ERDC/CERL TR-01-20

Construction Engineering Research Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Site Evaluation for Application of Fuel Cell Technology

Westover Air Reserve Base, MA

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February 2001

20010423085

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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 Westover Air Reserve Base (ARB), Chicopee, MA. Special thanks is owed to the Westover ARB point of contact (POC), John Czuber, 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. 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 Westover Air Reserve Base (ARB), Chicopee, MA 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 Westover ARB as a potential location for a fuel cell application.

Approach

On 23 and 24 May 1996, CERL and SAIC representatives visited Westover Air Reserve Base (the site) to investigate it as a potential location for a 200 kW 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.)
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
1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	°C (X 1.8) + 32

2 Site Description

Westover Air Reserve Base (ARB) is located in Chicopee, Massachusetts about 10 miles northeast of Springfield. It is the largest Air Force Reserve base in the United States. Westover ARB is home to reserve personnel who train one weekend per month as well as a 15-day annual tour. The base provides worldwide air movement of troops, supplies, equipment and medical patients. In addition, the Westover ARB personnel provide airdrop and combat off-load operations. Peacetime mission includes recruiting, training and supervision of personnel to ensure mission readiness. The base's 2-mile long main runway is an alternative landing site for the space shuttle. The ASHRAE design temperatures for the Site are 87 and 0 °F. Extreme temperatures range from 99 to -19 °F. The central heating plant (building 1411) was investigated as a potential application for a 200 kW fuel cell. The plant has four boilers, which provide 120 psi steam throughout the base. The boilers operate 7 months of the year, from mid-October to mid-May.

Site Layout

Figure 1 shows the overall site map for Westover ARB. The central heating plant is building 1411 at map location 11B. Figure 2 shows the site layout for the central heating plant. There is a main gas line running by the building about 10 ft from the northeast wall. There is also an open grassy area on this side of the building that has a tree on it. The building transformer is located on the southeast side of the building. A 200 kW portable emergency generator is located on the southwest side of the building. There is an 18,000-gal feed water storage tank and steam heater located directly above the pump area. Figure 3 presents a more detailed layout of the central heating plant.

Electrical System

The base receives electric power at 13,800 V into a substation where it is distributed around the base at 4,800 V. There is a 208/4,800 V, 225 kVA transformer located outside the transformer room. There is currently no 480 V power at the central heating plant. There are spare landing lugs on a switch located inside the transformer room.

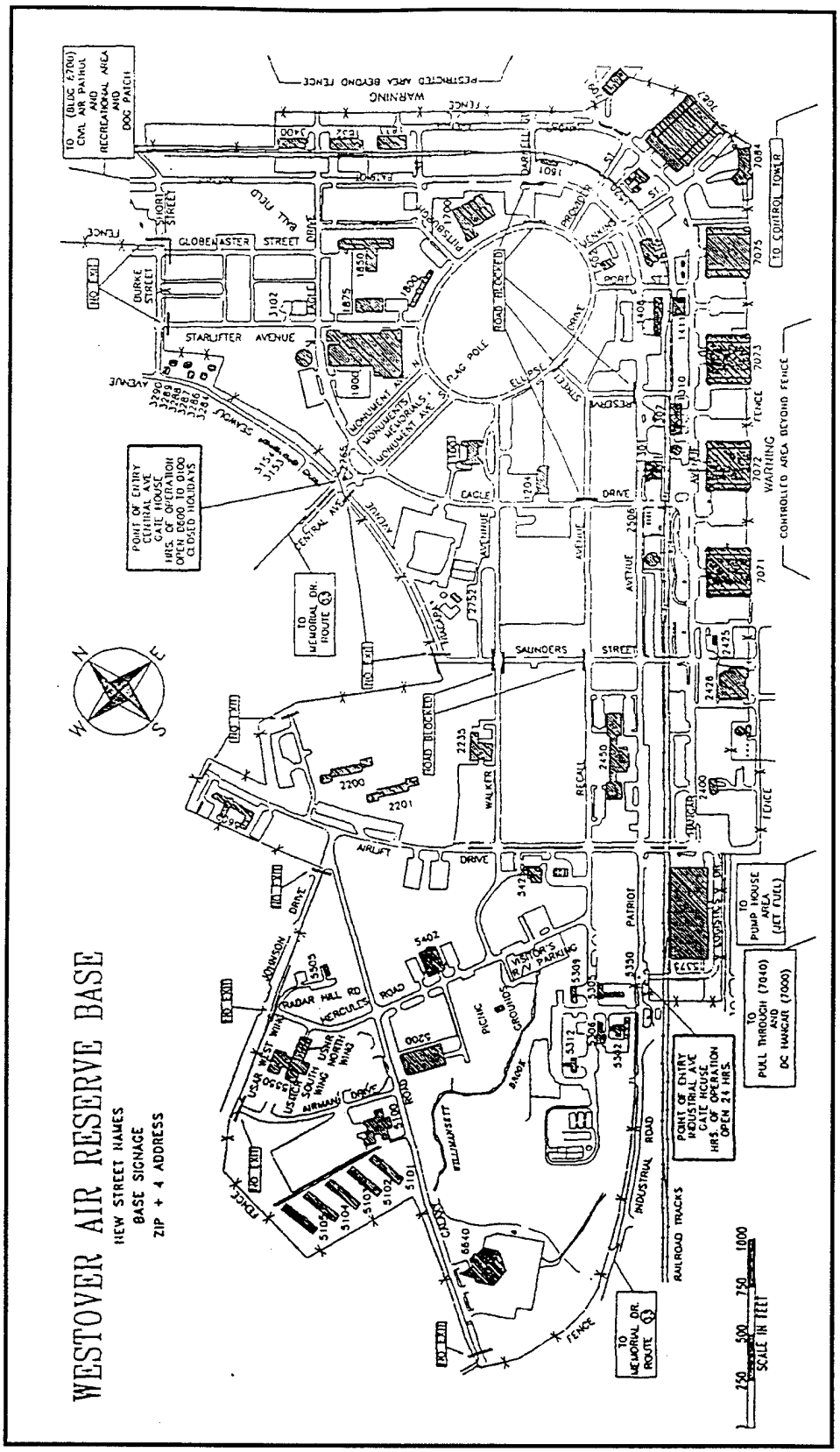

Figure 1. Westover ARB site map.

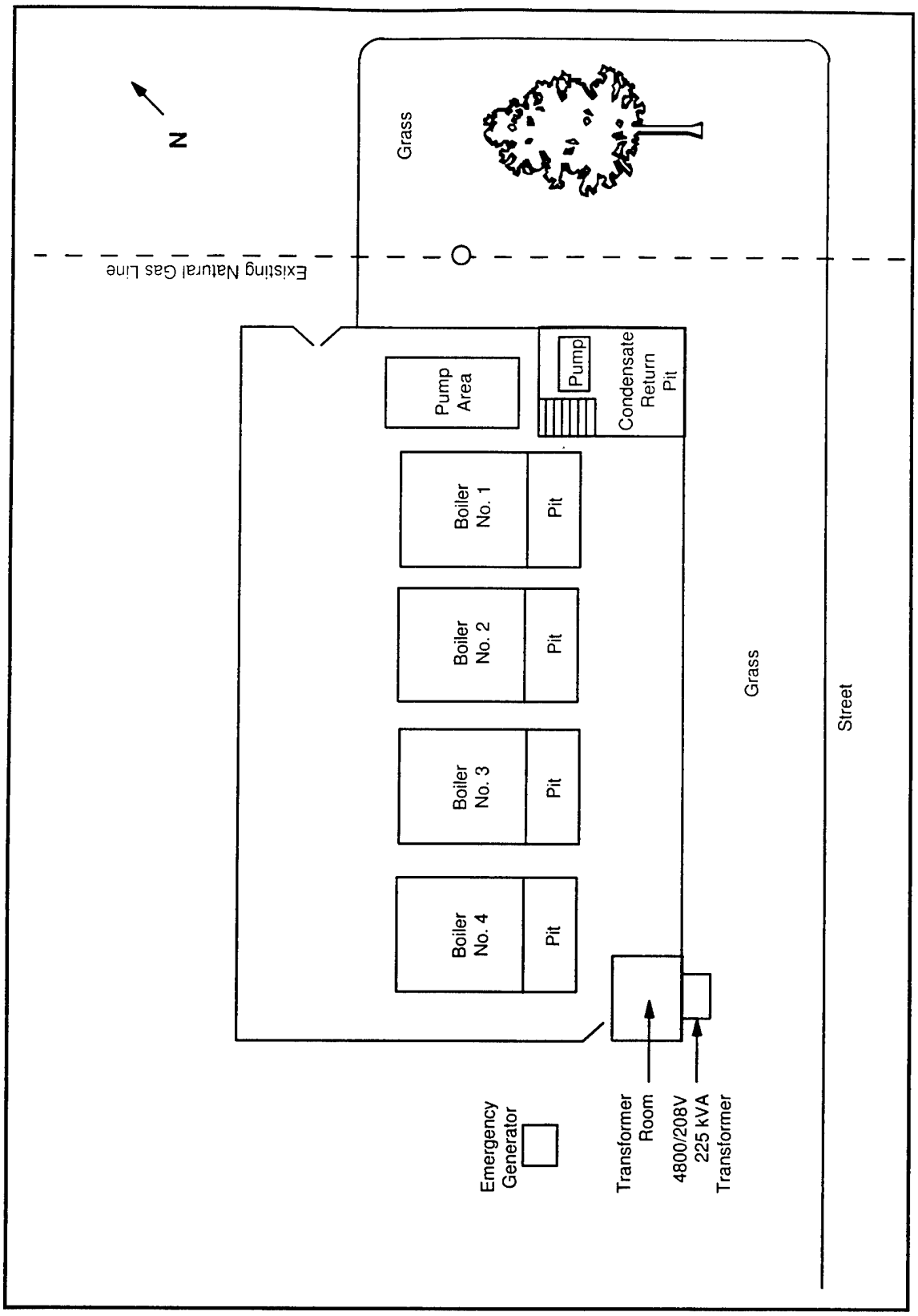

Figure 2. Central Heating Plant site layout.

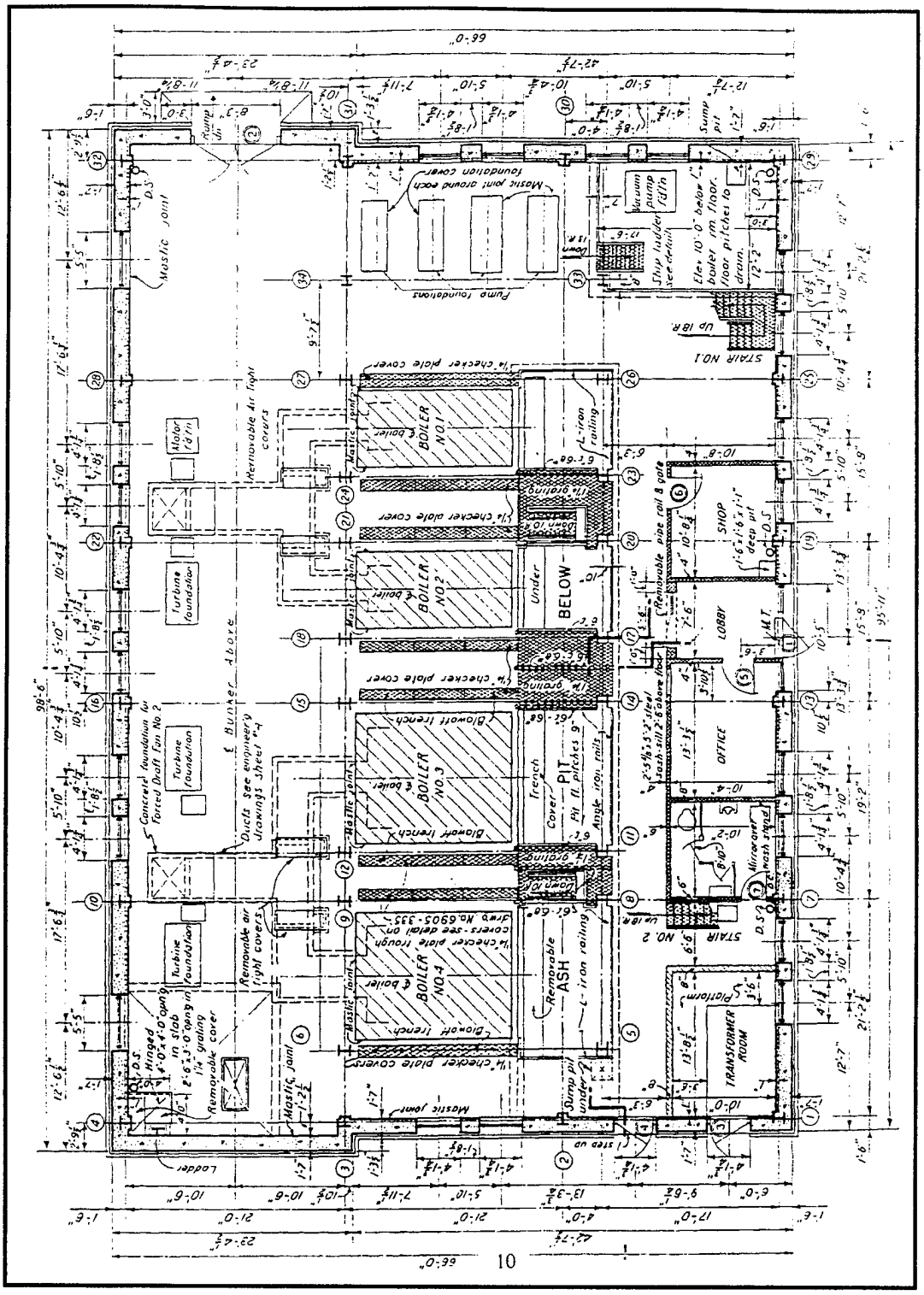

Figure 3. Central Housing Plant schematic.

Steam/Hot Water System

The central heating plant has four Wickes Boiler Co. boilers that were installed in 1941. Boilers 1 & 2 are rated at 269 hp and boilers 3 & 4 are rated at 510 hp The boilers currently operate on No. 6 fuel oil, but there is a project planned to make them dual fuel (natural gas). The boilers generate steam at 120 psi for send out to one distribution loop. There is a second distribution loop where the 120 psi steam is reduced to 10-12 psi which powers the central heating plant's pumps and is delivered to a few nearby buildings.

Space Heating System

Space heating is provided for individual buildings using steam heat exchangers off the central steam distribution system.

Space Cooling System

There is no space cooling in the central heating plant (does not operate in summer).

Fuel Cell Location

The fuel cell should be sited on the grassy area on the northeast side of the central heating plant as shown in Figure 4. The existing tree will have to be removed or relocated to site the fuel cell in this area. The fuel cell should run parallel to the northeast wall of the central heating plant with the thermal outlet facing towards the building. The cooling module can be positioned in a direction perpendicular to the fuel cell and the nitrogen tanks can be positioned against the wall as shown. A new 480 V transformer can be located next to the building's existing transformer.

The thermal piping from the fuel cell to the mechanical room will be approximately 35 ft. Natural gas should be tied into the main gas line (~15 ft). The make-up water can be taken from inside the building (~35 ft). The electrical run will be approximately 160 ft over to the electrical room. The cooling module piping run is ~20 ft.

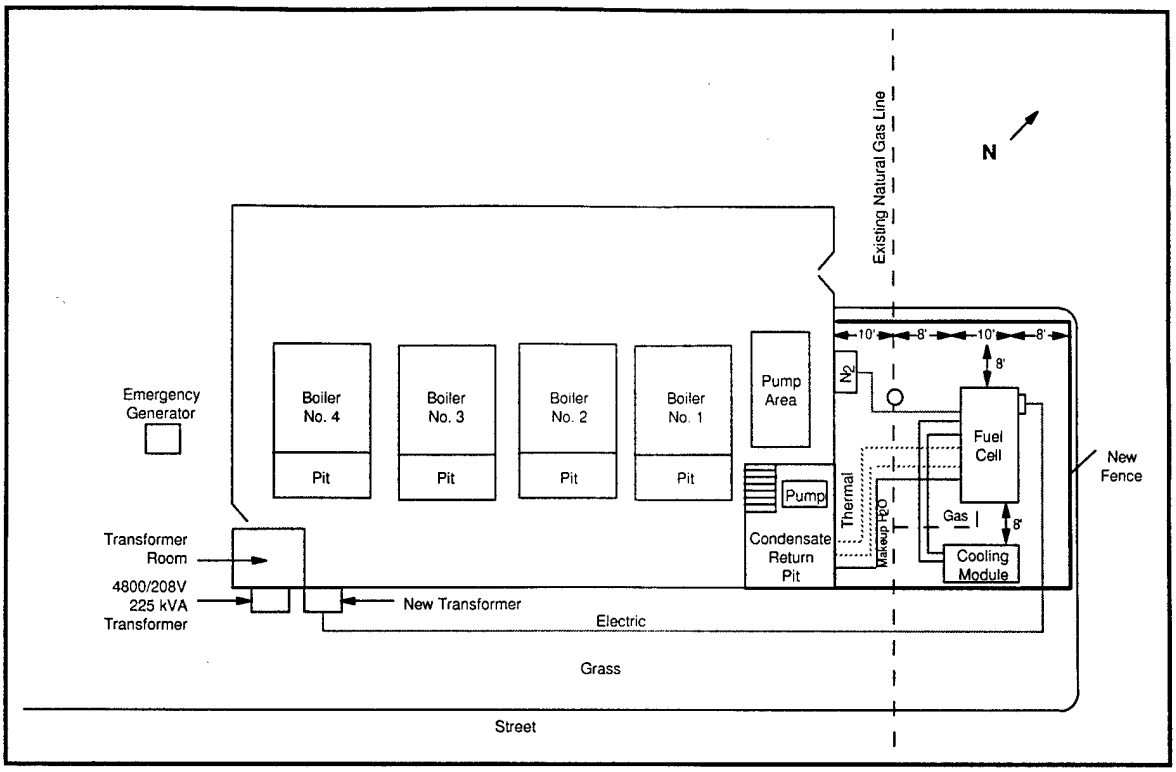

Figure 4. Fuel cell location and site interfaces.

Fuel Cell Interfaces

The central plant at Westover ARB uses 208 V power fed through a 225 kVA 4800/208 V transformer. A new transformer will be required to feed power from the fuel cell to the base grid. A 300 kVA 480/4800 V transformer should be installed adjacent to the central plant's existing transformer. A spare switch already exists in the electrical room of the central plant. Power will be fed from the fuel cell at 480 V through the 480/4800 V transformer and onto the 4800 V grid through the existing switch in the transformer room. There is currently a 200 kW mobile emergency generator located at the central plant. It is not recommended that the fuel cell be configured to serve an isolated emergency load at the central plant.

The primary thermal loads at the central plant which could be served by the fuel cell are heating of the condensate return and boiler make-up water loads. Steam is presently generated by the central plant and distributed to several outlying buildings. As the steam is used, it condenses and is returned through pipes to the central plant. These pipes have deteriorated and have leakage that results in approximately a 30 percent loss which must be replaced by the make-up water. The base is currently replacing the deteriorating pipes. When the pipes are

replaced, the make-up water requirement will be less. Therefore, the condensate return load should be included in the thermal interface with the fuel cell. The condensate returns at 180 °F and is fed to the boiler feed water heater. The feed water heater is heated by low pressure steam and maintains the condensate return tank at 226 °F. The boiler make-up water supplied at approximately 70 °F is heated by the feed water heater prior to delivery to the boilers.

The condensate return can only be heated by the high grade heat exchanger of the fuel cell while the low grade heat exchanger is adequate for heating of the boiler make-up water. Both thermal loads will only be available during the 5 to 7 winter months that the central plant operates. It is recommended that the PC25C fuel cell be modified to provide both high grade heat for condensate return heating and low grade heat for boiler make-up water heating. With the two heat exchangers in the fuel cell, approximately 380 kBtu/hr can be supplied at 250 °F and the remainder (320 kBtu/hr) at 140 °F. Any heat not supplied from the high grade heat exchanger is available through the low grade heat exchanger. Table 2 shows the amount of steam provided by the central plant over the past 3 years and the average condensate return on a monthly basis.

Assuming that 70 percent of the steam delivered is returned as condensate, the average condensate return flow shown above was calculated as follows (using the month of October as an example):

14,531 lb/hr x 1 gal/8.33 lb x 1 hr/60 min x 0.70 = 20.3 gpm

With a 20 gpm flow of 180 °F water, the high grade heat exchanger of the fuel cell can deliver the full 380 kBtu/hr available to the central plant condensate return. Based upon the central plant steam data provided, it is estimated that the condensate return heating load can utilize all of the output from the high grade heat exchanger of the fuel cell during the months of November through March.

Table 2. Monthly central plant steam delivery (lb/hr).

Month	1995/96 (lb/hr)	1994/95 (lb/hr)	1993/94 (lb/hr)	Average (lb/hr)	Average Condensate Flow (gpm)
Oct	10,822	14,546	18,165	14,531	20.3
Nov	27,385	25,062	27,985	18,465	25.9
Dec	20,550	24,040	37,642	27,411	38.4
Jan	19,571	30,037	46,877	32,162	45.0
Feb	14,201	34,419	42,698	30,439	42.6
Mar	25,327	29,090	35,715	30,044	42.1
Apr	n/a	19,704	1,875	10,789	15.1
May	n/a	13,714	0	6,857	9.6

The condensate load also appears to be sufficient to use all the high grade output during half of October and half of April. Therefore, it is estimated that the high grade heat from the fuel cell can be fully used during 6 months of the year.

Table 3 lists the amount of boiler make-up water used by the central plant over the past 3 years.

Assuming that the cold water is supplied at 70 °F and will be heated to 140 °F, the thermal load for the boiler make-up water shown above is calculated as follows (using the month of October as an example):

259,680 gal/mo x 1 mo/744 hr x 8.33 lb/gal x 1 Btu/lb- °F x (140 - 70) °F = 204 kBtu/hr

During November through March, the boiler make-up thermal load would exceed the thermal output of the low grade heat exchanger. Only a portion of the low grade heat would be used during October and April as shown in Table 4, which lists thermal utilization from the two heat exchangers. The load in May was not included in the evaluation since it is very small.

Table 3. Monthly central plant make-up water and thermal load.

Month	1995/96 (gal)	1994/95 (gal)	1993/94 (gal)	Average (gal)	Average Thermal Load kBtu/hr
Oct	118,500	114,426	545,900	259,608	204
Nov	459,500	400,426	697,400	519,188	420
Dec	662,375	562,460	1,167,400	797,312	625
Jan	1,348,084	580,800	1,328,100	1,085,661	851
Feb	934,200	598,170	882,900	805,090	609
Mar	1,184,629	531,100	859,000	858,243	673
Apr	n/a	397,875	271,300	334,588	271
May	n/a	106,350	0	53,175	42

Table 4. Monthly estimated fuel cell thermal utilization.

Month	High Grade (kBtu/hr)	Low Grade (kBtu/hr)	Total Thermal (kBtu/hr)	Thermal Util. %
Oct	380	204	584	83
Nov	380	320	700	100
Dec	380	320	700	100
Jan	380	320	700	100
Feb	380	320	700	100
Mar	380	320	700	100
Apr	380	271	651	93

The average hourly thermal utilization would be 686 kBtu/hr. If it is again assumed that the central plant operates half of October and half of April, then total annual thermal utilized by the site would be:

686 kBtu/hr * 6/12 mo * 8,760 hr/yr = 3,006 MBtu/yr

The percent of annual fuel cell thermal utilization is calculated as follows.

3,006 MBtu/yr / (700 kBtu/hr x 8,760 hr/yr) = 49%

Figure 5 presents a schematic of the fuel cell thermal interface. For the condensate return, 20 gpm should be routed to the high grade heat exchanger where it will be heated to 250 °F before delivery to the feed water heater. The total condensate return flow will normally exceed 20 gpm. A portion (15 gpm) or all of the make-up cold water should be routed to the low grade heat exchanger of the fuel cell where it is heated to a minimum of 140 °F before delivery to the steam heat exchanger of the boiler feed water. If the deteriorated condensate return pipes are replaced in the future, the make-up water requirement will be reduced.

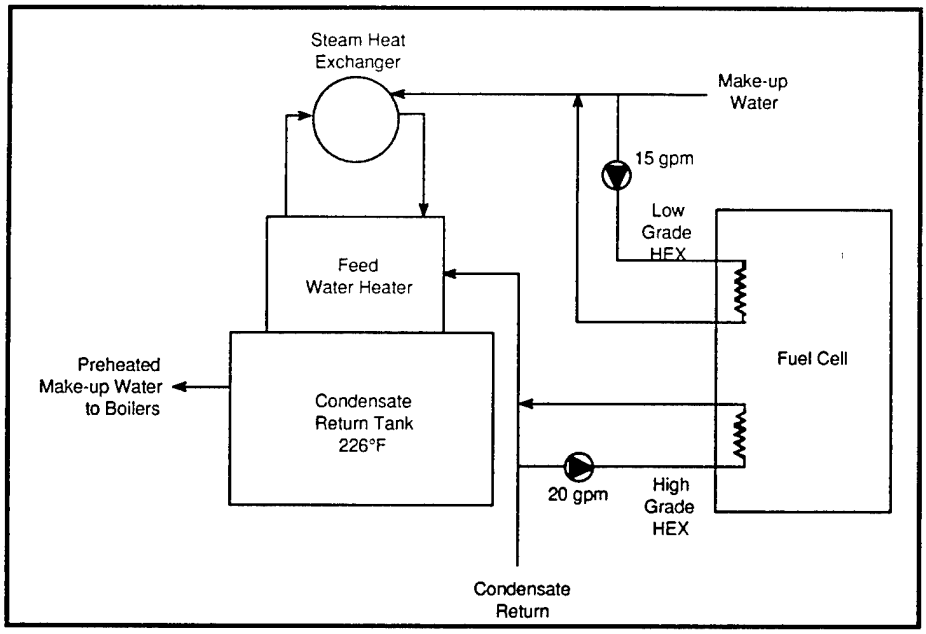

Figure 5. Fuel cell thermal interface — Central Steam Plant.

3 Economic Analysis

Westover ARB purchases electricity from the Chicopee Electric Light Department under rate schedule 18. Rate 18 has a demand and energy charge component, plus adjustments for power factor and primary voltage. Table 5 presents the electricity costs for the May-95 to April-96 time period. The base paid an average of $0.072/kWh for this time period. Rate 18 has the following components:

Demand Charge: $7.70/kVA
Energy Charge: $0.0468/kWh
Cost Adjustments: $0.007/kWh (average).

Table 6 presents No. 6 fuel oil consumption and costs for the central heating plant. No fuel oil is purchased during the months that the central heating plant is shut down.

Natural gas is purchased from Bay State Gas under a two-tiered rate structure. The second tier is only 4 percent lower than the upper tier, minimizing the impact on the displaced natural gas savings. Table 7 summarizes natural gas consumption and costs for Westover ARB.

Table 5. Westover ARB electricity consumption and costs.

Date	KVA	KWH	KVA Cost	KWH Cost	Adjustments	Total Cost	$/KWH
May-95	2,515	1,111,754	$19,367	$52,030	$6,574	$77,971	$0.070
Jun-95	2,829	1,083,550	$21,782	$50,710	$5,306	$77,798	$0.072
Jul-95	3,296	1,205,150	$25,379	$56,401	$5,937	$87,717	$0.073
Aug-95	3,224	1,266,400	$24,825	$59,268	$10,611	$94,704	$0.075
Sep-95	—	1,018,550	$20,952	$47,668	$8,422	$77,042	$0.076
Oct-95	5,846	1,165,200	$21,250	$54,531	$10,721	$86,502	$0.074
Nov-95	3,087	1,359,950	$23,765	$63,646	$11,844	$99,255	$0.073
Dec-95	3,226	1,425,200	$24,883	$66,699	$12,371	$103,953	$0.073
Jan-96	3,176	1,477,650	$24,460	$69,154	$9,382	$102,996	$0.070
Feb-96	3,008	1,367,200	$23,158	$63,985	$8,802	$95,945	$0.070
Mar-96	2,980	1,227,100	$22,944	$57,428	$7,805	$88,177	$0.072
Apr-96	2,741	1,281,700	$21,101	$59,984	$9,500	$90,585	$0.071
Tot/Avg	3,266	14,989,404	$273,866	$701,504	$107,275	$1,082,645	$0.072

* September kVA data not available.

Table 6. Westover ARB fuel oil #6 consumption and costs.

Date	MBTU	Cost	$/MBTU
May 95	1,628	$4,569	$2.81
Jun 95	—	—	—
Jul 95	—	—	—
Aug 95	—	—	—
Sep 95	—	—	—
Oct 95	3,495	$9,572	$2.74
Nov 95	17,504	$47,943	$2.74
Dec 95	27,226	$74,571	$2.74
Jan 96	22,329	$61,159	$2.74
Feb 96	23,181	$63,493	$2.74
Mar 96	20,297	$55,594	$2.74
Tot/Avg	115,660	$316,901	$2.74

Table 7. Westover ARB natural gas consumption and costs.

Date	MBTU	Cost	$/MBTU
May-95	2,742	$9,068	$3.31
Jun-95	943	$3,356	$3.56
Jul-95	975	$3,452	$3.54
Aug-95	1,120	$3,941	$3.52
Sep-95	1,067	$3,758	$3.52
Oct-95	2,656	$8,776	$3.30
Nov-95	3,609	$15,624	$4.33
Dec-95	5,233	$22,243	$4.25
Jan-96	8,133	$37,195	$4.57
Feb-96	5,283	$24,389	$4.62
Mar-96	4,625	$21,211	$4.59
Apr-96	3,251	$14,897	$4.58
Tot/Avg	39,637	$167,910	$4.24

Electric savings from the fuel cell were calculated based on the fuel cell operating 90 percent of the year (1,576,800 kWh). A power factor of 0.85 was assumed for the fuel cell which relates to 235 kVA (200 kW/.85). Assuming that the fuel cell will displace 235 kVA in each of the 12 billing months, the fuel cell electric savings would be:

Demand Charge:	235 kVA * $7.70/kVA * 12 mo/yr =	$21,714
Energy Charge:	1,576,800 kWh * $0.0468/kWh =	$73,794
Cost Adjustments:	1,576,800 kWh * $0.007/kWh =	$11,037

Electric savings from the fuel cell total $106,545.

It was estimated previously that the fuel cell would displace 3009 MBtu/yr of thermal energy at the central heating plant (49 percent thermal utilization). Assuming a displaced boiler efficiency of 70 percent and the fuel cell capacity factor of 90 percent, the fuel cell would displace 3,869 MBtu of fuel oil per year:

3,869 MBtu = (3,009 MBtu * 90%) / 70% boiler efficiency

The average #6 fuel oil rate paid by the central heating plant was $2.74/MBtu. The thermal cost savings from the fuel cell based on this rate are $10,601.

The assumed average natural gas cost for fuel cell input fuel is $4.24/MBtu. The fuel cell will consume 14,949 MBtu per year based on an electrical efficiency of 36 percent HHV (higher heating value). Input natural gas cost for the fuel cell is $63,383.

The net savings for the 49 percent thermal utilization case were calculated at $53,763 as shown in Table 8. Table 5 also presents savings for maximum thermal savings, a lower gas rate for the fuel cell, 50 percent demand savings, no demand savings and a 25 percent reduction in fuel cell thermal utilization due to lower make-up water flow. The Base will be converting the central heating plant to natural gas dual fuel capability and expects to be able to lower its gas rate. Lowering the gas rate to $3.00/MBtu (reasonable estimate by Base) increases the net savings by about $18,500.

The analysis is a general overview of the potential savings from the fuel cell. For the first 3-5 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 8. 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	$106,545	$21,602	$63,383	$64,764
Base Case	90%	49%	1,576,800	3,869	$106,545	$10,601	$63,383	$53,763
Gas Cost of $3.00/MBtu	90%	49%	1,576,800	3,869	$106,545	$10,601	$44,847	$72,299
Lower Make-up Water Flow	90%	37%	1,576,800	2,922	$106,545	$8,006	$63,383	$51,168
50% Demand Savings								
Max. Thermal	90%	100%	1,576,800	7,884	$95,688	$21,602	$63,383	$53,907
Base Case	90%	49%	1,576,800	3,869	$95,688	$10,601	$63,383	$42,906
Gas Cost of $3.00/MBtu	90%	49%	1,576,800	3,869	$95,688	$10,601	$44,847	$61,442
Lower Make-up Water Flow	90%	37%	1,576,800	2,922	$95,688	$8,006	$63,383	$40,311
No Demand Savings								
Max. Thermal	90%	100%	1,576,800	7,884	$84,831	$21,602	$63,383	$43,050
Base Case	90%	49%	1,576,800	3,869	$84,831	$10,601	$63,383	$32,049
Gas Cost of $3.00/MBtu	90%	49%	1,576,800	3,869	$84,831	$10,601	$44,847	$50,585
Lower Make-up Water Flow	90%	37%	1,576,800	2,922	$84,831	$8,006	$63,383	$29,454

Assumptions:

Natural Gas Rate: $4.24/MBtu
Fuel Oil #6 Rate: $2.74/MBtu
Fuel Cell Thermal Output: 700,000 Btu/hour
Fuel Cell Electrical Efficiency: 36%
ECF = Fuel cell electric capacity factor
TU = Thermal utilization

4 Conclusions and Recommendations:

This study concludes that the central heating plant at Westover ARB represents a good application for a 200 kW phosphoric acid fuel cell. The fuel cell power plant can be interfaced with both the plant's condensate return and boiler make-up water loops. A new 4800/480 V transformer will need to be installed with the fuel cell to interface with the base grid (there is no 480 V power at the boiler plant). Also, the high grade heat exchanger option will be required to interface with the condensate return loop. The fuel cell should be located on the northeast side of the building, making for short thermal interface and natural gas piping runs. The new transformer should be installed next to the existing transformer.

First year net savings for the fuel cell were estimated at $53,763. The base should negotiate a lower gas rate for the fuel cell. Savings can be increased an additional $18,500 if the gas rate is lowered from $4.24 to $3.00/MBtu.

Appendix: Fuel Cell Site Evaluation Form

Site Name: **Westover Air Reserve Base** Contacts: **John Czuber**

Location: **Chicopee, MA**

1. Electric Utility: **Chicopee Electric Light** Rate Schedule: **Rate 18 - LGS**

2. Gas Utility: **Bay State Gas** Rate Schedule:

3. Available Fuels: **Natural Gas, Fuel Oil #2 & #6**

4. Hours of Use and Percent Occupied:
   Boiler plant operates 7 months/year

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

5. Outdoor Temperature Range:
   Design dry bulb temperatures: **87 °F to 0 °F**
   Extremes: **99 °F to –19 °F**

6. Environmental Issues:
   No major issues anticipated.

7. Backup Power Need/Requirement:
   200 kW diesel generator portable backup at boiler plant (winter only).

8. Utility Interconnect/Power Quality Issues:
   Have outages 5-6 times per year (less than 1 hour).

9. On-site Personnel Capabilities:
   Boiler plant personnel.

10. Access for Fuel Cell Installation:
    Easy access from street. A tree will have to be removed.

11. Daily Load Profile Availability:
    No data available.

12. Security:
    Fence required.

Site Layout

Facility Type: **Boiler Plant** Age: **55 years**

Construction: **Steel/concrete with brick**

Square Feet: **6,400 sq ft**

See Figures 2 & 3

Show:

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

Electrical System

Service Rating: **13,800/4,800 V at distribution substation.**
4,800/208 V at boiler plant.

Electrically Sensitive Equipment: **N/A.**

Largest Motors (hp, usage): **N/A**

Grid Independent Operation?: **Already has back-up (200 kW mobile generator)**

Steam/Hot Water System

Description: **Four Boilers (The Wickes Boiler Co.) installed in 1941.**

System Specifications: **269 hp (2); 510 hp (2)**

Fuel Type: **#6 fuel oil. Are switching to dual fuel for natural gas**

Max Fuel Rate:

Storage Capacity/Type: **about 18,000 gal for boiler make-up water**

Interface Pipe Size/Description:

End Use Description/Profile: **Boiler plant delivers 120 psi steam around base. A low pressure steam line (10-12 psi) is also distributed to a few buildings.**

Space Cooling System

Description: **No space cooling at the boiler plant**

Air Conditioning Configuration:
Type:
Rating:
Make/Model:

Seasonality Profile:

Space Heating System

Description: **Space heating loops in individual buildings.**

Fuel: **#6 fuel oil**

Rating:

Water supply Temp: **120 psi steam**

Water Return Temp: **180 °F condensate**

Make/Model:

Thermal Storage (space?): **N/A**

Seasonality Profile: **Boiler plant operates 7 months per year.**

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE (DD-MM-YYYY)
02-2001

2. REPORT TYPE
Final

3. DATES COVERED (From - To)

4. TITLE AND SUBTITLE
Site Evaluation for Application of Fuel Cell Technology:
Westover Air Reserve Base, MA

5a. CONTRACT NUMBER
88-94-D-0020

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-01-20

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Westover Air Reserve Base
250 Patriot Ave.
Suite 1
Chicopee, MA 01022-1670

10. SPONSOR/MONITOR'S ACRONYM(S)
439 SPTG/CECD

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). CERL has 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 the manufacturer for commercially available fuel cell power plants installed at Department of Defense (DoD) locations.

This report presents an overview of the information collected at Westover Air Reserve Base (ARB), MA, 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 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
fuel cells
energy technology alternatives
energy conservation
Westover Air Reserve Base, MA

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Michael J. Binder
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
Unclassified	Unclassified	Unclassified	SAR	30	(217) 373-7214

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