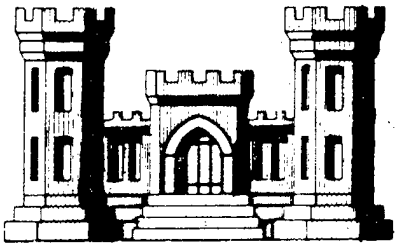
Basewide Energy Studies in Support of Energy Engineering Analysis Program

Executive Summary

Sunflower Army Ammunition Plant

DeSoto, Kansas

Contract No.- DAC41-81-C-0170



Final Submittal

Prepared For

Department of The Army

Kansas City District

Corps of Engineers

By

Booker Associates, Inc.

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Revised
May 1985

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EXECUTIVE SUMMARY

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1. PRELIMINARY SUBMITTAL

Volume 1 through 24 - dated June 1982.

Includes the following:

- List of buildings surveyed
- Prior energy conservation actions
- Energy conservation opportunities and building groupings
- Energy consumption data
- AE metering recommendations
- Increment "F" recommendations
- Phase II proposed analyses and studies
- Phase II sample computations
- All field survey data

2. INTERIM SUBMITTAL

Volumes 1 through 6 - dated February 1983

Includes the following:

- Calculations and information used in evaluating various energy conservation opportunities and tabulation of results
- Description of present conditions and ECOs being evaluated against said conditions
- Increment F recommendations

3. FINAL SUBMITTAL

Volume 0 - Executive Summary

Volume I - Narrative Report

Volume II- Project Calculations

Volume III-Programming Documents pertaining to projects recommended for implementation including the following:

- DD 1391 Forms
- Detailed justification
- Project development brochure

NOTE: Preliminary and interim submittal reports have already been submitted.

INTRODUCTION

1. Authority

This project is being undertaken for the U.S. Department of the Army, Kansas City District Corps of Engineers under the authority contained in DAEN-MPE-E letter, dated 6 June 1980, subject: FY 81 Energy Engineering Analysis Prgram (EEAP).

2. Scope of Work

The Scope of Work for this project consisted of plantwide studies to analyze present and future energy usage of Sunflower Army Ammunition Plant and the development of a systematic plan which will result in the reduction of energy consumption in compliance with the objectives set forth in the Army Facilities Energy Plan. The Scope of Work was organized in six increments as described below:

In Increment A, buildings were analyzed to determine the feasibility of modifying existing buildings, including architectural changes, energy distribution systems, and mechanical plants.

Increment B consisted of feasibility studies for improvements in existing energy distribution systems, such as steam piping, an energy monitoring and control system, and improvements to existing energy plants.

Increment C investigated the possible use of various renewable energy sources, such as: active solar heating and air-conditioning, solar domestic water heating, passive solar heating, wind turbines, and biomass powered boilers.

Increment E concerned the use of solid fuels and alternate methods of steam generation. Modifications that were considered included 1) conversion of a central boiler and small area boilers to coal, 2) addition of a modular baseload boiler, 3) and use of additional small area boilers or portable boilers.

Increment F addressed energy conservation projects that could be accomplished as part of general operation and maintenance, such as: repair of leaking steam traps, caulking and weatherstripping, and reducing thermostat setpoint in unoccupied areas.

Increment G initially contained those projects which had a B/C equal to or greater than 1 and an E/C of less than 17 while paying back within their economic life. Under the SIR criteria most of these projects shifted into Increment A. Increment G as listed in this summary contains projects with a B/C equal to or greater than 1 and an SIR less than 1. SIR calculations were not run on all of these buildings once B/C ratio calculations indicated their SIR would be below 1.

3. Implementation of Scope of Work

The work was accomplished in three phases as discussed below.

3.1 Phase I Effort:

In January, February and March, 1983 a field survey team consisting of up to 9 employees of Booker Associates, Inc. conducted the site investigations required under the Phase I portion of the project.

During this period, Field Inspection forms were completed on all buildings judged appropriate for consideration in regard to energy conservation. Data available from the plant, such as "Property Records" and "Plant Equipment Listings", was compiled. Also completed were "Building Dimensional Data for HVAC Calculations" sheets which provide wall, window, door, and ceiling/roof information.

Follow-up field investigation trips to the plant were made by a two man team the weeks of May 3, May 10, and May 21, 1982 to verify information and to accomplish the Increment F field work. The following paragraphs provide a summary of the work performed in the field:

Architectural

The architectural information gathered on each building consisted of general building data, such as 1) name, number, and function, 2) verification of as-built drawings or sketches of floor plans and cross-sections, 3) floor, wall, and ceiling data, and 4) window and door information. When actual conditions differed from that shown on as-built drawings, notations were made on the Field Inspection forms. Photographs were taken to assist in verification of existing conditions.

Mechanical

Mechanical as-built drawings were checked to verify that existing building mechanical systems were as shown on the plans. Mechanical equipment surveyed included 1) heating, ventilating, and air-conditioning systems, 2) domestic hot water systems, 3) ductwork, 4) heating and cooling media, 5) insulation of mechanical systems, 6) control system type, and 7) process equipment. Any variations from the drawings were noted. Nameplate data on all equipment was taken whenever it was available. The general condition of HVAC equipment was noted. Buildings were also checked to see if the building was shaded by another structure and what utilities were serving the building.

Electrical

The electrical survey for each building included 1) verifying light fixture types and quantities, and 2) identifying major sources of power consumption in the building. Excessive light levels were calculated and inefficient light sources were noted.

Steam Generating Plants

The existing steam generating plants in Buildings 154-1, 154-3, and 123 were checked and compared to the as-built drawings. Any variations between existing equipment and the as-built drawings were noted. Whenever possible, nameplate data of boilers and related equipment was taken. The general condition of the boilers and related equipment was noted.

3.2 Phase II Effort

Under Phase II, both the technical and economical feasibility of the various energy conservation opportunities outlined in the preliminary report were analyzed. The Building Loads and System Thermodynamics (BLAST) computer program and EEAP standard energy calculations were utilized to determine the baseline energy consumption and energy savings if a particular energy conservation measure were implemented. The potential energy savings and the cost to implement the measure were used to perform an economic analysis to determine the benefit/cost (B/C) ratio and the energy/cost (E/C) ratio, which were used in ranking the various projects.

Due to the number of buildings involved, it was not possible to perform a detailed analysis of all of the buildings in the plant. During Phase I of this study, the plant buildings were grouped for analyses purposes into "Base Buildings", those to be analyzed in detail, and "Similar Buildings", those which were judged to have similar energy conservation characteristics. In Phase II the energy savings and costs were extrapolated for the "Similar Buildings" using the appropriate "area" factor i.e.: window area: window area, wall area: wall area, etc. During this phase of the work, Energy Conservation Opportunities (ECOs) were grouped into ECIP projects.

3.3 Phase III Effort

Following the Phase II Interim Submittal, the criteria for approval of specific energy conservation measures was changed from B/C and E/C to Savings/Investment Ratio (SIR). SIR calculations were performed on the "Base Buildings" and the savings were extrapolated to the "Similar Buildings". Those buildings which were clearly not qualified under the ECIP criteria were not reconsidered for the SIR criteria. Only active buildings, as designated by the operating contractor, were considered in the preparation of programming documents.

Phase III of the Sunflower Basewide Energy Study consisted of the preparation of the programming documents (DD Forms 1391 and Project Development Brochures) and reports presenting the results and recommendations of the study.

FACILITY PROFILE

1. Location: Sunflower Army Ammunition Plant, Desoto, Kansas. Ref. Figures ES-1 and ES-2.

2. Mission: This facility is an integral part of the U.S. Army Armament Material Readiness Command (DARCOM), with a mission to manufacture explosive propellant for the armed services.

3. Workforce: U.S. Army Civilian 9, Operating Contractor (Hercules, Inc.) 493.

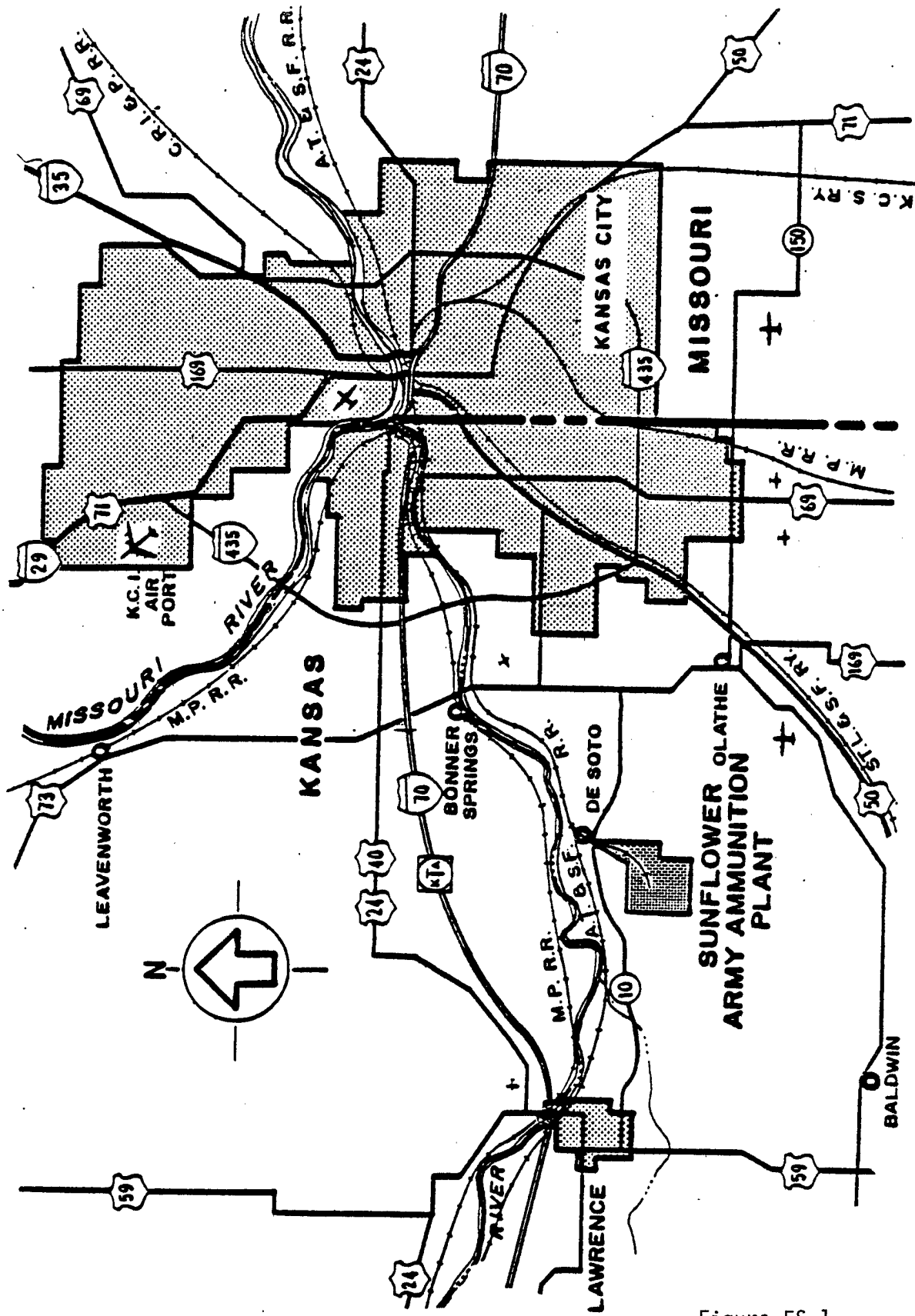


Figure ES-1

facilities requirements sketch, PDB- ½ | 2.0

DA FORM 5022-R, Feb 82

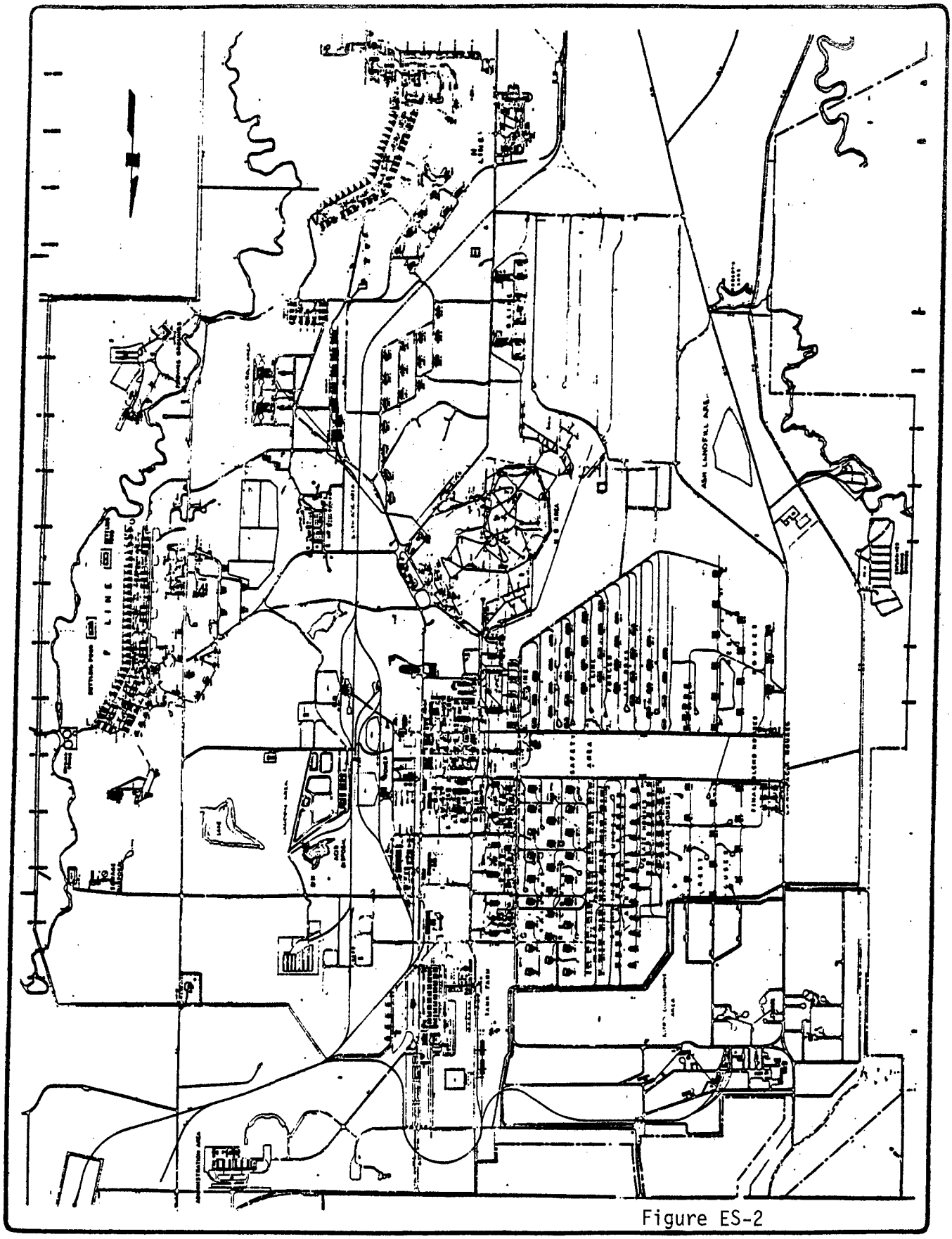


Figure ES-2

facilities requirements sketch, PDB- ½	2.0

DA FORM 5022-R, Feb 82

ENERGY CONSUMPTION DATA

During the plant field survey, data was compiled covering energy consumed for fiscal year 1975, 1979, 1980, and 1981 at the Sunflower Army Ammunition Plant. Gasoline consumed for mobile operation or vehicle fleet operation was not included. Trend graphs were developed covering electricity, natural gas, and oil consumed monthly. Total energy consumed and percentage of each type of energy consumed is illustrated in pie graphs. Data sheets and graphs appear on pages ES-10 through ES-17.

Data and graphs for gas and electricity were developed using actual utility bills. Abrupt changes in power consumption from one month to the other appear upon trend graphs. In some cases, power consumed in one month was carried over into the following month or months, possibly due to estimated bills. Interpolation of the data was not attempted because it would not improve accuracy.

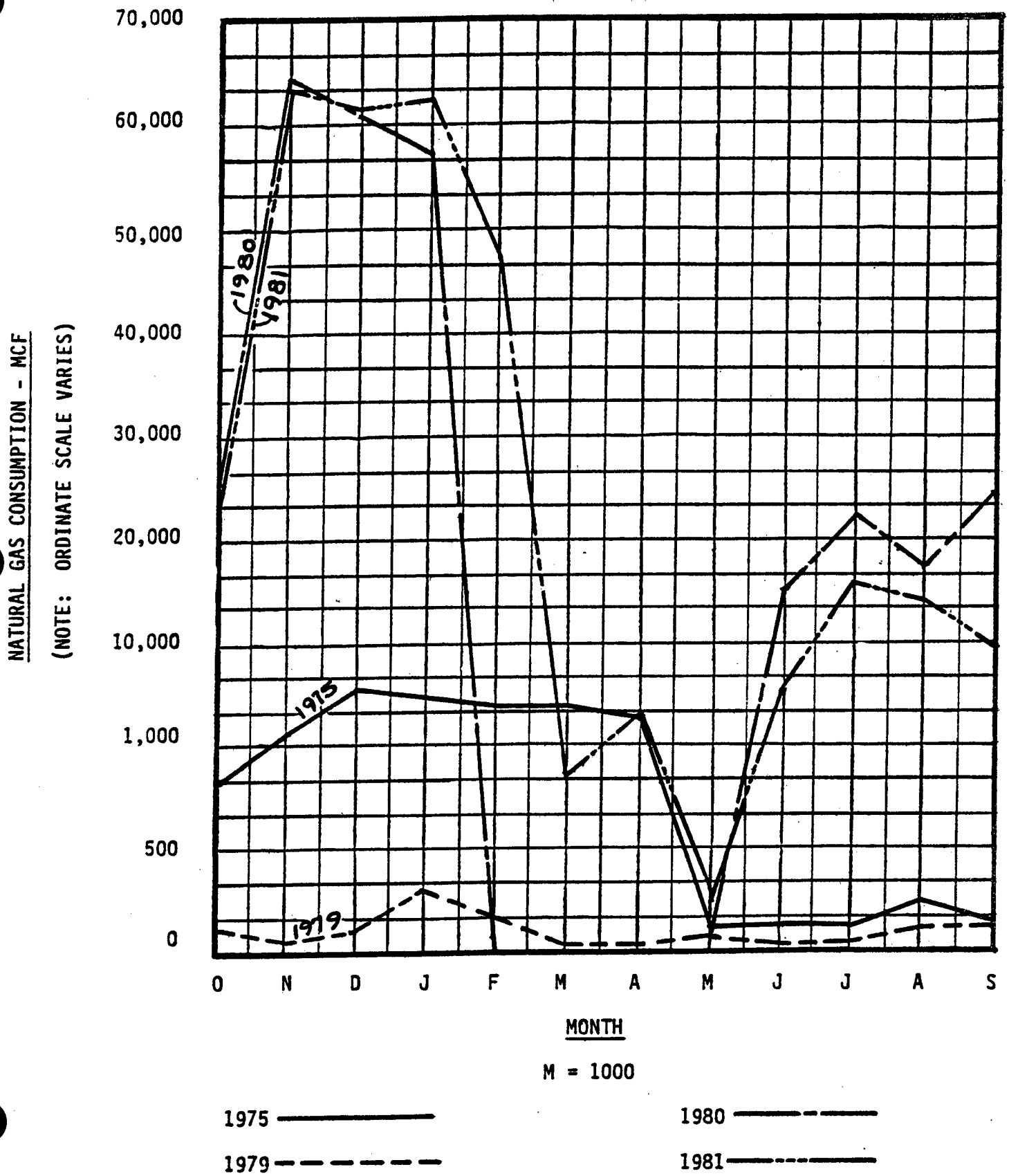
Sunflower Army Ammunition Plant, for the four years covered by this survey, has been strictly on a standby basis. At times, pilot plant operations were in progress, which probably accounts for unexplained temporary peaks in energy consumption. Because the plant has been on a standby basis with small increases and decreases of power consumption illustrated in the data, no trend in energy conservation could be determined.

Energy Consumption FY-1975, 1979, 1980 and 1981

	Consumption	Dollars
FY-1975		
Natural Gas	22,393 MCF	$9,945
Electricity	8,266,500 kWH	$176,903
Coal	None	None
Fuel Oil	60,169 Gal.	Unknown
FY-1979		
Natural Gas	973 MCF	$ 1,004
Electricity	10,492,000 kWH	$353,580
Coal	None	None
Fuel Oil	325,015 Gal.	Unknown
FY-1980		
Natural Gas	242,575 MCF	$346,048
Electricity	20,354,500 kWH	$679,840
Coal	13,207 Tons	$573,976
Fuel Oil	422,529 Gal.	Unknown
FY-1981		
Natural Gas	309,641 MCF	$530,248
Electricity	21,976,000 kWH	$808,717
Coal	2,111 Tons	$ 91,750
Fuel Oil	936,406 Gal.	Unknown

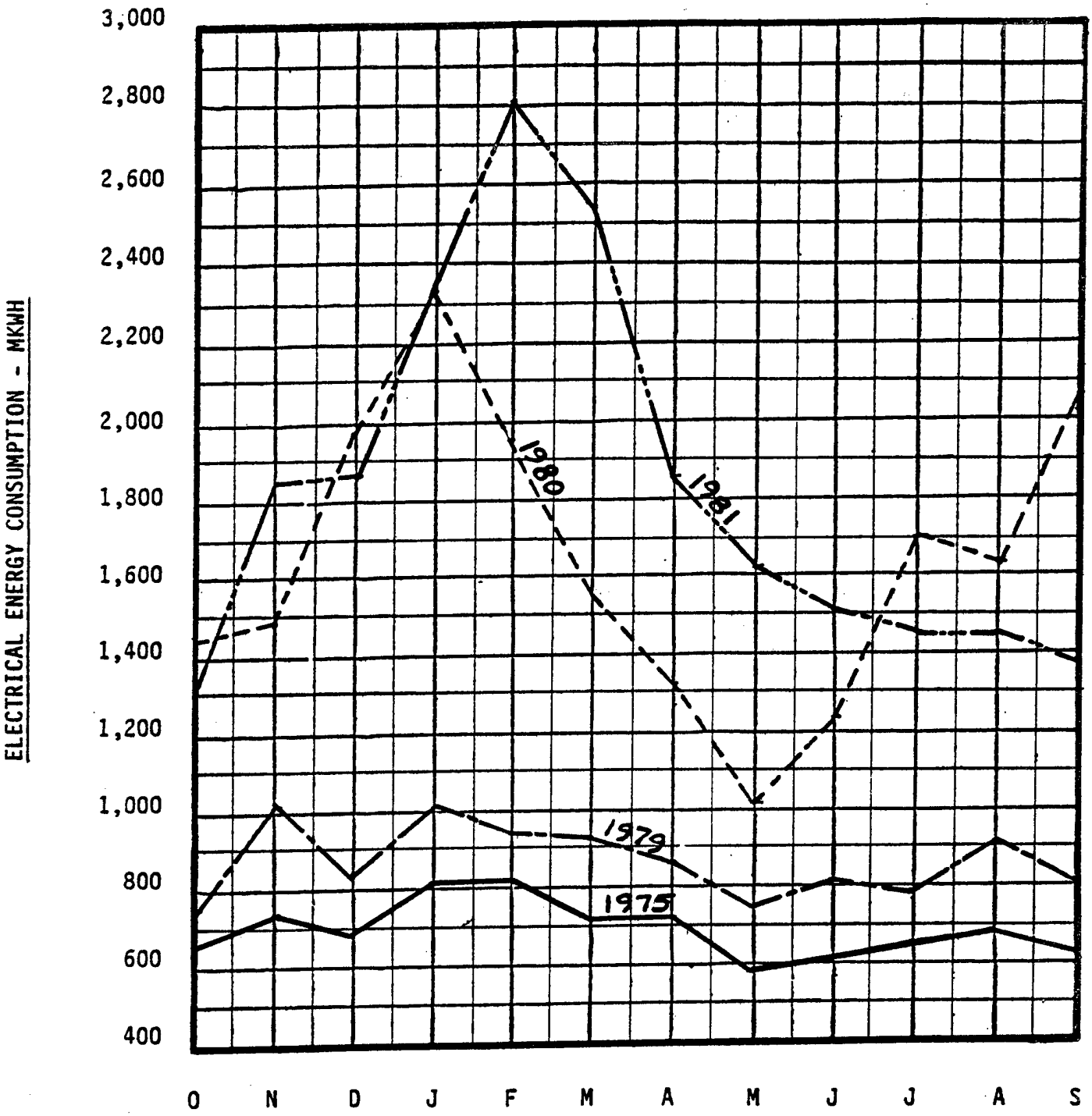
MONTHLY GAS CONSUMPTION

FY - 1975, 1979, 1980, 1981



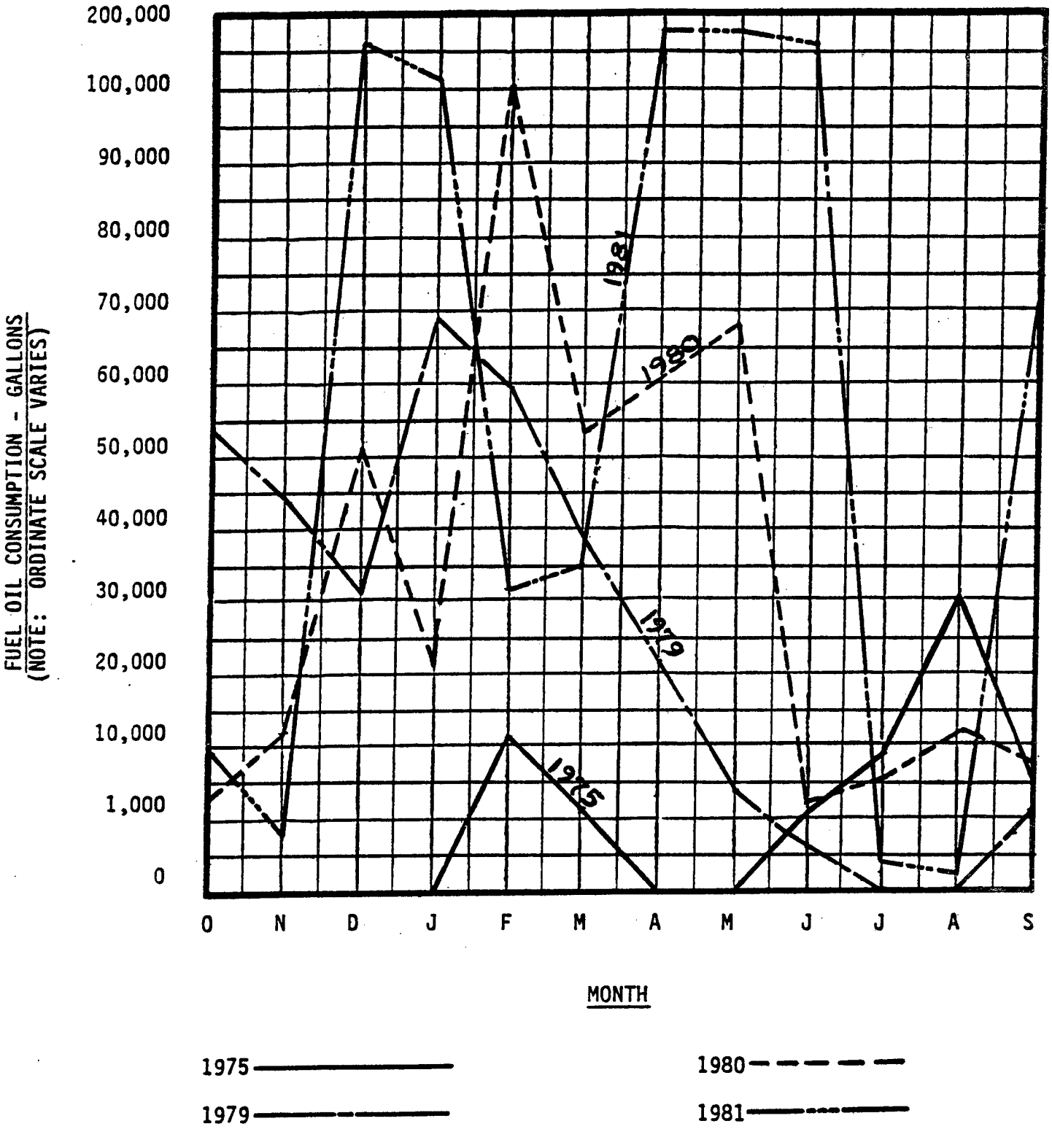
MONTHLY ELECTRICAL ENERGY CONSUMPTION

FY - 1975, 1979, 1980, 1981



MONTHLY FUEL OIL CONSUMPTION

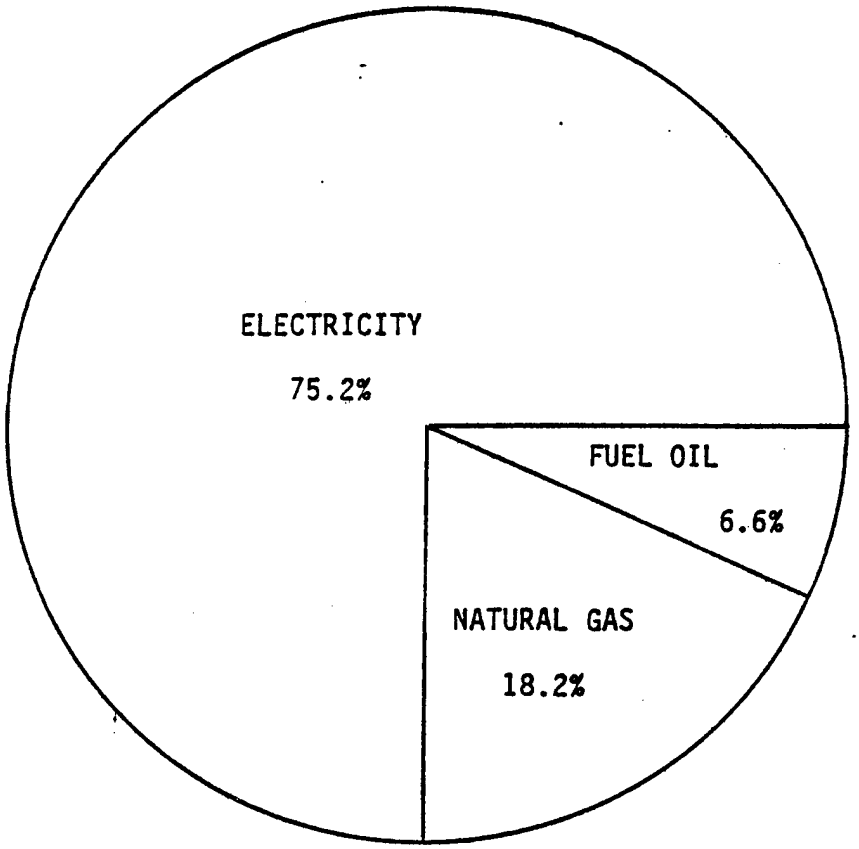
FY - 1975, 1979, 1980, 1981



TOTAL ENERGY CONSUMPTION

FY - 1975

ELECTRICITY 8,266,500 KWH (11,600 BTU/KWH)
NATURAL GAS 22,393,000 CU. FT. (1031 BTU/C.F.)
FUEL OIL 60,169 GAL. (140,000 BTU/GAL)

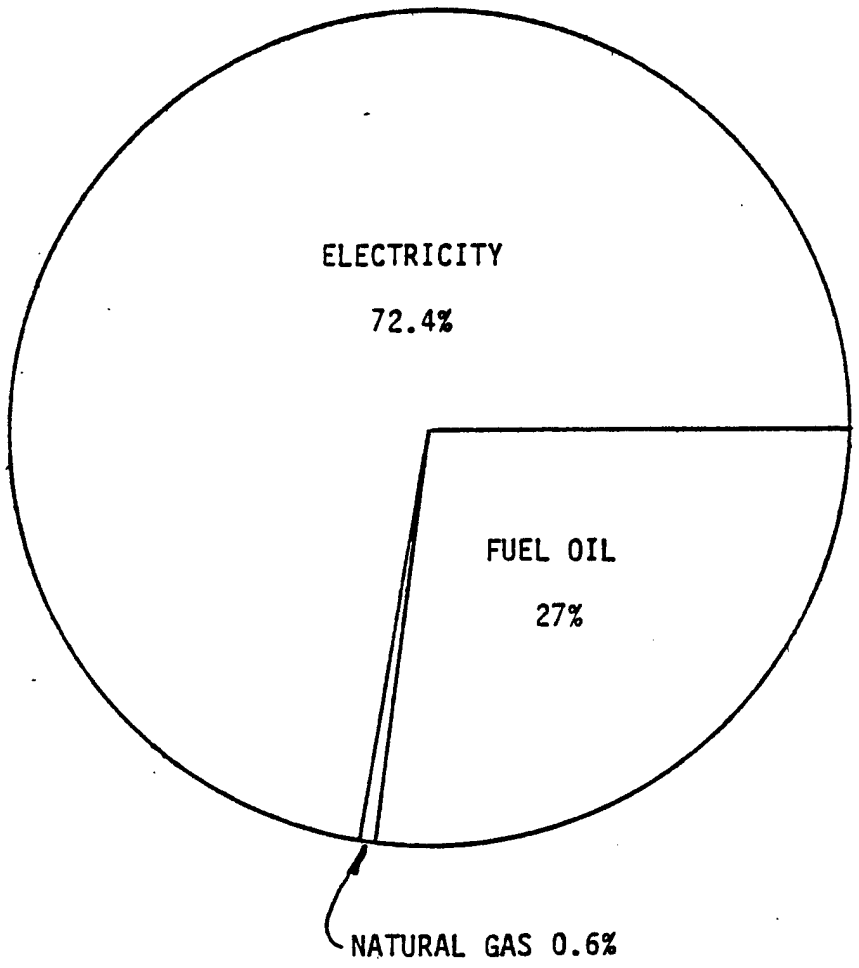


PERCENTAGES ARE OF TOTAL BTU's PER YEAR

TOTAL ENERGY CONSUMPTION

FY - 1979

ELECTRICITY 10,492,000 KWH (11,600 BTU/KWH)
NATURAL GAS 973,000 CU. FT. (1031 BTU/C.F.)
FUEL OIL 325,015 GAL. (140,000 BTU/GAL)

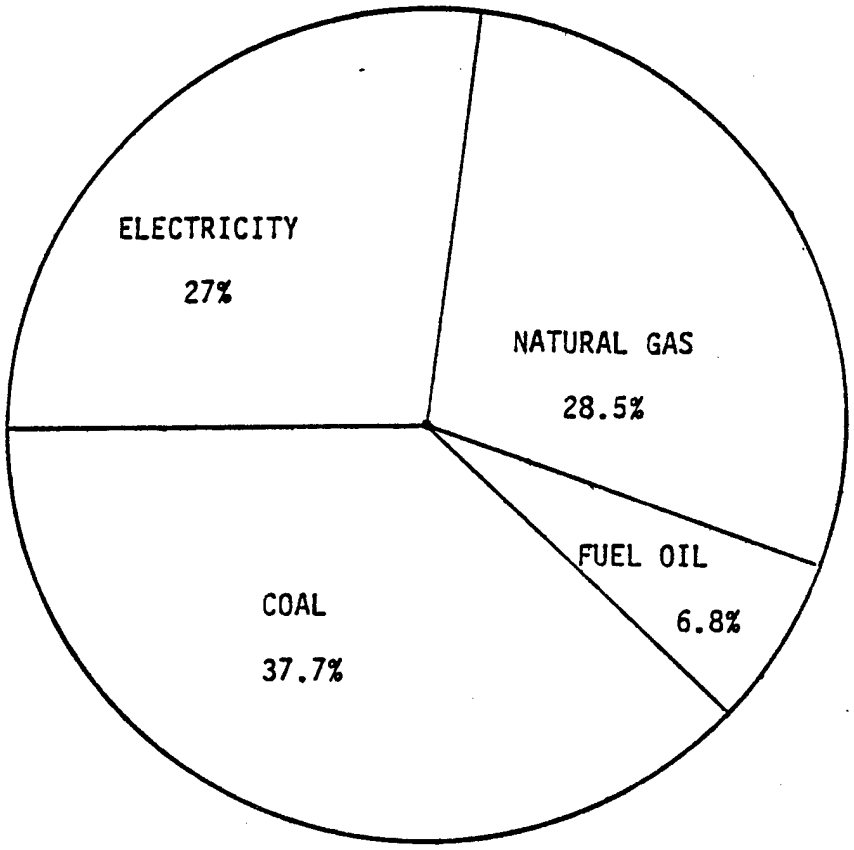


PERCENTAGES ARE OF TOTAL BTU's PER YEAR

TOTAL ENERGY CONSUMPTION

FY - 1980

ELECTRICITY 20,354,500 KWH (11,600 BTU/KWH)
NATURAL GAS 242,575,000 CU. FT. (1031 BTU/C.F.)
FUEL OIL 422,529 GAL (140,000 BTU/GAL)
COAL 26,414,560 LBS (12,500 BTU/LB)

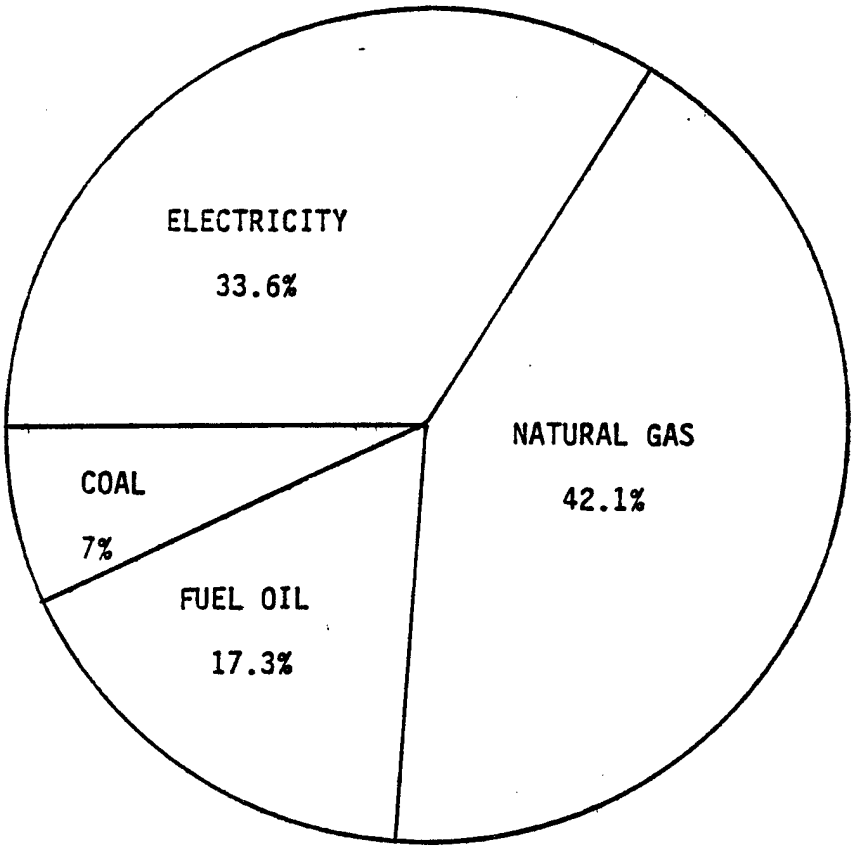


PERCENTAGES ARE OF TOTAL BTU's PER YEAR

TOTAL ENERGY CONSUMPTION

FY - 1981

ELECTRICITY 21,976,000 KWH (11,600 BTU/KWH)
NATURAL GAS 309,641,000 CU. FT. (1031 BTU/C.F.)
FUEL OIL 936,400 GAL (140,000 BTU/GAL)
COAL 4,222,080 LBS (12,500 BTU/LB)



PERCENTAGES ARE OF TOTAL BTU's PER YEAR

BASE-WIDE ENERGY CONSUMPTION/SAVINGS COMPARISONS

Consumption/Savings comparisons are provided below for two cases: Heating-Related Consumption/Savings and Total Consumption/Savings.

Heating-Related Consumption/Savings.

Base-wide heating-related energy consumption was estimated by calculating the heat loss for the current "Base" Buildings, and extrapolating for the active buildings being considered. Total heating energy consumption was estimated to be:

- 47,073,693 lbs. steam/yr or (45,190 MBTU steam/yr)

The savings for all heating-related ECOs is:

ECO	SAVINGS MBTU/YR
Recover Heat from Exhaust Air	4,851
Night Setback Thermostats	2,282
Replace Inefficient HVAC System	1,395
Install Insulation	11,465
Install Economizer	85
Heat Unoccupied Buildings to Provide Freeze Protection Only	317
Close Off Unoccupied Spaces	76
Install Locking Thermostat Covers on Thermostats	449
Insulate Ductwork	312
Install Automatic Door Closers	265
Caulk and Weatherstrip Windows and Doors	3,203
TOTAL	24,700 MBTU/YR
Heating Consumption	45,190 MBTU/YR
Savings	24,700 MBTU/YR
	20,490 MBTU/YR

Heating energy consumption will be reduced by approximately 55% with the implementation of all heating-related ECOs.

Total Consumption/Savings

Total energy consumption, based on actual fuel bills for FY 1979 are:

Natural Gas	973 MCF	= 1,003,163 MBTU
Electricity	10,492,000 KwH	121,707 MBTU
Coal	None	0 MBTU
Fuel Oil	325,015 Gal	45,080 MBTU
		1,169,950 MBTU

Total energy savings assuming implementation of all recommended projects is 221,175 MBTU/YR, as follows:

Increment A Savings:	40,859 MBTU/YR
Increment B Savings:	116,878 MBTU/YR
Increment E Savings:	42,199 MBTU/YR
Increment F Savings:	16,646 MBTU/YR
Increment G Savings:	4,593 MBTU/YR
	221,175 MBTU/YR

A wide variation in yearly consumption figures (for all fuels) was the result of fluctuations in plant activity, such as intermittent production runs and prove-out cycles. In addition, the fraction of consumption which is attributable to process requirements is unknown. For these two reasons, the value of determining a percent reduction figure based on total consumption is questionable. If FY 1979 were used as a base year, however, the percent reduction in energy consumption would be 19% if all ECOs were implemented. (Consumption information indicates that process activity in FY 1979 was minimal compared with FY 1975.) If process energy were removed from the total energy figure, the percent reduction would most likely exceed the 25% Army goal.

Energy usage per square foot:

- Based on FY 1979 - 3.2 MBTU/SQ. FT.
- After implementation of all recommended ECO - 2.6 MBTU/SQ. FT.

ENERGY CONSERVATION MEASURES INVESTIGATED

1. ECOs Developed During Phase I

As the result of field surveys conducted under Phase I of this program, the following Energy Conservation Opportunities (ECOs) exist. Each ECO is listed and a number assigned to that ECO. Under Phase II of the program, each ECO was analyzed to determine if it was technically and economically feasible. The ECOs are as follows:

ECO Number	Description
1.	Insulate walls or ceiling/roof
2.	Storm windows or double glazing
3.	Weatherstripping and caulking
4.	Solar films
5.	Install vestibules
6.	Install loading dock seals
7.	Reduction of glass area
8.	Shutdown water heater or modify controls
9.	Install more efficient lighting
10.	Reduce lighting levels
11.	Improve power factor
12.	High efficiency motor replacement
13.	Thermostats with night setback
14.	Infrared heaters
15.	Economizer cycles
16.	Control hot water circulation pump
17.	Radiator controls
18.	Decentralize domestic water heaters
19.	Flow restrictors
20.	Heat reclaim for hot refrigerant gas
21.	Reduce air flow
22.	Prevent air stratification
23.	Install time clocks
24.	Boiler oxygen trim controls
25.	Blowdown heat recovery
26.	Revise boiler controls
27.	Chiller controls
28.	Chiller replacement
29.	Reduce street lights
30.	Recover heat from exhaust air
31.	Insulate steam lines
32.	Return condensate
33.	Replace inefficient HVAC system
34.	Install or replace ventilator dampers

2. ECOs Developed During Phase II

ECO Number	Description
35.	Disconnect substations serving areas not currently in operation
36.	Install an energy monitoring and control system
37.	Active solar heating
38.	Active solar air-conditioning
39.	Solar domestic water heating
40.	Passive solar heating
41.	Wind turbines
42.	Biomass systems
43.	Conversion of Boiler House #3 to coal
44.	Addition of modular baseload boiler
45.	Conversion of small area boilers to coal
46.	Addition of small area boilers near major loads
47.	Addition of portable boiler for prove out
48.	Repair broken windows
49.	Repair/seal building membrane
50.	Repair leaking valves in steam or hot water piping
51.	Repair or replace leaking steam traps
52.	Perform flue gas analysis
53.	Adjust burner fuel/air ratio
54.	Reset temperature of domestic hot water heaters
55.	Check balance of air systems
56.	Clean or replace air filters
57.	Clean heating/cooling coils
58.	Check or reset hot/cold deck temperatures
59.	Adjust tension of belts
60.	Repair leaking roofs
61.	Install insulated base under thermostats
62.	Relocate thermostats to occupied area
63.	Install and/or adjust air dampers
64.	Check operation of controls
65.	Repair or replace damaged heaters
66.	Clean heat exchangers
67.	Insulate refrigerant piping
68.	Check refrigerant charge in air conditioners
69.	Remove wooden covers from radiators
70.	Clean radiators
71.	Remove equipment from in front of radiators
72.	Install locking covers on thermostats and check setting
73.	Install automatic door closers
74.	Insulate steam pipes (interior)
75.	Insulate domestic hot water pipes
76.	Close off unoccupied spaces
77.	Insulate ductwork
78.	Insulate water heater tanks
79.	Heat unoccupied buildings to provide freeze protection only.
80.	Replace 40W fluorescent lamps with 34W fluorescent lamps

ENERGY CONSERVATION PROJECTS DEVELOPED

1. INCREMENT A PROJECTS

   a. It was determined that a program is needed to repair or replace the condensate traps in the steam distribution mains serving the active buildings. The costs were estimated at $69,844, with savings of 11,725 MBTU/YR, and a payback of 0.47 years.

   b. Application of solar film to the windows of air conditioned buildings was evaluated and found to be advisable for 16 buildings. The total cost will be $13,487, with a savings of 1,443 MBTU/YR, and a payback of 2.0 years.

   c. Consideration was given to installing a run-around heat recovery system in the exhaust air duct(s) of several buildings. Such a system is recommended for two buildings at a cost of $127,961 with a savings of 4,851 MBTU/YR, and a payback of 2.2 years.

   d. The feasibility of a night setback thermostat was investigated and found to be applicable to 26 buildings. The project cost will be $67,067, will save 2,282 MBTU/YR, and will pay back in 2.4 years.

   e. A variable air volume HVAC system was considered for several buildings. It is recommended that this type of system be installed in Building 210 at a cost of $38,023, with a savings of 1,395 MBTU/YR, and a payback of 4.3 years.

   f. Replacement of incandescent light fixtures with high intensity discharge fixtures is recommended at a cost of $265,900, with savings of 7,613 MBTU/YR, and a payback of 5.1 years.

   g. The addition of insulation to walls and/or ceilings was investigated. It is recommended that insulation be added to the walls of 24 buildings and ceiling of 18 buildings. The cost will be $728,360, with a savings of 11,465 MBTU/YR, and a payback of 5.2 years.

   h. It was determined that the installation of an enthalpy economizer on the HVAC system for Building 927 would cost $2,166, save 85 MBTU/YR, and payback in 5.4 years.

2. INCREMENT B PROJECTS

   a. The steam distribution mains which serve the active buildings were found to have insulation which did not meet the minimum R-value standards. The cost of adding insulation to meet the standards is $770,800, with savings of 116,878 MBTU/YR, and a pay back of 0.6 years.

3. INCREMENT C PROJECTS

   a. The renewable energy sources listed in the introduction were considered in this increment. None of the projects qualified under ECIP guidelines.

4. INCREMENT E PROJECTS

   a. A 125,000 pound per hour steam modular baseload boiler operating in place of an existing boiler at the main boiler house was evaluated using a life cycle cost analysis. The greatest savings would be realized by operating a coal-fired modular boiler in place of the existing oil-fired boiler. The project cost was estimated at $2,444,420, with a savings of 42,199 MBTU/YR, and a pay back of 1.12 years.

5. INCREMENT F PROJECTS

   a. Heating two unoccupied buildings to provide freeze protection was estimated to cost $763, save 317 MBTU/YR, and pay back in 0.2 years.

   b. Closing off unoccupied areas in five partially occupied buildings was estimated to cost $367, save 76 MBTU/YR, and a payback in 0.40 years.

   c. Installing locking covers on thermostats in 26 buildings was estimated to cost $2,632, save 449 MBTU/YR, and pay back in 0.44 years.

   d. Insulating ductwork in five buildings will cost $3,033, and save 312 MBTU/YR, with a payback of 0.81 years.

   e. Insulating the steam pipes in 49 buildings was estimated to cost $113,369, and save 6,689 MBTU/YR, with a payback of 1.4 years.

   f. Water flow restrictors were considered for showers and sinks in two buildings, at a cost of $671, saving 33 MBTU/YR, with a payback of 1.7 years.

   g. Automatic door closers for 49 buildings will cost $7,560, save 265 MBTU/YR, and pay back in 2.3 years.

   h. Caulking and weatherstripping the windows and doors of 73 buildings was estimated to cost $136,167, while saving 3,203 MBTU/YR, with a payback of 2.7 years.

   i. Insulating the domestic hot water pipes in 15 buildings will cost approximately $7,217, save 197 MBTU/YR, and pay back in 3.4 years.

   j. Insulating the water heater tanks in 8 buildings will cost $298, save 5 MBTU/YR, and pay back in 3.6 years.

k. Replacing existing fluorescent lamps with lower wattage lamps and ballast was estimated to cost $106,034, save 5,098 MBTU/YR, and pay back in 4.5 years.

l. Cleaning the product heat exchanger in Building 5824 was estimated to cost $93, save 1 MBTU/YR, and pay back in 7.8 years.

m. Insulating the refrigerant piping in Building 210 was estimated to cost $76 and save 1 MBTU/YR, with a payback of 8.4 years.

6. INCREMENT G PROJECTS

a. Installing additional insulation in the walls of 8 buildings and the ceilings of 16 buildings was estimated to cost $393,099 and save 3,635 MBTU/YR.

b. Installation of a night setback thermostat in 8 buildings was estimated to cost $22,624 and save 102 MBTU/YR.

c. Installation of storm windows on 12 buildings was estimated to cost $97,182 and save 382 MBTU/YR.

d. Replacing existing incandescent light fixtures with High Intensity Discharge (HID) fixtures was estimated to cost $33,363 and save 474 MBTU/YR.

NOTE: The project-wide pay-backs were not calculated due to the wide variation from building to building. See the Actions and Savings Matrix (pages ES-31 through ES-33) for individual building information.

POLICY CHANGES - RECOMMENDATIONS

Listed below are operation and maintenance energy conservation opportunities that were found during the previous phases.

- Repair broken windows
- Repair/seal building membrane
- Repair leaking valves in steam or hot water piping
- Perform flue gas analysis
- Adjust burner fuel/air mixture
- Reset temperature of domestic hot water heaters
- Check balance of air system
- Clean or replace air filters
- Clean heating/cooling coils
- Check or reset hot/cold deck temperature
- Adjust tension of belts
- Repair leaking roofs
- Install insulated base under thermostats
- Relocate thermostats to occupied areas
- Install and/or adjust air dampers
- Check operation of controls
- Repair or replace damaged heaters
- Clean heat exchangers
- Insulate refrigerant piping
- Check refrigerant charge in air conditioners
- Remove wooden cover from radiators
- Clean radiators
- Remove equipment from in front of radiators
- Insulate domestic hot water pipes
- Insulate water heater tanks
- Specify energy efficient new or replacement equipment

ENERGY CONSERVATION ACTIONS SINCE FY 1975

The following is a list of energy conservation measures that have been implemented or are under consideration at the Sunflower Army Ammunition Plant.

1. Electrical

   a. In order to reduce electrical consumption due to water pumping, a leak detector has been used to locate any leaks in underground water piping.

   b. The volume of sewage treatment was reduced.

   c. An electrical power factor study was conducted and new capacitors were installed in the electrical distribution system to correct the power factor.

   d. The use of air conditioners was limited to periods when the room temperatures were above 78°F.

   e. The outside lighting was surveyed and lights were disconnected in non-critical areas.

   f. Domestic hot water temperatures were reduced.

2. Natural Gas and Fuel Oil

   a. Boilers are not fired until office area temperatures are below 65°F.

   b. Only essential buildings are heated. Buildings not in use were disconnected from the steam system.

   c. Building temperatures were reduced during off hours.

   d. A package boiler was installed for the laundry since it was the only building requiring heat during the summer.

   e. Non-electric thermostatic control valves were installed on some steam radiators providing comfort heating.

   f. Two package boilers were installed in the shops area to provide steam for heating the buildings in the shops and administrative areas. The rest of the steam distribution system was valved off and the main power plants remain shut down when process steam is not required.

3. Gasoline

   a. Tri-wheelers are used for transportation whenever possible to reduce the usage of larger, gasoline powered vehicles.

b. A car pool program was established.

c. Off-plant speed was reduced to 50 mph.

d. Engines of vehicles are not idled for more than three minutes.

e. Fuel tanks are not overfilled.

4. Projects Presently Under Consideration

a. A project to insulate Building 500 is being considered.

b. A project to locate and replace leaking steam traps is planned.

ACTIONS AND SAVINGS MATRIX

1. PROPOSED PROJECTS*

PROJECT TITLE	ANNUAL ENERGY SAVINGS (MBTU)	PROJECT COST ($000)	SIR RATIO	SIMPLE AMORTIZATION (YEARS)
Increment A				
Repair or Replace Defective Condensate Traps	11,725	69.844	9.4	0.47
Addition of Solar Films	1,443	13.487	5.3	2.0
Recover Heat From Exhaust Air	4,851	127.961	5.2	2.2
Night Setback Thermostats	2,282	67.067	4.9	2.4
Replace Inefficient HVAC System	1,395	38.023	3.1	4.3
Replace Inefficient Lights with H.I.D. Fixtures	7,613	265.900	2.0	5.1
Install Insulation	11,465	728.360	2.2	5.2
Install Economizer	85	2.166	2.0	5.4
SUBTOTAL INCREMENT A PROJECTS	40,859	1,312.808		

*See pages ES-31 through ES-33 for individual building information.

PROJECT TITLE	ANNUAL ENERGY SAVINGS (MBTU)	PROJECT COST ($000)	SIR RATIO	SIMPLE AMORTIZATION (YEARS)
Increment B				
Add Insulation to Steam Distribution Mains	116,878	770.800	20.9	0.6
Increment E				
Modular Baseload Boiler	42,199	2444.420	11.9	1.12
Increment F				
Heat Unoccupied Buildings to Provide Freeze Protection Only	317	0.763	57.2	0.20
Close Off Unoccupied Spaces	76	0.367	28.5	0.40
Install Locking Covers on Thermostats	449	2.632	25.4	0.44
Insulate Ductwork	312	3.033	14.0	0.81
Insulate Steam Pipes	6,689	113.369	8.1	1.4
Install Water Flow Restrictors	33	0.671	6.8	1.7
Intall Automatic Door Closers	265	7.560	5.1	2.3
Caulk and Weatherstrip Windows and Doors	3,203	136.167	4.2	2.7
Insulate Domestic Hot Water Pipes	197	7.217	3.3	3.4
Insulate Water Heater Tanks	5	0.298	3.2	3.6
Replace Fluorescent Lamps and Ballast	5,098	106.034	2.42	4.5
Clean and Insulate Heat Exchanger	1	0.093	1.5	7.8
Insulate Refrigerant Piping	1	0.076	1.3	8.4
SUBTOTAL INCREMENT F PROJECTS	16,646	378.280	---	---

PROJECT TITLE	ANNUAL ENERGY SAVINGS (MBTU)	FUEL TYPE	PROJECT COST ($)
Increment G			
Night Setback Thermostats	102	Fuel Oil	22.624
Replace Inefficient Lights with HID Fixtures	474	Electricity	33.363
Install Insulation	3,635	Fuel Oil	393.099
Install Storm Windows	382	Fuel Oil	97.182
SUBTOTAL INCREMENT G PROJECTS	4,593		546.268

ENERGY PLAN : MATRIX OF A

BUILDING NO.	DESCRIPTION	INCREMENT A: SOLAR FILM	HEAT RECOVERY SYSTEM	NIGHT SETBACK	REPLACE INEFF. HVAC SYSTEM	REPLACE INCAND. w/HID	INSUL. WALLS / CEILING	ENTHALPY ECONOMIZER	REPAIR OR REPLACE CONDENSATE TRAPS	INCREMENT B: ADD INSUL TO STI DISTRIB MAIN
129-2	BOOSTER STATION & PUMP HOUSE			74		744	531		TOTAL FOR STEAM LINES SERVING ACTIVE BUILDINGS	TOTAL FOR STEAM LINES SERVING ACTIVE BUILDINGS
132	WATER TREATMENT PLANT			197		672	2111			
154-4	MAIN DISTRIBUTION SWITCH HOUSE									
156	WELL WATER BOOSTER STATION			15		164	104			
166-1	CHEMICAL BUILDING					6				
166-2	CHEMICAL BUILDING					6				
181-42	SMOKING POINT SHELTER					13				
205	HOSPITAL			102		141	85			
210	COE ADMINISTRATION BUILDING			221	1395	437	424			
222	FIRE HOUSE	119		57		46	280			
222-3	FIRE STORE HOUSE						13			
225	CHEMICAL LABORATORY	127		58			796			
227-10	CHANGE HOUSE									
227-16	CHANGE HOUSE									
227-32	CHANGE HOUSE			17		129	125			
229	SAFETY & SERVICE BUILDING			136			424			
240	GUARD HEADQUARTERS			88			275			
271	PERSONNEL OFFICE	278		49		19	1841			
273-1	SEARCH HOUSE					13	3			
500	COMBINED SHOPS	109		209			1584			
501	LOCOMOTIVE SHOP & STORE					196				
503	PAINT STORE						38			
504	PAINT & SIGN SHOP	41					38			
505	PAINT SHOP	69				293				
510	MAIN STOREHOUSE	24		109		350	224			
512	PLUMBING SUPPLY WAREHOUSE	69		54			258			
520	FORGE & WELD SHOP	129		44			524			
522	TRAN REPAIR SHOP					135				
523	LEAD BURNING SHOP									
524	AREA MAINTENANCE OFFICE	51				62	48			
526	HEAVY EQUIPMENT SHOP	70		55			263			
530	SOLVENT STOREHOUSE						15			
541	AUTO REPAIR SHOP			10		132	197			
542	AUTO TIRE & PAINT SHOP	208		3			163			
544	GASOLINE SERVICE STATION	25								
550	STERILIZATION HOUSE									
713-2	AMMONIA COMPRESSOR HOUSE					31	37			
719-2	REPAIR SHOP	59		27		131	239			
731	WATER TREATMENT									
927	LABORATORY		732			338		85		
973	LUNCH ROOM			114		307				
998	CONTROL HOUSE	55		103		92				
1885-1	GENERAL WAREHOUSE					152				
1885-2	GENERAL WAREHOUSE					152				
1885-3	GENERAL WAREHOUSE					152				
1885-4	GENERAL WAREHOUSE					152				
1885-5	GENERAL WAREHOUSE					152				
1885-6	GENERAL WAREHOUSE					152				
1886	GENERAL WAREHOUSE					768				
1890-2	GENERAL WAREHOUSE					344				
4000	COTTON STORAGE & DRY HOUSE									
4562	LAUNDRY			48		239	255			
5000	COTTON-PULP STORE & DRY HOUSE			92		332	570			
5411-2	NITROGUANIDINE WEIGH-HOUSE									
9004	RAILROAD UNLOADING STATION		4119			335				
9022	AREA MAINTENANCE SHOP	10		42						
9040	WET GUANIDINE NITRATE			82		166				
9061	AREA OFFICE			276						
PROJECT BASEWIDE ANNUAL ENERGY SAVINGS SUBTOTAL (MBTU)		1443	4851	2282	1396	7813	11.465	85	11.725	116.876
ANNUAL ENERGY SAVINGS SUBTOTAL FOR EACH INCREMENT (MBTU)		INCREMENT A=40.859								INCREMENT B=116.876
PROJECT COST ($1,000)		13.487	127.961	67.067	38.023	265.900	728.360	2.166	69.844	770.800
SAVINGS TO INVESTMENT RATIO (SIR)		5.3	5.2	4.9	3.1	2.0	2.2	2.0	9.4	20.9
SIMPLE AMORTIZATION (YEARS)		2.0	2.2	2.4	4.3	5.1	5.2	5.4	0.47	0.6

AN : MATRIX OF ACTIONS AND SAVINGS

		INCREMENT B	INCREMENT E	INCREMENT G				
NTHALPY ONOMIZER	REPAIR OR REPLACE CONDENSATE TRAPS	ADD INSULATION TO STEAM DISTRIBUTION MAINS	BASELOAD BOILER	NIGHT SETBACK	REPLACE INCANDESCENT w/HID	INSULATE WALLS	INSULATE CEILING	STORM WINDOWS
	TOTAL FOR STEAM LINES SERVING ACTIVE BUILDINGS	TOTAL FOR STEAM LINES SERVING ACTIVE BUILDINGS	TOTAL FOR PROJECT					
				33		196	42	
				5		21	21	
				5		21	21	
						92		7
								71
					65			66
							77	
						131	77	
								20
								85
								56
				14				10
				11				8
							920	35
					360			
				8		15	25	6
					18			
					31	10	5	
							3	
85								
							1548	
							258	
				13				9
				13				9
						152		
86	11.725	116.878	42.199	102	474	638	2397	382
		INCREMENT B= 116.878	INCREMENT E= 42.199	INCREMENT G=4.593				
166	69.844	770.800	2444.420	22.624	33.363	393.099		97.182
.0	9.4	20.9	11.9	N.A.	N.A.	N.A.		N.A.
.4	0.47	0.6	1.12	N.A.	N.A.	N.A.		N.A.

NOTE: ALL MATRIX ENTR
ARE ENERGY SAVI
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(IN $1,000), SA
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Drawn by:

Checked by:

Submitted by:

US Army Corps of Engineers

ENERGY PLAN:MATRIX
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DESOTO,
CONTRACT NO.-DA

Scale:

Date: 12/1/83

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ONS AND SAVINGS

INCREMENT E	INCREMENT G				
BASELOAD BOILER	NIGHT SETBACK	REPLACE INCANDESCENT w/HID	INSULATE WALLS	INSULATE CEILING	STORM WINDOWS
	30		196	42	
	5		21	21	
	5		21	21	
			92		7
					71
		65			66
				77	
			131	77	
					20
					85
					56
	14				10
	11				8
				320	35
		360			
	8		15	25	6
		18			
		31	10	5	
				3	
				1548	
				258	
	13				9
	13				9
			152		
TOTAL FOR PROJECT					
42.199	102	474	638	2597	382

INCREMENT E= 42.199	INCREMENT B=4,593			
2444.420	22.624	33.363	393.099	97.182
11.9	N.A.	N.A.	N.A.	N.A.
1.12	N.A.	N.A.	N.A.	N.A.

NOTE: ALL MATRIX ENTRIES ON THIS PAGE ARE ENERGY SAVINGS (IN MBTU), EXCEPT FOR THE FINAL THREE ROWS, WHICH ARE PROJECT COST (IN $1,000), SAVINGS TO INVESTMENT RATIO (DIMENSIONLESS), AND SIMPLE AMORTIZATION (IN YEARS).

Revisions			
Symbol	Description	Date	Approved

Booker Engineers Architects Planners

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by:

Drawn by:

Checked by:

Submitted by:

US Army Corps of Engineers

ENERGY PLAN: MATRIX of ACTIONS and SAVINGS
BASEWIDE ENERGY STUDIES
IN SUPPORT OF
ENERGY ENGINEERING ANALYSIS PROGRAM
SUNFLOWER ARMY AMMUNITION PLANT
DESOTO, KANSAS
CONTRACT NO. -DAC41-81-C-0170

Scale:

Date: 12/1/83

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Sheet number: 1 of 3

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ENERGY PLAN : MATRIX OF ACTI

INCREMENT F

BUILDING NO.	DESCRIPTION	HEAT TO PROVIDE FREEZE PROT. ONLY	CLOSE OFF UNOCCUPIED AREAS	LOCKING COVERS ON THERMOSTATS	INSULATE DUCTWORK	INSULATE STEAM PIPES	WATER FLOW RESTRICTORS	AUTOMATIC DOOR CLOSERS	CAULK VEA STRI
112	TRACK SCALES & OFFICE			5				5	
129-2	BOOSTER STATION & PUMP HOUSE					283			
132	WATER TREATMENT PLANT			1				5	1
140	TELEPHONE EXCHANGE		16	8	63			5	
156	WELL WATER BOOSTER STATION			7		53			
166-1	CHEMICAL BUILDING								
166-2	CHEMICAL BUILDING								
181-42	SMOKING POINT SHELTER								
188	WATER POLLUTION			4					
191	WATER POL. MONITORING STA.			0.2					0
204-16	GATE HOUSE								
206	HOSPITAL			42	32	344			
210	COE ADMINISTRATION BUILDING			17		10		5	
211	STANDBY GEN. PLANT BUILDING			9					
214	ADMINISTRATION BUILDING		6		48				
215	MESS HALL AT HOSPITAL					300		5	
222	FIRE HOUSE			8				5	
225	CHEMICAL LABORATORY			69				5	1
227-1	CHANGE HOUSE							5	
227-20	MOTOR POOL OFFICE		7			99		7	
227-32	CHANGE HOUSE			17		69	12	5	
229	SAFETY & SERVICE BUILDING								
240	GUARD HEADQUARTERS					253	21		
271	PERSONNEL OFFICE							5	
500	COMBINED SHOP					1009		7	2
501	LOCOMOTIVE SHOPS & STORE							7	
503	PAINT STORE	262				87		5	
504	PAINT & SIGN SHOP					57		6	
505	PAINT SHOP					116		6	
507-1	GENERAL WAREHOUSE					125			
507-2	CHEMICAL PREP HOUSE								
510	MAIN STOREHOUSE								
512	PLUMBING SUPPLY WAREHOUSE					224		6	
520	FORGE & WELD SHOP					161		6	
522	TRAM REPAIR SHOP					16		5	
523	LEAD BURNING SHOP					76			
524	AREA MAIN OFFICE							5	
526	HEAVY EQUIPMENT REPAIR SHOP					201		5	
527-4	NITRATING AREA REPAIR SHOP					96		5	
530	SOLVENT STOREHOUSE			21		17		5	
532	HEAD GRINDER SHOP			7		22		5	
537-1	ROADS & GROUND SHOP & OFFICE							5	1
541	AUTO REPAIR SHOP					142			
542	AUTO TIRE & PAINT SHOP		26	8		78		5	
544	GASOLINE SERVICE STATION		21			53		5	
550	STERILIZATION HOUSE							6	
564-9	AREA OIL HOUSE COMBINED SHOPS	55							
563	CARPENTER SHOP F AREA					88			
580 A & B	BURNER & CONTROL HOUSE							5	
700-2	COMPRESSOR HOUSE								
707-2	ACID WEIGH HOUSE					37		5	
713-2	AMMONIA COMPRESSOR HOUSE					15		5	
719-2	REPAIR SHOP					104			
723-2	PUMP HOUSE								
903-1	MAC/SAC UNIT								
927	LABORATORY			17					
973	LUNCH ROOM								
998	CONTROL HOUSE			30					
1991	INERT GAS PRODUCER					54			
4000	COTTON STORAGE & DRY HOUSE					88		6	
4012	NITRATING HOUSE					0.1		6	
4019	BOILING TUB HOUSE					496			3
4022	BEATER HOUSE					160		5	
4024	POACHER & BLENDING HOUSE					570		5	3
5047	BLENDER HOUSE					464		5	
5622	N.G. WEIGH & STORE HOUSE					30		6	
5623-1	FORCED AIR DRY & HEATER HOUSE				42				

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PLAN : MATRIX OF ACTIONS AND SAVINGS

INCREMENT F

INSULATE STEAM PIPES	WATER FLOW RESTRICTORS	AUTOMATIC DOOR CLOSERS	CAULKING & WEATHER-STRIPPING	INSULATE DOMESTIC HOT WATER PIPES	INSULATE WATER HEATER TANK	REPLACE FLOURESCENT LAMPS & BALLAST	CLEAN & INSULATE HEAT EXCHANGER	INSULATE REFRIGERANT PIPES
		6	6					
283						18		
		5	150			21		
		6	13	16				
53			13					
						2		
						2		
						9		
			1					
			0.4					
			3					
344			90			579		
10		6						1
					0.5			
			6	21				
300		6	59	21				
		6	16	10		133		
		6	115	39				
		6	48	2				
99		7	27	3	0.5			
69	12	6	28			35		
			76					
253	21		65	16				
		5	49	14		174		
1009		7	276			2424		
		7	31	1	0.5	15		
87		5	16					
57		6	16			38		
116		6	24					
125			49					
			49					
			60			247		
224		6	35			214		
161		6	40			229		
15		6						
96			25	2	0.5			
		6	19					
201		6	47					
96		6	28					
17		6	35					
22		6	12					
		6	165					
142				13	0.5			
78		6	37	6	1			
59		6	6					
		6	6					
			3					
88			21					
		6	10					
			55					
37		6	14					
15		6	4					
104			39	1	0.5	7		
			3					
			45					
						44		
						55		
			50			630		
54			22					
88		6	21					
0.1		6	42					
496			335					
160		6	55					
570		6	320					
464		6	70					
30		6	8					

NOTE: ALL MATRIX E
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Submitted by:	Scale: Date: 12/1/83 Dwg. No.:

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AND SAVINGS

INSULATE DOMESTIC HOT WATER PIPES	INSULATE WATER HEATER TANK	REPLACE FLOURESCENT LAMPS & BALLAST	CLEAN & INSULATE HEAT EXCHANGER	INSULATE REFRIGERANT PIPES
		18		
		21		
16				
		2		
		2		
		9		
		579		
				1
	0.5			
21				
21				
10		133		
39				
2				
3	0.5			
		35		
16				
14		174		
		2424		
1	0.5	15		
		38		
		247		
		214		
		229		
2	0.5			
13	0.5			
5	1			
1	0.5	7		
		44		
		55		
		638		

NOTE: ALL MATRIX ENTRIES ON THIS PAGE ARE ENERGY SAVINGS (IN MBTU).

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

ENERGY PLAN: MATRIX of ACTIONS and SAVINGS
BASEWIDE ENERGY STUDIES
IN SUPPORT OF
ENERGY ENGINEERING ANALYSIS PROGRAM
SUNFLOWER ARMY AMMUNITION PLANT
DESOTO, KANSAS
CONTRACT NO.-DAC41-81-C-0170

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Checked by:
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Scale:
Date: 12/1/83
Dwg. No.:
Sheet number: 2 of 3

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ENERGY PLAN : MATRIX OF ACTI

INCREMENT F

BUILDING NO.	DESCRIPTION	HEAT TO PROVIDE FREEZE PROT. ONLY	CLOSE OFF UNOCCUPIED AREAS	LOCKING COVERS ON THERMOSTATS	INSULATE DUCTWORK	INSULATE STEAM PIPES	WATER FLOW RESTRICTORS	AUTOMATIC DOOR CLOSERS	CAUL WE/ STR
5625	L.P. HYDRAULIC STATION					16			
5649	POWDER AREA SHOP							5	
5653	MIXED ACID WEIGH HOUSE							5	
5660-1	REFRIGERATION HOUSE					17		5	
5673-1	PRE-MIX HOUSE					8		6	
5682	M.S. LAB					35		5	
5806-1	PUMP & HEATER HOUSE					46		5	
5810	PRESS HOUSE					112			
5824	CHEM. PREP. HOUSE					50		7	
5825	PASTE BLENDER HOUSE			9				5	
5850	WAX PURIF. & DIE WARMING HOUSE								
5900	DEHYDRATION PRESS HOUSE					181			
6825-1	TRUCK WASH HOUSE					5		5	
6826	X-RAY HOUSE					29		6	
6866	TRAILER & JEEP SHOP					67		6	
7884	MECHANIZED ROLL HOUSE			6		114			
9001	LIME STORAGE HOUSE			9					
9004	CAL CYN FACILITY			48				6	
9022	AREA MAINTENANCE SHOP			8					
9040	WET GUANIDINE NITRATE			15		8			
9041	DRY GENERATOR				137				
9061	AREA OFFICE			13					
9801	M.C. CONSISTENCY CONTROL HOUSE			48					
9824	CHEM. PREP.& PROCESS WATER HOUSE			24					
PROJECT BASEVIDE ANNUAL ENERGY SAVINGS SUBTOTAL (MBTU)		317	76	449	312	6689	33	265	3
ANNUAL ENERGY SAVINGS SUBTOTAL FOR THIS INCREMENT (MBTU)		INCREMENT F=16,646							
PROJECT COST ($1,000)		0.763	0.367	2.632	3.033	113.369	0.671	7.560	13
SAVINGS TO INVESTMENT RATIO (SIR)		57.2	28.5	25.4	14.0	8.1	6.8	5.1	4
SIMPLE AMORTIZATION (YEARS)		0.20	0.40	0.44	0.81	1.4	1.7	2.3	2

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GY PLAN : MATRIX OF ACTIONS AND SAVINGS

INCREMENT F

INSULATE STEAM PIPES	WATER FLOW RESTRICTORS	AUTOMATIC DOOR CLOSERS	CAULKING & WEATHER-STRIPPING	INSULATE DOMESTIC HOT WATER PIPES	INSULATE WATER HEATER TANK	REPLACE FLOURESCENT LAMPS & BALLAST	CLEAN & INSULATE HEAT EXCHANGER	INSULATE REFRIGERANT PIPES
16								
		5	19					
		5	19					
17		5	7					
8		6	7					
35		5	12		1			
45		5	20					
112								
50		7	17				1	
		5	15					
			19					
181			36					
5		5	12					
29		6	36					
67		6	19					
114			10	33				
			14					
		6	80					
8			25					
6689	33	265	3203	197	5	5098	1	1

INCREMENT F=16,646

113.369	0.671	7.560	136.167	7.217	0.298	106.034	0.093	0.076
8.1	6.8	5.1	4.2	3.3	3.2	2.42	1.5	1.3
1.4	1.7	2.3	2.7	3.4	3.6	4.5	7.8	8.4

NOTE: ALL MATRIX E
ARE ENERGY S
EXCEPT FOR
WHICH ARE PE
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Designed by:

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Submitted by:

US Army Corps of Engineers

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Scale:

Date: 12/1/83

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AND SAVINGS

INSULATE DOMESTIC HOT WATER PIPES	INSULATE WATER HEATER TANK	REPLACE FLOURESCENT LAMPS & BALLAST	CLEAN & INSULATE HEAT EXCHANGER	INSULATE REFRIGERANT PIPES
	1			
			1	
33				
159	5	5050	1	1
7.217	0.298	106.034	0.093	0.076
3.3	3.2	2.42	1.5	1.3
3.4	3.6	4.5	7.8	8.4

NOTE: ALL MATRIX ENTRIES ON THIS PAGE ARE ENERGY SAVINGS (IN MBTU), EXCEPT FOR THE FINAL THREE ROWS, WHICH ARE PROJECT COST (IN $1,000), SAVINGS TO INVESTMENT RATIO (DIMENSIONLESS), AND SIMPLE AMORTIZATION (IN YEARS).

Revisions			
Symbol	Description	Date	Approved

Booker Engineers Architects Planners

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by:
Drawn by:
Checked by:
Submitted by:

US Army Corps of Engineers

ENERGY PLAN: MATRIX of ACTIONS and SAVINGS
BASEWIDE ENERGY STUDIES
IN SUPPORT OF
ENERGY ENGINEERING ANALYSIS PROGRAM
SUNFLOWER ARMY AMMUNITION PLANT
DESOTO, KANSAS
CONTRACT NO.-DAC41-81-C-0170

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