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US Army Corps of Engineers®
Engineer Research and Development Center

Site Evaluation for Application of Fuel Cell Technology

Fort Huachuca, AZ

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Construction Engineering Research Laboratory

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Foreword

In fiscal years 93 and 94, Congress provided funds for natural gas utilization equipment, part of which was specifically designated for procurement of natural gas fuel cells for power generation at military installations. The purchase, installation, and ongoing monitoring of 30 fuel cells provided by these appropriations has come to be known as the "DOD Fuel Cell Demonstration Program." Additional funding was provided by: the Office of the Deputy Under Secretary of Defense for Industrial Affairs & Installations, ODUSD (IA&I)/HE&E; the Strategic Environmental Research & Development Program (SERDP); the Assistant Chief of Staff for Installation Management (ACSIM); the U.S. Army Center for Public Works (CPW); the Naval Facilities Engineering Service Center (NFESC); and Headquarters (HQ), Air Force Civil Engineer Support Agency (AFCESA).

This report documents work done at Fort Huachuca, AZ. Special thanks is owed to the Fort Huachuca points of contact (POCs), Bill Stein and Craig Hansen, for providing investigators with access to needed information for this work. The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Michael J. Binder. Part of this work was performed by Science Applications International Corp. (SAIC), under Contract DACA88-94-D-0020, task orders 0002, 0006, 0007, 0010, and 0012. The technical editor was William J. Wolfe, Information Technology Laboratory. Larry M. Windingland is Chief, CEERD-CF-E, and L. Michael Golish is Chief, CEERD-CF. The associated Technical Director was Gary W. Schanche, CEERD-CV-T. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

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1 Introduction

Background

Fuel cells generate electricity through an electrochemical process that combines hydrogen and oxygen to generate direct current (DC) electricity. Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Air emissions from fuel cells are so low that several Air Quality Management Districts in the United States have exempted fuel cells from requiring operating permits. Today's natural gas-fueled fuel cell power plants operate at electrical conversion efficiencies of 40 to 50 percent; these efficiencies are predicted to climb to 50 to 60 percent in the near future. In fact, if the heat from the fuel cell process is used in a cogeneration system, efficiencies can exceed 85 percent. By comparison, current conventional coal-based technologies operate at efficiencies of 33 to 35 percent.

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

Fuel cell technology has been found suitable for a growing number of applications. The National Aeronautics and Space Administration (NASA) has used fuel cells for many years as the primary power source for space missions and currently uses fuel cells in the Space Shuttle program. Private corporations have recently been working on various approaches for developing fuel cells for stationary applications in the utility, industrial, and commercial markets. Researchers at the U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93), and have successfully executed several research and demonstration work units with a total funding of approximately $55M.

As of November 1997, 30 commercially available fuel cell power plants and their thermal interfaces have been installed at DOD locations, CERL managed 29 of these installations. As a consequence, the Department of Defense (DOD) is the owner of the largest fleet of fuel cells worldwide. CERL researchers have developed a methodology for selecting and evaluating application sites, have supervised the design and installation of fuel cells, and have actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers. This accumulated expertise and experience has enabled CERL to lead in the advancement of fuel cell technology through major efforts such as the DOD Fuel Cell Demonstration Program, the Climate Change Fuel Cell Program, research and development efforts aimed at fuel cell product improvement and cost reduction, and conferences and symposiums dedicated to the advancement of fuel cell technology and commercialization. This report presents an overview of the information collected at Fort Huachuca, AZ along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report (see Table 1).

Objective

The objective of this work was to evaluate Fort Huachuca as a potential location for a fuel cell application.

Approach

On 7 and 8 May 1996, Science Applications International Corporation (SAIC) performed a site visit at Fort Huachuca to investigate it as a potential location for a 200 kW phosphoric acid fuel cell power plant. This report presents a conceptual fuel cell installation layout, thermal interface schematics, preliminary economic evaluation, description of potential benefits, and an overview of information collected at the site. The Appendix to this report contains a copy of the completed site evaluation form prepared during the site visit.

Table 1. Companion ERDC/CERL site evaluation reports.

Location	Report No
Fort Bliss, TX	TR 01-13
Fort Eustis, VA	TR 00-17
Fort Huachuca, AZ	TR 00-14
Fort Richardson, AK	TR 00-Draft
Picatinny Arsenal, NJ	TR 00-24
Pine Bluff Arsenal, AR	TR 01-15
U.S. Army Soldier Systems Center, Natick, MA	TR 00-Draft
U.S. Military Academy, West Point, NY	TR 00-Draft
Watervliet Arsenal, Albany, NY	TR 00-Draft
911th Airlift Wing, Pittsburgh, PA	TR 00-18
934th Airlift Wing, Minneapolis, MN	TR 00-19
Barksdale Air Force Base (AFB), LA	TR 01-29
Davis-Monthan AFB, AZ	TR 00-23
Edwards AFB, CA	TR 00-Draft
Kirtland AFB, NM	TR 00-Draft
Laughlin AFB, TX	TR 00-Draft
Little Rock AFB, AR	TR 00-Draft
Nellis AFB, NV	TR 01-31
Westover Air Reserve Base (ARB), MA	TR 00-20
Construction Battalion Center (CBC), Port Hueneme, CA	TR 00-16
Naval Air Station Fallon, NV	TR 00-15
Naval Education Training Center, Newport, RI	TR 00-21
Naval Hospital, Marine Corps Base Camp Pendleton, CA	TR 00-Draft
Naval Hospital, Naval Air Station Jacksonville, FL	TR 01-30
Naval Oceanographic Office, John C. Stennis Space Center, MS	TR 01-3
Subase New London, Groton, CT	TR 00-Draft
U.S. Naval Academy, Annapolis, MD	TR 00-22
National Defense Center for Environmental Excellence (NDCEE), Johnstown, PA	TR 01-33
Naval Hospital, Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, CA	TR 01-32

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

1 ft	=	0.305 m
1 mile	=	1.61 km
g1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	°C (X 1.8) + 32

2 Site Description

Fort Huachuca is located adjacent to the city of Sierra Vista in southeastern Arizona, approximately 70 mi southeast of Tucson. The ASHRAE design temperatures for the site are 98 and 28 °F. However, the extreme temperatures range from a high of 108 °F to a low of –5 °F. Fort Huachuca has 2,600 heating degree days and 1,566 cooling degree days. The heating season extends from 15 October to 15 April. The elevation is approximately 4,700 ft and humidity is relatively low. Figure 1 shows an overall Fort Huachuca site map.

The mission of Fort Huachuca is primarily military intelligence training. The Fort is a part of the U.S. Army Training and Doctrine Command (TRADOC), headquartered at Fort Monroe, VA. Along with the U.S. Army Intelligence Center and Fort Huachuca, the following organizations are major tenants located on Fort Huachuca: Headquarters U.S. Army Information Systems Command, U.S. Army Electronic Proving Ground, Department of Defense Joint Interoperability Test Center, and the U.S. Army Communications Security Logistic Activity. More than 40 commands, agencies, and activities are located on Fort Huachuca representing the U.S. Army, U.S. Air Force, U.S. Navy, U.S. Marine Corps, and the Army and Air National Guard, plus several other Federal agencies.

Based on discussions with site personnel, the evaluation focused on the Riley Barracks (Bldg. 51005) and the hospital (Bldg. 45001). The hospital uses 6,000 gal of hot water per day and recently installed two, 150-ton, double-effect absorption chillers. The hospital had limited space for the fuel cell and due to the recent modifications was considered an unattractive location. Site personnel preferred that the site evaluation focus on the Riley Barracks.

Although there are two central hot water plants at Fort Huachuca, Riley Barracks has its own boilers for space heating and domestic hot water (DHW). Tucson Electric Power Company provides power to the Fort from a 13.8 kV feeder. There is only one electric meter for billing purposes, but there are several submeters for information purposes. Site personnel indicated that power outages usually occur due to lightning, but are usually short in duration. Natural gas is supplied by Southwest Gas.

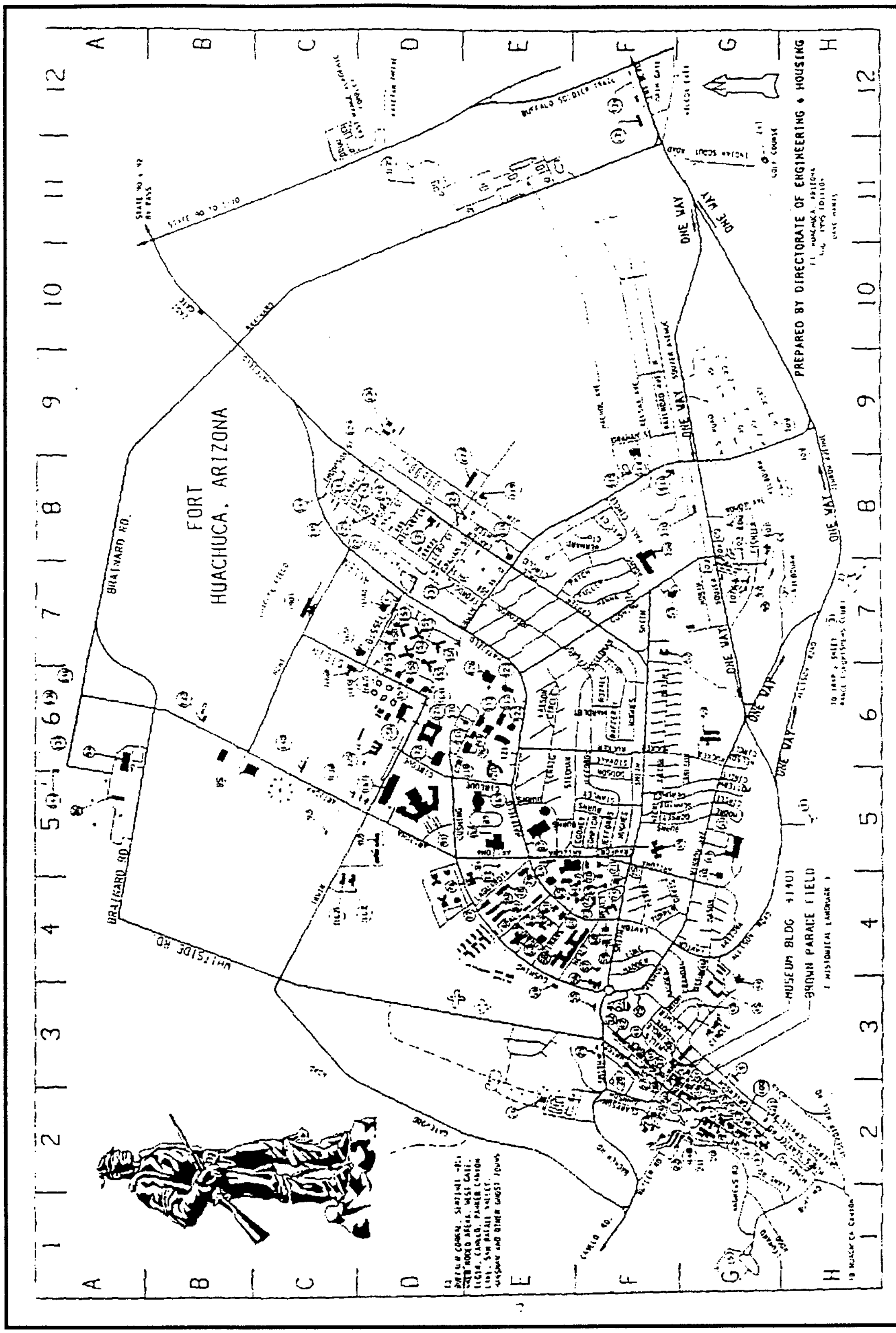

Figure 1. Fort Huachuca site map.

Riley Barracks is located on the western side of the Fort. Figure 1 shows Riley Barracks as Building No. 58, located at E-4. The barracks has 330 rooms, 33 latrines, and 20 laundry rooms. Most of the rooms house two people and the barracks has an occupancy of 88 percent. There is also some office space in the front of the facility. There is an adequate natural gas line and electric transformer in the mechanical room to meet the requirements of a fuel cell power plant. Make up water and telephone lines are available. A small wing was added on to the barracks that houses a small medical clinic, which is called "the Meddac." The Meddac has a separate energy system consisting of an electric hot water heater and electric heat pumps. More specific interface information for the site is provided in the Fuel Cell Interfaces section of this report (pp 12-15).

Site Layout

Figure 2 shows the mechanical room located at the back of the barracks. All the primary energy equipment is located in or near the mechanical room including the hot water and space heating boilers, electric panels, chiller, and the cooling tower.

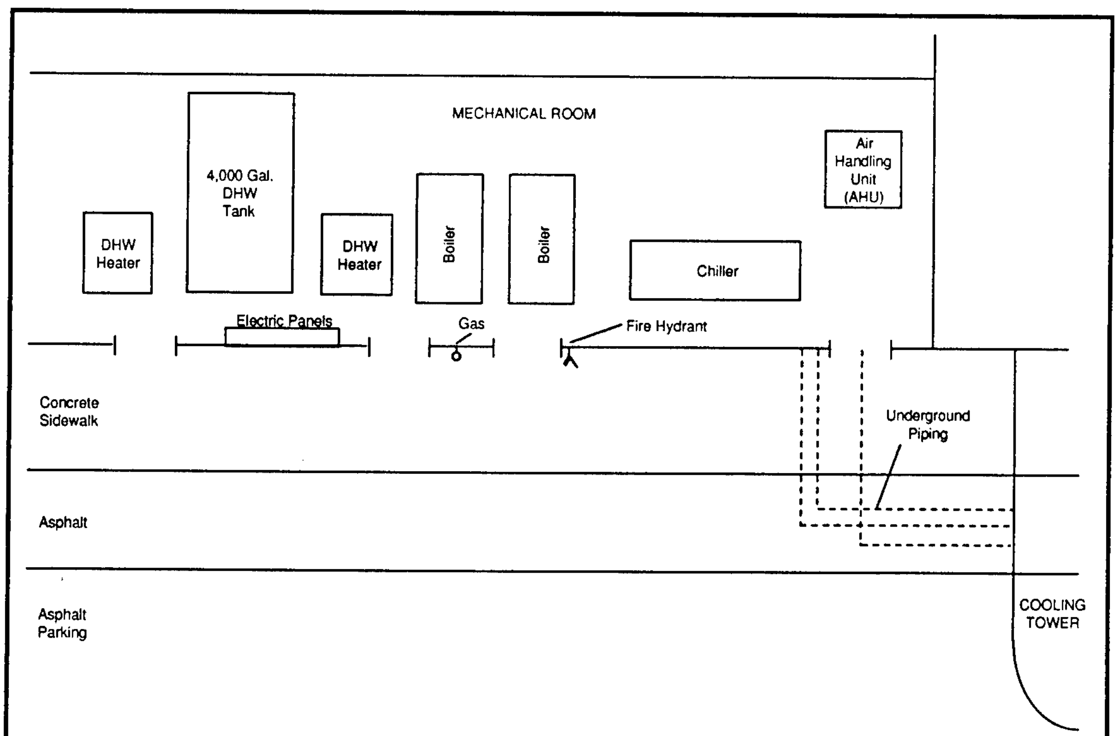

Figure 2. Riley Barracks site layout – mechanical room area.

Directly behind the mechanical room is a large concrete sidewalk bordered by an asphalt strip, which is adjacent to an asphalt parking area. The asphalt area directly behind the mechanical room is adequate for siting a fuel cell. It would be necessary to avoid underground piping and a fire hydrant.

Electrical System

A 13.8 kV electric line serves a 3,000 kVA transformer that provides 480 V power to the barracks. The barracks have a peak electric demand of 450 kW and would be able to consume all of the fuel cell's electrical output. Riley Barracks is currently served by a small 40 kW emergency generator. There were no significant requirements for using the fuel cell as an emergency generator.

Steam/Hot Water System

There are two redundant 3 MBtu/hr hot water boilers in the mechanical room of the barracks that produce 140 °F hot water that is stored in a 4,000-gal tank before delivery to the barracks. Hot water is used for domestic purposes in the rooms and for 20 small laundry rooms. A 30-gal electric hot water heater supplies hot water to the Meddac wing of the barracks.

Space Heating System

Two parallel 4.2 MBtu/hr boilers in the mechanical room of the barracks produce 120 °F to 190 °F hot water for space heating. The rooms are served by a two-pipe space heating distribution system. The office space is served by a four-pipe system. Two small heat pumps provide space heating for the Meddac wing. It is not recommended that these heat pumps be connected to the fuel cell thermal output.

Space Cooling System

A 400-ton centrifugal chiller provides 45 to 50 °F chilled water to fan coil units in the rooms for space cooling. The rooms are served by a two-pipe space cooling distribution system. The office space is served by a four-pipe system. Four small direct expansion air conditioning units also supply cooling to the office space.

Two small heat pumps provide space cooling for the Meddac wing of Riley Barracks.

Fuel Cell Location

The fuel cell is proposed to be located behind the mechanical room on the asphalt (Figure 3). There is adequate room around the fuel cell to maintain the desired 8-ft spacing. The electrical connection to the mechanical room electrical panels will require a run of less than 50 ft. The low grade thermal lines will be run approximately 70 ft to the domestic hot water tank. The high grade thermal lines will be run approximately 40 ft to the space heating boilers.

The natural gas line can be connected to the main gas line for the mechanical room, which is a piping run of approximately 60 ft. All lines are proposed to be run overhead to the mechanical room. The barracks will lose a few parking spaces behind the mechanical room. Site personnel stated this would not be a problem.

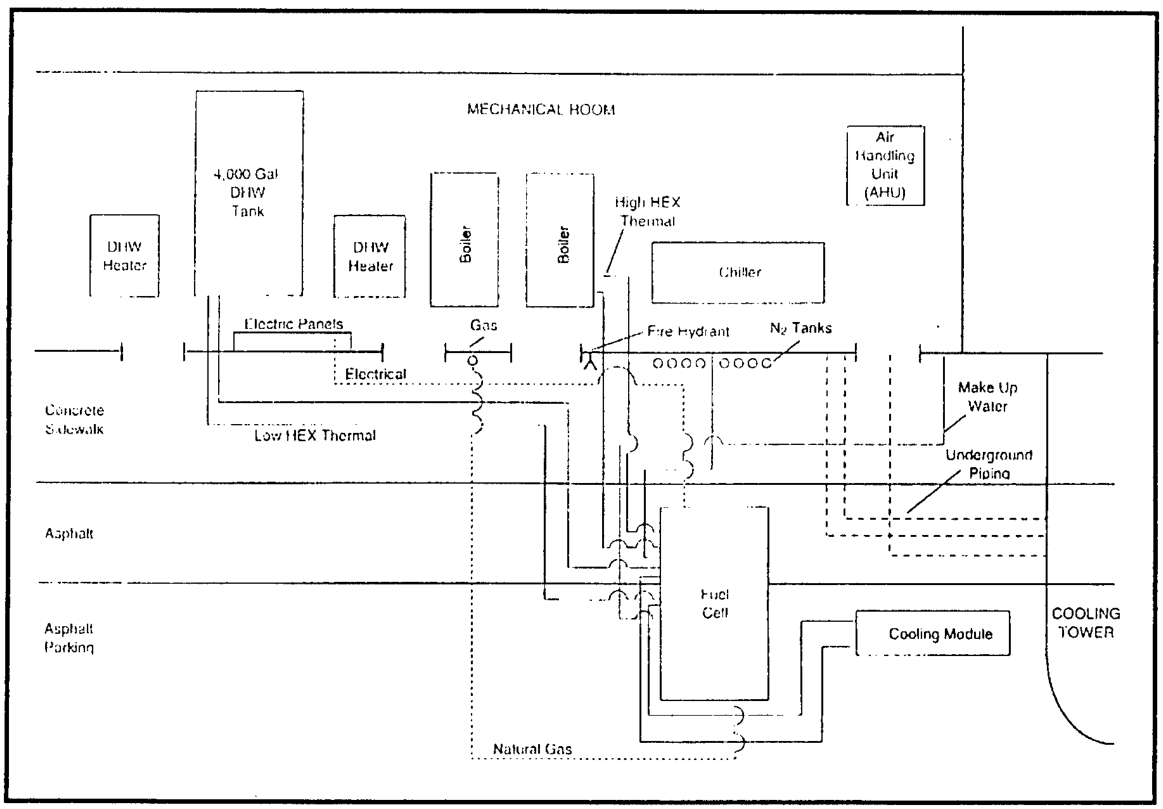

Figure 3. Fuel cell location and site interfaces.

Fuel Cell Interfaces

Riley Barracks uses 480 V power fed through a 3,000 kVA, 480 V/13.8 kV transformer. The peak electrical demand of the barracks is approximately 450 kW. The annual average demand is 285 kW. The fuel cell output will be connected to the low side of the transformer and can feed back through the existing transformer. However, this would be unlikely since the barracks will normally be able to use the full power from the fuel cell.

The primary thermal loads of the barracks are space heating and domestic hot water (DHW). The DHW load requires 140 °F and is compatible with the standard thermal output of the fuel cell. The space heating requires up to 190 °F hot water, which is only compatible with the high grade heat from the fuel cell. The DHW load will only use a portion of the fuel cell thermal output and the space heating will only be required during the 6 winter months. Therefore, it is recommended that the PC25C fuel cell be ordered with the high grade heat exchanger option to provide both high grade heat for space heating and low grade heat for DHW. With the two heat exchangers in the fuel cell, approximately 380 kBtu/hr can be supplied at 250 °F and the remaining 320 kBtu/hr at 140 °F. Any heat not supplied from the high grade heat exchanger is available through the low grade heat exchanger.

Domestic hot water is presently heated by two 3 MBtu/hr water heaters. The water heaters operate in parallel and heat a 4,000-gal storage tank. They heat the tank to approximately 140 °F although a controller determines the temperature based on hot water load. Therefore, the hot water delivery temperature can vary, but is usually 140 °F.

The cold water is approximately 70 °F. A 25 gpm pump would draw from the cold water line through the fuel cell low grade heat exchanger (Figure 4). The heated DHW would be fed into the water heater supply line. The pump would be controlled to shut off when the tank temperature reaches 140 °F. The existing DHW heater input controls would be readjusted so that the heaters would not be used until the tank temperature dropped below 130 °F, thus ensuring that the fuel cell would not only heat the make-up water, but would also maintain the tank temperature at 140 °F. During periods of high DHW usage, or when the fuel cell is not operating, the DHW supply temperature will be 130 °F, which should not be a problem. Site personnel previously measured the daily DHW load and determined that the barracks used approximately 6,000 gal/day. The DHW load was calculated as:

146 kBtu/hr = 6,000 gal/day x 8.33 lb/gal x 1 Btu/lb -°F x (140 °F – 70 °F) x 1 day/24 hr

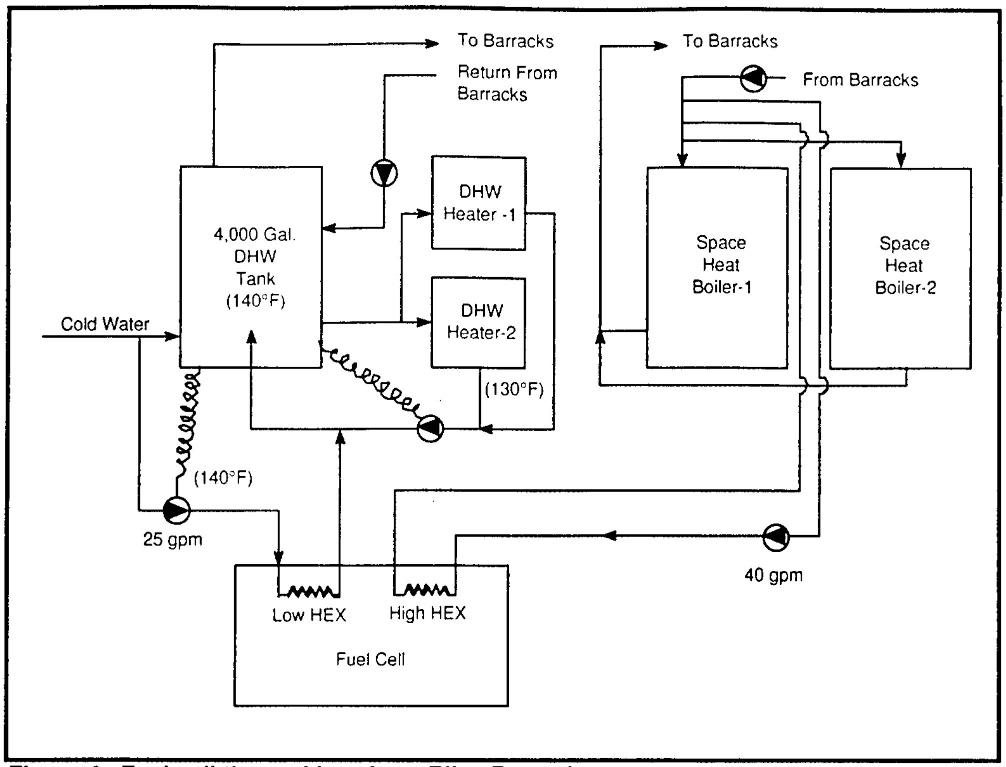

Figure 4. Fuel cell thermal interface, Riley Barracks.

This represents 46 percent of the fuel cell's low grade thermal output (146 kBtu/hr/320 kBtu/hr). Obtaining 320 kBtu/hr from the low grade heat exchanger assumes that the barracks is able to use the full thermal output of the fuel cell's high grade heat exchanger, which is 380 kBtu/hr.

The high grade heat exchanger would provide space heating. The hot water return from the air handlers of the barracks would be preheated by the fuel cell (Figure 4). The space heat hot water supply temperature varies between 120 °F and 190 °F depending on outside temperatures. However, site personnel indicated the supply temperature usually approaches 190 °F. Space heating is supplied 6 months a year.

The Riley Barracks is primarily a four-story facility composed of several wings. There are a few smaller single story wings. The barracks is composed of 260,000 sq ft. The construction is of uninsulated concrete block. The ASHRAE 1993 Fundamentals Handbook gives the following resistance (inverse of conductance) values for the barracks wall construction:

- Outside surface, 15 mph wind, Ro = 0.17 °F-sq-ft-hr/Btu
- Uninsulated concrete block, Rc = 0.58 °F-sq-ft-hr/Btu
- Inside surface, still air, Ri = 0.68 °F-sq-ft-hr/Btu

Rtotal = Ro + Rc + Ri = 0.17 + 0.58 + 0.68 = 1.43 °F-sq-ft-hr/Btu

Conductance, U = 1/R = 1/1.43 = 0.70 Btu/ °F-sq-ft-hr

The total wall area was estimated to be 45,600 sq ft. Fort Huachuca has 2,600 heating degree days. The space heating load is calculated as:

455kBtu/hr=2,600 °F-days/yr x 0.70 Btu/ °F-sq-ft-hr x 45,600 sq ft x 24 hr/day x 1 yr/4,380 hr

This represents the average thermal load for the 6-month space heating season. Based on previously measured space heating load profiles for apartment buildings (ref. GRI No. 86/0292.1; *Characterization of Instrumented Sites for the Onsite Fuel Cell Field Test Project,* November 1986), it was conservatively estimated that with a seasonal average load of 455 kBtu/hr, the fuel cell would supply about 70 percent of the requirement or 318 kBtu/hr:

318 kBtu/hr = 455 kBtu/hr x 0.70

This represents 84 percent of the fuel cell's high grade thermal output (318 kBtu/hr/380 kBtu/hr).

The annual fuel cell thermal utilization for the barracks's space heating and DHW loads is calculated as:

44% =[(146+318 kBtuh)/700 kBtuh)* 6 mo/yr + (146 kBtuh/700 kBtuh) * 6 mo/yr]/12 mo

Economic Analysis

Fort Huachuca purchases electricity from Tucson Electric Power Company under schedule Large Light and Power Rate No. 14. This rate schedule has both demand and energy charge components. There are different energy charges for the winter (November-April) and summer (May-October) periods. Table 2 lists the base electricity consumption and costs for the May 1995 to April 1996 time period. The Rate No. 14 schedule is currently:

- Demand Charge: $10.28/kW
- Energy Charge (summer): $0.047457/kWh
- Energy Charge (winter): $0.045084/kWh.

Natural gas is purchased on the spot market and transported by Southwest Gas. Table 3 presents natural gas consumption for the period from May 1995 to April 1996. The installation provided no gas cost data because it had recently switched to a spot market purchase. The base is charged about $2.20/MBtu (million Btu) for natural gas and $1.38/MBtu for gas transportation. Site personnel expect to sign a contract in the near future for gas transportation costs not to exceed $0.90/MBtu. The best estimate for gas costs for the fuel cell is $3.10/MBtu.

Table 2. Fort Huachuca electricity consumption and costs.

Month	KWH	KW	Cost	$/KWH
May-95	7,929,600	15,760	$560,901	$0.0707
Jun-95	9,676,800	18,255	$674,522	$0.0697
Jul-95	10,060,800	19,532	$706,921	$0.0703
Aug-95	10,464,000	20,820	$740,699	$0.0708
Sep-95	10,790,400	19,921	$747,028	$0.0692
Oct-95	9,043,200	18,009	$639,693	$0.0707
Nov-95	8,620,800	15,091	$566,603	$0.0657
Dec-95	7,680,000	14,600	$517,613	$0.0674
Jan-96	7,545,600	14,884	$514,334	$0.0682
Feb-96	7,908,800	14,531	$526,711	$0.0666
Mar-96	8,140,800	14,564	$537,713	$0.0661
Apr-96	8,332,800	15,688	$563,964	$0.0677
Tot/Avg	**106,193,600**	**16,805**	**$7,296,702**	**$0.0687**

Table 3. Fort Huachuca natural gas consumption.

Month	MBtu
May-95	20,645
Jun-95	11,585
Jul-95	15,030
Aug-95	13,678
Sep-95	13,257
Oct-95	18,714
Nov-95	44,970
Dec-95	77,003
Jan-96	61,773
Feb-96	57,516
Mar-96	53,792
Apr-96	35,486
Tot/Avg	**423,449**

Electric savings from the fuel cell were calculated based on the fuel cell operating 90 percent of the year (1,576,800 kWh). Demand savings were calculated as:

200 kW * 12 mo * $10.28/kW = $24,672

Summer Energy Charge Savings were calculated as:

1,576,800 kWh * 6/12 mo * $0.047457/kWh = $37,415

Winter Energy Charge Savings were calculated as:

1,576,800 kWh * 6/12 mo * $0.045084/kWh = $35,544

Total electric savings without State tax, based on 100 percent demand savings, are projected to be $97,631. When the 5 percent State tax savings is included, total fuel cell electricity savings grows to $102,513.

Thermal savings were estimated previously. Total thermal displaced by the fuel cell, assuming a 70 percent displaced boiler efficiency, is calculated as:

1,829 MBtu = [(318 + 146 MBtu/hr) * 8760 hr/yr * 6/12 mo] * 90% cap. factor

575 MBtu = [146 MBtu/hr * 8760 hr/yr * 6/12 mo] * 90% cap. factor

3,434 MBtu displaced thermal = (1,829 MBtu + 575 MBtu) / 70% boiler eff.

Using an average natural gas rate of $3.10/MBtu, thermal cost savings of $10,645 were calculated for the fuel cell.

The fuel cell will consume 14,949 MBtu per year based on an electrical efficiency of 36 percent higher heating value (HHV). Input natural gas cost for the fuel cell at $3.10/MBtu would be $46,342.

The net savings for the fuel cell, assuming 44 percent thermal utilization and 100 percent demand savings, are $66,816 (Table 4). Table 4 also presents savings for maximum thermal savings, partial demand savings, and two different gas rate scenarios (±10 percent).

The analysis gives a general overview of the potential savings from the fuel cell. For the first 3 to 5 years, ONSI will be responsible for the fuel cell maintenance. Maintenance costs are not reflected in this analysis, but could represent a significant impact on net energy savings. Since detailed load energy profiles were not available, net energy savings could vary depending on actual thermal and electrical utilization.

Table 4. Economic savings of fuel cell installation.

Case	ECF	TU	Displaced kWh	Displaced Gas (MBtu)	Electrical Savings	Thermal Savings	Nat. Gas Cost	Net Savings
100% Demand Savings								
Max. Thermal	90%	100%	1,576,800	7,884	$102,513	$24,440	$46,342	$80,611
Base Case	90%	44%	1,576,800	3,434	$102,513	$10,645	$46,342	$66,816
Low Gas Case ($2.80/MBtu)	90%	44%	1,576,800	3,434	$102,513	$9,615	$41,857	$70,271
High Gas Case ($3.40/MBtu)	90%	44%	1,576,800	3,434	$102,513	$11,675	$50,827	$63,361
50% Demand Savings								
Max. Thermal	90%	100%	1,576,800	7,884	$89,560	$24,440	$46,342	$67,658
Base Case	90%	44%	1,576,800	3,434	$89,560	$10,645	$46,342	$53,863
Low Gas Case ($2.80/MBtu)	90%	44%	1,576,800	3,434	$89,560	$9,615	$41,857	$57,318
High Gas Case ($3.40/MBtu)	90%	44%	1,576,800	3,434	$89,560	$11,675	$50,827	$50,408
No Demand Savings								
Max. Thermal	90%	100%	1,576,800	7,884	$76,607	$24,440	$46,342	$54,705
Base Case	90%	44%	1,576,800	3,434	$76,607	$10,645	$46,342	$40,910
Low Gas Case ($2.80/MBtu)	90%	44%	1,576,800	3,434	$76,607	$9,615	$41,857	$44,365
High Gas Case ($3.40/MBtu)	90%	44%	1,576,800	3,434	$76,607	$11,675	$50,827	$37,455

Assumptions:

Natural Gas Rate: $3.10 /MBtu

Fuel Cell Thermal Output: 700,000 Btu/hour

Fuel Cell Electrical Efficiency: 36%

ECF = Fuel cell electric capacity factor

TU = Thermal utilization

Conclusions and Recommendations

The Riley Barracks represents a good application for a 200 kW phosphoric acid fuel cell. The net energy bill savings are expected to be almost $67,000/year with full demand savings. The fuel cell installation at the barracks is straightforward with convenient piping and wiring runs.

The fuel cell is already electrically compatible with the site. There is an existing 3,000 kVA 480 V/13.8 kV transformer. It is recommended that the separate high and low grade heat exchanger option be ordered for the PC25C model so that the fuel cell can supply the DHW load throughout the year and thereby meet the higher temperature requirements of the space heating load during the winter months.

This site will also provide good visibility for the fuel cell because Riley Barracks often houses VIP visitors.

Appendix: Fuel Cell Site Evaluation Form

Site Name: **Fort Huachuca**

Contact: **Bill Stein**
(520) 533-1861

Location: **Fort Huachuca, AZ**

1. Electric Utility: **Tucson Electric Power**

   Rate Schedule: **Large Light and Power Rate No. 14**

2. Gas Utility: **Southwest Gas**

   Rate Schedule: **CT-1, Gas Transmission Agreement, Spot Mkt.**

3. Available Fuels: **Natural Gas, some propane**

4. Hours of Use and Percent Occupied:
   Boilers operate continuously, periodic
   87% occupied

Weekdays	5	Hrs.	24
Saturday	1	Hrs.	24
Sunday	1	Hrs.	24

5. Outdoor Temperature Range: **ASHRAE design: 98 °F high, 28 °F low, Extremes: 108 °F high, -5 °F low, 2,600 HDD, 1,566 CDD**

6. Environmental Issues: **No major issues. Will require NEPA documentation which was probably already developed for other bases.**

7. Backup Power Need/Requirement: **Riley barracks has a 40 kW emergency generator. There are no critical backup power needs at Riley Barracks.**

8. Utility Interconnect/Power Quality Issues: **None.**

9. On-site Personnel Capabilities: **Most station maintenance is performed by a contractor, Sci Tek.**

10. Access for Fuel Cell Installation: **Very Good.**

11. Daily Load Profile Availability: **No load profile data is available.**

12. Security: **The standard chain link fence will be required.**

Site Layout

Facility Type: **Barracks** Age: **25 years**
Construction: **Uninsulated concrete block**
Square Feet: **260,000**

See Figures 2, 3, and 4

Show: electrical/thermal/gas/water interfaces and length of runs
drainage
building/fuel cell site dimensions
ground obstructions

Electrical System

Service Rating: **13.8 kV service to building, 480 volt service in building**

Electrically Sensitive Equipment: **Computers**

Largest Motors (hp, usage): **400 ton centrifugal chiller**

Grid Independent Operation?: **No**

Steam/Hot Water System

Description: **There are two central energy plants at the Fort. Riley Barracks has its own independent energy system.**

System Specifications:

Fuel Type: **Natural Gas**

Max Fuel Rate:

Storage Capacity/Type: **4,000 gal**

Interface Pipe Size/Description: **3 in.**

End Use Description/Profile: **There are two 3 MBtu/hr hot water boilers that produce 140 °F hot water for domestic hot water. One 30 gal electric water heater serves the Meddac.**

Space Cooling System

Description: **One 400 ton centrifugal chiller, 4-pipe and 2-pipe distribution systems with air handling units and terminal units. Two heat pumps for Meddac.**

Air Conditioning Configuration:

Type:

Rating:

Make/Model:

Seasonality Profile:

Space Heating System

Description: **Two parallel 4.2 MBtu/hr boilers in the mechanical room of the barracks produce 120 °F to 190 °F hot water for space heating. The rooms are served by a two pipe space heating distribution system and the office space is served by a four pipe system. There are two small heat pumps which provide space heating for the Meddac wing that will not be connected to the fuel cell's thermal output.**

Fuel: **Natural Gas**

Rating:

Water Supply Temp: **120 °F to 190 °F**

Water Return Temp:

Make/Model: Kewanee Boiler Corp.

Thermal Storage (space?):

Seasonality Profile: **Winter space heating: October 15 – April 15**

CERL Distribution

Commander, Fort Huachuca
    ATTN: ATZS-EHE (2)

Chief of Engineers
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14. ABSTRACT

Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Researchers at the U.S. Army Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93), and have selected and evaluated application sites, supervised the design and installation of fuel cells, actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers for 29 of 30 commercially available fuel cell power plants and their thermal interfaces installed at Department of Defense (DOD) locations.

This report presents an overview of the information collected at Fort Huachuca, AZ, along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report.

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