PLUG POWER FUEL CELL DEMONSTRATION PROJECT AT THE WATERVLIET ARSENAL

Initial Project Description Report

Prepared for

THE CONSTRUCTION ENGINEERING RESEARCH LABORATORY
Champaign, Illinois

Franklin H. Holcomb
Project Manager

Prepared by

PLUG POWER INC.
Latham, New York

John Vogel
Project Manager

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Background and Objectives of the Project

The installation and operation of PEM fuel cells designed and manufactured by Plug Power at the Watervliet Arsenal, Watervliet, NY has objectives that further the missions of both the U.S. Army Corps of Engineers and Plug Power. The following points summarize the common high-level objectives for this program:

- Allow assessment of fuel cells in supporting sustainable military installations;
- Increase the Army's ability to more efficiently construct, operate and maintain its installations;
- Assess the role of PEM fuel cells in supporting the Army's training, readiness, mobilization, and sustainability missions;
- Provide a technology demonstration site for military base market;
- Provide operational testing & validation of product to assess installation, grid interconnection, operation of systems in all seasonal conditions, and integration of units into an existing military base environment.

Plug Power, a New York state designer and manufacturer of Proton Exchange Membrane (PEM) fuel cells has extensive experience in the design and operation of PEM fuel cell systems since its inception in 1997. Plug's focus on natural gas powered fuel cell systems has resulted in the successful demonstration of systems with increasing reliability, reduced cost, and increasing functionality. Plug Power fuel cells have been sold to, and operated for New York State Energy Research and Development Authority, General Electric, DTE Energy Technologies, and the Long Island Power Authority. In addition, Plug Power has operating experience of integrated fuel cell systems approaching 225,000 hours in laboratory, field demonstration, and prototypical environmental applications. Plug Power's initial approach to the marketplace is targeting electric and gas utility customers as well as government customers. This program supports Plug Power's recognition of the Department of Defense as a potentially significant customer for fuel cells in the future, and provides the opportunity for an initial assessment of the use of PEM fuel cells supporting military base infrastructure.

The Equipment Installed

Plug Power will install ten natural gas fuel cell power systems at the Watervliet Arsenal. A typical installation is shown in Figure 1. Plug Power will plan, install, and operate three installations of its fuel cells at various locations supporting operations at the Arsenal. These locations will support residential as well as operational facilities on the post. Plug Power will provide the site preparation, the fuel cell systems, installation, operations and maintenance support, and decommissioning for each of the fuel cells installed. The fuel cell systems will operated using natural gas as a fuel and will operate in grid parallel mode to provide supplemental on-site power to specific facilities. The systems will produce electricity and will not provide cogeneration during the demonstration period. The product specifications of the fuel cell systems are described in Table 1.

Figure 1: Multiple Unit Installation of Fuel Cells

Table 1: Product Specifications

Comment	Specification
Unit Size	Base Unit with integral skid: 84.5”L x 32”W x 68”H (excludes 22” exhaust stack)
Installation Location	Outdoor
Grid Parallel	Yes
Power Output/Setpoints	2.5kW, 4 kW, 5 kW
Remote monitoring capability	Via phone line
Output Voltage	120 / 240 VAC @ 60 Hz
Certification	Integrated System CSA International Listed; Inverter UL Listed
Power Quality	IEEE 519 or better
Emissions (steady-state)	NOx < 5 ppm Sox < 1 ppm CO < 50 ppm
Standard operating conditions	Temperature: O °F to 104 °F Elevation: up to 6,000 ft Noise: < 70 dBA @ 1 meter
Production Schedule	Systems would be manufactured between June, 2001 and October, 2001

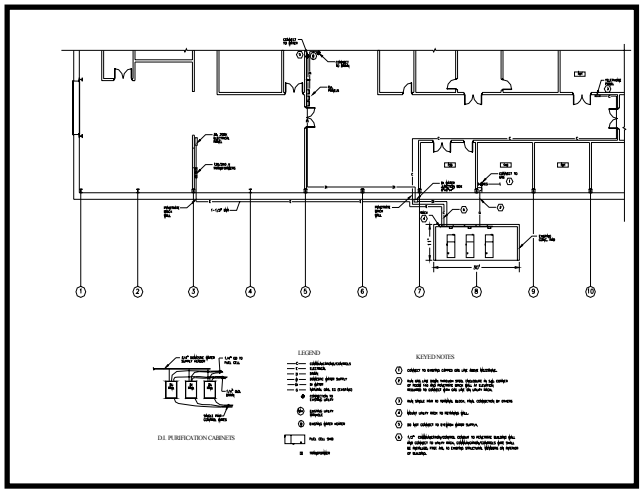
Site Information

Plug Power has worked with CERL and Arsenal personnel to select sites at the Arsenal. Each site was selected to match the power output of the systems to be installed.

The first installation is in support of the destructive testing facility in Building 115. The fuel cell systems will be located on the east side of the building on an existing 28' x 10' unused concrete pad as shown in Figure 2. Figure 3 shows the proposed installation schematic for the facility. Historical average demand for this facility has been approximately 5400 kW-hrs/month, which corresponds to a three system installation and an average fuel cell output of 2.5 kW.

Figure 2: Proposed Site at Bldg. 115

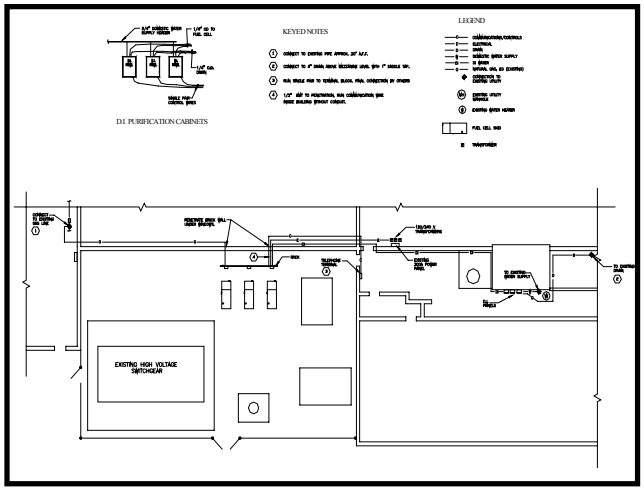
Figure 3: Bldg. 115 Installation Schematic



The second installation is in support of the Arsenal's telecommunication facility in Bldg. 110. The installation will be located at the fenced area for substation 1A3 on the west side exterior of the building shown in Figure 4. Figure 5 shows the proposed installation schematic for the facility. Historical average demand for this facility has been approximately 5400 kW-hrs/month, which corresponds to a three system installation and an average fuel cell output of 2.5 kW.

Figure 4: Proposed Site at Bldg. 110

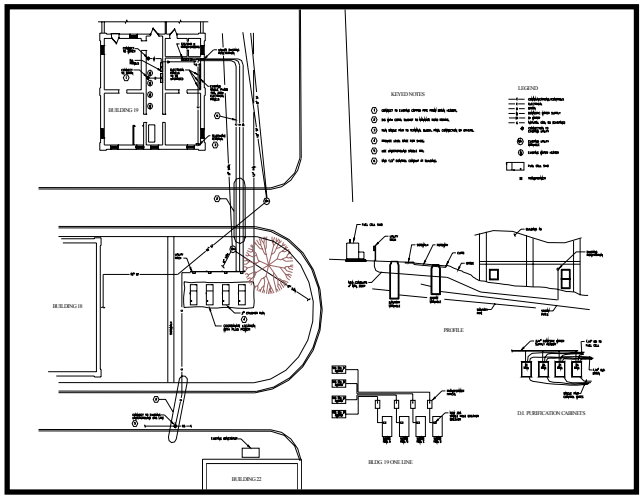
Figure 4: Bldg. 110 Installation Schematic



The third installation is in support of the Quarters 19 Officer Housing. Quarters 19 has 9,610 square feet of living space for 4 family units, with each unit individually metered. Power comes from Arsenal substation 2A4. Figure 6 shows the general vicinity if the installation and Figure 7 shows the proposed schematic. Historical average demand for this facility has been approximately 3400 kW-hrs/month, but the objective of demonstrating residential usage of fuel cell systems matched a single system to each housing unit. The four-system installation with an average fuel cell output of 2.5 kW will generate approximately 7200 kW-hrs per month. The additional electricity will be consumed by the local grid.

Figure 6: Vicinity Quarters 19

Figure 7: Q 19 Installation Schematic



Points of Contact

Plug Power, Inc.
Scott Wilshire, Director of Product Applications
(518) 782-7700 x1338
scott_wilshire@plugpower.com

Gerard Conway, Director of Government Relations
(518) 782-7700 x1970
gerard_conway@plugpower.com

John Vogel, Market Engagement Manager
(518) 782-7700 x1937
john_vogel@plugpower.com

Watervliet Arsenal
Vanessa Duenas
(518) 266-3672
duenas@wva.army.mil

Program Initial Economic Analysis

This program consists of the planning, installation, and operation of 10 Plug Power fuel cell systems at various locations supporting operations at the Watervliet Arsenal. The Watervliet Arsenal is serviced by Niagara Mohawk for both its electricity and natural gas supply. The Watervliet Arsenal Facilities Engineering (Vanessa Duenas) has supplied the following rates as average estimates for the last 12 months:

- Electrical = $0.077/kW-hr
- Natural Gas = $3.50/decatherm

The system gas usage rate is based upon the nominal Plug Power Lower Heating Value of natural gas of 804 kJ/mol and an average electrical efficiency of 24.8%. This efficiency is calculated using a weighted average of the system efficiencies at the different set points.

- System natural gas usage rate = 0.138 therm/kW-hr

The program run hours is based on 10 systems operating with a total availability of 90% for the one-year life of the program:

- Program run hours = 24 hrs X 365 days X 0.90 X 10 = 78,840 hrs.

The program number of kilowatt-hours produced is based on a system power set point of 2.5 kW for the program run hours above:

- Program kW-hrs. = 2.5 kW X 78,840 hrs. = 197,100 kW-hrs.

The program number of therms of natural gas consumed is based on the usage rate multiplied by the number of program kW-hrs above:

- Program therms consumed = 197,100 kW-hrs. X 0.138 therm/kW-hr = 27,199.8 therms.

The program total cost of natural gas is based on the number of therms consumed multiplied by the cost per therm:

- NG cost = 27,199.8 therms X $0.35/therm = $9,519.93

The equivalent cost of the fuel cell energy if purchased from Niagara Mohawk is based on the number of kilowatt-hours produced by the systems multiplied by Niagara Mohawk's charge per kW-hr:

- Electrical savings = 197,100 kW-hrs. X $0.077/kW-hr = $15,176.70

The projected total electrical savings for the program by using system-generated electricity instead of purchasing the power from Niagara Mohawk is:

- Avoided cost = $15,176.70 – 9,519.93 = $5,656.77