FINAL SUBMITTAL

EXECUTIVE SUMMARY

FORT CHAFFEE
ARKANSAS

EEAP PROJECT

CONTRACT NO DACA63-82-C-0192

TULSA DISTRICT, CORPS OF ENGINEERS

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FINAL SUBMITTAL

EXECUTIVE SUMMARY

FORT CHAFFEE, ARKANSAS

JUNE, 1984

INCREMENTS A, B, F AND G
EEAP PROJECT

Contract No. DACA63-82-C-0192

Tulsa District, Corps of Engineers

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I. EXECUTIVE SUMMARY

NOTE: The Scope of Work for this project is included in Appendix "I".

A. INTRODUCTION

Fort Chaffee, Arkansas, includes approximately one thousand three hundred (1,300) buildings, comprising approximately 5,000,000 square feet. Of this number, eighty-seven buildings are permanently heated and are used twelve months a year. There are an additional eighty-seven buildings utilized a portion of the year. It is extremely difficult to estimate current energy costs and anticipated savings for buildings where use changes so radically. We have developed a model utilizing all one hundred seventy-four buildings used during the year. Those buildings that are not used twelve months a year have an ill-defined occupancy schedule. We have estimated the hours of occupancy for each of these buildings and have included estimates of electric and natural gas consumption for each. Refer to Appendix "II" for Base Utility Consumption Model. Heat gain/heat loss calculation for each of the one hundred seventy-four buildings were provided earlier under separate cover.

B. EXISTING ENERGY CONSUMPTION

1. BASEWIDE CONSUMPTION FY1975

During 1975, Fort Chaffee was occupied by as many as 23,000 Vietnamese refugees at a time. There were also as many as 8,000 military personnel required at Fort Chaffee to handle the refugees. Utility data for electricity, natural gas and cooling is not available for 1975. In accordance with the Scope of Work, however, we have patterned an energy model for Fort Chaffee for 1975 based on normal occupancy and operations (no refugees or increased military personnel). Total energy consumption for 1975 is partitioned as follows:

Electricity............	68.6	x 10E9 BTU
Natural Gas............	119.01	x 10E9
Total.............	187.67	x 10E9 BTU

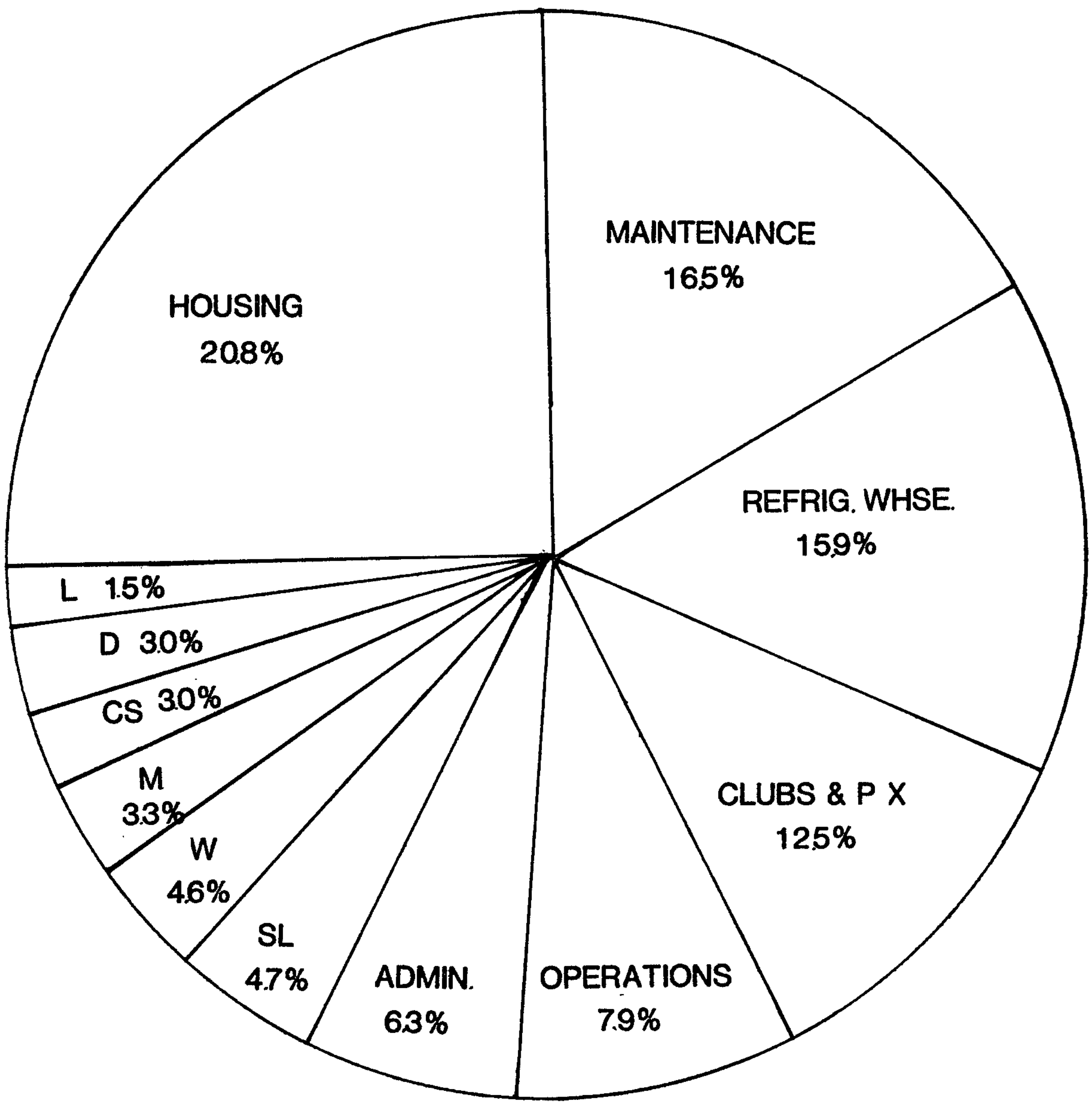
The results of this model are shown in Table 1 and

Figure 1 included herein.

TABLE 1

ENERGY MODEL FOR 1975

BUILDING TYPE	BUILDING AREA, S.F.	ELEC. ENERGY, MBTU	NATURAL GAS ENERGY, MBTU	TOTAL ENERGY CONSUMP. MBTU
Administration	133,781	5,324	6,583	11,907
Housing	140,036	2,144	36,958	39,102
Operations	99,526	1,823	13,056	14,879
Clubs and PX	90,569	7,771	15,716	23,487
Comm. Service	27,253	3,803	1,915	5,718
Dining	25,515	1,091	4,515	5,606
Medical	45,113	4,736	1,513	6,249
Warehouses	22,961	277	8,295	8,572
Ref. Warehouses	32,575	29,768	0	29,768
Maintenance	105,495	2,063	28,640	30,703
Laundry	2,458	1,043	1,819	2,862
Street Lights	-	8,817	0	8,817
TOTALS	725,282	68,660	119,010	187,670



STREET LIGHTS — 4.7%
WAREHOUSES — 4.6%
MEDICAL — 3.3%
COMMUNITY SERVICE — 3.0%
DINING — 3.0%
LAUNDRY — 1.5%

FY '75 CONSUMPTION
(187,670 x 10^6 BTU)
FIGURE 1

2. SOURCE ENERGY CONSUMPTION

Source energy consumption for Fort Chaffee, Arkansas consists of electricity and natural gas. Source energy consumption for electricity and natural gas for 1976 through 1982 are included in Appendix "II". Unknown quantities of coal were used in years 1975, 1976, 1980 and 1981 when refugees were present at Fort Chaffee. No records of coal consumption were available to us for these years.

3. TOTAL ANNUAL ENERGY USED

The following is an annual summary of energy used for years 1976 through 1982. Utility records for 1975 were not available so we have estimated energy consumption for a normal year (no refugees or increased military personnel).

Fort Chaffee Energy Consumption 1975 - 1982

		Electricity 1		Natural Gas		Total
Year	KW	MWH	KMBTU	KCF	KMBTU	KMBTU
1975+	15,152+	5,919+	68.66+	119,010+	119.01+	187.67+*
1976	14,101	5,881	68.22	154,462	154.46	222.68*
1977	13,825	5,745	66.64	102,717	102.72	169.36
1978	12,626	5,902	68.46	93,546	93.55	162.01
1979	12,345	5,645	65.48	86,179	86.18	151.66
1980	27,119	13,092	151.87	236,593	236.60	388.47*
1981	27,898	12,194	141.45	306,059	306.06	447.51*
1982	26,766	6,884	79.85	110,292	110.29	190.14

+ Estimated base year. See discussion.
* Plus unknown amount of coal used in the central boiler plants during these years.

4. BUILDING GROUP SOURCE ENERGY CONSUMPTION

Tables 3 and 4 contained in Appendix "III" provide energy consumption information on each of the 87 permanently heated buildings utilized twelve months a year and each of 87 additional buildings having air conditioning which are utilized a portion of the year. The total energy consumption for 1982 is partitioned as follows:

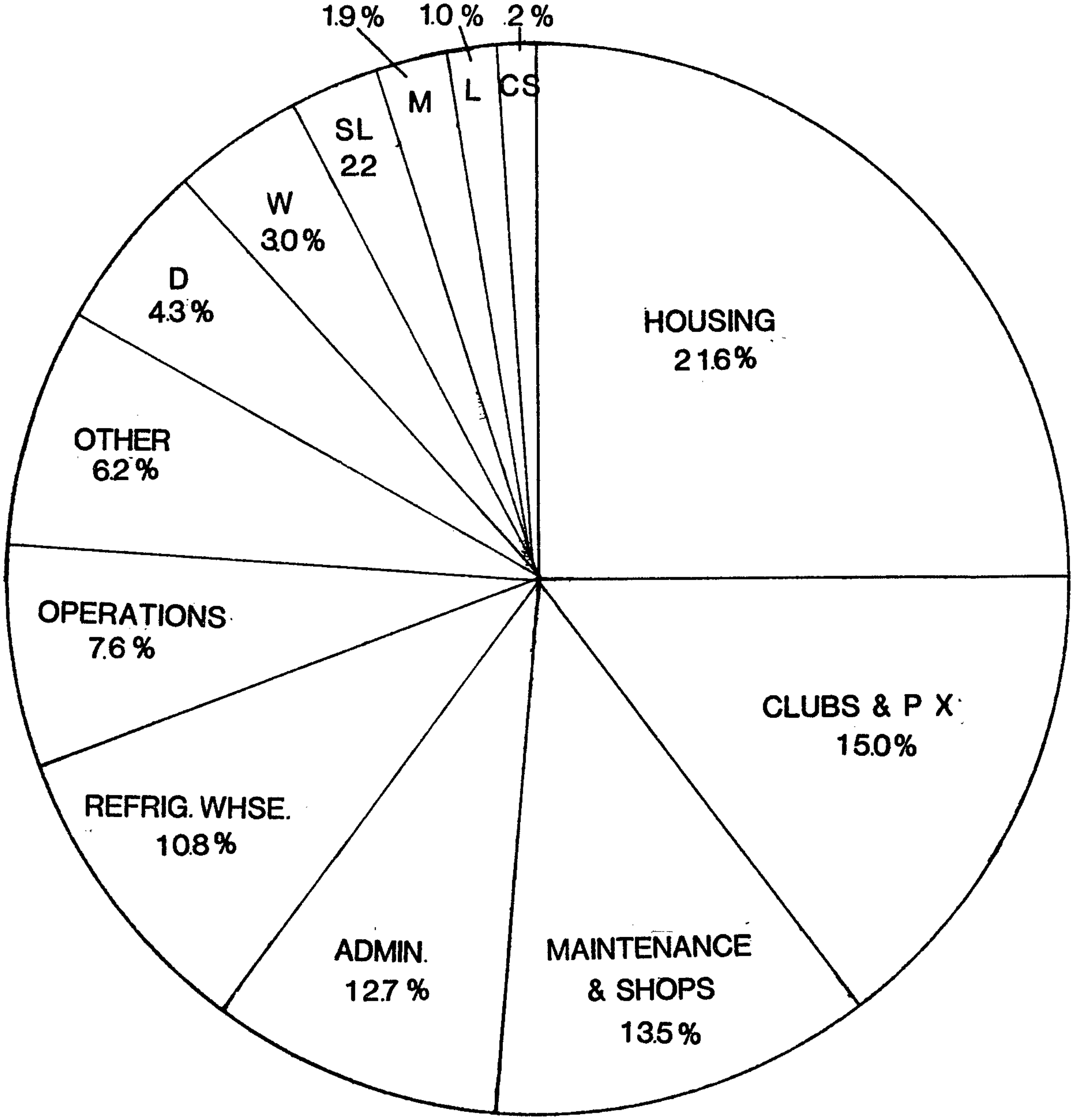
Electricity............	79.85 x 10E9 BTU
Natural Gas............	110.29 x 10E9
Total..................	190.14 x 10E9 BTU

Table 2 and Figure 2 show an energy model for Fort Chaffee for energy used in 1982. This model partitions energy consumption between the various buildings at Fort Chaffee by functional use.

TABLE 2

ENERGY MODEL FOR 1982

BUILDING TYPE	BUILDING AREA, S.F.	ELEC. ENERGY, MBTU	NATURAL GAS ENERGY, MBTU	TOTAL ENERGY CONSUMP. MBTU
Administration	133,781	7,184	16,882	24,066.0
Housing	140,036	8,015.5	32,863	40,878.5
Operations	99,526	6,843.1	7,687	14,530.1
Clubs and PX	90,569	14,086.7	14,358	28,444.7
Comm. Service	27,253	429.1	0	429.1
Dining	25,515	1,338.2	6,889	8,227.2
Medical	45,113	2,502.8	1,195	3,697.8
Warehouses	22,961	188.9	5,496	5,684.9
Ref. Warehouses	32,575	20,558.8	0	20,558.8
Maintenance	105,495	3,063.2	22,625	25,688.2
Laundry	2,458	538.3	1,436	1,974.3
Street Lights	-	4,226.0	0	4,226.0
Other	-	10,875.4	859	11,734.4
TOTALS	725,282	79,850.0	110,290	190,140.0



DINING	4.3%
WAREHOUSES	3.0%
STREET LIGHTS	2.2%
MEDICAL	1.9%
LAUNDRY	1.0%
COMMUNITY SERVICES	.2%

FY '82 CONSUMPTION

[190,140 x 10^6 BTU'S]

FIGURE 2

5. TYPICAL BUILDING ENERGY CONSUMPTION

A building's energy consumption may be partitioned according to use, i.e., air conditioning, lighting, heating and miscellaneous. For an example, we have selected Building 241, Headquarters Building. The building has approximately 7,165 square feet and has the following mechanical equipment:

(1) One 24 ton York condensing unit
(2) One air handling unit with economizer cycle
(3) One 400 MBH gas-fired duct furnace

The electrical energy consumption can be estimated as follows:

Air Conditioning

Assume:
(1) Connected KW for air conditioning - 35
(2) Equivalent full load hours - 1,130 (Reduced from 1981 Edition of ASHRAE Guide.)
KWH for air conditioning = 35 x 1,130 = 37,598

Lighting

Assume:
(1) Installed lighting = 1.5 watts/S.F.
(2) Operating hours per year = 2,640

KWH for lighting = $\frac{7165 \times 1.5 \times 2640}{1,000}$ = 28,373 KWH

Miscellaneous

Assume:
(1) Connected copy machines and office equipment = .5 watts/S.F.

KWH for misc. = $\frac{7,165 \times .5 \times 2640}{1,000}$ = 9,457 KWH

Total electrical energy consumption for the year = 37,598 + 28,373 + 9,457 = 75,428 KWH.

$\frac{75,428 \text{ KWH} \times 11,600}{1,000,000}$ = 875 MBTU

The natural gas consumed for the year for heating can be estimated from a formula found in the 1981 Edition of ASHRAE Guide. This formula is found on page 28.2 for various fuels, including natural gas. The formula is as follows:

$$E = \frac{(HL) \times (D) \times 24 \times (CD)}{(t) \times (K) \times (V)}, \text{ where}$$

E = fuel or energy consumption for period
HL = heat loss for building (279,400 BTU/hr)
D = degree days (3686)
K = correction factor which includes the effects of rated fuel load efficiency, part load performance, oversizing and energy conservation devices, natural gas = .25

CD = Empirical correction factor for heating effect (.67)
t = Design temperature difference (68F - 13F = 55F)
V (Natural gas) = 103,000 BTU/CCF

$$E = \frac{(279{,}400) \times (3686) \times (24) \times (.67)}{(55F)\ (.25)\ (103{,}000)} = 12{,}710 \text{ CCF}$$

Natural gas used for the generation of domestic hot water may be computed as follows:

Number of people - 40
Gallons/per day/per person - 5
Entering cold water temperature - 50F
Final hot water temperature - 110F
Efficiency of domestic water heater - .58

$$E = \frac{(40)(5)(22)(12)(7.5)(110F - 50F)}{(.58)\ (103{,}000)} = 398 \text{ CCF}$$

Total annual natural gas consumption = 12,710 + 398
= 13,108 CCF

$$\frac{13{,}108 \text{ CCF } (103{,}000 \frac{\text{BTU}}{\text{CCF}})}{1{,}000{,}000} = 1350 \text{ MBTU}$$

Table 3 in Appendix "III" includes estimates of electrical and natural gas energy consumption for all permanently heated buildings. Table 4 of Appendix "III" includes estimates of electrical and natural gas energy consumption for those buildings with air conditioning which are utilized a portion of the year. Table 5 of Appendix "III" lists the electrical loads in the permanently heated buildings.

C. ENERGY CONSERVATION MEASURES DEVELOPED

1. ECM'S INVESTIGATED

We have investigated numerous energy conservation measures. These measures may be divided into the following categories:

a. ECIP Measures
b. FE Measures
c. Numerous other energy conservation measures were studied in Increments F and G
d. Low cost/no cost measures. These were provided under separate cover, but are also included herein.

The ECIP measures include the following:

a. Reduction of natural gas transmission losses.
b. Improvement of mechanical equipment efficiencies.
c. Insulation of walls, ceilings and floors and installation of weatherstripping and caulking. Also included is the insulation of piping.

The FE measures include the following:

a. Installation of flow restrictors on showers.
b. Replacement of incandescent fixtures with fluorescent fixtures.

Those other energy conservation measures considered in Increments F and G are included herein in Section I and J.

Those low cost/no cost energy measures considered are included herein in Section K.

2. ECIP PROJECTS DEVELOPED

a. Reduction of natural gas transmission losses, T-285.

It is apparent from a review of natural gas bills for those months when no heating is performed and there are only caretaker forces present, that natural gas is consumed in considerable quantities. We are advised by Facility Engineering that mechanical heating equipment is turned off when a building is not in use or heating is not required.

We suspect that significant losses of natural gas occur monthly from the transmission system. Because of the age of the piping system and inadequate cathodic protection of the piping system, we feel that these losses occur annually. There are approximately twelve miles of natural gas transmission pipe. We feel that a systematic investigation of the piping system should be performed at a time when military personnel are present in only limited numbers. This is included as ECIP Energy Conservation Opportunity #1. The estimated energy savings for this energy conservation measure is 18,540 MBTU. DD Form 1391, PDB and Life Cycle Cost Analysis are bound in a separate volume of this report.

It should be pointed out that at our meetings of August 18, 1983,and March 28, 1984, at Fort Chaffee, the Facility Engineers concurred that it is quite likely there are numerous leaks in the system. They stated that during the time the Cuban refugees were housed at Fort Chaffee (1980-1982), there was a problem of maintaining sufficient natural gas pressure in the system.

b. Improvement of Mechanical Equipment Efficiencies, T-286.

It is apparent from an investigation of the gas-fired furnaces in the permanently heated buildings, that the systems are operating at minimal efficiency. This is borne out by the large gas consumption quantities during heating months. A sample calculation for Building 241, Headquarters, is presented on pages 8 and 9 herein. Tables 3 and 4 of Appendix "III" illustrate the energy consumption of the existing heating equipment. It is apparent from a review of these energy consumptions that the efficiencies of the of the heating equipment are quite low. The majority of the heating systems are forty years old coal fired systems which have been converted to natural gas. We recommend that these units be replaced with modern, efficient natural gas furnaces.

Building 1589, Main PX, has an absorption air conditioning system which operates at a very low efficiency and high operating costs. We propose that this system be replaced with a more efficient air cooled reciprocating chiller.

Building 1370, National Guard Headquarters, has a very inefficient air conditioning system. We propose that this system be replaced with a more efficient system.

The estimated energy savings for this energy conservation measure is conservatively estimated to be 43,992 MBTU. DD Form 1391,and PDB and Life Cycle Cost Analysis are bound in a separate volume of this report.

c. Insulation of Walls, Ceilings and Floors; Weather-Stripping and Caulking of Windows and Doors; Installation of Piping Insulation; Installation of Curtain Walls for Buildings Above Grade, T-287.

It is apparent from an inspection of the buildings at Fort Chaffee, that only a very few buildings have any insulation. We propose that all permanently heated buildings receive wall, ceiling and floor insulation. We also propose that curtain walls be installed around all buildings above grade. We are advised that considerable problems arise each winter due to frozen pipes. We also recommend that all exposed hot water and refrigeration piping be insulated. The estimated energy savings for this measure is 23,149 MBTU. DD Form 1391, PDB and Life Cycle Cost Analysis are bound in a separate volume of this report.

3. OTHER ENERGY CONSERVATION PROJECTS

Facility Engineer energy conservation measures included the installation of flow restrictors in showers and replacement of incandescent lighting with more efficient fluorescent lighting.

We measured the flow rate in numerous showers and found the flow rate to average 8 gallons per minute. This may be reduced to 3 gallons per minute by the installation of flow restrictors. Refer to Section H on page 21 and Appendix VIII herein for a more detailed discussion in this regard.

An inspection of numerous buildings revealed there are literally hundreds of inefficient incandescent fixtures that should be replaced by more efficient fluorescent fixtures. Refer to Section H and Appendix VIII herein for a more detailed discussion in this regard. The estimated energy savings for both of these energy conservation measures is 7,501 MBTU.

4. POLICY CHANGES/RECOMMENDATIONS

A review of occupancy statistics for Fort Chaffee and a review of the utility bills indicate there is some significant delay in decommissioning a building after its use by foreign refugees and military personnel. We observed certain buildings having mechanical systems in operation a month after reservists had left the Fort. We recommend a plan be established to cut off mechanical systems in buildings immediately after they become vacant.

D. ENERGY AND COST SAVINGS

1. BASEWIDE CONSUMPTION AFTER ENERGY CONSERVATION PROJECTS HAVE BEEN COMPLETED

Basewide energy consumption after augmenting recommended energy conservation opportunities is estimated as follows:

Electricity	-	77,588 MBTU/Year
Natural Gas	-	27,968 MBTU/Year
		105,556 MBTU/Year

This represents a reduction in energy consumption of 44.485%.

2. ALLOCATION OF ENERGY CONSERVATION PROJECTS

It is obvious from a review of the proposed energy conservation opportunities that major savings will be achieved in natural gas consumption. We feel this offers the best opportunity for energy savings. Each of the proposed energy conservation opportunities have been discussed in detail herein.

The electrical energy conservation opportunities are not as dramatic because of the following reasons.

1. Many of the permanently heated buildings are not air conditioned.
2. Those buildings that are air conditioned are only used five days per week during daylight hours.
3. Most air conditioning systems are of minimal size.
4. There are few potential electrical energy conservation opportunities.
5. The existing cold storage facility consumes over 25% of the total electrical energy utilized by Fort Chaffee. Our only recommendation in this regard is to shut down this

facility when it is not needed.

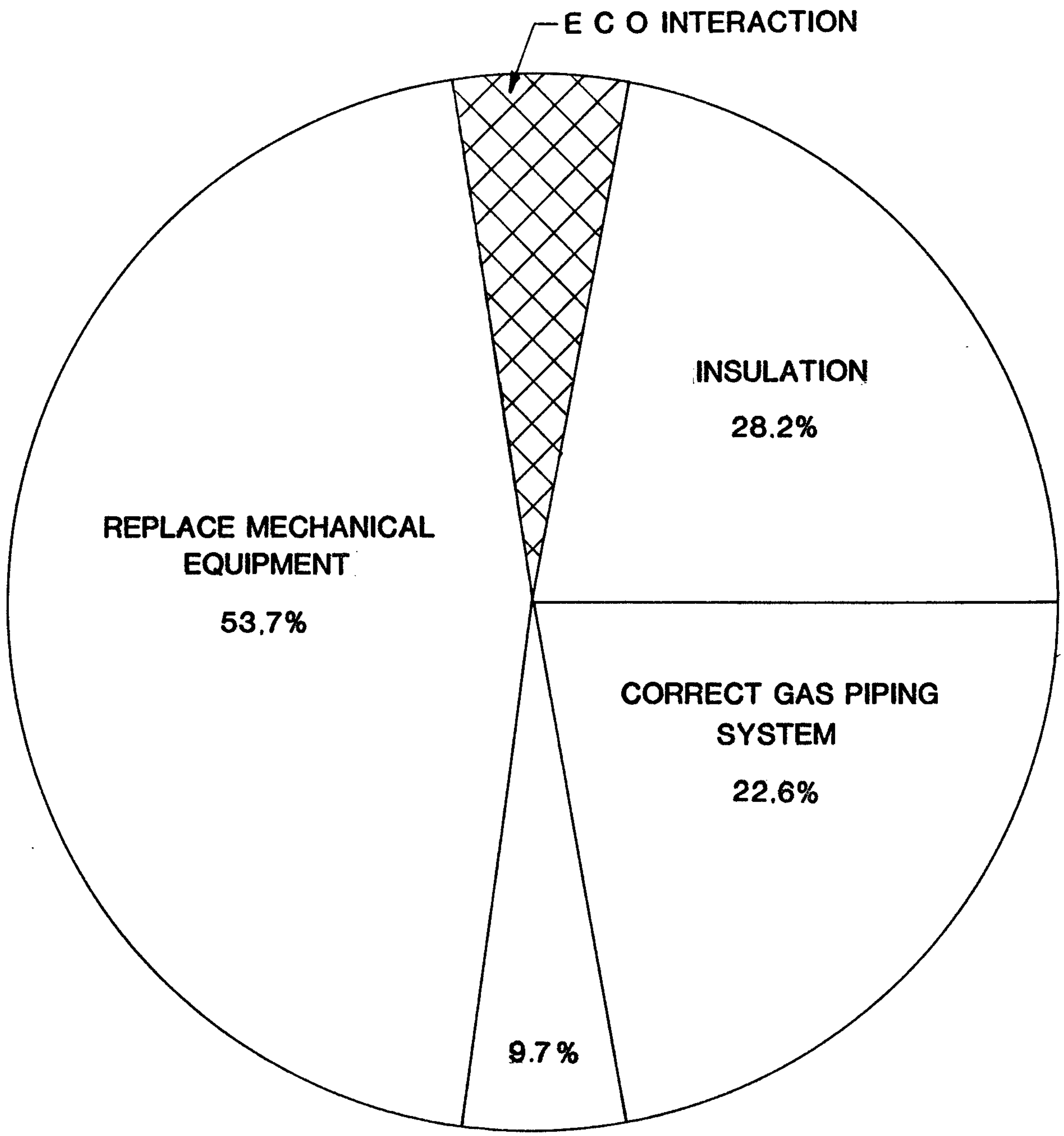
3. PROJECTED ENERGY CONSUMPTION

Table 5 partitions the predicted 1985 energy consumption between the various buildings at Fort Chaffee by functional use. This is after all energy conservation projects have been augmented. Figure 3 shows a partitioning of energy savings by the various energy conservation measures. Figure 4 shows a portioning of energy use among the various types of buildings.

TABLE 5

ENERGY MODEL FOR 1985
(AFTER ENERGY CONSERVATION OPPORTUNITIES ARE AUGMENTED)

BUILDING TYPE	BUILDING AREA, S.F.	ELEC. ENERGY, MBTU	NATURAL GAS ENERGY, MBTU	TOTAL ENERGY CONSUMP. MBTU
Administration	133,781	7,025.0	4,267	11,292.0
Housing	140,036	7,443.4	8,309	15,752.4
Operations	99,526	6,691.3	1,943	8,634.3
Clubs and PX	90,569	13,774.4	3,630	17,404.4
Comm. Service	27,253	419.5	0	419.5
Dining	25,515	1,308.6	1,742	3,050.6
Medical	45,113	2,446.9	302	2,748.9
Warehouses-Shops	22,961	184.7	1,390	1,574.7
Ref. Warehouses	32,575	20,298.7	0	20,298.7
Maintenance	105,495	2,995.4	5,721	8,716.4
Laundry	2,458	526.4	363	889.4
Street Lights	-	4,226.0	0	4,226.0
Other	-	10,247.7	301	10,548.7
TOTALS	725,282	77,588.0	27,968.0	105,556.0

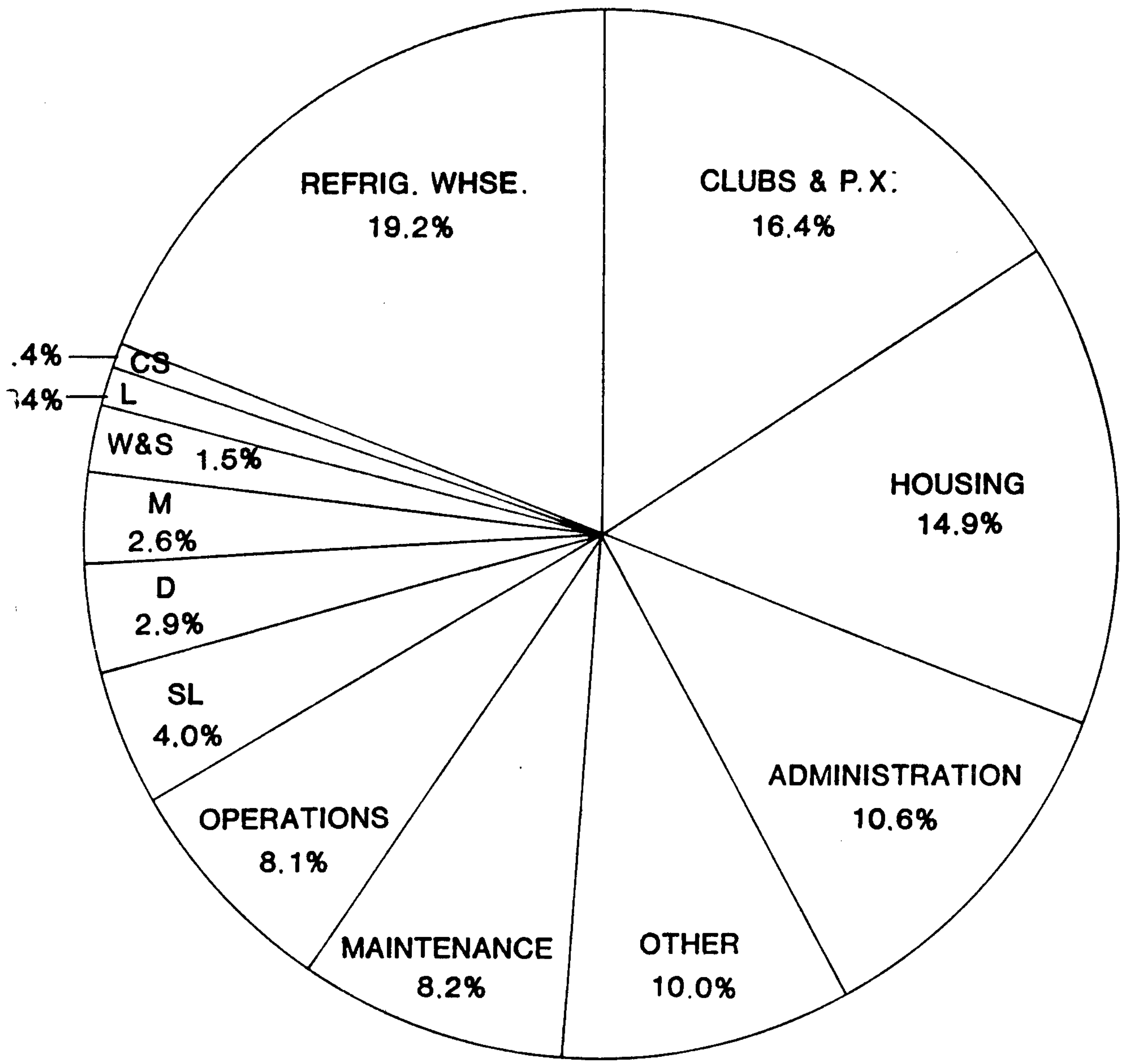


INSTALLATION OF INSULATION		28.2%
INSTALLATION OF MORE EFFICIENT MECHANICAL SYSTEMS		53.7%
	COMBINED	67.6%
CORRECTION OF GAS DISTRIBUTION SYSTEM LOSSES		22.6%
F E ENERGY CONSERVATION OPPORTUNITIES		9.7%

ENERGY CONSERVATION OPPORTUNITIES

(81,804 x 10^6 BTU'S)

FIGURE 3



STREET LIGHTS — 4.0%
DINING — 2.9%
MEDICAL — 2.6%
WAREHOUSE & SHOPS — 1.5%
LAUNDRY — .84%
COMMUNITY SERVICE — .4%

FY '85 CONSUMPTION

($105,556 \times 10^6$ BTU'S)

FIGURE 4

4. PROJECTED ENERGY COSTS

It is apparent that energy costs for both electricity and natural gas will increase substantially in the next few years. If the proposed energy conservation measures are not augmented, the anticipated 1985 energy costs will be as follows:

Electricity - 79,850 MBTU x \$5.02/MBTU = \$400,847.
Natural Gas - 110,290 MBTU X \$3.74/MBTU = \$412,485.
\$813,332.

If the energy conservation measures are augmented the 1985 energy costs will be as follows:

Electricity - (77,588) x (\$5.02 / MBTU) = \$389,492.
Natural Gas - (27,968) x (\$3.74 / MBTU) = \$104,600.
Total Cost = \$494,092.

It should be pointed out that the escalation rates for utilities were provided by the Corps of Engineers, and we feel that these escalation rates are conservative.

Energy cost savings that will be accrued if the energy conservation opportunities recommended herein are adopted will be as follows:

Electricity-(79,850-77,588)x(\$5.02 / MBTU)= \$ 11,355.
Natural Gas-(110,290-27,968)x(\$3.74 / MBTU)= \$ 308,707.
Total Savings = \$ 320,062.

This represents a savings of 39.35% of 1985 costs if energy conservation measures are not augmented.

E. INCREMENT "C" - RENEWABLE ENERGY, PRINCIPALLY SOLAR AND BIOMASS

1. SCOPE

Increment C is not a part of the Scope of Work for this Contract. We were requested, however, to perform Solcost studies on ten (10) buildings. We do not have the ability to alter the Solcost program. It is a non-proprietary program developed by the U. S. Department of Energy. Complete Solcost programs are included in Appendix "IV". In addition, we were requested to consider biomass for energy conservation.

2. BUILDINGS SELECTED FOR SOLAR STUDY

Although specific buildings were never selected for solar study, we have tried to select buildings which are representative. Those buildings selected and the type solar system considered are as follows:

a. 53 Man Barracks - Domestic hot water system
b. 74 Man Barracks - Domestic hot water system
c. Building 130, Infirmary - Domestic hot water system
d. Building 241, Headquarters - Domestic hot water system
e. Building 241, Headquarters - Hot water heating system
f. Building 242, Engineering - Domestic hot water system
g. Building 242, Engineering - Hot water heating system
h. Building 1384, Dining Hall - Domestic hot water system
i. Building 3602, B.O.Q. - Domestic hot water system
j. Building 3620, Hospital Ward - Domestic hot water system

3. METHODS OF STUDY

The solar life cycle cost system selected for study is the SOLCOST system. It is non-proprietary and makes an in-depth analysis of the use of solar heating for generation of domestic hot water and heating water. The program computes the optimum solar collector area required for the system, performs a life cycle cost analysis of the system and compares it to conventional system utilizing available fuels. The SOLCOST methodology is based on a one day simulation performed on the 15th day of each month using local weather data. Hourly steps are taken during the daylight hours of the simulation. Radiation incident on the collector must be available on an hourly basis. The simulation also requires that the collector be driven with two radiation profiles, one for a clear day and one for a totally cloudy day. The SOLCOST program is based on ASHRAE data and models and utilizes the SOLMET data base as directed by the Department of Energy.

Since the latitude of Fort Chaffee is 35.3 degrees, the program analyzes a solar system oriented to the South and mounted at angles of 35.3 degrees; 42.8 degrees and 50.3 degrees. The program is based on the least expensive type solar collector, i.e., single flat plate.

4. RESULTS OF SOLAR LIFE CYCLE COST STUDIES

As directed in ECIP Manual, the life cycle cost analysis shall be fifteen years. Consequently, none of the systems included in this study can be considered cost effective since payback time in each case exceeds fifteen years. The results of this study are as follows:

a. 53 Man Barracks
Solar system for generating domestic hot water
1. Optimum size of collector - 160 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 32 MBTU/Year
4. Payback - Greater than 15 years

b. 74 Man Barracks
Solar system for generating domestic hot water
1. Optimum size of collector - 260 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 53 MBTU/Year
4. Payback - Greater than 15 years

c. Building 130 - Infirmary
Solar system for generating domestic hot water
1. Optimum size of collector - 20 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 3 MBTU/Year
4. Payback - Greater than 15 years

d. Building 241 - Headquarters
Solar system for generating domestic hot water
1. Optimum size of collector - 20 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 3 MBTU/Year
4. Payback - Greater than 15 years

e. Building 241 - Headquarters
Solar system for heating system
1. Optimum size of collector - 920 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 107 MBTU/year
4. Payback - Greater than 15 years

f. Building 242 - Engineering
Solar system for generating domestic hot water
1. Optimum size of collector - 40 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 7 MBTU/year
4. Payback - Greater than 15 years

g. Building 242 - Engineering
Solar system for heating system
1. Optimum size of collector - 940 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 115 MBTU/year
4. Payback - Greater than 15 years

h. Building 1384 - Dining Hall
Solar system for generating domestic hot water
1. Optimum size of collector - 780 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 168 MBTU/year
4. Payback - Greater than 15 years

i. Building 1384 - B.O.Q.
Solar system for generating domestic hot water
1. Optimum size of collector - 20 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 3 MBTU/year
4. Payback - Greater than 15 years

j. Building 3620 - Hospital Ward
Solar system for generating domestic hot water
1. Optimum size of collector - 120 square feet
2. Optimum tilt angle - 35.3 degrees
3. Energy Savings - 23 MBTU/years
4. Payback - Greater than 15 years

5. CONCLUSIONS AND RECOMMENDATIONS

Because the payback on all solar systems exceeds fifteen (15) years, we do not recommend the installation of any solar systems at the present time. If, and when, the price of natural gas increases significantly, then consideration should be given to the installation of solar systems.

6. BIOMASS

<u>Discussion</u>

The economical potential for biomass energy generation at Fort Chaffee is very limited because of several reasons. First, there is no large consumption of heat energy on a year around basis, or on a 24 hours per day basis. The significant expense of installing a wood fired system usually requires four to six thousand hours of operation per year for a reasonable economic return. In addition, there is no geographical concentration of permanently heated buildings that would require a large enough project to be economically feasible. The most likely candidate meeting the size requirements would be the central steam plant which is coal fired. While wood competes fairly well cost wise with gas or oil fossil fuels, it is usually not cost effective to replace coal with wood.

For the above reasons and others, biomass was considered to be not applicable to Fort Chaffee. See Minutes, January 27, 1983, in review of Phase I Report.

F. INCREMENT "D" - COGENERATION AND SOLID WASTE

1. SCOPE

Increment "D" is not a part of the Scope of Work for this Contract.

G. INCREMENT "E" - CENTRAL BOILER PLANTS

1. SCOPE

Increment "E" is not a part of the Scope of Work for this Contract.

2. COMMENTS

If, however, the central boiler plant is to be activated, steps should be taken to maximize operating efficiency of the plant. The plant previously operated as a coal fired plant, however, natural gas is also available.

H. INCREMENT "F" - FACILITY ENGINEER CONSERVATION MEASURES

The purpose of work under this increment is to provide recommendations for modifications and changes in buildings and systems which are within the Facilities Engineer's funding authority and management control. There are two projects in this category.

1. The first project is to install flow restrictors (3 gpm) in all showers of barracks and living quarters. Estimated number of shower heads to be retrofited is 333. Estimated project cost is $2,038. Savings are estimated at 6,535 MBTU natural gas or $19,017 per year. See Appendix VIII for details.

2. The second project concerns the replacement of all incandescent fixtures in 14 barracks buildings (800 group) with fluorescent fixtures. Estimated retrofit cost is $2,270 per building or $31,782 for all 14 barracks. Total project cost is $33,406 including a five percent contingency allowance. Estimated savings are 1,360 MBTU or $5,861 per year. See Appendix VIII for detail calculations.

I. INCREMENT "G" - FACILITY ENGINEER CONSERVATION MEASURES

The following energy conservation opportunities have been studied and should be reconsidered in future Facilities Engineer projects.

1. WEATHERSTRIPPING AND CAULKING - Covered in ECIP recommendation number 3.

2. SOLAR FILM - This opportunity is not cost effective. See details in Appendix VIII.

3. VESTIBULES - Almost all buildings that are permanently heated and/or cooled already have vestibules. This ECO is not applicable.

4. LOAD DOCK SEALS - None of the buildings which would utilize dock seals are heated or cooled. This ECO is not applicable.

5. REDUCTION OF GLASS AREA - The buildings at Fort Chaffee do not have excessive glass. Most buildings need the light to be usable. This ECO is not applicable. See number 2 above.

6. REDUCE LIGHTING INTENSITY - The buildings at Fort Chaffee are not overly illuminated. This is not applicable.

7. SHUT DOWN ENERGY TO WATER HEATERS - This should be part of normal installation maintenance procedures. While performing the field audit, we found several instances where domestic water heaters were operating and the building was unoccupied. This is applicable.

8. IMPROVE POWER FACTOR - Fort Chaffee does not have a power factor problem. This is not applicable.

9. HIGH EFFICIENCY MOTOR REPLACEMENT - Included in Appendix VIII is a study to show that motors should be replaced with high efficiency motors when they have to be replaced. It is not cost effective to replace a motor until it has failed. This is applicable.

10. NIGHT SETBACK/SETUP - Air conditioning and heating systems at Fort Chaffee are currently setback/setup or turned off when the buildings are not in use, i.e., nights and weekends. This is done manually and as long as the practice continues, it is not cost effective to buy controls for same. However, if personnel are forgetful, then it might become beneficial to implement automatic controls. See product data in Appendix VIII.

11. ECONOMIZER CYCLES - None of the buildings at Fort Chaffee have a significant internal load such that mechanical cooling is necessary when the outdoor temperature is below 60F. Therefore, enthalpy controls are an added complexity that is not applicable.

12. CONTROL HOT WATER CIRCULATION PUMP - Fort Chaffee does not utilize hot water heating systems and does not have domestic hot water circulating pumps. This is not applicable.

13. FM RADIO CONTROLS - We were instructed by Fort Chaffee Facility Engineers not to utilize this type system. This is not applicable.

14. RADIATOR CONTROLS - The central steam plant is not in operation and this is not applicable. Permanently heated buildings have all air systems.

15. DECENTRALIZE DOMESTIC HOT WATER HEATERS - Domestic hot water systems are already decentralized and this is not applicable.

16. HEAT RECLAIM FOR HOT REFRIGERANT GAS - The only building having significant hot gas refrigerant is Building 238 (Cold Storage) and it has no domestic hot water or heating load. This is not applicable.

17. STREET LIGHTS - This is not a feasible or viable project area. Details to support this statement are furnished in Appendix VIII.

18. RETURN CONDENSATE - The central steam plant is not in operation and this is not applicable.

19. REPLACE INCANDESCENT LIGHTS WITH MORE EFFICIENT LIGHTING - We have included an energy conservation opportunity for this as an FE project. The base should endeavor to eliminate all incandescent lighting that is operated daily.

J. LOW COST/NO COST ENERGY SAVERS

These suggestions were delivered to the Facility Engineer bound under separate cover on November 16, 1982. Some of the ideas covered are repetitious with those presented in sections H and I.

1. SHOWERS

A standard showerhead releases from five to six gallons per minute. Actual random measurements indicate that the average rate of water delivery for showers at Fort Chaffee may be eight gallons per minute.

One way to reduce energy consumption is to convince everyone to take short showers. However, this is not practical, so an alternative is to install flow restrictors in each shower head which would limit water flow to three gallons per minute. This flow rate still provides a comfortable shower but saves about one gallon per minute of "hot" water or five gallons of "hot" water per shower. Multiplied by total number of showers taken on the base and it can provide significant savings.

2. HOT WATER THERMOSTAT SETTING

The thermostat setting on all hot water heaters not involved in laundromat or kitchen services can be lowered to 110 degrees Fahrenheit. If they are currently set between

140 - 160 degrees Fahrenheit, a reduced setting of 100 degrees Fahrenheit can reduce standby losses by one-half.

3. WINTER STANDBY LOSSES

Turn off all hot water heaters during unoccupied periods.

4. LAUNDROMAT HOT WATER

The base operates a significant number of laundromats. A switch to lower temperature on the washing machine can help reduce on utility bills. It takes about thirty-five gallons of water to do a full wash and rinse, or about seventeen gallons for each cycle. How much of that water is hot depends on which button you push. A hot wash and warm rinse combination, the highest setting on most machines, requires twenty-five gallons of hot water. Changing the rinse water to cold, which experts say does not affect the results of the wash, will save eight of those gallons per wash. By changing the wash setting from hot to warm, you could accrue additional savings. For gas hot water heaters, the savings would be $0.05 for each strategy.

To further increase the savings, use a cold water detergent and wash and rinse with cold water.

5. WEATHERSTRIPPING

Weatherstripping and caulk around windows and doors in the building that is heated throughout the winter season.

6. INFILTRATION

During the winter season, be sure to close windows or other openings where summer ventilation fans are installed.

In permanently heated buildings, plug all holes or cracks into the attic space around pipes, chimneys or other openings. It is common to find large openings where pipes, ducts, or exhaust fans are cut through the attic floor. They can be stuffed with foil-backed insulation or scrap plastic such as dry cleaner bags taped in place. Stopping attic bypasses can save from $25 to $80 a year in heating costs.

All of the obvious holes and gaps can be plugged with the exception of the gaps around recessed light fixtures and the vents in the attic. Do not cover light fixtures directly with insulation as this may cause a fire. Also, the vents must be able to breathe so that they can prevent moisture accumulation in the attic.

Another major bypass is the gap where the furnace stack or chimney meets the wood framing of the building. This gap is very important because it often creates a kind of mini-chimney effect, carrying air all the way from the basement to the attic and making a river of heat loss. Fireproof insulation can be stuffed between the wood frame and the wall of the chimney. Do not use cellulose here, as it may burn.

Even if the attic is not insulated, you should cut off the attic bypasses now. By doing so, you will increase the cost-effectiveness of the insulation you buy latter.

When people think of caulking and weatherstripping, they generally think of windows and doors. But most energy studies find that only twenty percent of that costly infiltration comes through these places. The other eighty percent gets in underneath the baseboards, through wall outlets, through holes where plumbing pipes and telephone wires enter the house, through holes around exhaust fans,a round dryer vents, and around sink and bathtub drain pipes as they exit from the house. These gaps and holes should all be caulked or stuffed with insulation. The electrical outlets can be sealed with inexpensive gaskets that can be purchased at hardware stores. Turn off the electrical current switch for the outlets in question, remove the plastic cover plates with a screwdriver, insert gaskets, reattach the plates, and turn the current back on.

7. REFRIGERATION

Lightbulbs are the symbols of conservation, but there are other things you can also turn off to save money. One example is the anti-sweat heater in refrigerators. These heaters keep moisture from appearing on the sides of the appliance. On large refrigerators, they add nearly $10 to the annual electric bill. They can be regulated with a switch inside the refrigerator compartment. The switch may have settings that say "dry/humid" or it may be called "power-miser switch" or "energy-saver switch". If your switch says "dry/humid", make sure it is set on "dry". If it says "power-miser" or "energy-saver", turn the switch on to turn the heaters off.

The heaters are unnecessary, except in humid climates where a house if not air-conditioned. If moisture ever does appear on the refrigerator, you can turn on the heaters for short intervals and turn them off again when the humid weather is over.

8. TEMPERATURE SETBACK/UP

Set back heating thermostats in permanently heated barracks during unoccupied periods, such as during the work day.

Set back cooling thermostats in residential quarters during unoccupied periods, such as during the work day.

Set back cooling thermostats in residential quarters during unoccupied periods, such as during work day. Better yet, turn air conditioning units off during unoccupied periods.

The best furnace or air conditioner energy-saving adjustment is still at the thermostat. Every degree that a space is artificially held above or below outdoor temperatures adds to the fuel bill. A ten degree night setback is a great way to achieve a ten to twenty-five percent savings on heating bills while you sleep. (If you have a heat pump, the savings will be from five to fifteen percent.) The no-cost way to get the setback savings is to manually turn down the thermostat at night and then turn it up again in the morning. There are also various thermostats on the market that do the job automatically.

9. SOLAR

Every building is a solar collector. The trouble is, it may be collecting the sun's heat when you don't want it and releasing that heat when you do. If you use air conditioning, you can save from $25 to $30 each cooling season per air conditioned building by keeping windows closed and shades or curtains tightly drawn, especially on the sunny sides of the house.

In the winter, you can cut fuel bills by opening the shades in the morning on the eastern and southern sides of the house and by closing them late in the day. If it is sunny in the afternoon, you can get additional solar heat by opening the shades on the west side of the house.

The shades on the north windows should be kept shut at all times during the winter.

10. INCANDESCENT LIGHTS

Eliminate all incandescent lighting in permanently occupied buildings. Screw-in circular fluorescent tubes are inexpensive, require no retrofit and save two-thirds the amount of consumption of incandescent fixtures.

Many of the incandescent lights have excessive wattage bulbs installed. An example is the mechanical room at the golf club which has a 300 watt bulb installed. A 60 watt bulb would be satisfactory. Review wattages in all incandescent fixtures.

11. HVAC FILTERS AND COILS

Clean heating, air conditioner and refrigerator filters and coils regularly to allow easy heat transfer.

12. REFRIGERATION

Eliminate all unnecessary "Coke" and other vending machines, particularly during the winter season or other unoccupied periods.

13. REFRIGERATION

Eliminate all unnecessary refrigeration. Each refrigerator, while convenient to have, consumes about $100 per year of electricity. This situation is especially energy intensive as the older less efficient refrigerators are the type which get tucked into the corners of offices and shops.

14. VEHICLES

Encourage car pooling or van transportation programs for the permanent civilian workers who live in town.

Review the fleet of base vehicles to determine if any are superfluous.

15. STREET LIGHTS

Review the street lights to determine if any that are currently turned on during the winter nights can be turned off until the base occupancy increases.

16. COLD STORAGE PLANT

Review operation of cold storage plant to determine if a consolidation of food supplies during low occupancy would permit a reduced operation from current levels.

17. PERMANENT BUILDINGS

Review current list of permanently heated or air conditioned buildings to determine if any can be transferred to the idle or lay-away category.

When opening a building during the off-season for a conference or meeting, be sure to follow-up and turn off heating systems and other energy consuming systems after the meeting is over.

18. VENTILATION

Many of the permanently heated buildings have roof mounted attic ventilators. Some of these have had plastic garbage bags placed over them for the winter season. This is a good idea as long as moisture and condensation conditions are not a problem during the winter time. Consider extending this practice to all permanently heated buildings.

19. COOLING TOWERS

Many of the wooden cooling towers are in poor condition. Many can easily be corrected by having the carpenters rebuild, mend and clean these units during the heating season. All missing fill material should be replaced.

20. INSULATION

Most of the refrigeration piping between exterior condensing units and interior evaporator units is uninsulated. Pre-molded foam insulation for copper piping is relatively inexpensive and easy to install. We suggest that a program be established in the HVAC shop to insulate all bare refrigeration piping when any refrigeration is serviced or worked on.

K. ENERGY PLAN

1. MATRIX OF ACTIONS AND SAVINGS

The following is a matrix of recommended energy actions to be augmented prior to 1985.

ENERGY CONSERVATION OPPORTUNITY	COST OF IMPLEMENTATION	ENERGY SAVINGS MBTU	ENERGY SAVINGS $ 1982	ENERGY SAVINGS $ 1985
ECIP #1 (T-285) (Reduce natural gas transmission losses)	$ 61,300	18,540	$ 53,951	$ 69,340.
ECIP #2 (T-286) (Improve mechanical equipment)	325,240	43,992	126,894	163,503
ECIP #3 (T-287) (Insulate walls, ceilings, floors)	669,737	23,149	69,749	88,758
FE #1 (Installation of shower flow restrictors)	2,038	6,535	19,017	24,440
FE #2 (Replace incandescent light fixtures with fluorescent fixtures)	33,406	1,360	5,862	6,827
Totals	$1,091,721	81,804*	$243,841*	$312.,216*

*It should be pointed out that augmenting both ECIP #2(T-286) and ECIP #3(T-287) does not produce additive energy savings. The anticipated annual energy savings are 55,369 MBTU/Year rather than 67,141 MBTU/Year for the two energy conservation opportunities.

2. PERCENTAGE REDUCTIONS OF ENERGY BY 1985

Energy savings which may be achieved by 1985 due to implementation of energy conservation opportunities are as follows:

FISCAL YEAR	ELECTRICITY MBTU	NATURAL GAS MBTU	TOTAL MBTU
1982	79,850	110,290	190,140
1985	77,588	27,968	105,556
Savings	2,262	82,322	84,584
Percentage Reduction	*2.83%	74.6%	44.48%

* The actual electrical energy savings projected as a result of the implementation of these energy conservation projects are 4.0 percent. However, one of the recommended projects involves converting the base's largest annual air conditioning load from gas to electricity. Therefore, while reducing overall energy consumption by 1,878 MBTU/yr., we are also increasing the electrical consumption by 945 MBTU. Thus, the net savings projected are the 2.83 percent indicated.

3. ENERGY USAGE FOR BUILDING IN 1985.

We have estimated the energy usage for various types of buildings at Fort Chaffee for 1985 after all energy conservation opportunities have been augumented. The estimated energy consumption for each type building and the energy consumption per square foot are shown in the following table.

ENERGY USAGE PER SQUARE FOOT BY 1985

BLDG. TYPE	BLDG. AREA S.F.	1985 ESTIMATED ENERGY CONSUMP. MBTU	ENERGY CONSUMP. PER S.F. MBTU/S.F.
Administration	133,781	11,292.0	84,406
Housing	140,036	15,752.4	112,488
Operations	99,526	8,634.3	86,751
Clubs and PX	90,569	17,404.4	192,162
Comm. Service	27,253	419.5	15,392
Dining	25,515	3,050.6	119,561
Medical	45,113	2,748.9	60,933
Warehouses and Shops	22,961	1,574.7	68,581
Refrigerated Warehouses	32,575	20,298.7	623,137
Maintenance	105,495	8,716.4	82,623
Laundry	2,498	889.4	356,044
Street Lights	-	4,226.0	-
Other	-	10,548.7	
TOTALS	725,282	105,556.0	

4. PROJECT BREAKOUTS WITH TOTAL COSTS AND SIR RATIO

Each of the ECIP and FE projects have been discussed in detail in Sections C and D herein. The following is a tabulation of the projects, construction cost, energy savings and SIR ratio.

PROJECT	CONSTRUCTION COST, $	ENERGY SAVINGS MBTU	SIR RATIO
FE-1	$ 2,038.	6,535	130.32
ECIP-1 (T-285)	$ 61,300.	18,540	12.22
ECIP-2 (T-286)	$325,240.	43,992	5.47
FE-2	$ 33,406.	1,360	2.15
ECIP-3 (T-287)	$669,737.	23,149	1.44

5. SCHEDULE OF ENERGY CONSERVATION PROJECTS

We recommend that the energy conservation projects be augmented under the following schedule:

(1) ECIP-1: A corrosion engineer registered by the Department of Transportation should be engaged immediately to conduct corrosion and gas leak surveys. This engineer will need the assistance of Facility Engineers in locating valves to close off various sections of natural gas distribution system to perform leak tests. When leaks have been located, a gas piping firm should be engaged to correct the leaks. After leaks have been corrected, Corrosion Engineer should prepare a cathodic protection plan for Fort Chaffee. He should also prepare an Operations and Maintenance Manual and Emergency Procedures Manual. The initial survey will take approximately two weeks to complete. The

corrections of leaks will take approximately thirty days to correct. The installation of cathodic protection system will take an additional thirty days.

(2) ECIP-2: Facility Engineering should make an inventory of gas-fired equipment to be replaced under this Contract. An engineering firm should be engaged to prepare Plans and Specifications for the replacement of existing gas-fired equipment. The engineering firm should also prepare Plans and Specifications for the replacement of the absorption cooling system in Building 1589 and the air conditioning system in Building 1370. Design time for this project should not exceed one hundred twenty (120) days and construction should be completed in six (6) months.

(3) ECIP-3: An architect should be engaged to prepare Plans and Specifications for the installation of ceiling, wall and floor insulation in the permanently heated buildings. Plans should also indicate the installation of curtain walls around the buildings constructed off-grade, the installation of weatherstripping around doors, and the installation of insulation on domestic hot water and refrigerant piping.

If Facility Engineering can assemble plans of the various permanently heated buildings for the architect's use, it will save considerable time and the fee will be much reduced. We were unable to find plans for this project.

Design time will probably be approximately six (6) months and construction period will be approximately twelve (12) to fifteen (15) months.

(4) FE-1: Facility Engineering may purchase flow restrictors for 3 GPM from any large plumbing wholesaler for $4.00 each. Maintenance personnel may install the flow restrictors. The time required to accomplish this work should not exceed thirty (30) days for one person.

(5) FE-2: Facility Engineering may purchase the recommended fluorescent light fixtures from any large electrical supply house. The current price for the fixture which we have recommended for installation in the fourteen barracks building is $43.83. The manufacturer of this fixture offers a twelve month unconditional warranty against breakage if installed as per their guidelines. We have allocated one hour per fixture for electrician's time in these estimates.