ERDC/CERL TR-01-51

US Army Corps of Engineers®
Engineer Research and Development Center

Site Evaluation for Application of Fuel Cell Technology

Naval Hospital – Marine Corps Base Camp Pendleton, CA

Michael J. Binder, Franklin H. Holcomb, and William R. Taylor

June 2001

20010614 092

Construction Engineering Research Laboratory

Foreword

In fiscal years 1993 and 1994, 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 and Installations, ODUSD (IA&I)/HE&E; the Strategic Environmental Research and 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 the Naval Hospital at the Marine Corps Base Camp Pendleton, Oceanside, CA. Special thanks is owed to the Naval Hospital at Camp Pendleton point of contact (POC), Jim Beesing, 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 Dr. Alan W. Moore.

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 Deputy to the Commander is A.J. Roberto, Jr.

Contents

List of Figures and Tables

Figures

Tables

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, 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 Naval Hospital — Marine Corps Base Camp Pendleton, CA 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 (Table 1).

Objective

The objective of this work was to evaluate Naval Hospital at Camp Pendleton as a potential location for a fuel cell application.

Approach

On 23 and 24 March 1995, Science Applications International Corporation (SAIC) visited Camp Pendleton Marine Corps Base (the Site) located in Oceanside, CA to investigate it as a potential location for a 200 kW phosphoric acid fuel cell. This report presents an overview of information collected at the Site along with a conceptual fuel cell installation layout and description of potential benefits. The Appendix to this report contains a copy of the site evaluation form filled out at the Site.

Table 1. Companion ERDC/CERL site evaluation reports.

Location	Report No.
Pine Bluff Arsenal, AR	TR 00-15
Naval Oceanographic Office, John C. Stennis Space Center, MS	TR 01-3
Fort Bliss, TX	TR 01-13
Fort Huachuca, AZ	TR 01-14
Naval Air Station Fallon, NV	TR 01-15
Construction Battalion Center (CBC), Port Hueneme, CA	TR 01-16
Fort Eustis, VA	TR 01-17
Watervliet Arsenal, Albany, NY	TR 01-18
911th Airlift Wing, Pittsburgh, PA	TR 01-19
Westover Air Reserve Base (ARB), MA	TR 01-20
Naval Education Training Center, Newport, RI	TR 01-21
U.S. Naval Academy, Annapolis, MD	TR 01-22
Davis-Monthan AFB, AZ	TR 01-23
Picatinny Arsenal, NJ	TR 01-24
U.S. Military Academy, West Point, NY	TR 01-28
Barksdale Air Force Base (AFB), LA	TR 01-29
Naval Hospital, Naval Air Station Jacksonville, FL	TR 01-30
Nellis AFB, NV	TR 01-31
Naval Hospital, Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, CA	TR 01-32
National Defense Center for Environmental Excellence (NDCEE), Johnstown, PA	TR 01-33
934th Airlift Wing, Minneapolis, MN	TR 01-38
Laughlin AFB, TX	TR 01-41
Fort Richardson, AK	TR 01-42
Kirtland AFB, NM	TR 01-43
Subase New London, Groton, CT	TR 01-44
Little Rock AFB, AR	TR 01-47
U.S. Army Soldier Systems Center, Natick, MA	TR 01-49
Naval Hospital, Marine Corps Base Camp Pendleton, CA	TR 01-51
Edwards AFB, CA	TR 01-Draft

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.

SI conversion factors		
1 ft	=	0.305 m
1 mi	=	1.61 km
1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	(°C x 1.8) + 32

2 Site Description

Camp Pendleton Marine Corps Base in Oceanside, CA is located approximately 25 miles north of San Diego. Camp Pendleton is home to more than 35,000 marines where they are trained in a broad range of mission related skills. Temperatures range from the 40's in the winter to over 100 °F in the summer.

A Naval hospital facility is located at Camp Pendleton. The hospital has 600 beds with an average occupancy of 125 patients. The hospital facility also receives up to 2,000 walk-in patients per day. The hospital is served by an 8,000 sq ft maintenance facility which houses two 35,000 lb/hr boilers, two 800-ton absorption chillers and two 4,500-gal domestic hot water tanks. No domestic hot water load profile data were available, but some make-up water log data and gas and electricity bills were provided.

Site Layout

Figure 1 presents the facility layout for the hospital boiler plant (Building H-99). This figure shows the location of the boilers, absorption chillers and domestic hot water tanks (W.H. #1, #2). A cooling tower and electric transformer (west side) as well as a 1,600 kW backup generator (south side) are located in a fenced area outside the maintenance facility. Natural gas is located on the northwest end of the building. An existing cement pad is located in an open space area on the north side of the building across a service road. This cement pad, which has a natural gas supply line, is the former location of an incinerator.

Electrical System

The boiler plant has a 12 kV to 480V transformer (1,500 kVA) that serves the hospital and maintenance facility. The Navy hospital purchases electricity from Camp Pendleton, which purchases it from San Diego Gas & Electric. Camp Pendleton owns and maintains all the electric distribution lines on the base.

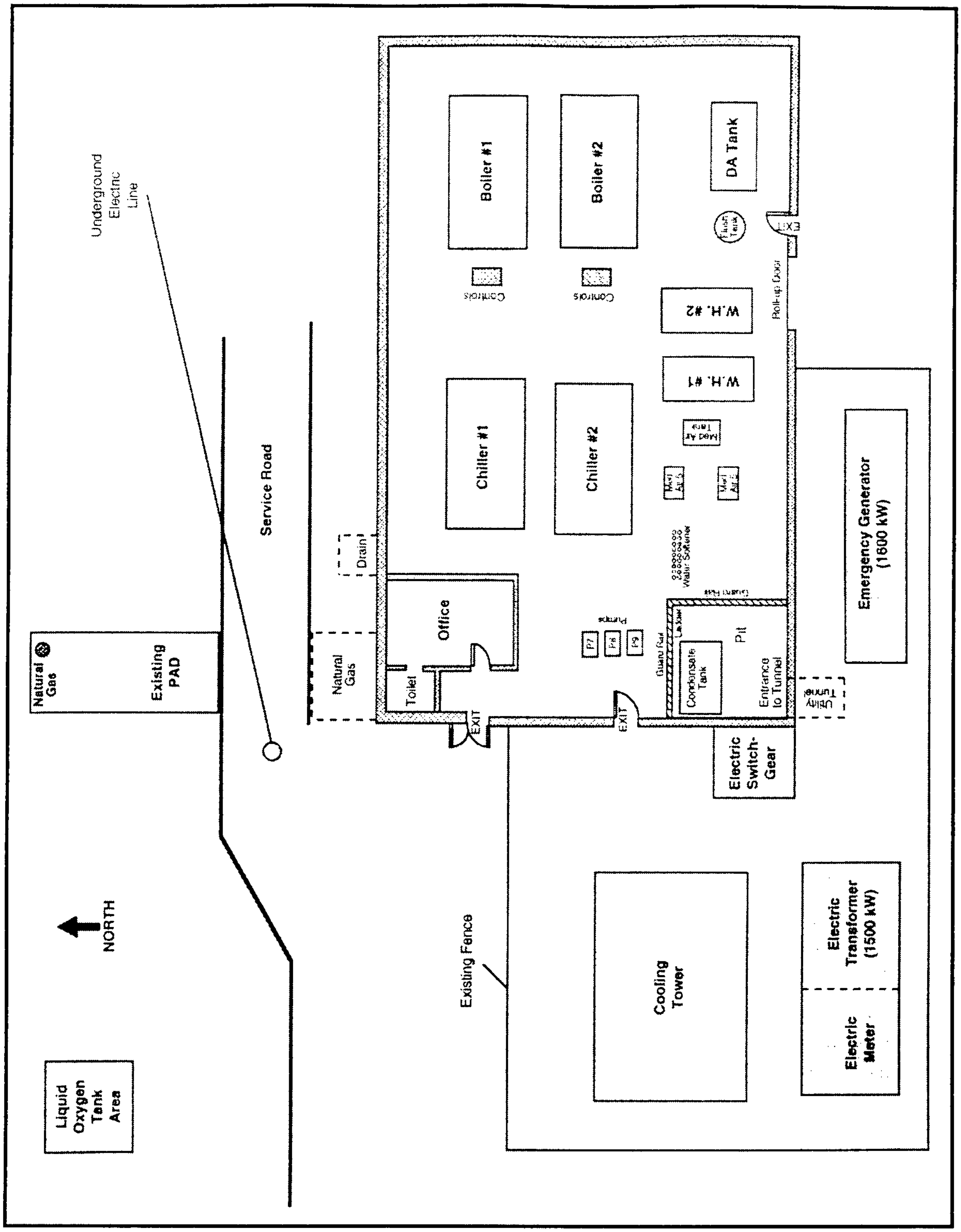

Figure 1. Camp Pendleton Hospital Power Plant site layout.

Steam/Hot Water System

The Site has two Babcock & Wilcox 35,000 lb/hr boilers that were built in 1972. The boilers are used to provide hot water and space heating to the hospital facility. Additionally, the boilers drive two 800-ton absorption chillers. Two 4,500-gal domestic hot water tanks are located inside the maintenance facility. Currently, the tanks are used one at a time on an alternating weekly basis. Steam is used to keep the tank temperature at about 120 °F. A 10 gpm pump is used to circulate hot water continuously through the hospital. The temperature differential for this recirculating loop is 10 °F.

Space Heating System

The boilers provide steam to the hospital for space heating. Heat exchangers are located throughout the hospital. Heating normally occurs November through April.

Space Cooling System

Two 800-ton Trane absorption chillers are located in the boiler plant. The chillers operate throughout the year, depending on ambient conditions. During the winter months, only one unit operates when cooling is required (usually only during the daytime). During the summer, both units are generally required during the day and only one unit operates at night. Steam from the boilers is used to drive the absorption chillers and also for reheating purposes to control relative humidity in the hospital. The maintenance facility will be replacing the two existing absorption chillers in about two years. They plan to install one 800-ton direct fired absorption chiller and one 800-ton electric centrifugal chiller. This will significantly reduce the load on the steam boilers in the summer.

Fuel Cell Location

The proposed location for the fuel cell is an open area just north of the maintenance facility (Building H-99) (Figure 2). There is a liquid oxygen tank 60 ft to the west of this location (nothing can be sited within 50 ft of this tank). There is an underground electric feeder running between Building H-99 and the proposed fuel cell location.

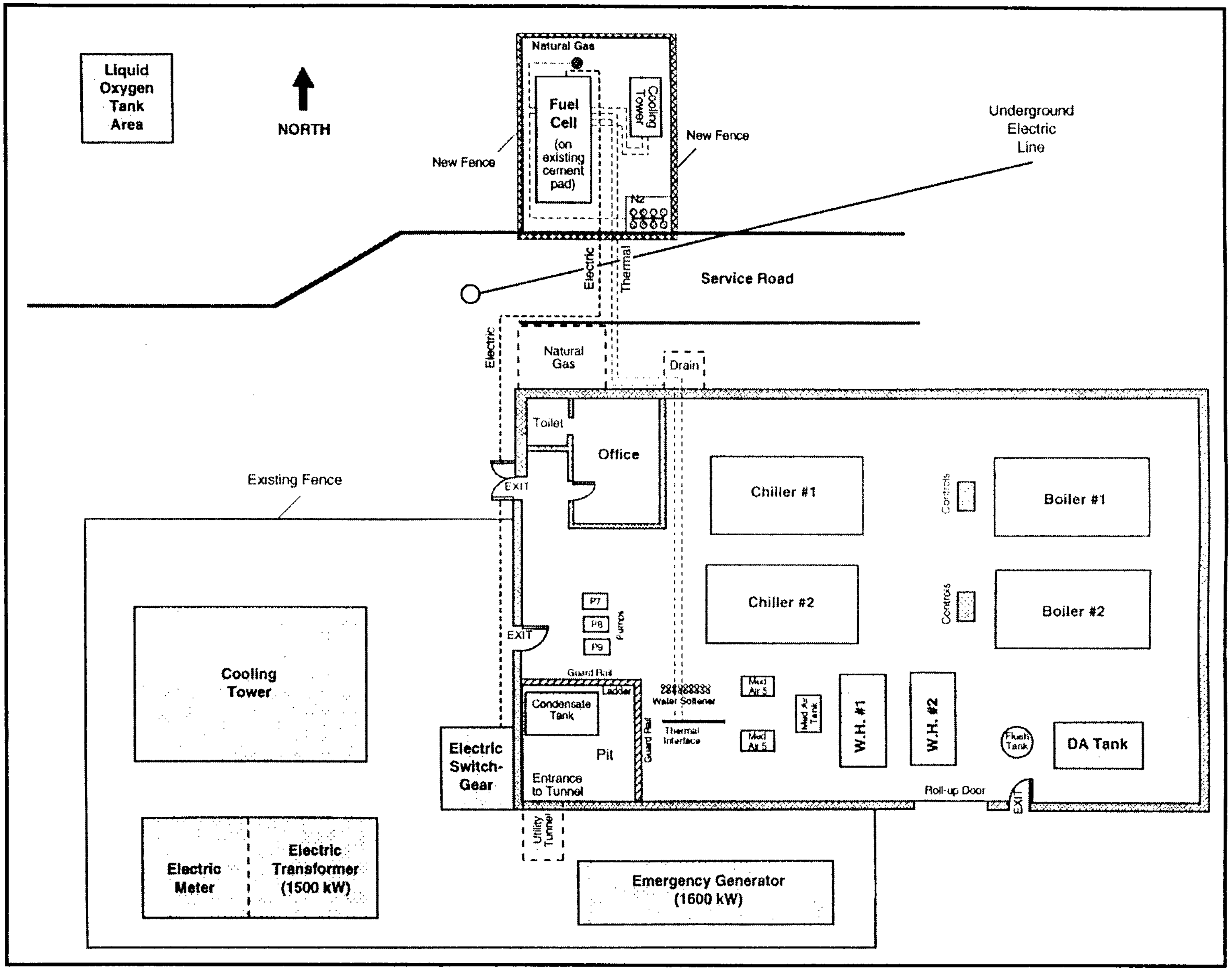

Figure 2. Camp Pendleton Hospital Power Plant fuel cell locations and interfaces.

Caution must be taken when trenching across the service road to avoid the utility lines. It is proposed that the fuel cell be sited on the existing cement pad (Figure 1). The cement pad could either be "capped" or completely replaced with a new pad. There is a gas line coming up from underneath the pad at the north end that could also be utilized by the fuel cell.

Figure 2 also shows the interfaces to the fuel cell. The thermal piping run will be approximately 40 ft underground to the building, up the side of the building about 12 ft, and then approximately 45 ft to the interface piping inside the building (about 100 ft total pipe run). The electric connection will require a wiring run of approximately 65 ft to the corner of the building underground, and then up and along the outside of the wall approximately 60 ft to the 480V electrical switch gear. The natural gas will be taken from the pipe coming up through the existing pad over to the gas interface (about 20 ft). There is a sanitary drain on the north side of the building where the fuel cell discharge can be directed.

Fuel Cell Interfaces

The hospital boiler plant has a 12,000/480V transformer (1,500 kVA) which supplies electricity to the hospital and maintenance facility. The fuel cell will be connected to the 480V breaker panel on the outside west wall of Building H-99. All of the fuel cell electrical output is expected to be utilized at the hospital maintenance facility and hospital. The fuel cell grid-isolated capability will not be used.

Potential thermal loads for the fuel cell heat include pre-heating the boiler make-up water, domestic hot water (DHW) make-up and DHW recirculating losses. Log data showed that the make-up water requirements for the boilers were only 300 to 400 gal per day (0.28 gal/minute). This load is very small and was eliminated from consideration. The DHW load was estimated based on three methods: (1) measured water usage at the maintenance facility; (2) standard ASHRAE calculations; and (3) gas consumption data.

1. *DHW heating load estimated from measured water usage data*: To determine DHW make-up load, the cooling tower water and water softener water log data were subtracted from the total water usage for the facility. Only 4 months of data were provided (Table 2).

Table 2. Data used to determine DHW make-up.

Month (1994)	Total H_2O (1,000 gal)	Cooling Tower (1,000 gal)	Softener H_2O (1,000 gal)	DHW H_20 (1,000 gal)
June	4,156	3,652	294	210
July	5,403	4,157	387	859
August	4,419	3,812	348	259
September	4,298	3,355	321	622
Total	19,276	15,976	2,350	2,950

The estimated heating load for the DHW make-up assuming a 60 °F average inlet water temperature is:

(1,950,000 gal/2928 hr) * 8.35 lb/gal * 1 Btu/lb-°F * (120-60 °F) = 333.6 kBtu/hr

The DHW recirculating loss load, assuming a 10 °F temperature differential, was calculated as follows:

10 gpm * 60 min/hr * 8.35 lb/gal * 1 Btu/lb- °F * (120-110 °F) = 50.1 kBtu/hr

The total estimated DHW load based on measured water data is about 384 kBtu/hr (333.6 kBtu + 50.1 kBtu). Fuel cell thermal utilization based on this estimate would be 55 percent (384/700 kBtu/hr).

2. *DHW heating load estimated from ASHRAE*. ASHRAE estimates that hospitals utilize 18.4 gal per day per occupied bed. The Navy hospital averages 125 occupied beds. This translates into an estimated thermal load of 98 kBtu/hr as calculated below:

(18.4 gal/bed/day / 24 hr/day) * 125 beds * 8.35 lb/gal * 1 Btu/lb- °F * (120-60 °F) = 48 kBtu/hr

48 kBtu/hr + 50 kBtu/hr (recirc. losses) = 98 kBtu/hr

In addition to the 125 bed occupancy average, the hospital also receives about 2,000 walk-in patients per day. This would increase the Site DHW load. Accounting for the walk-in patient load, the ASHRAE calculation supports the DHW load estimate based on the water log data.

3.) *DHW heating load estimated from hospital gas consumption data*. The predominant applications for boiler steam at the maintenance facility are the absorption chillers and DHW tanks. Site personnel provided estimates of average air-conditioning loads for an average year. Note that these estimates are based on plant personnel experience and are not based on recorded log data. Table 3 lists the estimated air-conditioning loading and calculated ton-hr.

Table 3. Estimated air-conditioning loading and calculated ton-hr.

Season	Average Hr/Day	Average Load (Tons)	Total Ton-Hr
Spring/Fall (120 days)	8	500	480,000
Winter (120 days)	12	700	1,080,000
Summer (120 days)	16	1100	2,112,000
TOTAL			3,672,000

The rated C.O.P. of the Trane absorption chillers is 0.67. Assuming an average boiler efficiency of 75 percent, the estimated gas usage for the chillers is as follows:

(3,672,000-ton-hr/yr. * 12,000 Btu/ton-hr) / (0.67 * 0.75 * 100,000 Btu/therm) = 876,895 therms/yr

The gas consumption for a 12 month period at the hospital was 2,112,107 therms. This leaves 1,235,212 therms (2,112,107 - 876,895) for DHW and other minor loads such as sterilization. This translates into over 14 MBtu/hr (1,235,212 therms / 10 therms/MBtu / 8,760 hr/year) for gas loads other than air-conditioning. Although the actual ton-hr and chiller C.O.P. could be different, thus reducing the amount of gas remaining for DHW, this method of estimation indicates that the DHW load could be large enough to use all of the fuel cell heat. Therefore, based on the available data and the three methods of estimating the DHW heating load, the fuel cell thermal utilization is estimated to be between 55 and 100 percent.

Figure 3 shows the recommended thermal interface. The fuel cell should be tied into the DHW recirculation return line. The make-up water should be fed directly into the fuel cell. An additional 20 gpm pump should be added to the fuel cell thermal loop. This will provide sufficient flow through the fuel cell and preferentially pull the make-up water through the fuel cell without restricting the flow during periods of high demand. One or both 4,500-gal DHW tanks can be used with this scenario. If both tanks are used in parallel, the storage capacity would be doubled. This may be beneficial if it is found that the fuel cell does not meet the entire DHW load during high demand periods.

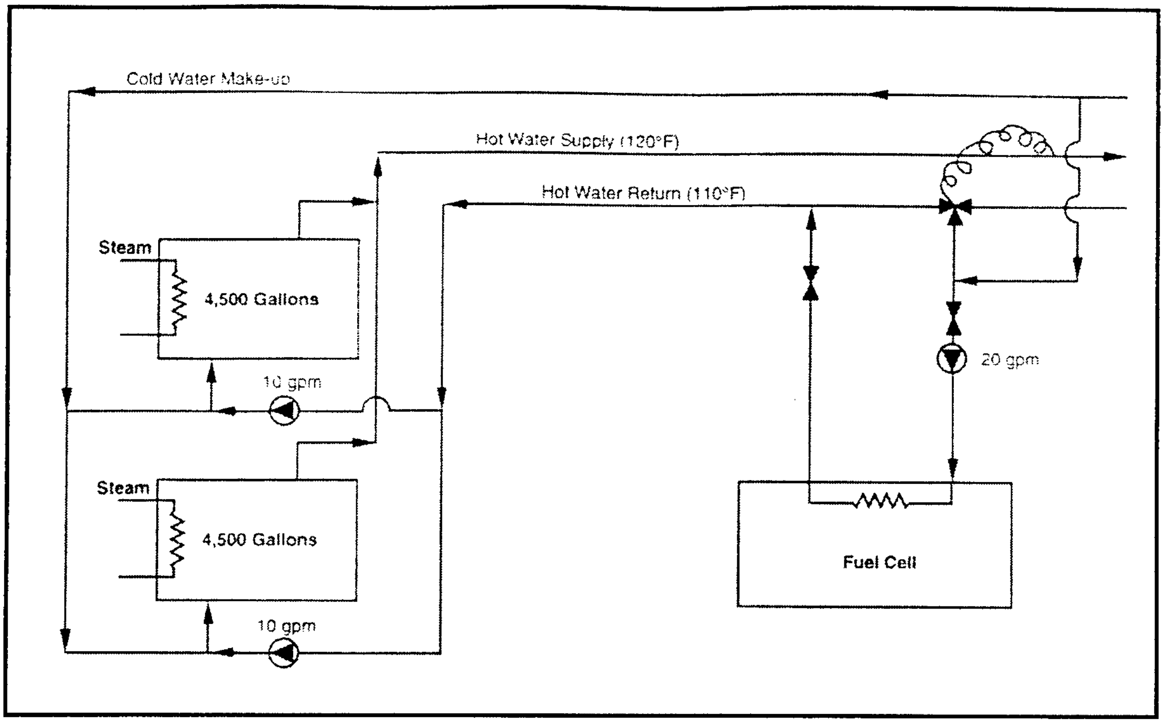

Figure 3. Fuel cell thermal interface—DHW.

3 Economic Analysis

The Site is located in San Diego Gas & Electric's (SDG&E) service territory. The Naval hospital purchases electricity from the Marine Corps base at a flat rate of 8 cents/kWh (this includes an administrative handling fee for Camp Pendleton). Table 4 lists the Site provided electric billing data for the period October 1993 through September 1994. During this period, the Naval hospital consumed 8,856,000 kWh and paid $708,480.

The Naval hospital purchases natural gas directly from SDG&E under rate schedule HNFM. Table 5 lists 12 months of natural gas consumption and cost data for the hospital between December 1993 and January 1995 (2 months of data were not provided). The average gas cost is $0.315/therm and ranged from $0.263/therm in October 1994 to $0.373/therm in December 1993. The hospital uses more natural gas in the summer than in the winter because air-conditioning is generated by an absorption chiller system.

Table 6 lists the results for three fuel cell energy savings scenarios. Since utilization of the fuel cell thermal output had to be estimated, the following scenarios were evaluated: maximum thermal utilization (100 percent), estimated mid-point thermal utilization (77.5 percent) and estimated minimum thermal utilization (55 percent).

Table 4. Camp Pendleton Naval Hospital electric bill summary.

Month-Yr.	KWh	Costs	$/KWh
Oct 93	804,000	$64,320	$0.080
Nov 93	696,000	$55,680	$0.080
Dec 93	756,000	$60,480	$0.080
Jan 94	696,000	$55,680	$0.080
Feb 94	672,000	$53,760	$0.080
Mar 94	636,000	$50,880	$0.080
Apr 94	888,000	$71,040	$0.080
May 94	588,000	$47,040	$0.080
Jun 94	744,000	$59,520	$0.080
Jul 94	792,000	$63,360	$0.080
Aug 94	744,000	$59,520	$0.080
Sep 94	840,000	$67,200	$0.080
Total/Avg	8,856,000	$708,480	$0.080

Table 5. Camp Pendleton Naval Hospital natural gas bill summary.

Month-Yr.	Therms	Customer Charge	Gas	Trans.	GPIN Fee	State Fee	Total	$/Therm
Dec-93	136,865	$405	$31,788	$16,324	$2,387	$104	$51,008	$0.373
Jan-94	165,407	$405	$37,626	$20,952	$2,196	$126	$61,305	$0.371
Feb-94	150,129	$405	$32,675	$19,017	$2,025	$114	$54,236	$0.361
Mar-94	118,711	$202	$26,488	$15,037	$1,660	$90	$43,477	$0.366
Apr-94	123,760	$202	$26,606	$12,331	$1,570	$94	$40,803	$0.330
May-94	—	—	—	—	—	—	—	—
Jun-94	243,390	$405	$44,481	$24,251	$3,112	$185	$72,434	$0.298
Jul-94	279,323	$405	$51,735	$27,832	$3,644	$212	$83,828	$0.300
Aug-94	269,674	$405	$47,529	$26,870	$4,256	$205	$79,265	$0.294
Sep-94	264,973	$405	$44,698	$26,402	$3,688	$201	$75,394	$0.285
Oct-94	177,697	$405	$25,859	$17,706	$2,607	$135	$46,712	$0.263
Nov-94	—	—	—	—	—	—	—	—
Dec-94	85,767	$202	$15,234	$10,787	$1,275	$65	$27,563	$0.321
Jan-95	96,411	$240	$17,017	$11,978	$985	$73	$30,293	$0.314
Total/Avg	2,112,107	$4,086	$401,735	$229,487	$29,405	$1,605	$666,317	$0.315

Table 6. Energy savings of fuel cell design alternatives (Camp Pendleton).

Case	ECF	TU	Displaced kWh	Displaced Gas (MBtu)	Electrical Savings	Thermal Savings	Nat. Gas Cost	Net Savings
Maximum Thermal	90%	100%	1,576,800	7,358	$126,144	$23,178	$47,089	$102,232
Estimated Thermal (Mid)	90%	77.5%	1,576,800	5,702	$126,144	$17,963	$47,089	$97,017
Estimated Thermal (Low)	90%	55%	1,576,800	4,047	$126,144	$12,748	$47,089	$91,802

Assumptions:

Natural Gas Rate: $3.15 /MBtu ($0.315/Therm * 10 Therms/MBtu)

Displaced Electricity Rate: $0.08 /kWh

Fuel Cell Thermal Output: 700,000 Btu/hr

Fuel Cell Electrical Efficiency (HHV): 36%

Seasonal Boiler Efficiency: 75%

ECF = Fuel cell electric capacity factor

TU = Thermal utilization

ECF = Fuel cell electric capacity factor

TU = Thermal utilization

Energy savings were calculated based on a 90 percent electric capacity factor for the fuel cell, a displaced electric rate of $0.08/kWh and an average gas cost of $0.315/therm. The results in Table 6 show net savings of $102,232 for the 100 percent thermal utilization case, $97,017 for the 77.5 percent thermal utilization case and $91,802 for the 55 percent thermal utilization case. Electric savings represent the largest contribution to net savings ($79,055) while thermal savings ranged from $12,748 (55 percent) to $23,178 (100 percent).

This analysis is meant to give a general overview of the economics. For the first 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 load profile data were not available, energy savings could vary depending on actual electrical and thermal utilization.

4 Conclusions and Recommendations

The Naval hospital maintenance facility at Camp Pendleton represents a good application for a 200 kW phosphoric acid fuel cell. Net first year savings from the fuel cell range from $91,802 to $102,232, depending on the fuel cell thermal utilization. The electric rate paid by the Site (8 cents/kWh) is very attractive for the fuel cell.

The thermal interface should be tied into the recirculation return line, bringing the make-up water directly into the line interfacing with the fuel cell. A 20 gpm pump should be added and will allow both 4,500-gal DHW tanks to be run in parallel, thus doubling the storage capacity of the system. The fuel cell should be located on the north side of the maintenance facility. An existing concrete pad can be used to help reduce costs of the installation.

Appendix: Fuel Cell Site Evaluation Form

Site Name: **Camp Pendleton Marine Corps Base**

Location: **Oceanside, CA** Contacts: **Jim Beesing**

1. Electric Utility: **San Diego Gas & Electric** Rate Schedule: **Contract w/Base**
   Contact: **Wayne Johnson**

2. Gas Utility: **San Diego Gas & Electric** Rate Schedule: **HNFM**
   Contact: **Wayne Johnson**

3. Available Fuels: **Natural Gas/ Propane/Diesel** Capacity Rate:

4. Hours of Use and Percent Occupied:

Weekdays	5	Hr	24
Saturday	1	Hr	24
Sunday	1	Hr	24

5. Outdoor Temperature Range: **40 to 100 °F throughout year**

6. Environmental Issues: **Will have to submit to Air Quality Management District in San Diego.**

7. Backup Power Need/Requirement: **Power plant has 1,600 kW back-up generator**

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

9. On-site Personnel Capabilities: **G.B.C. Electric will perform maintenance; boiler personnel at power plant.**

10. Access for Fuel Cell Installation: **No problems.**

11. Daily Load Profile Availability: **None**

12. Security: **Security fence required.**

Site Layout

Facility Type: **Power Plant for Hospital** Age: **About 21 Years**

Construction: **Concrete**

Square Feet: **about 8,000 sq ft**

See Figure 1

Electrical System

Service Rating: **12,000/480 transformer (1,500 kVA).**

Electrically Sensitive Equipment:

Largest Motors (hp, usage):

Grid Independent Operation?: **No.**

Steam/Hot Water System

Description: **Two 35,000 lb/hr Babcock & Wilcox boilers (1972).**

System Specifications: **Maximum rating 250 psi @ 406 °F**

Fuel Type: **Natural Gas**

Max Fuel Rate:

Storage Capacity/Type: **2 X 4,500-gal horizontal tanks**

Interface Pipe Size/Description: **2 in.**

End Use Description/Profile: **Facility currently alternates use of hot water storage tanks weekly. Hot water tanks are driven by steam boilers.**

Space Cooling System

Description: **Two 800-ton Trane absorption chiller systems. In 2 years, the Site will replace both chillers with one 800-ton direct fired absorption chiller and one 800-ton electric chiller.**

Air Conditioning Configuration:

Type: **Absorption**

Rating: **800-ton**

Make/Model: **Trane**

Seasonality Profile: **Chillers run 12 months throughout year, depending on temperature.**

Space Heating System

Description: **Heat exchangers on steam system.**

Fuel: **Natural Gas**

Rating:

Water supply Temp: **steam at 125 psi to heat exchanger**

Water Return Temp:

Make/Model:

Thermal Storage (space?): **None**

Seasonality Profile:

Billing Data Summary

ELECTRICITY

	Period	kWh	kW	Cost
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10				
11.				
12.				

NATURAL GAS

	Period	Consumption	Cost
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10			
11.			
12.			

OTHER

	Period	Consumption	Cost
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10			
11.			
12.			

CERL Distribution

Commander, Camp Pendleton, Oceanside, CA
ATTN: ATZS-EHE (2)

Chief of Engineers
ATTN: CEHEC-IM-LH (2)

Engineer Research and Development Center (Libraries)
ATTN: ERDC, Vicksburg, MS
ATTN: Cold Regions Research, Hanover, NH
ATTN: Topographic Engineering Center, Alexandria, VA

Defense Tech Info Center 22304
ATTN: DTIC-O

8
5/01

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
06-2001	Final	

4. TITLE AND SUBTITLE
Site Evaluation for Application of Fuel Cell Technology:
Naval Hospital—Marine Corps Base Camp Pendleton, CA

5a. CONTRACT NUMBER 88-94-D0020

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Michael J. Binder, Franklin H. Holcomb, and William R. Taylor

5d. PROJECT NUMBER DACA

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC/CERL TR-01-51

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Commander, Camp Pendleton
Facilities Management Department
Box 555191
Camp Pendleton, CA 92055-5191

10. SPONSOR/MONITOR'S ACRONYM(S)
01EJb

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

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 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 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 Camp Pendleton, CA, 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.

15. SUBJECT TERMS
energy conservation
fuel cells
fuel technology alternatives
Camp Pendleton MCB, CA

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Michael J. Binder
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	SAR	27	19b. TELEPHONE NUMBER (include area code) (217) 373-7214

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18