occasions when lift trucks were driven away from the fueling station while the fueling hoses were still attached to the lift truck. The lift trucks were subsequently modified to prevent them being driven while the fueling hoses were attached.

FedEx Freight found that the fuel cell-powered lift trucks at the Springfield facility had 63% more hours of operation per repair (115.2 hours/repair) compared to similar propane-powered lift trucks at the South Dallas facility (70.5 hours/repair) and 30% more hours of operation per repair compared to propane lift trucks at all FedEx Freight facilities (88.3 hour/repair).

Figure 1 shows a breakdown of the types of fuel cell repairs. Instrumentation and control (35%), cooling (16%), hydrogen (13%), and humidification (11%) systems accounted for 75% of all repairs. Figure 2 shows that 74% of all repairs required less than two hours of labor. Figure 3 shows that 35% of all fuel cell repairs to date have occurred during the first 100 hours of operation.

Based on the favorable operational results with the initial 35 power units, FedEx Freight purchased an additional five power units in December 2010 without DOE funding.

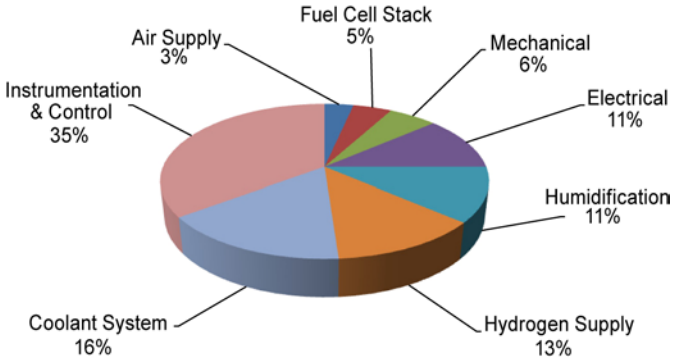

FIGURE 1. Types of Fuel Cell Repairs

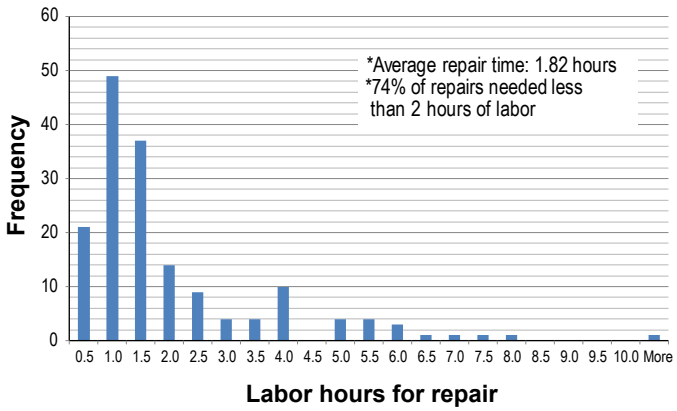

FIGURE 2. Labor Hours for Fuel Cell Repairs

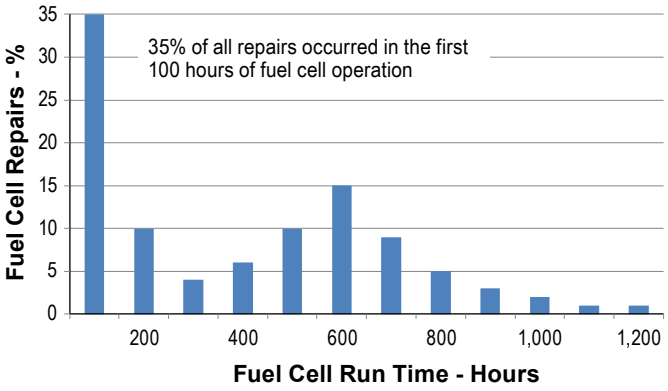

FIGURE 3. Fuel Cell Repair Frequency vs. Run Time

Conclusions and Future Directions

Based on our operational experience to date, hydrogen fuel cells appear to be a safe and economical alternative to batteries for electric lift trucks. We will continue to monitor the long-term costs and reliability of hydrogen fuel cells by:

- Providing ongoing operational and maintenance support for the GenDrive power units and the hydrogen storage and fueling equipment.
- Collecting data from the power units to evaluate performance, operability and safety.
- Collecting data from the hydrogen storage and fueling equipment to evaluate performance, operability and safety.
- Resolving cold-weather operation problems with air-actuated valves in the hydrogen storage and fueling equipment.
- Working with Plug Power to resolve cold-weather operation problems with fuel cells.

FY 2011 Publications/Presentations

1. Held an official ribbon-cutting ceremony in October 2010 to inaugurate the hydrogen fuel cell project at the FedEx Freight service center in Springfield, MO.

2. Delivered an American Recovery and Reinvestment Act merit review presentation in Washington, DC in May 2011.

3. Contributed a synopsis of project progress to the DOE's *Energy Empowers* blog.