ENERGY ENGINEERING ANALYSIS PROGRAM

INCREMENTS A,B,G

STRATFORD ARMY ENGINE PLANT

STRATFORD , CONNECTICUT

EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this analysis it to develop a systematic program of projects that will result in energy consumption reductions in compliance with the stated goals of the Army Facilities Energy Plan for the Stratford Army Engine Plant in Stratford, Connecticut. Reduced energy consumption is a stated goal for the Army Facility Energy Plan. Using FY75 as the base year, basewide energy consumption must be reduced by 20% by the end of FY85. This is known as the DARCOM goal. The goal was established to enable the ARMY to achieve energy conservation requirements and assigned by Executive Order 12003 and by the Department of Defense. In addition, the Army Facility Energy Plan dated February 24, 1978, established by a long term goal for a 50 percent reduction in facility energy usage by the year 2000.

The projects to be implemented under the ECAM program must be cost-effective. That is, costs must be amortized within the project's economic life. In addition, all projects must be produce a savings-to-Investment Ratio (SIR), equal to or greater than 1.0.

1.2 SCOPE

This energy engineering analysis is divided into three increments: Increment A- Energy conservation investigations for buildings and processes, Increment B - Energy conservation investigations of utilities and energy distribution systems and Increment G- Projects identified in Increment A and B that do not qualify under ECAM criteria.

2.0 SITE SURVEY INFORMATION

2.1 PLANT DESCRIPTION

The Stratford Army Engine Plant (SAEP) is a government owned, contractor operated, military - industrial installation. Avco Lycoming, the contractor-operator, does research, testing and production of gas turbine engines.

The plant is in Stratford, Connecticut (See Figures 2.1.1-1 and 2.1.1-2). It lies on Connecticut's southern shore approximately 55 miles northeast of New York City.

The Site is bounded by the Housatonic River on the north, Main Street on the southwest and, Sniffen Land to the southeast (See Figure 2.1.1-3). The facility consists of 48 individual buildings with a total area of 1,580,000 square feet. (See Table 2.1.1.)

2.2 AUDIT PROCEDURE AND FIELD SURVEY EFFORT

During the field survey, architectural, mechanical and electrical information was obtained on each building as well as data pertain ing to the distribution systems, and the steam generation facilities. For the larger buildings (i.e. Building 2), due to the large number of equipment and systems, field survey notes were made directly on available drawings. For relatively smaller buildings, field notes and sketches were prepared.

2.3 Buildings Surveyed

2.3.1 The buildings shown in table 2.3.1-1 are the buildings specified in the contract to be surveyed.

TABLE 2.3.1.-1

BUILDING NO.	DESCRIPTION
1	Main Administrative and Government Offices
2	Production Manufacturing Operations with Boiler and Compressed Air Plants
3	Research and Development Operations
3A	Engineering Materials Laboratory and Receiving Inspection
4	Experimental Processes and Materials Stores
6	Turbine Engine Environmental Processes and Materials Stores
6A	Turbine Engine Mechanical Component Test
10	Tank Engine Mechanical Component Test
16	Production and Development Test Cells and Supporting Services
17	Component Test Steam Generating Plant
18	Plant Chemical Plating Waste Treatment
38	Storm Drain Pumping Stations
44	Stores, Tooling and Equipment Warehouse
55	Production Material Warehouse

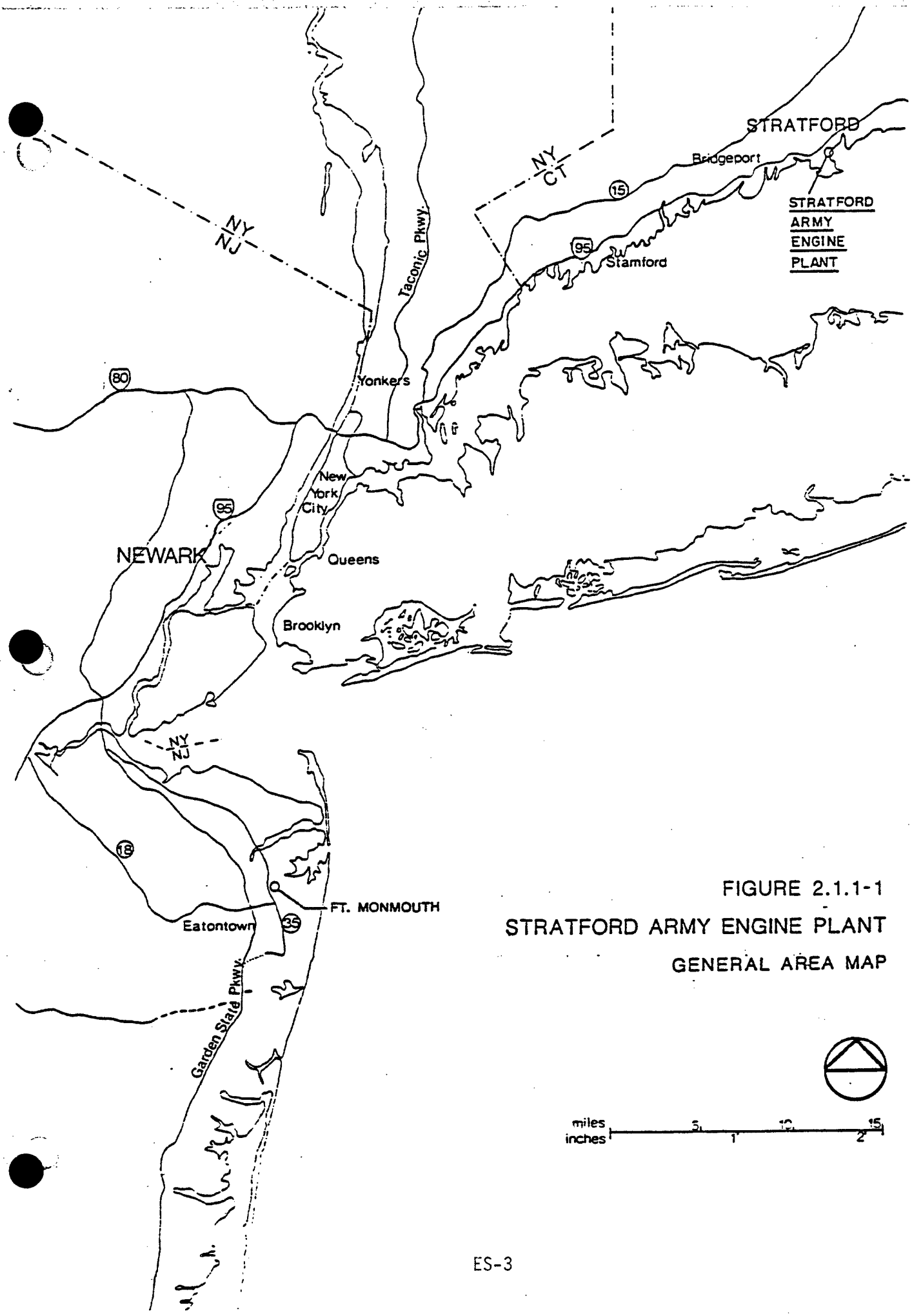


FIGURE 2.1.1-1

STRATFORD ARMY ENGINE PLANT

GENERAL AREA MAP

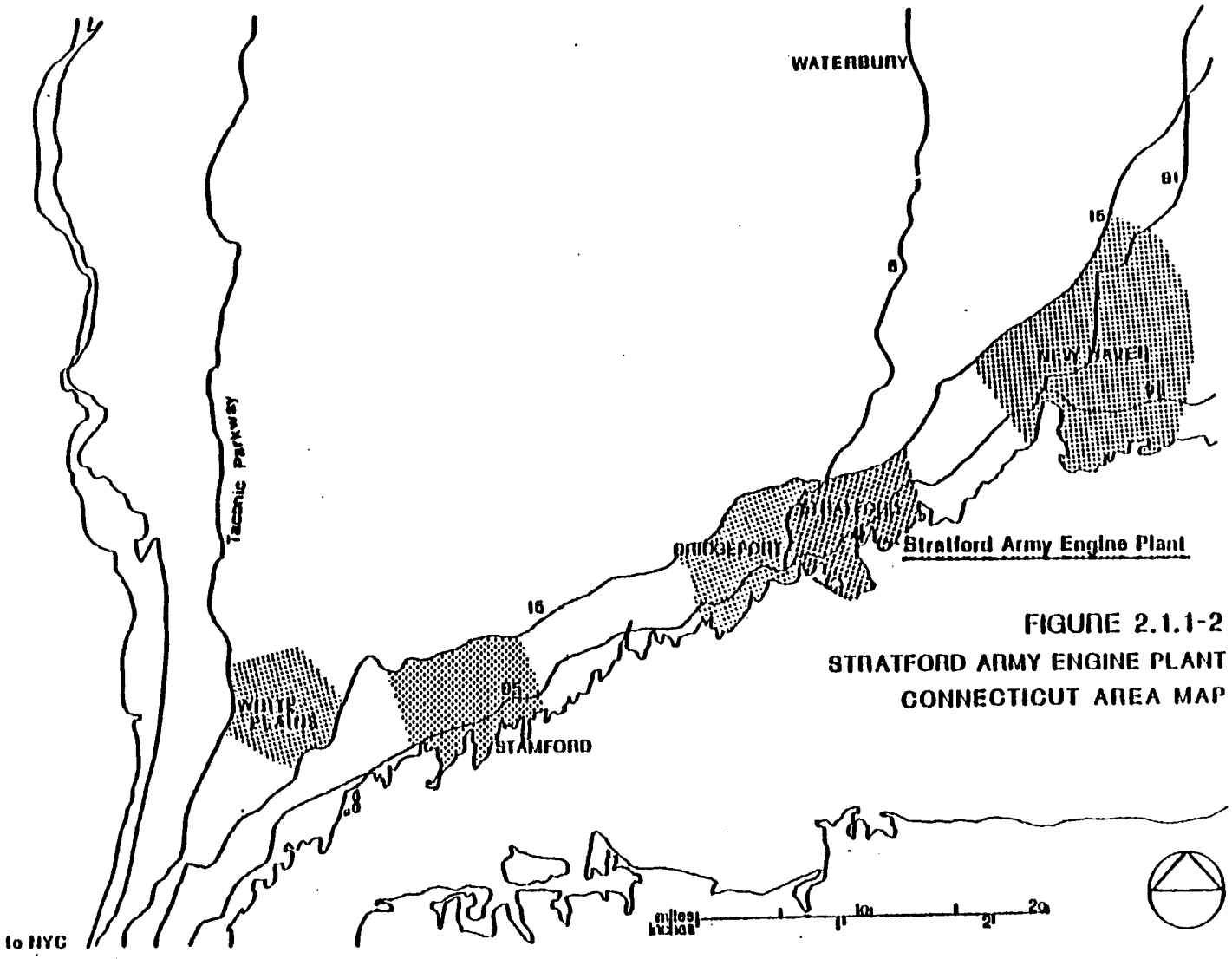


FIGURE 2.1.1-2
STRATFORD ARMY ENGINE PLANT
CONNECTICUT AREA MAP

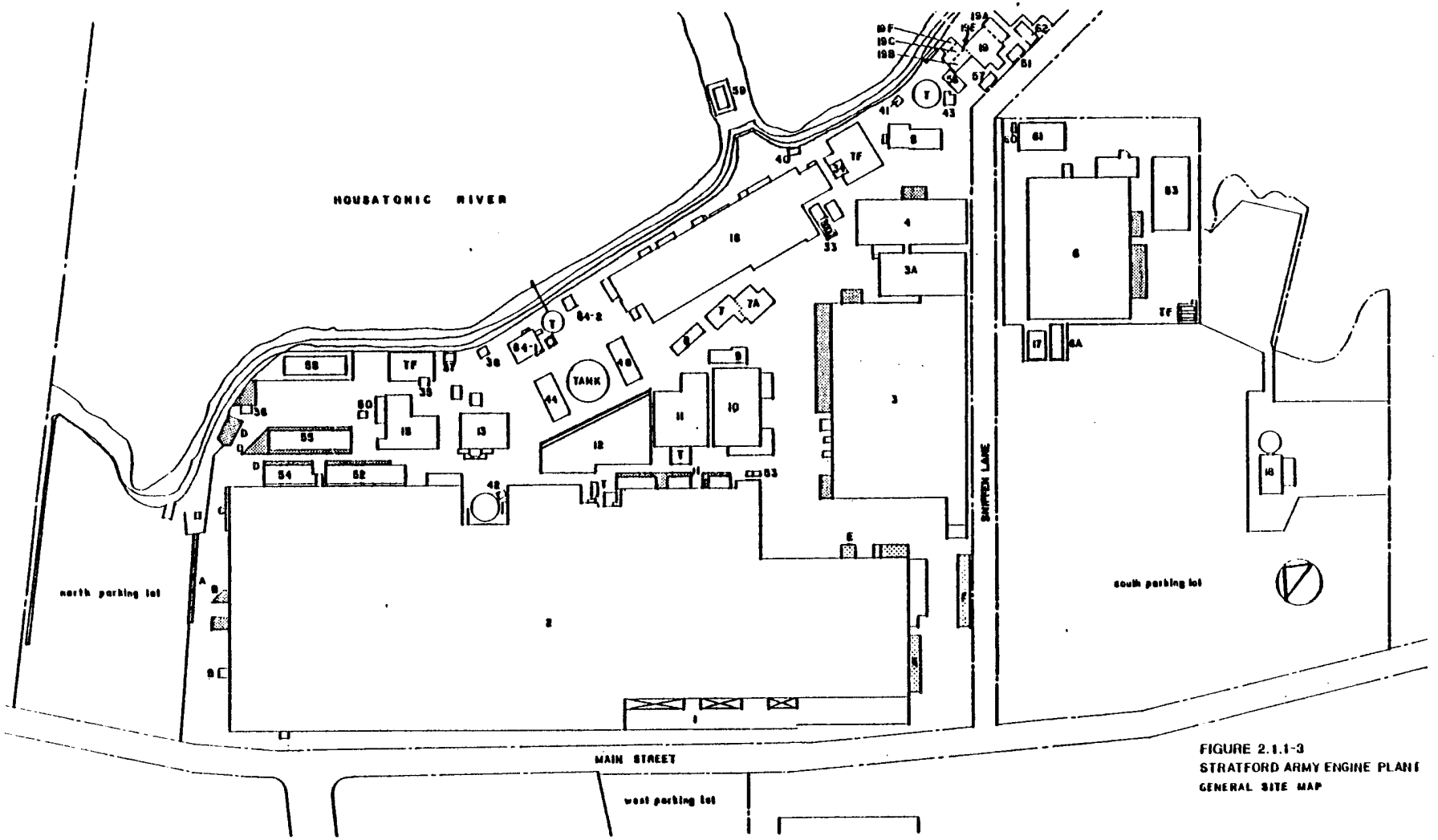


FIGURE 2.1.1-3
STRATFORD ARMY ENGINE PLANT
GENERAL SITE MAP

TABLE 2.1.1

MASTER BUILDING LIST

BLDG NO.	DESCRIPTION	AREA (SQ. FT.)	YR. CONST.
1	MAIN ADMINISTRATIVE & GOVERNMENT OFFICES	88,606	29-65
2	PROD. MFG. OPERATIONS, PLANT STEAM & COMPAIR GENERATING STATION	843,592	29-44
3	RESEARCH & DEVELOPMENT OPERATIONS	260,565	30-44
3A	ENGINEERING MATERIALS LABORATORY & RECEIVING INSPECTION	16,875	30-44
4	EXPERIMENTAL PROCESSES & MATERIALS STORES	24,000	45
5	TURBINE ENGINE FUEL SYSTEM DEVELOPMENT TEST	5,421	44
6	TURBINE ENGINE ENVIRONMENTAL PROCESSES & MATERIALS STORES	87,079	44
6A	TURBINE ENGINE MECHANICAL COMPONENT TEST	2,130	66
7	TURBINE ENG. PROD. FUEL SYSTEM & ACCESSORIES INSPECTION TEST	6,786	42
7A	TURBINE ENG. PROD. FUEL SYSTEM & ACCESSORIES INSPECTION TEST		62
8	VOLATILE STORAGE	1,829	39
9	AUTOMOTIVE MAINTENANCE	2,676	42
10	MFG. TANK ENGINE COMPONENTS & ASSEMBLY (RECUPERATOR LINE)	19,302	29
11	GENERAL STORAGE	22,010	40
12	MAINTENANCE SHOP	24,840	41
13	SCRAP & MATERIAL RECLAMATION PROCESSING	7,868	44
15	LUBRICATION & GENERAL PURPOSE STORAGE	10,816	45
16	PRODUCTION-DEVELOPMENT-TEST CELLS & SUPPORTING SERVICES	75,529	53
17	COMPONENT TEST STEAM GENERATING PLANT	2,400	52
18	PLANT CHEMICAL PLATING WASTE TREATMENT	3,600	58
19	TURBINE ENGINE COMPRESSOR & POWER TURBINE COMPONENT TEST	9,190	44-63
33	COOLING TOWER PUMPING STATION	616	53
34	TEST FUEL, TRANSFER & VALVE STATION	834	53
35	VALVE & TRANSFER & VALVE STATION FOR LUBRICATING & CUTTING OIL TANK FM	340	53
36	STORM DRAIN PUMPING STATIONS	387	53
37	STORM DRAIN PUMPING STATIONS	387	53
38	STORM DRAIN PUMPING STATIONS	387	53
40	STORM DRAIN PUMPING STATIONS	387	53
41	STORM DRAIN PUMPING STATIONS	387	53
42	SPRINKLER BOOSTER PUMPING STATION FOR 400,000 GAL. STOR. TANK	450	44
43	SPRINKLER BOOSTER PUMPING STATION FOR 300,000 GAL. STOR. TANK	484	44
44	STORES, TOOLING & EQUIPMENT WAREHOUSING	4,000	61
48	STORES, TOOLING & EQUIPMENT WAREHOUSING	4,000	61
51	COMPRESSOR & VACUUM PUMP-DEVELOP COMP. TEST	768	58
52	PRODUCTION MATERIAL WAREHOUSING	6,880	62
53	SURPLUS EQUIPMENT PROCESSING	12,800	61
54	PRODUCTION MATERIAL WAREHOUSE	4,400	63
55	PRODUCTION MATERIAL WAREHOUSE	7,200	61
56	HIGH PRESSURE COMPRESSOR TEST FAC.	1,212	65
57	TRANSFORMER STATION TEST FACILITY (19 COMPLEX)	800	64
58	MISSILE ASSEMBLY & TEST LABORATORY	5,540	67
59	MISSILE STORAGE MAGAZINE M.S.D.	1,081	60
60	HIGH PRESSURE NATURAL GAS PUMPING STATION Avco/Lycoming	250	68
61	REFRIGERATION PLANT (LOW TEMP. SYSTEM)	4,200	69
62	HIGH PRESSURE AIR FACILITIES	1,300	71
63	CHEMICAL WASTE TREATMENT SYSTEM PUMPING STATION	531	58
64-1	IND. & SI. WATER TREAT. PLANT (CONTROL RM.)	616	75
64-2	IND. & SI. WATER TREAT. PLANT (PUMP RM.)	200	75

2.4 EQUIVALENT BUILDINGS

There are 48 buildings in the plant totaling 1,577,639 square feet in area. Of these 14 totaling 1,435,265 square feet are actual surveyed buildings. They represent 91 percent of total floor area.

Of the remainder, 13, totaling 33,295 square feet or 2 percent of total area are classified as equivalent buildings. Each, based broadly on construction characteristics and use, is designated as equivalent to a building or group of buildings on the surveyed building list. The equivalent building list was prepared in conjunction with base personnel. The equivalency is used to extrapolate estimated energy consumption for the entire plant.

In addition 21 buildings totaling 109,079 square feet or 7 percent of total area have been omitted entirely from the report by direction. These buildings are those which are low energy users.

The incorporation of equivalent buildings with surveyed buildings provides a complete energy consumption picture of the entire plant.

A list of surveyed buildings and equivalent buildings is given in Table 2.4.

2.5 ENERGY PROJECTS COMPLETED, IN PROGRESS, OR PLANNED

2.5.1 Project Completed

The following energy saving project have already been completed at SAEP:

- o Rehabilitation of all roofs throughout the plant FY 78-81.
- o Installation of reflective film on windows FY 82.
- o Installation of high pressure sodium lighting FY 82
- o Reconditioning of condensate return pumps FY 79.
- o Window sash replacement in Building No. 10 FY 82.
- o Boiler room rehabilitation FY 82
- o Heating system rehabilitation FY 81
- o Air compressor control System FY 81 - FY 82.

2.5.2 Projects-In-Progress

The following Projects are in progress:

- o Replacement of window sash throughout the plant FY 81 - FY 82.
- o Restoration of Building No. 3A FY 82.
- o Replace main switch gear FY 81 - FY 83

TABLE 2.4

EQUIVALENT BUILDING LIST

SURVEYED BLDG. NO.	BUILDING USE	AREA SF	EQUIVALENT BLDG. NO.	BUILDING USE	AREA SF
1	MAIN ADMIN. & GOV'T OFFICES	88,606		NO EQUIVALENT BUILDING	
2	PROD. MFG. OPERATIONS	843,592		NO EQUIVALENT BUILDING	
3	R & D OPERATIONS	260,365		NO EQUIVALENT BUILDING	
3A	ENG. MAT'LS LAB.	16,873		NO EQUIVALENT BUILDING	
4	EXPERIMENTAL PROCESS & MATERIALS	24,000		NO EQUIVALENT BUILDING	
6	TURBINE ENGINE ENVIRONMENTAL PROCESSES & MATERIALS STORES	87,079		NO EQUIVALENT BUILDING	
6A	TURBINE ENGINE MECHANICAL COMPONENT TEST	2,130		NO EQUIVALENT BUILDING	
10	MFG. TANK ENGINE COMPONENTS & ASSEMBLY	19,302		NO EQUIVALENT BUILDING	
16	PRODUCTION DEVELOPMENT - TEST CELLS	75,529		NO EQUIVALENT BUILDING	
17	COMPONENT TEST STEAM GENERATING PLANT	2,400		NO EQUIVALENT BUILDING	
18	PLANT CHEMICAL PLATING WASTE TREATMENT	3,600		NO EQUIVALENT BUILDING	
38	STORM DRAIN PUMPING STATIONS	387	35	VALVE & TRANSFER STATION	340
			36	STORM DRAIN PUMPING STATIONS	387
			37	STORM DRAIN PUMPING STATIONS	387
			41	STORM DRAIN PUMPING STATIONS	387
			42	SPRINKLER BOOSTING PUMPING STATION	450
			43	SPRINKLER BOOSTING PUMPING STATION	464
44	STORES, TOOLING & EQUIPMENT WAREHOUSE	4,000	48	STORES, TOOLING & EQUIPMENT WAREHOUSING	4,000
55	PRODUCTION MATERIAL WAREHOUSE	7,200	51	COMPRESSOR & VACUUM PUMP	768
			52	PRODUCTION MATERIAL WAREHOUSING	6,880
			53	SURPLUS EQUIPMENT PROCESSING	12,800
			54	PRODUCTION MATERIAL WAREHOUSING	4,400
			56	HIGH PRESSURE COMPRESSOR TEST FACILITY	1,212
			57	TRANSFORMER STATION TEST FACILITY	800

- o Exterior restorations of buildings FY 82
- o Plant door rehabilitation FY 83
- o Insulation of steam lines FY 81 - FY 83.
- o Rehabilitation of condensate piping FY 82
- o Cafeteria Renovation FY 82 - FY 83.
- o Refrigeration plant controls FY 82 - FY 83.
- o Installation of automated radiator valves on a plant wide basis by Avco.

2.5.3 Planned Projects

The following projects are being planned:

- o Installation of an Energy Monitoring and Control System (EMCS) to include the following:
  - Installation of time clocks on selected air conditioning systems.
  - Time scheduled operation.
  - Duty cycling.
  - Demand Limiting start/stop.
  - Occupied Setback.
  - Increase cooling set point.
  - Unoccupied setback.
  - Damper control.
  - Enthalpy economizer.
  - Outside air temperature reset schedule.
  - Start/stop optimization.
  - Lighting control.
  - Run-time reports.
- o Air exhaust and make up air Building No. 2 FY 82.

2.5.4 Energy Savings

A list of energy savings for projects planned, recently completed or in progress is given below in Table 2.5. Refer to Appendix 9, page 9-147 for back-up calculations.

TABLE 2.5

Energy Savings for Projects Planned, Recently Completed, or in Progress

PROJECT	MBTU/YR SAVED
Roof Rehabilitation	29,000
Condensate System Rehabilitation	6,300
Installation of High Pressure Lighting	55,000
Rehabilitation of Building 3A	100
Installation of Kalwall	7,500
Total	97,900

3.0 Installation Energy Profile

3.1 General

Energy used at SAEP includes No. 2, No. 4 and No. 6 fuel oil, natural gas under both firm and interruptible contracts, electricity, diesel fuel, jet fuel and propane.

Firm contract natural gas, jet fuel, diesel fuel and propane are utilized for process-related functions.

Electricity has multiple uses. Building uses include motors for fans, pumps and air conditioning compressors as well as domestic hot water generation. Process uses include but are not limited to machine tools, electric furnaces, welders and conveyors.

No. 6 fuel and interruptible natural gas are used to generate steam in the central boiler plant in Building 2. Steam is used for space heating, boiler room auxiliaries, domestic hot water and process equipment. No. 2 fuel oil is used for testing diesel tank engines. No. 4 fuel oil is used for the high pressure steam boilers in Building 17.

3.2 Population

3.2.1 Present Population

The plant is in full operation with a full complement of personnel.

3.3 Historical Energy Consumption

3.3.1 General

The historical energy profile for SAEP is based on annual energy use from FY75 through FY81.

3.3.2 Tabular Information

Table 3.3.2 entitled "ANNUAL ENERGY CONSUMPTION," shows historical annual energy use from FY75 through FY81 for Total Source Energy and each of the individual energy sources discussed in Section 3.1. The sum of No. 6 fuel oil and interruptible natural gas is also indicated in Table 3.3.2. This quantity is a measure of the fuel input to the central boiler plant.

Table 3.3.2 indicates the following information for each fuel:

- Consumption (Base Unit) - CCF/YR is the base unit for natural gas, KWH/YR for electricity, and GAL/YR for fuel oil, diesel fuel, jet fuel and propane.

- Consumption in MBTU/YR.

- Unit Consumption in KBTU/GSF-YR - Energy consumption in 1,000 BTU (KBTU) divided by the Gross Square Foot Area of the Plant.

- Unit Consumption per Degree Day.

- Energy Index, Ref FY75 - Ratio of energy consumption in any year as compared to base year FY75. The value of Energy Index for FY75 is 100.

- Cost in Dollars per Year.

- Unit Cost in Dollars per 1,000 GSF per year.

- Cost Index, Ref FY75. Ratio of cost in any year to the base year of FY75. The value of the index for FY75 is 100.

- DARCOM Goal - The target figure for energy consumption in KBTU/GSF-YR. Using FY75 as the base year, basewide energy consumption must be reduced by 20% by the end of FY85. The goals were established to enable the ARMY to achieve energy conservation requirements assigned by Executive Order 12003 and by the Department of Defense. In addition, the Army Facility Energy Plan dated February 24, 1978, established by a long term goal for a 50 percent reduction in facility energy usage by the year 2000.

ANNUAL ENERGY CONSUMPTION

TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
GROSS AREA	GSF	1,560,764	1,560,764	1,560,764	1,560,764	1,560,764	1,560,764	1,560,764
DEGREE DAYS, HEATING	DD	5,293	5,066	5,783	5,821	5,268	5,405	5,797
TOTAL SOURCE ENERGY:								
CONSUMPTION	MBTU/YR	1,154,036	1,027,993	1,081,529	1,074,607	1,166,916	1,223,545	1,238,359
UNIT CONSUMPTION	KBTU/GSF/YR	739	659	693	689	748	790	793
DARCOM GOAL	KBTU/GSF/YR	739	724	709	695	680	665	650
UNIT COMSUMPTION / DD	BTU/GSF/DD/YR	140	130	120	118	142	146	112
ENERGY INDEX, REF. FY75		100	102	99	97	128	142	131
COST	DOLLARS/YR	3,157,071	2,839,360	3,270,257	3,183,905	4,138,622	6,446,916	8,465,164
UNIT COST	DOLLARS/KGSF/YR	2,023	1,819	2,095	2,040	2,652	4,130	5,424
COST INDEX, REF. FY75		100	109	115	118	186	312	381
NO: 6 FUEL OIL PLUS INTERRUPTIBLE GAS:								
CONSUMPTION	MBTU/YR	430,549	344,368	351,742	350,257	333,743	336,524	300,417
UNIT CONSUMPTION	KBTU/GSF/YR	275.9	220.6	225.4	224.4	213.8	215.6	192.5
UNIT CONSUMPTION/DD		52.11	43.55	38.9	38.55	40.59	39.89	33.20
ENERGY INDEX, REF. FY75	NONE	100	80	82	81	77	78	70
COST	DOLLARS/YR	876,563	680,034	770,382	808,488	919,205	1,382,758	1,577,556
UNIT COST	DOLLARS/KGSF/YR	561.6	435.7	493.6	518.0	588.9	885.9	1,010.8
COST INDEX, REF. FY75	NONE	100	80	88	92	105	158	180

ANNUAL ENERGY CONSUMPTION (CONT'D.)

TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
NO. 2 FUEL OIL								
CONSUMPTION	MBTU/YR	725	546	835	773	708	660	366
UNIT CONSUMPTION	KBTU/GSF/YR	0.46	0.35	0.53	0.50	0.45	0.42	0.23
UNIT CONSUMPTION/DD	BTU/GSF/DD/YR	0.09	0.07	0.09	0.09	0.09	0.08	0.04
ENERGY INDEX, REF. FY75	NONE	100	71	108	100	92	86	35
COST	DOLLARS/YR	1,643	1,221	2,285	2,452	2,616	4,319	2,986
UNIT COST	DOLLARS/KGSF/YR	1.05	0.78	1.46	1.57	1.68	2.77	1.91
COST INDEX, REF. FY75	NONE	100	74	139	149	159	263	182
CONSUMPTION	GALLONS	5,227	3,937	6,020	5,573	5,105	4,758	2,639
NO. 4 FUEL OIL								
CONSUMPTION	MBTU/YR	4,136	4,296	3,549	1,740	--	3,770	2,900
UNIT CONSUMPTION	KBTU/GSF/YR	2.65	2.75	2.27	1.11	--	2.42	1.86
UNIT CONSUMPTION/DD	BTU/GSF/DD/YR	0.50	0.54	0.39	0.19	--	0.45	0.35
ENERGY INDEX, REF. FY75	NONE	100	104	86	42	--	91	70
COST	DOLLARS/YR	10,109	10,074	9,065	4,360	--	20,500	18,111
UNIT COST	DOLLARS/KGSF/YR	6.48	6.45	5.81	2.79	--	13.13	11.60
COST INDEX, REF. FY75	NONE	100	100	90	43	--	203	179
CONSUMPTION	GALLONS	29,300	30,500	25,200	12,300	--	26,700	20,600
NO. 6 FUEL OIL								
CONSUMPTION	MBTU/YR	243,847	120,597	254,793	223,274	235,584	26,973	141,427
UNIT CONSUMPTION	KBTU/GSF/YR	156.24	77.27	163.25	143.05	150.94	17.28	90.61
UNIT CONSUMPTION/DD	BTU/GSF/DD/YR	29.52	15.25	28.23	24.58	28.65	3.2	15.6
ENERGY INDEX, REF. FY75	NONE	100	49	104	95	97	11	58
COST	DOLLARS/YR	551,148	263,829	551,697	512,005	589,582	139,341	856,031
UNIT COST	DOLLARS/KGSF/YR	353.13	169.04	353.48	328.05	377.75	89.28	548.47
COST INDEX, REF. FY75	NONE	100	48	100	93	107	25	155
CONSUMPTION	GALLONS	1,693,000	837,000	1,769,000	1,551,000	1,636,000	187,000	982,000

ANNUAL ENERGY CONSUMPTION (CONT'D.)

TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
INTERRUPTIBLE GAS								
CONSUMPTION	CCF/YR	1,867,020	2,237,710	969,490	1,269,830	981,590	3,095,510	1,589,900
CONSUMPTION	MBTU/YR	186,702	223,771	96,949	126,983	98,159	309.551	158,990
UNIT CONSUMPTION	KBTU/GSF/YR	119.6	143.4	62.1	81.4	62.9	198.3	101.9
UNIT CONSUMPTION/DD								
ENERGY INDEX. REF. FY75	NONE	100	120	52	68	53	166	85
COST	DOLLARS/YR	325,415	416,205	218,685	296,483	329,623	1,243,417	721,525
UNIT COST	DOLLARS/KGSF/YR	208.5	266.7	140.1	190.0	211.2	797.7	462.3
COST INDEX, REF. FY75	NONE	100	128	67	91	101	382	222
FIRM GAS								
CONSUMPTION	CCF/YR	291,810	293,800	274,540	275,790	451,345	329,997	221,314
CONSUMPTION	MBTU/YR	29,181	29,380	27,454	27,579	45,135	32,997	22,131
UNIT CONSUMPTION	KBTU/GSF/YR	18.7	18.8	17.6	17.7	28.9	21.1	14.2
ENERGY INDEX, REF. FY75	NONE	100	101	94	95	155	113	76
COST	DOLLARS/YR	72,561	92,762	100,061	99,618	144,880	147,383	117,347
UNIT COST	DOLLARS/KGSF/YR	46.5	59.4	64.1	63.8	92.8	94.4	75.2
COST INDEX, REF, FY75	NONE	100	128	138	137	200	203	162
ELECTRICITY								
CONSUMPTION	KWH/YR	42,835,000	39,562,000	41,313,000	44,668,000	49,932,422	52,751,067	53,965,564
CONSUMPTION AT SOURCE	MBTU/YR	496,886	458,919	479,231	518,149	579,216	611,912	626,001
UNIT CONSUMPTION	KBTU/GSF/YR	318.4	294.0	307.0	332.0	371.1	392.1	401.1
ENERGY INDEX, REF. FY75	NONE	100	92	96	104	117	123	126
COST	DOLLARS/YR	1,507,929	1,352,729	1,606,019	1,636,969	2,790,585	3,389,763	4,433,430
UNIT COST	DOLLARS/KGSF/YR	966.1	866.7	1,029.0	1,048.8	1,467.6	2,171.9	2,840.6
COST INDEX, REF. FY75	NONE	100	90	107	109	152	225	294
DEMAND	KW/YR	123,336	115,160	118,992	119,400	131,520	137,800	134,090

ANNUAL ENERGY CONSUMPTION (CONT'D.)

TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
PROPANE								
CONSUMPTION	GAL/YR	--	--	17,225	25,707	30,373	27,088	23,669
CONSUMPTION	MBTU/YR	--	--	1,576	2,352	2,779	2,479	2,166
UNIT CONSUMPTION	KBTU/GSF/YR	--	--	1.0	1.5	1.8	1.6	1.4
ENERGY INDEX, REF. FY75	NONE	--	--	*	*	*	*	*
COST	DOLLARS/YR	--	--	7,349	14,144	18,095	18,123	19,020
UNIT COST	DOLLARS/KGSF/YR	--	--	4.7	9.1	11.6	11.6	12.2
COST INDEX, REF. FY75	NONE	--	--	*	*	*	*	*
DIESEL FUEL								
CONSUMPTION	MBTU/YR	12,186	23,321	17,699	23,644	35,923	49,686	57,671
UNIT CONSUMPTION	KBTU/GSF/YR	7.8	14.9	11.3	15.1	23.0	31.8	36.9
ENERGY INDEX, REF. FY75	NONE	100	191	145	194	295	408	473
COST	DOLLARS/YR	26,641	54,792	45,725	63,259	129,415	270,858	419,518
UNIT COST	DOLLARS/KGSF/YR	17.1	35.1	29.3	40.5	82.9	173.5	268.8
COST INDEX, REF. FY75	NONE	100	206	172	237	486	1,017	1,575
JET FUEL								
CONSUMPTION	MBTU/YR	180,374	167,162	199,443	150,113	169,412	195,518	226,707
UNIT CONSUMPTION	KBTU/GSF/YR	115.6	107.1	127.8	96.2	108.5	125.27	145.25
ENERGY INDEX, REF. FY75	NONE	100	93	111	83	92	139	126
COST	DOLLARS/YR	658,021	641,694	729,167	552,828	642,300	1,219,102	1,884,802
UNIT COST	DOLLARS/KGSF/YR	421.6	411.1	467.2	354.2	411.5	781	1,207
COST INDEX, REF. FY75	NONE	100	98	111	84	98	185	286

* PROPANE WAS NOT USED DURING FY75 THEREFORE IS NO ENERGY OR COST INDEX, REF FY75

FIGURE 3-1

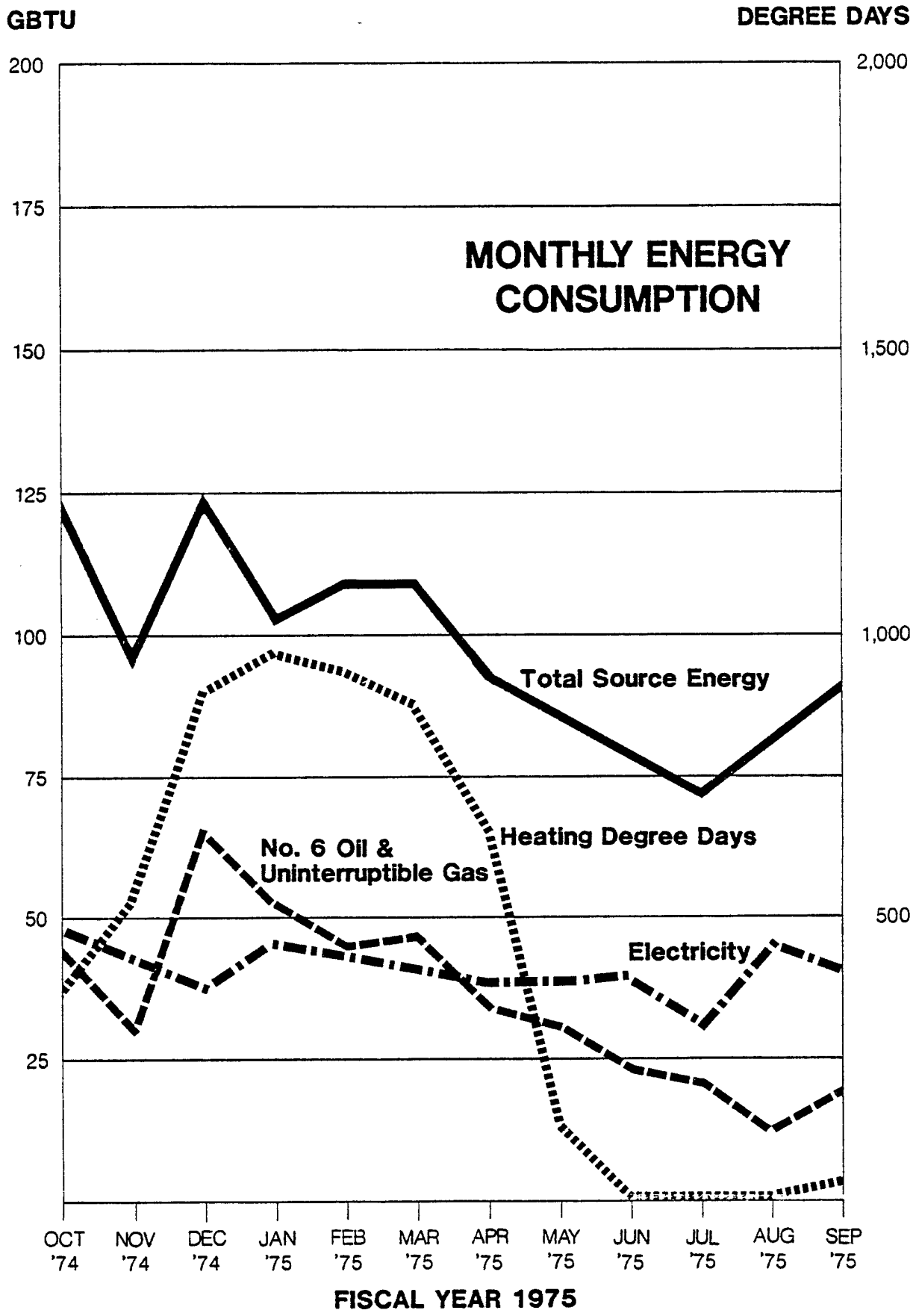

GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY CONSUMPTION
Total Source Energy
Heating Degree Days
No. 6 Oil & Uninterruptible Gas
Electricity
OCT '74
NOV '74
DEC '74
JAN '75
FEB '75
MAR '75
APR '75
MAY '75
JUN '75
JUL '75
AUG '75
SEP '75
FISCAL YEAR 1975

FIGURE 3-2

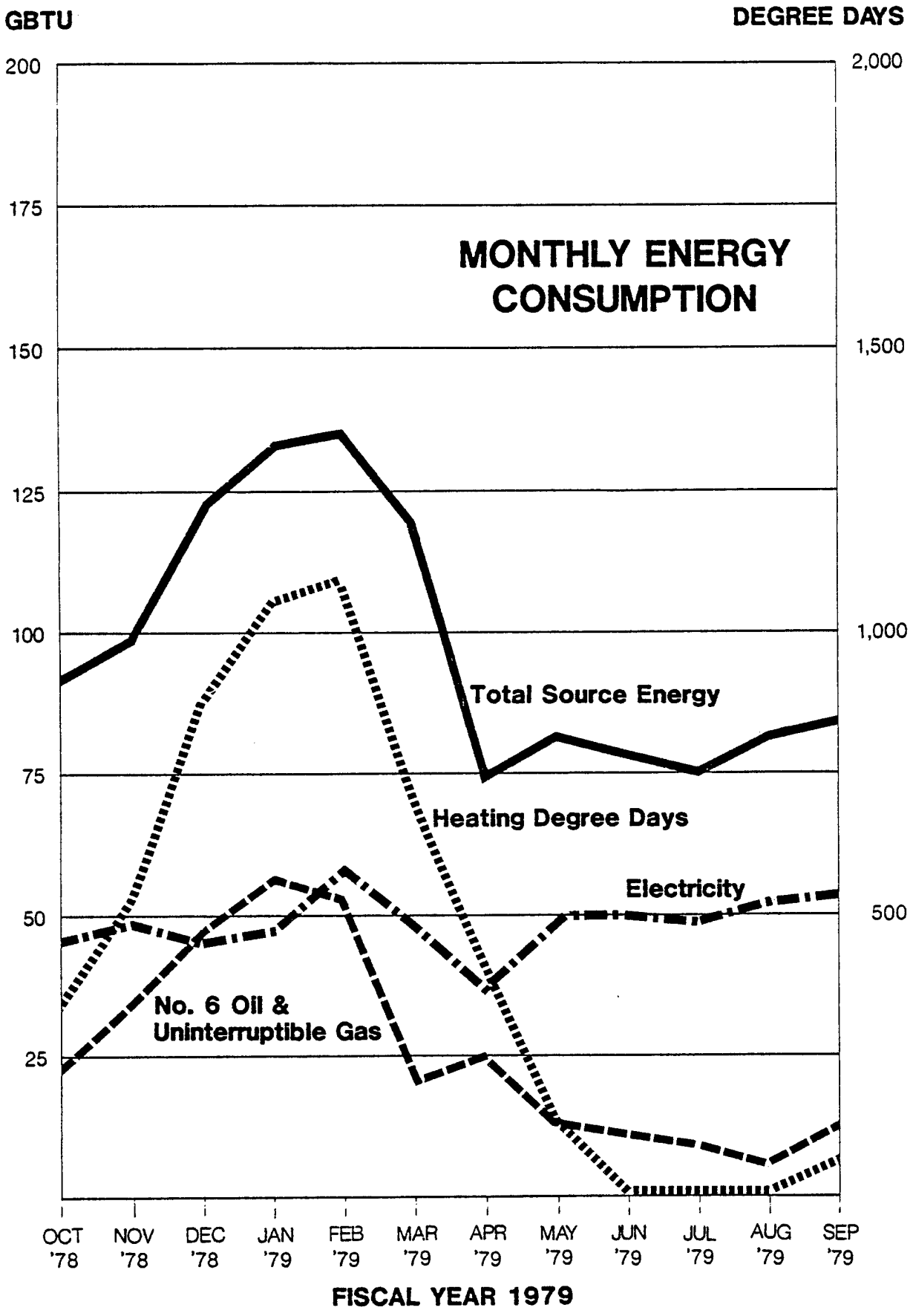

GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY CONSUMPTION
Total Source Energy
Heating Degree Days
Electricity
No. 6 Oil & Uninterruptible Gas
OCT '78
NOV '78
DEC '78
JAN '79
FEB '79
MAR '79
APR '79
MAY '79
JUN '79
JUL '79
AUG '79
SEP '79
FISCAL YEAR 1979

FIGURE 3-3

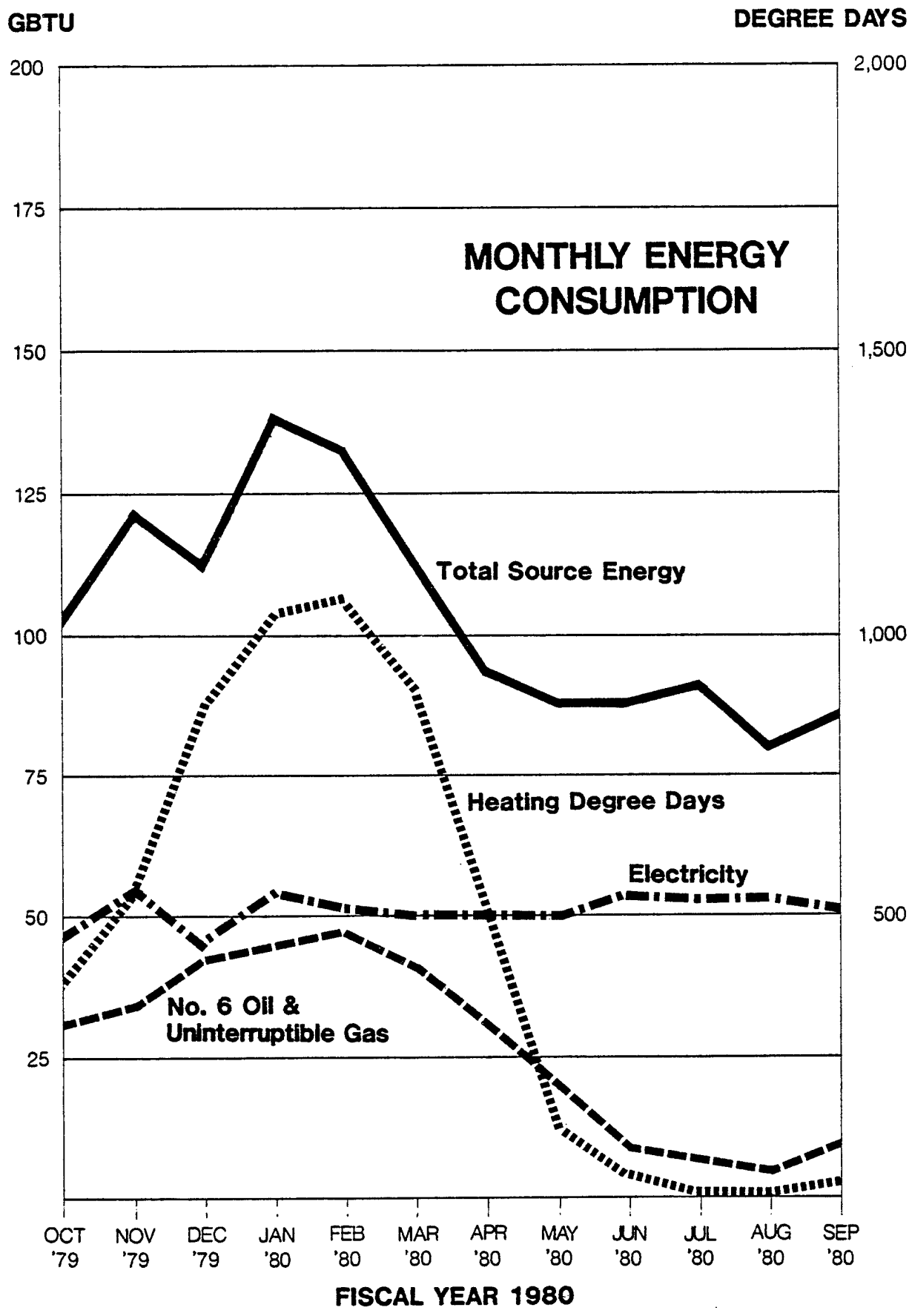
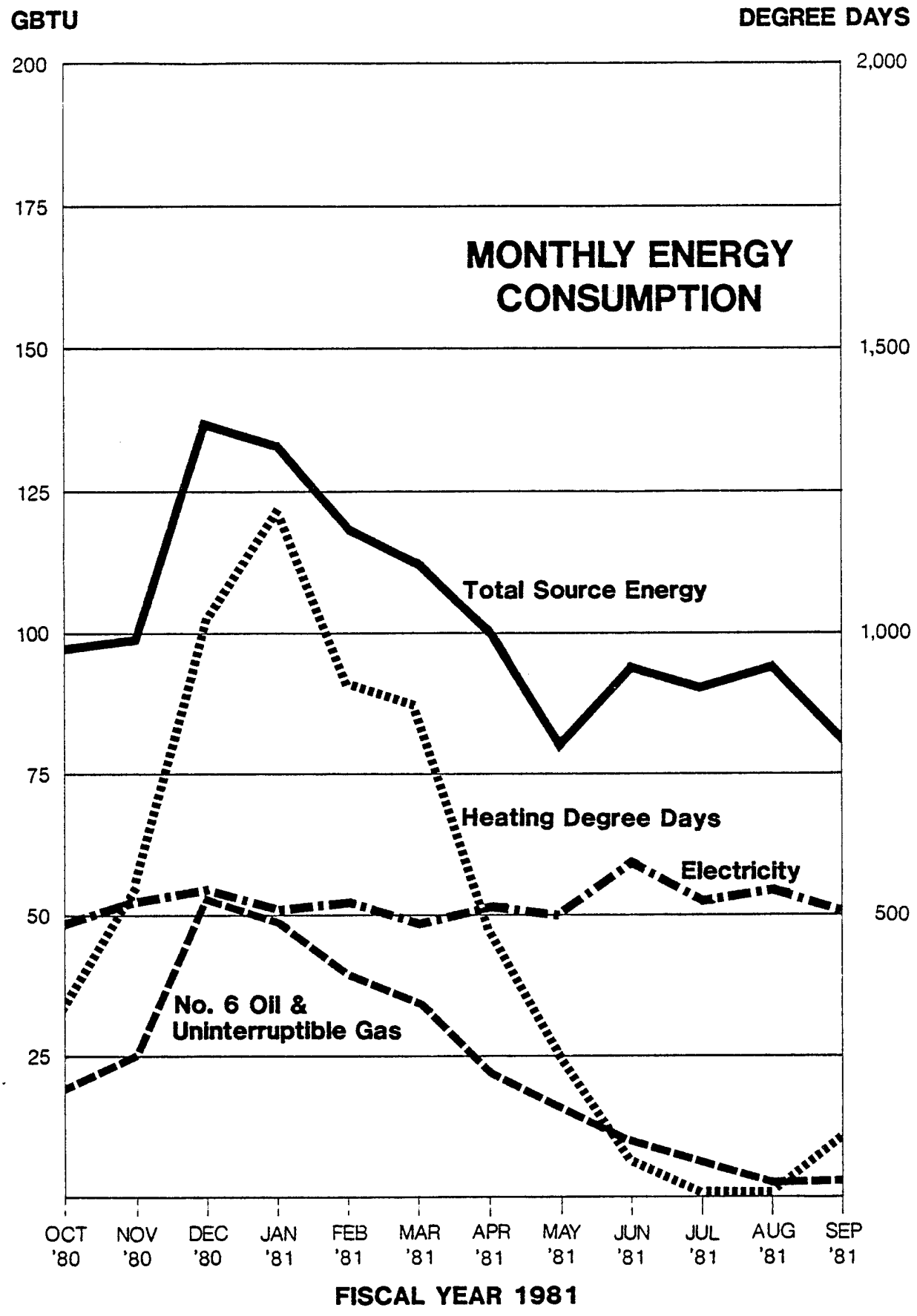
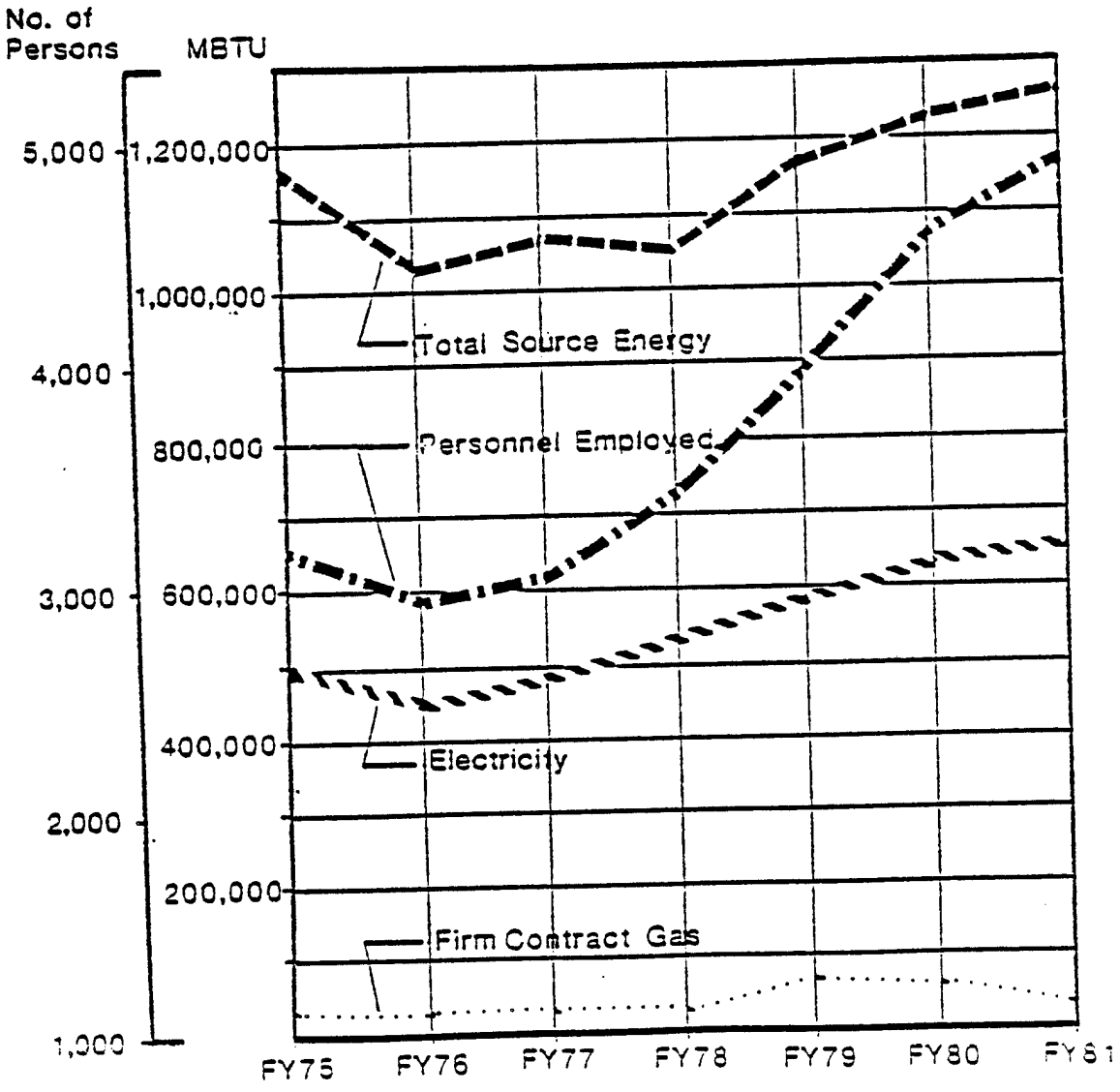

GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY CONSUMPTION
Total Source Energy
Heating Degree Days
Electricity
No. 6 Oil & Uninterruptible Gas
OCT '79
NOV '79
DEC '79
JAN '80
FEB '80
MAR '80
APR '80
MAY '80
JUN '80
JUL '80
AUG '80
SEP '80
FISCAL YEAR 1980

FIGURE 3 - 4


GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY CONSUMPTION
Total Source Energy
Heating Degree Days
Electricity
No. 6 Oil & Uninterruptible Gas
OCT '80
NOV '80
DEC '80
JAN '81
FEB '81
MAR '81
APR '81
MAY '81
JUN '81
JUL '81
AUG '81
SEP '81
FISCAL YEAR 1981

LEGEND

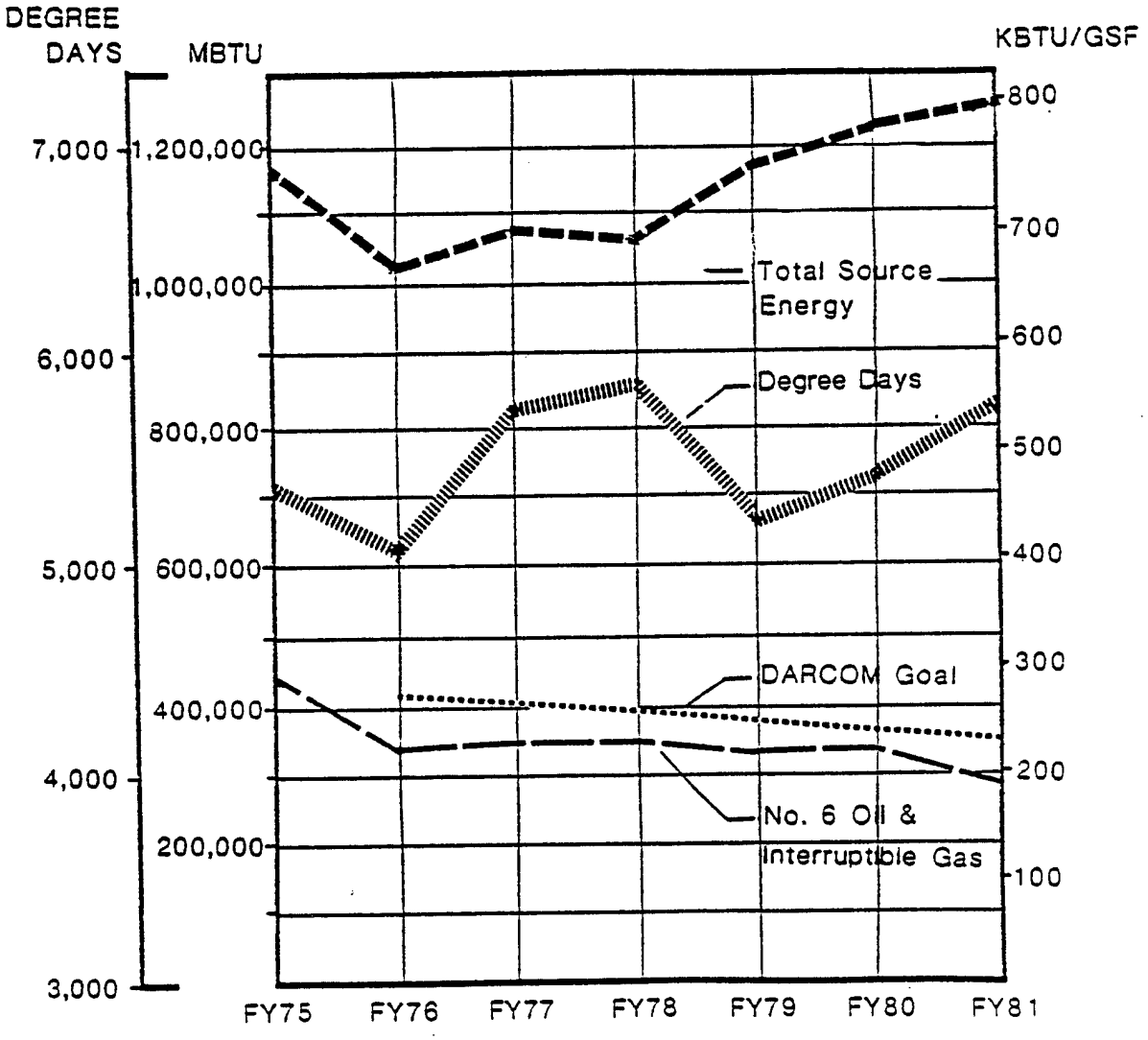
- Total Source Energy
- Electricity
- Personnel Employed
- Firm Contract Gas



ANNUAL ENERGY CONSUMPTION
PLATE 1

LEGEND

- Total Source Energy
- Heating Degree Days
- DARCOM Goal
- No. 6 Oil & Interruptible Gas



ANNUAL ENERGY CONSUMPTION
PLATE 2

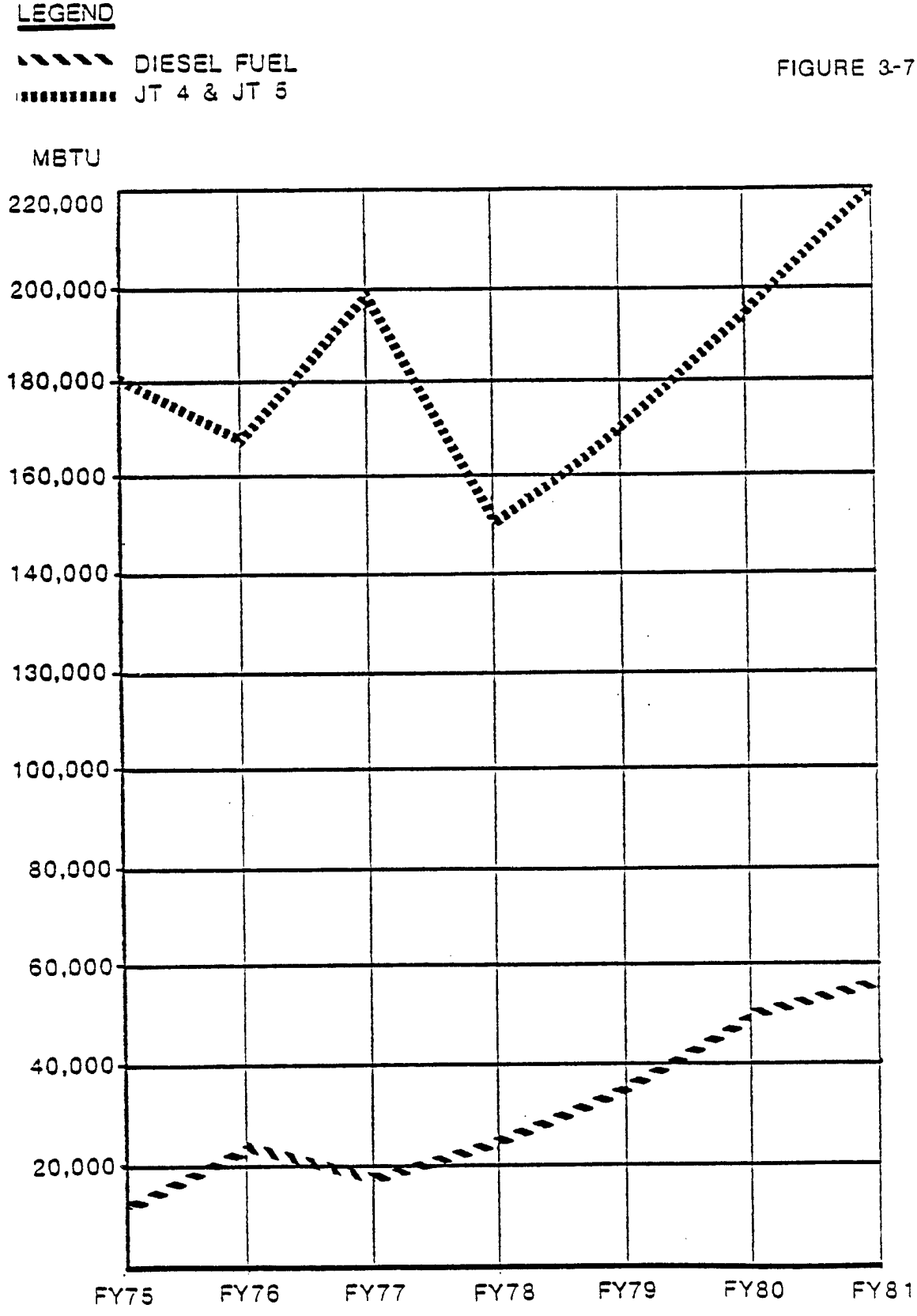


FIGURE 3-7

JET FUEL & DIESEL FUEL CONSUMPTION

3.3.3 Graphic Information

Figures 3-1 to 3-7 indicate the historical energy consumption profile at SAEP. Total source energy, interruptible natural gas, electricity and No. 6 fuel oil are plotted month by month for the Base Year (FY75) and the last three available years (FY79, FY80 and FY81). These fuels are also plotted on a year by year basis throughout the period FY75 through FY81. Jet fuel and diesel fuel consumption are graphically displayed for FY75 through FY81.

3.4 Energy Costs

Table 3.4 summarizes energy costs for electricity, interruptible natural gas and No. 6 fuel oil at SAEP.

Energy Costs
Table 3.4

Energy Source	Cost Per Unit FY 81	Cost Per MBTU FY 81 $	Cost Per MBTU Escalated To FY 85 $
Electrictiy	0.082 $/KWH	7.07	12.37
Interruptible Natural Gas	0.043 $/CCF	4.47	9.25
No. 6 Oil	0.87 $/Gal	6.01	10.52

4.0 FUTURE CHANGES

4.1 MISSION

No changes are contemplated in the SAEP mission which is to develop, design, test and manufacture turbine engines for military and commerical use.

SAEP is presently in full operation with complete utilization of facilities. This mode of operation will be maintained for the anticipated future.

5.0 ENERGY CONSERVATION MEASURES INVESTIGATED

Available sources of energy conservation were investigated to identify possible projects applicable to the Stratford Army Engine Plant. This information served as the basis for a more detailed investigation from which recommendations could be made.

Listed below are those energy conservation measures that involve modifying, improving or retrofitting existing buildings in the areas of architectural, HVAC, plumbing and electrical systems.

- Reduce Outside Air Intake
- Install Timer Controls
- Install Duty Cycling Controls
- Provide Additional Building Insulation
- Install Storm Windows and Doors
- Provide Window and Door Caulking and Weatherstripping
- Install Automatic Radiator Control Valves
- Install Entry Vestibules
- Install Outdoor Reset on Heating Systems
- Install Insulated Plastic Faced Translucent Sandwich Panels (Kalwall)
- Install Night Setback/Setup Controls
- Install Infrared Heaters
- Install Steam Radiator Supply Orifices
- Replace Unit Heater and Drip Rig Steam Traps
- Install Shutoff Valves and Thermostats For Unit Heaters
- Install Separate Domestic Hot Water Heater Tanks

- Replace Inefficient Domestic Water Heater with Energy Savers
- Insulate Domestic Hot Water Heater Tanks
- Remove Central Drinking Water System
- Install Aquastats on Domestic Hot Water Systems
- Reduce Domestic Hot Water Temperature
- Remove Unnecessary Sump Pumps
- Install Water Flow Restrictors
- Install Pressure Reducing Stations
- Install Power Line Switches on Electric Water Cooler
- Reset Compressor to Required Pressure
- Replace Light Fixtures with Energy Saving Type
- Reduce Number of Light Fixtures
- Replace Lamps with Energy Savers
- Reduce Number of Lamps
- Repair Light Fixture
- Re-circuit Light Fixtures
- Reduce Stratification
- Install Air Curtains
- Reduce Exhaust Fan Operating Time
- Provide Warm Up/Cool Down Cycle
- Install Enthalpy Economizer
- Replace Chiller with Screw Driven Chiller and Plate Type Heat Exchanger in Building No. 1.
- Install Antistratification Unit Heaters in Building Nos. 2, 3 and 6.

- Provide Dual-Cool Glycol A/C System with Free Cooling in Building No. 3.

- Insulate Domestic Hot Water Piping.

Additional energy conservation measures, for Boiler and Utility Systems, are listed below

- Install Oxygen Trim in Central Boiler Plant in Building 2.

- Install Stack Economizer in Central Boiler Plant in Building 2.

6.0 INCREMENT A PROJECTS

6.1 DEFINITION

This section presents energy saving Increment A projects that meet ECAM criteria.

Increment A projects involve modifying, improving or retro-fitting existing buildihngs. These projects typically involve architectural and structural features, HVAC systems, plumbing systems, interior and exterior building lighting and parking facilities lighting.

6.2 INCREMENT A PROJECT SELECTION PROCESS

Each ECM is analyzed in accordance with the ECAM Life Cycle Cost Economic Analysis Summary. An ECAM will be "recommended" for a building under Increment A, provided it has a Savings-to-Investment Ratio of at least 1.0.

A list of applicable projects using the above criteria were developed during the review and verification process and are summarized in Chapter 5 of this report.

6.3 RECOMMENDED ENERGY CONSERVATION MEASURES

6.3.1 ECM 5: Installation of Storm Windows in Buildings 1,2 and 3.

Estimated Annual Dollar Savings:	$ 50,263
Estimated Annual Energy Savings:	4,500 MBTU
ECR	14.9
SIR	2.2
Simple Amortization Period:	6.0 Years
CWE (FY85)	$303,015

6.3.2 ECM 29: Relamping Fixtures in Building 10, and 44.

Estimated Annual Dollar Savings:	4,366
Estimated Annual Energy Savings:	353 MBTU
ECR	29.3
SIR	3.8
Simple Amortization Period:	2.9 Years
CWE (FY85)	$12,045

6.3.3 ECM 41: Install antistratification unit heaters in Building 2.

Estimated Annual Dollar Savings:	$108,907
Estimated Annual Energy Savings:	11,415 MBTU
ECR	12.8
SIR	1.8
CWE (FY85)	$890,969

6.3.4 ECM 44: Install Insulation on Hot Water Piping.

Estimated Annual Dollar Savings:	$ 4,625
Estimated Annual Energy Savings:	422 MBTU
ECR	22.9
SIR	3.1
Simple Amortization Period:	4.2
CWE (FY85)	19,265

7.0 INCREMENT B PROJECTS

7.1 DEFINITION

This section presents energy savings Increment B projects that meet ECAM criteria.

Increment B projects involve utilities and energy distribution systems, EMCS for building and distribution systems, and existing energy plants. Energy distribution systems include steam, chilled water and hot water distribution as well as pumps, wells, storage and treatment facilities.

Recommended Energy Conservation Measures

7.2.1 ECM 45: Install oxygen trim system to Building No. 2 central boiler plant.

Estimated annual dollar savings:	$64,77!
Estimated annual energy savings:	6,157 MBTU
ECR	31.0
SIR	4.8
Simple Amortization Period:	3.1
CWE (FY85)	$198,824

7.2.2 ECM 46: Install stack economizer to Building No. 2 central boiler plant.

Estimated annual dollar savings:	$37,766
Estimated annual energy savings:	3,590 MBTU
ECR	24.1
SIR	3.7
Simple Amortization Period:	3.9
CWE (FY85)	$149,020

8.0 INCREMENT G PROJECTS

8.1 DEFINITION

This section presents those Increment A and Increment B projects that have an SIR less than 1.0 and therefore do not qualify under ECAM criteria. ECM 30, Delamping, was included in Increment G not because it has an SIR less than 1.0 but because it is a maintenance measure rather than a energy savings measure.

8.2 Energy Conservation Measures Investigated

8.2.1 ECM 4: Installation of wall insulation in Buildings 1, 2, 3, 3A, 4, 6A, 10, 16, 17, 18, 35, 36, 37, 38, 41, 42, 43, 44, and 48.

Estimated annual dollar savings:	$116,481
Estimated annual energy savings:	11,808 MBTU
ECR	5.1
SIR	0.7
Simple Amortization Period:	19.9
CWE (FY85)	$2,319,000

8.2.2 ECM 19: Replace inefficient hot water heaters in Buildings 2, 16 and 17.

Estimated annual dollar savings:	$ 147
Estimated annual energy savings:	13 MBTU
ECR	0.7
SIR	0.1
Simple Amortization Period:	121.4
CWE (FY85)	$17,934

8.2.3 ECM 30: Delamping Lighting Fixtures in Building 10.

Estimated Annual Dollar Savings:	$ 2,758
Estimated Annual Energy Savings:	223 MBTU
ECR	122.2
SIR	15.8
Simple Amoritization Period:	0.7 Years
CWE (FY85)	$1,825

8.2.4. ECM 40: Replace chiller with screw driven chiller and plate type heat exchanger.

Estimated annual dollar savings:	$ 31,617
Estimated annual energy savings:	2,556 MBTU
ECR	1.3
SIR	0.2
Simple Amortization Period:	63.6
CWE (FY85)	$2,010,729

9.0 RECOMMENDATIONS AND CONCLUSIONS

9.1 Introduction

This chapter summarizes all energy conservation measures developed and recommends projects to be implemented.

9.2 Solar Energy Application

In our investigations at SAEP, consideration has been given to the feasibility of solar energy projects. The Plant has addressed their concern for the ability to add additional loading to the existing roof structures. In addition, the lack of available real estate in the Plant negates the possibility of installing solar panels on ground level.

With the logistical problems encountered as described above and the geographic location of the Plant, it is not anticipated that solar system projects will be viable at SAEP.

9.3 Energy Conservation Measures Developed

Energy conservation measures listed in Table 9.3 summarize all ECAM and Increment G projects examined. Projects listed in ECM number order.

9.4 Recommended Energy Conservation Measures

Table 9.4 summarizes recommended energy conservation measures arranged in priority order according to descending ECR.

9.5 Energy Conservation Measures Not Recommended

Chapter 5, Section 5.5 Energy Conservation Measures Investigated lists all the possible energy conservation Measures considered for this feasibility study. Because certain ECM's did not apply to SAEP, they were disregarded at the outset. Explanations as to why certain ECMs were not recommended are also provided in Section 5.5.

9.6 Energy Conservation Projects Planned, Recently Completed or In Progress

The design of an Energy Monitoring and Control System (EMCS) by EMC Incorporated of Denver, Colorado is the most significant energy saving project in this catergory. The energy savings for the EMCS are estimated to be 53,456 MBTU per year at a total installed cost of $1,834,900 (FY82) as indicated in their Phase 1 Feasibility study prepared in November 1981 under Contract No. DACA 51-81-C-0055.

Estimates of energy savings for projects which were recently completed by the Plant or are in progress were performed to help project energy consumption in FY85. Table 9.6 summarizes energy savings for these projects.

TABLE 3

ENERGY CONSERVATION MEASURES DEVELOPED

ECM	PROJECT TITLE	BUILDINGS SERVED	ANNUAL SAVINGS MBTU	ANNUAL SAVINGS DOLLARS	FY85 CWE ($000)	SIR	ECR	SAP	Increment
4	WALL INSULATION	1,2,3,3A 4,6A,10,16 17,18,35,36 37,38,41,42 43,44,48	11,808	116,481	2,319.0	0.7	5.1	19.9	INC. G
5	STORM WINDOWS	1,2,3	4,500	50,263	303.0	2.2	14.9	6.0	INC. A
19	REPLACE INEFFICIENT DHW HEATER	2,6,17	13	147	17.9	0.1	0.7	121.4	INC. G
29	RELAMPING	10,44	353	4,366	12.0	3.8	29.3	2.8	INC. A
30	DELAMPING	16	223	2,758	1.8	15.8	122.2	0.7	INC. G
40	SCREW CHILLER	1,2	2,556	31,617	2,010.7	0.2	1.3	63.6	INC. G
41	ANTI-STRAT. UNIT HEATERS	2	11,415	108,907	891.0	1.8	12.8	8.2	INC. A
44	INSULATE DHW PIPING	2,16,17	442	4,625	19.3	3.1	22.9	4.2	INC. A
45	OXYGEN TRIM	2	6,157	64,771	198.8	4.8	31.0	3.1	INC. B
46	ECONOMIZER FINTUBE	2	3,590	37,766	149.0	3.7	24.1	3.9	INC. B
TOTALS			41,057	421,701	5,922.5				

TABLE 9.4

RECOMMENDED ENERGY CONSERVATION MEASURES

ECM	PROJECT TITLE	BUILDINGS SERVED	ANNUAL SAVINGS MBTU	ANNUAL SAVINGS DOLLARS	FY85 CWE ($000)	SIR	ECR	SAP	Increment
30	DELAMPING	16	223	2,758	1.8	15.8	122.2	0.7	INC. G
45	OXYGEN TRIM	2	6,157	64,771	198.8	4.8	31.0	3.1	INC. B
29	RELAMPING	10,44	353	4,366	12.0	3.8	29.3	2.8	INC. A
46	ECONOMIZER FINTUBE	2	3,590	37,766	149.0	3.7	24.1	3.9	INC. B
44	INSULATE DHW PIPING	2,16,17	442	4,625	19.3	3.1	22.9	4.2	INC. A
5	STORM WINDOWS	1,2,3	4,500	50,263	303.0	2.2	14.9	6.0	INC. A
41	ANTI-STRAT. UNIT HEATERS	2	11,415	108,907	891.0	1.8	12.8	8.2	INC. A
TOTALS			26,680	273,456	1,574.9				

TABLE

ENERGY CONSERVATION MEASURES NOT RECOMMENDED

ECM	PROJECT TITLE	BUILDINGS SERVED	ANNUAL SAVINGS MBTU	ANNUAL SAVINGS DOLLARS	FY85 CWE ($000)	SIR	ECR	SAP	Increment
4	WALL INSULATION	1,2,3,3A, 4,6A,10,16, 17,18,35,36, 37,38,41,42, 43,44,48	11,808	116,481	2,319.0	0.7	5.1	19.9	INC. G
40	SCREW CHILLER	1,2	2,556	31,617	2,010.7	0.2	1.3	63.6	INC. G
19	REPLACE INEFFICIENT DHW HEATER	2,16,17	13	147	17.9	0.1	0.7	121.4	INC. G
TOTALS			14,377	148,245	4,347.6				

TABLE 9.6

Energy Savings for Projects Planned, Recently Completed, or in Progress

PROJECT	MBTU/YR SAVED
Roof Rehabilitation	29,000
Condensate System Rehabilation	6,300
Installation of High Pressure Lighting	55,000
Rehabilitation of Building 3A	100
Installation of Kalwall	7,500
Total	97,900

9.7 ECM Implementation

As intended by this Energy Study for SAEP, ECM cost estimates have been calculated such that the ECM can be implemented at the start of FY85. Since it may not be possible to start all ECMs at this time, escalation rates for FY86, FY87 and FY88 have been given below. To determine the cost of a project implemented after FY85, multiply the FY85 construction cost by the appropriate escalation rate(s).

FY86	4.53%
FY87	4.44%
FY88	4.44%

CWE 85 x 1.0453 = CWE 86
CWE 85 x 1.0453 x 1.0444 = CWE 85 x 1.0917 = CWE 87
CWE 85 x 1.0453 x 1.0444 = CWE 85 x 1.14 = CWE 88
Construction cost escalation rates are taken from EIRS Bulletin 82-02, dated 12 May 1982.

9.8 Predicted Energy Savings

Figure 9.7, Future Energy Consumptions, shows the DARCOM goal, source energy consumption per unit area from FY75 to FY81, and projected consumption from FY81 to FY85.

Projected energy consumption is based on the following energy conservation projects:

- Increment A, B and G projects developed in this report and summarized in Table 9.4. (26,680 MBTU/YR)
- Energy Monitoring and Control System developed by EMC Inc. (53,456 MBTU/YR)
- Estimate of energy savings from projects planned, recently completed or in progress. (97,900 MBTU/YR)

Total energy savings for the above items is 114 or 178,036 MBTU/YR.

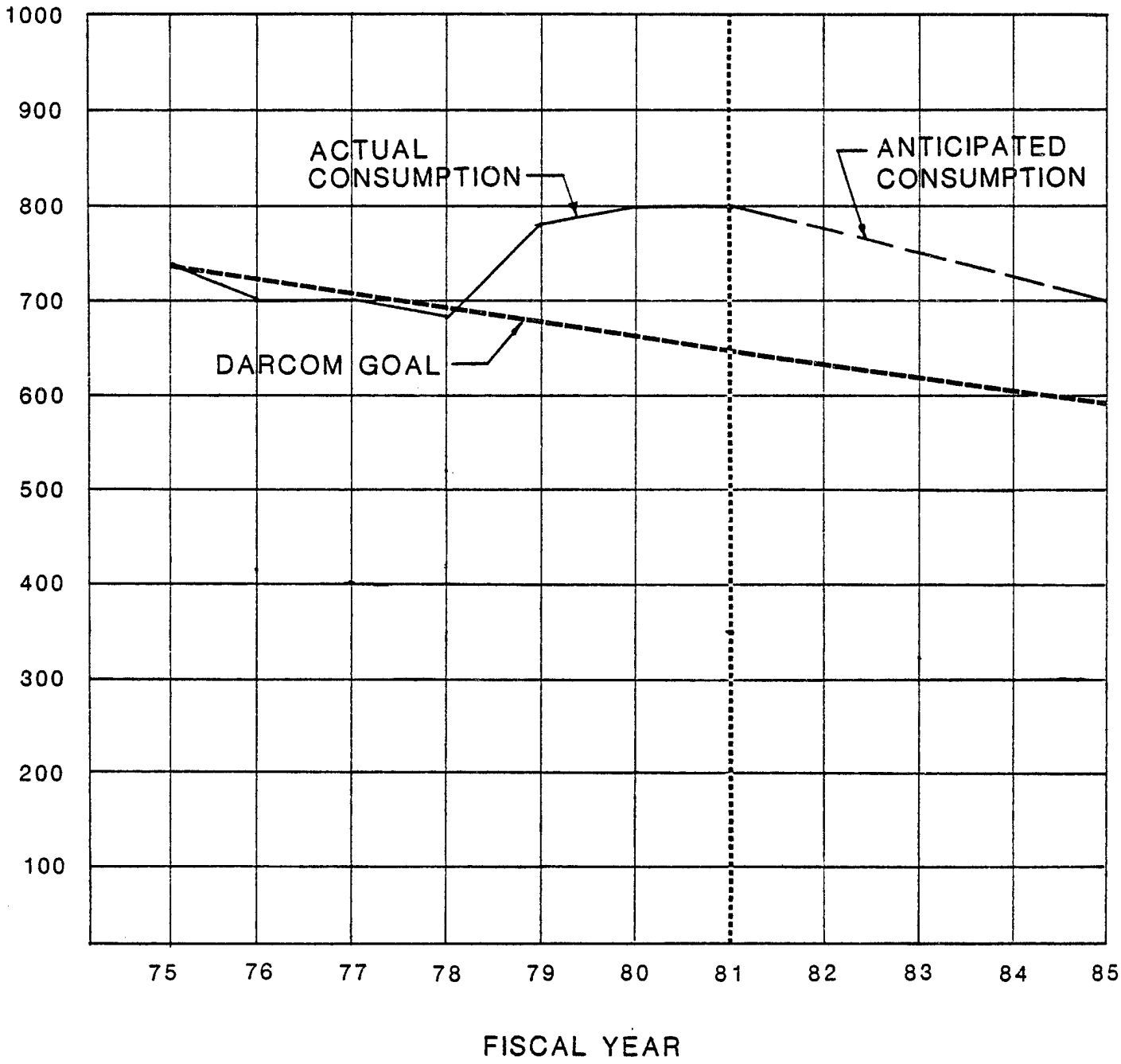
When all the recommended ECMs will be implemented, energy consumption at SAEP will be reduced by 15 percent (114 KBTU/GSF-YR ÷ 739 KBTU/GSF-YR) with reference to FY75 energy consumption. This does

ENERGY CONSUMPTION

Actual and Anticipated
FY75 to FY85

KBTU/GSF-Yr.

FIGURE 9-8



not meet the DARCOM goal (a 20% reduction from FY75 to FY85) of 591.2 KBTU/GSF-YR.

9.8.1 Elimination of Process Fuels from DARCOM Goal

The energy consumed in FY75, as well as subsequent years were primarily untilized for process related functions. In FY 75, for example, jet fuel, diesel fuel, No. 2 fuel oil, No. 4 fuel oil and firm natural gas which were used solely for process related functions comprise 42 percent of the total source energy (489,591 MBTU + 1,154,036 MBTU). The remaining 58% of the total source energy is used for both process and non-process related functions.

This Energy Engineering Analysis deals with recommending energy conservation measures for non-process related functions. Therefore, in order to get a clearer picture of the anticipated energy savings in relation to the DARCOM goal, process related energy consumption should be disregarded and only non-process related functions should be considered.

By removing the process related fuels from the FY75 energy consumption, the energy savings for non-process fuels can be estimated. Taking FY75 energy consumption multiplied by the percentage of non-process related fuel consumption the following results:

739 KBTU/GSF-YR x 0.58 = 429 KBTU/GSF-YR

Using 429 KBTU/GSF-YR as the energy consumed in FY75, a 27% reduction (114÷429) in source energy consumption per unit area is realized.

A 27% reduction in source energy consumption per unit area can be achieved if fuels used only for process related functions are discounted from the energy consumption profile.