EXECUTIVE SUMMARY
FINAL REPORT
Of

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM

For

PINE BLUFF ARSENAL
ARKANSAS

Prepared for

UNITED STATES ARMY DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

Under

CONTRACT NO. DACA 63-79-C-0177

Prepared by
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JULY 1982

EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM
PINE BLUFF ARSENAL

Introduction

The objective of this Energy Engineering Analysis (EEA) Program for Pine Bluff Arsenal (PBA) is to develop a systematic plan of projects which will result in the reduction of energy consumption at PBA in compliance with the objectives set forth in the Army Facilities Energy Plan dated 1 October 1978. The long-range objective of the Army is to implement a policy through which PBA will become as energy efficient as the state of the art for energy conservation will allow. In development of the planned projects, an assessment of the entire energy picture at PBA was completed. This report is a summary of that effort.

Located approximately 30 miles southeast of Little Rock, Arkansas, Pine Bluff Arsenal (PBA) is a Government owned and operated facility. The Arsenal was established 10 November 1941 as the U.S. Chemical Warfare Arsenal. The Arsenal is currently a U.S. Army Materiel Development and Readiness Command installation, under the jurisdiction of the Commander, U.S. Army Armament Materiel Readiness Command (ARRCOM).

In brief, the mission of PBA is to engineer, design, and manufacture chemical, smoke, riot control, incapacitating, incendiary, and other pyrotechnic mixes and munitions to supplement commercial industrial capacity.

Data Base for Analysis

The study commenced with the collection of all data and information required to determine the distribution and forms of present energy consumption at PBA. Such information includes building envelope characteristics, type and method of operating environmental and process energy systems, building population and occupancy schedules, historical energy usage, and related items. This information was then used as the basis for developing a detailed energy data base breakdown for the entire facility. The data base maps the form and quantity of energy consumption from the receiving point, through conversion processes, and on to the point of end use in such areas as heating, cooling, lighting, and process use. It further provides a detailed picture of present energy consumption, which is then used to identify energy conservation opportunities (ECOs). The data base thus serves as a gauge against which energy savings calculations can be compared.

In this study, present energy consumption is defined as the actual total energy consumption recorded for FY1980, which was the most recent complete year of data at the time the study commenced. Thus, the energy data base used is a detailed breakdown of the actual total energy consumption for FY1980. Table ES-1 on the following page shows the composite breakdown for an energy consumption assessment in six categories. A more detailed breakdown on a building-by-building basis may be found in Table 3.12 beginning on page 3-32 in Section 3.0 of the report.

TABLE ES-1
PBA
ENERGY DATA BASE (FY1980)

ENERGY CATEGORY	FOSSIL FUEL (mBtu)	FOSSIL FUEL % of TOTAL	ELECTRICITY (kWh)	ELECTRICITY % of TOTAL	TOTAL SOURCE* (mBtu)	TOTAL SOURCE* % of TOTAL
Heating	77,586	29.7	220,165	2.0	80,140	20.6
Cooling	-	-	2,708,020	24.6	31,413	8.1
Lighting	-	-	1,695,260	15.4	19,665	5.1
Process	26,647	10.2	2,443,820	22.2	54,995	14.1
Utilities			2,498,860	22.7	28,987	7.5
Other:						
o Distribution and transformer losses	35,267	13.5	671,500	6.1	43,056	11.1
o Boiler plant conversion losses & in-plant auxiliaries	106,322	40.7			106,322	27.3
o Domestic HW	1,828	0.7	187,140	1.7	3,999	1.0
o Little-use facilities	13,584	5.2	583,435	5.3	20,352	5.2
Totals	261,234	100.0	11,008,200	100.0	388,929	100.0

*Electrical energy converted to source energy by using 11,600 Btu/kWh conversion factor.

Evaluation of Energy Conservation Opportunities

Potential ECOs were identified in a number of areas during the initial energy analysis. It was found that energy could be saved through the establishment of an Energy Monitoring and Control System; in addition, typical building envelope ECOs were identified, along with opportunities in process ventilation systems, outside air reductions, steam and condensate return systems, boiler blowdown heat recovery, and lighting systems. All ECOs were evaluated to determine feasibility in accordance with the requirements of the Energy Conservation Investment Program (ECIP) guidelines.

Since many ECOs are interrelated (i.e., the savings of one affect the savings of another), the energy conservation analysis of a building with multiple ECOs was performed in the following sequence:

- Centralized control of energy systems through use of an Energy Monitoring and Control System (EMCS) was evaluated first.
- The building envelope ECOs were then evaluated to ensure that the buildings were as weathertight as is economically feasible under ECIP guidelines.
- Next, the heating, ventilating, air conditioning, and exhaust systems were evaluated, assuming the feasible building envelope ECOs and EMCS functions were implemented. Internal process systems and functions were evaluated at the same time, provided this evaluation did not interrupt the performance of functional process requirements.
- Internal and external building steam distribution, compressed air, boiler, and lighting systems were evaluated.

Based on ECIP criteria, the results of the detailed analysis of ECOs, including the EMCS, are summarized in Table ES-2 on pages ES-4 and ES-5. ECO descriptions and identification of buildings to which they apply may be found in Sections 4.0 and 5.0.

TABLE ES-2
PBA
FEASIBLE ENERGY CONSERVATION OPPORTUNITIES
(INCREMENTS A AND B)

	ANNUAL ENERGY SAVINGS				
	Electricity		Nat. Gas	Estimated Capital	E/C
ECO DESCRIPTION	Demand(kW)	Energy(kWh)	(mBtu)	Cost**	Ratio
BUILDING ENVELOPE:					
Caulk and Weatherstrip	-	17,633	2,838	$ 71,310	42.7
Seal Holes in Walls and Roofs	-	860	277	1,870	153.5
Partition Bldg	-	-	752	32,840	22.9
Install Roof Vent Dampers and Seals	-	-	359	3,710	96.8
Roof Insulation	-	30,677	9,408	168,370	58.0
Wall Insulation	-	-	673	40,960	16.4
Drop Ceiling	-	-	1,333	35,300	37.8
HVAC SYSTEM ECOs:					
Air Flow Reduction	-	600	205	1,080	196.3
Replace Electric Heat	96	31,958	(199)*	10,170	16.9
Ceiling Fans	(24)*	(18,747)*	1,368	31,600	36.4
Flue Dampers	-	-	582	12,960	44.9
Automatic Furnace Ignition	-	-	873	40,830	21.4
VAV Conversion	-	252,140	1,739	21,260	219.4
Cover Door Louvers	-	-	85	4,220	20.1
Backdraft Dampers	-	90	263	2,640	100.0
Reduce Preheat	-	16,182	694	43,420	20.3
PROCESS ECOs:					
Insulate Indoor Steam Lines	-	-	8,152	93,380	87.3
Domestic Hot Water Heater Insulation	-	1,609	40	2,390	24.5
Laundry Heat Reclaim	-	-	721	27,710	26.0
Showerhead Flow Restrictors	-	36,640	225	2,710	239.9

*( ) indicates an increase in energy consumption.
**Escalated per ECIP Criteria to end of FY1984 to determine initial feasibility.

TABLE ES-2 Contd.

PBA

FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

(INCREMENTS A AND B)

ECO DESCRIPTION	ANNUAL ENERGY SAVINGS Electricity Demand (kW)	Electricity Energy (kWh)	Nat. Gas (mBtu)	Estimated Implementation Cost**	E/C Ratio
ELECTRICAL ECOs:					
Exterior Lighting Control	-	16,430	-	$ 3,300	57.8
Timers For Lighting	-	4,719	-	590	92.8
Task Lighting	81	14,443	-	8,110	20.7
UTILITY SYSTEM ECOs:					
Boiler FD Fan Motor Replacement	-	-	756	690	1,095.6
Reduce Boiler Operating Pressure	-	-	43	910	47.3
Automatic Boiler Ignition	-	-	493	3,150	156.5
Utilize Electric Feedwater Pumps	(180)*	(131,760)*	9,662	68,800	118.2
Utilize Single Boiler Operation	-	-	57	910	62.6
Steam Trap Repair and Replacement	-	-	5,908	22,830	258.8
Reduce Compressed Air Pressure	-	57,485	-	25,010	26.7
Additional Steam Line Insulation	-	-	11,607	404,460	28.7
EMCS for 95 Buildings	2,215	708,724	31,930	1,253,800	32.0
TOTAL		1,039,683	90,844	$2,441,290	42.2

*( ) indicates an increase in energy consumption.
**Escalated per ECIP Criteria to end of FY1984 to determine initial feasibility.

Implementation of all of the above ECIP ECOs would provide the following percentage reduction in energy use by fuel type with respect to FY1975 and FY1980 data base years. For FY1980 the reduction is shown graphically on Figures ES-1 and ES-2, on pages ES-7 and ES-8.

	Annual Energy Consumption		Annual Source
Data Base Year	Fossil Fuel (mBtu)	Electricity (kWh/yr)	Energy Consumption (mBtu)
FY1980 Data Base	261,234	11,008,200	388,929
% Reduction	34.8%	9.4%	26.5%
FY1975 Data Base	436,511	8,816,000	538,776
% Reduction	20.8%	11.8%	19.1%

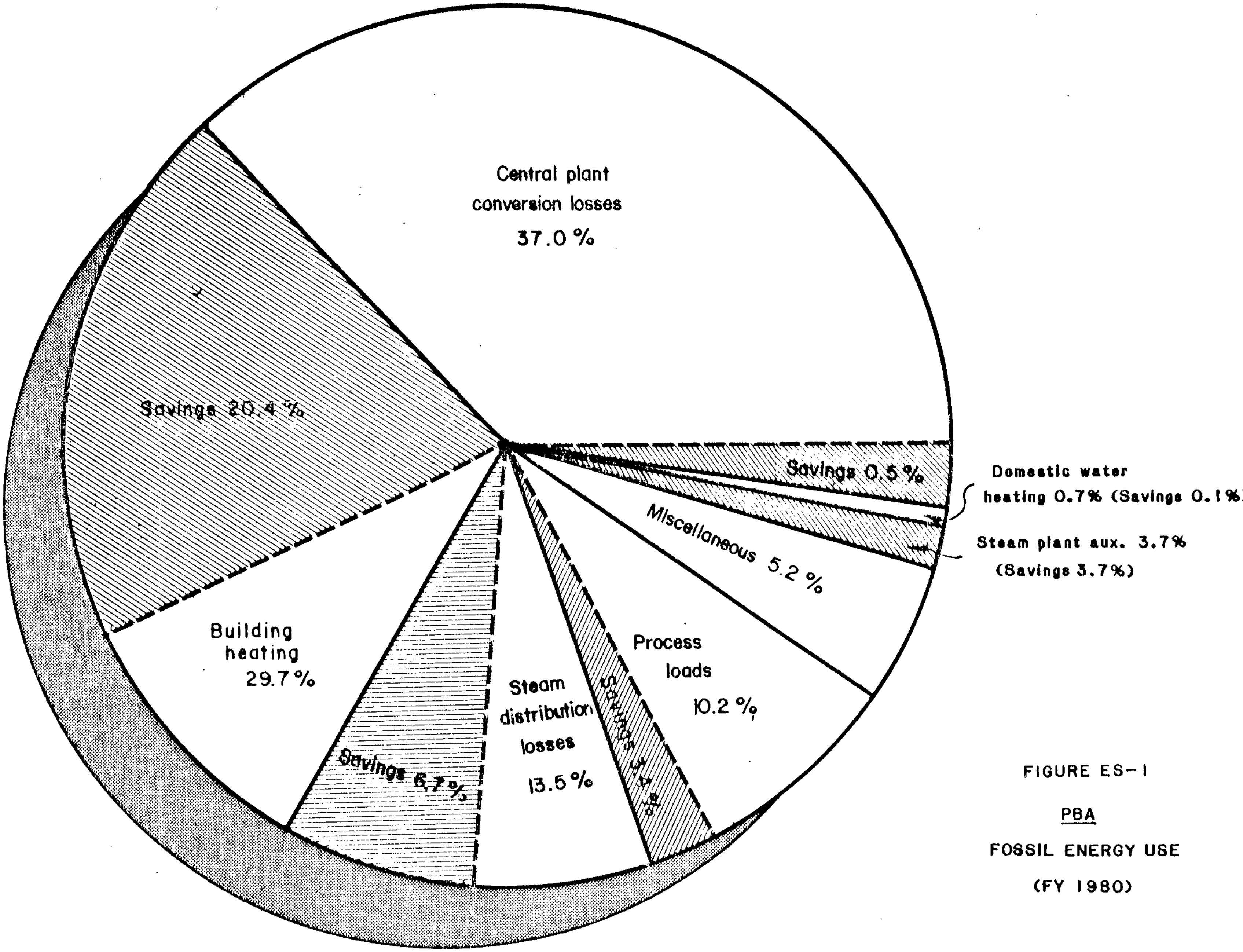

FIGURE ES-1

PBA

FOSSIL ENERGY USE

(FY 1980)

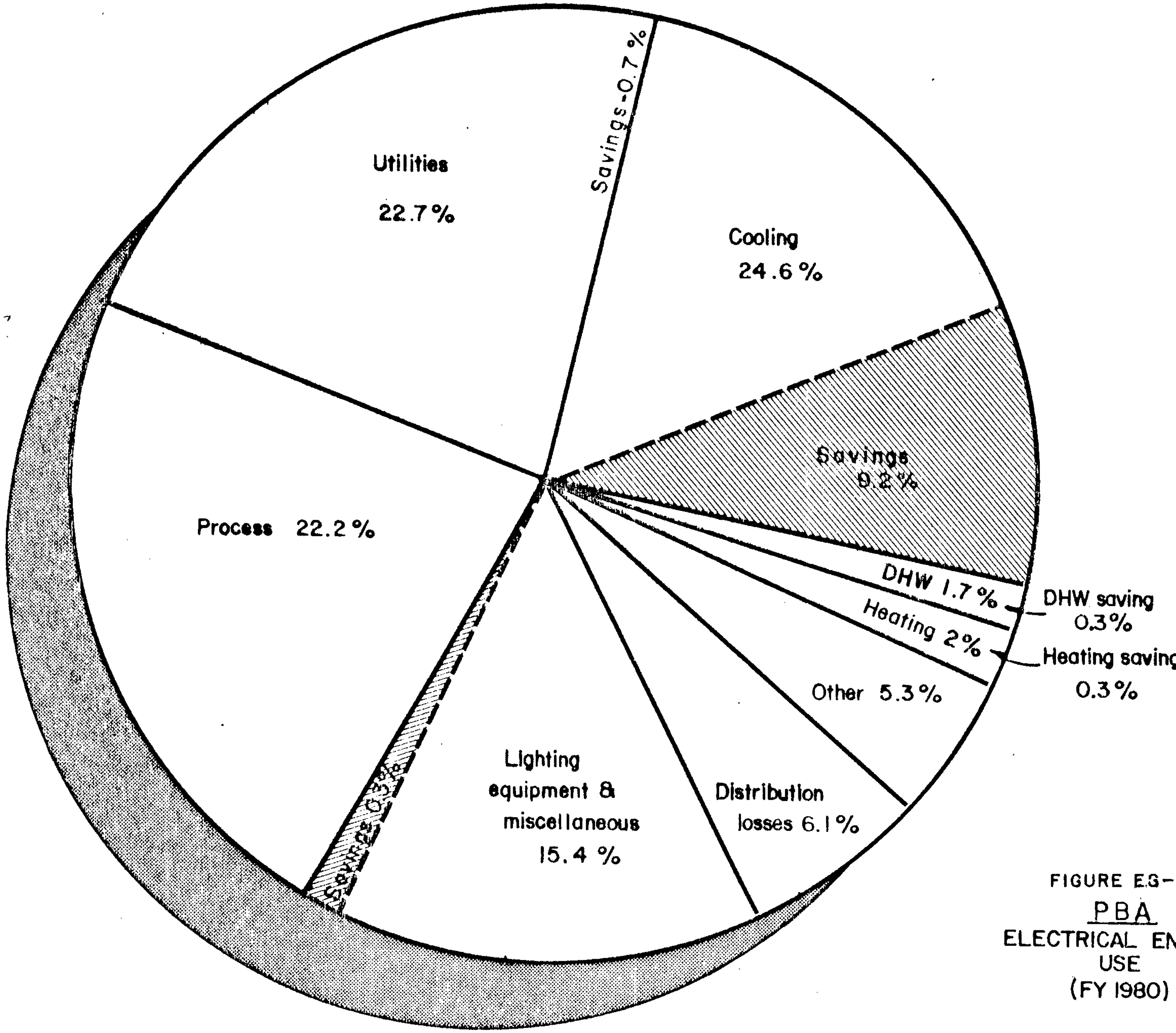

FIGURE ES-2
PBA
ELECTRICAL ENERGY
USE
(FY 1980)

The feasible ECIP ECOs, based on an E/C ratio of 13 or greater*, were developed into FY1984 ECIP projects for funding and Form 1391s and Project Development Brochures (PDBs) were prepared. Identification of these projects and the ECOs contained within them is as follows in Table ES-3.

TABLE ES-3
PBA
ECIP PROJECT IDENTIFICATION

Project No.	Project Title	ECOs Included in Project
PBA/E-0101	Building Weatherization	Caulk and Weatherstrip Roof Insulation Wall Insulation Install Roof Vent Dampers and Seals Seal Holes Partition Building Drop Ceiling
PBA/E-0102	Process, Lighting and HVAC Modifications	Insulate Indoor Steam Lines Domestic Water Heater Insulation Domestic Water Flow Restrictors Laundry Heat Reclaim Task Lighting and Timers for Lighting Exterior Lighting Control Air Flow Reduction Replace Electric Heat Ceiling Fans Flue Dampers and Automatic Ignition Backdraft Dampers and Door Louvers VAV Conversion and Reduce Preheat
PBA/E-0103	EMCS	Energy Monitoring and Control System; 95 Buildings
PBA/E-0104	Additional Steam Line Insulation	Additional Steam Line Insulation
PBA/E-0105	Utility Modifications	Automatic Boiler Ignition Steam Trap Repair and Replacement Single Boiler Operation Utilize Electric Feedwater Pumps Reduce Boiler Operating Pressure Reduce Compressed Air Pressure Boiler FD Fan Replacement

* DAEN-MPO-U TWX dated 29 December 1980.

Guidance* in preparing the programming documents, economic computations and DD-Form 1391s for each project was received from the Fort Worth District, Corps of Engineers. Instructions were as follows:

- o Construction cost escalation factors, provided by AR-415-17 and EIRS Bulletin, should be used to calculate construction cost in Paragraph 1 of the ECIP Economic Analysis Summary, and Items 8 and 9 of DD-Form 1391 (Project Cost and Cost Estimates).

- o Differential fuel escalation rates set forth in the ECIP guidance should be used to calculate energy costs in Paragraphs 2 and 3 of the ECIP Economic Analysis Summary.

These rates and factors were used in preparing each project for FY1984 funding and in adjusting the economic justification to that year. Construction costs were escalated to Midpoint of Construction Date (MCD) per AR-415-17 using the Building Construction Indices of EIRS Bulletin 0-181. Fuel costs were escalated per ECIP criteria.

Based on ECIP criteria and project costs for the programming year, a summary of the project results is presented in Table ES-4 following:

TABLE ES-4
ECIP PROJECTS - PBA
(FY1984)

PROJECT TITLE	Annual Source Energy Savings (mBtu/yr)	Project Cost (FY84)** ($1000)	E/C Ratio	B/C Ratio	Simple Payback Period (yr)
PBA/E-0105 Utility Modifications	16,058	$ ~~130.6~~	122.9	4.2	1.4
PBA/E-0102 Process, Lighting, HVAC System Modifications	18,878	~~327.3~~	57.7	3.8	3.2
PBA/E-0101 Building Weatherization	16,211	~~377.5~~	42.9	4.0	4.3
PBA/E-0103 EMCS	40,151	~~1,339.7~~	30.0	1.4	13.6
PBA/E-0104 Additional Steam Line Insulation	11,607	~~432.2~~	26.9	3.0	6.2
	102,905	$2,607.3	39.5		

The projects evaluated in Increments A and B, and listed in Table ES-4 above, represent logical groupings of ECOs which are associated based on application or implementation means. The table lists the projects in the order of the recommended sequence of implementation, based on E/C ratio.

* 27 February 1981

** Per latest EIRS Bulletin Indices for appropriate escalation, mid FY1984.

Central Coal Fired Heating Plant Feasibility Study (Increment E)

In assessing the feasibility of a coal fired central heating plant (CHP) as an energy conservation project at PBA, the following approach was used:

- o Establish the thermal load base requirements at PBA.
- o Analyze the existing means of supplying those requirements (Base Case) in terms of fuel consumption and O&M costs.
- o Develop an optimum CHP concept suitable for PBA and estimate its capital investment cost.
- o Project the performance of the CHP concept in terms of annual fuel and O&M costs.
- o Compare the CHP alternative to the Base Case in terms of present worth life cycle costs.

Considering the amount of initial capital investment involved and long-term committments to serve the facility, any new central plant concept must be sufficiently sized to meet the peak demands required at PBA in times of maximum utilization of the facilities presently in existence. Also, because coal itself is a less expensive fuel than natural gas and is considered a secure fuel source in the long term, it should have as large a base as possible. With these considerations in mind, the thermal load base for evaluating CHP concepts at PBA was developed as follows:

- o The FY1980 thermal load characteristics were evaluated for the Areas 31, 32, 33, 34 and 44; annual, monthly, daily, and hourly profiles were developed.
- o Two adjustments were made to the FY1980 load base:
  - Energy savings credits for all economically feasible ECOs which were developed into ECIP projects were applied to the load base, and profiles were adjusted.
  - Next, based on historical energy usage, building utilization, personnel mobilization schedules, and building similarity during FY1980 of inactive facilities to active facilities, the FY1980 load base was increased to reflect the expected load if all facilities were active at a single shift, 8 hrs per day, 5 days per week (1-8-5) mobilization level.

The resultant profiles were referred to as the "reference year." The reference year was used as the basis for evaluating both the existing condition and its life cycle cost, and for evaluating CHP concepts which could also serve Areas 31, 32, 33, 34, and 44. This is considered a more representative basis for assessing the economic feasibility than the FY1980 level of activity.

The results of this load base development are shown in Tables 7.1 through 7.5 beginning on page 7-5 of Section 7.0 of the report and can be summarized as follows:

Annual Steam Load Requirements:	209,080,000 lbs
Peak Steam Demand:	134,670 lbs/hr

Based on these two key parameters and the range of coals to consider (furnished by the Defense Fuel Supply Center (DFSC) for PBA), a central coal fired plant (operating at 140 psig) consisting of three 50,000 lb/hr travelling grate spreader stoker boilers and necessary auxiliaries, was developed. Capital costs were determined, and life cycle costs were developed; the results were compared to the base case (existing systems serving the same load base) to determine economic feasibility. The results (in terms of FY1980 dollars) are itemized in Table ES-5 on the following page.

TABLE ES-5
LIFE CYCLE COST SUMMARY

	BASE CASE	CHP
Capital Cost Estimate	$ 700,000	$16,044,500
First Year Annual Operating Costs		
O&M Costs		
- Personnel	480,000	660,000
- M&R	51,920	79,500
- Pollution Control	-	45,500
- Subtotal	531,920	785,000
First Year Annual Energy Costs		
- Electricity	-	7,000*
- Natural Gas	1,189,429	-
- Fuel Oil	-	-
- Coal (FOB, mine)	-	486,000
- Wood	-	-
- Transportation (coal delivery)	-	272,160
- Subtotal	1,189,429	765,160
Life Cycle Operating Costs		
O&M	4,389,400	6,477,820
Energy		
- Electricity	-	158,900
- Natural Gas	31,563,880	-
- Fuel Oil	-	-
- Coal	-	8,141,000
- Wood	-	-
- Transportation	-	7,222,300**
- Subtotal	35,953,280	22,000,020
Total Life Cycle Costs		
- Capital Cost	700,000	16,044,500
- Operating Cost	35,953,280	22,000,020
TOTAL	$36,653,280	$38,044,520

*Cost of incremental electricity required in CHP for such accessories as fuel handling equipment.

**Because of its dependence on oil, transportation cost was escalated at the rate of oil.

Although the present-worth life cycle cost analysis indicates that the coal fired CHP is approximately 3.8% more costly than continued operation of the existing plants, certain key factors used in the analysis merit consideration:

- The performance of the existing plant systems at PBA was predicated on the implementation of all feasible ECOs contained in this report, including new boiler controls and other related improvements. Therefore, the performance characteristics of the existing plants (Base Case) used in the analysis are significantly more efficient than present performance levels.

- The coal sources considered for PBA by the DFSC are Midwestern coals, which may or may not be the least costly sources in the long term. Coal costs used are "spot market" costs and not long-term contract prices, which may be less over a 25 year period should a long-term contract be possible. Also, western coals are presently being used by utility companies in the region and may be less expensive to PBA, thus offsetting this small life cycle cost difference. An in-depth analysis of this possibility should be considered in a more detailed assessment, which is outside of this scope of work and direction given.

- In comparison to the proposed central plant presented in the Master Planning and Construction Programming, Analysis of Heating System by Harland, Bartholomew and Associates, 1978; the plant described in this study is 25% larger, due to the development of the full building utilization level of mobilization. The DD-1391 developed as a result of the earlier study (for both a CHP and a central compressed air plant) had an annual savings of $157,000 and a simple payback period of 94 years. Because of the differences in the basis for sizing and level of operation, this feasibility study resulted in an annual first-year savings of $171,189 and a benefit-to-cost (B/C) ratio of 0.91.

- The use of supplemental refuse derived fuel (RDF) based on the annual availability at PBA would result in approximately 33,181 mBtu/yr to replace coal purchases (approximately 1,399 tons of coal), reducing the present worth life cycle cost difference of $1,391,240 to $20,313. This difference between the base case and the coal fired CHP with supplemental RDF is insignificant over a 25 year analysis period.

A sensitivity analysis was performed to determine if certain variations in the life cycle analysis would change the results of conversion to coal. Assuming all other factors remained the same as used in the life cycle analysis, the following sensitivities were performed:

- Assume a 10% differential cost growth rate (DCG).

- Assume an economic life and analysis period of 30 years versus 25 years.

The results of these sensitivity analyses are summarized as follows:

TOTAL LIFE CYCLE COST SUMMARY

	Base Case	CHP
Reference: 8% DCG for Natural Gas, 25 year Analysis Period	$36,586,819	$38,044,520
10% DCG for Natural Gas; 25 year Analysis Period	48,586,819	38,044,520
30 year Analysis Period; 8% DCG for Natural Gas	42,481,698	40,685,132

The biggest influence, thus the most sensitive factor, is the differential cost growth rate for natural gas. By using 10% versus 8%, the life cycle cost of the base case increased $12,000,000; this indicates the coal fired CHP would be 21.7% less expensive than maintaining present operations over the next 25 years. The analysis based on Army criteria for natural gas escalation showed that the base case would be 3.8% less expensive.

It is also reasonable to assume that the life of a coal fired installation would be longer than 25 years. If a 30 year period is used, the coal fired CHP would have a lower life cycle cost, and would thus be cost effective.

In conclusion, the most critical economic factor in the life cycle analysis is the fuel escalation rate used, since fuel and operating costs over the life cycle period exceed the total installed cost of a central heating plant by 50% or more. Therefore, the conclusions drawn can vary significantly based on the DCG rate used. Even so, the results of this analysis indicate that the margin of difference between the base case and the coal fired CHP is small; therefore, based on the uncertainty of future energy availability and costs, plus supplemental RDF, the coal fired CHP is recommended for concept design consideration.

Biomass Feasibility Study (Increment C)

The current level of forestry management practiced at PBA produces a harvest of approximately 6,312 tons of wood annually for commercial use. Considering other than commercially harvested timber, the biomass resources available on a sustained annual basis are as follows:

In-forest Residue Left from Harvesting Operations:	25,766 mBtu/yr
Unmerchantable Timber Stands:	28,053 mBtu/yr
Timber Wastes Created by Maintenance and Construction Projects:	2,365 mBtu/yr
Cottonwood In-forest Harvest Residue:	5,016 mBtu/yr
Total	61,200 mBtu/yr

This equals approximately 7,193 tons per year of biomass. The amount of input fuel energy available from these waste and residue sources can provide approximately 23% of the fossil fuel energy used in FY1980 at PBA. Based on the assumption that these sources are harvested for boiler fuel, two concepts were developed for PBA to determine the economic feasibility of utilizing biomass at PBA. Since there is sufficient biomass to supplant only a portion of the fossil fuel requirements, the concepts developed for analysis were as follows:

- o Retrofitting Boiler Plant 44-120 with a wood gasifier system.
- o Installing a base-loaded wood fired steam plant for the central steam system at PBA in Building 13-060.

The first concept would utilize the existing boilers of plant 44-120 to serve the current loads. The base-loaded plant for the central steam system would be a new facility in Building 13-060 sized to produce a steady, base-loaded steam output. The facility would be operated at a high average load on the boiler for 11 months of the year and would utilize all of the biomass available for fuel on an annual basis.

The results of the wood gasifier retrofit indicate that the life cycle cost of this concept is $1,749,543 versus $1,534,841 for the continued gas fired operation, or a 14% incremental increase above the present operation. For the smaller sized, base-loaded plant, however, a life cycle cost savings of more than $989,523 over a 25 year period would result, making the 5,000 lb/hr steam generating plant economically feasible and attractive. Since the output is interconnected with other plants which also serve the manufacturing area, operation at a steady output can be attained, allowing the other steam plant to adjust to load variations.

In summary, key economic parameters for the base-loaded plant concept are as follows:

Capital Cost Estimate	$ 672,000
Additional Life Cycle O&M Cost	1,144,528
Reduction in Life Cycle Energy Costs	(-)2,806,051
Total Life Cycle Cost Savings	$ 989,523

This life cycle cost savings represents a 3% reduction in the total life cycle cost if the present mode of operation (with ECOs implemented in the existing boiler plants serving the manufacturing area) would continue over the next 25 years.

Based on the results of this feasibility study, which are discussed in detail in Section 8.0 of the report, it is recommended that this second biomass concept be implemented at PBA.

Maintenance, Repair, and Minor Construction Projects (Increment G)

The basis for justification for Increment G projects is economic feasibility; the cost of implementation must be recovered within the economic lifetime of the project. Most projects considered did not meet the ECIP requirement of an E/C ratio criteria of 13 or greater, or were of a low-cost nature which could be handled locally by the Facilities Engineer utilizing either the maintenance department personnel or local contractors on an "as needed" basis. The economic criteria for determining feasibility of projects are the benefit-to-cost (B/C) ratio and the payback period.

At PBA, several types of funding programs are available, each with various limiting economic criteria for submitting projects. The two major funding programs considered for the energy savings projects which did not meet ECIP criteria are the Operations and Maintenance (O&M) budget, and Minor Military Construction Appropriations (MMCA). For maintenance and repair projects not exceeding $100,000, approval can be granted by the Commanding Officer of the facility, if funds are available in the annual budget. It is desirable that O&M projects have a B/C ratio greater than 1.0; however, it is not mandatory if the project is associated with accomplishing the mission of PBA. MMCA funding has a ceiling of $500,000 per project, and must have a B/C ratio greater than 1.0.

The economic analyses of identified maintenance and repair ECOs (presented in detail in Section 9.0 of the report) were based on ECIP procedures, as outlined in the Army Facilities Energy Plan, dated 1 October 1978, and Army Regulations (AR) 415-35, 420-10 and Army pamphlet 420-6. Using these guidelines, energy savings, energy savings-to-cost (E/C) ratios, benefit-to-cost (B/C) ratios, man-hours required to accomplish the project, and current working estimates (CWE) were developed.

The ECOs evaluated as part of the Increment G portion of the study were divided into three general categories:

- Non-qualifying ECIP ECOs.
- Maintenance and repair ECOs.
- Unit basis ECOs.

The results of these evaluations are presented in Tables ES-6 through ES-9 on the following pages.

At this time, three projects have been identified and DD Form 1391s have been prepared (repair and upgrading of condensate return system in the production area, primary line power factor correction, and replacing the 800 HP and 350 HP electric motors with natural gas engines). These projects are presented in the formal programming documents submitted with this report.

The implementation of the non-qualifying ECIP projects and the maintenance and repair projects which had a B/C greater than 1.0 should reduce the energy consumption at PBA by approximately 1.9%, using FY1975 as the reference year.

TABLE ES-6
NON-QUALIFYING ECIP ECO SUMMARY

Description	Annual Energy Savings(mBtu)	Man-hours Required	Capital Cost (CWE)(FY84$)	E/C Ratio	B/C Ratio
Primary Line Power Factor Correction	40	5	$ 50,400	0.80	5.65
Replace 350 HP Incinerator Motor with Natural Gas Engine*	550	182	133,200	4.1	2.55
Replace 800 HP Motors with Natural Gas Engines*	106	130	219,500	0.48	1.35
Upgrade and Repair Condensate Return in Production Area	7,850	7,870	805,756	9.7	1.11
Total	8,546	8,187	$1,208,856		

*These projects are combined into one MMCA project.

TABLE ES-7
MAINTENANCE AND REPAIR ECO SUMMARY

DESCRIPTION	Annual Energy Savings (mBtu)	Manhours Required	Capital Cost (CWE)(FY84$)	E/C Ratio	B/C Ratio
Maintenance of Unit Heater Thermostats	736	8	$ 374	1,968.0	17.85
Maintenance of Filters, Fan Belts and Cooling Coils	377	34	1,123	335.7	4.01
Condenser Coil Maintenance	247	104	1,728	142.9	1.89
HVAC Controls Maintenance	540	146	7,050	76.6	1.32
Total	1,900	292	$10,275	184.8	

TABLE ES-8
UNIT BASIS ECO SUMMARY

Description	Annual Energy Savings Per Unit (mBtu)	Man-hours Per Unit Required	Unit Cost (FY82$)	E/C Ratio	B/C Ratio
Flange, Valve, and Elbow Insulation					
6" Ø	45.2	1.5	$ 32.25	1,402.0	135.5
5" Ø	38.3	1.0	23.85	1,606.0	155.5
2" Ø	14.5	0.5	17.36	835.3	80.9
Steam Trap Maintenance					
Repair	45	1.0	18.63	2,415.0	55.7
Replacement	45	2.0	122.80	366.4	8.4
Radiator Hand Valve Maintenance					
Repair	16	0.5	8.57	1,867.0	42.9
Replacement	16	1.0	48.23	331.7	32.0
Repair Air Leaks	38	1.5	40.00	101.0	11.8
Repair or Replace PRVs					
Maintenance	33	0.5	8.00	4,125.0	19.8
Repair	33	0.5	50.70	650.9	15.1
Replacement	33	2.5	854.40	38.6	3.7
Steam Valve Maintenance					
Repair	24	1.0	50.70	473.4	10.9
Replacement	24	3.0	303.00	79.2	7.7

TABLE ES-9

REPLACEMENT ITEM ECO SUMMARY

(When replacement of existing item is required)

Description	Annual Energy Savings Per Unit (mBtu)	Man-hours Per Unit Required	Unit Cost (FY82$)	E/C Ratio	B/C Ratio
Replace Standard Fluorescent Lamps and Ballasts with High Efficiency Lamps and Ballasts	0.34	0	$ 4.34	78.3	3.3
Incandescent Conversion to Fluorescent Circline	1.5	0	20.75	72.3	4.7
Replace Standard Fluorescent Ballasts with Reduced Wattage Ballasts	0.194	0	2.98	65.1	2.5
Replace Standard Fluorescent Lamps with High Cool-White	0.24	0	0.85	282.5	4.9
Lite-White	0.24	0	0.62	387.1	6.7

Electric Motor Replacement

Motor HP	kW Saved	Price Premium FY82$	Operational Hours Per Year to Achieve B/C of 1.0
1	0.063	$ 60	3,516
2	0.041	54	4,863
3	0.123	69	2,071
5	0.117	82	2,588
7.5	0.195	85	1,609
10	0.150	105	2,584
15	0.451	136	1,113
20	0.441	154	1,289
25	0.470	171	1,343
30	0.475	189	1,469
40	0.821	255	1,147
50	0.810	301	1,372
60	0.826	440	1,967
75	0.845	558	2,438
100	1.301	661	1,876
125	1.351	835	2,282
150	1.636	1,035	2,336

Energy Conservation Plan - Energy Savings Summary

The Army Energy Plan has set a goal of 25% net energy consumption reduction by FY1985, based upon historic FY1975 energy consumption levels. A review of FY1980 energy consumption in comparison to FY1975 consumption shows that a significant energy reduction of 149,847 mBtu/yr, or 27.8%, has already been achieved by completed energy conservation projects and improved operation and maintenance procedures. Assuming implementation by FY1985 of all the recommended ECIP projects including EMCS and the non-qualifying ECIP and maintenance and repair ECOs as evaluated under Increment G, Pine Bluff Arsenal would achieve net annual energy savings since FY1975 of 263,198 mBtu/yr, or a 48.8% reduction in comparison to FY1975 energy consumption levels. An itemized summary of the projected energy savings is presented in Table ES-10 below.

TABLE ES-10
PBA ENERGY PROFILE: FY1975 - FY1985

Item	Annual Energy Base Fossil Fuel (mBtu)	Annual Energy Base Electric (kWh)	Total Annual Energy Savings For Item (mBtu)	% Savings
FY1975 Energy Consumption Level (No Savings)	436,511	8,816,000	538,777	-
Savings, Between FY1975-FY1980	175,277	(2,192,200)*	149,847	27.8
ECIP Project Savings	90,844	1,039,683	102,905	19.1
Increment G ECO Savings	3,307	615,463	10,446	1.9
Total Savings Since FY1975	269,428	(537,054)*	263,198	48.8
Wood Fired Boiler	43,440	(22,980)*	N/A	N/A

*( ) indicates an increase in energy consumption.

Note: Estimated wood use is 61,200 mBtu/yr, or equivalent to approximately 4,078 cords of wood per year.

Recommendations

As illustrated in Table ES-10 above, implementation of all energy conservation opportunities recommended in Sections 4.0, 5.0, and 9.0 of this report, in addition to savings already realized, will result in 48.8% net annual energy consumption reduction in comparison to FY1975 consumption levels, thus achieving Army energy conservation goals and DOD energy conservation goals for existing facilities as required by Executive Order 12003.

It is recommended that all five ECIP projects, the biomass plant concept, all non-qualifying ECIP ECOs, and maintenance and repair ECOs be implemented as soon as funding will permit.

A further reduction in energy can be achieved by the on-going implementation of "unit basis" maintenance ECOs. The establishment of such a program is highly recommended.