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Testimony

Before the Subcommittee on National Parks, Recreation, and Public Lands

Committee on Resources

United States House of Representatives

Oversight Hearing on the Use of Hydrogen Fuel Cell Technology

in the National Park Service

May 15, 2004

Mr. Chairman, thank you for the opportunity to discuss the U.S. Army Engineer Research and Development Center's (ERDC's) experience with hydrogen fuel cell technology and our relationship with the National Park Service (NPS), which supports this technology. ERDC's fuel cell project with Yosemite National Park, in particular, furthers the goals of Congressman Radanovich's Clean Air Yosemite Initiative. This partnership is also helping NPS meet objectives of the Green Energy Parks Program. We welcome the opportunity to discuss these efforts with the Committee.

ERDC is the premier research and development facility for the U.S. Army Corps of Engineers. It consists of seven laboratories at four geographical sites, with over 2,000 employees, \$1.2B in facilities, and an annual research program of almost \$700M. It conducts research in both military and civil works mission areas for the Department of Defense (DoD) and the nation.

Introduction

DoD has invested its own resources to develop and demonstrate fuel cell technology for many years. Military applications of fuel cells, such as for ships, aircraft support, field base camps, heavy trucks, soldier power requirements, etc., are of particular interest to the DoD. However, DoD also maintains a large inventory of fixed facilities at its bases, which includes buildings of all sizes and types such as office buildings, hospitals, industrial facilities, barracks buildings, gymnasiums, etc. Some of these facilities could benefit from distributed generation, in particular fuel cells, to augment their power, heat, reliability, and security requirements in an environmentally friendly fashion. Consequently, fuel cell technology can contribute to DoD's goals for sustainable military installations.

ERDC is recognized worldwide as an authoritative expert on the fielding of stationary fuel cell power plants. This experience has come largely from managing and participating in fuel cell demonstrations of various fuel cell technologies and from providing consulting services to various federal agencies (including NPS), state agencies, and private institutions. Knowledge and experience gained from field demonstrations have allowed ERDC to provide valuable feedback to fuel cell manufacturers, resulting in retrofits and enhancements to provide better and more robust products for consumers.

ERDC Managed Fuel Cell Demonstrations

ERDC first became involved with fuel cell technology in the early 1990s. The FY93 and FY94 Defense Appropriations Acts provided \$18M and \$18.75M, respectively, in equipment procurement funds for the purchase and installation of natural gas fuel cells at DoD installations. DoD subsequently assigned ERDC to manage this demonstration project. The overall goals of this demonstration were to increase production levels, thereby reducing the cost of fuel cell power plants through economies of scale, and to provide a thorough evaluation of fuel cell performance over a wide range of conditions. Selection of these sites was based on a combination of various criteria, including interest of site personnel, energy cost savings, diversity of electrical and thermal applications, geographic region and climatic diversity, site physical conditions, and environmental considerations.

Thirty United Technologies Corporation (UTC) Fuel Cells PC25 phosphoric acid fuel cell (PAFC) power plants (1-Model PC25A, 14-Model PC25B, and 15-Model PC25C) were purchased and installed at DoD demonstration sites through this project. These units were installed from February 1995 through November 1997. This fleet of fuel cells achieved over 875,000 total operating hours during the five-year demonstration period, while saving an estimated \$6M in avoided energy costs. From an environmental standpoint, the fleet abated an estimated 281 tons of NO_x, 595 tons of SO_x, 24 tons of CO, and 36,000 tons of CO₂.

A similar fuel cell demonstration project using residential-scale Proton Exchange Membrane (PEM) fuel cells began with FY01 Congressional funding. Residential PEM fuel cells are in the pre-commercial stages of development, with limited field demonstrations and testing being performed to date. ERDC was assigned to manage and implement this activity based on previous experiences and successes with fuel cell demonstrations. Subsequent funding increments in FY02, FY03, and FY04 have effectively extended this project, where additional fuel cells are being placed at various military facilities. A total of 69 PEM fuel cells will be installed and demonstrated from the FY01 (21 units), FY02 (24 units), and FY03 (24 units) project funding. A solicitation for the FY04 funding is pending at this time and will result in additional PEM fuel cells being fielded. The total funding allocated for this project for FY01-FY04 is in excess of \$12M.

A significant achievement of the Residential PEM fuel cell project has been the demonstration of PEM fuel cells with a minimum average availability of 90% and record performance of durability for the cell stack assemblies in these units. Backup power systems utilizing PAFC technology have demonstrated 99.9999% availability, or six "9s" of availability. Today's residential PEM technology is not nearly as mature, and 90%+ availability is indicative of the state of the art at this time. In early 2003, two fuel cell units installed at Watervliet Arsenal, NY, achieved milestones of 7,056 hours and 6,742 hours of run time, respectively, on individual cell stack assemblies. These two fuel cell stacks represented the longest lived stacks in the manufacturer's history. Three additional PEM fuel cells at the U.S. Military Academy at West Point, NY, and Naval Support Unit Saratoga Springs, NY, are on the brink of achieving 10,000 hours of operation on individual cell stacks, another milestone for PEM fuel cell technology. These fuel cells demonstrated their reliability by maintaining power to their loads during the recent major blackout in the Northeast.

ERDC Testing and Evaluation of Fuel Cells

During the early fuel cell demonstrations, ERDC researchers realized that an independent fuel cell testing facility would benefit DoD and third parties. It was envisioned that this facility would be a national resource for the testing and evaluation of fuel cells, as well as supporting other efforts such as fuel cell integration and demonstrations. With the assistance of funding supported by Congressman John P. Murtha, the DoD Fuel Cell Test and Evaluation Center (FCTec) effort was initiated in 1998, and the facility was officially dedicated in February 2000.

The FCTec is a national resource facility for the independent, unbiased testing and validation of fuel cell systems for both military and commercial applications. Located at Concurrent Technologies Corporation's (CTC's) Environmental Technology Facility in Johnstown, PA, the FCTec was established through a collaborative effort between ERDC and CTC.

The FCTec's primary goal is to significantly accelerate the development and commercialization of fuel cell systems. The following objectives and capabilities have been established to support this goal:

- Validate prototype, pre-commercial, and commercial fuel cell systems and components
- Evaluate design and off-design operating characteristics of fuel cell systems
- Enhance the performance of fuel cell technologies
- Reduce life-cycle costs for fuel cell systems
- Support the development of codes and standards for military and commercial fuel cell applications
- Educate stakeholders regarding fuel cell technologies and applications
- Serve as a demonstration site for fuel cell technologies
- Provide research, development, and component integration services to the fuel cell community

Since FCTec's inception, several federal, state, and private institutions have collaborated with ERDC to use the capabilities and resources of this unique facility. As outside agencies bring unique projects and requirements to ERDC and FCTec, improvements to the facility are continually incorporated with regard to

equipment, expertise, and capabilities. Funding for the FCTec from its inception to date has surpassed \$19M.

ERDC and the NPS

The relationship between ERDC and NPS began in May 2000, when Mr. Kent Summers of the Yosemite National Park attended a fuel cell workshop presented by Dr. Mike Binder and Mr. Franklin H. Holcomb of ERDC. This particular workshop focused on the design considerations of several thermal applications of PAFC technology. Mr. Summers was intrigued by the wealth of information on ERDC's real world applications of fuel cells and began a dialogue with Dr. Binder and Mr. Holcomb regarding the applicability of fuel cells at Yosemite. At the time, the only viable fuel cell technology available was that of the PAFC, which was 200 kW in size and consumed natural gas (propane was a fuel option at one time for this unit, but this option had been discontinued) as its fuel. Yosemite National Park does not have a utility natural gas supply, and the only other source of natural gas available was from the byproducts of a wastewater treatment plant. It was determined that the wastewater treatment plant could not supply the amount of natural gas necessary for the operation of the PAFC; however, Mr. Summers agreed to stay in touch with the ERDC researchers to see when other fuel cell technologies would become available which could be used at the park. ERDC researchers were particularly interested in pursuing a relationship with NPS because of the unique climates, altitudes, and operating conditions found at NPS sites, which would mimic many operational conditions of potential military operations.

ERDC researchers then conducted site visits at Yosemite National Park and determined that a small (5-10 kW) demonstration fuel cell, available to view by the public, was perhaps the best initial project for Yosemite. In fall 2003, a pre-commercial residential-scale PEM fuel cell became available that could use propane as its fuel. ERDC and NPS co-funded the purchase and installation of two of these units -- the first to be installed and operated by a contractor, and the second to be installed and operated by Yosemite National Park personnel. A dedication ceremony for the first of these units was recently held at the park on April 8, 2004.

The first fuel cell was installed at the Administration Building in Yosemite Village. The electric output of the fuel cell will displace a portion of the electric grid power used at the building. Heat from the fuel cell will be used to supplement the building's diesel-fired boiler, resulting in less diesel fuel use and emissions. An electric car charging station was installed on the circuit from the fuel cell to the building, which will use fuel cell power to charge the cars from Yosemite's fleet of electric vehicles. Beyond the electric grid power displaced, the fuel cell will reduce load on the backup diesel generator during times of grid outage, providing another benefit in reduced diesel fuel consumption and exhaust emissions. The second fuel cell will be installed later this year after a suitable site has been identified. Following this initial project with Yosemite National Park, ERDC and NPS signed a formal Memorandum of Agreement on November 16, 2003, to pursue fuel cell technology and other areas of interest between the two organizations.

The installation of the initial fuel cell at Yosemite National Park was accomplished under circumstances unique to the site and the NPS. To preserve the inherent beauty and pristine nature of the NPS parks, ERDC complied with strict policies during the installation process. For example, the trench (~350 feet in length) for the propane supply line was excavated by hand due to the potential presence of cultural and historic artifacts at the site. Each shovelful of dirt was required to be hand-sifted while a certified archeologist observed the process. Another requirement was that of a fence around the fuel cell, which was for aesthetic reasons and for compliance with the historical value of the existing building. The fencing material was required to be constructed of materials indigenous to the area, which in this case was a locally obtained sugar pine wood. ERDC gained invaluable experience working with Yosemite on this project, and Yosemite in turn benefited from this insight for the future installation of their second unit.

Other ERDC-NPS Fuel Cell Projects

ERDC is also among six partners, including the Cuyahoga Valley National Park (CVNP), who have embarked on the first 10 kW commercial Solid Oxide Fuel Cell (SOFC) demonstration project in the state of Ohio. This will be the fourth fuel cell to be located in a national park. The fuel cell will be installed at November Lodge, the state-of-the-art building at the Cuyahoga Valley Environmental Education Center (CFEEC), which already uses a geothermal heating system and energy-efficient lighting. The fuel cell will provide 10 kW of electricity, which can be operated grid-interconnected or stand alone, to power the November Lodge. The fuel cell is powered by natural gas and produces essentially no emissions of air pollutants.

Through an FY03 appropriation, ERDC will develop and install a canola oil-fueled fuel cell and demonstrate it at Yellowstone National Park. Canola oil is produced from the seeds of the canola plant, which was developed through careful crossbreeding of rapeseed plants. Canola oil is thus a renewable fuel and is another resource that can help alleviate United States' dependence on foreign oil sources. Research is being conducted to develop the fuel processor technology required to extract hydrogen from canola oil. Once developed, the completed fuel processor will be integrated with a fuel cell to perform a one-year demonstration of the integrated system at Yellowstone. Through an FY04 appropriation, this project will be extended to include other forms of biodiesel fuel, culminating in a fuel cell demonstration at another NPS facility. The combined funding for this project is equal to approximately \$2.6 million.

Summary

ERDC's experience and leadership with hydrogen fuel cell technology has developed through a collaboration of diverse organizations including federal, state, and private stakeholders to demonstrate the potential of this emerging technology. The relationship with NPS has provided yet another opportunity to demonstrate fuel cells under a unique set of challenges. This experience adds to the global body of knowledge available for this technology, which can help the industry advance toward commercialization. In addition to the inherent benefits fuel cells can offer to DoD and other end users, this technology offers the potential for significant growth in the U.S. economy. Further, fuel cells can reduce the nation's dependence on foreign sources of oil while helping to reduce environmental pollution.

Mr. Chairman, in conclusion, I will be pleased to answer any questions from you and members of the subcommittee.