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Central Heating Plant Modernization Study for the Defense Personnel Support Center

by
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This report documents a study to determine alternatives for modernizing the central heating plant at the Defense Personnel Support Center (DPSC), Philadelphia, PA. The central heating plant contains five boilers; four are 50 years old and one is 14 years old. The age of this equipment warranted an investigation of alternatives for providing thermal energy to the installation. These alternatives include maintaining the status quo, upgrading the existing system, installing new boilers, cogeneration, and absorption chilling. Heating and cooling loads were analyzed using computer simulations. Based on the simulations and design temperatures, life cycle costs were developed for each alternative.

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13. ABSTRACT (Maximum 200 words)

This report documents a study to determine alternatives for modernizing the central heating plant at the Defense Personnel Support Center (DPSC), Philadelphia, PA. The central heating plant contains five boilers; four are 50 years old and one is 14 years old. The age of this equipment warranted an investigation of alternatives for providing thermal energy to the installation. These alternatives include maintaining the status quo, upgrading the existing system, installing new boilers, cogeneration, and absorption chilling. Heating and cooling loads were analyzed using computer simulations. Based on the simulations and design temperatures, life cycle costs were developed for each alternative.

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Foreword

This research was performed for Philadelphia District, U.S. Army Corps of Engineers (CENAP) under Military Interdepartmental Purchase Request (MIPR) No. NAPEN-MM-92001, dated 4 March 1992. The technical monitor was Roger Souser, CENAP-EN-MM.

The work was conducted by the Energy and Utility Systems Division (FE) of the Infrastructure Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Martin J. Savoie. Russ Price is a member of Stanley Consultants, Inc., Muscatine, Iowa. Dr. David M. Joncich is Acting Chief, CECER-FE, and Alan Moore is Acting Chief, CECER-FL. The USACERL technical editor was Thomas E. Rice, Information Management Office.

LTC David J. Rehbein is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

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1 Introduction

Background

This report documents results of a study to investigate alternatives for modernizing the central heating plant (CHP) at the Defense Personnel Support Center (DPSC), Philadelphia, PA. The CHP contains five boilers; four are 50 years old and one is 14 years old. The age of this equipment warranted an investigation of alternatives for providing thermal energy to the installation.

DPSC is responsible for the massive task of purchasing food, clothing, textiles, medicine, and medical equipment for the U.S. military. The organization also services the District of Columbia public school system, Veterans' Administration hospitals, and Federal prisons. A unique feature of the installation is its garment factory, which employs about 1000 workers whose task is to produce special-issue military uniforms and apparel.

DPSC has begun investigating modernization opportunities for its CHP, and because of increasing electrical costs cogeneration has been considered a potential alternative for modernizing the plant. The U.S. Army Corps of Engineers Philadelphia District, which is in charge of the modernization project, requested the U.S. Army Construction Engineering Research Laboratories (USACERL) to perform a study to determine the most viable options available to improve the energy supply situation.

Objective

The objective of this study was to identify the most cost-effective technologies for meeting current and future thermal and electrical energy needs at DPSC.

Approach

Information available from past studies and operations records was analyzed and verified to establish baseline conditions. A visual inspection was made of central heating plant equipment and the steam distribution system to assess baseline operating conditions and problem areas.

The next task analyzed the energy use patterns of DPSC. This analysis included current thermal and electrical energy demand, heating load, and usage patterns. This task also projected future energy use for the facility. A variety of prediction methods were used depending on the specific energy pattern being investigated.

Based on the energy use pattern analysis, potential thermal energy supply options were identified. These options were evaluated in terms of their cost, efficiency, and reliability. The evaluation also considered regionally available and appropriate fuel supplies. Potential electrical energy supply options also were identified based on the energy use pattern analysis. Like the thermal energy supply options, electrical energy will be evaluated according to cost and reliability.

Environmental factors including asbestos removal, demolition material disposal, and air pollution control requirements were evaluated and included in the cost analysis of each alternative.

Based on the findings of the above tasks, life-cycle cost (LCC) analyses were developed for maintaining the status quo, upgrading the existing system, installing new boilers, cogeneration, and absorption chilling. Additional options within these alternatives will be considered to further improve the life cycle costs.

2 Existing Steam Supply Systems

This section describes the existing central energy plant equipment and steam distribution system.

Central Heating Plant

The DPSC central heating plant, located in Building No. 8, consists of five steam boilers. Boilers 1 to 4 from east to west are Edge Moore Iron Works water tube boilers that were originally designed to burn No. 6 oil. They were installed in 1941-42, each having a current rating of 100,000 lb/hr steam at 180 psi, 435 °F. Boilers No. 1 and 2 were converted in 1944 to burn coal using dump grate technology, but operated on coal for only a few years. They have not operated for at least 25 years, and the coal-feed systems have been disconnected from the boilers. Design data for Boilers 1 and 2 are summarized in Table 1*

Boilers No. 3 and 4 were converted to dual fuel (natural gas and No. 6 oil) and are used for heating all buildings and for process steam during the heating season. Because only one boiler is required to supply the complex, the second boiler is operated on a standby basis. Both boilers were retubed in February 1966 and the superheaters and crossovers were replaced in June 1983. Both units have airheaters and blowdown heat exchangers, but neither have economizers or oxygen trim control. These boilers appear to be in acceptable condition considering that the last retube was 26 years ago and that they were operated alternately most of this time. The fireside inspection showed no tube warping, blistering, pitting, or soot accumulation. The drums also appeared to be in good condition.

Boilers No. 3 and 4 are equipped with an external induced air blower (41,000 CFM) and an external forced air blower (23,600 CFM). Additional boiler support equipment includes four turbine-driven feed water pumps (two are steam-powered rated at 250 GPM each and two are steam-electric powered rated at 200 GPM each) and three electric motor-driven condensate return pumps rated at 50 GPM each. Also, both units have an air heater and a blowdown heat exchanger, but neither has an economizer or oxygen trim. Table 2 summarizes design data for Boilers No. 3 and 4.

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*Tables and figures are included at the end of their associated chapters.

Boiler No. 5 is a packaged dual fuel boiler installed in 1977. It has a rating of 30,000 lb/hr at 180 psi, 550 °F. This boiler has an economizer but the oxygen trim control is not operating. Boiler No. 5 typically operates in the summer to provide steam for process loads, which include heat exchangers for domestic hot water and the factory sponging plant. The CHP feedwater pumps also are driven by 180 psi steam. The boiler heating surface is 2,405 sq ft and has a 523 sq ft waterwall. Table 3 summarizes the design data for Boilers No. 5.

Steam Distribution System

The CHP provides steam for heating and process loads to 15 buildings via steam lines that measure about 33,500 linear feet. Figure 1 shows the main distribution system pipes (in bold). Because the lines run primarily through the building ceilings and utility tunnels, the heat losses will be minimal. A visual inspection of those pipes located in the ceilings was limited; however, exposed pipes were well insulated and no leaks were found.

The condensate return system also appears to be in good condition based on a visual inspection and the amount of condensate returned to the CHP. There is a small constant loss of condensate at the fuel oil pump house from steam used to heat the oil. Figures 2 and 3 show the percent boiler makeup water and the total makeup water used, respectively. Over the last 3 years, the percentage of makeup water varied from about 20 percent in the heating season to 45 percent in the summer months. The higher percentage in the summer is caused by a fairly constant condensate loss and the lower amount of steam produced. The amount of makeup used in the summer over the last 3 years was about 2.8 million lbs, and the amount in the winter ranged from 3.5 million lbs to 6 million lbs.

Table 1. Boilers No. 1 and 2 design data.

Manufacturer	Edge Moore
Year Built	1941 (converted 1944)
Type	Stoker fired (originally oil fired)
Capacity	75,000 lb/hr, 275 psig allowable pressure
Boiler Size	2,100 HS (coal fired)

Table 2. Boilers No. 3 and 4 design data.

Manufacturer	Edge Moore
Year Built	1941
Serial Number	#3 - NB 3337; #4 - NB 3336
Boiler Size	2,100 HS; 1,051 HP
Fuel	No. 6 oil and natural gas
Capacity	100,000 lb/hr, 160-180 psig normal operating, 275 psig allowable pressure
Note:	There are four 4-inch safety valves set at 205, 215, 218, and 220 psig, respectively.

Table 3. Boiler No. 5 design data.

Manufacturer	Cleaver Brooks
Year Built	1976
Serial Number	WL 2633
Model Number	WT-400X-BR-3 and D-60-S
Firing Rate	40,703 MBtu/hr
Fuel	Natural gas at 55 in. w.c.; No. 6 oil at 100 psi
Pressure	260 psig; 30,000 lb/hr; 200 psi operating; 260 psig design
Note:	The feedwater control valve is Bailey Meter Co., Type VBH 11000A, size1-1/2 x 1-1/2.

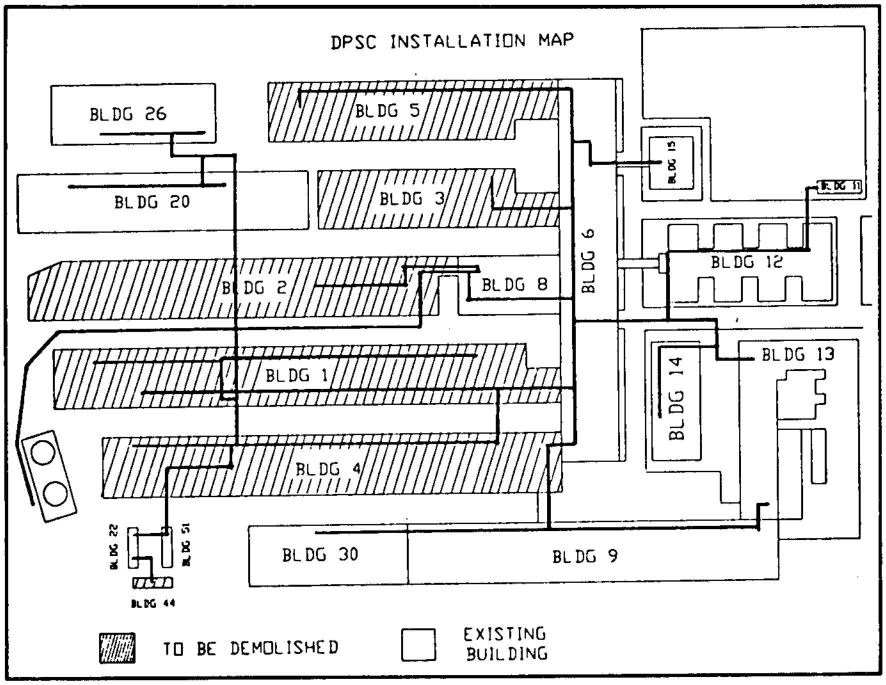


Figure 1. Steam distribution system.

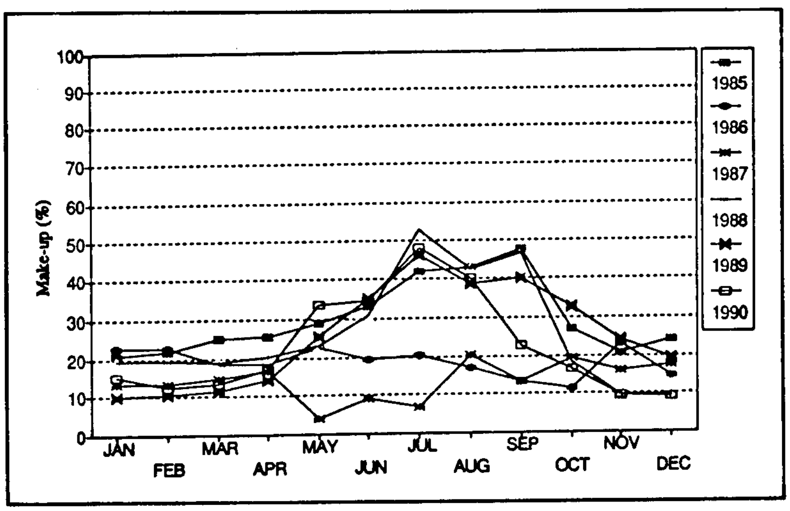


Figure 2. Percent boiler water makeup.

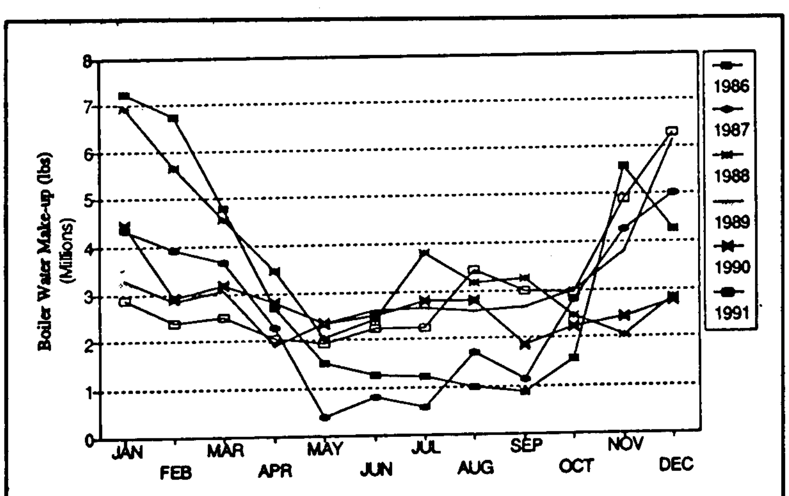


Figure 3. Total boiler water makeup.

3 Thermal Energy Supply and Consumption

This section describes current thermal energy supply and use. Central heating plant steam output and fuel use were analyzed for trends, and building heating loads and distribution systems losses were modeled. This section also develops correlations between thermal energy use and heating degree days for use in load prediction.

Cost of Steam

An estimate for the cost of steam was developed from three major cost elements: fuel, labor, and other operation and maintenance (O&M) costs. Other O&M costs such as utilities, minor repairs, and water treatment chemicals were estimated from the 1991 *Facilities Engineer Annual Work Plan*, DPSC Form 2547-1. Annual fuel costs were about $1,155,600 (natural gas cost is about $4.95/MBtu), labor costs were about $240,300, and other O&M costs were about $206,500. The total cost of producing steam was about $1,993,400 per year. Dividing this cost by the amount of steam produced (172,703 lbs) gives a cost of $11.5/K lb steam or $9.61/MBtu. A good cost for steam is about $6/MBtu, although $10/MBtu is not unusual for DOD.

Central Heating Plant Steam Load

CHP personnel collected system data on DA Form 3995, *Daily Boiler Plant Operating Log*, which contains hourly and shift information on many important operating parameters. This information is summarized on a monthly basis in a record book maintained by the plant foreman. The hourly steam flow readings were the primary source for estimating peak steam usage because of the detail available. Monthly natural gas consumption was also used to provide a cross-check of the steam flow readings.

The baseline year selected for thermal energy consumption was 1991 because it was the most current period with complete and available records. No unusual activities were identified that might skew projections of energy consumption. Figure 4 shows the hourly steam demand for 1991, with the highest demand recorded about 53,000 lb/hr in both December and February. The summer demand averages about

7000 lbs/hr with peaks of about 10,000 lbs/hr. Table 4 shows the total steam flow and average hourly steam flow on a monthly basis for 1991.

The CHP also records the natural gas flow and No. 6 oil flow once during each operating shift; this is summarized in a monthly log book. Table 5 shows the monthly fuel input for 1991. To compare the natural gas input with steam demand, the natural gas readings were converted to lbs/hr steam by applying the following assumptions: natural gas heating value at 1000 Btu/cf, enthalpy of steam at 1197 Btu/lb, and boiler efficiency at 75 percent. Figure 5 represents estimated monthly averages for the last 6 years, showing little change in steam production for those years. The figure also shows a problem with the December 1991 fuel record, which is obviously incorrect, probably because of a natural gas outage and incorrect reading of the gas or fuel oil meters.

Figure 6 compares the recorded steam flow and natural gas estimate for 1991 to provide a comparison of the recorded steam flow and the steam flow estimated from the fuel input. The steam demand estimated from fuel input was slightly lower than the recorded steam flow, except for the month of December, which had a problem with the recorded fuel consumption. This indicates the steam flow recorder is quite close to calibration. The month of December 1991 was replaced with December 1990 for the rest of this analysis.

Steam End-Use

The CHP output is a good indicator of current thermal energy use; however, individual building and process loads must be estimated if substantial facility changes are expected so that they can be removed from the CHP load profile. DPSC has no significant steam process or cooling loads. A potentially large load from a preshrinking (sponging) plant in the factory was discontinued in 1990 with no plans to replace it. There are a few small process steam demands from hot water heaters (listed in Table 6) and from 136 steam presses at the factory.

There are currently no operating steam submeters to measure building heating or process loads. The factory had steam meters, but they have not been used since the preshrinking plant ceased operations. End-user loads had to be estimated using the modeling techniques HEATLOAD and Building Loads Analysis and System Thermodynamics (BLAST). This study used both these techniques to add another level of confidence to the estimations.

HEATLOAD

HEATLOAD, developed by USACERL, provides a simple method of calculating building heat requirements. Other computer programs such as BLAST or DOE2 can provide more accurate analysis, but require much more information to develop a heat load estimate. Experience with HEATLOAD has shown it to be quite accurate for estimating installation-wide building heat requirements for central energy plant alternatives.

HEATLOAD is based on a series of linear regressions developed from heating use measurements at typical facilities on several Army installations. The facility categories and regressions are listed in Table 7. Each building type has a corresponding daily heating energy consumption equation in the form of $E_h = a_1 + (b_1 \times HDD_d)$, where a_1 and b_1 are regression parameters. The symbol E_h is the daily heating energy consumption (Btu/sq ft/day) and HDD_d is the daily heating degree day. The regression parameter a_1 is a constant that represents energy usage that occurs for zero HDD and reflects nonheating loads such as hot water and cooking. The regression parameter b_1 is the heating load parameter. Building categories and area (sq ft) are obtained from DPSC Master Planning files.

The climatological data required for HEATLOAD, such as the historical average HHD and the design temperature, are obtained from the Army technical manual *Engineering Weather Data* (TM 5-785, 1978) or directly from the U.S. Air Force Environmental Technical Applications Center (ETAC) at Scott Air Force Base, IL. With this information, HEATLOAD will calculate the peak hourly heating load, average monthly loads, maximum monthly loads, and total annual heating load.

BLAST

The BLAST program, also developed by USACERL, is a comprehensive program for predicting energy consumption and energy system performance in buildings. BLAST uses rigorous and detailed algorithms to compute loads, to simulate fan systems, and to simulate heating and chiller systems. Because this study emphasized using a central heating plant and not individual building heating systems, only the load simulation portion of the program was used. The load simulation performs a complete radiative, convective, and conductive heat balance for each zone surface and a heat balance on room air. This heat balance includes transmission load, solar loads, internal heat gains, infiltration loads, and the temperature control strategy used to maintain the space temperature. The BLAST program contains many supporting data libraries, including Schedules, Locations, Design Days, Controls, Materials, Walls, Roofs, Floors, Doors, Windows, Passive Controls, and Weather.

Because this was a conceptual study, the BLAST analysis took advantage of the many defaults available in the BLAST Libraries. Additional site-specific information was gathered over a four-day site visit. The primary site-specific inputs to BLAST were building orientation, interior temperature, number of personnel, lighting, number of computers, number of floors, floor area, window area, and roof area.

Heating Load Estimates

Table 8 shows the total monthly building heat loads estimated by HEATLOAD and BLAST. The individual building loads were estimated based on 1991 heating degree days and summed for each month. These loads are compared graphically in Figure 7 with the CHP output based on 75 percent of fuel consumption and on the recorded steam flow. It is important to note that neither HEATLOAD nor BLAST account for distribution losses. Also, HEATLOAD estimates include domestic hot water use, whereas BLAST does not. Distribution losses are estimated in the following section.

Distribution System Losses

A steam distribution system typically consists of pipes, regulators, valves, traps, and vaults. Steam enters the system at the steam plant, passes through pipes, vaults, and regulators, and is delivered to the buildings. The steam loses heat through pipe walls by conduction. As the steam passes through the pipes, regulators, and valves, steam pressure drops. Condensate formed in the pipes is removed from the system through steam traps and a condensate piping system. The amount of lost energy from the steam distribution system can be substantial.

One way of estimating the distribution losses is to look at the lowest hourly steam flow during the summer months. This technique works only if there are no substantial summer steam loads. Figure 4 shows the lowest steam demand to be about 3000 lbs steam/hr, indicating the distribution losses are about 3000 lbs steam/hr (3.6 MBtu/hr). Determining the lowest summer load by analyzing steam load data is a good method for estimating distribution losses, but is not a rigorous method. To better quantify these losses, this study used a computer model called the Steam Heat Distribution Program (SHDP) to analyze distribution system losses.

SHDP Analysis. SHDP is a pressure-flow thermal efficiency computer program for modeling steam district heating systems. This program has several capabilities, including (1) design and economic evaluation of manhole renovation and modifications or additions to existing distribution systems, and (2) economic evaluation of operating at lower pressures and improved maintenance of steam traps. In this study, SHDP was used primarily to estimate distribution losses.

In order to use SHDP, the entire DPSC steam distribution system was mapped. As discussed in Chapter 2, Figure 1 shows the distribution map with the general location of buildings on the distribution system.

SHDP is designed to estimate the total heat load to the heating plant with a breakdown of the distribution losses. This requires entering distribution line nodes, line diameters and lengths, CHP supply pressure, and individual building loads. Nodes are locations of pipe size changes, pressure reducing valves, and thermal loads (typically buildings). Pipe diameters and lengths were obtained from blueprints of the DPSC distribution system. As described in the previous section, the thermal loads for each building were estimated using the HEATLOAD program. Table 9 lists the basic assumptions that were made in creating the distribution model for DPSC.

The SHDP model was run using unconstrained pressure throughout the system to determine if adequate pressure is available to each building. The results indicated that the boiler outlet pressure is 180 psi and that Building 30 would experience the lowest pressure in the system at 158 psi. This analysis indicates that the distribution system can easily provide the required pressure at all buildings. It also indicates that absorption chillers could be located anywhere in the distribution system. Table 10 lists the unconstrained pressures and steam flows for each building.

For the design day of 14 °F, SHDP predicts that the total steam to all loads will be 57,667 lbs/hr or 62.3 Mbtu/hr, and the total plant output required will be 59,465 lbs/hr or 71.2 MBtu/hr. The total thermal system losses will be 2.27 MBtu/hr for this design temperature.

The distribution losses estimated by SHDP are shown in Table 11. The building heat loads were set to zero. The distribution loss in the summer is about 2 MBtu/hr, fairly close to the 3.6 MBtu/hr rough estimate by inspection of the hourly steam logs. These losses were added to the HEATLOAD monthly estimates to obtain a total monthly steam demand on the CHP. For BLAST, the distribution losses and an average of 8.5 MBtu/hr for process loads were added to the monthly estimates to obtain a total monthly steam demand on the CHP.

Figure 8 compares the CHP steam load profiles based on 75 percent fuel input and on recorded steam flow and the HEATLOAD and BLAST monthly load profiles. The HEATLOAD profile compares most favorably to the CHP steam load profiles.

Heating Load Versus HDD Model

Heating loads are typically closely related to the outside temperature or heating degree day (HDD). However, a single year is not a good prediction of the steam demand for the 25-year period required for life cycle cost analysis of alternatives, unless it is close to the normal HDD for the region. A correlation developed between steam demand and HDD for 1 year can be used to project the steam demand for the normal HDD.

Linear regressions were performed on the monthly load profiles in Figure 8 and the corresponding monthly HDD. The monthly HDDs for the study period obtained from ETAC are shown in Table 12. The results are shown graphically in Figure 9, and indicate that the HEATLOAD regression provides a better prediction than BLAST; therefore, the HEATLOAD regression will be used to model projected steam requirements for the modernization alternatives.

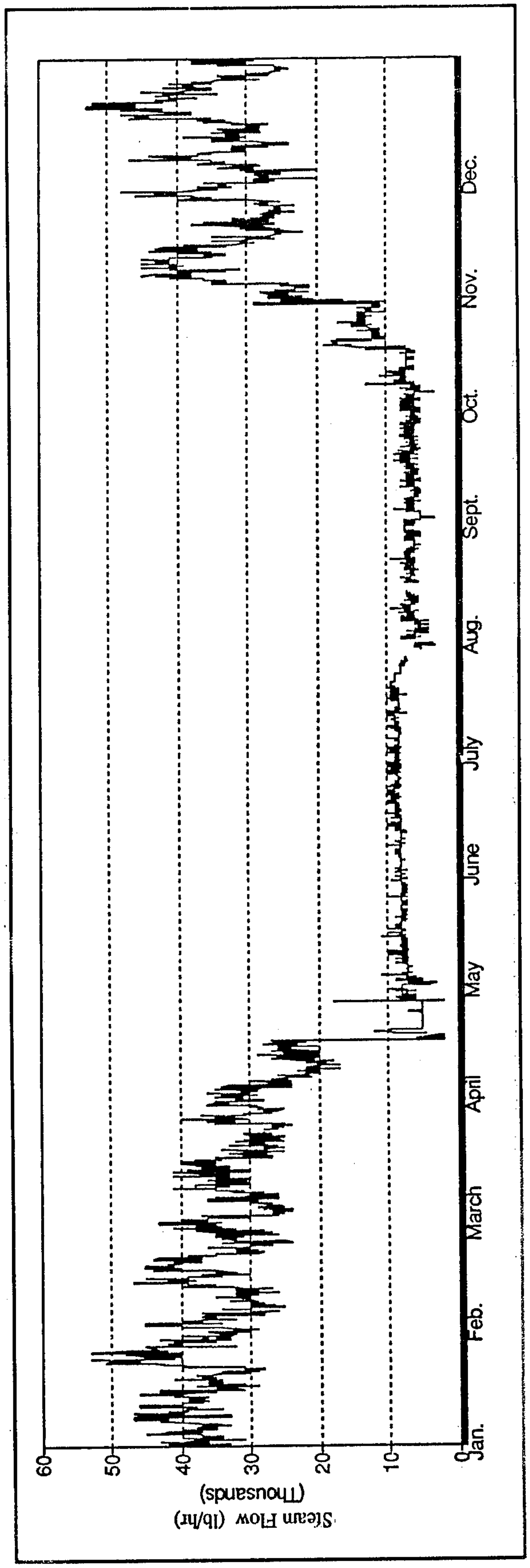


Figure 4. Recorded steam flow for 1991.

Table 4. CHP average monthly steam loads for 1991.

Month	Total Steam Flow (K lbs)	Average Steam Flow (lbs/hr)	Total Average Steam Flow (MBtu)	Steam Flow (MBtu/hr)
Jan	28,472	38,269	34,081	45.8
Feb	22,834	33,979	27,332	40.5
Mar	22,255	29,913	26,639	35.7
Apr	10,977	15,246	13,139	18.2
May	5,709	7,673	6,834	9.1
Jun	6,149	8,540	7,340	10.2
Jul	5,557	7,469	6,652	8.9
Aug	4,500	6,048	5,387	7.2
Sep	4,468	6,483	5,348	7.7
Oct	8,172	10,984	9,782	13.1
Nov	23,347	32,426	27,946	38.7
Dec	25,499	34,273	30,522	40.9

Table 5. CHP average monthly fuel consumption for 1991.

Month	Total (MBtu)	Average (MBtu/hr)
Jan	38,360	51.6
Feb	30,712	45.7
Mar	29,903	40.2
Apr	14,925	20.7
May	7,439	10.0
Jun	7,137	9.9
Jul	6,709	9.0
Aug	7,385	9.9
Sep	6,831	9.2
Oct	11,460	15.4
Nov	27,734	38.5
Dec	13,547	18.2

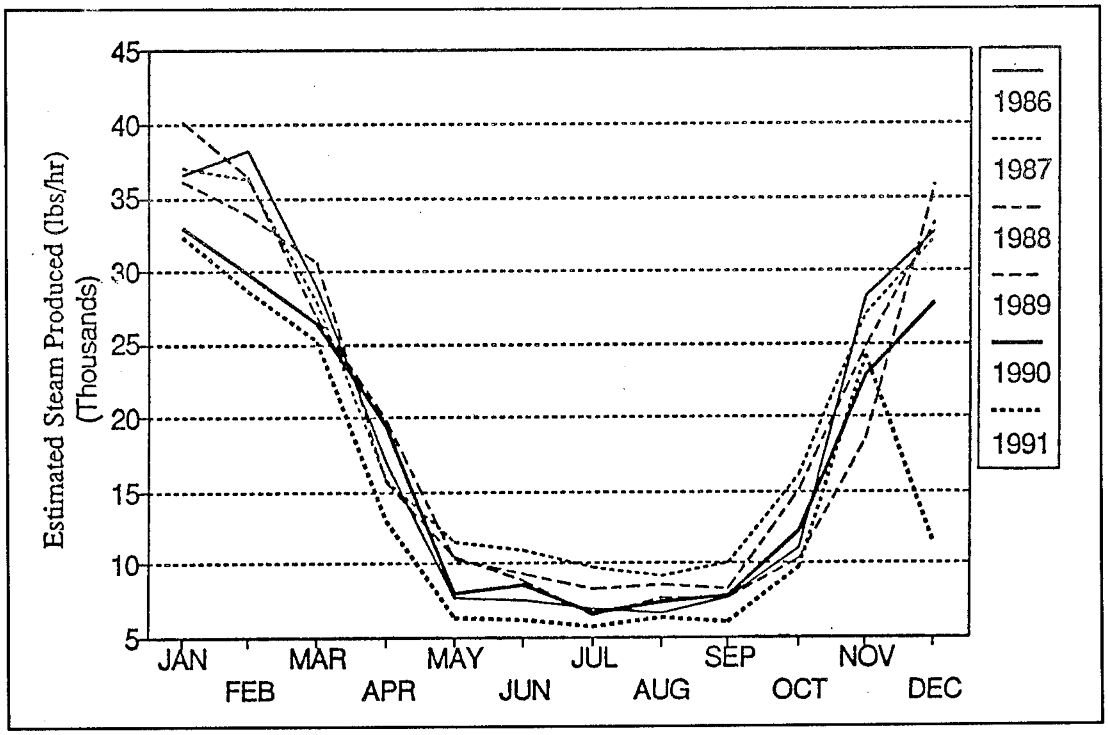


Figure 5. Monthly estimated steam flow for 1986-1991.

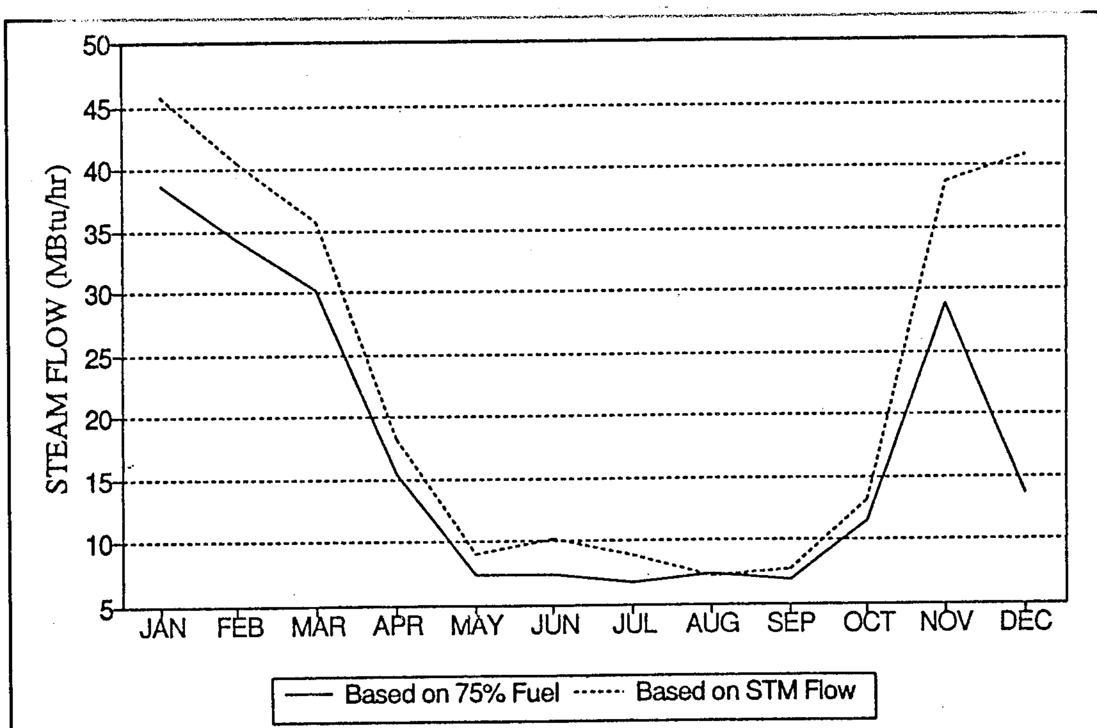


Figure 6. Recorded and estimated steam flow for 1991.

Table 6. Hot water heat exchangers.

Bldg. No.	Tank Size Dia. (in.)	 Lth. (ft.)	Water Temp. Min. °F	 Max. °F	Steam Temp. Press. PSI	Steam Reading °F	Steam Pipe (in.)	Water Supply
5	42"	10	110°	160°	15#	140°	2"	Bldg. #5 For Emerg. Disp. Bldg. 6
61C	42"	10	110°	145°	15#	145°	3/4"	Supplies 6-2 to Pole 46 6-1 Mail Room 8-1 Boiler Rm Elec. Shop
9 SP Base Bay	36"	9	130°	190°	15#	145°	3/4"	9-A,B,C All Floors
9-1 F	36"	9	130°	190°	20#	145°	3/4"	Rest of Bldg. All Floors
11	31"	6	140°	180°	8#	140°	1/2"	All Floors
12	42"	10	130°	190°	45#	135°	1"	All Floors
13	59"	10	110°	150°	15#	130°	1"	All Floors
14	30"	8	130°	190°	45#	158°	3/4"	Everything Kitchen
15	42"	8	120°	170°	15#	145°	1"	All Floors
30	30"	10	130°	190°	20#	145°	1"	Bldg. #30
$^{m}2_{C}$	30"	6	120°	150°	8#	110°	1"	M-2-C Men's

Table 7. Building categories and energy consumption equations.

Troop housing barracks	$E_h = 130.50 + (10.53 \times HDD_d)$
Troop housing barracks (after 1966)	$E_h = 81.91 + (7.40 \times HDD_d)$
Troop housing barracks (modular)	$E_h = 295.90 + (10.53 \times HDD_d)$
Dining facilities	$E_h = 241.90 + 0$
Family housing	$E_h = 113.5 + (10.53 \times HDD_d)$
Administration/training	$E_h = 75.71 + (7.02 \times HDD_d)$
Medical/dental	$E_h = 254.40 + (11.41 \times HDD_d)$
Storage	$E_h = 35.70 + (10.53 \times HDD_d)$
Production/maintenance	$E_h = 138.25 + (10.53 \times HDD_d)$
Fieldhouses/gymnasiums	$E_h = 73.69 + (4.39 \times HDD_d)$

Table 8. Estimated monthly building heating loads for 1991.

Month	HEATLOAD (MBtu/hr)	BLAST (MBtu/hr)
Jan	43.9	51.7
Feb	38.1	43.5
Mar	30.7	33
Apr	20.3	18.4
May	10.2	4.2
Jun	8.5	1.8
Jul	8.5	1.8
Aug	8.5	1.8
Sep	10.2	4.2
Oct	16.8	13.5
Nov	29.5	31.3
Dec *	38.5	44

* December 1990

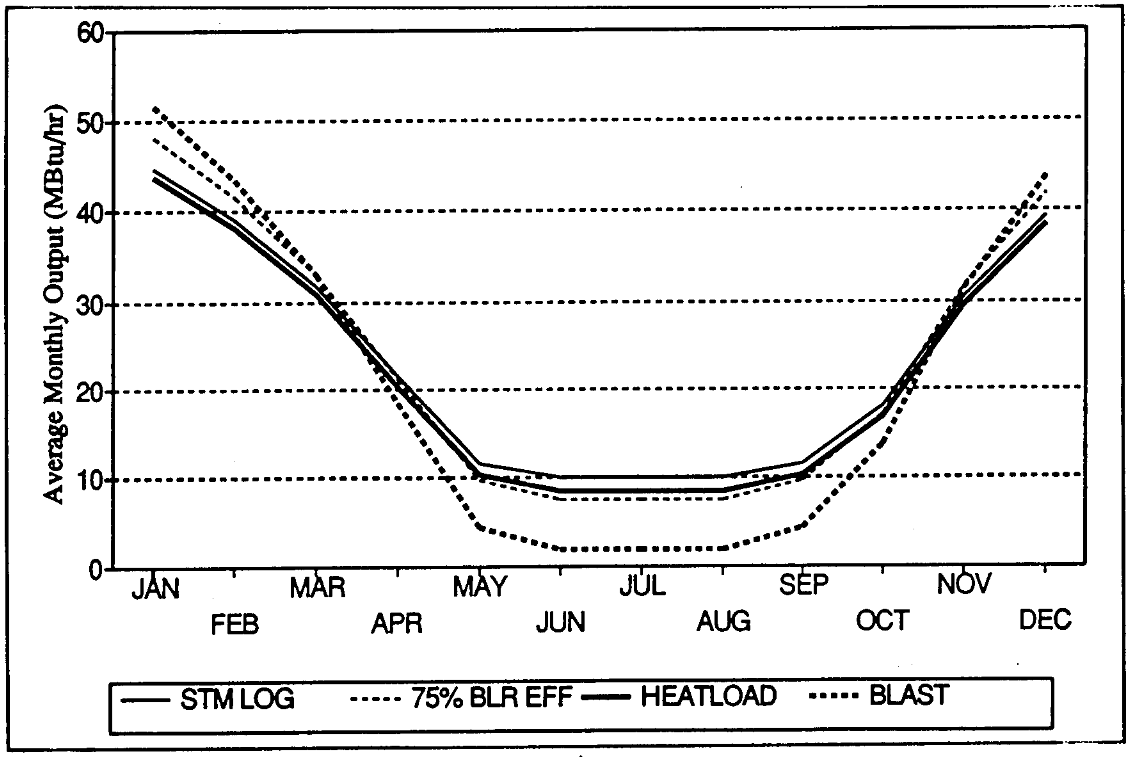


Figure 7. Estimated building loads and steam supply.

Table 9. SHDP model assumptions.

Pipe roughness	0.0025
Pipe environment temperature	65 °F
Load condensate temperature	150 °F
Steam trap leakage rate	0
Fraction of load condensate returned	0.9
Fraction of pipe condensate returned	0.9

Table 10. Unconstrained distribution results.

Building	Pressure (psi)	Steam Flow (lb/hr)
CHP	180	59465
1	178	4533
2	176	3963
3	179	2079
4	179	4246
6	180	5572
8	180	1712
9	178	15862
11	166	138
12	165	2959
13	178	8698
14	179	1827
15	179	565
20	179	2517
22	179	74
26	179	1544
30	158	1678
51	179	94

* All values for design temperature of 14 °F or 51 HDD.

Table 11. Distribution loss estimates for 1991.

Month	Losses (MBtu/hr)
Jan	2.3
Feb	2.1
Mar	2
Apr	1.8
May	1.7
Jun	1.6
Jul	1.6
Aug	1.6
Sep	1.7
Oct	1.8
Nov	2
Dec *	2.1

* December 1990

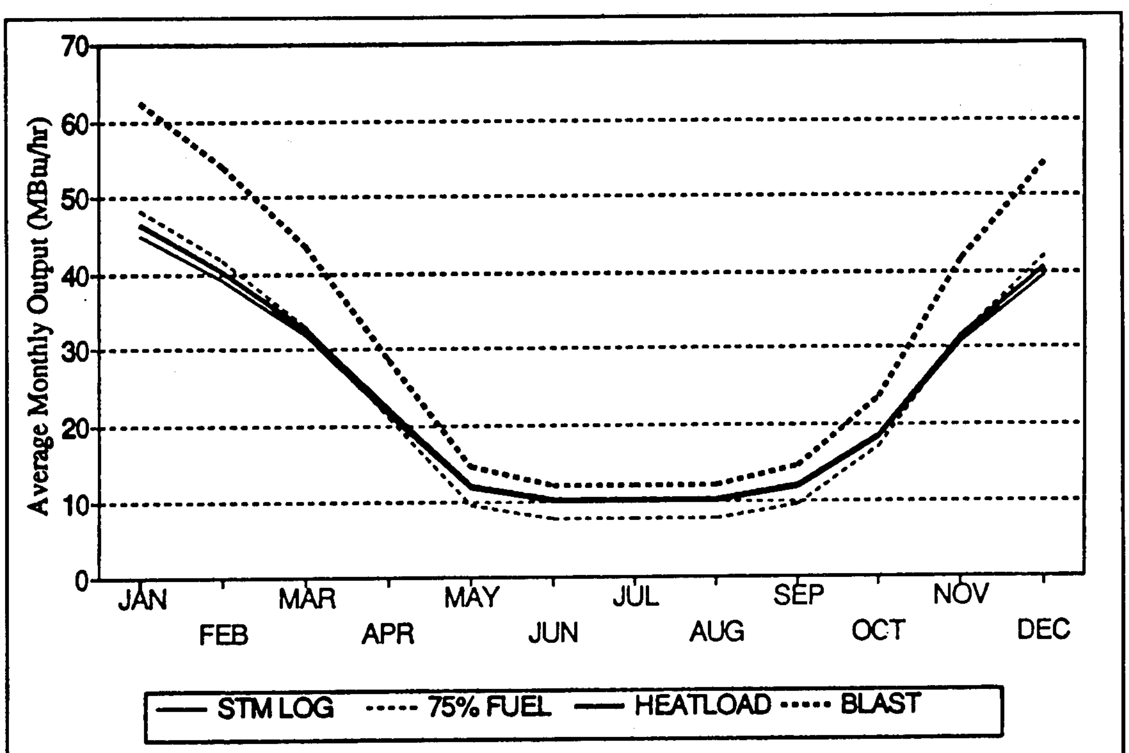


Figure 8. Heat load with losses and steam supply profiles.

Table 12. Monthly average HDDs for 1991.

Month	HDD
Jan	920
Feb	694
Mar	576
Apr	296
May	44
Jun	0
Jul	0
Aug	0
Sep	42
Oct	215
Nov	527
Dec *	701

* December 1990

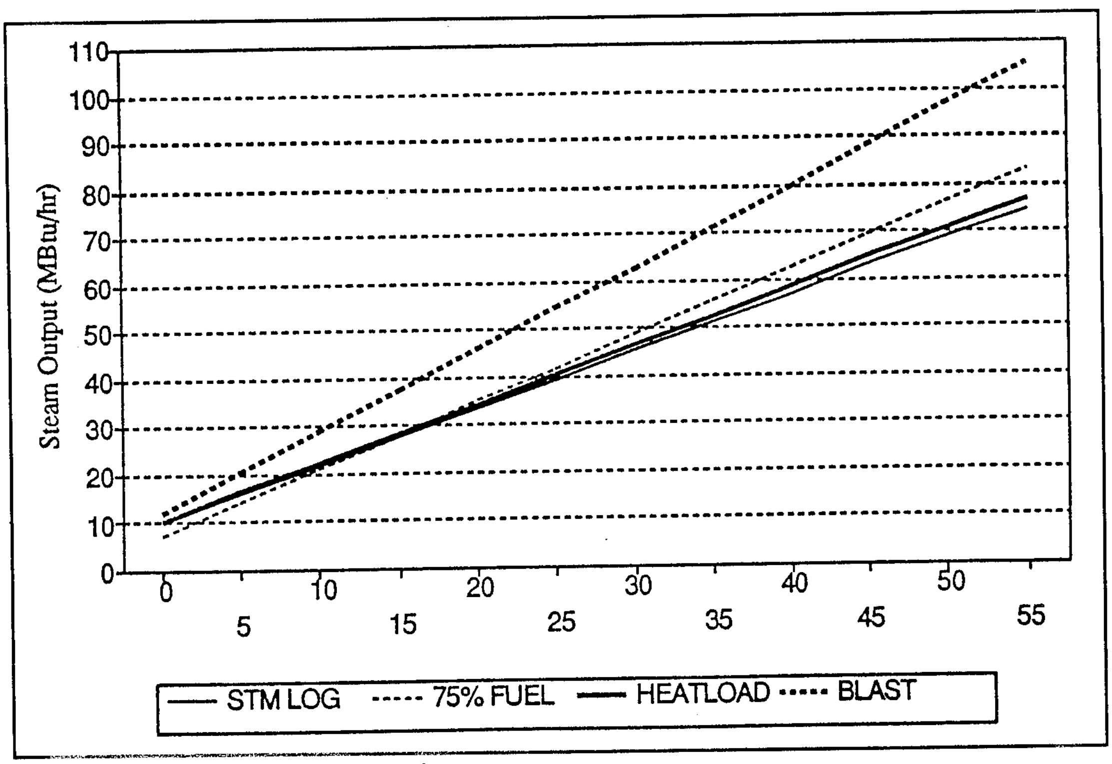


Figure 9. Heat loads vs. HDD regressions.

4 Electrical Power Consumption

This section describes current electrical energy supply and use. Trends in electrical power supplied by the utility were analyzed and building cooling loads were modeled.

Electrical Costs

DPSC's electrical power is supplied by the Philadelphia Electric Company (PECO), and electricity costs are based on PECO's High-Tension Light and Power (HT) rate schedule. A three-tier energy usage charge and a demand charge make up most of the bill; a small customer charge and various tax and incentive adjustments make up the balance of the bill. The basic rate schedule is shown in Table 13.

The billed demand consists of the maximum 30-minute measured demand in the month computed to the nearest kW but not less than the measured demand, adjusted for the power factor. For October to May the billing demand cannot be less than 40 percent of the maximum demand specified in the contract (7,500 kW), nor less than 80 percent of the highest billing demand in the preceding months of June to September.

Time of use adjustments are used for customers with a measured demand of 2000 kW or greater. A credit is given for energy use during off-peak hours and an additional charge is added for energy use during on-peak hours. The on-peak hours are 8 a.m. to 8 p.m. Monday to Thursday and 8 a.m. to 4 p.m. Friday. All remaining hours, including weekends and holidays, are considered off-peak.

Of these costs, the energy-use charges and the demand charge are the most significant. Figure 10 compares the magnitude of the major electric charges for FY90 with DPSC electric bills. The demand charge accounts for about 25 percent of the annual electric charges, the energy-use charges account for 76 percent, and on-peak use accounts for about 1 percent (not including the tax and energy adjustments).The demand charge for FY90 averaged $84,000 per month in the summer and $54,000 per month in the winter, or $64,240 per month for the year. The average demand cost was $10.48/kW based on an average peak demand of 6,143 kW. The total cost of electricity was $2.8 million for 31.7 million kWh or $0.0895/kWh ($26.2/MBtu).

The electricity charges remain relatively constant partly because of DPSC's stable load. The winter charges, however, are constant because of the 40 percent and 80 percent minimum peak demand rates discussed previously. This minimum peak rate added another $38,000 to the winter month bills.

Purchased Electricity

PECO provided DPSC daily and hourly electrical information for 1991. Daily records included on-peak and off-peak consumption and the highest on-peak and off-peak peak demands. Hourly records contained half-hour peak demands for the entire day. Figure 11 is an area graph that shows the off-peak electrical use in dark shade and the on-peak (light shade) added to it. The tall peaks represent the electrical use on workdays, and these peaks occur in the summer months on workdays because of the cooling load. The highest daily use is about 135,000 kWh. The dark peaks between the light peaks represent the highest electrical use on nonworking days, typically Saturday. The nonworking day electrical use also increases in the summer to maintain a minimum level of cooling.

Figure 12 shows the daily on- and off-peak demands for 1991. The on-peak demand follows a similar pattern to the on-peak use (see Figure 11), the winter and summer months being constant. The peak demand is just below 7,500 kW and the off-peak demand follows a similar pattern with the addition of two subset patterns. The pattern directly below the on-peak demand represents the off-peaks just before or after the on-peak hours of 8 a.m. to 8 p.m. The lower pattern of off-peaks is made up of nonworking days. Within this pattern are separate patterns, one for Saturdays and one for Sundays. Sundays typically have a lower peak than Saturdays. The low peaks of the Christmas holidays can be seen in the far right of the graph.

The half-hour demand profiles for the cooling season and the heating season are shown in Figure 13. This figure shows an example profile for (1) a summer workday, (2) a summer weekend, (3) a winter workday, and (4) a winter weekend. The workday profiles for summer and winter are very similar, even showing the same dip at 11 a.m. when personnel turn off lights, computers, and other equipment in the shops and the factory for their lunch break. The figure indicates the cooling load is fairly constant at about 2000 kW between 8 a.m. and 3 p.m. The weekend profiles are also similar because they remain fairly constant throughout the day. Both workday and weekend profiles show an off-peak cooling peak of about 1000 kW.

Electricity End-Use

As discussed in the previous sections, the DPSC electrical usage and demand peaks are fairly constant during the noncooling season, averaging about 2.2 million kWh per month and 5100 kW, respectively. The noncooling loads are primarily from lighting, computers, and factory operations.

The cooling season loads are fueled by approximately 75 chillers with a total chilling capacity of about 4075 tons. A significant portion of this capacity is from a few large chillers, which are listed in Table 14. Appendix B contains a complete list of the chillers. There are also numerous window units.

Like the heating loads, the building cooling loads were modeled using the BLAST program. Currently there is no counterpart to the HEATLOAD model for cooling loads. The BLAST cooling loads, however, were about one-third the load estimated from the PECO records. The BLAST simulations will be reviewed to refine the estimate.

Cooling Load Versus CDD Model

A standard practice for electrical power alternatives studies is to use the electrical consumption and demand pattern of a year with similar cooling degree days (CDD) as the normal CDD. The most recent time period with CDD similar to the normal was FY90. The next closest year was FY85, but being 7 years old it would pose additional problems in determining facility loads. The monthly normal and FY90 CDD, obtained from ETAC, are shown in Table 15.

Another method of projecting loads is to develop a linear model based on a previous year. For DPSC, a model of both peak demands (kW) and consumption (kWh) was required because electric bills are based on daily on-peak kW and monthly kWh. Although cooling peak demands and consumption are affected by many factors, they are highly dependent on CDD. Regression analyses were made between 1991 CDD data and the daily on-peak kW and monthly kWh. These regressions are shown graphically in Figures 14 and 15. The peak kW regression used only workdays and neglected days with daily peak demands below 6,500 kW to factor out the influence on nonworking days. The regression has a correlation coefficient of 0.63, indicating a strong correlation between CDD and daily on-peak demand.

Figure 15 shows the regression between monthly consumption and monthly CDD data. This regression has a correlation coefficient of 0.92, indicating a stronger correlation between CDD and monthly consumption. The points grouped near the origin (zero

CDD) are months that have no cooling load. The monthly noncooling electric load is approximately 2,300,000 kWh.

These two regressions or models were then used to project long-term (normal) energy use patterns. In Figures 16 and 17 the normal projections are compared to the FY90 energy use patterns. Figure 16 indicates that the FY90 data underpredicted the peak kW for the noncooling months, but was quite close for the cooling months. The FY90 data compared favorably with the normal projection of monthly consumption.

The FY90 data was used for the preliminary alternative analysis; however, the regression models will be used for the more detailed conceptual design of the selected alternative.

Table 13. Electric rate schedule.

Customer charge	$281.48 (Jun-Sep) $257.20 (Oct-May)	
Demand charge	$12.52 per billed kW demand (Jun-Sep) $ 7.93 per billed kW demand (Oct-May)	
Energy charge	$0.0856 per kWh for first 150 kWh per billed kW demand $0.0582 per kWh for next 150 kWh per billed kW demand not to exceed 7,500,000 kWh $0.0312 per kWh for all additional kWh	
Time of use adjustments	(Jun-Sep)	(Oct-May)
Off-Peak Credit	$0.0021 per kWh	$0.0021 per kWh
On-Peak Charge	$0.0057 per kWh	$0.0022 per kWh

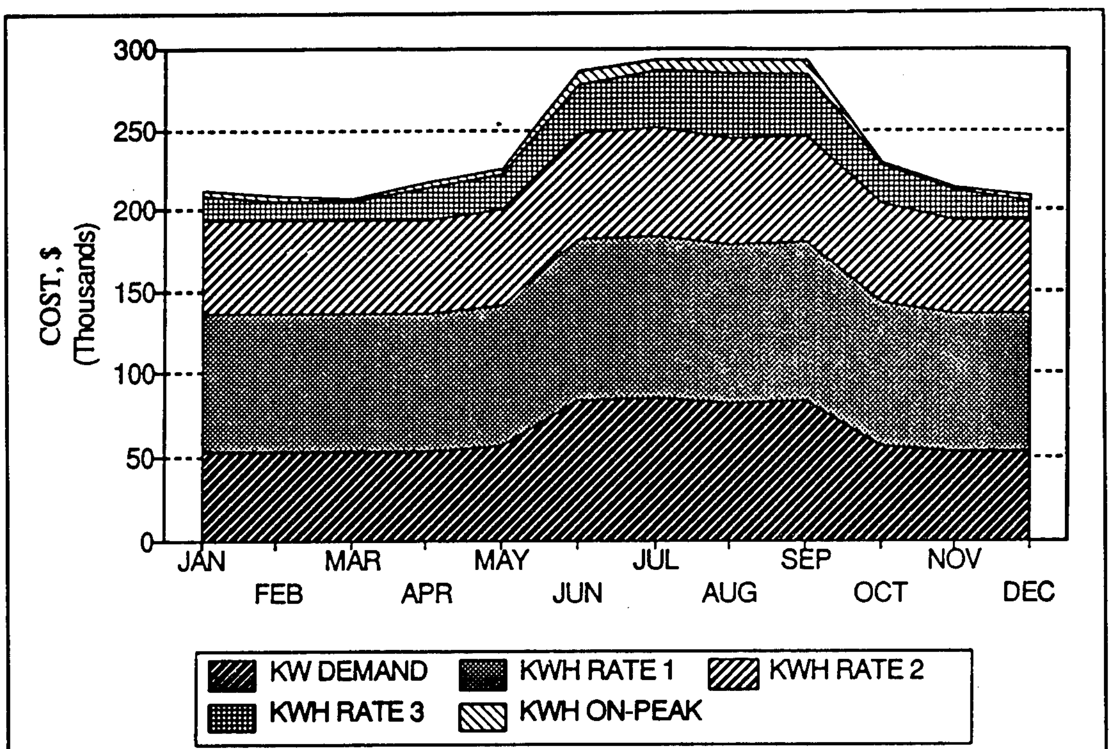


Figure 10. Major electric power charges for FY90.

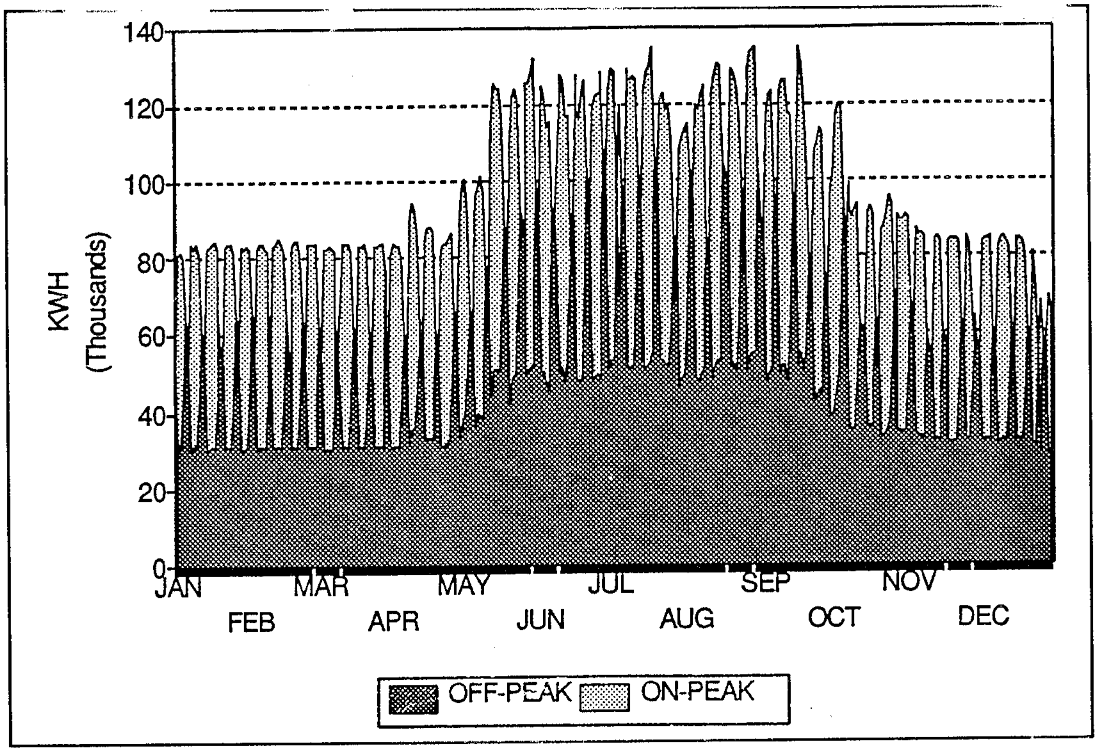


Figure 11. 1991 daily electric consumption.

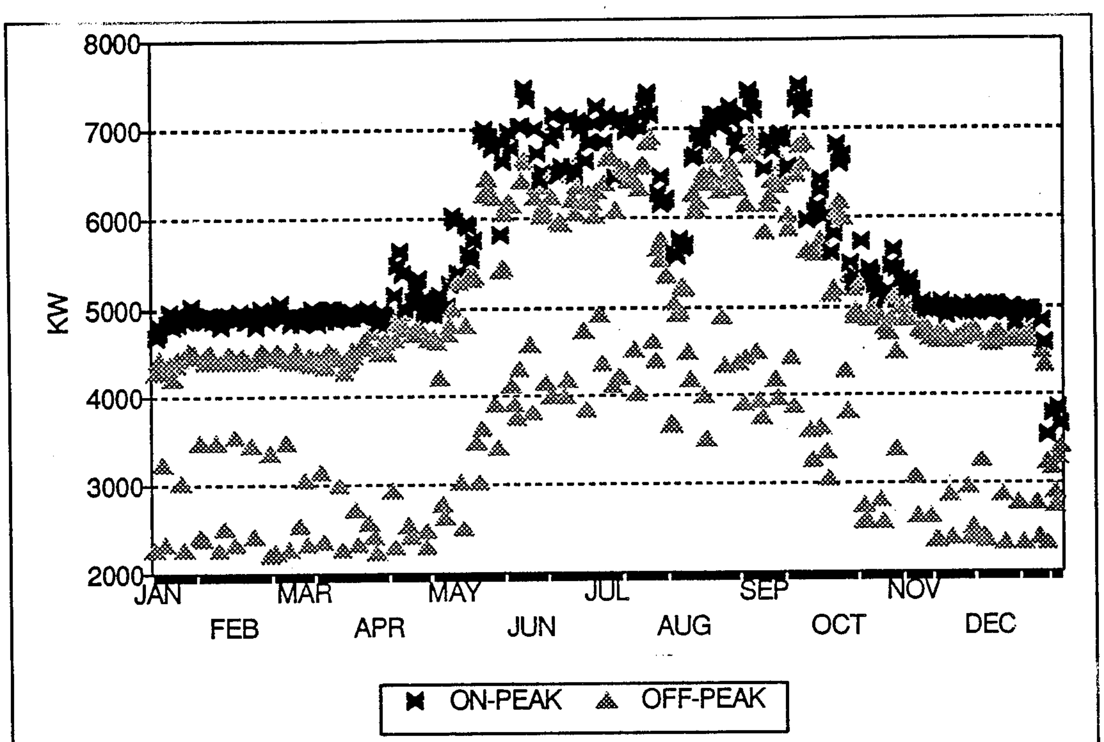


Figure 12. 1991 daily demand peaks.

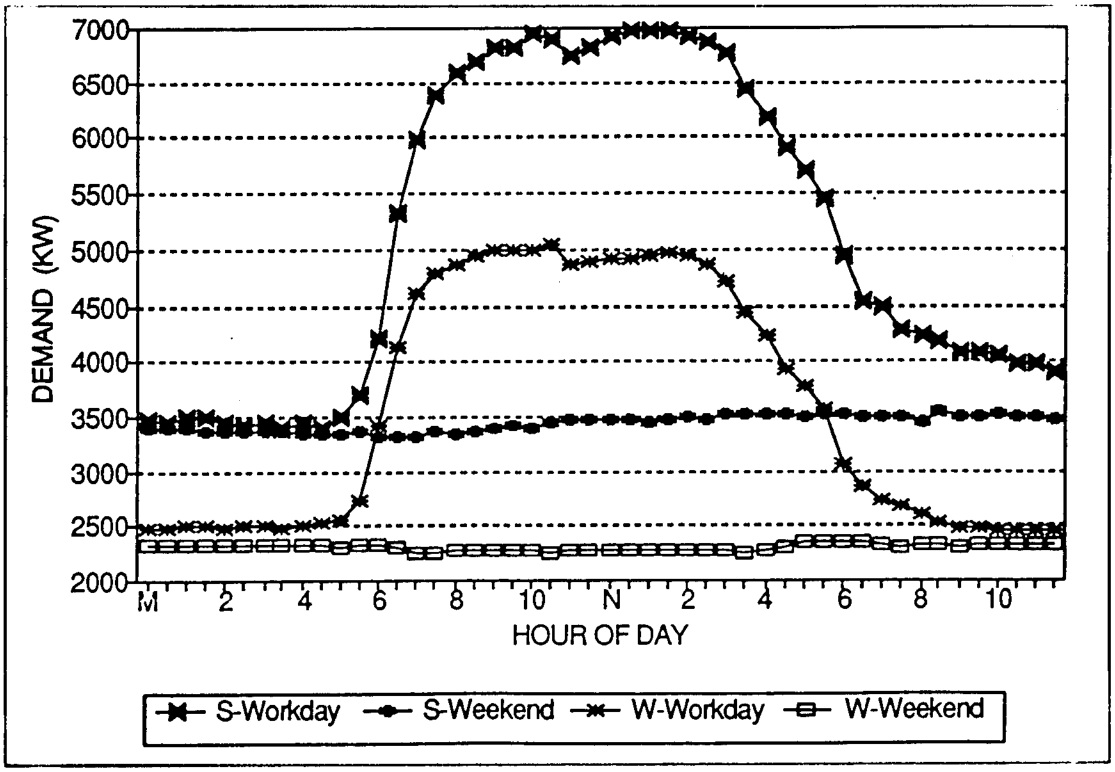


Figure 13. Half-hour demand profiles.

Table 14. Chillers over 100-ton capacity.

Bldg	Units	Capacity	Use	Age	Media
6-1-C	2	400 Ton	Entire Bldg	1986	R-11
9-1E&F	1	130 Ton	OTIS & Subs	1990	R-22
9-3E&F	1	140 Ton	Subs & Med	1991	R-22
12-LL	1	550 Ton	Entire Bldg	1990	R-11
12	1	1200 Ton	Factory	1973	R-11
14-R	1	130 Ton	Partial	1961	R-11
15	1	250 Ton	Entire Bldg	1973	R-12

Table 15. Monthly average CDD.

Month	FY90	Normal
Jan	0	0
Feb	0	0
Mar	9	0
Apr	29	0
May	20	59
Jun	226	202
Jul	413	357
Aug	341	319
Sep	152	129
Oct	18	9
Nov	1	0
Dec	0	0
Total	**1209**	**1075**

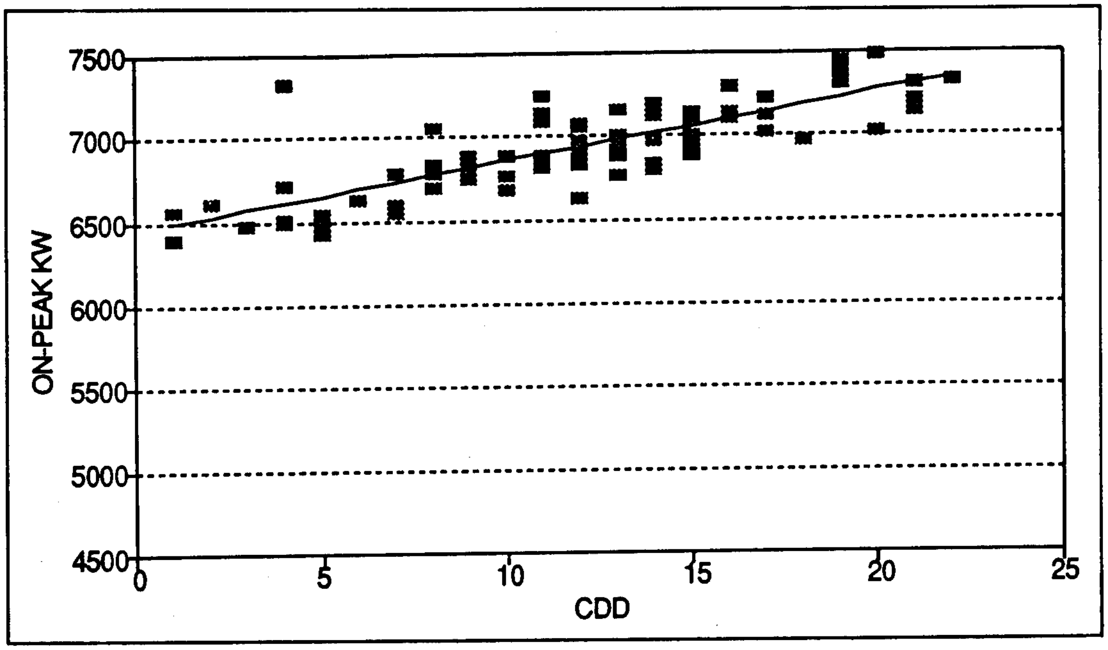


Figure 14. Workdays with CDD.

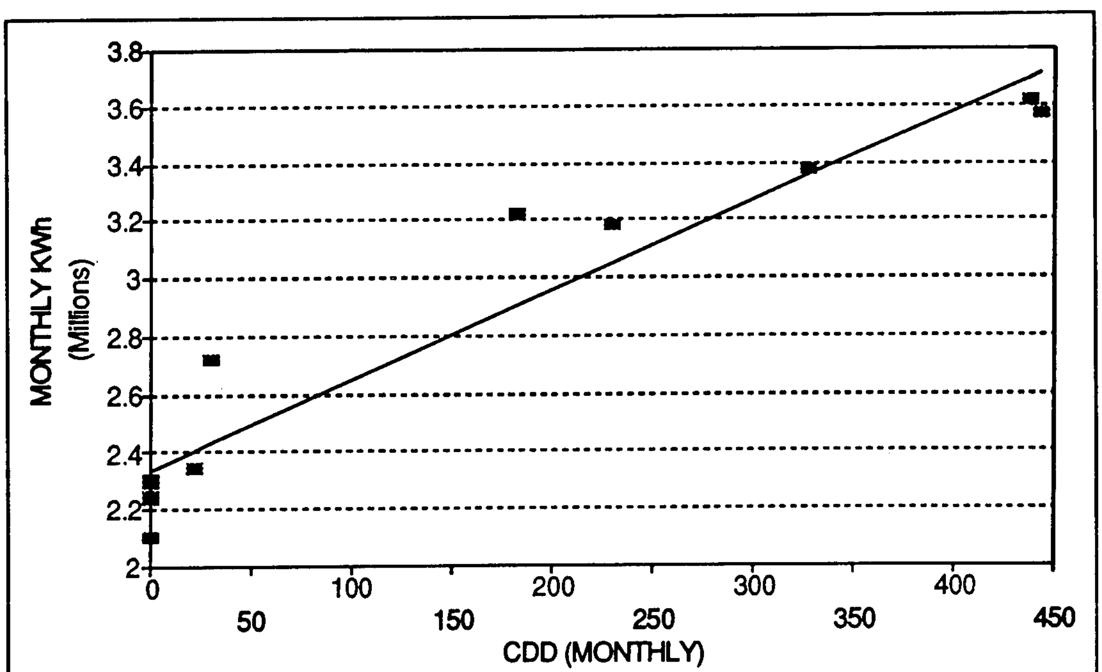


Figure 15. Monthly CDD and kW.

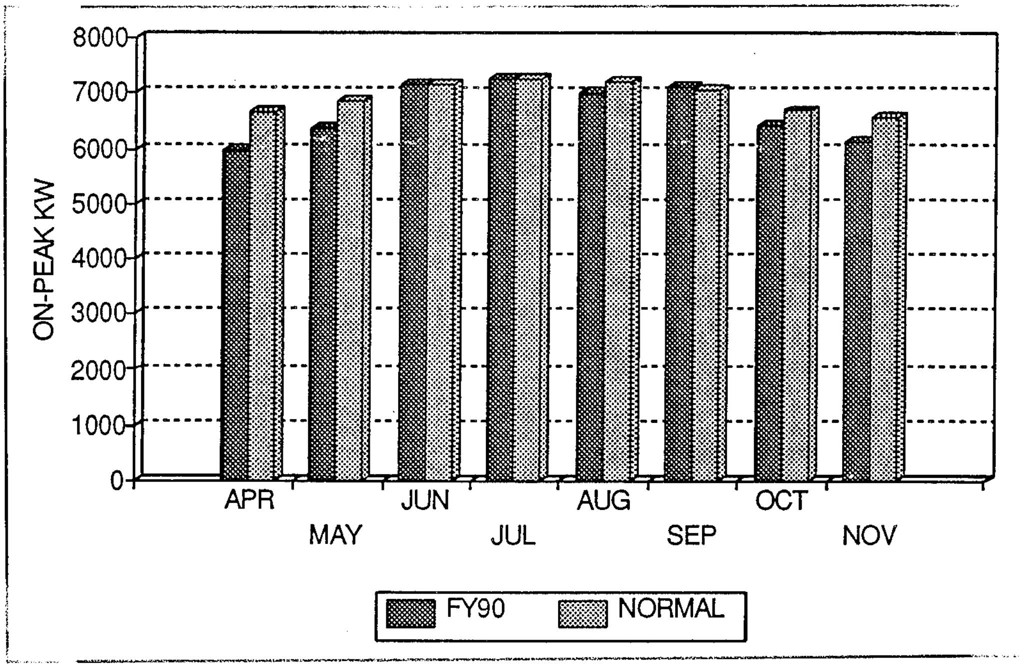


Figure 16. Projection of monthly kW.

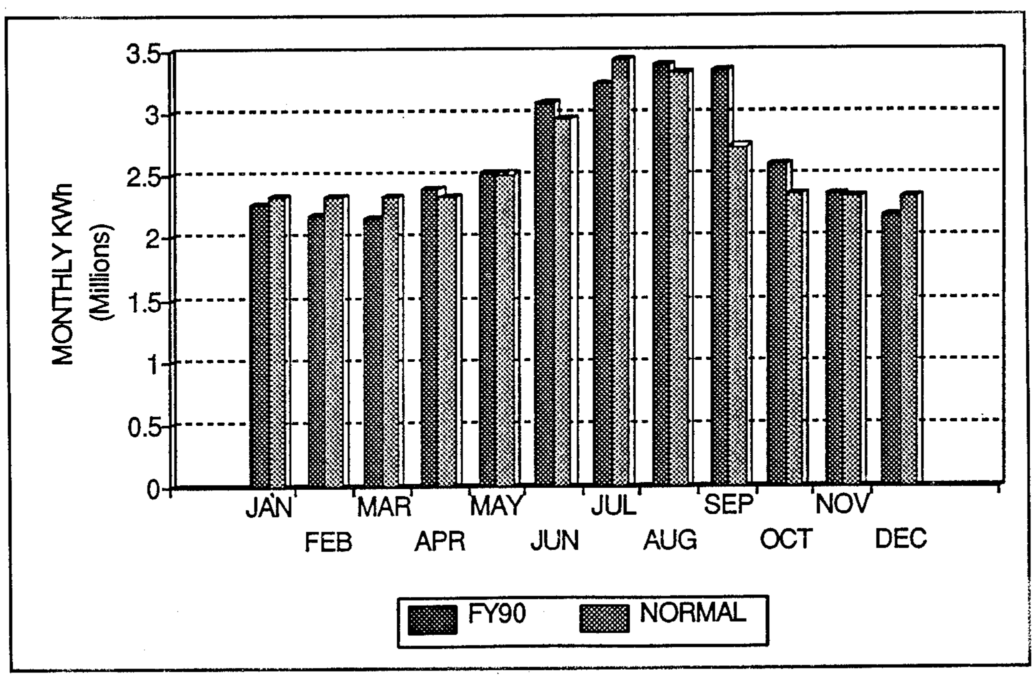


Figure 17. Projection of monthly kWh.

5 Projected Energy Consumption

DPSC has not finalized a master plan projecting building, personnel, or mission changes that might affect the consumption of thermal and electrical energy. There are tentative plans to demolish some of the World War I warehouse buildings (Building 5 was demolished during this study) and add one new facility (Figure 18). The loss of the warehouses would reduce the heating load but would have little effect on the electrical load. There is also a tentative plan to construct a new Operations/ADP building located at the center of the installation. DPSC engineering personnel indicated that this building would replace existing building functions without the addition of personnel. Although the new building might increase electrical consumption because of more computer equipment, the heating load would probably drop because the building would be more energy efficient.

Because of the tentative nature of these changes, energy consumption projections will be based on normal weather data and design temperatures only. The effect will be to somewhat overdesign the heating plant and underpredict electrical consumption. The heating plant will be designed to provide adequate turndown for the tentative reductions in heating load.

Table 16 shows normal HDD, monthly heating load estimates, and design day estimate using the steam log data, 75 percent fuel data, HEATLOAD, and BLAST. The linear model of heating load and HDD developed from the 1991 data was modified using the normal HDD to estimate the average monthly heating loads. Figure 19 compares the projected heating loads, with HEATLOAD providing the best model of heating load. Based on the design HDD of 51, the maximum plant capacity is about 69.4 MBtu/hr (58,000 lbs steam/hr) output.

As discussed previously, FY90 was selected as a comparable year to the normal year for estimating the energy consumption and peak demands. Table 17 shows the monthly consumption data.

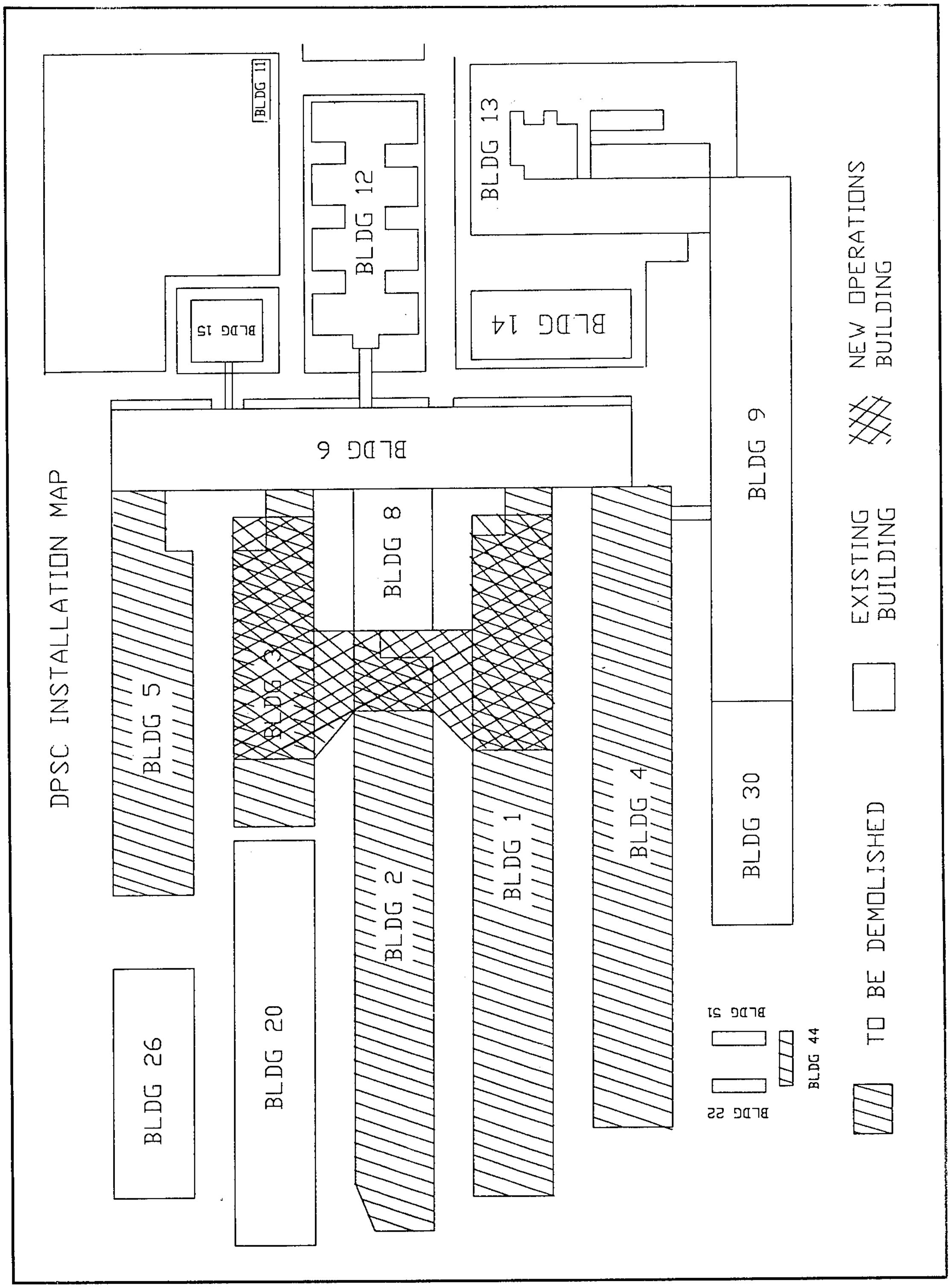


Figure 18. Tentative facility changes.

Table 16. Normal heating load projections.

Month	Normal HDD	HEATLOAD MBtu/hr	BLAST MBtu/hr	75% Fuel MBtu/hr	Steam Log MBtu/hr
Jan	1048	51.2	69.4	54	49.8
Feb	893	48.9	66.2	51.4	47.6
Mar	718	38.3	51.4	39.4	37.3
Apr	363	24.9	32.6	24.2	24.2
May	127	15.1	18.9	13.2	14.7
Jun	0	10.1	11.9	7.5	9.9
Jul	0	10.1	11.9	7.5	9.9
Aug	0	10.1	11.9	7.5	9.9
Sep	33	11.6	13.9	9.1	11.2
Oct	273	20.8	26.9	19.7	20.3
Nov	576	33.4	44.6	34	32.6
Dec	915	46	62.2	48.1	44.8
Design	51	69.4	87.5	70.2	77.7

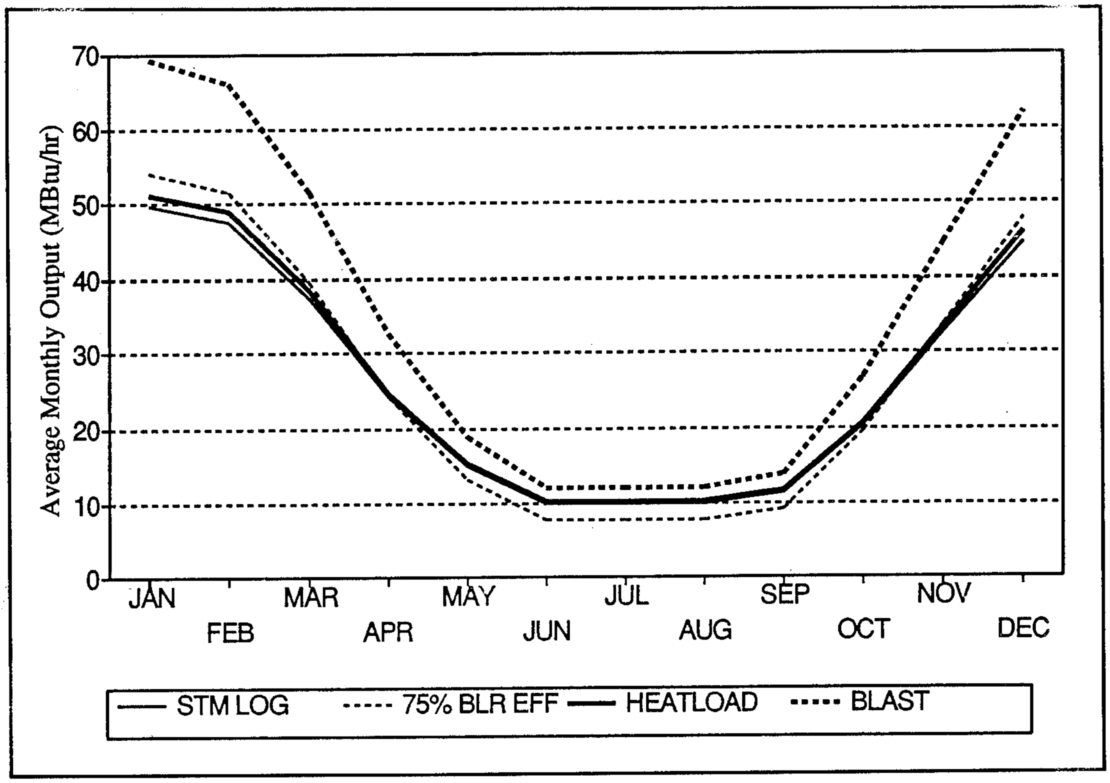


Figure 19. Projected load profiles.

Table 17. FY90 monthly electric consumption data.

Month	BILLED Peak kW	ACTUAL Peak kW	Rate 1&2 kW	Rate 3 kW	On-Peak kWh	Off-Peak kWh	Total kWh
Jan	6139	4992	920850	421300	952005	1310995	2263000
Feb	6139	5040	920850	341300	1028583	1154417	2183000
Mar	6139	5160	920850	308300	1035774	1114226	2150000
Apr	6139	5976	920850	557300	1052274	1346726	2399000
May	6366	6366	954900	648200	1154673	1373327	2528000
Jun	7263	7164	1089450	915100	1392300	1701700	3094000
Jul	7333	7248	1099950	1043100	1359837	1883163	3243000
Aug	7144	7032	1067100	1262800	1368810	2028190	3397000
Sep	7186	7110	1077900	1192200	1450011	1897989	3348000
Oct	6426	6426	963900	674200	1170546	1431454	2602000
Nov	6139	6139	920850	508800	1089531	1260969	2350500
Dec	6139	5064	920850	343300	1008516	1176484	2185000

6 Air Quality Regulations

Air quality regulations are the most significant environmental regulations that will affect the analysis of alternatives for this study. The Clean Air Act Amendments of 1990 (CAAA) have placed tighter constraints on emissions from most industrial sources, particularly combustion sources.

Federal Regulatory Requirements

The Philadelphia area has been designated as nonattainment (does not meet current air quality standards) for ozone (O_3), carbon monoxide (CO), and total suspended particulate (TSP) in *New Source Review* (NSR), a publication of the U.S. Environmental Protection Agency. Virtually all of the Philadelphia Consolidated Metropolitan Statistical Area (CMSA), which includes Pennsylvania, New Jersey, and Delaware, is designated a *severe* nonattainment area for O_3. High traffic density areas in the City of Philadelphia and some areas in Trenton and Burlington, NJ, are designated as *moderate* nonattainment for CO. Some census tracts within the City of Philadelphia; Pottstown Borough in Montgomery County, PA; South Coatesville Borough in Chester County, PA; and Camden, NJ, are designated nonattainment for TSP.

The TSP nonattainment designation essentially restricts the fuel selection for DPSC to natural gas because natural gas combustion systems emit very little particulate matter. CO should not be a factor because the nonattainment designation only applies in very limited areas and mobile sources are the major source of CO problems in moderate CO nonattainment areas. Therefore, the O_3 nonattainment rules will be the controlling regulations for this study.

The 1990 CAAA's establish emission limits for O_3 precursors in areas designated as severe O_3 nonattainment. The emission limits for O_3 precursors [volatile organic compounds (VOC) and nitrogen oxides (NO_x)] are set at 25 tons per year (TPY). These limits became effective 15 November 1992. The emission thresholds defining a major modification to an existing major source in a nonattainment area under the previous rules have not been modified by the 1990 CAAA's. However, the 25 TPY major source definition is less than the old major modification definition. A major source is also defined as "any physical change or change in method of operation at an existing non-major source that constitutes a major stationary source by itself." Therefore, any existing source that increases emissions of VOC or NO_x by 25 TPY is subject to nonattainment NSR.

A source that is subject to nonattainment NSR in a severe O_3 area must install emission control equipment that meets Lowest Achievable Emission Rate (LAER) requirements and obtain offsetting emissions decreases from existing sources at a ratio of 1.3:1. Emissions offsets could also be obtained from reduced operation of the owner's existing boilers at a ratio of 1:1.

The 1990 CAAA's require Reasonably Available Control Technology (RACT) on all facilities (entire facility) that emit 25 TPY or more of VOC or NO_x. This will apply to existing boilers and possibly to the gas turbines or spark gas engines once the program takes effect under the federal operating permit requirements of the 1990 CAAA's.

State and Local Regulatory Requirements

A permit to construct must be obtained from the Philadelphia Air Management Service (AMS), which enforces Federal, State, and local air quality regulations. However, the Federal requirements outlined previously should be the most restrictive regulations that apply to a gas turbine or spark gas engine installation. Pennsylvania state regulations limit SO_2 emissions from any source located in the southeastern Pennsylvania air basin greater than 250 million Btu per hour (MBtu/hr) heat input to 1.0 lb/MBtu, and sources less than 250 MBtu/hr to 0.6 lb/MBtu [Pennsylvania Regulations 123.22(4)(i) and 123.22 (4)(iv)(e)(1)]. No. 2 and lighter fuel oils must contain no more than 0.2 percent sulfur by weight, and No. 4 and heavier fuel oils cannot exceed 0.5 percent sulfur by weight [Pennsylvania Regulation 123.22 (4)(iv)(e)(2)]. Sources with heat inputs greater than 250 MBtu/hr and an average annual capacity greater than 30 percent are required to install, operate, and maintain a continuous emissions monitoring system (CEMS) for NO_x.

Pennsylvania air quality regulations for nonattainment areas are still in effect at this time, although the Federal nonattainment regulations discussed previously are more rigorous and will constitute the basis for design. The Pennsylvania nonattainment regulations are found in Subchapter C of the Pennsylvania air quality regulations. A major source in a nonattainment area is defined in Section 127.63, a major VOC source is defined in Section 127.63(2), and a major CO source is defined in Section 127.63(3). These are sources that emit 50 TPY, 1000 lb/day, or 100 lb/hr of these air pollutants. Section 127.65(1) requires LAER on major sources, Section 127.65(3) requires offsets for major sources, and Section 127.66(a)(1) requires offsets in the ratio of 1.3:1 for VOC and 1.1:1 for CO from major sources.

Summary

Air pollution regulations essentially limit the combustion fuel for DPSC to natural gas. However, because of the severe nonattainment designation for ozone, DPSC will also be limited to an increase in nitrogen oxide emissions of 25 TPY to avoid RACT regulations that would require costly pollution control equipment.

7 Study Alternatives

This section presents a brief summary of the alternatives evaluated during this study. Six alternatives were evaluated with various options, and a status quo option was developed as a baseline for comparison. Life cycle cost (LCC) analyses were performed on all alternatives and status quo using the Life Cycle Cost in Design (LCCID) program.

Status Quo Alternative

The status quo or baseline alternative was developed using the STATUS QUO model developed by USACERL to provide a microcomputer-based technique to establish the existing condition of a CHP. This program was funded by the DOD coal use program. The status quo situation implies the continued operation of the CHP by performing routine maintenance and repair. The STATUS QUO model provides a baseline alternative with which to compare CHP plant alternatives.

The evaluation of the CHP's status quo is determined by a field survey and the completion of an evaluation form for major plant components. Currently, the model is capable of estimating the life expectancy and cost of oil and natural gas-fired equipment for boilers in the 20 to 200 MBtu/hr range that have a maximum plant capacity of 600 MBtu/hr. Coal technology components are under development, while electric generation and thermal distribution components are planned for future development. The current model data input is simple, consisting of equipment size (dimensions, capacity, power requirements, etc.) and year of installation. The STATUS QUO program will display (for each component) equipment cost in 1991 dollars and the year the equipment should be replaced. Costs are based on average industry prices and the replacement year is based on industry experience.

The program also allows the default values to be changed if better information is available. For instance, a good method of establishing water tube boiler life is measuring the steam drum thickness and comparing it to the original thickness and pressure rating. Boiler codes limit allowable pressures that are based on drum thickness. Many other components have methods available to determine their condition and life expectancy; these include vibration analysis, motor testing, ultrasonic listening, thickness testing, oil analysis or ferrography, infrared thermal surveys, eddy current testing, equipment performance tracking, and equipment run time.

The program also contains defaults for labor, maintenance, spare parts, and utility costs. Actual costs should be used to obtain an accurate economic analysis. The STATUS QUO model uses the LCCID program to perform the LCC analysis. The STATUS QUO program produces an LCCID input file containing all the plant components with their replacement year, replacement cost, plant labor, maintenance, spare parts, and utility costs.

Table 18 shows the LCC summary for the status quo alternative. Costs are net present worth (October 1992 basis).

General Improvements and Upkeep

Because of the similarity of many of the alternatives and options, initial equipment improvements and improvements required during the life of the system were combined in Tables 19 and 20, respectively. These tables do not list the new energy conversion equipment that is discussed with each alternative section.

Alternative 1 - Two New Gas/Oil Boilers

Alternative 1 involves removing existing Boilers No. 1, 2, 3, and 4 and installing two packaged gas/oil-fired 50,000 lb/hr boilers with low NO_x burners, economizers, and O_2 trim. Boilers No. 1 and 2 would be demolished first and the new boilers, which would be operated at 125 psig (saturated), would be installed in their location. Boilers No. 3 and 4 would remain operational until the new boilers are in service. The superheater on Boiler No. 5 would be removed and the burner would be replaced with a low NO_x burner. Boiler No. 5 also would be operated at 125 psig (saturated). No. 2 fuel oil would be used as a backup fuel in place of No. 6 fuel oil.

Table 21 shows the LCC summary for Alternative 1. Costs are net present worth (October 1992 basis).

To investigate the potential of absorption chilling without cogeneration, a variation of Alternative 1 was analyzed which replaced a 1200-ton centrifugal chiller in Building 13-1 with a 1200-ton single-stage absorption chiller. Table 22 shows the LCC summary for this variation. Absorption chilling appears more cost effective compared to the existing electrically-driven chilling system. However, this option optimistically assumed no increase in capital costs or operations and maintenance (O&M) costs for the absorption system. Absorption chilling will be analyzed in combination with cogeneration to determine possible economic improvements (Alternatives 3 and 6).

Alternative 2 - Two New Gas/Oil Boilers and Cogeneration

Alternative 2 considers six options as follows:

Option 1. Install one 1.6 megawatt (MW) spark gas engine generator with a 6,000 lb/hr heat recovery steam generator.
Option 2. Install two 1.6 MW spark gas engine generators with two 6,000 lb/hr heat recovery steam generators.
Option 3. Install one 1.1 MW gas turbine generator with a 6,000 lb/hr heat recovery steam generator.
Option 4. Install two 1.1 MW gas turbine generators with two 6,000 lb/hr heat recovery steam generators.
Option 5. Install three 1.1 MW gas turbine generators with three 6,000 lb/hr heat recovery steam generators.
Option 6. Install one 3.5 MW gas turbine generator with an 18,000 lb/hr heat recovery steam generator.

All options for Alternative 2 consider the following:

Boilers No. 1 and 2 would be demolished and two packaged gas/oil-fired 50,000 lb/hr boilers with low NO_x burners, economizers, and O_2 trim would be installed in their place. After these new boilers are in operation, Boilers No. 3 and 4 would be demolished and the new cogeneration unit(s) would be installed in the vacated area. The new boilers would be operated at 125 psig (saturated). The superheater on Boiler No. 5 would be removed and the burner would be replaced with a low NO_x burner. Boiler No. 5 also would be operated at 125 psig (saturated). The heat recovery steam generator(s) would operate at 125 psig. No. 2 fuel oil would be used as a backup fuel for the boilers instead of No. 6 fuel oil.

Tables 23 through 28 show the LCC summary for the six options under Alternative 2. Costs are net present worth (October 1992 basis).

Alternative 3 - Two New Gas/Oil Boilers, Cogeneration, and Absorption Chiller

Alternative 3 considers the following two options:

Option 1. Install two 1.6 MW spark gas engine generators with two 6,000 lb/hr heat recovery steam generators.
Option 2. Install one 3.5 MW gas turbine generator with an 18,000 lb/hr heat recovery steam generator.

All options for Alternative 3 consider the following:

Boilers No. 1 and 2 would be demolished and two packaged gas/oil-fired 50,000 lb/hr boilers with low NO_x burners, economizers, and O_2 trim would be installed in their place. After these new boilers are in operation, Boilers No. 3 and 4 would be demolished and the new cogeneration unit(s) would be installed in the vacated area. The new boilers would be operated at 125 psig (saturated). The superheater on Boiler No. 5 would be removed and the burner would be replaced with a low NO_x burner. Boiler No. 5 also would be operated at 125 psig (saturated). The heat recovery steam generator(s) would operate at 125 psig. In addition, a 1200-ton centrifugal chiller in Building 13-1 would be replaced by a 1200-ton single-stage absorption chiller. No. 2 fuel oil would be used as a backup fuel for the boilers instead of No. 6 fuel oil.

Tables 29 and 30 show the LCC summary for the two options under Alternative 3. Costs are net present worth (October 1992 basis).

Alternative 4 - Refurbish Existing Plant, Summer Boiler

Alternative 4 involves removing existing Boilers No. 1 and 2. The superheaters on Boilers No. 3, 4, and 5 would be removed and the burners would be replaced with low NO_x burners. Boilers No. 3, 4, and 5 would be operated at 125 psig (saturated). This alternative will also include installing a 10,000 lb/hr fire tube boiler for summer operation. No. 2 fuel oil would be used as a backup fuel instead of No. 6 fuel oil.

Table 31 shows the LCC summary for Alternative 4. Costs are net present worth (October 1992 basis).

Alternative 5 - Refurbish Existing Plant, Summer Boiler, Cogeneration

Alternative 5 involves removing existing Boilers No. 1 and 2. The superheaters on Boilers No. 3, 4, and 5 would be removed and the burners would be replaced with low NO_x burners. Boilers No. 3, 4, and 5 would be operated at 125 psig (saturated). This alternative would include two 1.6 MW spark gas engine generators with heat recovery steam generators. These generators would operate at 100 psig. In addition, a 10,000 lb/hr fire tube boiler would be installed for summer operation. No. 2 fuel oil would be used as a backup fuel instead of No. 6 fuel oil.

Table 32 shows the LCC summary for Alternative 5. Costs are net present worth (October 1992 basis).

Alternative 6 - Refurbish Existing Plant, Two New Spark Gas Engine Generators, and One New Absorption Chiller

Alternative 6 involves removing existing Boilers No. 1 and 2. The superheaters on Boilers No. 3, 4, and 5 would be removed and the burners would be replaced with low NO_x burners. Boilers No. 3, 4, and 5 would be operated at 125 psig (saturated). This alternative would include installation of two 1.6 MW spark gas engine generators with heat recovery steam generators. These generators would operate at 100 psig. Also, the 1200-ton centrifugal chiller in Building 13-1 would be replaced with a 1200-ton single-stage absorption chiller. No. 2 fuel oil would be used as a backup fuel instead of No. 6 fuel oil.

Table 33 shows the LCC summary for Alternative 6. Costs are net present worth (October 1992 basis).

Summary of Alternatives and Recommendations

The LCC for the alternatives and options are summarized in Table 34. The difference between Alternative 2, Option 2 and Alternative 5 is adding new boilers (Alternative 2) or keeping the existing boilers (Alternative 5). Based on LCC, it is better to buy new boilers.

Based on LCC, Alternative 2, Option 6 is the best selection. However, Alternative 3, Option 2 is quite close and could be improved with a smaller absorption chiller. A 1200-ton chiller had been assumed that required a boiler to be operated to meet the chiller's energy requirements. A smaller turbine sized at about 550 ton-hr would require only the excess steam from the turbine, which is essentially free energy. If Alternative 2, Option 6 is implemented and a smaller electrically driven chiller is due for replacement, it would be economical to replace it with an absorption unit.

Another improvement would be the use of a storage cooling system (SCS) to further reduce peak electrical demands. The next section describes a preliminary analysis for SCS application.

Storage Cooling System Analysis

Storage cooling systems (SCS) have become an important tool in reducing on-peak electric demand by shifting power to off-peak periods. The need to lower electric demand has arisen because utility companies usually increase electric rates for hours associated with high demand. The effective use of "demand-side management" by U.S.

electric utility companies forestalls the addition of costly new power plants while still meeting an increasing electric demand. Therefore, electric companies have tried to control electric demand by increasing the demand charge.

The Philadelphia Electric Company charges about $12.50 per kW in the summer and about $8.00 per kW in the winter. However, the summer peak still affects the winter demand charges because PECO sets the winter peak demand at a minimum of 80 percent of the summer peak; therefore, a reduction of the peak demand in the summer also affects the demand charges in the winter.

A way to shift electrical demand for air-conditioning from on-peak to off-peak hours is a diurnal storage cooling system. Rather than operating a chiller to meet the cooling load as it arises, the chiller is operated either partially or solely during the off-peak period, and the refrigeration produced is stored to meet the next day's on-peak cooling requirements. It can be stored in chilled water, ice, or freezing eutectic salts. A diurnal storage cooling system uses ice as a storage medium.

To assist in evaluating these systems, USACERL has developed a computer model to estimate their economic feasibility. The program, called STOFEAS (storage feasibility), calculates the simple payback and savings-to-investment ratio (SIR) based on system first cost and the expected annual savings in the demand charge. STOFEAS provides a quick, simple, and inexpensive initial assessment of the cost-effectiveness of installing and using an SCS at a particular facility. The model estimates the annual specific savings in demand charges for each kilowatt shifted from on-peak to off-peak hours, based on a number of typical electric demand rate schedules. SCS first-cost models are run for new/replacement, retrofit, and theoretical highest cost applications.

The cost of an SCS, an important factor in determining its economic performance, is expressed in terms of dollars per storage capacity ($/ton-hour). The cost of an SCS in STOFEAS is the differential cost between a conventional cooling system and an SCS serving the same building. For the new/replacement case the differential cost is due to the storage tanks and their associated installation. In the retrofit case an SCS is added to an existing cooling system to provide cooling during a short period (2 to 4 hours) when the installation is experiencing a peak demand. The purchase of a new condensing unit and storage tanks is required for a retrofit application and for paying for system installation charges. The upper limit case demonstrates the impact of a high system first cost on the economic feasibility of an SCS.

The model provides default economic parameters such as study life, discount rate, factors for economy of scale, demand charge escalation rates, differential SCS operation and maintenance costs, and conversion constant between the electric power input and the mechanical refrigeration output.

Besides these and a number of other factors, the most important parameters in determining the economic feasibility of an SCS are the annual savings in electric demand and system first cost. The economic feasibility of an SCS is measured by the payback period and savings-to-investment ratio.

After STOFEAS has been executed, four reports are produced: (1) a summary of the data entered for the information requested, (2) the economic analysis results for the case of new/replacement, (3) the economic analysis results for the case of retrofit, and (4) the economic analysis results for the case of upper limit. Based on these outputs, the user can determine the feasibility of a prospective SCS.

A STOFEAS model was run to examine the economic feasibility of an SCS at DPSC. The economic analysis results for the three cases indicate that the new/replacement scenario is the best alternative, while the upper limit scenario shows a potential for poor economic feasibility. (More information on STOFEAS is in Appendix G.) Example economics for a 1,050 ton-hr system for each scenario follow.

Scenario	**First Costs**	**Payback**	**SIR**	**Savings**
New/replacement	$73,000	4.4	3:5	$185,000
Retrofit	$137,000	11	1:9	$121,000
Upper limit	$158,000	16.5	0:9	-$16,000

A more detailed study is needed to determine if SCS is economically feasible. The addition of a small SCS would not adversely affect Alternative 2-6.

Table 18. Status quo alternative LCC summary.

Initial investment costs	0
Energy costs:	
Electricity	$43,213
Natural Gas	$32,364
Total energy costs	$75,577
Recurring maintenance and repair/custodial costs	$12,123
Major repair/replacement costs	$2,656
LCC of all costs/benefits (net present worth)	$90,355

Table 19. Initial central heating plant improvements.

* Remove asbestos from area and equipment related to alternative.
* Remove existing turbine driven boiler feed pumps and feedwater piping; add motor-driven boiler feed pumps and feedwater piping.
* Remove the coal and ash silos and associated equipment.
* Remove the below-ground and above-ground fuel oil tanks; add new above-ground and below-ground fuel oil tanks.
* Remove existing make-up air heater; add make-up air heater.
* Remove existing air receiver; add air receiver.
* Remove existing switch gear; add switch gear.
* Remove existing condensate receiver; add condensate receiver.
* Remove existing expansion tank; add expansion tank.
* Remove existing water storage tank; add water tank.
* Remove existing flash tank; add flash tank.
** Remove existing stack and breeching; add new breeching and steel stacks.

* Alternative #1 - #6.

** Alternative #1, #2, #3.

Table 20. Plant upkeep after implementation.

**	Boilers No. 3 and 4; add two packaged gas/oil-fired 80,000 lb/hr boilers and related equipment. (2001)
***	Boilers No. 3 and 4; add two packaged gas/oil-fired 50,000 lb/hr boilers and related equipment. (2001)
****	Steel stack and breeching (2001)
*	Fuel oil unloading pump (2004)
*	Fuel oil piping below grade (2006)
*	Air compressor center (2007)
*	Emergency generator (2008)
*	Revalve (2008, 2009, 2010)
*	Water softener system (2009)
*	Heat exchanger (2010)
*	Condensate pump (2011)
*	Simplex pumps (2012)
*	Steel tank (2012)
*	Space heaters for building heat (2016)
*	Boiler No. 5 and related equipment (2017)
**	Remove Boiler No. 5. Note Boiler No. 5 would not be replaced. (2017)
***	Remove Boiler No. 5; add one packaged gas/oil-fired 30,000 lb/hr boiler and related equipment. (2017)
*	Transformer (2018)

* Alternative 1 to 6
** Alternative 4 and 5
*** Alternative 6
**** Alternative 4to 6

Table 21. Alternative 1 LCC summary. (Two new gas/oil boilers)

Initial investment costs	$3,787
Energy costs:	
Electricity	$43,213
Natural gas	$30,341
Total energy costs	$73,554
Recurring maintenance and repair/custodial costs	$12,123
Major repair/replacement costs	$605
LCC of all costs/benefits (net PW)	$90,069

Table 22. Alternative 1, Option 1 LCC summary. (Two new gas/oil boilers, absorption chiller)

Initial investment costs	$3,787
Energy costs:	
Electricity	$38,430
Natural gas	$32,364
Total energy costs	$70,793
Recurring maintenance and repair/custodial costs	$12,123
Major repair/replacement costs	$605
Other O&M costs & monetary benefits	0
Disposal costs/retention value	0
LCC of all costs/benefits (net PW)	$87,308

Table 23. Alternative 2, Option 1 LCC summary.
(One 1.6 MW spark gas engine)

Initial investment costs	$7,129
Energy costs:	
Electricity	$23,798
Natural gas	$42,523
Total energy costs	$66,321
Recurring M&R/custodial costs	$12,764
Major repair/replacement costs	$605
LCC of all costs/benefits (net PW)	$86,820

Table 24. Alternative 2, Option 2 LCC summary.
(Two 1.6 MW spark gas engines)

Initial investment costs	$10,470,000
Energy costs:	
Electricity	$23,798,000
Natural gas	$42,523,000
Total energy costs	$66,321,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$90,161,000

Table 25. Alternative 2, Option 3 LCC summary.
(One 1.1 MW gas turbine)

Initial investment costs	$5,521,000
Energy costs:	
Electricity	$31,013
Natural gas	$37,934
Total energy costs	$68,948,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$87,838,000

Table 26. Alternative 2, Option 4 LCC summary.
(Two 1.1 MW gas turbines)

Initial investment costs	$7,255,000
Energy costs:	
Electricity	$19,302,000
Natural gas	$45,388,000
Total energy costs	$64,689,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$85,313,000

Table 27. Alternative 2, Option 5 LCC summary.
(Three 1.1 MW gas turbines)

Initial investment costs	$8,989,000
Energy costs:	
Electricity	$10,776,000
Natural gas	$52,543,000
Total energy costs	$63,319,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$85,677,000

Table 28. Alternative 2, Option 6 LCC summary.
(One 3.5 MW gas turbine)

Initial investment costs	$6,874,000
Energy costs:	
Electricity	$9,746,000
Natural gas	$50,630,000
Total energy costs	$60,376,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$80,619,000

Table 29. Alternative 3, Option 1 LCC summary.
(New boilers, absorption chiller, two gas engines)

Initial investment costs	$11,433,000
Energy costs:	
Electricity	$23,390,000
Natural gas	$51,234,000
Total energy costs	$74,623,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$99,426,000

Table 30. Alternative 3, Option 2 LCC summary.
(New boilers, absorption chiller, turbine generator)

Initial investment costs	$7,713,000
Energy costs:	
Electricity	$7,111,000
Natural gas	$55,999,000
Total energy costs	$63,110,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$84,192,000

Table 31. Alternative 4 LCC summary. (Refurbish existing plant)

Initial investment costs	$2,369,000
Energy costs:	
Electricity	$43,213,000
Natural gas	$30,341,000
Total energy costs	$73,554,000
Recurring M&R/custodial costs	$12,122,000
Major repair/replacement costs	$2,605,000
LCC of all costs/benefits (net PW)	$90,651,000

Table 32. Alternative 5 LCC summary. (Refurbish existing plant, summer boiler, cogeneration)

Initial investment costs	$9,053,000
Energy costs:	
Electricity	$23,798,000
Natural gas	$42,523,000
Total energy costs	$66,321,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$2,605,000
LCC of all costs/benefits (net PW)	$90,743,000

Table 33. Alternative 6 LCC summary. (Refurbish existing plant, two engine generators, absorption chiller)

Initial investment costs	$9,892,000
Energy costs:	
Electricity	$23,390,000
Natural gas	$51,234,000
Total energy costs	$74,623,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$2,605,000
LCC of all costs/benefits (net PW)	$99,885,000

Table 34. LCC summary of alternatives/options.

Alternative		Net PW (Oct 1992) of LCC
#2	Option 6 One 3.5 MW Gas Turbine	$80,619,000
#3	Option 2 One 3.5 MW Gas Turbine Absorption Chiller	$84,192,000
#2	Option 4 Two 1.1 MW Gas Turbines	$85,313,000
#2	Option 5 Three 1.1 MW Gas Turbines	$85,677,000
#2	Option 1 One 1.6 MW Gas Engine	$86,819,880
#1	Option 1 Absorption Chiller	$87,308,000
#2	Option 3 One 1.1 MW Gas Turbine	$87,838,000
#1	New Boilers	$90,069,150
#2	Option 2 Two 1.6 MW Gas Engines	$90,161,280
	Status Quo	**$90,355,060**
#4	Refurbish Plant	$90,650,840
#5	Refurbish Plant Two 1.6 MW Gas Engines	$90,742,870
#3	Option 1 Two 1.6 MW Gas Engines Absorption Chiller	$99,425,980
#6	Refurbish Plant Two 1.6 MW Gas Engines Absorption Chiller	$99,884,690

8 Selected Alternative Description

This section provides more details on Alternative 2, Option 6, the selected alternative, which consists primarily of two new natural gas boilers and a 3.5 MW natural gas turbine-generator with an 18,000 lb/hr heat recovery steam generator.

Description of System

This project requires several plant auxiliary upgrades and wornout equipment demolition to implement its major components. The following list summarizes these changes.

- Remove asbestos from area and equipment related to alternative.
- Remove existing turbine-driven boiler feed pumps and feedwater piping; add motor-driven boiler feed pumps.
- Remove coal and ash silos and associated equipment.
- Remove below-ground and above-ground fuel oil tanks; add new above ground and below-ground fuel oil tanks.
- Remove existing makeup air heater; add makeup air heater.
- Remove existing air receiver; add air receiver.
- Remove existing switch gear; add switch gear.
- Remove existing condensate receiver; add condensate receiver.
- Remove existing expansion tank; add expansion tank.
- Remove existing water storage tank; add water tank.
- Remove existing flash tank; add flash tank.
- Remove existing stack and breeching; add new breeching and steel stacks.

Boilers No. 1 and 2 would be demolished to make room for two new packaged natural gas/No. 2 oil-fired boilers rated at 50,000 lb/hr steam and 125 psig (sized to more efficiently meet steam demands). The failing No. 6 fuel oil system will be replaced by No.2 oil as the backup fuel for the boilers. This will meet air pollution regulations that restrict heavy oil burning. After the new boilers are operational, Boilers No. 3 and 4 would be removed to make room for the cogeneration system.

The cogeneration system suggested is a Solar Turbines Inc. (STI) *Centaur* Type H single-shaft industrial gas turbine-generator and an STI heat recovery steam generator (HRSG). The actual turbine-generator rating is 3.88 MW but has been derated to 3.5 MW to more accurately reflect expected production capacity at local operating conditions. The HRSG will produce a maximum of 18,000 lb/hr at 125 psig when the turbine-generator is operating at 100 percent capacity.

This type of turbine-generator is the world's second most widely distributed industrial gas turbine, with over 2200 in service. An exposed view of the gas turbine-generator is shown in Figure 20. The systems are highly reliable and easy to transport and install. They are less size and weight per capacity than engine-driven systems and are virtually vibration free, allowing for lighter foundations. Figure 21 shows front and side views of the turbine-generator. The HRSG, shown in Figure 22, is a continuous tube-type economizer. Figure 23 shows a rough layout of the boiler room, which is approximately 180 feet by 80 feet. The new gas turbine-generator and HRSG will be located in the general area where Boilers No. 3 and 4 were located.

In addition to normal equipment maintenance the plant will require replacement of wornout equipment after implementation of the project. These items are shown in Table 35. The year of replacement is estimated based on typical expected component life. Actual replacement times will vary depending on equipment maintenance and operating conditions.

Description of Operation

This project will alter the amount and type of energy used by the installation. The gas turbine-generator will increase the consumption of natural gas while decreasing the amount of electricity purchased. Although energy consumption on a Btu basis will increase, energy costs will drop significantly because natural gas is $3.4/MBtu compared to electricity at $26/MBtu. Cogeneration decreases electric costs by reducing both energy consumption and peak demands. The HRSG will also offset boiler fuel requirements.

Figures 24 and 25 show the electric demand for a typical weekend day in the winter and the summer, respectively. These two figures show that the 3.5 MW generating capacity of the turbine-generator will provide essentially all weekend electrical needs for the entire year.

Reducing the peak demand during workdays is a significant part of reducing electric costs. Besides reducing summer costs, the summer peak reduction also reduces winter demand charges because those charges are set at 80 percent of the summer demand.

Figures 26 and 27 show typical peak demands for winter and summer workdays, respectively. During the on-peak hours of 8 a.m. to 8 p.m., 3.5 MW will be removed from the demand peak for summer workdays and about 2 MW for winter workdays.

The same conclusions can be drawn from Figures 28 and 29, which are representative load duration curves for winter and summer months, respectively. Figure 28 shows that the turbine-generator alone will be able to meet DPSC's electricity needs for about 550 hours a month or 73 percent of the time during the heating season. Figure 29 shows the turbine-generator can meet electrical needs for about 150 hours (20 percent) during the cooling season. On an annual basis, the turbine-generator will produce about 75 percent of all the electricity needed and reduce the peak electrical demand by about 50 percent.

DPSC requires about 232 million pounds of steam per year. The HRSG will produce about 109 million pounds per year or 47 percent of the required steam. Figure 30 shows the expected monthly steam output of the boilers and the HRSG. The boilers should not have to operate during the months of June through September.

The estimated annual energy use for natural gas and electricity for both the status quo and the selected alternative are summarized in Table 36. The project uses significantly more natural gas than the status quo because of the gas turbine-generator. The effect of cogenerating is reflected in the much smaller amount of purchased electricity and the lower peak demand for the project.

Description of Costs

The LCC analysis for this project and the status quo were revised to reflect current natural gas prices and the electric rate structure. The natural gas cost dropped from \$4.95/MCF to \$3.41/MCF, which improved the economics of using natural gas for cogeneration. The new net present worth is \$64,868,000 instead of \$80,619,000. Table 37 shows the LCC summary for the selected alternative. Costs are net present worth (October 1992 basis).

Table 38 shows a detailed breakdown of the initial costs associated with this project. The initial investment costs consist mainly of the purchase and installation of the two packaged gas/oil-fired 50,000 lb/hr boilers and the 3.5 MW gas turbine-generator with 18,000 lb/hr HRSG. The major repairs/replacements over the next 25 years were listed in Table 35.

Operation and maintenance costs also will be affected by the addition of the cogeneration equipment. Maintenance labor costs will increase because another operator/maintenance person will be needed. However, this cost may be offset by cross-training an existing operator to maintain the cogenerating equipment. The general maintenance and supply costs increased about 10 percent over the status quo.

The lower overall energy costs will generate significant savings for DPSC. Figures 31 and 32 show the monthly electric and fuel costs, respectively, for the project versus the status quo. Although fuel costs will rise due to the increase in natural gas consumption by the turbine-generator, the purchased electricity costs will decrease greatly. The total energy costs shown in Figure 33 reflect the monthly energy savings DPSC will achieve. Table 39 summarizes the estimated annual energy costs for the status quo option and the selected alternative. The almost $700,000 increase in fuel costs for the project is offset by the $1,800,000 decrease in electrical costs for an estimated annual energy savings of approximately $1,153,000.

Project Funding Documents

The initial costs for Alternative 2, Option 6 total about $7.1 million. Unless the project is implemented in phases, it will need to be funded as a Military Construction (MILCON) project. However, because of the substantial savings it may be funded through the Energy Conservation Investment Program (ECIP). The ECIP program funding has been increased substantially over the last few years and there is a shortage of good projects, particularly cogeneration projects.

Draft 1391 information for an ECIP project is contained in Appendix I and is in the form required for the 1391 Processor computer program. The ECIP economic analysis was made using the LCCID program. The economics are quite good, showing a first year savings of $1,043,012; total net discounted savings of $13,607,660; discounted SIR of 1:98; and simple payback of 6.59 years.

Appendix I also contains Draft Project Development Brochure checklists (DA Form 5024).

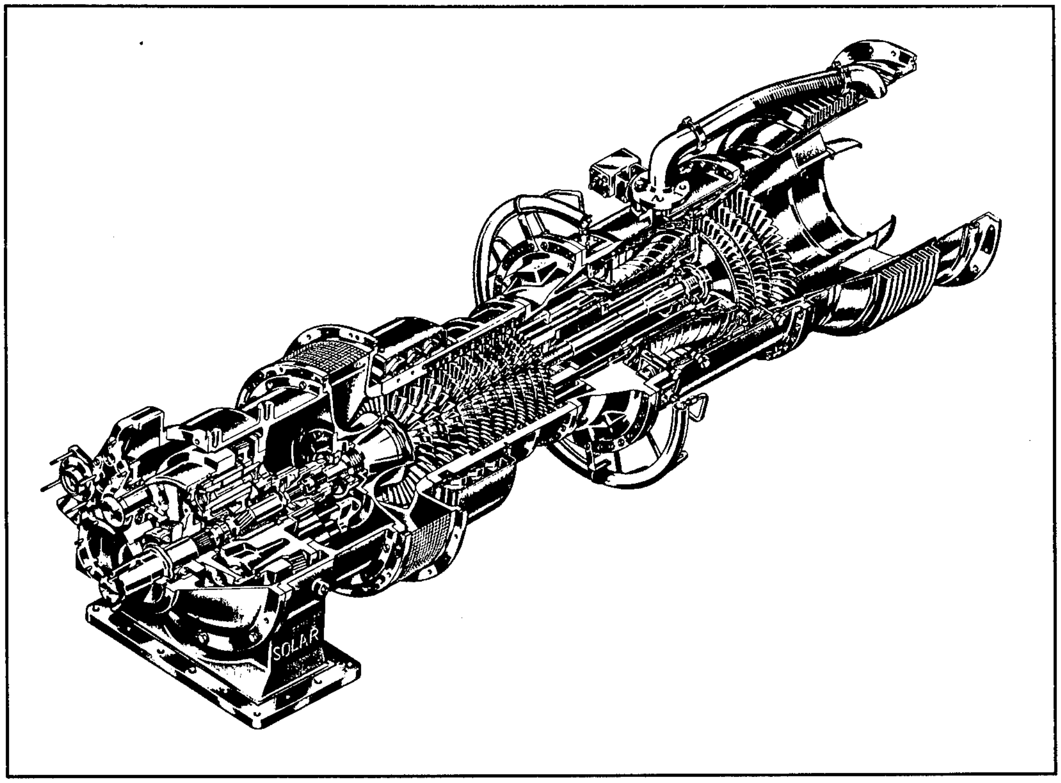


Figure 20. Solar *Centaur* Type H gas turbine.

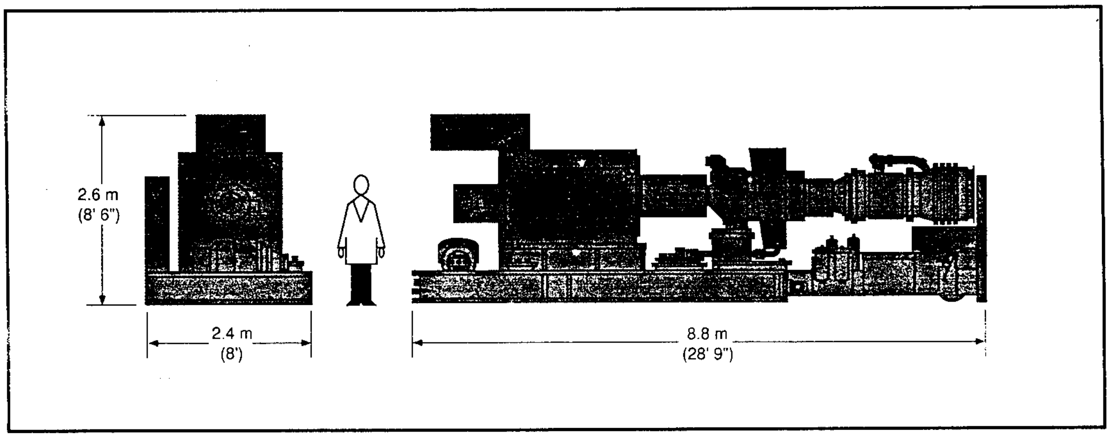


Figure 21. Orthographic of gas turbine.

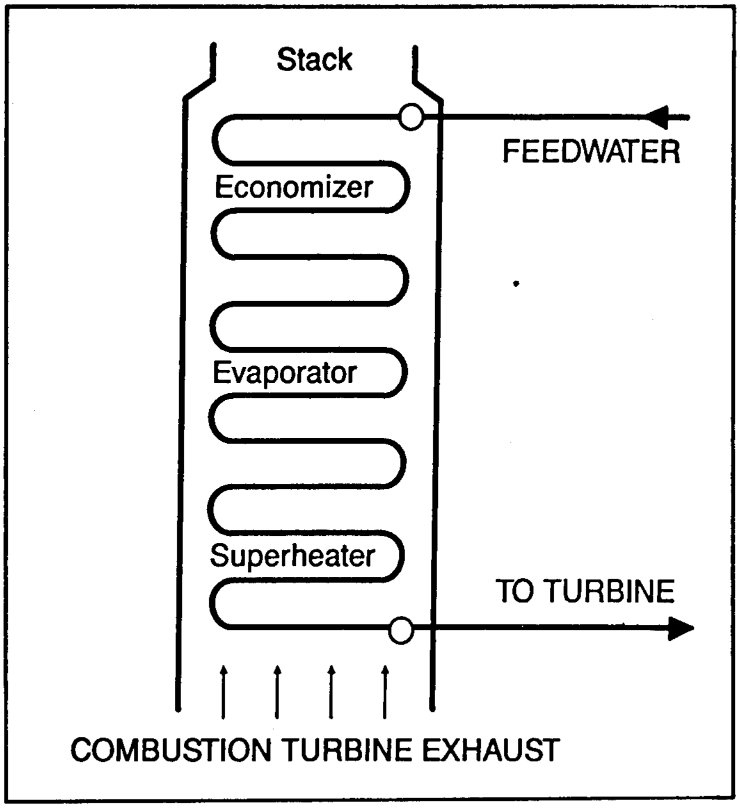


Figure 22. Heat recovery steam generator (HRSG).

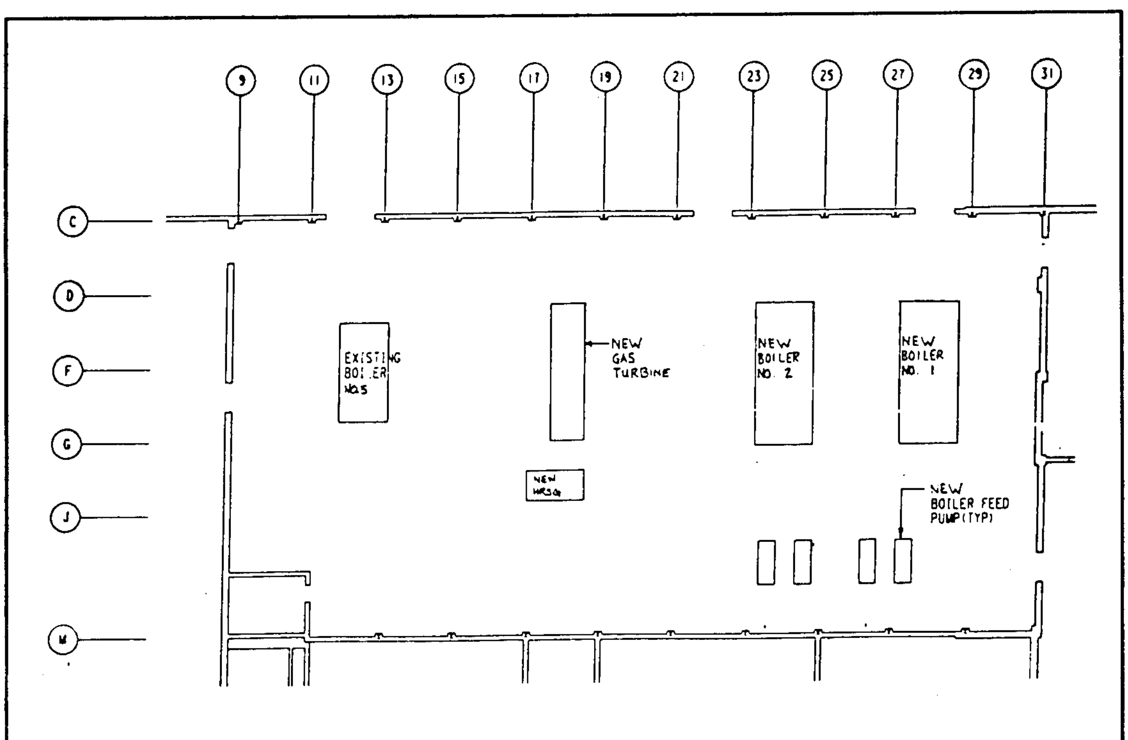


Figure 23. CHP boiler room layout.

Table 35. Plant upkeep after initial construction.

Equipment To Be Replaced	Year of Replacement
Fuel oil unloading pump	2004
Fuel oil piping below grade	2006
Air compressor center	2007
Emergency generator	2008
Revalve	2008, 2009, 2010
Water softener system	2009
Heat exchanger	2010
Condensate pump	2011
Simplex pumps	2012
Steel tank	2012
Space heaters for building heat	2016
Boiler No. 5 and related equipment	2017
Transformer	2018

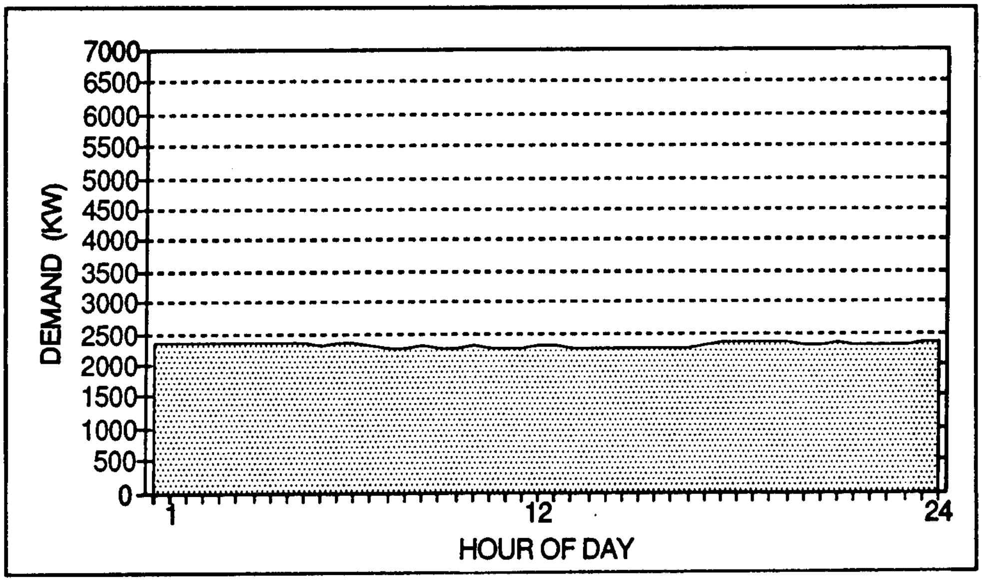


Figure 24. Winter weekend demand.

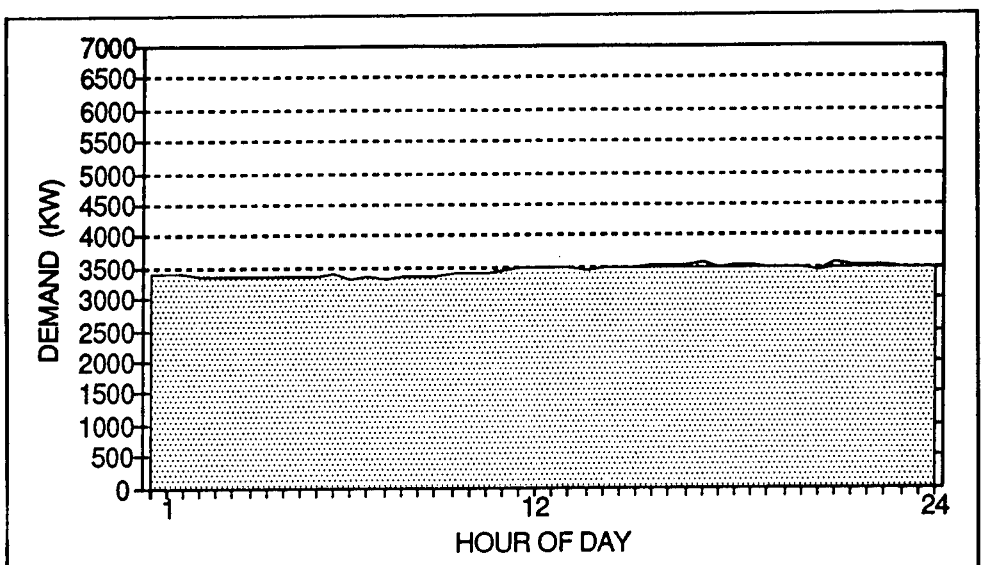


Figure 25. Summer weekend demand.

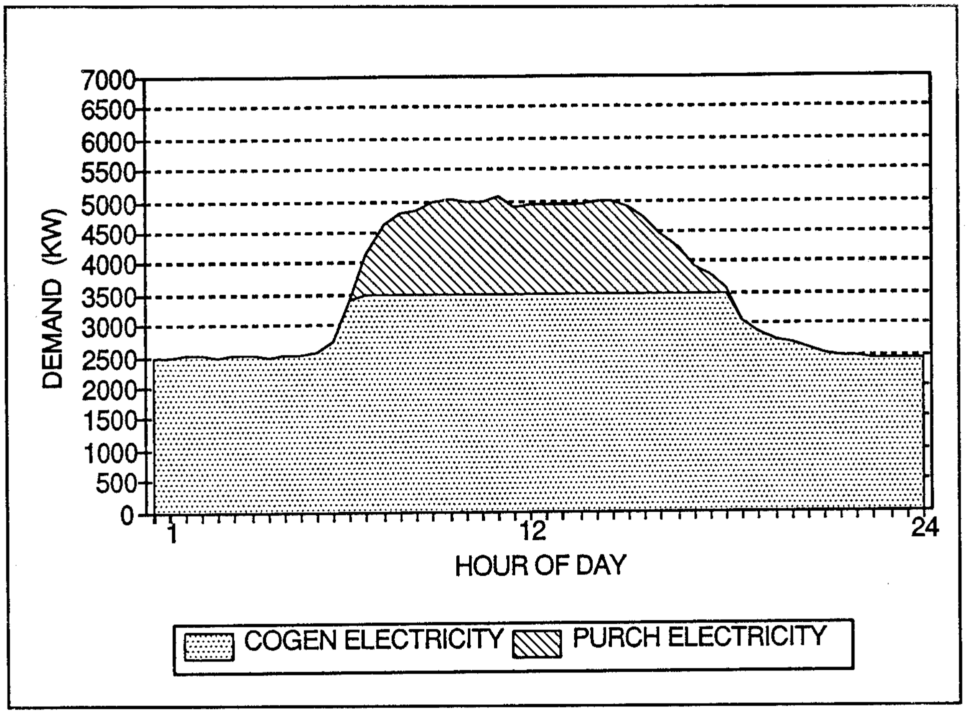


Figure 26. Winter weekday demand.

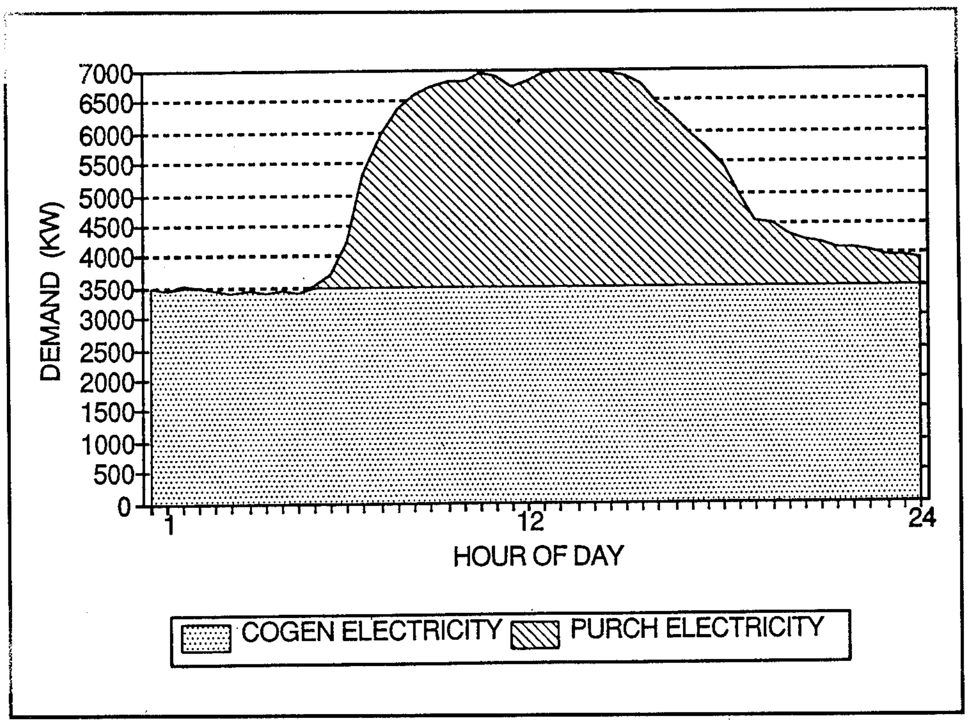


Figure 27. Summer weekday demand.

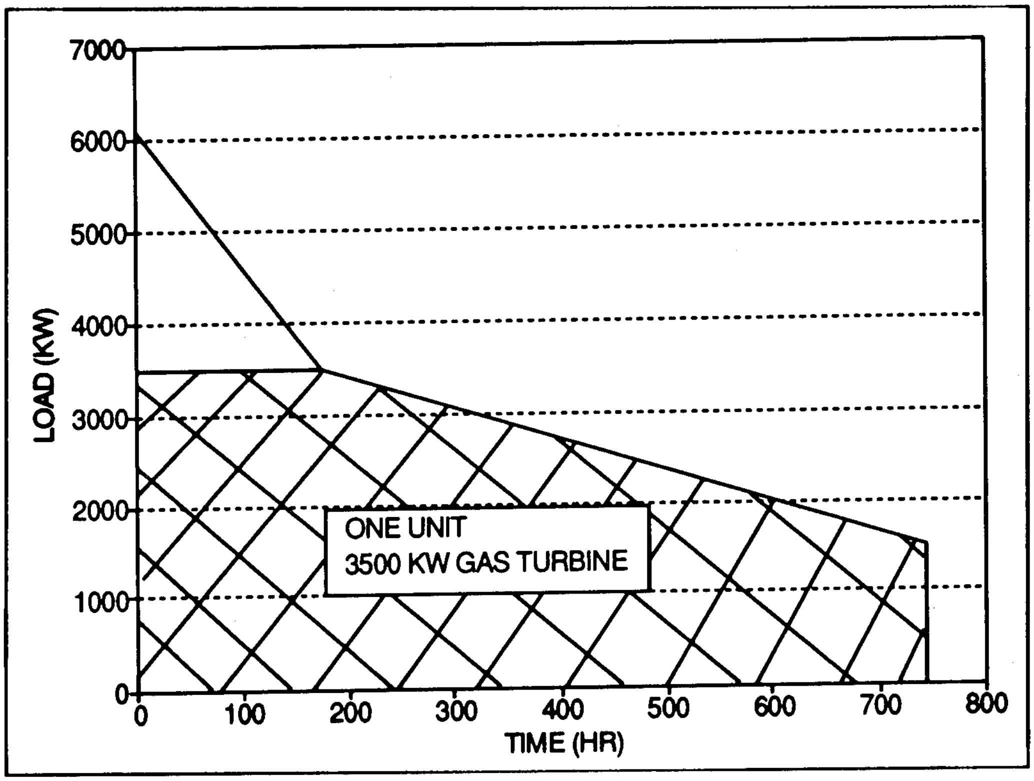


Figure 28. Winter load duration curve.

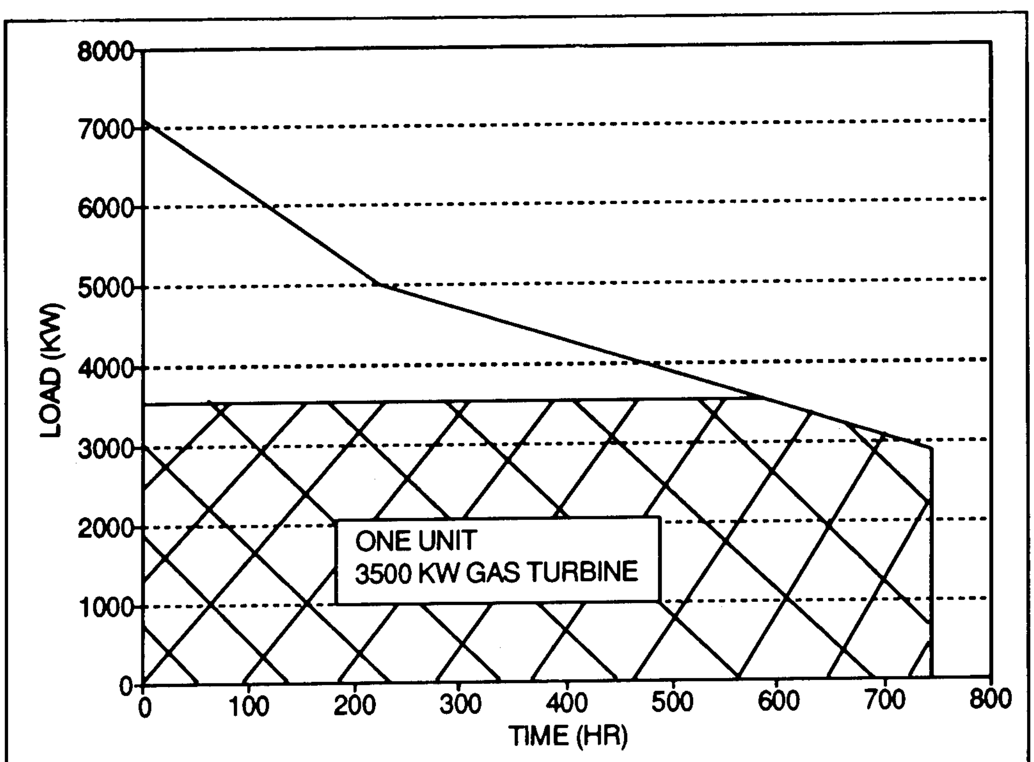


Figure 29. Summer load duration curve.

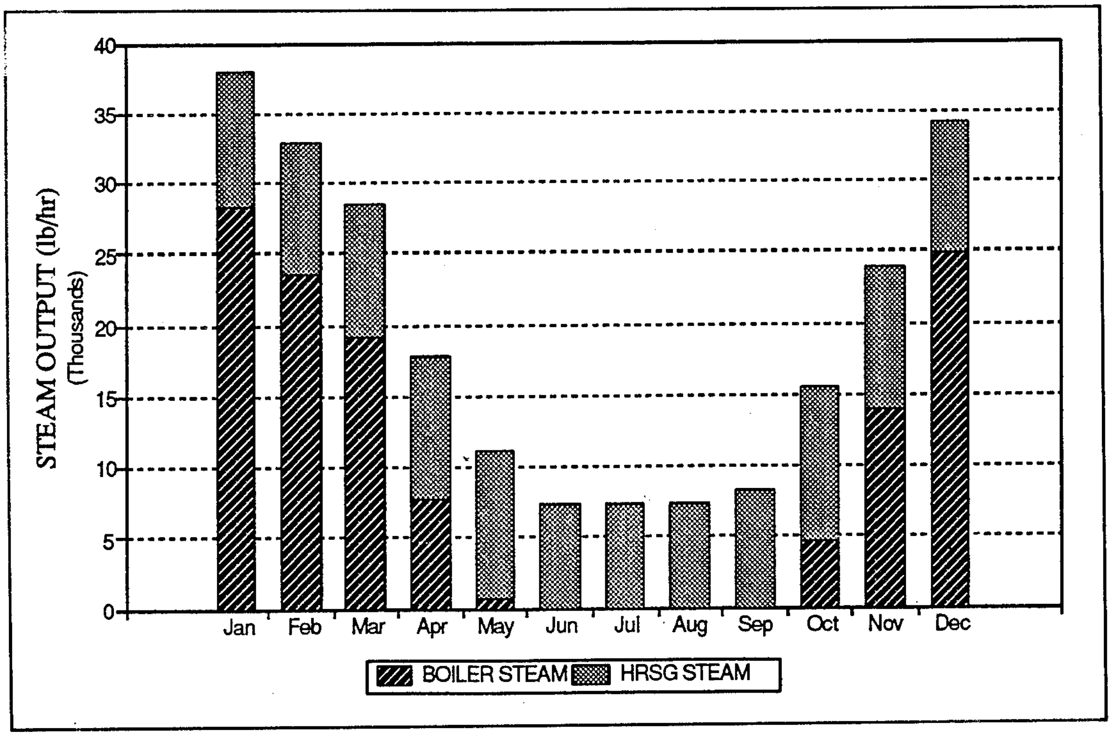


Figure 30. Monthly steam supply.

Table 36. Estimated annual energy use.

Natural Gas	**Status Quo**	**Alt 2-6**
Boiler, MSCF	290.7	153.9
Turbine, MSCF	-----	331.1
Total, MSCF	290.7	484.0
Electric		
Peak Demand, kW	7.3	3.1
Purchase, GWh *	31.7	7.2
Generated, GWh *	-----	26.5

* GWh = million kWh

Table 37. Alternative 2, Option 6 LCC summary. (One 3.5 MW gas turbine)

Initial investment costs	$6,874,000
Energy costs:	
Electricity	$9,746,000
Natural gas	$34,879,000
Total energy costs	$44,625,000
Recurring M&R/custodial costs	$12,764,000
Major repair/replacement costs	$605,000
LCC of all costs/benefits (net PW)	$64,868,000

Table 38. Estimated annual energy costs.

	Status Quo	Alt 2-6
Natural Gas		
Boiler	$991,000	$525,000
Turbine	-----	$1,129,000
Total fuel	$991,000	$1,654,000
Electric		
Demand charge	$771,000	$397,000
Use charge	$2,024,000	$582,000
Total electric	$2,795,000	$979,000
Total energy cost	**$3,786,000**	**$2,633,000**

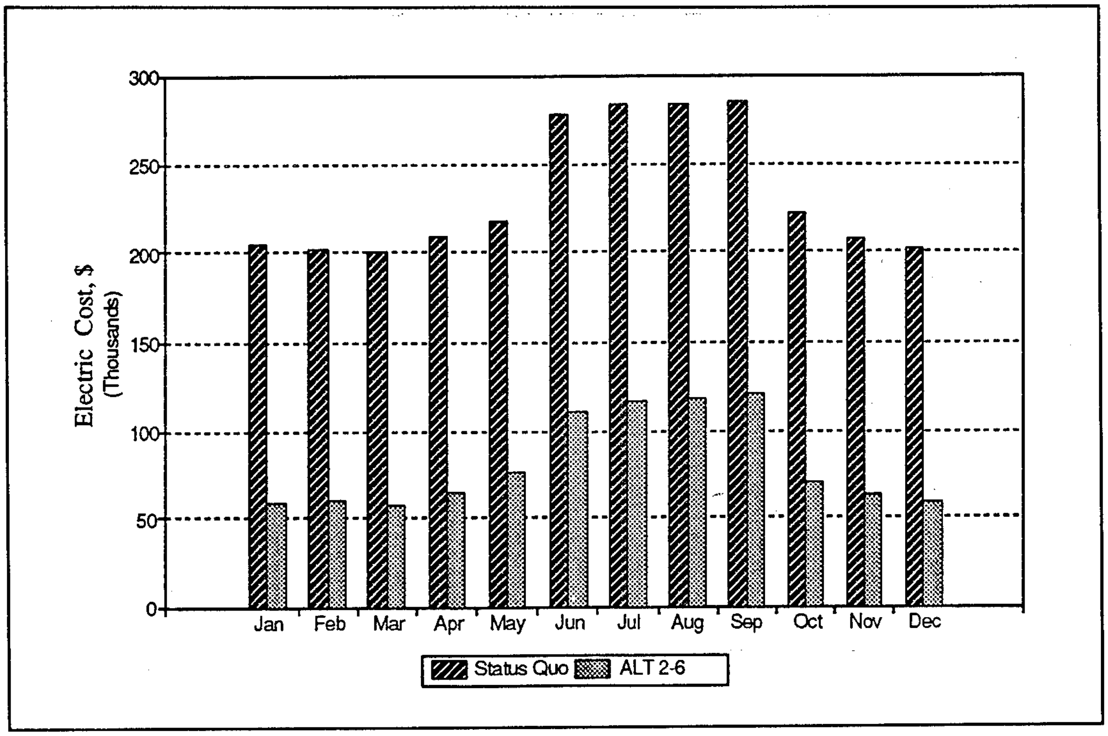


Figure 31. Status quo vs. Alternative 2, Option 6 electrical costs.

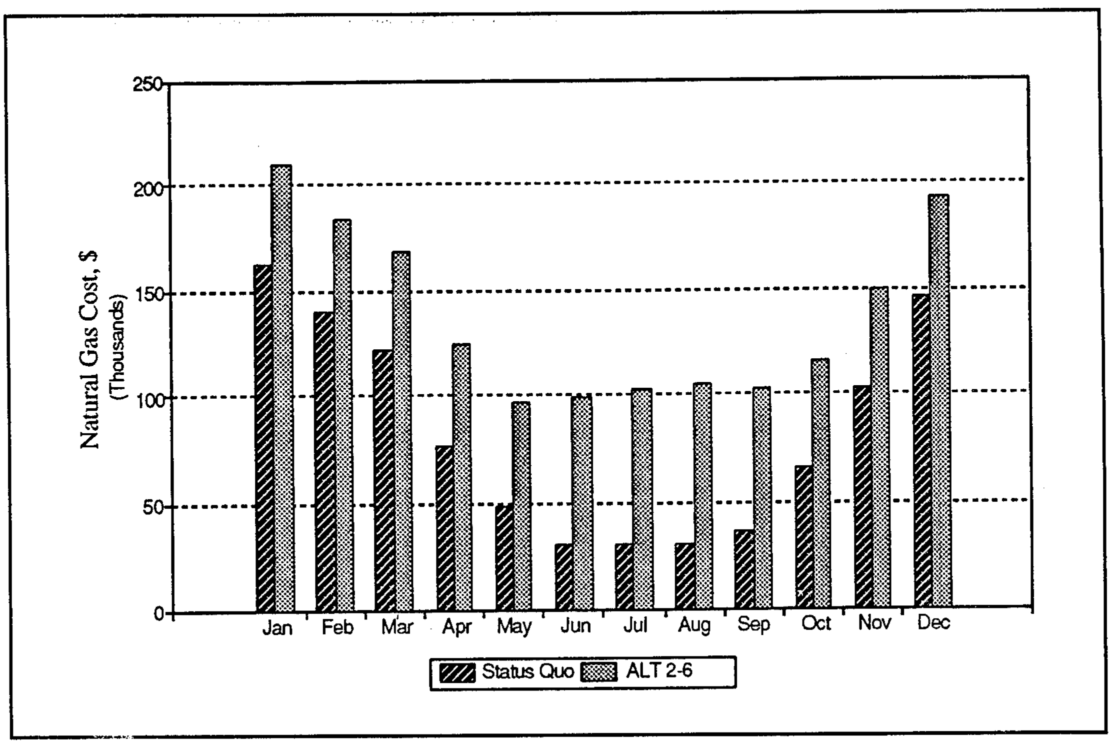


Figure 32. Status quo vs. Alternative 2, Option 6 fuel costs.

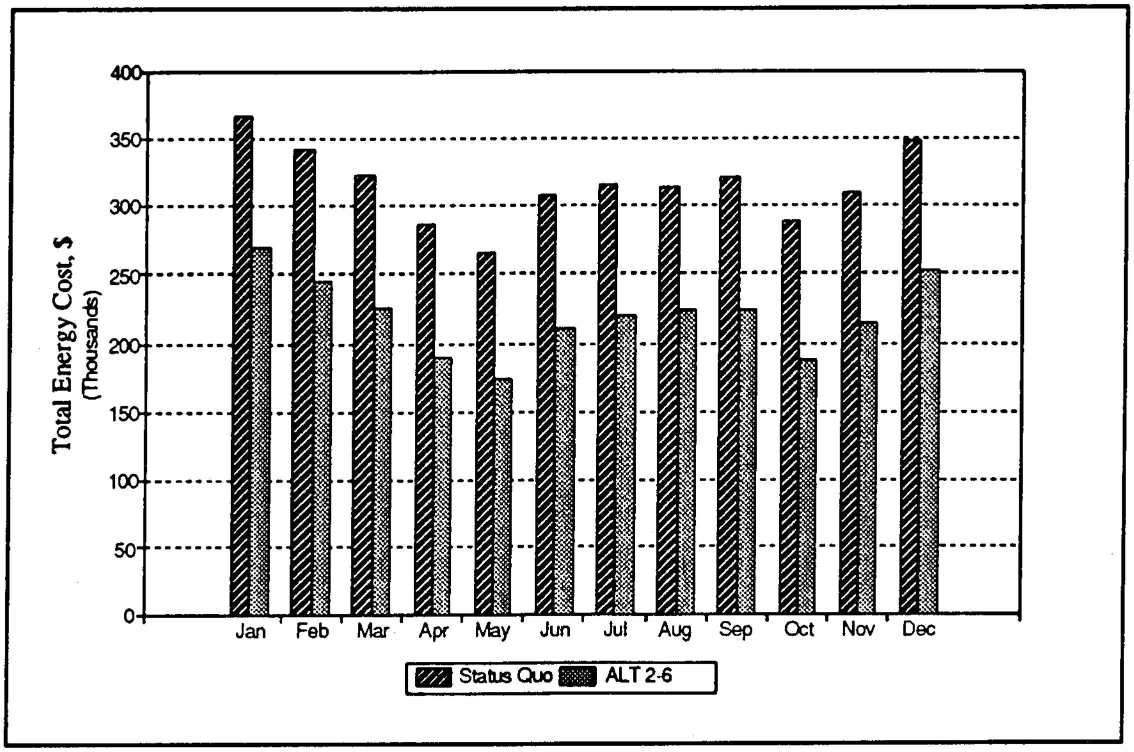


Figure 33. Status quo vs. Alternative 2, Option 6 total energy costs.

ITEM DESCRIPTION	QUANTITY NO. UNITS	UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	TOTAL
(OPTION 6) ALTERNATIVE # 2 – ONE 3500 KW GAS TURBINE				
DEMOLITION				
BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
PIPING	—	LS	—	$5,000
ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
ASBESTOS ABATEMENT	—	LS	—	$500,000
NEW CONSTRUCTION				
REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
ECONOMIZERS	2	EA	$25,000.00	$50,000
BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
CONDUIT AND CABLE	—	LS	—	$75,000
MOTOR CONTROL CENTER	—	LS	—	$40,000
MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
GAS TURBINE, GENERATOR AND INSTALLATION	—	LS	—	$1,800,000
WATER INJECTION	1	EA	$122,725.00	$122,725
HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	1	EA	$300,000.00	$300,000
AIR HEATER	1	EA	$5,463.00	$5,463
AIR RECEIVER	1	EA	$382.00	$382
SWITCH GEAR	1	EA	$75,969.00	$75,969
CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
EXPANSION TANK	1	EA	$19,444.00	$19,444
WATER STORAGE TANK	1	EA	$17,595.00	$17,595
ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
BELOW GROUND TANK	1	EA	$108,375.00	$108,375
FLASH TANK	1	EA	$1,706.00	$1,706
SUBTOTAL				$4,949,801
UNDEVELOPED DESIGN DETAILS				$742,470
OVERHEAD				$853,841
PROFIT				$569,227
TOTAL				$7,115,339
PROBABLE COST USE				$7,115,000

Figure 34. Initial project capital investments.

9 Conclusions

This study evaluated six primary alternatives: (1) new boilers, (2) new boilers with absorption chilling, (3) new boilers with cogeneration, (4) refurbish plant, (5) refurbish plant with absorption chiller, and (6) refurbish plant with cogeneration. Various options within these alternatives were also analyzed. A baseline or status quo option was developed, using the Status Quo model, for comparison of the alternatives to the existing situation. Life cycle cost (LCC) analyses were performed using the Life Cycle Cost in Design (LCCID) program.

Air quality regulations are the most significant environmental regulations that affected the analysis of alternatives for this study. The Philadelphia area has been designated as nonattainment for ozone (O_3), carbon monoxide (CO), and total suspended particulate (TSP). Virtually all of the Philadelphia Consolidated Metropolitan Statistical Area (CMSA), which includes Pennsylvania, New Jersey, and Delaware, is designated a *severe* nonattainment area for O_3. Air quality regulations essentially limit the combustion fuel for DPSC to natural gas. However, because of the severe nonattainment designation for ozone, DPSC also will be limited to an increase in nitrogen oxide emissions of 25 TPY to avoid RACT regulations that would require costly pollution control equipment.

Based on LCC, Alternative 2, Option 6 (new natural gas boilers and a natural gas turbine-generator with a heat recovery steam generator) is the best selection. The net present worth of this alternative is $64,868,000. On an annual basis the turbine-generator will produce about 75 percent of all the electricity needed and reduce the peak electrical demand by about 50 percent. The HRSG will produce about 109 million pounds per year or 47 percent of the required steam. The almost $700,000 increase in fuel costs for Alternative 2-6 is offset by the $1,800,000 decrease in electrical costs for an estimated annual energy savings of approximately $1,153,000.

The initial costs for Alternative 2-6 total about $7.1 million. Unless the project is implemented in phases, it will need to be funded as a MILCON project. However, because of the substantial savings, it may be funded through ECIP. The ECIP program funding has been increased substantially over the last few years and there is a shortage of good projects, particularly cogeneration projects. The ECIP economic analysis for Alternative 2-6 is quite good, showing a first year savings of $1,043,012;

total net discounted savings of $13,607,660; discounted SIR of 1:98; and simple payback of 6.59 years.

Alternative 3, Option 2 was quite close to the best alternative and could be improved with a smaller absorption chiller. A 1200-ton chiller had been assumed that required a boiler to be operated to meet the chiller's energy requirements. A smaller turbine sized at about 550 ton-hr would require only the excess steam from the turbine, which is essentially free energy. If Alternative 2, Option 6 is implemented and a smaller electrically driven chiller is due for replacement, it would be economical to replace it with an absorption unit.

Another improvement may be a storage cooling system (SCS) to further reduce peak electrical demands. A preliminary feasibility analysis was made using the storage feasibility model (STOFEAS). The model shows potential for an SCS; however, a more detailed study is needed to determine if an SCS is economically feasible. The addition of a small SCS would not adversely affect Alternative 2-6.

Appendix A: Description of Buildings and Their Uses

BUILDING #	DESCRIPTION OF SPACE	TYPE OF SPACE	CAC
M-1-A	Corps of Engineer's Off. Area (FE)	Administrative	93166.3000
M-1	Warehouse	Storage	93164
M-2-C	FE Maintenance Shops	Maint & Prod	93162
M-2-D	Warehouse	Storage	93164
M-3-A	Post Exchange	Community Facility	93168
M-3-I	Union Office, AFGE	Administrative	93166
M-3	Warehouse	Storage	93164
M-4-AA	Box Shop	Maint & Prod	93162
M-4	Driver Training Classroom	Training	93161
M-4	Warehouse	Storage	93164
M-5-B	Weatherometer Room	R, D, T & E	93163
M-5	Warehouse	Storage	93164
6-1-A	Ballistics Range	R, D, T & E	93163
6-1-A	Mail & Distribution	Administrative	93166
6-1-A	Records Holding Area	Administrative	93166
6-1-A	Contract Distribution	Administrative	93166
6-1-A&B	Warehouse	Storage	93164
6-1-C	OMD Warehouse	Storage	93164
6-1-C	OMD Office Area	Administrative	93166
6-1-C	Quality Assurance Training Lab	Training	93161
6-1-D	DOD Asst. Insp. General for Invest.	Administrative	93166
6-1-D	Department of Agriculture	Administrative	93166
6-1-D	US General Accounting Office	Administrative	93166
6-1-D	Medical Lab	R, D, T & E	93163
6-1-D	Environmental Rooms	R, D, T & E	93163
6-1-E	Ofc of Safety & Health (Under Command)	Administrative	93166
6-1-E	DOD Deputy Asst. Insp. Gen'l for Inspections	Administrative	93166
6-1-E	Dispensary	Hospital & Medical	93165
6-1-E	Machine Shop	R, D, T & E	93163
6-1-E	Medical Laboratory	R, D, T & E	93163

BUILDING #	DESCRIPTION OF SPACE	TYPE OF SPACE	CAC
6-2-A	Internal Review Ofc (Under Command)	Administrative	93166
6-2-A&B	Office of Comptroller	Administrative	93166
6-2-A&B	Office of Plans & Policy	Administrative	93166
6-2-B&C	US Army Support Activity	Administrative	93166
6-2-B,C&D	DCASR	Administrative	93166
6-2-E	DCASMA	Administrative	93166
8-1	Boiler Plant	Other Buildings	93169
8-1	Facilities Engr Shops	Maint & Prod	93162
8-1	Facilities Engr Div Office	Administrative	93166
8-2	Defense Career Intern Trng Center	Training	93161
8-3	Training Tower	Training	93161
8-4	Guesthouse	Community Facility	93168
8-5	Medals Assembly	Maint & Prod	93162
8-2	Warehouse (DCASR Storage Area)	Storage	93164
9-1-A&B	Directorate/Mfg·Sponging Plant	Maint & Prod	93162.3000
9-1-C&D	Warehouse Area	Storage	93164
9-1-E	Dir/Med Mat'l (Small Ofc Area)	Administrative	93166
9-1-E/F	Office of Telecom & Info Systems	Administrative	93166
9-2-A&B	Directorate of Manufacturing	Maint & Prod	93162
9-2-B,C&D	DSAC-W	Administrative	93166
9-2-E&F	Directorate of Subsistence	Administrative	93166
9-3-A&B	Directorate of Manufacturing	Maint & Prod	93162
9-3-C&D	Warehouse Area	Storage	93164
9-3-E	Directorate of Subsistence	Administrative	93166
9-3&4-F	Directorate of Medical Materiel	Administrative	93166
9-4-A&B	Directorate of Manufacturing	Maint & Prod	93162
9-4-C&D	Warehouse Area	Storage	93164
9-4-E	Ofc of Transportation & Traffic Mgmt	Administrative	93166
9-4-E	Directorate of Med Mat'l (Small Ofc)	Administrative	93166
11-Garage	OCP Veterans Coordinator	Administrative	93166
11-1&2	Security	Administrative	93166

BUILDING #	DESCRIPTION OF SPACE	TYPE OF SPACE	CAC
12-LL-B	Print Shop	Maint & Prod	93162
12-LL-D	Audiovisual	Maint & Prod	93162
12-LL-D	Library	Administrative	93166
12-LL	Administrative Services Division	Administrative	93166
12-1-A,B&C	Office of Civilian Personnel	Administrative	93166
12-1-D	Admin Management	Administrative	93166
12-1-D	Directorate of Instl Svcs	Administrative	93166
12-1-D	Forms Management	Administrative	93166
12-1-D	Travel Authorization	Administrative	93166
12-1-D	Records Management	Administrative	93166
12-1-D	Freedom of Info Act	Administrative	93166
12-1-D	Base Procurement	Administrative	93166
12 Room 113	Installation Contracts	Administrative	93166
12-1-E	Small Business Office	Administrative	93166
12-1-E	Equal Employment Opportunity Ofc	Administrative	93166
12 Room 109	Public Affairs Office	Administrative	93166
12-1-F	Office of Contracting	Administrative	93166
12-1-G	Office of Counsel	Administrative	93166
12-1-H	Office of Command	Administrative	93166
12-2-A - H	Directorate of Clothing & Textiles	Administrative	93166
12-2 Rm 216	US Army Natick R & D Center	Administrative	93166
12-2 Rm 201	US Navy C&T Research Facility	Administrative	93166
12-2-H	US Coast Guard Liaison Ofc	Administrative	93166
12-3-A - H	Directorate of Clothing & Textiles	Administrative	93166
12-3-D	Air Force C&T Office	Administrative	93166
12-3 Rms 315 & 318	Air Force C&T Office	Administrative	93166
12-3-F	US Marine Corps	Administrative	93166
12-Roof-E&W	Penthouses	Community Facility	93168
12	Warehouse Area	Storage	93164
13	Directorate of Manufacturing	Maint & Production	93162.3000
14	Restaurant	Community Facility	93410
	Credit Union	Community Facility	93168
	Office Areas	Administrative	93166

BUILDING #	DESCRIPTION OF SPACE	TYPE OF SPACE	CAC
14	Officer's Open Mess	Community Facility	93410
	Auditorium	Community Facility	93168
	Bowling Alley	Community Facility	93410
	Barber Shop	Community Facility	93410
	General Storehouse	Storage	93410
15	Clothing & Textile Lab	R, D, T & E	93163
16	Nonmetallic Material Facility	R, D, T & E	93163
17	Scale House	Other Buildings	93169
18	Pump Station	Other Buildings	93169
20-A	Recreation Center	Community Facility	93410
20-B - G	US Treasury Dept. (US Mint Whse)	Storage	93164
22	FE Maintenance Shop	Maint & Prod	93162
26	Warehouse Area	Storage	93164
26	Office Area	Administrative	93166
26-A	Fort George G. Meade	Maint & Prod	93162
26-B	Electronics Shop (Weapons Maint)	Maint & Prod	93162
26-C	Defense Reutilization & Market. Ofc	Storage	93164
28	Gas Station	Other Buildings	93169
29	Flag Pole	Other Structures	93172
30	Fort George G. Meade	Maint & Prod	93162
31,32,37,38, 39,40,& 41	Sentry Stations	Other Buildings	93169
34	Flag Pole	Other Structures	93172
35,36,&42	Waiting Shelters	Community Facility	93172
44	Flammable Storage Facility	Storage	93164

BUILDING #	DESCRIPTION OF SPACE	TYPE OF SPACE	CAC
46	Hazardous Material Storage	Storage	93164
49	Switch House	Other Buildings	93169
50	Gas Metering Station		93169
51	FE Maintenance Shop	Maint & Prod	93162
	Asst. Insp. Gen'l for Invest.	Administrative	93166
	Motor Equipment Pool	Maint & Prod	93162
130&134	Underground Fuel-Oil Storage		93172
135&136	Aboveground Fuel-Oil Storage		93172
137,138&139	Footbridges		93169

Appendix B: SHDP Model and Results

SYSTEM VARIABLES AND EXECUTION CONTROLS

FLOW TOLERANCE = 10.00 lbm/hr
UNKNOWN PARAMETER TOLERANCE = .000500
UNKNOWN PRESSURE TOLERANCE = .000050
UNKNOWN NODE FLOW TOLERANCE = 1.000 lbm/hr

PC =	20	1	5	20	1	5	5	0	0	0
UNS =	1	2	2	2	4	3	1	1	2	2

PIPE DESCRIPTION SECTION

NCE NUM	FROM NODE	TO NODE	STATUS	DIAMETER (in)	LENGTH (ft)		RELATIVE ROUGHNESS	HEAT LOSS COEF (Btu/hr-ft-F)	TEMP (F)
1	CHP	8PRS		15.0	50.+	0.	.167E-3	.53	65.0
2	8PRS	8A		5.0	200.+	0.	.500E-3	.27	65.0
3	8A	8		5.0	20.+	0.	.500E-3	.27	65.0
4	8A	2C		4.0	131.+	0.	.625E-3	.27	65.0
5	2C	2		3.0	331.+	0.	.833E-3	.23	65.0
6	8PRS	6C		12.0	238.+	0.	.208E-3	.46	65.0
7	6C	6		12.0	20.+	0.	.208E-3	.46	65.0
8	6C	6D1		8.0	369.+	0.	.312E-3	.42	65.0
9	6D1	3PRS		3.0	56.+	0.	.833E-3	.23	65.0
10	3PRS	3		3.0	194.+	0.	.833E-3	.23	65.0
11	6D1	6D2		8.0	88.+	0.	.312E-3	.42	65.0
12	6D2	15		2.5	300.+	0.	.100E-2	.21	65.0
13	6D2	6E		6.0	181.+	0.	.417E-3	.30	65.0
14	6E	5C		6.0	181.+	0.	.417E-3	.30	65.0
15	5C	5E		8.0	275.+	0.	.312E-3	.42	65.0
16	5E	5		6.0	394.+	0.	.417E-3	.30	65.0
17	6C	6B		14.0	112.+	0.	.179E-3	.48	65.0
18	6B	ROG		8.0	256.+	0.	.312E-3	.42	65.0
19	ROG	12D		5.0	219.+	0.	.500E-3	.27	65.0
20	12D	12B		2.0	237.+	0.	.125E-2	.22	65.0
21	12B	12		2.0	20.+	0.	.125E-2	.22	65.0
22	12B	12A		2.0	237.+	0.	.125E-2	.22	65.0
23	12A	11		2.0	144.+	0.	.125E-2	.22	65.0
24	ROG	HART		8.0	150.+	0.	.312E-3	.42	65.0
25	HART	13A		6.0	56.+	0.	.417E-3	.30	65.0
26	HART	14		6.0	375.+	0.	.417E-3	.30	65.0
27	6B	6AB		12.0	150.+	0.	.208E-3	.46	65.0
28	6AB	6A		10.0	250.+	0.	.250E-3	.49	65.0
29	6A	9D		8.0	200.+	0.	.312E-3	.42	65.0
30	9D	9C		6.0	294.+	0.	.417E-3	.30	65.0
31	9C	9W		6.0	20.+	0.	.417E-3	.30	65.0
32	9C	13C		6.0	350.+	0.	.417E-3	.30	65.0
33	9D	9E		6.0	250.+	0.	.417E-3	.30	65.0
34	9E	9O		6.0	20.+	0.	.417E-3	.30	65.0
35	9E	30A		4.0	356.+	0.	.625E-3	.27	65.0
36	30A	30		1.5	275.+	0.	.167E-2	.16	65.0
37	6AB	1A		8.0	188.+	0.	.312E-3	.42	65.0
38	1A	RR		10.0	62.+	0.	.250E-3	.49	65.0
39	RR	4PRS		6.0	69.+	0.	.417E-3	.30	65.0
40	4PRS	4C		10.0	381.+	0.	.250E-3	.49	65.0
41	4C	4D		9.0	162.+	0.	.278E-3	.42	65.0

(1)

PIPE DESCRIPTION SECTION

NCE NUM	FROM NODE	TO NODE	STATUS	DIAMETER (in)	LENGTH (ft)	RELATIVE ROUGHNESS	HEAT LOSS COEF (Btu/hr-ft-F)	TEMP (F)
42	4D	4E		8.0	175.+ 0.	.312E-3	.42	65.0
43	4E	4F		7.0	150.+ 0.	.357E-3	.30	65.0
44	4F	4G		6.0	162.+ 0.	.417E-3	.30	65.0
45	4G	4H		6.0	188.+ 0.	.417E-3	.30	65.0
46	4H	4		4.0	125.+ 0.	.625E-3	.27	65.0
47	4G	BASH		4.0	294.+ 0.	.625E-3	.27	65.0
48	BASH	22		3.0	150.+ 0.	.833E-3	.23	65.0
49	BASH	51		4.0	219.+ 0.	.625E-3	.27	65.0
50	1A	1C		10.0	550.+ 0.	.250E-3	.49	65.0
51	1C	1D		9.0	150.+ 0.	.278E-3	.42	65.0
52	1D	1E		8.0	150.+ 0.	.312E-3	.42	65.0
53	1E	1F		7.0	175.+ 0.	.357E-3	.30	65.0
54	1F	1F1		6.0	63.+ 0.	.417E-3	.30	65.0
55	1F1	1L1		1.5	150.+ 0.	.167E-2	.16	65.0
56	1F	1F2		6.0	75.+ 0.	.417E-3	.30	65.0
57	1F2	1L2		4.0	450.+ 0.	.625E-3	.27	65.0
58	1F2	1F3		3.0	25.+ 0.	.833E-3	.23	65.0
59	1F3	1L3		2.5	125.+ 0.	.100E-2	.21	65.0
60	RR	2F		10.0	975.+ 0.	.250E-3	.49	65.0
61	2F	ALE		10.0	420.+ 0.	.250E-3	.49	65.0
62	ALE	ALE1		6.0	175.+ 0.	.417E-3	.30	65.0
63	ALE1	20D		5.0	275.+ 0.	.500E-3	.27	65.0
64	20D	20W		5.0	288.+ 0.	.500E-3	.27	65.0
65	20D	20M		5.0	375.+ 0.	.500E-3	.27	65.0
66	ALE1	26C		4.0	312.+ 0.	.625E-3	.27	65.0
67	26C	26		4.0	387.+ 0.	.625E-3	.27	65.0

REGULATOR AND VALVE DESCRIPTION SECTION

NCE NUM	FROM NODE	TO NODE	STATUS	SIZING COEFFICIENT	CONFIGURATION CONSTANT	MINIMUM PRESSURE DROP

NO REGULATORS OR VALVES IN SYSTEM

TRAP INPUT DATA

NO FAULTY TRAPS

VAULT INPUT DATA

VAULT NUMBER	NODE NAME	MAIN PIPE DIAMETER (in)	MAIN PIPE LENGTH (ft)	HEAT TRANSFER COEFFICIENT (Btu/hr-ft-F)	ENVIROMENT TEMPERATURE (F)

NODE INPUT DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	NODE FLOW RETURNED	PIPE CONDS RETURNED	LOAD CONDS TEMPERATURE
CHP	180.00	20000.?	.90	.90	150.0
8PRS	180.00?	0.	.90	.90	150.0
8A	5.00?	0.	.90	.90	150.0
8	5.00?	-232.	.90	.90	150.0
2C	5.00?	0.	.90	.90	150.0
2	5.00?	-82.	.90	.90	150.0
6C	180.00?	0.	.90	.90	150.0
6	180.00?	-903.	.90	.90	150.0
6D1	180.00?	0.	.90	.90	150.0
3PRS	5.00?	0.	.90	.90	150.0
3	5.00?	-72.	.90	.90	150.0
6D2	180.00?	0.	.90	.90	150.0
15	180.00?	-99.	.90	.90	150.0
6E	180.00?	0.	.90	.90	150.0
5C	180.00?	0.	.90	.90	150.0
5E	6.50?	0.	.90	.90	150.0
5	6.50?	0.	.90	.90	150.0
6B	180.00?	0.	.90	.90	150.0
ROG	180.00?	0.	.90	.90	150.0
12D	180.00?	0.	.90	.90	150.0
12B	45.00?	0.	.90	.90	150.0
12	45.00?	-517.	.90	.90	150.0
12A	45.00?	0.	.90	.90	150.0
11	45.00?	-24.	.90	.90	150.0
HART	180.00?	0.	.90	.90	150.0
13A	180.00?	-589.	.90	.90	150.0
14	180.00?	-532.	.90	.90	150.0
6AB	180.00?	0.	.90	.90	150.0
6A	180.00?	0.	.90	.90	150.0
9D	180.00?	0.	.90	.90	150.0
9C	180.00?	0.	.90	.90	150.0
9W	180.00?	-718.	.90	.90	150.0
13C	180.00?	-589.	.90	.90	150.0
9E	180.00?	0.	.90	.90	150.0
9O	180.00?	-690.	.90	.90	150.0
30A	180.00?	0.	.90	.90	150.0
30	180.00?	-227.	.90	.90	150.0
1A	180.00?	0.	.90	.90	150.0
RR	180.00?	0.	.90	.90	150.0
4PRS	180.00?	0.	.90	.90	150.0
4C	10.00?	0.	.90	.90	150.0
4D	10.00?	0.	.90	.90	150.0
4E	10.00?	0.	.90	.90	150.0
4F	10.00?	0.	.90	.90	150.0
4G	10.00?	0.	.90	.90	150.0
4H	10.00?	0.	.90	.90	150.0
4	10.00?	-265.	.90	.90	150.0
BASH	5.00?	0.	.90	.90	150.0
22	5.00?	-10.	.90	.90	150.0
51	5.00?	-13.	.90	.90	150.0

1C	10.00?	0.	.90	.90	150.0
1D	10.00?	0.	.90	.90	150.0
1E	10.00?	0.	.90	.90	150.0
1F	10.00?	0.	.90	.90	150.0

(3)

NODE INPUT DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	NODE FLOW RETURNED	PIPE CONDS RETURNED	LOAD CONDS TEMPERATURE
1F1	10.00?	0.	.90	.90	150.0
1L1	10.00?	-94.	.90	.90	150.0
1F2	10.00?	0.	.90	.90	150.0
1L2	10.00?	-94.	.90	.90	150.0
1F3	10.00?	0.	.90	.90	150.0
1L3	10.00?	-94.	.90	.90	150.0
2F	10.00?	0.	.90	.90	150.0
ALE	10.00?	0.	.90	.90	150.0
ALE1	5.00?	0.	.90	.90	150.0
20D	5.00?	0.	.90	.90	150.0
20W	5.00?	-120.	.90	.90	150.0
20M	5.00?	-102.	.90	.90	150.0
26C	5.00?	0.	.90	.90	150.0
26	5.00?	-96.	.90	.90	150.0

NODE CORRESPONDENCE TABLE AND LIST OF ADJACENT NODES

NODE NUMBER	NODE NAME	ADJACENT NODES(BY NAME)			
1	CHP	8PRS			
2	8PRS	8A	6C	CHP	
3	8A	8	2C	8PRS	
4	8	8A			
5	2C	2	8A		
6	2	2C			
7	6C	6	6D1	6B	8PRS
8	6	6C			
9	6D1	3PRS	6D2	6C	
10	3PRS	3	6D1		
11	3	3PRS			
12	6D2	15	6E	6D1	
13	15	6D2			
14	6E	5C	6D2		
15	5C	5E	6E		
16	5E	5	5C		
17	5	5E			
18	6B	ROG	6AB	6C	
19	ROG	12D	HART	6B	

20	12D	12B	ROG	
21	12B	12	12A	12D
22	12	12B		
23	12A	11	12B	
24	11	12A		
25	HART	13A	14	ROG
26	13A	HART		
27	14	HART		
28	6AB	6A	1A	6B
29	6A	9D	6AB	
30	9D	9C	9E	6A
31	9C	9W	13C	9D
32	9W	9C		

NODE CORRESPONDENCE TABLE AND LIST OF ADJACENT NODES

NODE NUMBER	NODE NAME	ADJACENT NODES(BY NAME)		
33	13C	9C		
34	9E	9O	30A	9D
35	9O	9E		
36	30A	30	9E	
37	30	30A		
38	1A	RR	1C	6AB
39	RR	4PRS	2F	1A
40	4PRS	4C	RR	
41	4C	4D	4PRS	
42	4D	4E	4C	
43	4E	4F	4D	
44	4F	4G	4E	
45	4G	4H	BASH	4F
46	4H	4	4G	
47	4	4H		
48	BASH	22	51	4G
49	22	BASH		
50	51	BASH		
51	1C	1D	1A	
52	1D	1E	1C	
53	1E	1F	1D	
54	1F	1F1	1F2	1E
55	1F1	1L1	1F	
56	1L1	1F1		
57	1F2	1L2	1F3	1F
58	1L2	1F2		
59	1F3	1L3	1F2	
60	1L3	1F3		
61	2F	ALE	RR	
62	ALE	ALE1	2F	
63	ALE1	20D	26C	ALE
64	20D	20W	20M	ALE1
65	20W	20D		
66	20M	20D		
67	26C	26	ALE1	
68	26	26C		

```
***** PROBLEM SUMMARY *****
   68 NODES IN THE SYSTEM
   67 PIPES IN THE SYSTEM
    0 VALVES OR REGULATORS
    0 FAULTY TRAPS
    0 VAULTS IN THE SYSTEM
    0 UNKNOWN PARAMETERS
   67 UNKNOWN PRESSURES
    1 UNKNOWN FLOWS
```

07/15/92 15:43:18
HC

SOLUTION COMPLETED IN 14 ITERATIONS
SOME NODES MAY NOT BE BALANCED

*** PROBLEM SUMMARY ***
68 NODES IN THE SYSTEM
67 PIPES IN THE SYSTEM
0 VALVES OR REGULATORS
0 FAULTY TRAPS
0 VAULTS IN THE SYSTEM
0 UNKNOWN PARAMETERS
67 UNKNOWN PRESSURES
1 UNKNOWN FLOWS

COMPUTED NODE DATA

NODE NAME	PRESSURE (psig)	NODE FLOW (lbm/hr)	CONDS FLOW (lbm/hr)	FLOW LOSS (Btu/hr)	CONDS LOSS (Btu/hr)	TEMP (F)	RESIDUAL (lbm/hr)
CHP	180.00	7979.9?	-4.9	.0	174.2	379.6	-35.68
8PRS	180.00?	.0	-35.4	.0	1249.0	379.6	66.47
8A	180.00?	.0	-17.6	.0	623.1	379.6	-17.16
8	180.00?	-231.9	-1.0	2714.4	35.5	379.6	-6.97
2C	180.00?	.0	-20.8	.0	733.1	379.6	-.33
2	179.99?	-82.3	-14.2	963.3	500.5	379.6	.01
6C	179.99?	.0	-61.0	.0	2152.6	379.6	-62.32
6	179.99?	-903.2	-1.7	10571.8	60.5	379.6	22.20
6D1	179.99?	.0	-38.1	.0	1346.6	379.6	275.19
3PRS	179.99?	.0	-10.7	.0	378.0	379.6	-260.88
3	179.99?	-72.0	-8.3	842.7	293.4	379.6	-.05
6D2	179.99?	.0	-28.7	.0	1014.2	379.6	-13.14
15	179.98?	-98.7	-11.7	1155.3	414.2	379.6	.03
6E	179.99?	.0	-20.2	.0	714.0	379.6	7.02
5C	179.99?	.0	-31.6	.0	1116.4	379.6	1172.59
5E	179.99?	.0	-43.5	.0	1536.5	379.6	-1181.35
5	179.99?	.0	-22.0	.0	777.1	379.6	5.16
6B	179.99?	.0	-42.9	.0	1514.0	379.6	49.02
ROG	179.99?	.0	-42.8	.0	1509.8	379.6	-2.87
12D	179.98?	.0	-20.7	.0	731.0	379.6	.81
12B	179.51?	.0	-20.2	.0	713.1	379.4	-.08
12	179.48?	-516.5	-.8	6045.6	28.9	379.3	.02
12A	179.51?	.0	-15.6	.0	550.3	379.4	.02
1	179.51?	-24.2	-5.9	283.3	208.0	379.4	.03
HART	179.99?	.0	-35.8	.0	1264.3	379.6	-.39
13A	179.99?	-589.3	-3.1	6897.7	110.5	379.6	-.24
14	179.98?	-531.8	-20.9	6224.6	739.6	379.6	.59
6AB	179.99?	.0	-50.4	.0	1778.1	379.6	-23.40
6A	179.99?	.0	-38.5	.0	1357.6	379.6	4.86
9D	179.98?	.0	-46.0	.0	1625.2	379.6	-4.05
9C	179.97?	.0	-37.1	.0	1309.6	379.6	12.50
9W	179.97?	-717.7	-1.1	8400.6	39.4	379.6	-10.45
13C	179.97?	-589.3	-19.6	6897.7	690.3	379.6	-1.03
9E	179.98?	.0	-33.0	.0	1164.4	379.6	6.39
9O	179.98?	-689.7	-1.1	8072.8	39.4	379.6	-5.19
30A	179.97?	.0	-26.1	.0	920.9	379.6	.07
30	179.56?	-227.3	-8.2	2660.5	288.8	379.4	.00
1A	179.99?	.0	-70.5	.0	2490.7	379.6	756.27
RR	179.99?	.0	-98.5	.0	3476.8	379.6	-63.71
4PRS	179.99?	.0	-38.6	.0	1363.5	379.6	1049.99
4C	179.98?	.0	-47.4	.0	1674.7	379.6	-1038.79
4D	179.98?	.0	-26.4	.0	930.6	379.6	-4.13
4E	179.98?	.0	-22.1	.0	779.1	379.6	-2.64
4F	179.98?	.0	-17.4	.0	615.4	379.6	-4.42
4G	179.98?	.0	-34.3	.0	1212.2	379.6	188.43
4H	179.98?	.0	-16.8	.0	592.7	379.6	2.38
4	179.98?	-264.7	-6.3	3098.3	221.9	379.6	-.30
BASH	179.98?	.0	-32.2	.0	1137.5	379.6	-187.43
[illegible]2	179.98?	-10.1	-6.4	118.2	226.8	379.6	-.78

COMPUTED PIPE FLOWS AND PARAMETERS

ROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
CHP	8PRS		8010.6	9.87	8336.1	15.00	1.65E+5	1.71E-2
8PRS	8A		343.3	20.11	16986.7	5.00	2.13E+4	2.24E-2
8A	8		225.9	2.01	1698.7	5.00	1.40E+4	2.93E-2
8A	2C		116.9	13.17	11126.3	4.00	9.05E+3	3.29E-2
2C	2		96.5	28.35	23948.0	3.00	9.96E+3	3.24E-2
8PRS	6C		7565.4	40.77	34438.8	12.00	1.95E+5	1.71E-2
6C	6		927.1	3.43	2894.0	12.00	2.39E+4	2.52E-2
6C	6D1		390.2	57.72	48751.4	8.00	1.51E+4	2.84E-2
6D1	3PRS		-169.9	4.80	4051.6	3.00	1.75E+4	2.45E-2
3PRS	3		80.3	16.62	14035.9	3.00	8.29E+3	3.39E-2
6D1	6D2		246.8	13.76	11626.3	8.00	9.56E+3	3.19E-2
6D2	15		110.5	23.46	19817.5	2.50	1.37E+4	3.04E-
6D2	6E		120.8	20.22	17080.9	6.00	6.24E+3	3.59E-2
6E	5C		93.5	20.22	17080.9	6.00	4.83E+3	3.85E-2
5C	5E		-1110.7	43.01	36332.4	8.00	4.30E+4	2.12E-2
5E	5		27.2	44.02	37181.7	6.00	1.40E+3	4.65E-2
6C	6B		6249.4	20.02	16911.0	14.00	1.38E+5	1.77E-2
6B	ROG		1825.6	40.04	33822.0	8.00	7.07E+4	2.05E-2
ROG	12D		604.7	22.02	18600.1	5.00	3.75E+4	2.38E-2
12D	12B		583.2	19.38	16396.0	2.00	9.03E+4	2.37E-2
12B	12		517.3	1.64	1383.2	2.00	8.01E+4	2.39E-2
12B	12A		45.7	19.40	16390.7	2.00	7.08E+3	3.57E-2
12A	11		30.1	11.79	9958.9	2.00	4.67E+3	3.96E-2
ROG	HART		1180.9	23.46	19817.5	8.00	4.57E+4	2.22E-2

COMPUTED PIPE FLOWS AND PARAMETERS CONTINUED

ROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
HART	13A		592.2	6.26	5284.7	6.00	3.06E+4	2.45E-2
HART	14		553.3	41.90	35388.3	6.00	2.86E+4	2.48E-2
6B	6AB		4332.0	25.70	21705.0	12.00	1.12E+5	1.85E-2
6AB	6A		2437.7	45.62	38534.1	10.00	7.55E+4	2.00E-2
6A	9D		2394.4	31.28	26423.2	8.00	9.27E+4	1.97E-2
9D	9C		1365.8	32.84	27744.1	6.00	7.05E+4	2.10E-2
9C	9W		708.4	2.23	1887.3	6.00	3.66E+4	2.36E-2
9C	13C		607.8	39.10	33028.3	6.00	3.14E+4	2.43E-2
9D	9E		986.6	27.93	23592.0	6.00	5.09E+4	2.22E-2
9E	9O		685.6	2.23	1887.4	6.00	3.54E+4	2.38E-2
9E	30A		261.6	35.80	30235.3	4.00	2.03E+4	2.72E-2
30A	30		235.5	16.37	13836.6	1.50	4.86E+4	2.63E-
6AB	1A		1867.3	29.41	24838.0	8.00	7.23E+4	2.04E-2
1A	RR		1295.9	11.31	9556.4	10.00	4.01E+4	2.26E-2
RR	4PRS		547.5	7.71	6511.5	6.00	2.83E+4	2.49E-2
4PRS	4C		-541.1	69.53	58725.8	10.00	1.68E+4	2.11E-2
4C	4D		450.2	25.34	21402.9	9.00	1.55E+4	2.82E-2
4D	4E		428.0	27.37	23120.4	8.00	1.66E+4	2.76E-2
4E	4F		408.6	16.76	14155.3	7.00	1.81E+4	2.75E-2
4F	4G		395.6	18.10	15287.7	6.00	2.04E+4	2.67E-2
4G	4H		289.9	21.00	17741.3	6.00	1.50E+4	2.87E-2
4H	4		270.7	12.57	10616.5	4.00	2.10E+4	2.71E-2
4G	BASH		-117.1	29.56	24970.0	4.00	9.07E+3	2.65E-2
BASH	22		15.7	12.85	10852.4	3.00	1.63E+3	5.12E-2

COMPUTED PIPE FLOWS AND PARAMETERS CONTINUED

FROM NODE	TO NODE	STATUS	FLOW (lbm/hr)	CONDENSATE (lbm/hr)	HEAT LOSS (Btu/hr)	DIAMETER (in)	RE NUMBER	FRIC FACTOR
BASH	51		22.4	22.02	18600.1	4.00	1.74E+3	4.86E-2
1A	1C		-255.4	100.37	84774.8	10.00	7.91E+3	2.18E-2
1C	1D		439.8	23.46	19817.5	9.00	1.51E+4	2.83E-2
1D	1E		382.7	23.46	19817.5	8.00	1.48E+4	2.86E-2
1E	1F		375.4	19.55	16514.6	7.00	1.66E+4	2.79E-2
1F	1F1		107.9	7.04	5945.2	6.00	5.57E+3	3.69E-2
1F1	1L1		98.7	8.94	7549.3	1.50	2.04E+4	2.94E-2
1F	1F2		245.8	8.38	7077.7	6.00	1.27E+4	2.99E-2
1F2	1L2		116.4	45.25	38219.4	4.00	9.02E+3	3.29E-2
1F2	1F3		103.0	2.14	1808.7	3.00	1.06E+4	3.19E-2
1F3	1L3		99.1	9.78	8257.3	2.50	1.23E+4	3.11E-2
RR	2F		713.7	177.92	150282.5	10.00	2.21E+4	2.38E-
2F	ALE		535.4	76.64	64737.0	10.00	1.66E+4	2.75E-2
ALE	ALE1		395.7	19.55	16514.5	6.00	2.04E+4	2.12E-2
ALE1	20D		303.8	27.65	23356.2	5.00	1.88E+4	2.74E-2
20D	20W		133.4	28.96	24460.3	5.00	8.27E+3	3.34E-2
20D	20M		121.7	37.71	31849.4	5.00	7.54E+3	3.43E-2
ALE1	26C		151.5	31.37	26498.7	4.00	1.17E+4	3.09E-2
26C	26		115.6	38.91	32868.5	4.00	8.95E+3	3.29E-2

Appendix C: BLAST Monthly Building Heating Loads

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 1
JAN	5.677E+09	727	7.81	31.4	33.6	
FEB	4.483E+09	672	6.67	33.1	31.9	
MAR	2.565E+09	639	4.01	43.1	21.9	
APR	1.011E+09	450	2.25	51.4	13.6	
MAY	8.386E+07	83	1.01	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	5.160E+08	201	2.57	57	8	
NOV	1.938E+09	504	3.85	45.7	19.3	
DEC	4.173E+09	722	5.78	36.1	28.9	
	2.045E+10	3998	5.11			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 1
JAN	5.677E+09	727	7.81	31.4	33.6	6.98
FEB	4.483E+09	672	6.67	33.1	31.9	6.63
MAR	2.565E+09	639	4.01	43.1	21.9	4.63
APR	1.011E+09	450	2.25	51.4	13.6	2.96
MAY	8.386E+07	83	1.01	62.4	2.6	0.76
OCT	5.160E+08	201	2.57	57	8	0.24
NOV	1.938E+09	504	3.85	45.7	19.3	0.24
DEC	4.173E+09	722	5.78	36.1	28.9	0.24
						0.24
						1.84
						4.11
						6.03

Regression Output:

Constant		0.236199
Std Err of Y Est		0.620794
R Squared		0.939826
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	0.200586	
Std Err of Coef.	0.020721	

BASE	VARIABL
0.236	0.201

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 2
JAN	2.246E+09	727	3.09	31.4	33.6	
FEB	1.772E+09	672	2.64	33.1	31.9	
MAR	1.011E+09	637	1.59	43.1	21.9	
APR	3.955E+08	450	0.88	51.4	13.6	
MAY	3.105E+07	79	0.39	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	2.014E+08	197	1.02	57	8	
NOV	7.630E+08	504	1.51	45.7	19.3	
DEC	1.649E+09	722	2.28	36.1	28.9	
	8.069E+09	3988	2.02			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	2.246E+09	727	3.09	31.4	33.6	2.76
FEB	1.772E+09	672	2.64	33.1	31.9	2.62
MAR	1.011E+09	637	1.59	43.1	21.9	1.83
APR	3.955E+08	450	0.88	51.4	13.6	1.17
MAY	3.105E+07	79	0.39	62.4	2.6	0.30
OCT	2.014E+08	197	1.02	57	8	0.09
NOV	7.630E+08	504	1.51	45.7	19.3	0.09
DEC	1.649E+09	722	2.28	36.1	28.9	0.09
						0.09
						0.72
						1.62
						2.38

Regression Output:

Constant	0.089402
Std Err of Y Est	0.249254
R Squared	0.938217
No. of Observations	8
Degrees of Freedom	6

BASE	VARIABL
0.089	0.079

X Coefficient(s)	0.079414
Std Err of Coef.	0.00832

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 3
JAN	1.551E+09	727	2.13	31.4	33.6	
FEB	1.224E+09	672	1.82	33.1	31.9	
MAR	6.992E+08	639	1.09	43.1	21.9	
APR	2.748E+08	452	0.61	51.4	13.6	
MAY	2.232E+07	83	0.27	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	1.407E+08	201	0.70	57	8	
NOV	5.286E+08	507	1.04	45.7	19.3	
DEC	1.139E+09	722	1.58	36.1	28.9	
	5.580E+09	4003	1.39			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.551E+09	727	2.13	31.4	33.6	1.90
FEB	1.224E+09	672	1.82	33.1	31.9	1.81
MAR	6.992E+08	639	1.09	43.1	21.9	1.26
APR	2.748E+08	452	0.61	51.4	13.6	0.81
MAY	2.232E+07	83	0.27	62.4	2.6	0.20
OCT	1.407E+08	201	0.70	57	8	0.06
NOV	5.286E+08	507	1.04	45.7	19.3	0.06
DEC	1.139E+09	722	1.58	36.1	28.9	0.06
						0.06
						0.50
						1.12
						1.65

Regression Output:

Constant		0.057753
Std Err of Y Est		0.171053
R Squared		0.939207
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	0.054969	
Std Err of Coef.	0.005709	

BASE	VARIABL
0.058	0.055

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 4
JAN	5.261E+09	727	7.24	31.4	33.6	
FEB	4.153E+09	672	6.18	33.1	31.9	
MAR	2.373E+09	639	3.71	43.1	21.9	
APR	9.335E+08	452	2.07	51.4	13.6	
MAY	7.572E+07	83	0.91	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	4.756E+08	201	2.37	57	8	
NOV	1.792E+09	504	3.56	45.7	19.3	
DEC	3.864E+09	722	5.35	36.1	28.9	
	1.893E+10	4000	4.73			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	5.261E+09	727	7.24	31.4	33.6	6.46
FEB	4.153E+09	672	6.18	33.1	31.9	6.15
MAR	2.373E+09	639	3.71	43.1	21.9	4.28
APR	9.335E+08	452	2.07	51.4	13.6	2.73
MAY	7.572E+07	83	0.91	62.4	2.6	0.68
OCT	4.756E+08	201'	2.37	57	8	0.20
NOV	1.792E+09	504	3.56	45.7	19.3	0.20
DEC	3.864E+09	722	5.35	36.1	28.9	0.20
						0.20
						1.69
						3.80
						5.59

Regression Output:

Constant		0.196088
Std Err of Y Est		0.57628
R Squared		0.940043
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	0.186562	
Std Err of Coef.	0.019235	

BASE	VARIABL
0.196	0.187

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 6 ZONE 1
JAN	2.265E+06	111	0.02	31.4	33.6	
FEB	2.538E+05	21	0.01	33.1	31.9	
MAR	0.000E+00	0	ERR	43.1	21.9	
APR	0.000E+00	0	ERR	51.4	13.6	
MAY	0.000E+00	0	ERR	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	ERR	69.2	0	
OCT	0.000E+00	0	ERR	57	8	
NOV	0.000E+00	0	ERR	45.7	19.3	
DEC	9.897E+03	3	0.00	36.1	28.9	
	2.529E+06	135	0.02			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	2.265E+06	111	0.02	31.4	33.6	0.02
FEB	2.538E+05	21	0.01	33.1	31.9	0.01
DEC	9.897E+03	3	0.00	36.1	28.9	-0.02
						-0.05
						-0.09
						-0.10
						-0.10
						-0.10
						-0.10
						-0.07
						-0.03
						0.00

Regression Output:

Constant		-0.10003
Std Err of Y Est		0.001719
R Squared		0.979804
No. of Observations		3
Degrees of Freedom		1
X Coefficient(s)	0.003558	
Std Err of Coef.	0.000511	

BASE	VARIABL
-0.100	0.004

DATE	HEATING	HOURS	MBTU/HR	TEMP	HDD	BLDG 6 ZONE3
JAN	3.822E+09	726	5.26	31.4	33.6	
FEB	3.003E+09	652	4.61	33.1	31.9	
MAR	1.663E+09	599	2.78	43.1	21.9	
APR	6.784E+08	388	1.75	51.4	13.6	
MAY	6.327E+07	84	0.75	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	5.144E+05	3	0.17	69.2	0	
OCT	3.082E+08	166	1.86	57	8	
NOV	1.290E+09	464	2.78	45.7	19.3	
DEC	2.824E+09	712	3.97	36.1	28.9	
	1.365E+10	3794	3.60			

DATE	HEATING	HOURS	MBTU/HR	TEMP	HDD	
JAN	3.822E+09	726	5.26	31.4	33.6	0.02
FEB	3.003E+09	652	4.61	33.1	31.9	0.01
MAR	1.663E+09	599	2.78	43.1	21.9	-0.02
APR	6.784E+08	388	1.75	51.4	13.6	-0.05
MAY	6.327E+07	84	0.75	62.4	2.6	-0.09
SEP	5.144E+05	3	0.17	69.2	0	-0.10
OCT	3.082E+08	166	1.86	57	8	-0.10
NOV	1.290E+09	464	2.78	45.7	19.3	-0.10
DEC	2.824E+09	712	3.97	36.1	28.9	-0.10
	Regression Output:					-0.07
Constant			0.265797			-0.03
Std Err of Y Est			0.353721			0.00
R Squared			0.962902			
No. of Observations			9			
Degrees of Freedom			7		BASE	VARIABL
					0.266	0.135
X Coefficient(s)		0.134735				
Std Err of Coef.		0.009996				

ZONE 1 WAREHOUSE BLDG 8

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD
JAN	6.608E+07	62	1.07	31.4	33.6
FEB	3.616E+07	37	0.98	33.1	31.9
MAR	0.000E+00	0	0.00	43.1	21.9
APR	0.000E+00	0	0.00	51.4	13.6
MAY	0.000E+00	0	0.00	62.4	2.6
JUN	0.000E+00	0	0.00	70.8	0
JUL	0.000E+00	0	0.00	76.3	0
AUG	0.000E+00	0	0.00	74.6	0
SEP	0.000E+00	0	0.00	69.2	0
OCT	0.000E+00	0	0.00	57	8
NOV	0.000E+00	0	0.00	45.7	19.3
DEC	0.000E+00	0	0.00	36.1	28.9
	1.022E+08	99	1.03		

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD
JAN	6.608E+07	62	1.07	31.4	33.6
FEB	3.616E+07	37	0.98	33.1	31.9

m = 0.05
BASE = -0.62

		ZONE 2 OFFICE			BLDG 8
DATE	HEATIN	HOURS	MBTU/HR	TEMP	HDD
JAN	8.51E+07	364	0.23	31.4	33.6
FEB	4.73E+07	227	0.21	33.1	31.9
MAR	4.09E+06	51	0.08	43.1	21.9
APR	0.00E+00	0	0.00	51.4	13.6
MAY	0.00E+00	0	0.00	62.4	2.6
JUN	0.00E+00	0	0.00	70.8	0
JUL	0.00E+00	0	0.00	76.3	0
AUG	0.00E+00	0	0.00	74.6	0
SEP	0.00E+00	0	0.00	69.2	0
OCT	0.00E+00	0	0.00	57	8
NOV	1.08E+06	18	0.06	45.7	19.3
DEC	2.88E+07	202	0.14	36.1	28.9
	1.66E+08	862	0.19		

DATE	HEATIN	HOURS	MBTU/HR	TEMP	HDD	
JAN	8.51E+07	364	0.23	31.4	33.6	0.22
FEB	4.73E+07	227	0.21	33.1	31.9	0.20
MAR	4.09E+06	51	0.08	43.1	21.9	0.08
NOV	1.08E+06	18	0.06	45.7	19.3	-0.02
DEC	2.88E+07	202	0.14	36.1	28.9	-0.15
						-0.18
						-0.18
						-0.18
						-0.18
						-0.08
						0.05
						0.17

Regression Output:

Constant		-0.18059
Std Err of Y Est		0.016512
R Squared		0.964973
No. of Observations		5
Degrees of Freedom		3
X Coefficient(s)	0.012003	
Std Err of Coef.	0.00132	

BASE	VARIABL
-0.181	0.012

ZONE 1 WAREHOUSE BLDG 9

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD
JAN	6.943E+09	720	9.64	31.4	33.6
FEB	5.407E+09	672	8.05	33.1	31.9
MAR	2.899E+09	606	4.78	43.1	21.9
APR	9.875E+08	392	2.52	51.4	13.6
MAY	2.925E+07	20	1.46	62.4	2.6
JUN	0.000E+00	0	0.00	70.8	0
JUL	0.000E+00	0	0.00	76.3	0
AUG	0.000E+00	0	0.00	74.6	0
SEP	0.000E+00	0	0.00	69.2	0
OCT	4.792E+08	151	3.17	57	8
NOV	2.176E+09	454	4.79	45.7	19.3
DEC	5.024E+09	712	7.06	36.1	28.9
	2.394E+10	3727	6.42		

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	6.943E+09	720	9.64	31.4	33.6	8.48
FEB	5.407E+09	672	8.05	33.1	31.9	8.07
MAR	2.899E+09	606	4.78	43.1	21.9	5.65
APR	9.875E+08	392	2.52	51.4	13.6	3.64
MAY	2.925E+07	20	1.46	62.4	2.6	0.99
OCT	4.792E+08	151	3.17	57	8	0.36
NOV	2.176E+09	454	4.79	45.7	19.3	0.36
DEC	5.024E+09	712	7.06	36.1	28.9	0.36
						0.36
						2.29
						5.02
						7.34

Regression Output:

Constant	0.359711
Std Err of Y Est	0.86747
R Squared	0.920631
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	0.241549
Std Err of Coef.	0.028954

BASE	VARIABL
0.360	0.242

ZONE 2 OFFICE BLDG 9

DATE	HEATING	HOURS	MBTU/HR	TEMP	HDD
JAN	1.824E+09	620	2.94	31.4	33.6
FEB	1.390E+09	542	2.56	33.1	31.9
MAR	6.033E+08	392	1.54	43.1	21.9
APR	1.647E+08	207	0.80	51.4	13.6
MAY	2.287E+06	6	0.38	62.4	2.6
JUN	0.000E+00	0	0.00	70.8	0
JUL	0.000E+00	0	0.00	76.3	0
AUG	0.000E+00	0	0.00	74.6	0
SEP	0.000E+00	0	0.00	69.2	0
OCT	6.791E+07	65	1.04	57	8
NOV	4.377E+08	318	1.38	45.7	19.3
DEC	1.237E+09	586	2.11	36.1	28.9
	5.727E+09	2736	2.09		

DATE	HEATING	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.824E+09	620	2.94	31.4	33.6	2.62
FEB	1.390E+09	542	2.56	33.1	31.9	2.49
MAR	6.033E+08	392	1.54	43.1	21.9	1.74
APR	1.647E+08	207	0.80	51.4	13.6	1.12
MAY	2.287E+06	6	0.38	62.4	2.6	0.29
OCT	6.791E+07	65	1.04	57	8	0.10
NOV	4.377E+08	318	1.38	45.7	19.3	0.10
DEC	1.237E+09	586	2.11	36.1	28.9	0.10
						0.10
						0.70
						1.54
						2.26

Regression Output:

Constant	0.095868
Std Err of Y Est	0.269382
R Squared	0.920642
No. of Observations	8
Degrees of Freedom	6

BASE	VARIABL
0.096	0.075

X Coefficient(s)	0.075016
Std Err of Coef.	0.008991

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 11
JAN	8.101E+07	687	0.12	31.4	33.6	
FEB	6.275E+07	610	0.10	33.1	31.9	
MAR	3.419E+07	502	0.07	43.1	21.9	
APR	1.359E+07	296	0.05	51.4	13.6	
MAY	8.816E+05	41	0.02	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	6.229E+06	121	0.05	57	8	
NOV	2.799E+07	424	0.07	45.7	19.3	
DEC	6.231E+07	659	0.09	36.1	28.9	
	2.890E+08	3340	0.09			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	8.101E+07	687	0.12	31.4	33.6	0.11
FEB	6.275E+07	610	0.10	33.1	31.9	0.10
MAR	3.419E+07	502	0.07	43.1	21.9	0.08
APR	1.359E+07	296	0.05	51.4	13.6	0.05
MAY	8.816E+05	41	0.02	62.4	2.6	0.02
OCT	6.229E+06	121	0.05	57	8	0.02
NOV	2.799E+07	424	0.07	45.7	19.3	0.02
DEC	6.231E+07	659	0.09	36.1	28.9	0.02
						0.02
	Regression Output:					0.04
Constant			0.015832			0.07
Std Err of Y Est			0.008243			0.10
R Squared			0.943892			
No. of Observations			8			
Degrees of Freedom			6		BASE	VARIABL
					0.016	0.003
X Coefficient(s)		0.002764				
Std Err of Coef.		0.000275				

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 12
JAN	2.219E+09	709	3.13	31.4	33.6	
FEB	1.722E+09	634	2.72	33.1	31.9	
MAR	9.280E+08	532	1.74	43.1	21.9	
APR	3.707E+08	314	1.18	51.4	13.6	
MAY	2.976E+07	57	0.52	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	2.222E+05	2	0.11	69.2	0	
OCT	1.720E+08	133	1.29	57	8	
NOV	7.474E+08	436	1.71	45.7	19.3	
DEC	1.662E+09	678	2.45	36.1	28.9	
	7.851E+09	3495	2.25			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	2.219E+09	709	3.13	31.4	33.6	2.89
FEB	1.722E+09	634	2.72	33.1	31.9	2.76
MAR	9.280E+08	532	1.74	43.1	21.9	1.98
APR	3.707E+08	314	1.18	51.4	13.6	1.33
MAY	2.976E+07	57	0.52	62.4	2.6	0.47
SEP	2.222E+05	2	0.11	69.2	0	0.26
OCT	1.720E+08	133	1.29	57	8	0.26
NOV	7.474E+08	436	1.71	45.7	19.3	0.26
DEC	1.662E+09	678	2.45	36.1	28.9	0.26
						0.89
						1.77
						2.52

Regression Output:

Constant		0.264806
Std Err of Y Est		0.217821
R Squared		0.958325
No. of Observations		9
Degrees of Freedom		7
X Coefficient(s)	0.078095	
Std Err of Coef.	0.006155	

BASE	VARIABL
0.265	0.078

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 13
JAN	2.050E+09	620	3.31	31.4	33.6	
FEB	1.553E+09	537	2.89	33.1	31.9	
MAR	7.451E+08	418	1.78	43.1	21.9	
APR	2.446E+08	242	1.01	51.4	13.6	
MAY	7.526E+06	15	0.50	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	1.213E+08	90	1.35	57	8	
NOV	6.139E+08	358	1.71	45.7	19.3	
DEC	1.475E+09	586	2.52	36.1	28.9	
	6.810E+09	2866	2.38			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	2.050E+09	620	3.31	31.4	33.6	2.99
FEB	1.553E+09	537	2.89	33.1	31.9	2.85
MAR	7.451E+08	418	1.78	43.1	21.9	2.04
APR	2.446E+08	242	1.01	51.4	13.6	1.37
MAY	7.526E+06	15	0.50	62.4	2.6	0.47
OCT	1.213E+08	90	1.35	57	8	0.26
NOV	6.139E+08	358	1.71	45.7	19.3	0.26
DEC	1.475E+09	586	2.52	36.1	28.9	0.26
						0.26
						0.91
						1.83
						2.61

Regression Output:

Constant		0.260151
Std Err of Y Est		0.290664
R Squared		0.921285
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	0.081301	
Std Err of Coef.	0.009702	

BASE	VARIABL
0.260	0.081

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD
JAN	1.358E+09	700	1.94	31.4	33.6
FEB	1.067E+09	621	1.72	33.1	31.9
MAR	5.915E+08	543	1.09	43.1	21.9
APR	2.502E+08	346	0.72	51.4	13.6
MAY	2.505E+07	80	0.31	62.4	2.6
JUN	0.000E+00	0	0.00	70.8	0
JUL	0.000E+00	0	0.00	76.3	0
AUG	0.000E+00	0	0.00	74.6	0
SEP	4.257E+05	4	0.11	69.2	0
OCT	1.119E+08	154	0.73	57	8
NOV	4.664E+08	447	1.04	45.7	19.3
DEC	1.013E+09	669	1.51	36.1	28.9
	4.883E+09	3564	1.37		

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.358E+09	700	1.94	31.4	33.6	1.80
FEB	1.067E+09	621	1.72	33.1	31.9	1.71
MAR	5.915E+08	543	1.09	43.1	21.9	1.22
APR	2.502E+08	346	0.72	51.4	13.6	0.82
MAY	2.505E+07	80	0.31	62.4	2.6	0.28
SEP	4.257E+05	4	0.11	69.2	0	0.15
OCT	1.119E+08	154	0.73	57	8	0.15
NOV	4.664E+08	447	1.04	45.7	19.3	0.15
DEC	1.013E+09	669	1.51	36.1	28.9	0.15
	Regression Output:					0.54
Constant			0.15003			1.09
Std Err of Y Est			0.113345			1.57
R Squared			0.970915			
No. of Observations			9			
Degrees of Freedom			7		BASE	VARIABL
					0.150	0.049
X Coefficient(s)		0.048962				
Std Err of Coef.		0.003203				

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 15
JAN	3.720E+08	511	0.73	31.4	33.6	
FEB	3.030E+08	472	0.64	33.1	31.9	
MAR	1.855E+08	442	0.42	43.1	21.9	
APR	8.867E+07	316	0.28	51.4	13.6	
MAY	1.164E+07	100	0.12	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	6.145E+05	10	0.06	69.2	0	
OCT	3.654E+07	147	0.25	57	8	
NOV	1.456E+08	373	0.39	45.7	19.3	
DEC	2.949E+08	516	0.57	36.1	28.9	
	1.438E+09	2887	0.50			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	3.720E+08	511	0.73	31.4	33.6	0.67
FEB	3.030E+08	472	0.64	33.1	31.9	0.64
MAR	1.855E+08	442	0.42	43.1	21.9	0.46
APR	8.867E+07	316	0.28	51.4	13.6	0.31
MAY	1.164E+07	100	0.12	62.4	2.6	0.11
SEP	6.145E+05	10	0.06	69.2	0	0.06
OCT	3.654E+07	147	0.25	57	8	0.06
NOV	1.456E+08	373	0.39	45.7	19.3	0.06
DEC	2.949E+08	516	0.57	36.1	28.9	0.06
	Regression Output:					0.21
Constant			0.059871			0.41
Std Err of Y Est			0.03378			0.59
R Squared			0.98125			
No. of Observations			9			
Degrees of Freedom			7		BASE	VARIABL
					0.060	0.018
X Coefficient(s)		0.018271				
Std Err of Coef.		0.000955				

ZONE 1 WAREHOUSE BLDG 20

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD
JAN	1.436E+09	727	1.98	31.4	33.6
FEB	1.133E+09	672	1.69	33.1	31.9
MAR	6.460E+08	637	1.01	43.1	21.9
APR	2.527E+08	451	0.56	51.4	13.6
MAY	1.974E+07	79	0.25	62.4	2.6
JUN	0.000E+00	0	0.00	70.8	0
JUL	0.000E+00	0	0.00	76.3	0
AUG	0.000E+00	0	0.00	74.6	0
SEP	0.000E+00	0	0.00	69.2	0
OCT	1.288E+08	196	0.66	57	8
NOV	4.877E+08	503	0.97	45.7	19.3
DEC	1.054E+09	721	1.46	36.1	28.9
	5.158E+09	3986	1.29		

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.436E+09	727	1.98	31.4	33.6	1.76
FEB	1.133E+09	672	1.69	33.1	31.9	1.68
MAR	6.460E+08	637	1.01	43.1	21.9	1.17
APR	2.527E+08	451	0.56	51.4	13.6	0.75
MAY	1.974E+07	79	0.25	62.4	2.6	0.19
OCT	1.288E+08	196	0.66	57	8	0.06
NOV	4.877E+08	503	0.97	45.7	19.3	0.06
DEC	1.054E+09	721	1.46	36.1	28.9	0.06
						0.06
						0.46
						1.04
						1.52

Regression Output:

Constant		0.057428
Std Err of Y Est		0.160163
R Squared		0.937649
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	0.050781	
Std Err of Coef.	0.005346	

BASE	VARIABL
0.057	0.051

		ZONE 2	GYM		BLDG 20
DATE	HEATIN	HOURS	MBTU/HR	TEMP	HDD
JAN	2.99E+09	744	4.02	31.4	33.6
FEB	2.45E+09	672	3.64	33.1	31.9
MAR	1.70E+09	731	2.33	43.1	21.9
APR	9.72E+08	662	1.47	51.4	13.6
MAY	2.63E+08	380	0.69	62.4	2.6
JUN	1.04E+07	35	0.30	70.8	0
JUL	0.00E+00	0	0.00	76.3	0
AUG	0.00E+00	0	0.00	74.6	0
SEP	4.23E+07	134	0.32	69.2	0
OCT	5.37E+08	508	1.06	57	8
NOV	1.36E+09	680	2.00	45.7	19.3
DEC	2.39E+09	744	3.22	36.1	28.9
	1.27E+10	5290	2.41		

DATE	HEATIN	HOURS	MBTU/HR	TEMP	HDD	
JAN	2.99E+09	744	4.02	31.4	33.6	
FEB	2.45E+09	672	3.64	33.1	31.9	3.74
MAR	1.70E+09	731	2.33	43.1	21.9	3.56
APR	9.72E+08	662	1.47	51.4	13.6	2.52
MAY	2.63E+08	380	0.69	62.4	2.6	1.66
JUN	1.04E+07	35	0.30	70.8	0	0.51
SEP	4.23E+07	134	0.32	69.2	0	0.24
OCT	5.37E+08	508	1.06	57	8	0.24
NOV	1.36E+09	680	2.00	45.7	19.3	0.24
DEC	2.39E+09	744	3.22	36.1	28.9	0.24
	Regression Output:					1.07
Constant			0.240791			2.25
Std Err of Y Est			0.181842			3.25
R Squared			0.984358			
No. of Observations			10			
Degrees of Freedom			8		BASE	VARIABL
					0.241	0.104
X Coefficient(s)		0.104107				
Std Err of Coef.		0.00464				

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 26
JAN	1.922E+09	727	2.64	31.4	33.6	
FEB	1.517E+09	672	2.26	33.1	31.9	
MAR	8.661E+08	638	1.36	43.1	21.9	
APR	3.398E+08	452	0.75	51.4	13.6	
MAY	2.707E+07	82	0.33	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	ERR	69.2	0	
OCT	1.733E+08	200	0.87	57	8	
NOV	6.547E+08	505	1.30	45.7	19.3	
DEC	1.412E+09	722	1.96	36.1	28.9	
	6.912E+09	3998	1.73			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.922E+09	727	2.64	31.4	33.6	2.36
FEB	1.517E+09	672	2.26	33.1	31.9	2.25
MAR	8.661E+08	638	1.36	43.1	21.9	1.56
APR	3.398E+08	452	0.75	51.4	13.6	1.00
MAY	2.707E+07	82	0.33	62.4	2.6	0.25
OCT	1.733E+08	200	0.87	57	8	0.07
NOV	6.547E+08	505	1.30	45.7	19.3	0.07
DEC	1.412E+09	722	1.96	36.1	28.9	0.07
						0.07
	Regression Output:					0.62
Constant			0.069821			1.39
Std Err of Y Est			0.211263			2.04
R Squared			0.939747			
No. of Observations			8			
Degrees of Freedom			6		BASE	VARIABL
					0.070	0.068
X Coefficient(s)		0.068214				
Std Err of Coef.		0.007052				

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 30
JAN	1.602E+09	709	2.26	31.4	33.6	
FEB	1.209E+09	653	1.85	33.1	31.9	
MAR	5.839E+08	537	1.09	43.1	21.9	
APR	1.520E+08	271	0.56	51.4	13.6	
MAY	5.692E+06	17	0.33	62.4	2.6	
JUN	0.000E+00	0	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	0.000E+00	0	0.00	69.2	0	
OCT	9.781E+07	116	0.84	57	8	
NOV	4.505E+08	415	1.09	45.7	19.3	
DEC	1.101E+09	689	1.60	36.1	28.9	
	5.202E+09	3407	1.53			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.602E+09	709	2.26	31.4	33.6	1.95
FEB	1.209E+09	653	1.85	33.1	31.9	1.85
MAR	5.839E+08	537	1.09	43.1	21.9	1.31
APR	1.520E+08	271	0.56	51.4	13.6	0.85
MAY	5.692E+06	17	0.33	62.4	2.6	0.25
OCT	9.781E+07	116	0.84	57	8	0.11
NOV	4.505E+08	415	1.09	45.7	19.3	0.11
DEC	1.101E+09	689	1.60	36.1	28.9	0.11
						0.11
						0.55
						1.17
						1.69

Regression Output:

Constant		0.112228
Std Err of Y Est		0.238353
R Squared		0.886956
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	0.054586	
Std Err of Coef.	0.007956	

BASE	VARIABL
0.112	0.055

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	BLDG 51
JAN	1.060E+09	723	1.47	31.4	33.6	
FEB	8.355E+08	672	1.24	33.1	31.9	
MAR	4.860E+08	655	0.74	43.1	21.9	
APR	2.047E+08	471	0.43	51.4	13.6	
MAY	3.052E+07	148	0.21	62.4	2.6	
JUN	3.237E+05	3	0.00	70.8	0	
JUL	0.000E+00	0	0.00	76.3	0	
AUG	0.000E+00	0	0.00	74.6	0	
SEP	1.599E+06	21	0.08	69.2	0	
OCT	1.165E+08	278	0.42	57	8	
NOV	3.742E+08	530	0.71	45.7	19.3	
DEC	7.764E+08	723	1.07	36.1	28.9	
	3.886E+09	4224	0.92			

DATE	HEATING LO	HOURS	MBTU/HR	TEMP	HDD	
JAN	1.060E+09	723	1.47	31.4	33.6	
FEB	8.355E+08	672	1.24	33.1	31.9	1.30
MAR	4.860E+08	655	0.74	43.1	21.9	1.24
APR	2.047E+08	471	0.43	51.4	13.6	0.86
MAY	3.052E+07	148	0.21	62.4	2.6	0.55
JUN	3.237E+05	3	0.00	70.8	0	0.13
SEP	1.599E+06	21	0.08	69.2	0	0.03
OCT	1.165E+08	278	0.42	57	8	0.03
NOV	3.742E+08	530	0.71	45.7	19.3	0.03
DEC	7.764E+08	723	1.07	36.1	28.9	0.03
	Regression Output:					0.34
Constant			0.03454			0.76
Std Err of Y Est			0.096674			1.12
R Squared			0.966859			
No. of Observations			10			
Degrees of Freedom			8		BASE	VARIABL
					0.035	0.038
X Coefficient(s)		0.037684				
Std Err of Coef.		0.002467				

Appendix D: Chiller Equipment

CHILLER EQUIPMENT

BLDG.	UNITS	TONNAGE	LOCATION USE	INSTALLED	REFRIGERANT	
M-3	2 EA	3 Ton Chrysler	P.X. (not in use)	1960	R-22	
M-3	1 EA	5 Ton York	P.X.	1990	R-22	
M-5	1 EA	5 Ton Dunn-Bush	Environ. Rm	1970	R-22	*2
M-5C&D	1 EA	130 Ton Carrier	C&D Bays	1981	R-11	*2
6-1-A	1 EA	25 Ton Singer	Ball. Range	1980	R-22	
6-1-C	2 EA	400 Ton Carrier	Entire Bldg	1986	R-11	*1
6-1-D	1 EA	60 Ton McQuay	Medical Lab	1984	R-22	
6-1-D	1 EA	3 Ton Dunn&Bush	Environ. Rm	1975	R-22	*3
6-1-E	1 EA	40 Ton Trane	Dispensary	1979	R-22	
6-2-B	1 EA	25 Ton Trane	Cmndrs Suite	1986	R-22	
6-2-C	1 EA	20 Ton Liebert	DCASR Comp. Rm	1983	R-22	
8-1	1 EA	15 Ton Carrier	F.E. Office	1985	R-22	
8-3	1 EA	25 Ton Carrier	Trng Rooms	1986	R-22	
9-1E&F	1 EA	130 Ton Trane	OTIS & Subs	1990	R-22	
9-1-F	3 EA	20 Ton Datec	Computer Room	1987	R-22	
9-1-F	4 EA	20 Ton Liebert	Computer Room	1990	R-22	
9-1-F	2 EA	25 Ton Liebert	Computer Room	1990	R-22	
9-1-F	1 EA	20 Ton Liebert	Tele Comm	1991	R-22	
9-1-F	1 EA	15 Ton Liebert	Computer Room	1986	R-22	
-2-C	1 EA	25 Ton Bohn	DSAC-W	1980	R-22	
9-2-D	1 EA	25 Ton Trane	DSAC-W	1985	R-22	
9-3E&F	1 EA	140 Ton Carrier	Subs & Medical	1991	R-22	
9-4-E	1 EA	25 Ton Trane	Medical	1985	R-22	
9-4-F	1 EA	85 Ton York	Medical	1991	R-22	
11-1	1 EA	5 Ton York	Security	1981	R-22	
12-LL	1 EA	550 Ton York	Entire Bldg	1990	R-11	*1
12-LL	1 EA	5 Ton York	Tele & Eqpt. Rm	1966	R-22	*3
12-LL	1 EA	3 Ton York	Tele & Eqpt. Rm	1960	R-22	*3
12-LL	1 EA	15 Ton Carrier	Cmnd Cntrl Ctr	1978	R-22	
12-LL	1 EA	5 Ton Rund	Photo Lab	1985	R-22	
12-1-H	1 EA	15 Ton Carrier	Command Wing	1976	R-22	
12-2-F	1 EA	5 Ton Liebert	C&T Key Punch	1983	R-22	
13-1	1 EA	10 Ton Carrier	Cmpt Lay Out Rm	1984	R-22	
13-1	1 EA	5 Ton Carrier	Computer Room	1989	R-22	
13-1	1 EA	1200 Ton Trane (1500 HP)	Factory	1973	R-11	
14-1	1 EA	15 Ton Carrier		1987	R-22	
14-R	1 EA	130 Ton Trane		1961	R-11	

BLDG.	UNITS	TONNAGE	LOCATION USE	INSTALLED	REFRIGERANT	
.5	1 EA	250 Ton Wstghse	Entire Building	1973	R-12	*1
15	1 EA	40 Ton Carrier	Ex. Cold Chamb.	1971	R-502	*1
15	1 EA	15 Ton Trane	Textile Room	1968	R-12	*1
15	1 EA	15 Ton Carrier	Textile Room	1978	R-12	*1
15, 2	6 EA	Environ. Boxes	Testing Labs	1978	R-12	*1
15	1 EA	7.5 Ton York	Optics Lab	1966	R-12	*1
15	1 EA	5 Ton Carrier	#1 Environ. Lab	1969	R-12	*1
15	1 EA	7.5 Ton Dunn&Bush	#2 Environ. Lab	1973	R-12	*1
15	1 EA	7.5 Ton Carrier	#3 Environ. Lab	1970	R-12	*1
15	1 EA	5 Ton Trane	Shading Lab	1962	R-22	*1
26-A	1 EA	25 Ton Carrier	Maint. Ft Meade	1984	R-22	
26-A	1 EA	7.5 Ton Carrier	Office	1989	R-22	
26-B	1 EA	5 Ton Rund	Small Arms	1988	R-22	
26-C	1 EA	7.5 Ton Carrier	Salvage	1962	R-22	
26-C	1 EA	3 Ton Carrier	Salvage Offices	1988	R-22	
30-1	1 EA	5 Ton Copeland	Elect. Vault	1962	R-12	*1,3
30-1	1 EA	7.5 Ton Carrier	Garage	1988	R-22	
51	1 EA	20 Ton Trane	M.P./Food Insp.	1989	R-22	

*1 Title VI of the Clean Air Act Amendments of 1990 requires that production of CFC refrigerants be prohibited by 1999.

2 Removed

*3 Not in service

Appendix E: BLAST Monthly Building Cooling Loads

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 06 ZONE 2
JAN	0.000E+00	0	ERR	31.4	-33.6	
FEB	0.000E+00	0	ERR	33.1	-31.9	
MAR	2.766E+07	44	0.63	43.1	-21.9	
APR	4.488E+07	78	0.58	51.4	-13.6	
MAY	2.324E+08	190	1.22	62.4	-2.6	
JUN	3.749E+08	210	1.79	70.8	5.8	
JUL	4.824E+08	210	2.30	76.3	11.3	
AUG	5.212E+08	230	2.27	74.6	9.6	
SEP	3.017E+08	188	1.60	69.2	4.2	
OCT	1.596E+08	146	1.09	57	-8	
NOV	3.452E+07	64	0.54	45.7	-19.3	
DEC	1.441E+06	5	0.29	36.1	-28.9	
	2.181E+09	1365	1.60			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	0.000E+00	0	ERR	31.4	-33.6	
FEB	0.000E+00	0	ERR	33.1	-31.9	
MAR	2.766E+07	44	0.63	43.1	-21.9	0.45
APR	4.488E+07	78	0.58	51.4	-13.6	0.87
MAY	2.324E+08	190	1.22	62.4	-2.6	1.42
JUN	3.749E+08	210	1.79	70.8	5.8	1.84
JUL	4.824E+08	210	2.30	76.3	11.3	2.11
AUG	5.212E+08	230	2.27	74.6	9.6	2.03
SEP	3.017E+08	188	1.60	69.2	4.2	1.76
OCT	1.596E+08	146	1.09	57	-8	1.15
NOV	3.452E+07	64	0.54	45.7	-19.3	0.58
DEC	1.441E+06	5	0.29	36.1	-28.9	0.10

Regression Output:

Constant		1.546868		
Std Err of Y Est		0.197005		
R Squared		0.935769		
No. of Observations		10		
Degrees of Freedom		8	BASE	VARIABL
			1.547	0.050
X Coefficient(s)	0.049961			
Std Err of Coef.	0.004628			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 08 ZONE 2
JAN	5.335E+05	14	0.04	31.4	-33.6	
FEB	2.020E+05	5	0.04	33.1	-31.9	
MAR	2.859E+07	98	0.29	43.1	-21.9	
APR	5.932E+07	189	0.31	51.4	-13.6	
MAY	1.419E+08	220	0.65	62.4	-2.6	
JUN	1.797E+08	210	0.86	70.8	5.8	
JUL	2.133E+08	210	1.02	76.3	11.3	
AUG	2.294E+08	230	1.00	74.6	9.6	
SEP	1.571E+08	190	0.83	69.2	4.2	
OCT	1.161E+08	208	0.56	57	-8	
NOV	4.615E+07	123	0.38	45.7	-19.3	
DEC	5.962E+06	31	0.19	36.1	-28.9	
	1.178E+09	1728	0.68			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	5.335E+05	14	0.04	31.4	-33.6	0.03
FEB	2.020E+05	5	0.04	33.1	-31.9	0.06
MAR	2.859E+07	98	0.29	43.1	-21.9	0.27
APR	5.932E+07	189	0.31	51.4	-13.6	0.45
MAY	1.419E+08	220	0.65	62.4	-2.6	0.69
JUN	1.797E+08	210	0.86	70.8	5.8	0.86
JUL	2.133E+08	210	1.02	76.3	11.3	0.98
AUG	2.294E+08	230	1.00	74.6	9.6	0.95
SEP	1.571E+08	190	0.83	69.2	4.2	0.83
OCT	1.161E+08	208	0.56	57	-8	0.57
NOV	4.615E+07	123	0.38	45.7	-19.3	0.33
DEC	5.962E+06	31	0.19	36.1	-28.9	0.13

Regression Output:

Constant		0.741316
Std Err of Y Est		0.056633
R Squared		0.976794
No. of Observations		12
Degrees of Freedom		10
X Coefficient(s)	0.021298	
Std Err of Coef.	0.001038	

BASE	VARIABL
0.741	0.021

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 09 ZONE 2
JAN	2.148E+06	7	0.31	31.4	-33.6	
FEB	5.710E+06	10	0.57	33.1	-31.9	
MAR	1.238E+08	80	1.55	43.1	-21.9	
APR	2.547E+08	156	1.63	51.4	-13.6	
MAY	7.764E+08	215	3.61	62.4	-2.6	
JUN	1.082E+09	210	5.15	70.8	5.8	
JUL	1.299E+09	210	6.19	76.3	11.3	
AUG	1.395E+09	230	6.07	74.6	9.6	
SEP	9.182E+08	190	4.83	69.2	4.2	
OCT	6.102E+08	193	3.16	57	-8	
NOV	1.984E+08	109	1.82	45.7	-19.3	
DEC	1.200E+07	14	0.86	36.1	-28.9	
	6.678E+09	1624	4.11			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	2.148E+06	7	0.31	31.4	-33.6	0.04
FEB	5.710E+06	10	0.57	33.1	-31.9	0.26
MAR	1.238E+08	80	1.55	43.1	-21.9	1.54
APR	2.547E+08	156	1.63	51.4	-13.6	2.61
MAY	7.764E+08	215	3.61	62.4	-2.6	4.03
JUN	1.082E+09	210	5.15	70.8	5.8	5.11
JUL	1.299E+09	210	6.19	76.3	11.3	5.82
AUG	1.395E+09	230	6.07	74.6	9.6	5.60
SEP	9.182E+08	190	4.83	69.2	4.2	4.90
OCT	6.102E+08	193	3.16	57	-8	3.33
NOV	1.984E+08	109	1.82	45.7	-19.3	1.88
DEC	1.200E+07	14	0.86	36.1	-28.9	0.64

Regression Output:

Constant		4.361224		
Std Err of Y Est		0.417566		
R Squared		0.965842		
No. of Observations		12		
Degrees of Freedom		10	BASE	VARIABL
			4.361	0.129
X Coefficient(s)	0.128709			
Std Err of Coef.	0.007654			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 11
JAN	1.107E+03	1	0.00	31.4	-33.6	
FEB	3.994E+04	5	0.01	33.1	-31.9	
MAR	3.552E+06	64	0.06	43.1	-21.9	
APR	6.754E+06	129	0.05	51.4	-13.6	
MAY	2.116E+07	202	0.10	62.4	-2.6	
JUN	2.923E+07	210	0.14	70.8	5.8	
JUL	3.641E+07	210	0.17	76.3	11.3	
AUG	3.891E+07	230	0.17	74.6	9.6	
SEP	2.391E+07	187	0.13	69.2	4.2	
OCT	1.374E+07	159	0.09	57	-8	
NOV	3.880E+06	80	0.05	45.7	-19.3	
DEC	2.539E+05	13	0.02	36.1	-28.9	
	1.778E+08	1490	0.12			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	1.107E+03	1	0.00	31.4	-33.6	-0.00
FEB	3.994E+04	5	0.01	33.1	-31.9	0.01
MAR	3.552E+06	64	0.06	43.1	-21.9	0.04
APR	6.754E+06	129	0.05	51.4	-13.6	0.07
MAY	2.116E+07	202	0.10	62.4	-2.6	0.11
JUN	2.923E+07	210	0.14	70.8	5.8	0.14
JUL	3.641E+07	210	0.17	76.3	11.3	0.16
AUG	3.891E+07	230	0.17	74.6	9.6	0.16
SEP	2.391E+07	187	0.13	69.2	4.2	0.14
OCT	1.374E+07	159	0.09	57	-8	0.09
NOV	3.880E+06	80	0.05	45.7	-19.3	0.05
DEC	2.539E+05	13	0.02	36.1	-28.9	0.02

Regression Output:

Constant		0.121244		
Std Err of Y Est		0.010291		
R Squared		0.973842		
No. of Observations		12		
Degrees of Freedom		10	BASE	VARIABL
			0.121	0.004
X Coefficient(s)	0.00364			
Std Err of Coef.	0.000189			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 12
JAN	0.000E+00	0	ERR	31.4	-33.6	
FEB	1.796E+05	2	0.09	33.1	-31.9	
MAR	7.524E+07	52	1.45	43.1	-21.9	
APR	1.324E+08	108	1.23	51.4	-13.6	
MAY	4.742E+08	199	2.38	62.4	-2.6	
JUN	6.732E+08	210	3.21	70.8	5.8	
JUL	8.314E+08	210	3.96	76.3	11.3	
AUG	8.953E+08	230	3.89	74.6	9.6	
SEP	5.421E+08	189	2.87	69.2	4.2	
OCT	2.996E+08	152	1.97	57	-8	
NOV	8.100E+07	75	1.08	45.7	-19.3	
DEC	4.594E+06	6	0.77	36.1	-28.9	
	4.009E+09	1433	2.80			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN						0.06
FEB	1.796E+05	2	0.09	33.1	-31.9	0.20
MAR	7.524E+07	52	1.45	43.1	-21.9	1.01
APR	1.324E+08	108	1.23	51.4	-13.6	1.68
MAY	4.742E+08	199	2.38	62.4	-2.6	2.57
JUN	6.732E+08	210	3.21	70.8	5.8	3.25
JUL	8.314E+08	210	3.96	76.3	11.3	3.70
AUG	8.953E+08	230	3.89	74.6	9.6	3.56
SEP	5.421E+08	189	2.87	69.2	4.2	3.12
OCT	2.996E+08	152	1.97	57	-8	2.13
NOV	8.100E+07	75	1.08	45.7	-19.3	1.22
DEC	4.594E+06	6	0.77	36.1	-28.9	0.44

Regression Output:

Constant		2.782408
Std Err of Y Est		0.306144
R Squared		0.949269
No. of Observations		11
Degrees of Freedom		9
X Coefficient(s)	0.080992	
Std Err of Coef.	0.006241	

BASE	VARIABL
2.782	0.081

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 13
JAN	2.371E+07	33	0.72	31.4	-33.6	
FEB	3.266E+07	34	0.96	33.1	-31.9	
MAR	2.550E+08	128	1.99	43.1	-21.9	
APR	4.666E+08	192	2.43	51.4	-13.6	
MAY	9.911E+08	219	4.53	62.4	-2.6	
JUN	1.227E+09	210	5.84	70.8	5.8	
JUL	1.401E+09	210	6.67	76.3	11.3	
AUG	1.506E+09	230	6.55	74.6	9.6	
SEP	1.010E+09	190	5.32	69.2	4.2	
OCT	7.127E+08	203	3.51	57	-8	
NOV	2.902E+08	130	2.23	45.7	-19.3	
DEC	4.400E+07	44	1.00	36.1	-28.9	
	7.960E+09	1823	4.37			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	2.371E+07	33	0.72	31.4	-33.6	0.41
FEB	3.266E+07	34	0.96	33.1	-31.9	0.64
MAR	2.550E+08	128	1.99	43.1	-21.9	1.98
APR	4.666E+08	192	2.43	51.4	-13.6	3.10
MAY	9.911E+08	219	4.53	62.4	-2.6	4.57
JUN	1.227E+09	210	5.84	70.8	5.8	5.70
JUL	1.401E+09	210	6.67	76.3	11.3	6.44
AUG	1.506E+09	230	6.55	74.6	9.6	6.21
SEP	1.010E+09	190	5.32	69.2	4.2	5.49
OCT	7.127E+08	203	3.51	57	-8	3.85
NOV	2.902E+08	130	2.23	45.7	-19.3	2.33
DEC	4.400E+07	44	1.00	36.1	-28.9	1.04

Regression Output:

Constant		4.921291
Std Err of Y Est		0.313909
R Squared		0.981966
No. of Observations		12
Degrees of Freedom		10
X Coefficient(s)	0.13427	
Std Err of Coef.	0.005754	

BASE	VARIABL
4.921	0.134

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 14
JAN	3.598E+05	4	0.09	31.4	-33.6	
FEB	5.589E+04	1	0.06	33.1	-31.9	
MAR	4.473E+07	58	0.77	43.1	-21.9	
APR	8.081E+07	110	0.73	51.4	-13.6	
MAY	2.761E+08	198	1.39	62.4	-2.6	
JUN	3.915E+08	210	1.86	70.8	5.8	
JUL	4.846E+08	210	2.31	76.3	11.3	
AUG	5.227E+08	230	2.27	74.6	9.6	
SEP	3.203E+08	188	1.70	69.2	4.2	
OCT	1.850E+08	161	1.15	57	-8	
NOV	5.905E+07	86	0.69	45.7	-19.3	
DEC	3.830E+06	7	0.55	36.1	-28.9	
	2.369E+09	1463	1.62			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	3.598E+05	4	0.09	31.4	-33.6	0.07
FEB	5.589E+04	1	0.06	33.1	-31.9	0.15
MAR	4.473E+07	58	0.77	43.1	-21.9	0.61
APR	8.081E+07	110	0.73	51.4	-13.6	1.00
MAY	2.761E+08	198	1.39	62.4	-2.6	1.51
JUN	3.915E+08	210	1.86	70.8	5.8	1.90
JUL	4.846E+08	210	2.31	76.3	11.3	2.15
AUG	5.227E+08	230	2.27	74.6	9.6	2.08
SEP	3.203E+08	188	1.70	69.2	4.2	1.82
OCT	1.850E+08	161	1.15	57	-8	1.26
NOV	5.905E+07	86	0.69	45.7	-19.3	0.73
DEC	3.830E+06	7	0.55	36.1	-28.9	0.29

Regression Output:

Constant		1.630002
Std Err of Y Est		0.166205
R Squared		0.958694
No. of Observations		12
Degrees of Freedom		10
X Coefficient(s)	0.046414	
Std Err of Coef.	0.003047	

BASE	VARIABL
1.630	0.046

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	BLDG 15
JAN	8.527E+07	180	0.47	31.4	-33.6	
FEB	9.134E+07	176	0.52	33.1	-31.9	
MAR	1.883E+08	238	0.79	43.1	-21.9	
APR	2.319E+08	246	0.94	51.4	-13.6	
MAY	3.426E+08	362	0.95	62.4	-2.6	
JUN	4.087E+08	554	0.74	70.8	5.8	
JUL	4.704E+08	693	0.68	76.3	11.3	
AUG	4.871E+08	669	0.73	74.6	9.6	
SEP	3.503E+08	491	0.71	69.2	4.2	
OCT	2.865E+08	296	0.97	57	-8	
NOV	1.812E+08	216	0.84	45.7	-19.3	
DEC	1.005E+08	193	0.52	36.1	-28.9	
	3.224E+09	4314	0.75			

DATE	COOLING LO	HOURS	MBTU/HR	TEMP	CDD	REG
JAN	8.527E+07	180	0.47	31.4	-33.6	0.64
FEB	9.134E+07	176	0.52	33.1	-31.9	0.65
MAR	1.883E+08	238	0.79	43.1	-21.9	0.69
APR	2.319E+08	246	0.94	51.4	-13.6	0.73
MAY	3.426E+08	362	0.95	62.4	-2.6	0.77
JUN	4.087E+08	554	0.74	70.8	5.8	0.81
JUL	4.704E+08	693	0.68	76.3	11.3	0.83
AUG	4.871E+08	669	0.73	74.6	9.6	0.83
SEP	3.503E+08	491	0.71	69.2	4.2	0.80
OCT	2.865E+08	296	0.97	57	-8	0.75
NOV	1.812E+08	216	0.84	45.7	-19.3	0.70
DEC	1.005E+08	193	0.52	36.1	-28.9	0.66

Regression Output:				
Constant		0.785233		
Std Err of Y Est		0.162294		
R Squared		0.177978		
No. of Observations		12		
Degrees of Freedom		10	BASE	VARIABL
			0.785	0.004
X Coefficient(s)	0.004377			
Std Err of Coef.	0.002975			

Appendix F: Life Cycle Cost Analyses

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 1 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATIVE # 1				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$2,727,076
	UNDEVELOPED DESIGN DETAILS				$409,061
	OVERHEAD				$470,421
	PROFIT				$313,814
	TOTAL				$3,920,172
	PROBABLE COST USE				$3,920,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 2 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	ALTERNATIVE # 2 - ONE ENGINE (OPTION 1)				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	GAS ENGINES AND INSTALLATION	1	EA	—	$1,740,000
	GENERATOR AND INSTALLATION	1	EA	$241,500.00	$241,500
	AUXILIARIES AND INSTALLATION	1	EA	$264,500.00	$264,500
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	1	EA	$160,000.00	$160,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$5,133,076
	UNDEVELOPED DESIGN DETAILS				$769,961
	OVERHEAD				$885,456
	PROFIT				$590,304
	TOTAL				$7,378,797
	PROBABLE COST USE				$7,379,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

SHEET 3 OF 11

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATIVE # 2 - TWO ENGINE (OPTION 2)				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	GAS ENGINES AND INSTALLATION	2	EA	—	$3,480,000
	GENERATOR AND INSTALLATION	2	EA	$241,500.00	$483,000
	AUXILIARIES AND INSTALLATION	2	EA	$264,500.00	$529,000
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	2	EA	$160,000.00	$320,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$7,539,076
	UNDEVELOPED DESIGN DETAILS				$1,130,861
	OVERHEAD				$1,300,491
	PROFIT				$866,994
	TOTAL				$10,837,422
	PROBABLE COST USE				$10,837,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 4 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	(OPTION 3) ALTERNATIVE # 2 - ONE 1100 KW GAS TURBINE				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	GAS TURBINE, GENERATOR AND INSTALLATION	—	LS	—	$1,020,000
	WATER INJECTION	1	EA	$68,400.00	$68,400
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	1	EA	$160,000.00	$160,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$3,975,476
	UNDEVELOPED DESIGN DETAILS				$596,321
	OVERHEAD				$685,770
	PROFIT				$457,180
	TOTAL				$5,714,747
	PROBABLE COST USE				$5,715,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/8/92
CHECKER:	D.R.DRAKE	12/8/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL–DPSC STUDY
JOB NO.: 10838–07–652

SHEET 5 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	(OPTION 4) ALTERNATIVE # 2 – TWO 1100 KW GAS TURBINES				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	GAS TURBINE, GENERATOR AND INSTALLATION (2 EA)	—	LS	—	$2,040,000
	WATER INJECTION	2	EA	$68,400.00	$136,800
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	2	EA	$160,000.00	$320,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$5,223,876
	UNDEVELOPED DESIGN DETAILS				$783,581
	OVERHEAD				$901,119
	PROFIT				$600,746
	TOTAL				$7,509,322
	PROBABLE COST USE				$7,509,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/8/92
CHECKER:	D.R.DRAKE	12/8/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 6 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	(OPTION 5)				
	ALTERNATIVE # 2 - THREE 1100 KW GAS TURBINES				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	GAS TURBINE, GENERATOR AND INSTALLATION (3EA)	—	LS	—	$3,060,000
	WATER INJECTION	3	EA	$68,400.00	$205,200
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	3	EA	$160,000.00	$480,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$6,472,276
	UNDEVELOPED DESIGN DETAILS				$970,841
	OVERHEAD				$1,116,468
	PROFIT				$744,312
	TOTAL				$9,303,897
	PROBABLE COST USE				$9,304,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/8/92
CHECKER:	D.R.DRAKE	12/8/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 7 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	(OPTION V) ALTERNATIVE # 2 - ONE 3500 KW GAS TURBINE				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	GAS TURBINE, GENERATOR AND INSTALLATION	—	LS	—	$1,800,000
	WATER INJECTION	1	EA	$122,725.00	$122,725
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	1	EA	$300,000.00	$300,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	SUBTOTAL				$4,949,801
	UNDEVELOPED DESIGN DETAILS				$742,470
	OVERHEAD				$853,841
	PROFIT				$569,227
	TOTAL				$7,115,339
	PROBABLE COST USE				$7,115,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/8/92
CHECKER:	D.R.DRAKE	12/8/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 8 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY		LABOR & MATERIAL	
		NO. UNITS	UNIT MEAS.	$ PER UNIT	TOTAL
	ALTERNATIVE # 3				
	DEMOLITION				
	BOILERS NO. 1,2,3,&4	4	EA	$30,000.00	$120,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$500,000
	CENTRIFUGAL CHILLER 1200 TON	—	LS	—	$40,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 50,000 #/ HR	2	EA	$490,000.00	$980,000
	ECONOMIZERS	2	EA	$25,000.00	$50,000
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	STEEL STACK, 24" DIA. 60' HIGH	2	EA	$10,000.00	$20,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$60,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$150,000
	CONDUIT AND CABLE	—	LS	—	$75,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	ABSORPTION CHILLER 1200 TON	1	EA	$458,000.00	$458,000
	COOLING TOWER	1	EA	$89,000.00	$89,000
	COOLING TOWER PUMP 4800 GPM, 70' TDH, 150 HP	2	EA	$28,000.00	$56,000
	COOLING TOWER PIPING	—	LS	—	$50,000
	GAS ENGINES AND INSTALLATION	2	EA	—	$3,480,000
	GENERATOR AND INSTALLATION	2	EA	$241,500.00	$483,000
	AUXILIARIES AND INSTALLATION	2	EA	$264,500.00	$529,000
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	2	EA	$160,000.00	$320,000
	SUBTOTAL				$8,232,076
	UNDEVELOPED DESIGN DETAILS				$1,234,811
	OVERHEAD				$1,420,033
	PROFIT				$946,689
	TOTAL				$11,833,609
	PROBABLE COST USE				$11,834,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 9 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATIVE # 4				
	DEMOLITION				
	BOILERS NO. 1&2	2	EA	$30,000.00	$60,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$350,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 10,000 #/ HR	1	EA	$90,000.00	$90,000
	SUMMER BOILER FEED PUMP 21 GPM, 404' TDH, 5 HP	1	EA	$9,100.00	$9,100
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$30,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$75,000
	CONDUIT AND CABLE	—	LS	—	$50,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	REMOVE & MODIFY BOILER NO.3 SUPERHEATER & BURNER	1	EA	$135,000.00	$135,000
	REMOVE & MODIFY BOILER NO.4 SUPERHEATER & BURNER	1	EA	$135,000.00	$135,000
	SUBTOTAL				$1,706,176
	UNDEVELOPED DESIGN DETAILS				$255,926
	OVERHEAD				$294,315
	PROFIT-				$196,210
	TOTAL				$2,452,628
	PROBABLE COST USE				$2,453,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

SHEET 10 OF 11

PROJECT: MECHANICAL STUDY
LOCATION: CERL–DPSC STUDY
JOB NO.: 10838–07–652

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATIVE # 5				
	DEMOLITION				
	BOILERS NO. 1&2	2	EA	$30,000.00	$60,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$350,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	BOILER, 10,000 #/ HR	1	EA	$90,000.00	$90,000
	SUMMER BOILER FEED PUMP 21 GPM, 404' TDH, 5 HP	1	EA	$9,100.00	$9,100
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$30,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$75,000
	CONDUIT AND CABLE	—	LS	—	$50,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	REMOVE & MODIFY BOILER NO.3 SUPERHEATER & BURNER	1	EA	$135,000.00	$135,000
	REMOVE & MODIFY BOILER NO.4 SUPERHEATER & BURNER	1	EA	$135,000.00	$135,000
	GAS ENGINES AND INSTALLATION	2	EA	—	$3,480,000
	GENERATOR AND INSTALLATION	2	EA	$241,500.00	$483,000
	AUXILIARIES AND INSTALLATION	2	EA	$264,500.00	$529,000
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	2	EA	$160,000.00	$320,000
	SUBTOTAL				$6,518,176
	UNDEVELOPED DESIGN DETAILS				$977,726
	OVERHEAD				$1,124,385
	PROFIT				$749,590
	TOTAL				$9,369,878
	PROBABLE COST USE				$9,370,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

PROJECT: MECHANICAL STUDY
LOCATION: CERL-DPSC STUDY
JOB NO.: 10838-07-652

SHEET 11 OF 11

CONCEPTUAL COST ESTIMATE

CODE NO.	ITEM DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR & MATERIAL $ PER UNIT	LABOR & MATERIAL TOTAL
	ALTERNATIVE # 6				
	DEMOLITION				
	BOILERS NO. 1&2	2	EA	$30,000.00	$60,000
	TURBINE DRIVEN BOILER FEED PUMP	4	EA	$5,000.00	$20,000
	COAL AND ASH SILOS,CONVEYORS AND EQUIPMENT	—	LS	—	$100,000
	PIPING	—	LS	—	$5,000
	ELECTRICAL INSTRUMENT AND CONTROL	—	LS	—	$50,000
	ASBESTOS ABATEMENT	—	LS	—	$350,000
	CENTRIFUGAL CHILLER 1200 TON	—	LS	—	$40,000
	NEW CONSTRUCTION				
	REMOVE AND MODIFY BOILER 5 SUPERHEATER	—	LS	—	$50,000
	SUMMER BOILER FEED PUMP 50 GPM, 404' TDH, 10 HP	1	EA	$10,500.00	$10,500
	BOILER FEED PUMPS ,15 HP, 81 GPM,404FT.	3	EA	$12,000.00	$36,000
	PIPING, VALVES, HANGERS, AND INSTALLATION	—	LS	—	$30,000
	INSTRUMENTS AND CONTROLS	—	LS	—	$75,000
	CONDUIT AND CABLE	—	LS	—	$50,000
	MOTOR CONTROL CENTER	—	LS	—	$40,000
	MISC. ELECTRICAL AND LIGHTING	—	LS	—	$50,000
	AIR HEATER	1	EA	$5,463.00	$5,463
	AIR RECEIVER	1	EA	$382.00	$382
	SWITCH GEAR	1	EA	$75,969.00	$75,969
	CONDENSATE RECEIVER	1	EA	$35,700.00	$35,700
	EXPANSION TANK	1	EA	$19,444.00	$19,444
	WATER STORAGE TANK	1	EA	$17,595.00	$17,595
	ABOVE GROUND TANK	1	EA	$156,442.00	$156,442
	BELOW GROUND TANK	1	EA	$108,375.00	$108,375
	FLASH TANK	1	EA	$1,706.00	$1,706
	ABSORPTION CHILLER 1200 TON	1	EA	$458,000.00	$458,000
	COOLING TOWER	1	EA	$89,000.00	$89,000
	COOLING TOWER PUMP 4800 GPM, 70' TDH, 150 HP	2	EA	$28,000.00	$56,000
	COOLING TOWER PIPING	—	LS	—	$50,000
	REMOVE & MODIFY BOILER NO.3 SUPERHEATER & BURNER	1	EA	$135,000.00	$135,000
	REMOVE & MODIFY BOILER NO.4 SUPERHEATER & BURNER	1	EA	$135,000.00	$135,000
	GAS ENGINES AND INSTALLATION	2	EA	—	$3,480,000
	GENERATOR AND INSTALLATION	2	EA	$241,500.00	$483,000
	AUXILIARIES AND INSTALLATION	2	EA	$264,500.00	$529,000
	HEAT RECOVERY STEAM GENERATOR AND INSTALLATION	2	EA	$160,000.00	$320,000
	SUBTOTAL				$7,122,576
	UNDEVELOPED DESIGN DETAILS				$1,068,386
	OVERHEAD				$1,228,644
	PROFIT				$819,096
	TOTAL				$10,238,703
	PROBABLE COST USE				$10,239,000

PRICES INCLUDE ESCALATION TO
X PRICES ARE AS OF DATE OF THIS ESTIMATE

		DATE
ESTIMATOR:	G.B.BLAZEK	12/1/92
CHECKER:	D.R.DRAKE	12/1/92
CONST. MGR.:		

STANLEY CONSULTANTS

```
    LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                  DATE/TIME:  11-16-92  10:15:06
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. B;   TITLE: ALTERNATIVE #1
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITICERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	3920000.0	.00	JUL 93
ELECTRICITY	2839518.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	1438757.0	3.11	JUL94-JUL18
MAINT LABOR	205977.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	178294.0	.00	JUL94-JUL18
F_FAN	11875.0	.00	JAN 17
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBURNER	57000.0	.00	JAN 17
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18
CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                           STUDY: DPSC
LCCID  1.065                    DATE/TIME:  11-16-92  10:15:06
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. B;   TITLE: ALTERNATIVE #1
NAME OF DESIGNER: SCI

               BASIC INPUT DATA SUMMARY

| HEATEXCH                  |  20500.0 |     .00     |     JAN 10 |
| SZSOFT                    | 363334.0 |     .00     |     JAN 09 |
====================================================================


                OTHER KEY INPUT DATA

     LOCATION  - PENNSYLVANNIA        CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90


ENERGY USAGE:  10**6 BTUS       ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT          26.21  108337.2         .0          JAN94-JAN19
NAT G           4.95  290658.0                     JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                    DATE/TIME:  11-16-92  10:15:06
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. B;   TITLE: ALTERNATIVE #1
NAME OF DESIGNER: SCI
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		3787268.
ENERGY COSTS:		
ELECTRICITY	43213020.	
NATURAL GAS	30341000.	
TOTAL ENERGY COSTS		73554020.
RECURRING M&R/CUSTODIAL COSTS		12122550.
MAJOR REPAIR/REPLACEMENT COSTS		605310.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		90069150.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

```
     LIFE CYCLE COST ANALYSIS                       STUDY: DPSC
LCCID  1.065                  DATE/TIME:  12-16-92  16:14:25
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. B;   TITLE: ALTERNATIVE #1 A
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS \$ (\$ X 10**3)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	3920.0	.00	JUL 93
ELECTRICITY	2525.2	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	1534.7	3.11	JUL94-JUL18
MAINT LABOR	206.0	.00	JUL94-JUL18
MAINT SERV	479.4	.00	JUL94-JUL18
MAINT SUPPLY	178.3	.00	JUL94-JUL18
F_FAN	11.9	.00	JAN 17
RELVALVE	1.2	.00	JAN 09
RELVALVE	1.2	.00	JAN 08
RELVALVE	3.3	.00	JAN 08
RELVALVE	3.3	.00	JAN 09
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
WTBOILER	725.0	.00	JAN 17
WTBURNER	57.0	.00	JAN 17
PUMPSIMPLEX	3.0	.00	JAN 12
TANKSTEEL	.5	.00	JAN 12
BOILMASTER	5.0	.00	JAN 07
FLAMESAFE	10.0	.00	JAN 07
AIRCOMPCENTR	34.8	.00	JAN 07
EMERGENCYGEN	174.0	.00	JAN 08
TRANSPCB	32.5	.00	JAN 18
CONDPUMP	18.8	.00	JAN 11
FWPIPINGVAL	7.8	.00	JAN 05
HEATER	8.0	.00	JAN 16
OILPIPEBELOW	14.4	.00	JAN 06
PUMP	10.2	.00	JAN 09
UNLOADPUMP	5.4	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                        STUDY: DPSC
LCCID  1.065                   DATE/TIME:  12-16-92  16:14:25
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. B;   TITLE: ALTERNATIVE #1
NAME OF DESIGNER: SCI

               BASIC INPUT DATA SUMMARY

| HEATEXCH                   |        20.5 |        .00    |          JAN 10   |
| SZSOFT                     |       363.3 |        .00    |          JAN 09   |
======================================================================


                OTHER KEY INPUT DATA

     LOCATION   - PENNSYLVANNIA         CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90


ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**3 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT           26.21   96345.2             .0       JAN94-JAN19
NAT G            4.95  310035.0                      JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                        STUDY: DPSC
LCCID  1.065                  DATE/TIME:  12-16-92  16:14:25
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. B;    TITLE: ALTERNATIVE #1 A
NAME OF DESIGNER: SCI
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		3787.
ENERGY COSTS:		
ELECTRICITY	38430.	
NATURAL GAS	32364.	
TOTAL ENERGY COSTS		70793.
RECURRING M&R/CUSTODIAL COSTS		12123.
MAJOR REPAIR/REPLACEMENT COSTS		605.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		87308.

*NET PW EQUIVALENTS ON OCT92; IN 10**3 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: DPSC
LCCID 1.065 DATE/TIME: 11-16-92 10:58:29
PROJECT NO., FY, & TITLE: 1 FY 1993 CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. C; TITLE: ALTERNATIVE #2- OPTION 1
NAME OF DESIGNER: SCI
ONE 1.6 MW Spark Gas Engine

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	7379000.0	.00	JUL 93
ELECTRICITY	1563778.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2016412.0	3.11	JUL94-JUL18
MAINT LABOR	230000.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	200000.0	.00	JUL94-JUL18
F FAN	11875.0	.00	JAN 17
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBURNER	57000.0	.00	JAN 17
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18
CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                    DATE/TIME:  11-16-92  10:58:29
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. C;   TITLE: ALTERNATIVE #2
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION  - PENNSYLVANNIA         CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	59663.4	.0	JAN94-JAN19
NAT G	4.95	407356.0		JAN94-JAN19

```
     LIFE CYCLE COST ANALYSIS                        STUDY: DPSC
LCCID  1.065                DATE/TIME:  11-16-92  10:58:29
PROJECT NO., FY, & TITLE: 1   FY 1993   CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. C;   TITLE: ALTERNATIVE #2
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                           7129146.

ENERGY COSTS:

ELECTRICITY                           23798250.
NATURAL GAS                           42522790.

TOTAL ENERGY COSTS                                66321030.

RECURRING M&R/CUSTODIAL COSTS                     12764400.

MAJOR REPAIR/REPLACEMENT COSTS                      605310.

OTHER O&M COSTS & MONETARY BENEFITS                     0.

DISPOSAL COSTS/RETENTION VALUE                          0.

LCC OF ALL COSTS/BENEFITS (NET PW)                86819880.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LIFE CYCLE COST ANALYSIS STUDY: DPSC
LCCID 1.065 DATE/TIME: 11-16-92 10:59:32
PROJECT NO., FY, & TITLE: 1 FY 1993 CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. C; TITLE: ALTERNATIVE #2 - OPTION 2
NAME OF DESIGNER: SCI
TWO 1.6 MW Spark Gas Engine

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	10837500.0	.00	JUL 93
ELECTRICITY	1563778.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2016412.0	3.11	JUL94-JUL18
MAINT LABOR	230000.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	200000.0	.00	JUL94-JUL18
F FAN	11875.0	.00	JAN 17
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBURNER	57000.0	.00	JAN 17
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18
CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04

```
        LIFE CYCLE COST ANALYSIS                        STUDY: DPSC
LCCID  1.065                         DATE/TIME:  11-16-92  10:59:32
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. C;   TITLE: ALTERNATIVE #2
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION   - PENNSYLVANNIA          CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

```
ENERGY USAGE:  10**6 BTUS         ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU    AMOUNT     ELECT. DEMAND  PROJECTED DATES
ELECT           26.21   59663.4           .0          JAN94-JAN19
NAT G            4.95  407356.0                       JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                           STUDY: DPSC
LCCID  1.065                 DATE/TIME:  11-16-92  10:59:32
PROJECT NO., FY, & TITLE: 1   FY 1993   CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. C;   TITLE: ALTERNATIVE #2
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                          10470540.

ENERGY COSTS:

ELECTRICITY                          23798250.
NATURAL GAS                          42522790.

TOTAL ENERGY COSTS                                66321030.

RECURRING M&R/CUSTODIAL COSTS                     12764400.

MAJOR REPAIR/REPLACEMENT COSTS                      605310.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                90161280.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

LIFE CYCLE COST ANALYSIS STUDY: PRP
LCCID 1.065 DATE/TIME: 12-07-92 14:29:24
PROJECT NO., FY, & TITLE: 1 FY 1993 CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. I; TITLE: 1 - 1100KW GAS TURBINE
NAME OF DESIGNER: SCI

Alternative No. 2 - OPTION 3

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**3)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	5715.0	.00	JUL 93
ELECTRICITY	2037.9	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	1798.8	3.11	JUL94-JUL18
MAINT LABOR	230.0	.00	JUL94-JUL18
MAINT SERV	479.4	.00	JUL94-JUL18
MAINT SUPPLY	200.0	.00	JUL94-JUL18
F_FAN	11.9	.00	JAN 17
RELVALVE	1.2	.00	JAN 09
RELVALVE	1.2	.00	JAN 08
RELVALVE	3.3	.00	JAN 08
RELVALVE	3.3	.00	JAN 09
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
WTBOILER	725.0	.00	JAN 17
WTBURNER	57.0	.00	JAN 17
PUMPSIMPLEX	3.0	.00	JAN 12
TANKSTEEL	.5	.00	JAN 12
BOILMASTER	5.0	.00	JAN 07
FLAMESAFE	10.0	.00	JAN 07
AIRCOMPCENTR	34.8	.00	JAN 07
EMERGENCYGEN	174.0	.00	JAN 08
TRANSPCB	32.5	.00	JAN 18
CONDPUMP	18.8	.00	JAN 11
FWPIPINGVAL	7.8	.00	JAN 05
HEATER	8.0	.00	JAN 16
OILPIPEBELOW	14.4	.00	JAN 06
PUMP	10.2	.00	JAN 09
UNLOADPUMP	5.4	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                          STUDY: PRP
LCCID  1.065                      DATE/TIME:  12-07-92  14:29:24
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. I;   TITLE: 1 - 1100KW GAS TURBINE
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20.5	.00	JAN 10
SZSOFT	363.3	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION  - PENNSYLVANNIA        CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**3 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	77751.6	.0	JAN94-JAN19
NAT G	4.95	363401.0		JAN94-JAN19

```
        LIFE CYCLE COST ANALYSIS                                   STUDY: PRP
LCCID  1.065                            DATE/TIME:  12-07-92  14:29:24
PROJECT NO., FY, & TITLE: 1    FY 1993      CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC      PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. I;    TITLE: 1 - 1100KW GAS TURBINE
NAME OF DESIGNER: SCI

                    LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                  5521.

ENERGY COSTS:

ELECTRICITY                                 31013.
NATURAL GAS                                 37934.

TOTAL ENERGY COSTS                                       68948.

RECURRING M&R/CUSTODIAL COSTS                            12764.

MAJOR REPAIR/REPLACEMENT COSTS                             605.

OTHER O&M COSTS & MONETARY BENEFITS                          0.

DISPOSAL COSTS/RETENTION VALUE                               0.

LCC OF ALL COSTS/BENEFITS (NET PW)                       87838.

*NET PW EQUIVALENTS ON OCT92; IN 10**3 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
     LIFE CYCLE COST ANALYSIS                             STUDY: PRP
LCCID  1.065                       DATE/TIME:   12-07-92  14:29:48
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. J;   TITLE: 2 - 1100KW GAS TURBINES
NAME OF DESIGNER: SCI
```

ALTERNATIVE 2- OPTION 4

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**3)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	7509.0	.00	JUL 93
ELECTRICITY	1268.3	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2152.3	3.11	JUL94-JUL18
MAINT LABOR	230.0	.00	JUL94-JUL18
MAINT SERV	479.4	.00	JUL94-JUL18
MAINT SUPPLY	200.0	.00	JUL94-JUL18
F_FAN	11.9	.00	JAN 17
RELVALVE	1.2	.00	JAN 09
RELVALVE	1.2	.00	JAN 08
RELVALVE	3.3	.00	JAN 08
RELVALVE	3.3	.00	JAN 09
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
WTBOILER	725.0	.00	JAN 17
WTBURNER	57.0	.00	JAN 17
PUMPSIMPLEX	3.0	.00	JAN 12
TANKSTEEL	.5	.00	JAN 12
BOILMASTER	5.0	.00	JAN 07
FLAMESAFE	10.0	.00	JAN 07
AIRCOMPCENTR	34.8	.00	JAN 07
EMERGENCYGEN	174.0	.00	JAN 08
TRANSPCB	32.5	.00	JAN 18
CONDPUMP	18.8	.00	JAN 11
FWPIPINGVAL	7.8	.00	JAN 05
HEATER	8.0	.00	JAN 16
OILPIPEBELOW	14.4	.00	JAN 06
PUMP	10.2	.00	JAN 09
UNLOADPUMP	5.4	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                           STUDY: PRP
LCCID  1.065                     DATE/TIME:  12-07-92  14:29:48
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. J;   TITLE: 2 - 1100KW GAS TURBINES
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20.5	.00	JAN 10
SZSOFT	363.3	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION  - PENNSYLVANNIA          CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**3 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	48390.7	.0	JAN94-JAN19
NAT G	4.95	434800.0		JAN94-JAN19

```
     LIFE CYCLE COST ANALYSIS                             STUDY: PRP
LCCID  1.065                   DATE/TIME:  12-07-92  14:29:48
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. J;   TITLE: 2 - 1100KW GAS TURBINES
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                              7255.

ENERGY COSTS:

ELECTRICITY                              19302.
NATURAL GAS                              45388.

TOTAL ENERGY COSTS                                   64689.

RECURRING M&R/CUSTODIAL COSTS                        12764.

MAJOR REPAIR/REPLACEMENT COSTS                         605.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                   85313.

*NET PW EQUIVALENTS ON OCT92; IN 10**3 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
        LIFE CYCLE COST ANALYSIS                              STUDY: PRP
LCCID  1.065                       DATE/TIME:  12-07-92  14:30:13
PROJECT NO., FY, & TITLE: 1    FY 1993     CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. K;    TITLE: 3 - 1100KW GAS TURBINES
NAME OF DESIGNER: SCI
```

ALTERNATIVE 2 - OPTION 5

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**3)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	9304.0	.00	JUL 93
ELECTRICITY	708.1	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2491.5	3.11	JUL94-JUL18
MAINT LABOR	230.0	.00	JUL94-JUL18
MAINT SERV	479.4	.00	JUL94-JUL18
MAINT SUPPLY	200.0	.00	JUL94-JUL18
F FAN	11.9	.00	JAN 17
RELVALVE	1.2	.00	JAN 09
RELVALVE	1.2	.00	JAN 08
RELVALVE	3.3	.00	JAN 08
RELVALVE	3.3	.00	JAN 09
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
WTBOILER	725.0	.00	JAN 17
WTBURNER	57.0	.00	JAN 17
PUMPSIMPLEX	3.0	.00	JAN 12
TANKSTEEL	.5	.00	JAN 12
BOILMASTER	5.0	.00	JAN 07
FLAMESAFE	10.0	.00	JAN 07
AIRCOMPCENTR	34.8	.00	JAN 07
EMERGENCYGEN	174.0	.00	JAN 08
TRANSPCB	32.5	.00	JAN 18
CONDPUMP	18.8	.00	JAN 11
FWPIPINGVAL	7.8	.00	JAN 05
HEATER	8.0	.00	JAN 16
OILPIPEBELOW	14.4	.00	JAN 06
PUMP	10.2	.00	JAN 09
UNLOADPUMP	5.4	.00	JAN 04

```
        LIFE CYCLE COST ANALYSIS                              STUDY: PRP
LCCID  1.065                          DATE/TIME:  12-07-92  14:30:13
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. K;   TITLE: 3 - 1100KW GAS TURBINES
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20.5	.00	JAN 10
SZSOFT	363.3	.00	JAN 09

OTHER KEY INPUT DATA

```
LOCATION  - PENNSYLVANNIA           CENSUS REGION:  1
RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**3 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	27016.2	.0	JAN94-JAN19
NAT G	4.95	503343.0		JAN94-JAN19

```
   LIFE CYCLE COST ANALYSIS                            STUDY: PRP
LCCID  1.065                        DATE/TIME:   12-09-92  10:50:56
PROJECT NO., FY, & TITLE: 1    FY 1993     CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. L;    TITLE: 3500 KW GAS TURBINE
NAME OF DESIGNER: SCI
```

ALTERNATIVE 2 - OPTION 6

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**3)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	7115.0	.00	JUL 93
ELECTRICITY	640.4	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2400.9	3.11	JUL94-JUL18
MAINT LABOR	230.0	.00	JUL94-JUL18
MAINT SERV	479.4	.00	JUL94-JUL18
MAINT SUPPLY	200.0	.00	JUL94-JUL18
F FAN	11.9	.00	JAN 17
RELVALVE	1.2	.00	JAN 09
RELVALVE	1.2	.00	JAN 08
RELVALVE	3.3	.00	JAN 08
RELVALVE	3.3	.00	JAN 09
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
WTBOILER	725.0	.00	JAN 17
WTBURNER	57.0	.00	JAN 17
PUMPSIMPLEX	3.0	.00	JAN 12
TANKSTEEL	.5	.00	JAN 12
BOILMASTER	5.0	.00	JAN 07
FLAMESAFE	10.0	.00	JAN 07
AIRCOMPCENTR	34.8	.00	JAN 07
EMERGENCYGEN	174.0	.00	JAN 08
TRANSPCB	32.5	.00	JAN 18
CONDPUMP	18.8	.00	JAN 11
FWPIPINGVAL	7.8	.00	JAN 05
HEATER	8.0	.00	JAN 16
OILPIPEBELOW	14.4	.00	JAN 06
PUMP	10.2	.00	JAN 09
UNLOADPUMP	5.4	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                          STUDY: PRP
LCCID  1.065                  DATE/TIME:  12-07-92  14:30:13
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. K;   TITLE: 3 - 1100KW GAS TURBINES
NAME OF DESIGNER: SCI
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		8989.
ENERGY COSTS:		
ELECTRICITY	10776.	
NATURAL GAS	52543.	
TOTAL ENERGY COSTS		63319.
RECURRING M&R/CUSTODIAL COSTS		12764.
MAJOR REPAIR/REPLACEMENT COSTS		605.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		85677.

*NET PW EQUIVALENTS ON OCT92; IN 10**3 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

```
     LIFE CYCLE COST ANALYSIS                          STUDY: PRP
LCCID  1.065                  DATE/TIME:  12-09-92  10:50:56
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. L;   TITLE: 3500 KW GAS TURBINE
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20.5	.00	JAN 10
SZSOFT	363.3	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION  - PENNSYLVANNIA        CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

```
ENERGY USAGE:  10**6 BTUS       ELECTRIC DEMAND: 10**3 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT          26.21   24432.7          .0          JAN94-JAN19
NAT G           4.95  485022.0                      JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                             STUDY: PRP
LCCID  1.065                 DATE/TIME:  12-09-92  10:50:56
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. L;   TITLE: 3500 KW GAS TURBINE
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                              6874.

ENERGY COSTS:

ELECTRICITY                               9746.
NATURAL GAS                              50630.

TOTAL ENERGY COSTS                                   60376.

RECURRING M&R/CUSTODIAL COSTS                        12764.

MAJOR REPAIR/REPLACEMENT COSTS                         605.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                   80619.

*NET PW EQUIVALENTS ON OCT92; IN 10**3 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                      DATE/TIME:  11-18-92  14:13:31
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. D;   TITLE: ALTERNATIVE #3 - OPTION 1
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	11833500.0	.00	JUL 93
ELECTRICITY	1536936.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2429480.0	3.11	JUL94-JUL18
MAINT LABOR	230000.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	200000.0	.00	JUL94-JUL18
F FAN	11875.0	.00	JAN 17
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBURNER	57000.0	.00	JAN 17
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18
CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04

```
     LIFE CYCLE COST ANALYSIS                              STUDY: DPSC
LCCID  1.065                      DATE/TIME:  11-18-92  14:13:31
PROJECT NO., FY, & TITLE: 1   FY 1993   CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. D;   TITLE: ALTERNATIVE #3
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
LOCATION  - PENNSYLVANNIA        CENSUS REGION:  1
RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	58639.3	.0	JAN94-JAN19
NAT G	4.95	490804.0		JAN94-JAN19

```
     LIFE CYCLE COST ANALYSIS                           STUDY: DPSC
LCCID  1.065                    DATE/TIME:  11-18-92  14:13:31
PROJECT NO., FY, & TITLE: 1    FY 1993     CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. D;   TITLE: ALTERNATIVE #3
NAME OF DESIGNER: SCI
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		11432820.
ENERGY COSTS:		
ELECTRICITY	23389760.	
NATURAL GAS	51233710.	
TOTAL ENERGY COSTS		74623460.
RECURRING M&R/CUSTODIAL COSTS		12764400.
MAJOR REPAIR/REPLACEMENT COSTS		605310.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		99425980.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90

LIFE CYCLE COST ANALYSIS STUDY: PRP
LCCID 1.065 DATE/TIME: 12-09-92 11:08:49
PROJECT NO., FY, & TITLE: 1 FY 1993 CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. L; TITLE: 3500 KW GAS TURBINE
NAME OF DESIGNER: SCI

ALTERNATIVE 3 - OPTION 2

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**3)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	7983.8	.00	JUL 93
ELECTRICITY	467.3	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2655.4	3.11	JUL94-JUL18
MAINT LABOR	230.0	.00	JUL94-JUL18
MAINT SERV	479.4	.00	JUL94-JUL18
MAINT SUPPLY	200.0	.00	JUL94-JUL18
F FAN	11.9	.00	JAN 17
RELVALVE	1.2	.00	JAN 09
RELVALVE	1.2	.00	JAN 08
RELVALVE	3.3	.00	JAN 08
RELVALVE	3.3	.00	JAN 09
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
RELVALVE	2.0	.00	JAN 10
WTBOILER	725.0	.00	JAN 17
WTBURNER	57.0	.00	JAN 17
PUMPSIMPLEX	3.0	.00	JAN 12
TANKSTEEL	.5	.00	JAN 12
BOILMASTER	5.0	.00	JAN 07
FLAMESAFE	10.0	.00	JAN 07
AIRCOMPCENTR	34.8	.00	JAN 07
EMERGENCYGEN	174.0	.00	JAN 08
TRANSPCB	32.5	.00	JAN 18
CONDPUMP	18.8	.00	JAN 11
FWPIPINGVAL	7.8	.00	JAN 05
HEATER	8.0	.00	JAN 16
OILPIPEBELOW	14.4	.00	JAN 06
PUMP	10.2	.00	JAN 09
UNLOADPUMP	5.4	.00	JAN 04

```
      LIFE CYCLE COST ANALYSIS                             STUDY: PRP
LCCID  1.065                        DATE/TIME:  12-09-92  11:08:49
PROJECT NO., FY, & TITLE: 1   FY 1993   CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. L;   TITLE: 3500 KW GAS TURBINE
NAME OF DESIGNER: SCI

                    BASIC INPUT DATA SUMMARY

| HEATEXCH                          |   20.5 |     .00     |     JAN 10   |
| SZSOFT                            |  363.3 |     .00     |     JAN 09   |
=====================================================================


                     OTHER KEY INPUT DATA

      LOCATION  - PENNSYLVANNIA         CENSUS REGION:  1
      RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90


ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**3 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT     ELECT. DEMAND  PROJECTED DATES
ELECT          26.21    17828.5          .0          JAN94-JAN19
NAT G           4.95   536454.0                      JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                            STUDY: PRP
LCCID  1.065                  DATE/TIME:  12-09-92  11:08:49
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. L;   TITLE: 3500 KW GAS TURBINE
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                  7713.

ENERGY COSTS:

ELECTRICITY                                  7111.
NATURAL GAS                                 55999.

TOTAL ENERGY COSTS                                       63110.

RECURRING M&R/CUSTODIAL COSTS                            12764.

MAJOR REPAIR/REPLACEMENT COSTS                             605.

OTHER O&M COSTS & MONETARY BENEFITS                          0.

DISPOSAL COSTS/RETENTION VALUE                               0.

LCC OF ALL COSTS/BENEFITS (NET PW)                       84192.


*NET PW EQUIVALENTS ON OCT92; IN 10**3 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                     DATE/TIME:  11-18-92  14:16:10
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. E;   TITLE: ALTERNATIVE #4
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	2452500.0	.00	JUL 93
ELECTRICITY	2839518.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	1438757.0	3.11	JUL94-JUL18
MAINT LABOR	205977.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	178294.0	.00	JUL94-JUL18
DRUMCTL	10000.0	.00	JAN 01
F_FAN	11875.0	.00	JAN 17
F_FAN	44000.0	.00	JAN 01
I_FAN	50000.0	.00	JAN 01
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBOILER	2600000.0	.00	JAN 01
WTBURNER	57000.0	.00	JAN 17
WTBURNER	206666.0	.00	JAN 01
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	10000.0	.00	JAN 01
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                    DATE/TIME:  11-18-92  14:16:10
PROJECT NO., FY, & TITLE: 1   FY 1993   CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. E;   TITLE: ALTERNATIVE #4
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04
HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
LOCATION  - PENNSYLVANNIA          CENSUS REGION:  1
RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	108337.2	.0	JAN94-JAN19
NAT G	4.95	290658.0		JAN94-JAN19

```
     LIFE CYCLE COST ANALYSIS                            STUDY: DPSC
LCCID  1.065                      DATE/TIME:  11-18-92  14:16:10
PROJECT NO., FY, & TITLE: 1   FY 1993     CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. E;   TITLE: ALTERNATIVE #4
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                           2369458.

ENERGY COSTS:

ELECTRICITY                          43213020.
NATURAL GAS                          30341000.

TOTAL ENERGY COSTS                                73554020.

RECURRING M&R/CUSTODIAL COSTS                     12122550.

MAJOR REPAIR/REPLACEMENT COSTS                     2604812.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                90650840.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                 DATE/TIME:   11-18-92  14:18:11
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. F;   TITLE: ALTERNATIVE #5
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	9369900.0	.00	JUL 93
ELECTRICITY	1563778.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2016412.0	3.11	JUL94-JUL18
MAINT LABOR	230000.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	200000.0	.00	JUL94-JUL18
DRUMCTL	10000.0	.00	JAN 01
F_FAN	11875.0	.00	JAN 17
F_FAN	44000.0	.00	JAN 01
I_FAN	50000.0	.00	JAN 01
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBOILER	2600000.0	.00	JAN 01
WTBURNER	57000.0	.00	JAN 17
WTBURNER	206666.0	.00	JAN 01
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	10000.0	.00	JAN 01
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18

```
     LIFE CYCLE COST ANALYSIS                         STUDY: DPSC
LCCID  1.065                   DATE/TIME:  11-18-92  14:18:11
PROJECT NO., FY, & TITLE: 1    FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC     PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. F;   TITLE: ALTERNATIVE #5
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04
HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION   - PENNSYLVANNIA         CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

```
ENERGY USAGE:  10**6 BTUS        ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT     ELECT. DEMAND  PROJECTED DATES
ELECT          26.21   59663.4             .0        JAN94-JAN19
NAT G           4.95  407356.0                       JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                        STUDY: DPSC
LCCID  1.065                DATE/TIME:  11-18-92  14:18:11
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. F;   TITLE: ALTERNATIVE #5
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                        9052634.

ENERGY COSTS:

ELECTRICITY                        23798250.
NATURAL GAS                        42522790.

TOTAL ENERGY COSTS                             66321030.

RECURRING M&R/CUSTODIAL COSTS                  12764400.

MAJOR REPAIR/REPLACEMENT COSTS                  2604812.

OTHER O&M COSTS & MONETARY BENEFITS                  0.

DISPOSAL COSTS/RETENTION VALUE                       0.

LCC OF ALL COSTS/BENEFITS (NET PW)             90742870.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
     LIFE CYCLE COST ANALYSIS                         STUDY: BRENT
LCCID  1.065                  DATE/TIME:  11-18-92  14:21:47
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. K;   TITLE: ALTERNATIVE #6-REVISED
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	10238700.0	.00	JUL 93
ELECTRICITY	1536936.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	2429480.0	3.11	JUL94-JUL18
MAINT LABOR	230000.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	200000.0	.00	JUL94-JUL18
DRUMCTL	10000.0	.00	JAN 01
F_FAN	11875.0	.00	JAN 17
F_FAN	44000.0	.00	JAN 01
I_FAN	50000.0	.00	JAN 01
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBOILER	2600000.0	.00	JAN 01
WTBURNER	57000.0	.00	JAN 17
WTBURNER	206666.0	.00	JAN 01
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	10000.0	.00	JAN 01
BOILMASTER	5000.0	.00	JAN 07
FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
EMERGENCYGEN	174000.0	.00	JAN 08
TRANSPCB	32500.0	.00	JAN 18

```
     LIFE CYCLE COST ANALYSIS                            STUDY: BRENT
LCCID  1.065                    DATE/TIME:  11-18-92  14:21:47
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. K;   TITLE: ALTERNATIVE #6-REVISED
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CONDPUMP	18750.0	.00	JAN 11
FWPIPINGVAL	7800.0	.00	JAN 05
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
UNLOADPUMP	5400.0	.00	JAN 04
HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
     LOCATION  - PENNSYLVANNIA          CENSUS REGION:  1
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90


ENERGY USAGE:  10**6 BTUS       ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
ELECT          26.21   58639.3          .0         JAN94-JAN19
NAT G           4.95  490804.0                     JAN94-JAN19
```

```
     LIFE CYCLE COST ANALYSIS                         STUDY: BRENT
LCCID  1.065                 DATE/TIME:  11-18-92  14:21:47
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. K;   TITLE: ALTERNATIVE #6-REVISED
NAME OF DESIGNER: SCI

               LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                         9892016.

ENERGY COSTS:

ELECTRICITY                         23389760.
NATURAL GAS                         51233710.

TOTAL ENERGY COSTS                              74623460.

RECURRING M&R/CUSTODIAL COSTS                   12764400.

MAJOR REPAIR/REPLACEMENT COSTS                   2604812.

OTHER O&M COSTS & MONETARY BENEFITS                   0.

DISPOSAL COSTS/RETENTION VALUE                        0.

LCC OF ALL COSTS/BENEFITS (NET PW)              99884690.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                 DATE/TIME:  10-23-92  11:34:41
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.7%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	OCT 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 93
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 94
ANALYSIS END DATE (AED)	JAN 19

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUL 93
ELECTRICITY	2839518.0	.66	JUL94-JUL18
ELECT DEMAND	.0	.00	JUL94-JUL18
NATURAL GAS	1534673.0	3.11	JUL94-JUL18
MAINT LABOR	205977.0	.00	JUL94-JUL18
MAINT SERV	479420.0	.00	JUL94-JUL18
MAINT SUPPLY	178294.0	.00	JUL94-JUL18
BREECHING	20000.0	.00	JAN 01
STACK	20000.0	.00	JAN 01
AIRPHEAT	8570.0	.00	JAN 93
DRUMCTL	10000.0	.00	JAN 01
DRUMCTL	5000.0	.00	JAN 97
F_FAN	11875.0	.00	JAN 17
F_FAN	44000.0	.00	JAN 01
I_FAN	50000.0	.00	JAN 01
RELVALVE	1235.0	.00	JAN 09
RELVALVE	1175.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 08
RELVALVE	3280.0	.00	JAN 09
RELVALVE	2025.0	.00	JAN 10
RELVALVE	2045.0	.00	JAN 10
RELVALVE	2048.0	.00	JAN 10
RELVALVE	2040.0	.00	JAN 10
WTBOILER	725000.0	.00	JAN 17
WTBOILER	2600000.0	.00	JAN 01
WTBURNER	57000.0	.00	JAN 17
WTBURNER	206666.0	.00	JAN 01
PUMPSIMPLEX	3000.0	.00	JAN 12
TANKSTEEL	500.0	.00	JAN 12
BOILMASTER	10000.0	.00	JAN 01
BOILMASTER	5000.0	.00	JAN 07

```
     LIFE CYCLE COST ANALYSIS                          STUDY: DPSC
LCCID  1.065                  DATE/TIME:  10-23-92  11:34:41
PROJECT NO., FY, & TITLE: 1    FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC      PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER: SCI
```

BASIC INPUT DATA SUMMARY

FLAMESAFE	10000.0	.00	JAN 07
AIRCOMPCENTR	34800.0	.00	JAN 07
AIRRECV	600.0	.00	JAN 93
EMERGENCYGEN	174000.0	.00	JAN 08
SWITCH	48000.0	.00	JAN 93
SWITCH	14667.0	.00	JAN 93
SWITCH	56500.0	.00	JAN 93
TRANSPCB	32500.0	.00	JAN 18
CONDPUMP	18750.0	.00	JAN 11
CONDREC	56000.0	.00	JAN 93
EXPTANK	30500.0	.00	JAN 93
FEEDPUMP	43000.0	.00	JAN 10
FWPIPINGVAL	7800.0	.00	JAN 05
WATERSTOR	27600.0	.00	JAN 93
HEATER	8000.0	.00	JAN 16
OILPIPEBELOW	14400.0	.00	JAN 06
PUMP	10200.0	.00	JAN 09
TANKABOVE	245400.0	.00	JAN 93
TANKBELOW	170000.0	.00	JAN 93
UNLOADPUMP	5400.0	.00	JAN 04
FLASHTANK	2675.0	.00	JAN 93
HEATEXCH	20500.0	.00	JAN 10
SZSOFT	363334.0	.00	JAN 09

OTHER KEY INPUT DATA

```
LOCATION  - PENNSYLVANNIA          CENSUS REGION:  1
RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 90
```

ENERGY USAGE:	10**6 BTUS		ELECTRIC DEMAND: 10**0 DOLLARS	
ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
ELECT	26.21	108337.2	.0	JAN94-JAN19
NAT G	4.95	310035.0		JAN94-JAN19

```
        LIFE CYCLE COST ANALYSIS                        STUDY: DPSC
LCCID  1.065                 DATE/TIME:  10-23-92  11:34:41
PROJECT NO., FY, & TITLE: 1   FY 1993    CENTRAL HEATING PLANT MOD
INSTALLATION & LOCATION: DPSC    PENNSYLVANNIA
DESIGN FEATURE: STATQUO
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER: SCI

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                0.

ENERGY COSTS:

ELECTRICITY                        43213020.
NATURAL GAS                        32363710.

TOTAL ENERGY COSTS                              75576730.

RECURRING M&R/CUSTODIAL COSTS                   12122550.

MAJOR REPAIR/REPLACEMENT COSTS                   2655780.

OTHER O&M COSTS & MONETARY BENEFITS                     0.

DISPOSAL COSTS/RETENTION VALUE                          0.

LCC OF ALL COSTS/BENEFITS (NET PW)              90355060.

*NET PW EQUIVALENTS ON OCT92; IN 10**0 DOLLARS; IN CONSTANT OCT92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 90
```

Appendix G: STOFEAS Analysis

Data Input Descriptions

Array 1. PROJECT DESCRIPTION - contains information that identifies the project when the program generates its output.

Array 2. ECONOMIC PARAMETERS - contains the elements "STUDY LIFE" which is needed to calculate the SIR and "INTEREST RATE" which is used to calculate the compensated rate of actual saving.

Array 3. ELECTRIC UTILITY RATE - used to calculate the annual demand charge savings per kW shifted.

Array 4. WINDOW SIZE - contains information for the shifted power percentage and is used to calculate the cost of demand shifting.

Array 5. ELECTRIC UTILITY DATA - contains the elements "PEAK DEMAND" (in kW) and "UTILITY INCENTIVE" ($/kW)(in 1000 kWh).

Array 6. SYSTEM FIRST COST - the cost of an SCS is one of the critical factors in determining the payback period (PBP).

Array 7. SCALE OF ECONOMY FOR FIRST COST - specifies the costs of installment for the three different types of applications: new/replacement, retrofit, and upper limit.

Array 8. The data in this array are required by the "SYSTEM OPERATION" and "MAINTENANCE COST" model. The costs for system operation and maintenance can be interpreted as the extra differential cost for a new SCS.

Array 9. ANNUAL DEMAND CHARGE ESCALATION RATE - allows for specification of the projected escalation rate of the demand charge in upcoming years.

Report Column Descriptions

1. Percentage peak power shifted by the SCS.

2. Corresponding shifted power (in kW) by SCS with respect to the percentage given in column 1.

3. Required storage capacity (or size) in terms of ton-hours for the specified shifted power in column 2.

4. System First Cost in terms of thousands of dollars for the corresponding storage capacity in column 3.

5. First Year Savings in terms of thousands of dollars for the corresponding shifted power in column 2.

6. Simple payback period based on the nondiscounted interest rate for the corresponding shifted power.

7. Discounted payback period based on the specified discounted interest rate (similar to column 6).

8. Savings and Investment Ratio (SIR), a valuable economic parameter for the feasibility study.

9. Net Savings in thousands of dollars under the specified percentage peak power shifted, the input Electric Demand Charge, and the System First Cost Model.

FEASIBILITY REPORT ON STORAGE COOLING SYSTEMS

***** PROJECT DESCRIPTION *****

PROJECT TITLE: DPSC Modernization
PROJECT LOCATION: Philadelphia, PA
PROJECT YEAR: FY92
PROJECT NUMBER: N/A
CAT CODE: N/A
DESIGNER: M. Savoie
DATE: 12-04-1992

***** INPUT DATA *****

STUDY LIFE : 25yrs   DISCOUNT RATE : 5%

***** ELECTRIC UTILITY RATE STRUCTURE *****

--- STRAIGHT DEMAND (TWO DEMAND CHARGES) ---

DEMAND CHARGE ($/kW) IN SUMMER: 13.00000
DEMAND CHARGE ($/kW) IN WINTER: 8.00000

***** WINDOW SIZE FOR SHIFTED POWER PERCENTAGE ****

1- 3%	4- 6%	7- 9%	10- 12%	13- 15%	16- 18%	19- 21%	22- 24%
7 hr	8 hr	8 hr	8 hr	8 hr	8 hr	8 hr	8 hr

***** ELECTRIC UTILITY DATA *****

YEARLY PEAK DEMAND (kW):   7,500.00
UTILITY INCENTIVE ($/kW):   0.00

***** SYSTEM FIRST COST MODEL *****

NEW/REPLACEMENT ($/ton-hr)	RETROFIT ($/ton-hr)	UPPER LIMIT ($/ton-hr)
80	150	300

***** ECONOMY OF SCALE FOR FIRST COST *****

Small(<1000 t-h)	Medium	Large(>10kt-h)
1	.87	.77

***** SYSTEM O&M COST MODEL *****

PERCENT OF SYSTEM FIRST COST(%)

0

***** EXPECTED ANNUAL DEMAND CHARGE ESCALATION RATE *****

1	2	3	4	5	(YEAR)
-.065	1.3639	.7049	-.2549	.9573	(%)
6	7	8	9	10	(YEAR)
1.0104	1.1256	1.8555	1.7	.4775	(%)
11	12	13	14	15	(YEAR)
.7133	.9436	1.2852	.8083	.9729	(%)
16	17	18	19	20	(YEAR)
.0568	.3964	1.7497	.6103	.6142	(%)
21	22	23	24	25	(YEAR)
.6163	.6201	.623	.6257	.6293	(%)

***** New/Replacement *****

Shift (%)	Shifted (kW)	Storage Sz(ton-hr)	System 1st Cst(1000$)	1st yr Svns(1000$)	Payback Smpl	Payback Dsct	SIR	Net Svng (1000$)
1	75	525	42	8	5.0	6.0	3.1	87
2	150	1,050	73	17	4.4	5.0	3.5	185
3	225	1,575	110	25	4.4	5.0	3.5	277
4	300	2,400	167	33	5.0	6.0	3.1	349
5	375	3,000	209	42	5.0	6.0	3.1	436
6	450	3,600	251	50	5.0	6.0	3.1	523
7	525	4,200	292	58	5.0	6.0	3.1	610
8	600	4,800	334	67	5.0	6.0	3.1	697
9	675	5,400	376	75	5.0	6.0	3.1	785
10	750	6,000	418	83	5.0	6.0	3.1	872
11	825	6,600	459	92	5.0	6.0	3.1	959
12	900	7,200	501	100	5.0	6.0	3.1	1,046
13	975	7,800	543	108	5.0	6.0	3.1	1,133
14	1,050	8,400	585	117	5.0	6.0	3.1	1,220
15	1,125	9,000	626	125	5.0	6.0	3.1	1,308
16	1,200	9,600	668	133	5.0	6.0	3.1	1,395
17	1,275	10,200	628	142	4.4	6.0	3.5	1,564
18	1,350	10,800	665	150	4.4	6.0	3.5	1,656
19	1,425	11,400	702	158	4.4	6.0	3.5	1,747
20	1,500	12,000	739	167	4.4	6.0	3.5	1,839
21	1,575	12,600	776	175	4.4	6.0	3.5	1,931
22	1,650	13,200	813	183	4.4	6.0	3.5	2,023
23	1,725	13,800	850	191	4.4	6.0	3.5	2,115
24	1,800	14,400	887	200	4.4	6.0	3.5	2,207
25	1,875	15,000	924	208	4.4	6.0	3.5	2,299

* Annual O&M Cost is assumed to be 0% of system cost.

***** Retrofit Case *****

Shift (%)	Shifted (kW)	Storage Sz(ton-hr)	System 1st Cst(1000$)	1st yr Svns(1000$)	Payback Smpl	Payback Dsct	SIR	Net Svng (1000$)
1	75	525	79	8	9.5	13.0	1.6	50
2	150	1,050	137	17	8.2	11.0	1.9	121
3	225	1,575	206	25	8.2	11.0	1.9	181
4	300	2,400	313	33	9.4	12.0	1.6	203
5	375	3,000	392	42	9.4	12.0	1.6	253
6	450	3,600	470	50	9.4	12.0	1.6	304
7	525	4,200	548	58	9.4	12.0	1.6	354
8	600	4,800	626	67	9.4	12.0	1.6	405
9	675	5,400	705	75	9.4	12.0	1.6	456
10	750	6,000	783	83	9.4	12.0	1.6	506
11	825	6,600	861	92	9.4	12.0	1.6	557
12	900	7,200	940	100	9.4	12.0	1.6	608
13	975	7,800	1,018	108	9.4	12.0	1.6	658
14	1,050	8,400	1,096	117	9.4	12.0	1.6	709
15	1,125	9,000	1,175	125	9.4	12.0	1.6	759
16	1,200	9,600	1,253	133	9.4	12.0	1.6	810
17	1,275	10,200	1,178	142	8.3	11.0	1.9	1,014
18	1,350	10,800	1,247	150	8.3	11.0	1.9	1,073
19	1,425	11,400	1,317	158	8.3	11.0	1.9	1,133
20	1,500	12,000	1,386	167	8.3	11.0	1.9	1,193
21	1,575	12,600	1,455	175	8.3	11.0	1.9	1,252
22	1,650	13,200	1,525	183	8.3	11.0	1.9	1,312
23	1,725	13,800	1,594	191	8.3	11.0	1.9	1,372
24	1,800	14,400	1,663	200	8.3	11.0	1.9	1,431
25	1,875	15,000	1,733	208	8.3	11.0	1.9	1,491

* Annual O&M Cost is assumed to be 0% of system cost.

***** Upper Limit Case *****

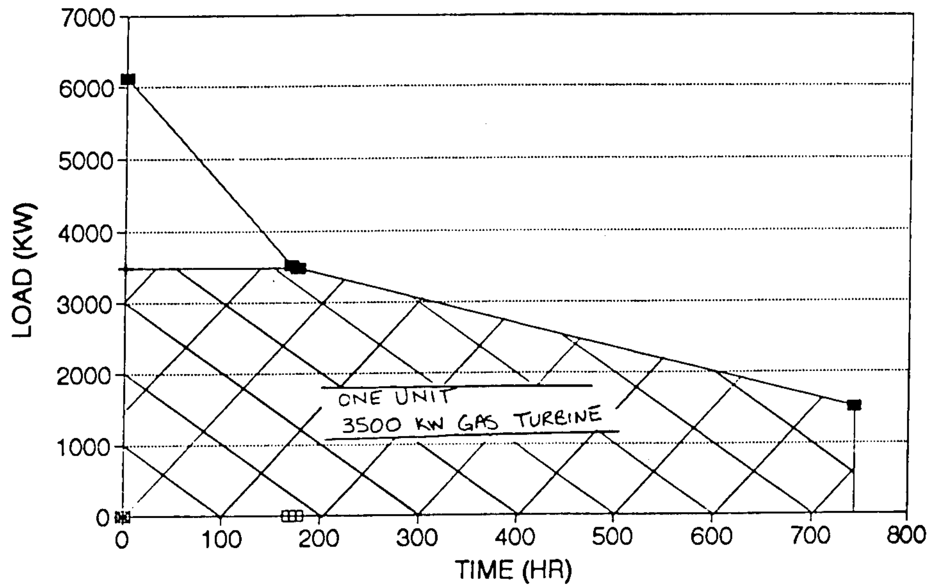
Shift (%)	Shifted (kW)	Storage Sz(ton-hr)	System 1st Cst(1000$)	1st yr Svns(1000$)	Payback Smpl	Payback Dsct	SIR	Net Svng (1000$)
1	75	525	158	8	18.9	**.*	0.8	-29
2	150	1,050	274	17	16.5	**.*	0.9	-16
3	225	1,575	411	25	16.5	**.*	0.9	-24
4	300	2,400	626	33	18.8	**.*	0.8	-111
5	375	3,000	783	42	18.8	**.*	0.8	-138
6	450	3,600	940	50	18.8	**.*	0.8	-166
7	525	4,200	1,096	58	18.8	**.*	0.8	-194
8	600	4,800	1,253	67	18.8	**.*	0.8	-221
9	675	5,400	1,409	75	18.8	**.*	0.8	-249
10	750	6,000	1,566	83	18.8	**.*	0.8	-277
11	825	6,600	1,723	92	18.8	**.*	0.8	-304
12	900	7,200	1,879	100	18.8	**.*	0.8	-332
13	975	7,800	2,036	108	18.8	**.*	0.8	-360
14	1,050	8,400	2,192	117	18.8	**.*	0.8	-387
15	1,125	9,000	2,349	125	18.8	**.*	0.8	-415
16	1,200	9,600	2,506	133	18.8	**.*	0.8	-443
17	1,275	10,200	2,356	142	16.6	**.*	0.9	-164
18	1,350	10,800	2,495	150	16.6	**.*	0.9	-174
19	1,425	11,400	2,633	158	16.6	**.*	0.9	-184
20	1,500	12,000	2,772	167	16.6	**.*	0.9	-193
21	1,575	12,600	2,911	175	16.6	**.*	0.9	-203
22	1,650	13,200	3,049	183	16.6	**.*	0.9	-213
23	1,725	13,800	3,188	191	16.6	**.*	0.9	-222
24	1,800	14,400	3,326	200	16.6	**.*	0.9	-232
25	1,875	15,000	3,465	208	16.6	**.*	0.9	-242

* Annual O&M Cost is assumed to be 0% of system cost.

Appendix H: Monthly Electric Load Curves for Alternative 2, Option 6

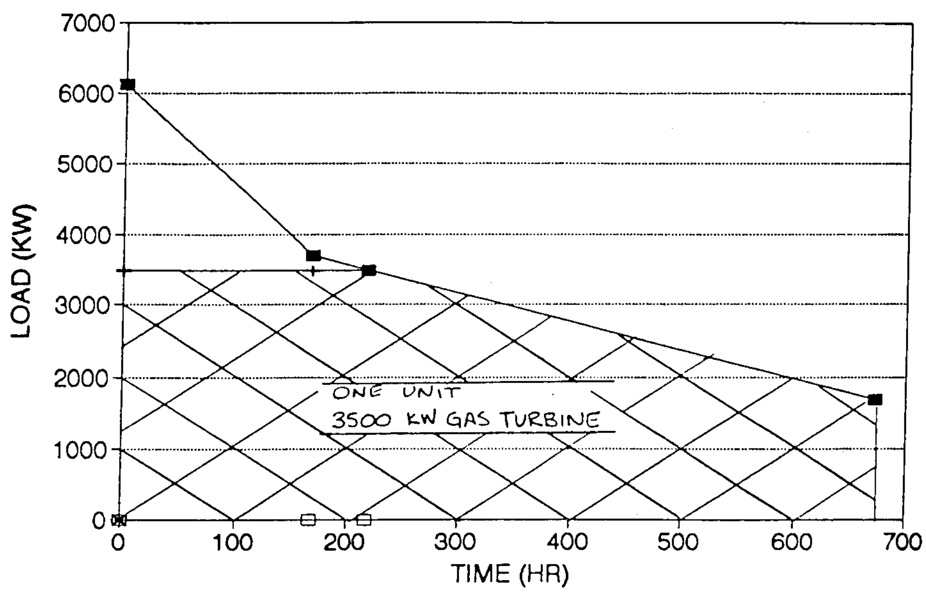
DPSC LOAD DURATION CURVE

3500 KW GAS TURBINE JANUARY



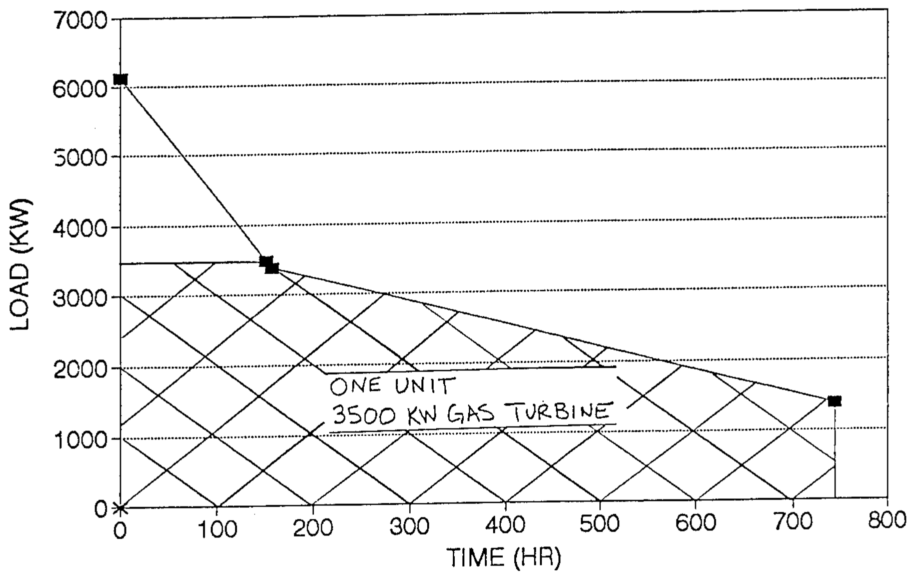
DPSC LOAD DURATION CURVE

3500 KW GAS TURBINE FEBRUARY



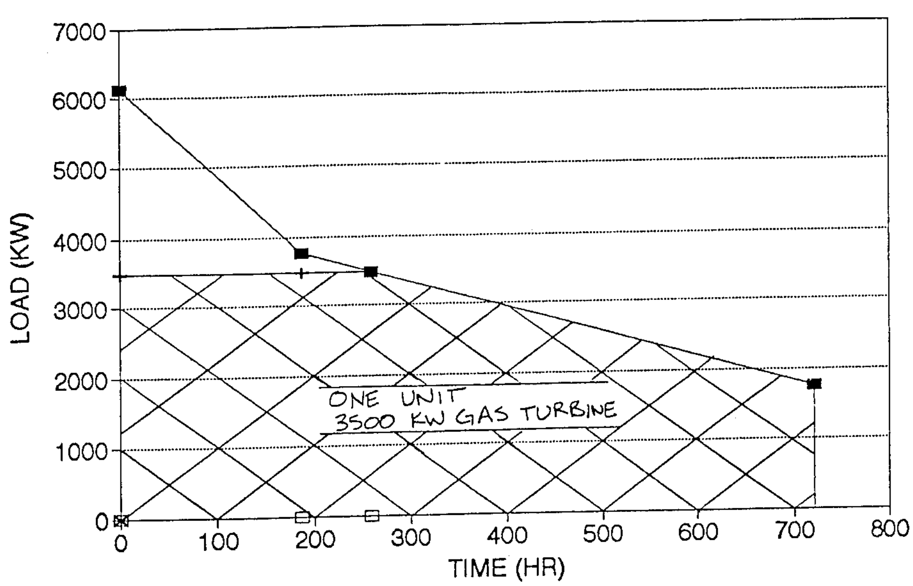
DPSC LOAD DURATION CURVE

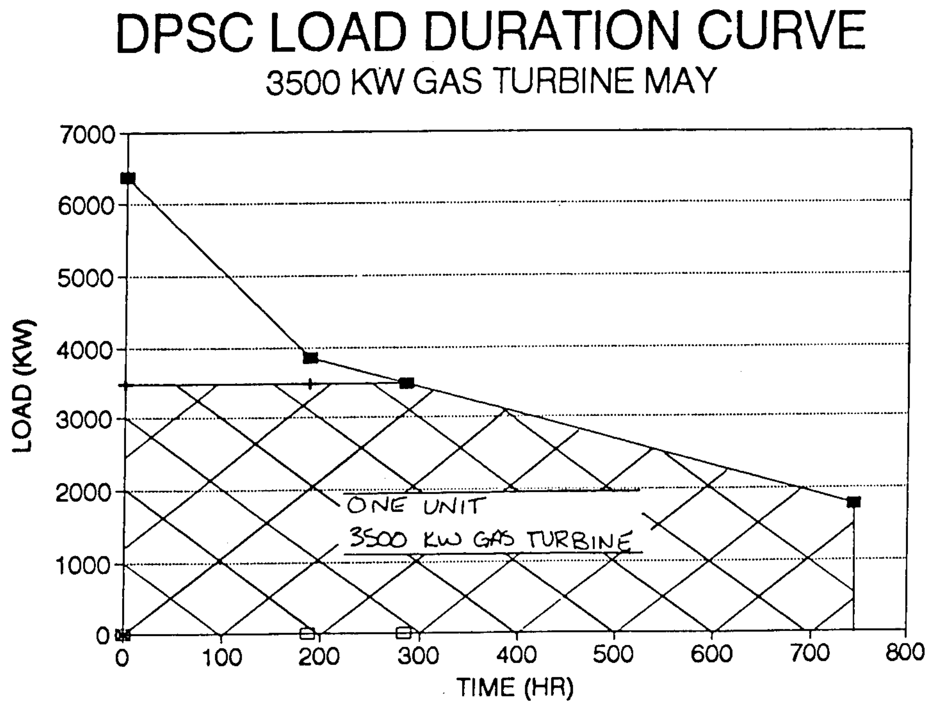
3500 KW GAS TURBINE MARCH

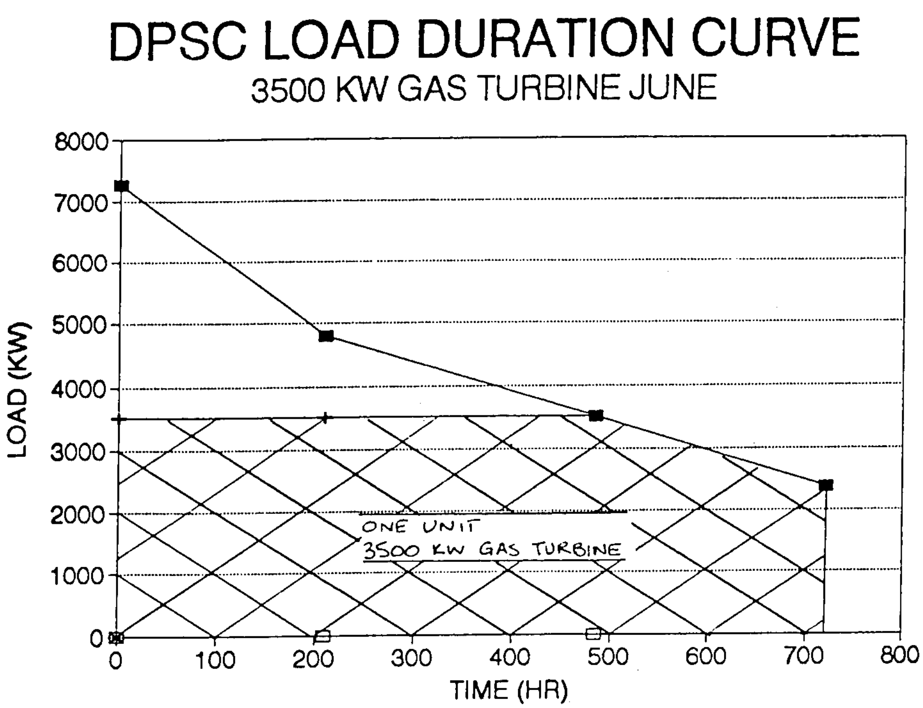


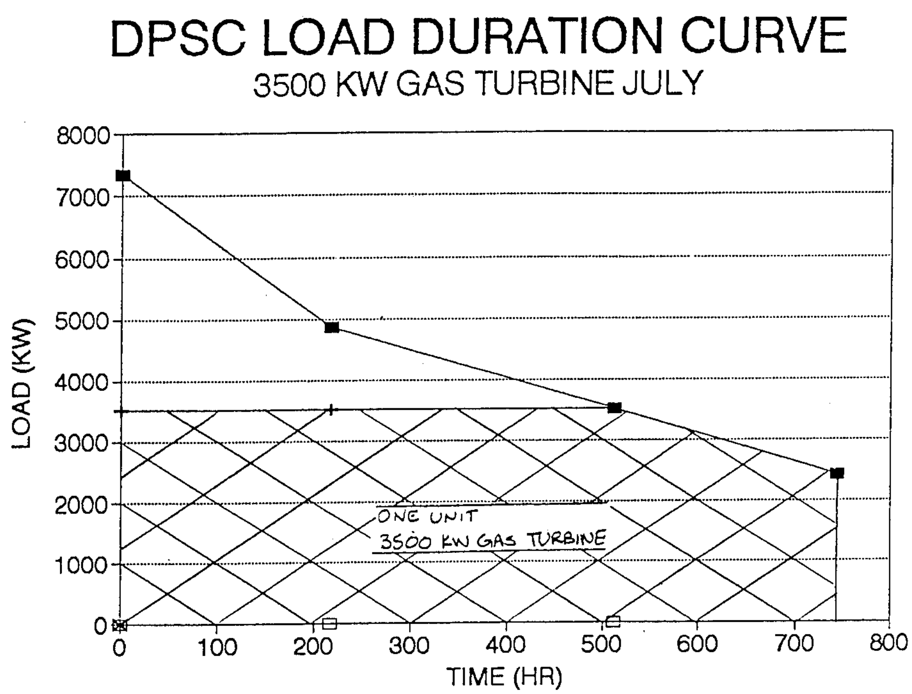
DPSC LOAD DURATION CURVE

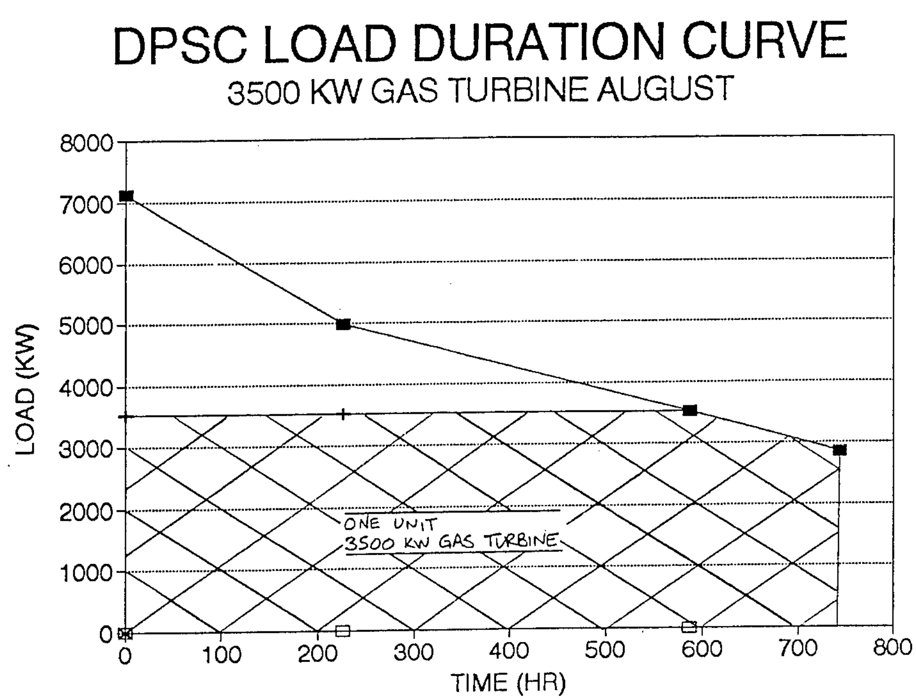
3500 KW GAS TURBINE APRIL




DPSC LOAD DURATION CURVE
3500 KW GAS TURBINE MAY
LOAD (KW)
7000
6000
5000
4000
3000
2000
1000
0
TIME (HR)
0
100
200
300
400
500
600
700
800
ONE UNIT
3500 KW GAS TURBINE

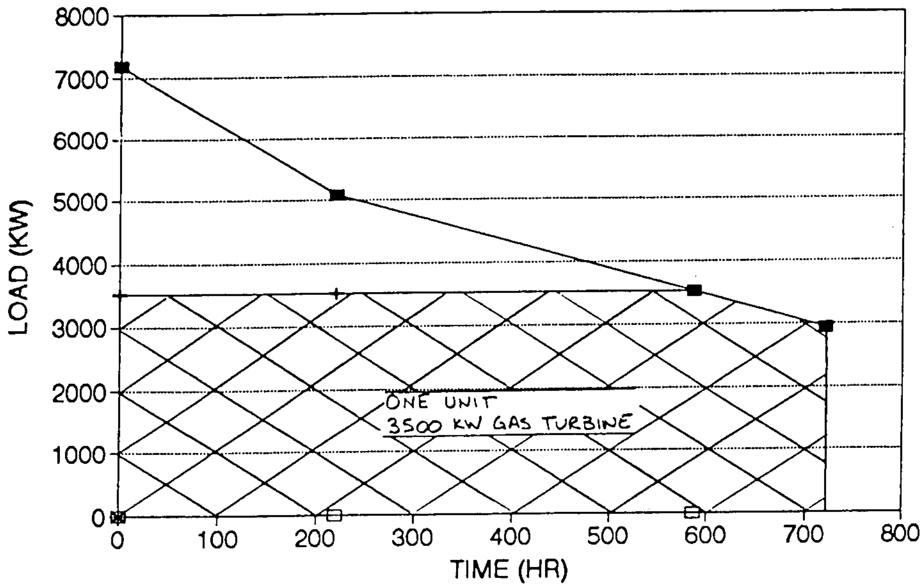

DPSC LOAD DURATION CURVE
3500 KW GAS TURBINE JUNE
LOAD (KW)
8000
7000
6000
5000
4000
3000
2000
1000
0
TIME (HR)
0
100
200
300
400
500
600
700
800
ONE UNIT
3500 KW GAS TURBINE


DPSC LOAD DURATION CURVE
3500 KW GAS TURBINE JULY
LOAD (KW)
8000
7000
6000
5000
4000
3000
2000
1000
0
ONE UNIT
3500 KW GAS TURBINE
0
100
200
300
400
500
600
700
800
TIME (HR)


DPSC LOAD DURATION CURVE
3500 KW GAS TURBINE AUGUST
LOAD (KW)
8000
7000
6000
5000
4000
3000
2000
1000
0
ONE UNIT
3500 KW GAS TURBINE
0
100
200
300
400
500
600
700
800
TIME (HR)

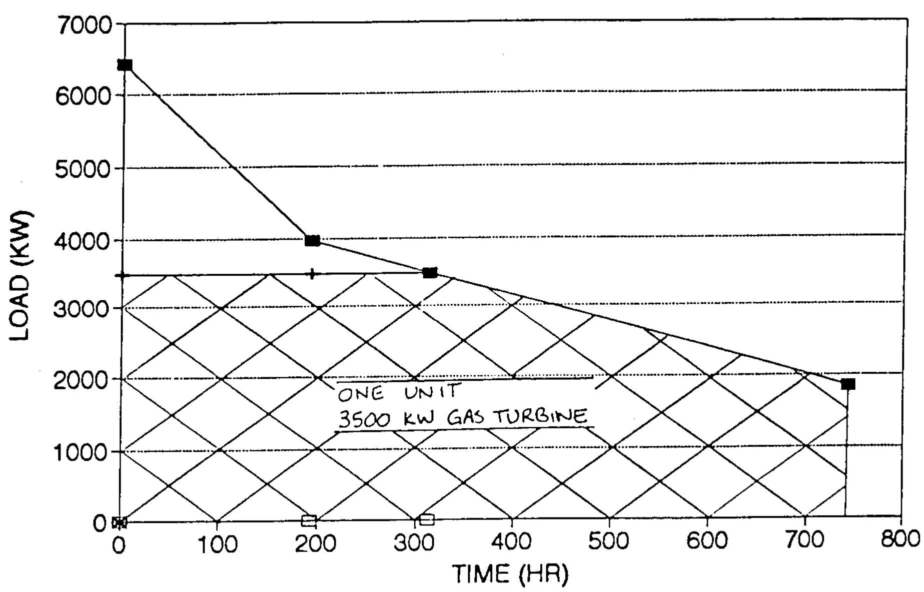
DPSC LOAD DURATION CURVE

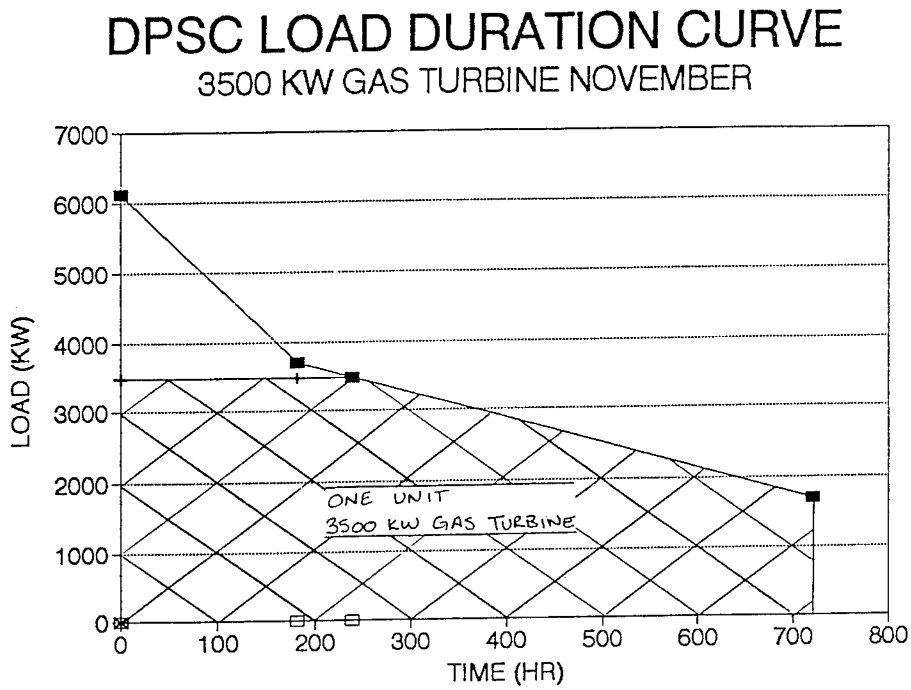
3500 KW GAS TURBINE SEPTEMBER

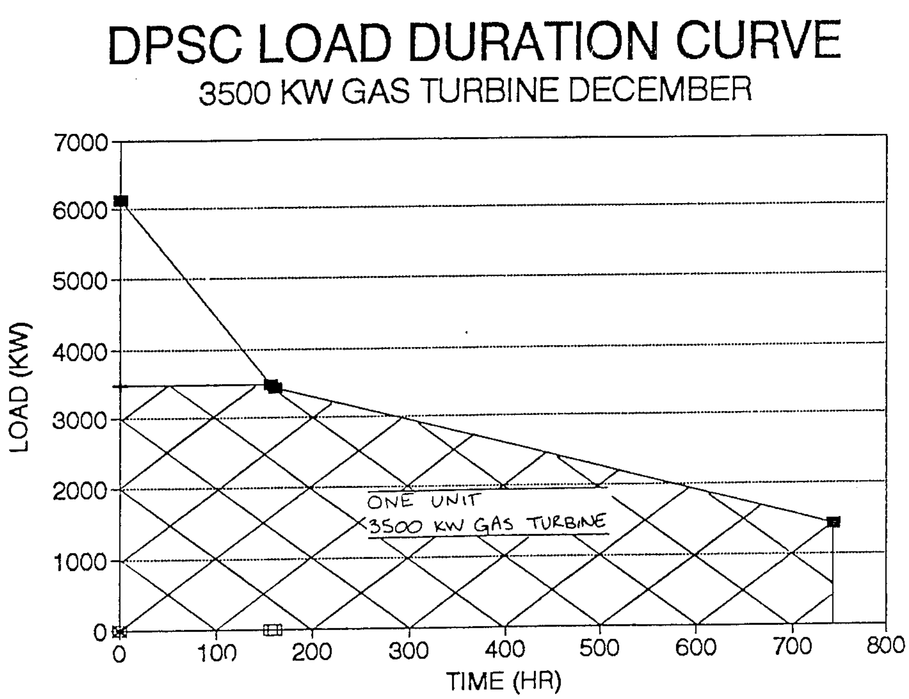


DPSC LOAD DURATION CURVE

3500 KW GAS TURBINE OCTOBER




DPSC LOAD DURATION CURVE
3500 KW GAS TURBINE NOVEMBER
LOAD (KW)
TIME (HR)
ONE UNIT
3500 KW GAS TURBINE


DPSC LOAD DURATION CURVE
3500 KW GAS TURBINE DECEMBER
LOAD (KW)
TIME (HR)
ONE UNIT
3500 KW GAS TURBINE

Appendix I: DD 1391 and Project Development Brochure Forms

1391 PROCESSOR DATA INPUT

SECTION NUMBER 1

1A PROGRAM TYPE (Enter one of the following: MCA, PBS, NAF, CFF, S6S, BCA, MR, AFH, COMM, AAFES, MED, DLA, SOP, MCON, SES, RB, DS) = MCA

1B COMPONENT = DLA

1C FISCAL YEAR = 1995

1D1 CONSTRUCTION START DATE ASSUMPTION = 04/1995

1D2 CONSTRUCTION END DATE ASSUMPTION = 04/1996

CONSTRUCTION MIDPOINT = 10/1995

1E1 INSTALLATION NAME = Defense Personnel Support Center

1F LOCATION = Philadelphia

1G CATEGORY CODE = 80000

1H PROJECT TITLE = ECIP - New Boiler & Gas Turbine Cogeneration

1I TYPE OF WORK: MULTIPLE CHOICE - 2 ENTRIES ALLOWED SEPARATED BY A COMMA (New, Addition, Alteration, Conversion, Modernization, Repair, or Other) = MODERNIZATION

1J1 MOBILIZATION/EMERGENCY (Y/N) = N

1K TYPE OF CONSTRUCTION (T = Temporary, P = Permanent, S = Semi-Permanent) = P

1L PROGRAM ELEMENT

1M PERMANENT PROJECT NUMBER

1N TEMPORARY PROJECT NUMBER

1O PREPARATION DATE = 12/30/1992

ENTER SECTION NUMBER 2

2A1 GENERAL PRIMARY FACILITIES

01.00)811	Steam Boilers	MBtu	2	991,500	1,983
02.00)811	Gas Turbine	KW	1	3,482,000	3,482

SUBTOTAL FOR BLOCK 2A1 = 5,465

2A2 INFORMATION SYSTEMS PRIMARY FACILITIES

SUBTOTAL FOR BLOCK 2A2
TOTAL PRIMARY FACILITIES COST = 5,465

2B SUPPORT FACILITIES

2B1 ELECTRIC SERVICE

SUBTOTAL FOR BLOCK 2B1

2B2 WATER, SEWER, GAS

SUBTOTAL FOR BLOCK 2B2

2B3 STEAM AND/OR CHILLED WATER DISTRIBUTION

SUBTOTAL FOR BLOCK 2B3

2B4 PAVING, WALKS, CURBS AND GUTTERS

SUBTOTAL FOR BLOCK 2B4

2B5 STORM DRAINAGE

SUBTOTAL FOR BLOCK 2B5

2B6 SITE IMPROVEMENT/DEMOLITION

01.00) Coal Boilers 2 397,500
795

SUBTOTAL FOR BLOCK 2B6 = 795

2B7 INFORMATION SYSTEMS

SUBTOTAL FOR BLOCK 2B7

2B8 OTHER

SUBTOTAL FOR BLOCK 2B8
TOTAL SUPPORTING FACILITIES COST = 795
PERCENT OF SUPPORTING COSTS TO PRIMARY COSTS = .16

ESTIMATED CONTRACT COST = 6,260

2C CONTINGENCY FACTOR = 6.0000

CONTINGENCY AMOUNT = 376
SUBTOTAL = 6,636

2D SIOH PERCENT = 7.0000

SIOH AMOUNT = 464
TOTAL REQUEST = 7,100

2F ESTIMATED PROJECT COST (ROUNDED) = 7,100

2G INSTALLED EQUIPMENT - OTHER APPROPRIATIONS ($000)

SECTION NUMBER 3

3A DESCRIPTION OF PROPOSED CONSTRUCTION

The recommended alternative is based on the lowest net present worth (NPW) of all life cycle costs (LCC) associated with each of the alternatives examined. The suggested proposal consists of installing two new gas/oil boilers and a natural gas turbine generator with a heat recovery steam generator (HRSG) in the existing central heating plant.

3B REMARKS

The central heating plant (CHP) at the Defense Personnel Support Center (DPSC), Philadelphia, PA, consists of five steam boilers, of which four are 50 years old and one is 14 years old. Boilers 1 to 4 are Edge Moore Iron Works water tube boilers, which were installed in 1941-42. Boilers No. 1 and 2 are coal-fired dump grate spreader stokers, rated at 75,000 lb/hr steam at 180 psi, 435 °F. However, these boilers operated only for a few years and have not operated for at least 25 years. Current air pollution regulations will not allow coal to be burned.

Boiler Nos. 3 and 4 are dual fuel (natural gas and No. 6 oil), rated at 100,000 lb/hr steam at 180 psi, 435 °F. These two boilers are used for heating all buildings, most of the domestic hot water, and process steam at the clothing factory. One boiler is large enough to supply the maximum loads that occur in the winter. The other boiler is operated on a stand-by basis.

Boiler No. 5 is a Cleaver Brooks packaged dual-fuel boiler installed in 1977. It has a rating of 30,000 lb/hr at 180 psi, 550 °F. Boiler No. 5 typically operates in the summer to provide steam for hot water and process loads.

The age of this equipment and high electric costs ($26/MBtu) warranted an investigation of alternatives for providing thermal and electrical energy to the installation.

3C PROJECT DESCRIPTION

This project will allow DPSC not only to improve fuel efficiency by replacing 50-year-old boilers with high-efficiency, low-polluting boilers, it also will substantially lower total energy costs through cogeneration. Boilers No. 1 and 2 would be demolished to make room for cogeneration equipment. Boilers No. 3 and 4 would be replaced by two packaged gas/oil-fired 50,000 lb/hr boilers (sized to more efficiently meet steam demands). The No. 6 fuel oil system would be replaced by No. 2 oil as the backup fuel for the boilers. This will allow the replacement of the failing No. 6 oil system and meet air pollution regulations that restrict heavy oil burning.

A new natural gas Solar Centaur Type H single-shaft industrial gas turbine with a solar heat recovery steam generator (HRSG) will be installed to generate 3.5 MW of electricity. The actual rating is 3.88 MW but has been derated to more accurately reflect expected production capacity at local operating conditions. This generating equipment will produce about 75 percent of all the electricity needed and reduce the peak electrical demand by about 50 percent. The HRSG will produce a maximum of 18,000 lb/hr at 125 psig when the turbine is operating at 100 percent capacity.

3D REQUIREMENT (Why is it needed now?)

The primary boilers are 50 years old. They are inefficient and maintenance parts are difficult to obtain. This project will reduce energy costs, saving $1,000,000 per year. DPSC does not have a backup electrical generating system to supply minimum base needs during interruptions from PECO.

3E CURRENT SITUATION (How is the need currently being met?)

The CHP currently provides steam for heating and process loads to 15 buildings via steam lines that measure about 33,500 linear feet. The maximum winter load is about 50,000 lb/hr and the summer demand averages about 7,000 lb/hr with peaks near 10,000 lb/hr. All electricity is supplied by Philadelphia Electric Company (PECO). DPSC electrical usage and demand peaks are fairly constant during the noncooling season, averaging about 2.2 million kWh per month and 5100 kW, respectively. The highest daily use is about 135,000 kWh and the peak demand is just below 7,500 kW, occurring in the cooling season. DPSC does not have a backup electrical generating system to supply minimum base needs during interruptions from PECO.

3F IMPACT IF NOT PROVIDED

DPSC will lose about $1,000,000 per year. DPSC will not have a backup electrical generating system to supply minimum base needs during interruptions from PECO.

3G ADDITIONAL

This ECIP project was developed through a comprehensive study performed by the U.S. Army Construction Engineering Research Laboratories, Energy & Utilities Division. The study is documented in a technical report titled "Central Heating Plant Modernization Study for the Defense Personnel Support Center." DPSC measures savings from the project by comparing the costs of steam, generated electricity, and purchased electricity to the costs of steam produced by the CHP and electricity purchased from the utility company. This will be done for a minimum of 1 year to document savings. Calculations will be made using a PC spreadsheet program.

3I RELATED PROJECTS

ENTER SECTION NUMBER 11

11 ECONOMIC ANALYSIS DATA

11A IS PROJECT EXEMPT FROM ECONOMIC ANALYSIS (Y/N)? = N

11B RETRIEVE DATA FROM ECONPACK (Y/N) ? = N

11C CONSIDERATION OF ALTERNATIVES

1) New Boilers	10752	N
2) New Boilers/Absorption Chiller	10752	N
3) New Boilers/Cogen	10752	N
4) New Boilers/Cogen/Absorption Chiller	10752	N

5) Refurbish Plant	10752	N
6) Refurbish Plant/Absorption Chiller	10752	N
7) Refurbish Plant/Cogen/Absorption Chiller	10752	N

11D ECONOMIC JUSTIFICATION SUMMARY

To provide an equitable comparison for the proposed ECIP project, a baseline or status quo scenario was developed that accounts for the annual CHP operation and maintenance cost including labor, maintenance, and fuel use, and the annual installation electrical use. Table 1 shows the LCC summary for the status quo. Costs are net present worth (Oct 1992 basis). The life cycle cost was analyzed using the methods required by 10 CFR, Part 436, Subpart A, and the "Energy Prices and Discount Factors for Life-Cycle Cost Analysis 1992," NISTIR 85-3273-6.

Table 1. Status quo cost summary.

Initial Investment Costs		0
Energy Costs:		
Electricity	$43,213,000	
Natural Gas	$32,364,000	
Total Energy Costs		$75,577,000
Recurring M&R/Custodial Costs		$12,123,000
Major Repair/Replacement Costs		$2,656,000
LCC of all Costs/Benefits (Net PW)		$90,355,000

Similarly, costs were developed for the suggested alternative. Table 2 summarizes these costs. Based on LCC the project will be $10 million less than maintaining the status quo.

Table 2. ECIP project cost summary.

Initial Investment Costs		$6,874,000
Energy Costs:		
Electricity	$9,746,000	
Natural Gas	$50,630,000	
Total Energy Costs	$60,376,000	
Recurring M&R/Custodial Costs		$12,764,000
Major Repair/Replacement Costs		$605,000
LCC of all Costs/Benefits (Net PW)		$80,619,000

11E ECONOMIC ANALYSIS

```
          LIFE CYCLE COST ANALYSIS SUMMARY              STUDY: DPSC
     ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)        LCCID  1.062
INSTALLATION & LOCATION: DPSC          REGION NOS.  3 CENSUS: 1
PROJECT NO. & TITLE: 1   CENTRAL HEATING PLANT MOD
FISCAL YEAR 1993    DISCRETE PORTION NAME: ALT 2 OPT 6
ANALYSIS DATE:  01-07-93  ECONOMIC LIFE 25 YEARS PREPARED BY: TLM

1. INVESTMENT
    A. CONSTRUCTION COST                                         $  6165022.
    B. SIOH                                                      $   339077.
    C. DESIGN COST                                               $   369902.
    D. SALVAGE VALUE COST                                       -$        0.
    E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)                      $  6874001.

2. ENERGY SAVINGS (+) / COST (-)
    ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

             UNIT COST   SAVINGS      ANNUAL $      DISCOUNT   DISCOUNTED
    FUEL     $/MBTU(1)   MBTU/YR(2)   SAVINGS(3)    FACTOR(4)  SAVINGS(5)

    A. ELECT $ 26.21       83905.     $ 2199137.      15.11      33228960.
    B. DIST  $   .00           0.     $        0.     21.31             0.
    C. RESID $   .00           0.     $        0.     25.22             0.
    D. NAT G $  3.41     -174987.     $ -596706.      20.70     -12351810.
    E. COAL  $   .00           0.     $        0.     15.93             0.

    F. TOTAL              -91083.     $ 1602431.                $ 20877150.

3. NON ENERGY SAVINGS(+) / COST(-)

   A. ANNUAL RECURRING (+/-)                                    $   -641450.
       (1) DISCOUNT FACTOR (TABLE A)                     14.53
       (2) DISCOUNTED SAVING/COST (3A X 3A1)                    $  -9320268.

   B. NON RECURRING SAVINGS(+) / COSTS(-)
                                SAVINGS(+)    YR   DISCNT      DISCOUNTED
               ITEM              COST(-)      OC   FACTR       SAVINGS(+)/
                                   (1)       (2)    (3)        COST(-)(4)
    1. MR/RC                    $2050780.     0    1.00         2050780.

    d. TOTAL                    $2050780.                       2050780.

   C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -7269488.

   D. PROJECT NON ENERGY QUALIFICATION TEST
       (1) 25% MAX NON ENERGY CALC (2F5 X .33)        $  6889459.
           A IF 3D1 IS = OR > 3C   GO TO ITEM 4
           B IF 3D1 IS < 3C  CALC    SIR = (2F5+3D1)/1F)______
           C IF 3D1B IS = > 1  GO TO ITEM 4
           D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$  1043012.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)                        $ 13607660.

6. DISCOUNTED SAVINGS RATIO                 (SIR)=(5 / 1F)=    1.98
   (IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED)     SPB=1F/4             6.59
```

11F NUMBER OF ADDITIONAL OPERATIONAL PERSONNEL = 1

Project Development Brochure Checklists

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
A-1	Cost estimates for each primary and supporting facility	R			
A-2	Telecommunications system coordination with USACC and authorization for exceptions	NR			
A-3	Coordination with state and local governmental requirements (blind vendors, medical facilities, construction and operating permits, clearinghouse coordination, etc.)	R	D		
A-4	Assignment of airspace	NR			
A-5	Economic analysis of alternatives	R	D		
A-6	Approval for new starts	NR			
A-7	International balance of payments (IBOP) coordination with U.S. European command and NATO-overseas cost estimates and comparables (include rate of exchange used in estimates)	NR			
A-8	Impact on historic places—on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation	NR			
A-9	Exceptions to established criteria	NR			
A-10	Physical Security Analysis and Threat Statement prepared by Provost Marshal/Physical Security Officer	NR			
A-11	Coordination with other various user staff agencies (G/S-2 Intelligence Personnel)	NR			
A-12	Identification of related or support projects (so projects can be coordinated)	NR			
A-13	Required completion date	R	B		
A-14	Other Special Considerations (list and number items)	NR			

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DA FORM 5023-A-R, Jan 87 EDITION OF FEB 82 IS OBSOLETE.

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
B-1	Consultation with the District Office to determine and evaluate flood plain hazards	NR			
B-2	Preparation, submission, and/or approval of new –				
(A)	General Site Plan	R	B		✓
(B)	Annotated General Site Plan	R	B		
(C)	Sketch Site Plan	R	B		
(D)	Facilities Requirements Sketch	R	B		✓
B-3	Preparation of				
(A)	Site Survey	R	C		
(B)	Subsoil Information	NR			
B-4	Approval by Department of Defense Explosive Safety Board (DDESB) for Safety Site Plan	NR			
B-5	Approval of site plan by Provost Marshal/Physical Security (Comparisons with Terrorist Threat Assessment)	NR			
	Other Site Development Considerations (list and number items)	NR			

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FORM 5023-B-R, Jan 87 EDITION OF FEB 82 IS OBSOLETE.

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
C-1	Reconciliation with troop housing programs and requirements	NR			
C-2	Evaluation of existing facilities (including degree of utilization)	R	B		
C-3	Approval for removal and relocation of existing useable facilities	NR			
C-4	Evaluation of off-post community facilities	NR			
C-5	Storage and maintenance facilities (including nuclear weapons)	NR			
C-6	Coordination hospitals, medical and dental facilities with Surgeon General	NR			
C-7	Coordination of aviation facilities with FAA	NR			
C-8	Coordination air traffic control and navigational aids with USACC	NR			
C-9	Tabulation of types and numbers of aircraft	NR			
C-10	Evaluation of laboratory, research and development, and technical maintenance facilities	NR			
C-11	Coordination chapels with Chief of Chaplains	NR			
C-12	Review food service facilities by USATSA	NR			
C-13	Automated data processing system or equipment approvals—cost analysis when ADP and/or communication centers not co-located with related facilities	NR			
C-14	Coordination postal facilities with U.S. Postal Service Regional Director	NR			
C-15	Laundry and dry cleaning facilities coordination with ASO(I&L)	NR			
C-16	Tenant facilities coordination with installation where sited	NR			
C-17	Facilities for or exposed to explosions, toxic chemicals, or ammunition—review by DDESB (See also Item B-4)	NR			
C-18	Analysis of deficiencies	NR			
C-19	Consideration of alternatives	R	D		
C-20	Determination whether occupants will include physically handicapped or disabled persons	R	B		
C-21	As-build drawings for alterations or additions	R	C		
C-22	Availability of Standard Design or site adaptable designs	NR			
C-23	Evaluation of facilities with Provost Marshal/Physical Security Officer (Installation Terrorist Threat Assessment)	NR			
	Other Architectural and Structural (list and number items)	R	D		

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DA FORM 5023-C-R, Jan 87 EDITION OF FEB 82 IS OBSOLETE.

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
D-1	Fuel considerations and cost comparison analysis	R	D		
D-2	Energy requirements appraisal (ERA)	R	D		
D-3	Conformance with DOD Energy Reduction requirements	R	D		
D-4	Evaluation of existing and/or proposed utility systems	R	D		
D-5	Evaluation of systems with Provost Marshal/Physical Security (Installation Terrorist Threat Assessment)	NR			
-	Other Mechanical and Utility Systems (list and number items)	R	D		

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FORM 5023-D-R, Jan 87 EDITION OF FEB 82 IS OBSOLETE.

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
E-1	Environmental impact assessment	R	D		
E-2	EIA conclusions require Environmental Impact Statement	NR			
E-3	Determination of health, environmental or related hazards. Assistance to determine existence of any health, environmental or related hazard may be requested from Aberdeen Proving Ground, MD 21010, the Office of the Surgeon General, Attn: DASG-HCH (Army Environmental Hygiene Agency)	R	D		
E-4	Air/water pollution permit, coordination with agencies and compliance with standards at Federal, state and local level	R	D		
E-5	Corrective measures associated with Environmental Impact Statements or assessment—list separately and evaluate.	NR			
	Other environmental considerations (list and number items)	NR			

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documentation checklist

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DA FORM 5023-E-R, Feb 82

F. PHYSICAL SECURITY ENHANCEMENT AGAINST TERRORIST THREAT

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
F-1	Preparation of the Physical Security Survey and Threat Analysis prepared by Provost Marshal/ Physical Security	NR			
F-2	Preparation, submission, and/or approval of site plan by Provost Marshal/Physical Security	NR			
F-3	Evaluation of mission essential project by Provost Marshal/Physical Security	NR			
F-4	Tabulation of Assets to be protected	NR			
F-5	Evaluation of ingress/egress time by intruder and security response time	NR			
F-6	Evaluation of Project by G/S-2 Intelligence Personnel	NR			

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documentation checklist 6 OF 6

DA FORM 5023-F-R, Jan 87

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
A-1	Factors of risk, restriction or unusual circumstance expected to increase costs beyond applicable area averages	NR			
A-2	Construction phasing requirements	R	D		
A-3	Functional support equipment (mechanical, electrical, structural, and security) to be built in	R	D		
A-4	Equipment in place and justification	R	D		
A-5	Other equipment and furniture (O&MA, OPA) and costs	R	D		
A-6	Special studies and tests (hazards analyses, compatibility testing, new technology testing, etc.)	NR			
A-7	Type of construction (permanent, temporary, semi-permanent)	R	B		
A-8	Government furnished equipment (quantities, procurement time, availability and special handling and storage requirements). Funds used for procurement.	R	B		
	Other special considerations (list and number items),	R	D		

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DA FORM 5024-A-R, Feb 82

B. SITE DEVELOPMENT

	ITEM	Required or Not Required	To Be Determined*	Comment Attached	Document Attached
B-1	Construction restrictions or guidelines pertaining to				
(A)	site access and preferred construction routes	R	B		
(B)	Airfield clearance, explosive storage, working hours, safety, etc.	NR			
(C)	Facilities and/or functions or adjoining areas (structures, materials, impact)	R	B		
B-2	Real estate actions (acquisition, disposal, lease, right-of-way)	NR			
B-3	Demolition/relocation required (data)				
(A)	Special considerations due to explosives/radioactivity/ chemical contamination/asbestos emissions/toxic gases	R	D		
(B)	Restrictions on disposal of demolished/relocated material including hazardous waste	R	B		
B-4	Pavement types and requirements (including traffic surveys and MTMC coordination)	NR			
B-5	Landscape considerations				
(A)	Protection of existing vegetation	NR			
(B)	Stockpile topsoil	NR			
	Other Site Development (List and number items)	NR			

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technical data checklist 2 OF 7

DA FORM 5024-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
C-1	Vibration-producing equipment requiring isolation	NR			
C-2	Seismic zone and other design load criteria (typhoon, hurricane, earthquake loads, high or low loss potential)	R	D		
C-3	Protective shelter evaluation and resistant design criteria (conventional/nuclear blast and radiation, chemical/biological)	NR			
C-4	Unusual foundation requirements (pier, pile, caisson, deep foundations, mat, special treatment, permafrost areas, soil bearing)	NR			
C-5	Designation and strength of units to be accommodated	R	D		
C-6	Requirements and data for special design projects	R	B		
C-7	Unusual floor and roof loads (safes, equipment)	NR			
C-8	Security features (arms rooms, vaults, interior secure areas)	NR			
	Other Architectural & Structural (List and number items)	NR			

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technical data checklist 3 OF 7

DA FORM 5024-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
D-1	Special mechanical requirements or considerations (elevator, crane, hoist, etc.)	NR			
D-2	Special peak usage periods and peak leveling techniques	R	D		
D-3	Maintenance considerations (accessibility of equipment, compatibility with existing equipment)	R	D		
D-4	Plumbing—availability, general system type and characteristics (proposed and/or existing, incl. compressed air and gas)	R	D		
D-5	Heating—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-6	Ventilating, air condition/refrigeration—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-7	Electrical—availability, general system type and characteristics incl. airfield lighting, communication, etc. (proposed and/or existing)	R	D		
D-8	Water supply/waste treatment—availability, general system type and characteristics (proposed and/or existing)	R	D		
D-9	Energy requirements/fuel conversion (sources, availability, loads, types of fuel, etc.)	R	D		
D-10	Solar energy evaluation	NR			
	Other Mechanical & Utility Systems (List and number items)	NR			

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technical data checklist 4 of 7

DA FORM 5024-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
E-1	Waste water treatment, air quality, and solid waste disposal criteria	R	D		
	Other Environmental Considerations (List and number items)	NR			

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technical data checklist 5 of 7

DA FORM 5024-E-R, Feb 82

F. FIRE PROTECTION

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
F-1	Special fire protection systems or features (detection and suppression equipment, hazards, etc.)	R	D		
	Other Fire Protection Considerations (List and number items)	NR			

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technical data checklist 6 of 7

DA FORM 5024-F-R, Feb 82

G. PHYSICAL SECURITY ENHANCEMENT AGAINST TERRORIST THREAT

	ITEM	Required or Not Required	To Be Determined *	Comment Attached	Document Attached
G-1	Site Considerations Related to Physical Security Enhancements	NR			
G-2	Site Protective Barriers				
(A)	Active	NR			
(B)	Passive	R	D		
G-3	Architectural and Structural Considerations				
(A)	Protective shelters and secure areas	NR			
(B)	Passive Design features	NR			
(C)	Lock and key systems	NR			
G-4	Mechanical, Electrical, Utility Systems				
(A)	Security lighting	R	D		
(B)	IDS	NR			
(C)	Communications	NR			
(D)	EMP Protection	NR			
(E)	Personnel Identification Systems	NR			
(F)	Biological and Chemical Protection for Utilities	NR			
G-5	Other Special Security Features (arms rooms, vaults, nuclear storage, etc.)	NR			

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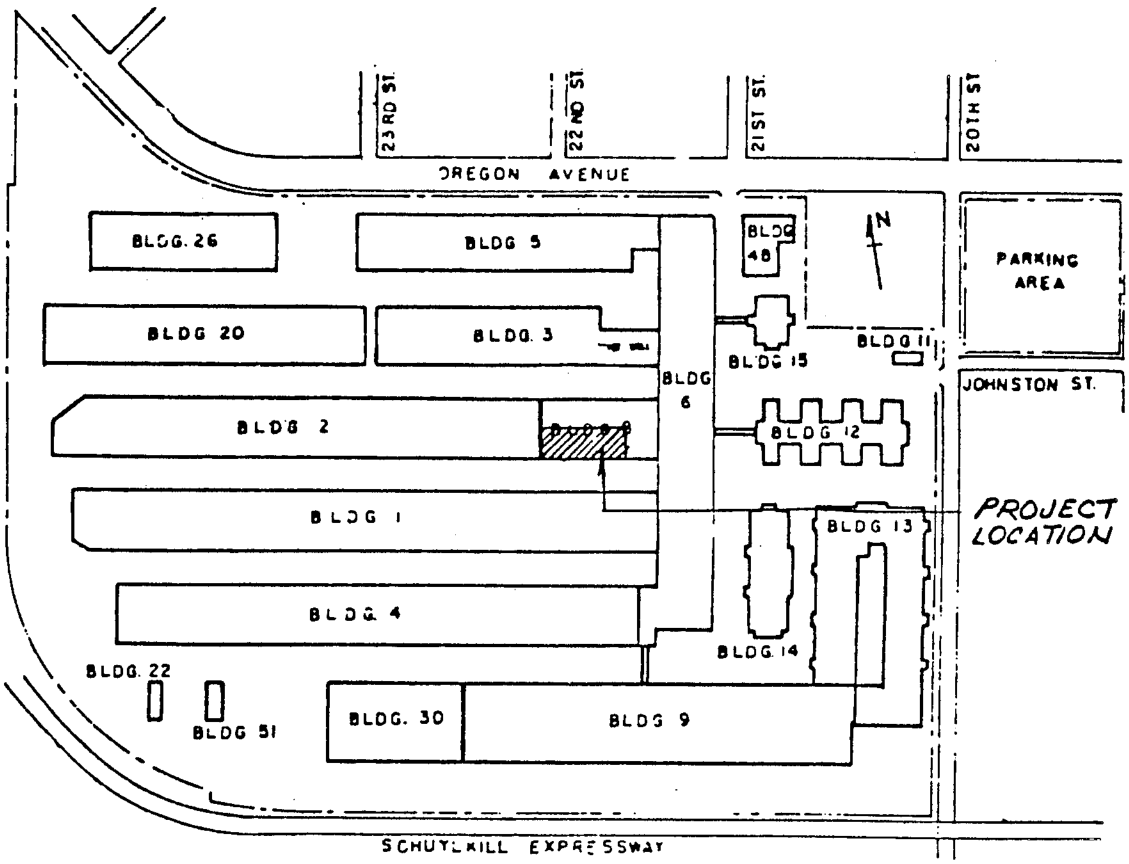
DA FORM 5024-G-R, Jan 87



PLOT PLAN

NO SCALE

facilities requirements sketch, PDB- 1/2 | 1 of 2

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