DOD Fuel Cell Demonstration Program

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INTRODUCTION

The supply of reliable, cost-effective electric power with minimal environmental impact is a constant concern of Department of Defense (DOD) installation energy personnel. Electricity purchased from the local utility is expensive and represents only about 30% of the original energy input at the generating station due to generation and distribution inefficiencies. Because of master metering and large air conditioning loads, the demand portion of the installation's electric bill can be in excess of 50% of the total bill.

While the electric utilities in the United States have a very good record of reliability, there is significant potential for improving the security of electrical power supplied by using on-site power generation. On-site, dispersed power generation can reduce power outages due to weather, terrorist activities, or lack of utility generating capacity. In addition, as increased emphasis is placed on global warming, acid rain, and air pollution in general, the development of clean, highly efficient power producing technologies is not only desirable, but mandatory. Since the majority of central heat plants on U. S. military installations are nearing the end of their useful life, there is an opportunity to replace outdated existing equipment with modern technologies.

THE TECHNOLOGY

Fuel cells are electrochemical power generators with the potential for attaining very high electrical energy conversion efficiencies while operating quietly with minimal polluting emissions. In addition, by-product thermal energy generated in the fuel cell is available for use for cogeneration of hot water or steam, bringing the overall potential conversion efficiency (electrical plus thermal) to approximately 85%. Air emissions from fuel cells are so low that several Air Quality Management Districts in the United States, including several in California which has the nation's strictest limits on air pollutants, have exempted them from requiring a permit to operate.

Phosphoric Acid Fuel Cells (PAFCs) are in the initial stages of commercialization. While PAFCs are not economically competitive with other more conventional energy production technologies at the present time, current cost projections predict that PAFC systems will become economically competitive within the next few years as market demand increases.

THE DOD FUEL CELL DEMONSTRATION PROJECT

The FY 1993 Defense Appropriations Act provided $6.0M worth of equipment procurement funds per Service for the implementation of "non-developmental item natural gas fuel cells currently in production in the United States ... for power generation at military installations ... " with the recommendation that "... some of the cells be installed at locations in need of enhanced air quality ...". The purposes of this demonstration project are to stimulate growth in the fuel cell industry, which will lower costs through economies of scale and competition, and to determine the role fuel cells should play in DOD long-term energy supply strategy. The three Services, acting through the Defense Utilities Energy Coordinating Council (DUECC), requested that the U. S. Army Construction Engineering Research Laboratories (USACERL), a U. S. Army Corps of Engineers research laboratory affiliated with the University of Illinois at Urbana-Champaign, coordinate this fuel cell demonstration program for all three Services.

The FY 1994 Defense Appropriations Act provided $6.25M worth of equipment procurement funds per Service "to continue procurement of nondevelopmental item (NDI) 200 kW phosphoric acid natural gas fuel cells currently in production in the United States".

Specific tasks associated with USACERL's coordination role in this program include the following: (1) Procurement of turnkey Phosphoric Acid Fuel Cell Power Plant packages: (2) Evaluation of potential DOD site installation candidates in order to identify the specific sites where the PAFCs will be installed; (3) Monitoring of the electrical generation efficiency, degree of thermal utilization, air emission characteristics, and overall system reliability of the PAFCs to determine the economic and environmental benefits of owning and operating these systems: (4) Development of application guidelines based on the results of this project for the implementation of PAFC technology at DOD facilities; and (5) Documentation of all aspects of the entire DOD Fuel Cell Demonstration Project.

A solicitation was prepared for the purchase of turnkey Phosphoric Acid Fuel Cell Power Plant packages, to include purchase, site engineering, installation and startup, operation and maintenance training, and a five year warranty, maintenance and repair period. Following a negotiation period, ONSI Corporation was awarded a contract for the purchase of these turnkey PAFC systems. The terms of this contract involve cost-sharing on the part of ONSI Corporation and calls for partnering with the local utility serving the selected posts. A total of 12 200-kW PAFCs were purchased with the FY 1993 Appropriations and have been, or will be, installed at DoD installations, with specific installation sites being identified through contract modifications.

SITE SELECTION CRITERIA

Initial candidate sites were identified by Army, Air Force, and Navy/Marine Corps Headquarters through solicitation of their respective Major Commands/Major Claimants. As awareness of the program grows, individual installations are requesting to become a part of this program. Initial screening of candidate sites is performed through an economic analysis based on total electricity and natural gas usage and average unit costs as provided by the Defense Energy Information System (DEIS). This economic analysis considers the electrical savings available

through operation of a fuel cell power plant. the associated natural gas costs to operate the system, and the natural gas savings obtainable through recovery of the by-product thermal energy.

Installations which appear to be good potential candidates as a result of this initial screening are then asked to submit copies of their actual past utility bills for a twelve month period in order that the economic analysis can be refined through the use of actual monthly energy consumption and utility rate schedule data. In addition, each candidate installation is asked to provide information regarding the degree of air quality attainment for the region in which they are located, as well as a description of the intended application for the recovered by-product thermal energy and an estimate of the amount of this recovered thermal energy which they could use. At the same time, potential opportunities for financial leveraging through cost sharing and/or rebates by the local utilities providing service to these candidate sites are investigated. Efforts are also made to insure equal distribution of fuel cell installation sites among the three Services, and to provide as wide a geographical and climatic distribution as feasibility allows.

Site visits are then made to those installations which still appear to be good potential candidate sites at the end of this evaluation process. These site visits allow for refinement of the estimate of by-product thermal energy usage, an analysis of the logistical factors surrounding potential fuel cell installation (e.g. distance from gas line, lengths of pipe and wiring runs, availability of sufficient land space for siting, etc.), and the development of a conceptual design package. The successful candidate sites are then identified to the ONSI Corporation to be selected installation sites through individual contract modifications. A kickoff meeting is held on site shortly after each contract modification to initiate the design and installation process.

CURRENT STATUS

From the FY 1993 appropriation, ten ONSI model B PAFCs have been installed and are operational at Natick Research, Development and Engineering Center, MA. Newport Naval Education Training Center, RI, the 934th Tactical Air Group, Minneapolis, MN, Kirtland Air Force Base, NM, Twenty-Nine Palms Marine Corps Base, CA, Nellis Air Force Base, NV, Camp Pendleton, CA, Ft Eustis, VA, U. S. Military Academy, West Point, NY, and Picatinny Arsenal, NJ. A PAFC is also slated for installation at the Galley at the U. S. Naval Academy, Annapolis, MD during 1997 as part of an overall building renovation project. (Another PAFC was installed by others at Vandenberg AFB.)

From the FY1994 appropriation, five PAFC are operational (as of July 1997). The five operational plants are at the following sites: 911th Airlift Wing, Pittsburgh, PA; Naval Air Station (NAS), Jacksonville, FL; NAS Fallon, NV; Fort Richardson, AK; Edwards AFB, CA. Twelve additional sites are scheduled to be installed and operational by the end of September 1997. The twelve additional sites are: Laughlin AFB, TX; Watervliet Arsenal, NY; Fort Huachuca, AZ; Westover ARB, MA; Little Rock AFB, AR; Stennis Space Center, MS; Davis-Monthan AFB, AZ; Fort Bliss, TX; Pine Bluff Arsenal, AR; Port Hueneme, CA; Barksdale AFB, LA; and NDCEE, PA. Of the seventeen total PAFCs to be installed from the FY 1994 appropriation, thirteen will be ONSI model C power plants and four will be the older model B power plants.

As of July 1997 with 15 PAFCs installed operational, the fleet has logged more than 136,000 hours of operation (mostly by model B power plants). The first units came on line during February 1995. As of June 1997, the total fleet unadjusted availability was 74%. Several factors have contributed to this 74% unadjusted availability which is somewhat lower than the manufacturers stated (> 90%) availability for the worldwide fleet. In early 1996 after one unit experienced water chemistry problems related to local conditions, some units were intentionally shut down while the problem was being investigated. Another site intentionally shuts down their PAFC during winter months due to high gas prices. Adjusting for these intentional shutdowns, the fleet has an adjusted availability of 85%. This availability could be adjusted further by following the common industry practice of adjusting for down time which is not attributed to power plant itself. For the 136,000 fleet hours, estimated (cumulative) dollars savings (based on the actual Mwh generated) are more than $900,000. Also, estimated (cumulative) pollution abated (compared to a typical mix of conventional electric utility generation) is approximately 45 tons of NOx and 90 tons of SOx.

Monitoring of PAFC performance continues while new plants are added to the fleet. It is anticipated that continued monitoring (contingent on available funding) will eventually permit a more detailed analysis of PAFC long term performance, identifying causes for outages, and development of application guidance for DoD facilities.