FINAL SUBMISSION

INCREMENTS D,E,F

# STRATFORD ARMY ENGINE PLANT

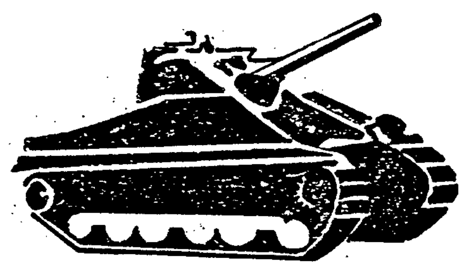
## STRATFORD, CONNECTICUT

EXECUTIVE SUMMARY



# ENERGY ENGINEERING ANALYSIS







prepared for:
DEPARTMENT OF THE ARMY
NORFOLK DISTRICT
CORPS OF ENGINEERS
Project Management Branch (NAOEN-MA)

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CONTRACT NO. : DACA65-81-C-0024

in association with:
MDM Mariano D. Molina, P.C.

DECEMBER 1983

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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# ENERGY ENGINEERING ANALYSIS PROGRAM
# STRATFORD ARMY ENGINE PLANT
# STRATFORD, CONNECTICUT

FINAL SUBMISSION INCREMENTS D, E, F

EXECUTIVE SUMMARY

PREPARED FOR

U. S. ARMY CORPS OF ENGINEERS
NORFOLK DISTRICT

UNDER
CONTRACT NO. DACA65-81-C-0024

PREPARED BY

SEELYE STEVENSON VALUE & KNECHT
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DECEMBER 1983

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December 22, 1983

Department of the Army
Norfolk District - Corps of Engineers
803 Front Street
Norfolk, Virginia 23510

Attention: NAOEN-MA/Gerald Barnes

Reference: Energy Engineering Analysis Program (EEAP)
Stratford Army Engine Plant (SAEP)
Stratford, Connecticut

Subject: Final Submission
Increments D, E, F

Contract No.: DACA65-81-C-0024

SSV&K Project No.: 24-4184-02

Dear Mr. Barnes:

Enclosed please find one (1) set of the Final Submission of Increments D, E, F for the Stratford Army Engine Plant at Stratford, Connecticut. This submission consists of the following components:

- o Executive Summary
- o Main Report
- o Increment F
- o Appendix
- o Project Programming Documents

In addition to being separately bound, the Executive Summary and Increment F are included within the Main Report.

All comments from the Prefinal Submission have been reviewed and incorporated as appropriate. The Prefinal Submission review comments are in the Appendix-Section G. Selected correspondence, including Minutes of Meetings, are in the Appendix Section A.

The assistance that was provided by AVCO-LYCOMING Division and Corps of Engineers personnel proved invaluable in completing this assignment. Their cooperation is greatly appreciated.

Thank you for this opportunity to be of service.

Very truly yours,

STV/SEELYE STEVENSON VALUE & KNECHT

Alfred Klein, P.E.
Vice President

**STV/SEELYE STEVENSON VALUE & KNECHT.**

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FINAL SUBMISSION - INCREMENTS D, E, F

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ENERGY ENGINEERING ANALYSIS PROGRAM
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

FINAL SUBMISSION - INCREMENTS D, E, F

EXECUTIVE SUMMARY

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| acfm | Actual Cubic Feet Per Minute |
| AECP | Annual Energy Consumption Program |
| AFEP | Army Facilities Energy Plan |
| APEC | Automated Procedures for Engineering Consultants |
| ASHRAE | American Society of Heating, Refrigerating, and Air Conditioning Engineers |
| Ave | Avenue |
| BECP | Building Energy Consumption Program |
| Bldg | Building |
| BOD | Beneficial Occupancy Date |
| BSC | Building Selection Code |
| BTU | British Thermal Unit |
| BTUH | British Thermal Unit Per Hour |
| °C | Degree Centrigrade |
| CCC | Current Construction Cost |
| CCF | One Hundred Cubic Feet |
| Cp | Specific Heat |
| CCU | Central Control Unit |
| CF | Cubic Foot |
| CFM | Cubic Foot Per Minute |
| CLT | Communications Link Termination |
| CMU | Concrete Masonry Unit |
| COE | Corps of Engineers |
| CW | Cold Water |
| DARCOM | Department of the Army Readiness Command |
| DD | Degree Days |
| DOD | Department of Defense |
| DTM | Data Transmission Medium |
| ECAM | Energy Conservation and Management Program |
| ECM | Energy Conservation Measure |
| ECR | Energy-to-Cost Ratio |
| EMCS | Energy Monitoring and Control System |
| EPA | Environmental Protection Agency |
| °F | Degree Fahrenheit |
| FID | Field Interface Device |
| Fluor. | Fluorescent |
| Ft | Foot |
| FY | Fiscal Year |

## LIST OF ABBREVIATIONS (Cont'd)

| | |
|---|---|
| Gal | Gallon |
| Goco | Government Owned-Contractor Operated |
| GPM | Gallons Per Minute |
| GBTU | Giga BTU - $10^9$ BTU = 1 Billion BTU |
| GSF | Gross Square Feet |
| HE | Heat Exhcnager |
| Horiz | Horizontal |
| HP | Horsepower |
| HPS | High Pressure Sodium |
| Hr | Hour |
| HTW | High Temperature Hot Water |
| HVAC | Heating, Ventilating, and Air Conditioning |
| HW | Hot Water |
| In | Inch |
| INCAND | Incandescent |
| I/O | Input/Output |
| KBH | Kilo BTU Per Hour |
| KBTU | Kilo British Thermal Unit (KBTU = $10^3$ BTU) |
| KGSF | Kilo Gross Square Feet (KGSF - $10^3$ GSF) |
| KV | KiloVolt |
| KVA | KiloVolt Amp |
| Kw | Kilowatt |
| Kwh | Kilowatt Hour |
| L | Lumen |
| lbs | Pounds |
| MBTU | Mega British Thermal Unit (MBTU = $10^6$ BTU) |
| MCR | Main Control Room |
| Min | Minute |
| Mon | Months |
| MTW | Medium Temperature Hot Water |
| MUX | Multiplexer |
| MV | Mercury Vapor |
| NAC | Nitric Acid Concentractor |
| NC | Normally Closed |
| NO | Normally Open |
| P | Permanent Building |
| PDB | Project Development Brochure |
| ppm | Parts Per Million |
| psi | Pounds Per Square Inch (Absolute) |
| psig | Pounds Per Square Inch (Gate) |

## LIST OF ABBREVIATIONS (Cont'd)

| | |
|---|---|
| Q | Heat Per Unit of Time (BTUH's) |
| Qty | Quantity |
| RDF | Refuse Derived Fuels |
| SAP | Simple Amortization Period |
| SC | Series Connected |
| SCFM | Standard Cubic Feet Per Minute |
| SIOH | Supervision, Inspection, and Overhead |
| SIR | Savings to Investment Ratio |
| SF | Square Foot |
| Sq | Square |
| $T_1$ | Final Temperature |
| $T_2$ | Initial Temperature |
| T | Temperature |
| TIC | Total Installed Cost |
| TPD | Tons Per Day |
| TW | Tempered Water |
| W | Watts |
| WC | Water Column |
| WDW | Window |
| Wk | Week |
| WSF | Window Square Foot Area |
| Yr | Year |

## DEFINITION OF TERMS

### BENEFICIAL OCCUPANCY DATE (BOD)

The date a facility begins to operate.

### COST INDEX

Comparison of Energy cost Indices for various years giving a chosen base year a value of 100.

### CURRENT CONSTRUCTION COST (CCC)

The project installation cost in the year the project was analyzed. Installation costs are non-recurring and include all labor and material. Also taken into account are location, taxes, contractor costs, bond, and SIOH. Design costs are not included and must be added to the CCC to develop the total installed cost (TIC).

### 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 a long term goal for a 50 percent reduction in facility energy usage by the year 2000.

### ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

Military funded program for retrofiting existing DOD facilities to make them more energy efficient.

### ENERGY CONSERVATION MEASURES (ECM)

Programs to conserve energy and/or costs through energy/manpower reductions.

### ENERGY COST

Cost of Source Energy Consumed (obtained from utility bills).

### ENERGY COST INDEX

Energy cost per square foot of building.

## DEFINITION OF TERMS (Cont'd)

### ENERGY MONITORING AND CONTROL SYSTEM (EMCS)

This is a computer-based control system used to achieve energy dollar savings through automatic control of building heating, ventilating and air conditioning (HVAC) systems. This includes implementation of various energy conservation measures, such as programmed equipment shutoff, programmed outside air shutoff, and equipment optimization, to reduce the total energy consumption of individual buildings, reduce energy distribution system losses and improve HVAC system capability.

### ENERGY-TO-COST RATIO (ECR)

Annual energy savings (MBTU/YR) divided by the construction cost ($1,000).

### ELECTRICAL COST INDEX

Electricity cost comparison for various years using a base year with an assigned value of 100.

### ELECTRICITY INDEX

Comparison of Electrical Energy Indices for various years to a chosen base year.

### FUELS ENERGY INDEX

Ratio of BTU's of fuel consumed to the square footage of the base.

### HEATING DEGREE DAYS

Total number of degree days based on 65°F.

### HIGH TEMPERATURE HOT WATER (HTW)

A hot water heat transfer system generally using water above 350°F.

### MEDIUM TEMPERATURE HOT WATER (MTW)

A hot water heat transfer system generally using water between 230°F and 350°F.

## DEFINITIONS OF TERMS (Cont'd)

### SAVINGS TO INVESTMENT RATIO (SIR)

Energy Conservation Investment Program (ECIP) Life Cycle Cost Economic Analysis Criterion. The Savings to Investment Ratio is the lifetime dollar savings of a project divided by the total investment (including construction cost, design supervision, inspection and overhead). For a project to qualify for ECIP funding, the SIR must be at least 1.0.

### SIMPLE AMORTIZATION PERIOD (SAP)

The project capital investment divided by the yearly savings. This yields the period of time required to recover the initial capital investment.

### SOURCE ELECTRICITY ENERGY

Total amount of electricity purchased or total amount produced before line and efficiency losses.

### SOURCE ENERGY CONSUMED

Sum of fuels consumed and electricity used (includes all fuels such as heating oil, diesel fuel, natural gas, propane, coal, etc.).

### SOURCE ENERGY INDEX

Ratio of BTU's source energy consumed to square footage of the base.

### SOURCE INDEX

Comparison of the Source Energy Indices for various years giving a chosen base year a value of 100.

### STANDBY STATUS

Active of laid-away buildings or equipment used to maintain the plant at a areduced production level in readiness for mobilization.

### TOTAL INSTALLED COST (TIC)

The sum of the CCC and the design costs.

## 1.0 Introduction

This Energy Engineering Analysis; covering Increments D, E and F; contains technical and economic analyses for cogeneration, central boiler plant coal conversion, engine test cell heat recovery, waste oil recovery, package boiler for summer use and Facilities Engineer conservation measures. This report is a supplement to previous work by SSV&K involving buildings, utilities and energy distribution systems which was accomplished under Increments A, B and G.

## 1.1 Purpose of Study

The purpose of this analysis is 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.

A. Reduce Army installation and active energy consumption by 25% of that consumed in FY75 as the base year.

B. Reduce average annual energy consumption per gross square foot of floor area by 20% in existing facilities compared to FY75 as the base year. At least 12% of the energy consumption reduced in existing buildings shall be accomplished through energy conservation projects under the Energy Conservation Investment Program (ECIP).

C. Reduce average annual energy consumption per gross square foot of floor area by 45% in new buildings compared to FY75 as the base year.

D. Reduce dependence on critical fuels. The DOD goals to reduce dependence on critical fuels are:

(1) To obtain at least 10% of total Army installation energy from coal, coal gasification, solid waste, refuse derived fuel and biomass.

(2) To equip all natural gas only heating units and plants over 5 MEGA BTU per hour output with the capability to use oil or other alternate fuels (1982 goal).

(3) To have on hand at the beginning of each heating season a 30-day fuel supply for all oil only, oil - natural gas, and coal heating units over 5 mega BTU per hour output based upon the coldest month recorded and in a mobilization condition.

In order to achieve these goals, the following will be incorporated:

- applicable data and results of related past and current studies

- a coordinated Energy Engineering Analysis of the base

- Project Development Brochures (PDB's), Military Construction Project Data (DD Forms 1391), and supporting documentation for feasible Energy Conservation Investment Program (ECIP) projects

- practical and economically feasible energy conservation methods

- a listing of recommended ECIP projects in SIR order

## 1.2 Authority for Study

This Energy Engineering Analysis was undertaken and this Report was prepared under Contract No. DACA65-81-C-0024 issued by the Department of the Army, Norfolk Disrict, Corps of Engineers, to Seelye Stevenson Value & Knecht.

## 1.3 Scope of Work

The scope of work for this Energy Engineering Analysis is defined in "DAEN-MPE-E SCOPE OF WORK FOR ENERGY ENGINEERING ANALYSIS PROGRAM" dated January 22, 1982. This document has been reproduced and is in the Appendix Section B.

Economic analyses are performed in accordance with "DAEN-MPO-U ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) GUIDANCE" dated August 10, 1982.

## 1.4 Increments of Work

### 1.4.1 Increment D

Increment D projects involve determining the feasibility of new co generation and solid waste plants utilizing solid fuels supplemented, if feasible, with refuse derived fuels (RDF) and waste oil fuels. The primary objective is to reduce energy consumption through the capture and reuse of energy presently being wasted.

Solid waste and RDF plants are not part of this contract. Refer to Detailed Scope of Work and DACA65-81-C-0024 supplementary contract of July 1982 for futher details. The Scope of Work is in the Appendix- Section B.

### 1.4.2 Increment E

Increment E projects involve determining the feasibility of constructing central boiler plants to supply steam or high temperature hot water, as applicable, to all or discrete parts of the base.

1.4.3 Increment F

Increment F projects involve recommending modifications and changes in system operation which are within the Facilities Engineer funding authority and management control. Other areas under Increment F include determining any energy-related areas of operation requiring additional training of Facilities Engineering personnel and describing expendable equipment which should be changed to a higher efficiency type at its next replacement.

## 2.0 SITE DESCRIPTION, HISTORY AND ENERGY DISTRIBUTION SYSTEMS

### 2.1 Site 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 Lane to the southeast (See Figure 2.1.1-3). The facility consists of 48 individual buildings with a total area of 1,577,639 square feet. (See Table 2.1.1.)

### 2.2. Plant History

The history of the Stratford Army Engine Plant is closely tied to the history of aviation. The site was developed in 1929 by Igor Sikorsky for the production of flying boats. During the initial development of the site, Buildings 1, 2, 3, 3A and 10 were constructed.

In 1939, the Chance Voight Company merged with Sikorsky to manufacture the 'King Fisher' observation plane. In 1942, the United States War Department contracted with the Chance Voight Company for the production of the Corsair aircraft. This program required the construction of additional buildings and extensions to existing buildings.

With the end of the war, the Change Voight Company had a reduction in Government contracts which led to the de-activation of the Stratford Plant between the years 1948 and 1951.

In 1951, the Chance Voight Company was acquired by AVCO LYCOMING. At this time the U.S. Air Force contracted Avco Lycoming to manufacture the R-1820 radial engine and major components of the J-47 jet aircraft engine under a license agreement. This agreement also transferred control of the Stratford Plant to the Air Force and allowed Avco Lycoming to operate the site. Major renovations and additions occurred during this reactivation of the Plant.

Over the years, Avco Lycoming increased its contractural work with the government and expanded to serve the private sector. In 1954, the government contracted Avco Lycoming to develop and manufacture the T-53 and T-55 engines whose chief application would be in helicopters and aircraft. In the late 1960's, Avco Lycoming upgraded their T-53 and T-55 engines to suit commercial and international markets. In 1976, they manufactured the 'Super TF'

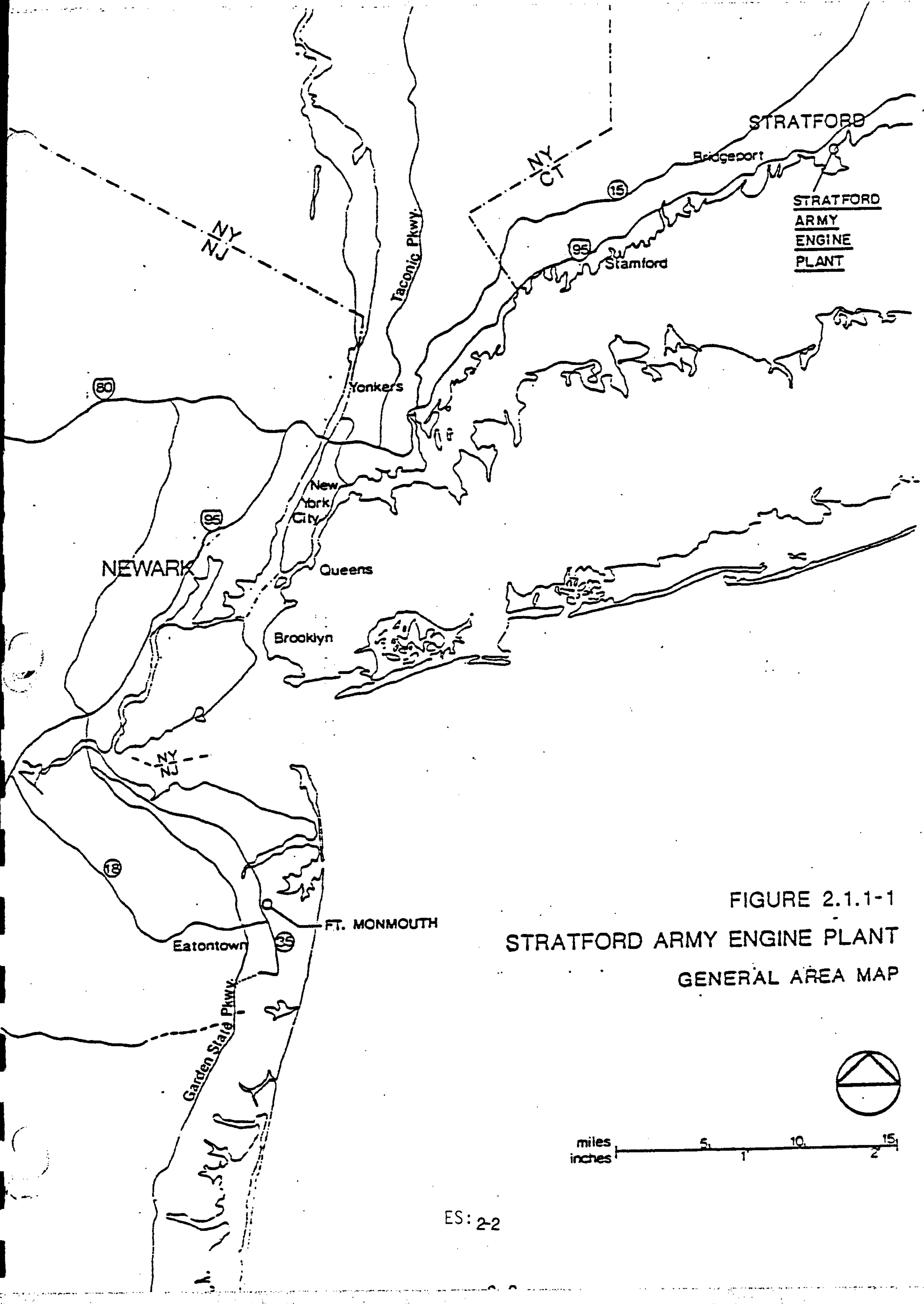



FIGURE 2.1.1-1
STRATFORD ARMY ENGINE PLANT
GENERAL AREA MAP

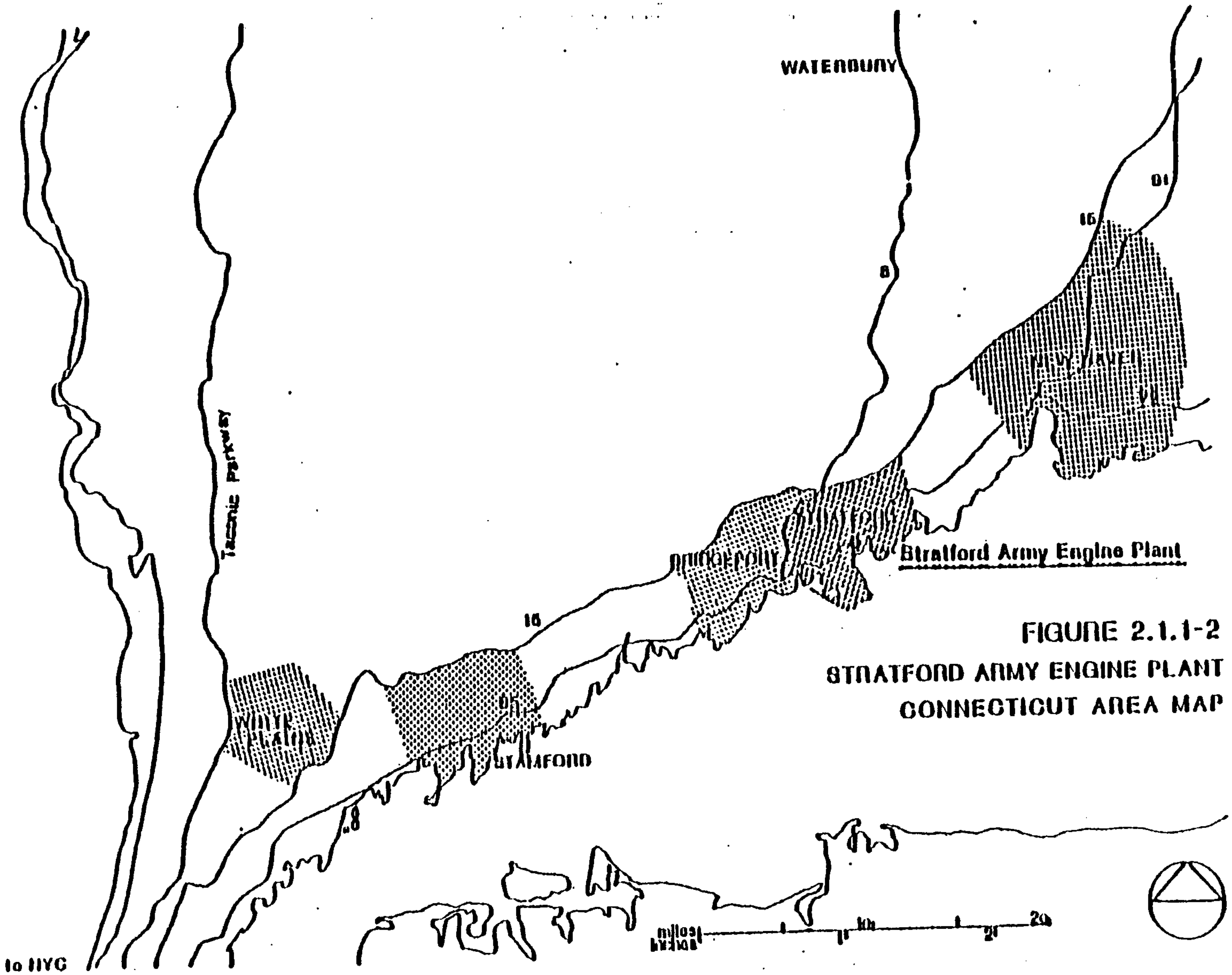



FIGURE 2.1.1-2
STRATFORD ARMY ENGINE PLANT
CONNECTICUT AREA MAP

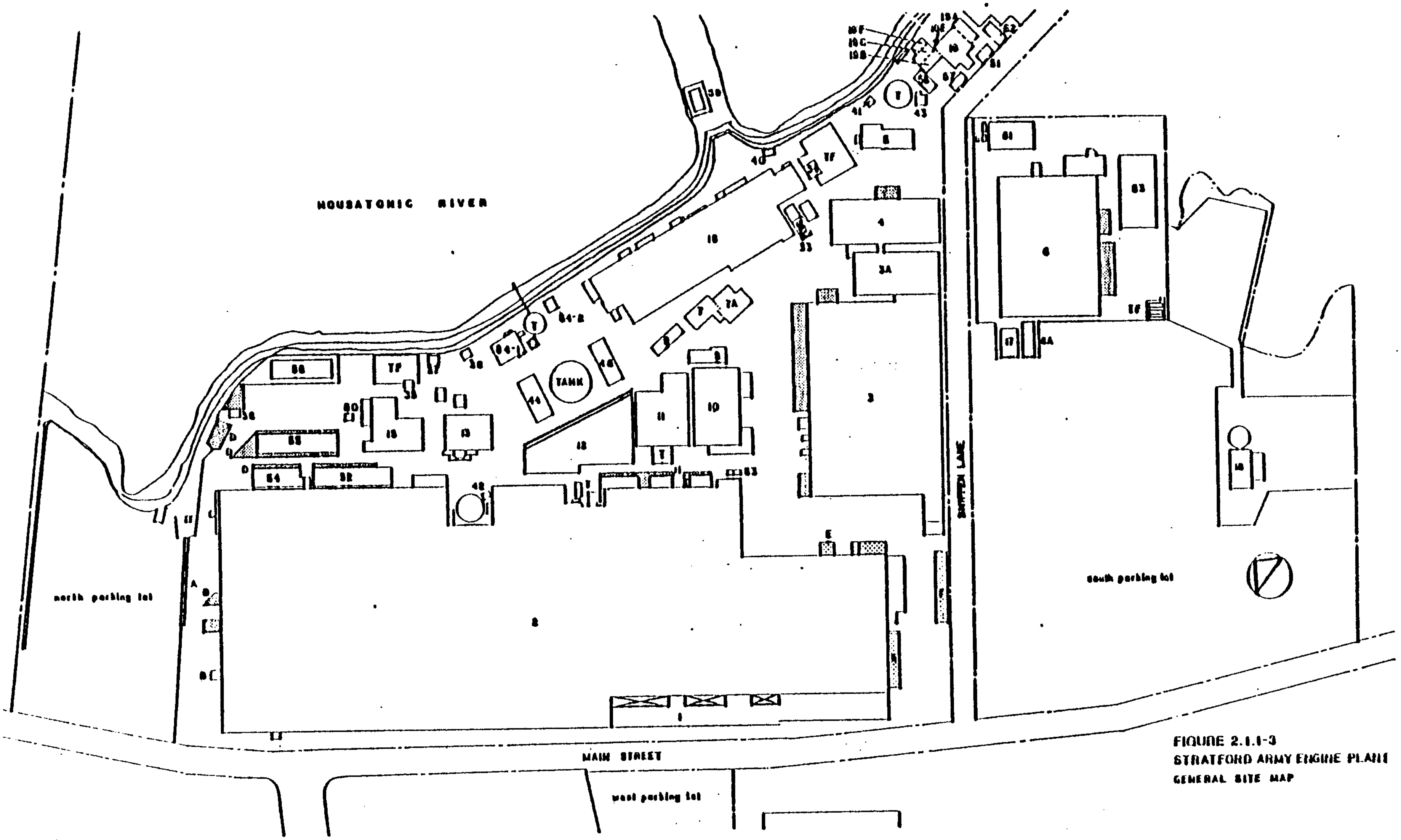



FIGURE 2.1.1-3
STRATFORD ARMY ENGINE PLANT
GENERAL SITE MAP

## 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 | | 42 |
| 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 | 63 |
| 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 | 68 |
| 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. & ST. WATER TREAT. PLANT (CONTROL RM.) | 616 | 75 |
| 64-2 | IND. & ST. WATER TREAT. PLANT (PUMP RM.) | 200 | 75 |

series of marine and industrial engines that are included in compressor sets, pump sets, generator sets, off-road vehicles and railroad engines. Avco Lycoming's recent projects include the development and manufacture of a new 1500 shaft horsepower gas turbine engineer for battle tanks.

In 1976, the U.S. Army Corps of Engineers acquired the Stratford Army Engine Plant from the U.S. Air Force. At this point the plant became a Government Owned Contractor Operated (GOCO) facility with Avco Lycoming as tenant.

## 2.3 Description of Energy Distribution Systems

### 2.3.1 Steam

Steam for heating is produced in the central boiler plant in Building No. 2. The system heats the entire plant except for several small buildings with self-contained heating systems. The steam and condensate return systems run partly above and partly below ground.

The steam distribution system has an operating pressure of 100 psig, is insulated, and is well maintained.

The present condensate return system is in poor condition resulting in a loss of condensate return. This reflects in a loss of energy, waste of water, and a more than normal requirement of water treatment. The following conditions exist:

o Missing motors and pumps that have been removed over the years and not replaced.

o Direct dumping of the condensate into sewer lines.

o Improper pitch and changes in elevation of condensate lines which may possibly result in sediment accumulation, rusting of pipes and sticking check valves.

o Most of the underground lines are in an unsatisfactory condition, with clogged lines and a backing up of condensate to the point where check valves stay closed and receivers overflow.

o Many of the condensate return lines are uninsulated resulting in a loss of energy.

The condensate return system is scheduled for replacement. The new system, when installed, will efficiently conserve energy.

### 2.3.2 Natural Gas

Natural gas which is used for Boiler fuel in Building No. 2 is supplied on an interruptible basis by the Southern Connecticut Gas

Company. Gas which is used for process heating is supplied and separately metered on a firm contract basis by the same utility company. All piping and equipment is in satisfactory condition.

### 2.3.3 Central Boiler Plant

#### 2.3.3.1 General

The central boiler plant, fired by both No. 6 Fuel Oil and Interruptible Natural Gas, operates 24 hours per day, 365 days per year. It supplies energy in the form of steam for heating and processes. There are three package boilers which have a total capacity of 180,000 pounds of steam per hour with a minimum output capacity of 8,000 pounds of steam per hour.

#### 2.3.3.2 Description of Existing Central Heating Plant

The central boiler plant is located on the east side of Building No. 2. The boiler plant consists of three water tube "D" type steam boilers built by the Bigelow Boiler Co. in 1970 and put on line in 1972. Each boiler package is equipped with stub stacks and a pressurized furnace that delivers 60,000 pounds of steam per hour at an operating pressure of 100 psi and a maximum working pressure rating of 225 psi.

The dual burners are of the steam atomizing type burning both No. 6 oil and natural gas. Also included is a windbox, register, gas pilot and electric ignition.

The forced draft is accomplished by dual drive fans mounted on the wind box. Air flow is controlled by an inlet damper that is actuated by a signal from the air/fuel ratio controller.

The boiler plant has two duplex type, No. 6 oil pump and heater sets. The duplex oil pumps on each set are of the rotary type and the two heaters are of the tubular heat exchanger type that utilizes steam from the boilers as the heating medium. The steam condensate from the heat exchanger is wasted by going into the sewer at 110°F, in order to prevent contamination from possible oil leaks.

Present heat recovery equipment consists of an economizer on boiler No. 1. The two remaining boilers, Nos. 2 and 3, are not equipped with any heat recovery devices.

The economizer installed on boiler No. 1 is not being used due to malfunction.

The feed water system has three pumps. One is a dual drive type (electric & steam turbine) 40 HP pump and two are electrical drive pumps 20 HP and 40 HP each.

There is a recently installed deaerator capable of maintaining 0.005 C.C. of oxygen per liter in effluent that heats the feed water to 220°F.

The surge tank consists of a receiver that handles the condensate return from the entire facility. It is equipped with pumps to transfer the condensate return and make-up water to the deaerator.

Zeolite water softeners are used for the pretreatment of make-up water. In addition, each boiler has a chemical feed system that injects chemicals directly into the steam drum.

2.3.3.3 Instrumentation

Instrumentation and controls are as follows:

Hagan (Westinghouse) pneumatic semi-automatic non-recycling metering type control, consisting of a master pressure controller for gas/air and oil/air ratio control. Indicators consist of gas, oil and atomizer steam pressure gages. There is also a three point draft gage used to monitor the windbox, the furnace and the stack pressure. For permanent records they utilize a steam flow and stack temperature recorder.

The feed water has a two element control. Both steam flow and drum level are utilized to position the control valve. This control valve is a Fisher air operated model.

2.3.3.4 Condition of Existing System

The major pieces of equipment such as boilers, boiler feed system, deaerator, surge tank, transfer pumps, oil heating and pump sets, water softeners and chemical feed units, are in good condition.

Boiler feed pumps are presently being replace by new higher efficiency types. The original installation consisted of one 40 HP dual driven pump (steam turbine and electric motor) and one 40 HP electric motor pump. To date a new 20 HP electrically driven low net positive suction head (NPSH) pump has been installed. In the near future two more 20 HP electrically driven pumps and one 20 HP steam driven pump will be installed to replace the existing 40 HP electrically driven and the dual drive motors.

Tests were performed by Associated Control Equipment Service, Inc., of Stamford, Connecticut on February 21, 1983 on Boilers 2 and 3. Boiler 1 was on standby at the time. The boiler plant description and findings can be found in Appendix Section C. The test results indicate, even with Boilers running on low loads, a Boiler efficiency of 79.2 percent for Boiler 2 and 80.1 percent for Boiler 3.

The economizer on Boiler 1 is malfunctioning and therefore not in use. The installation of economizers in Boilers 2 and 3 and the upgrading of the economizer on Boiler 1 would increase boiler efficiency and is a recommended project.

The addition of $O_2$ trim on all boilers will also increase boiler efficiency. A savings of 3 percent of No. 6 fuel oil can be realized. This project is recommended.

See Appendix - Section C for back-up calculations.

2.3.4 Cooling Systems

There is no central chilled water plant for the facility. Office areas are cooled by window and roof-top direct expansion units.

## 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 following is a breakdown of base personnel. The figures were supplied by Ayco-Lycoming, Division of Timekeeping and Labor Distribution in August 1982.

| Direct (Production) | Total |
|---|---|
| Engineering | 936 |
| Manufacturing | 1,374 |
| Quality Assurance | 456 |
| Information and System Service | 145 |
| TOTAL............... | ~~2,932~~ 2,911 |

| Indirect (Support) | Total |
|---|---|
| General Manager | 5 |
| Business Strategies | 17 |
| Commercial Engine Program | 10 |
| Engineering | 233 |
| Manufacturing | 1,291 |
| Quality Assurance | 191 |
| Finance | 186 |
| Marketing and Production Support | 66 |
| Personnel | 98 |
| Information Systems and Service | 148 |
| Military Engine Programs | 30 |
| TOTAL................ | 2,275 |
| Total Personnel | 5,207 |

The plant is at present in full operation with a full complement of personnel. See Figure 3-5 for historical trend at the SAEP.

## 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. Fuel records obtained from SAEP are in Appendix, Section D.

### 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. For compilation of fuel consumption data, see Appendix, Section D.

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.

## 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 CONSUMPTION / 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 | 63.6 | 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 | 27,083 | 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

- 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.

### 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.

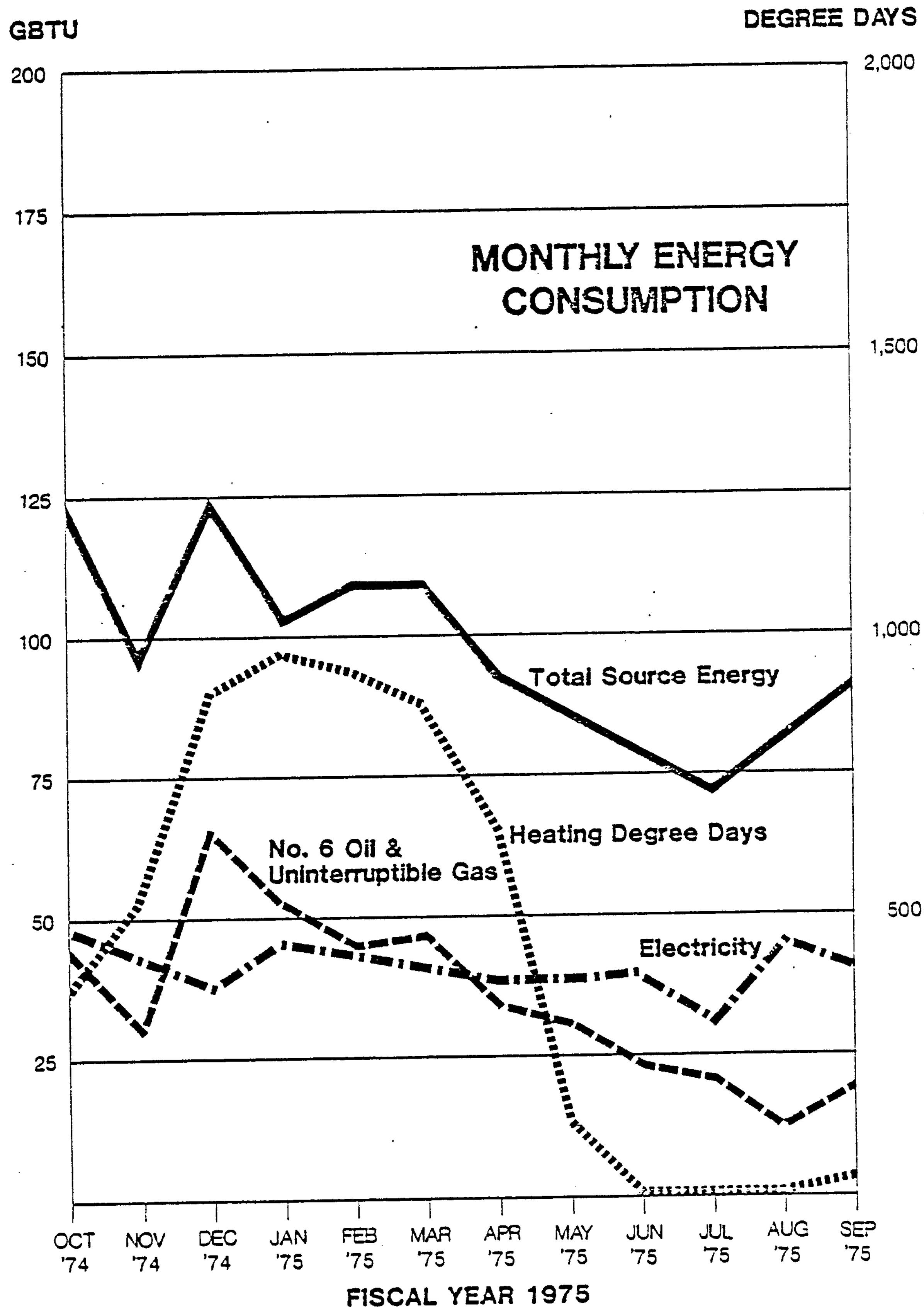
Figures 3-1, 3-2, 3-3 and 3-4 show the expected degree of correlation between heating degree days and fuel input (electricity, No. 6 fuel oil and interruptible natural gas) to the central boiler plant.

Figure 3-5 indicates electricity, firm contract gas, and personnel employed from FY75 through FY81. Employment increases from FY76 as does electricity. Firm gas consumption also rises with the exception of a slight decline in the last two years.

Figure 3-6 shows the No. 6 fuel oil/interruptible natural gas combination against heating degree days and the DARCOM goal. The boiler fuel line follows a downward slope paralleling the DARCOM goal.

Figure 3-7 indicates the two process fuels (jet fuel and diesel fuel) consumed at the Plant from FY75 to FY81.

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

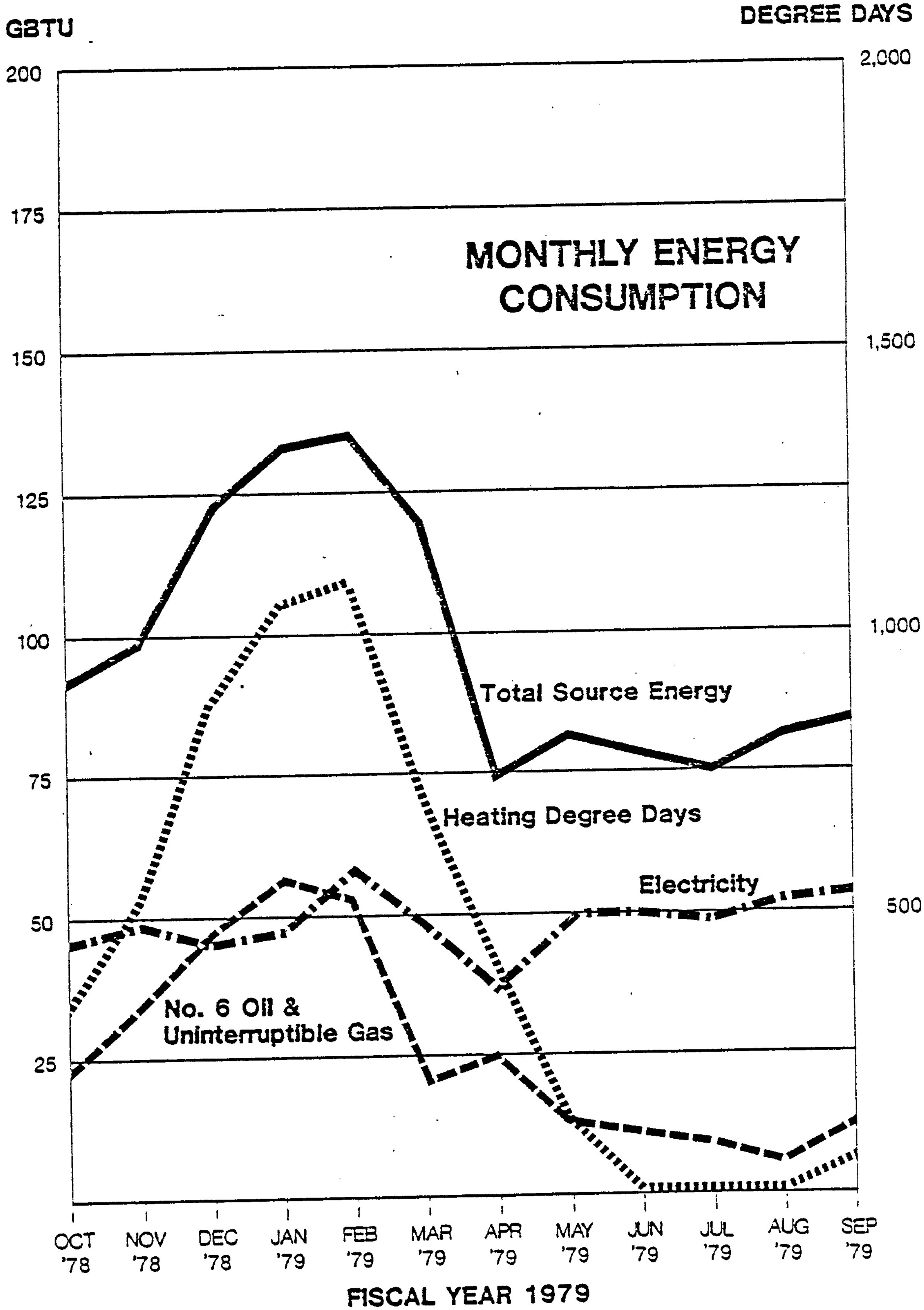

GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY
CONSUMPTION
Total Source Energy
Heating Degree Days
Electricity
No. 6 Oil &
Uninterruptible Gas
OCT '78
NOV '78
DEC '78
JAN '79
FEB '79
MAR '79
APR '79
MAY '79
JUN '79
JUL '79
AUG '79
SEP '79
FISCAL YEAR 1979

FIGURE 3-3

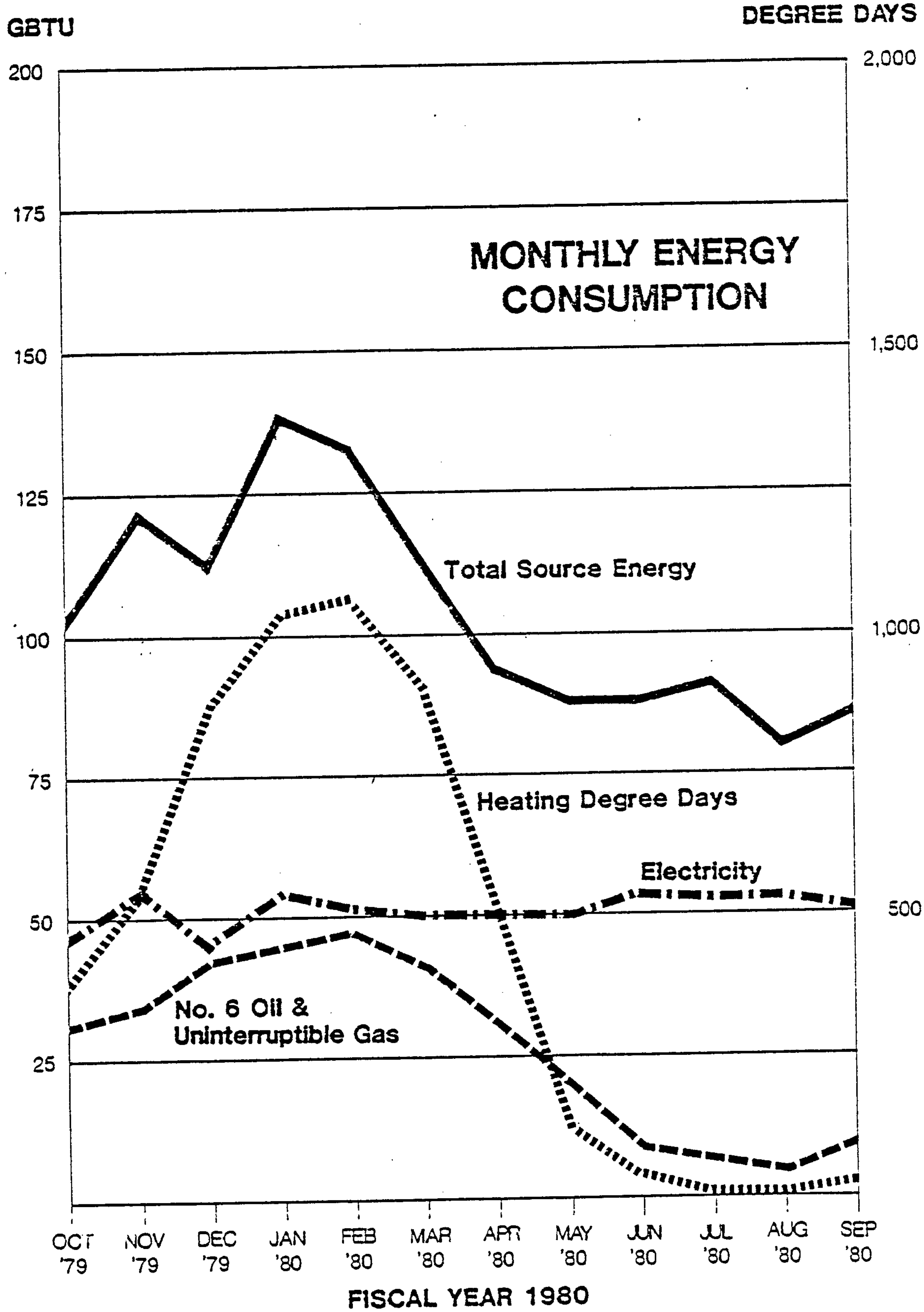
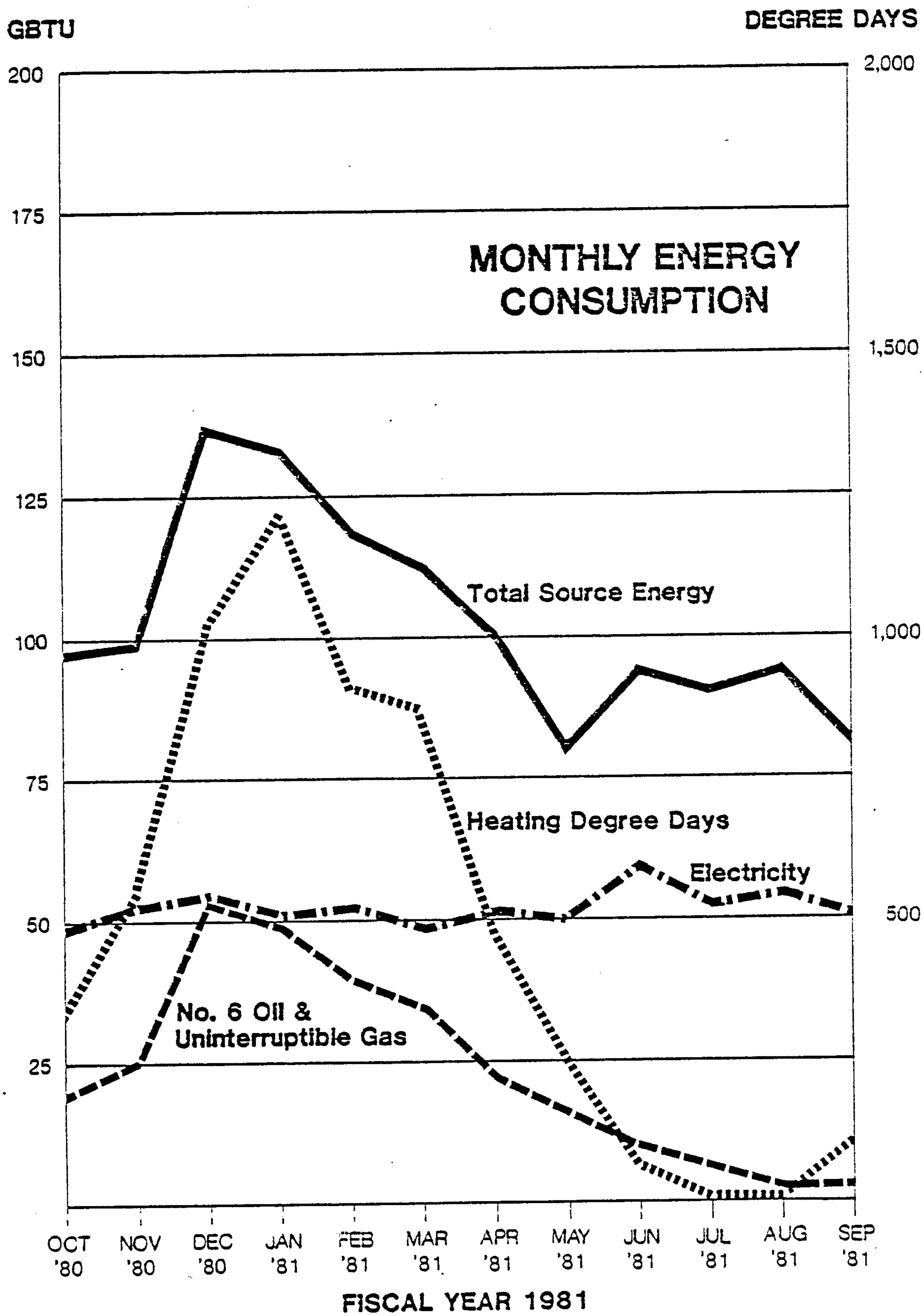
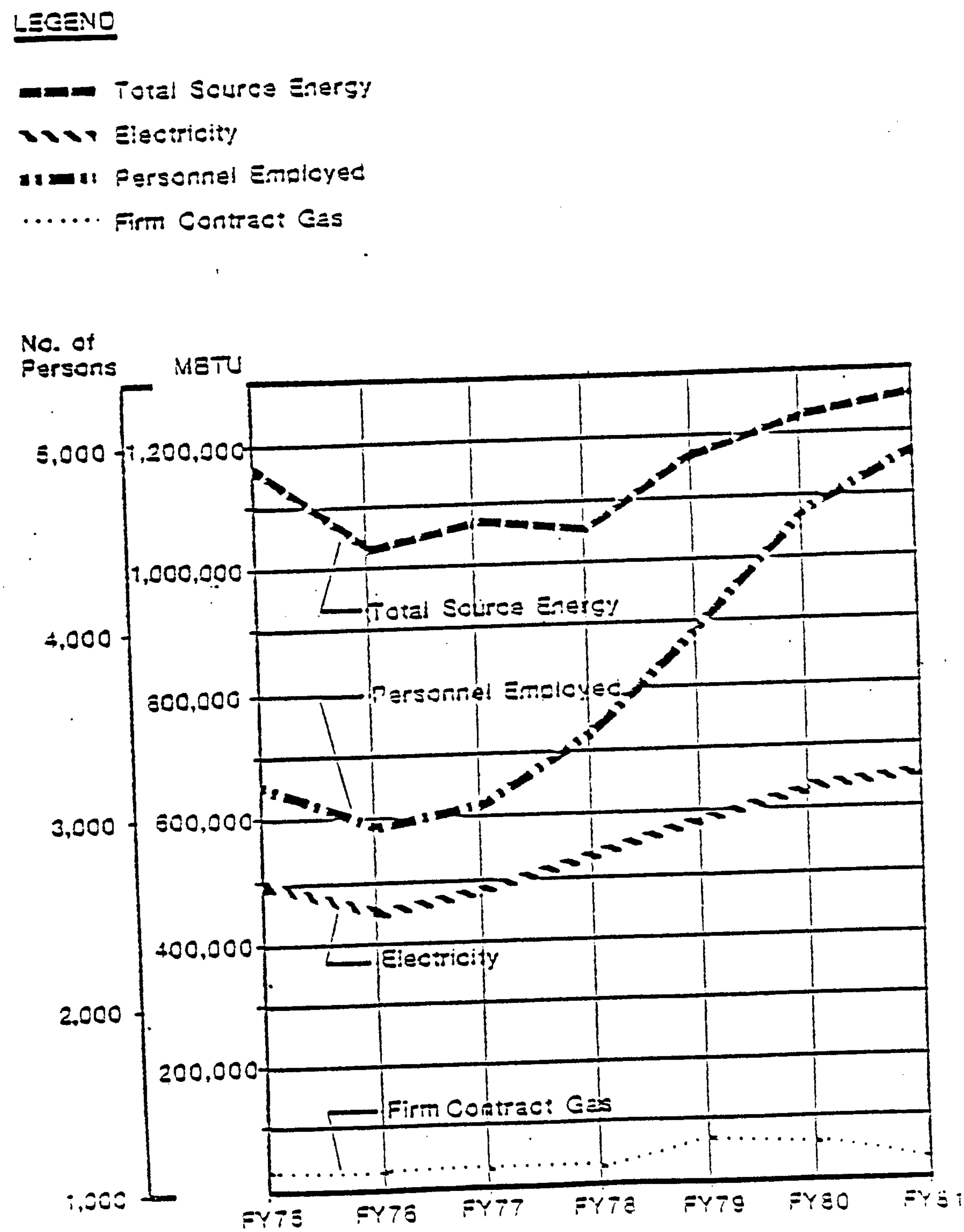

GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY CONSUMPTION
Total Source Energy
Heating Degree Days
Electricity
No. 6 Oil & Uninterruptible Gas
OCT '79
NOV '79
DEC '79
JAN '80
FEB '80
MAR '80
APR '80
MAY '80
JUN '80
JUL '80
AUG '80
SEP '80
FISCAL YEAR 1980

FIGURE 3 - 4



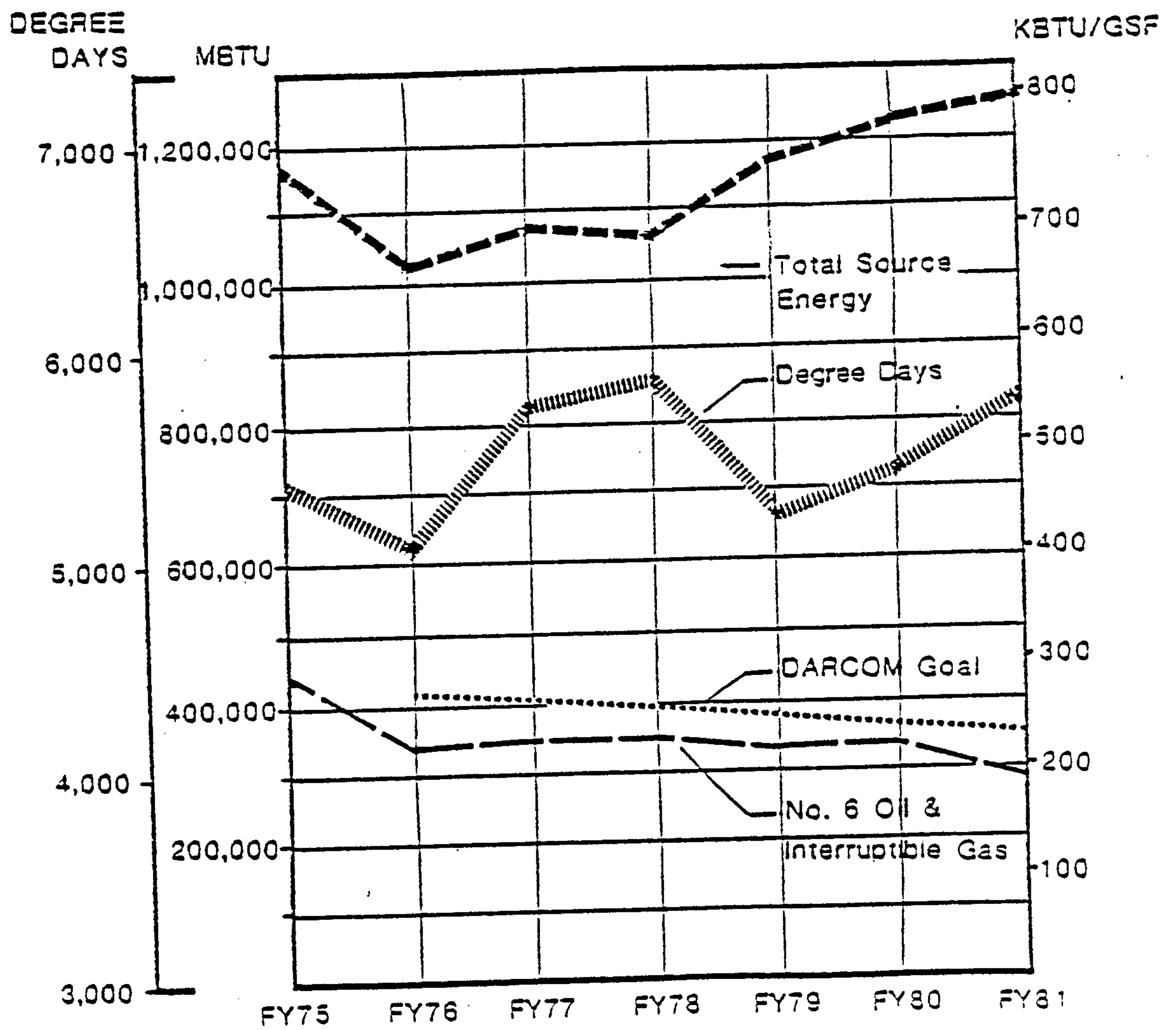
GBTU
DEGREE DAYS
200
175
150
125
100
75
50
25
2,000
1,500
1,000
500
MONTHLY ENERGY
CONSUMPTION
Total Source Energy
Heating Degree Days
Electricity
No. 6 Oil &
Uninterruptible Gas
OCT '80
NOV '80
DEC '80
JAN '81
FEB '81
MAR '81
APR '81
MAY '81
JUN '81
JUL '81
AUG '81
SEP '81
FISCAL YEAR 1981




## ANNUAL ENERGY CONSUMPTION
## PLATE 1

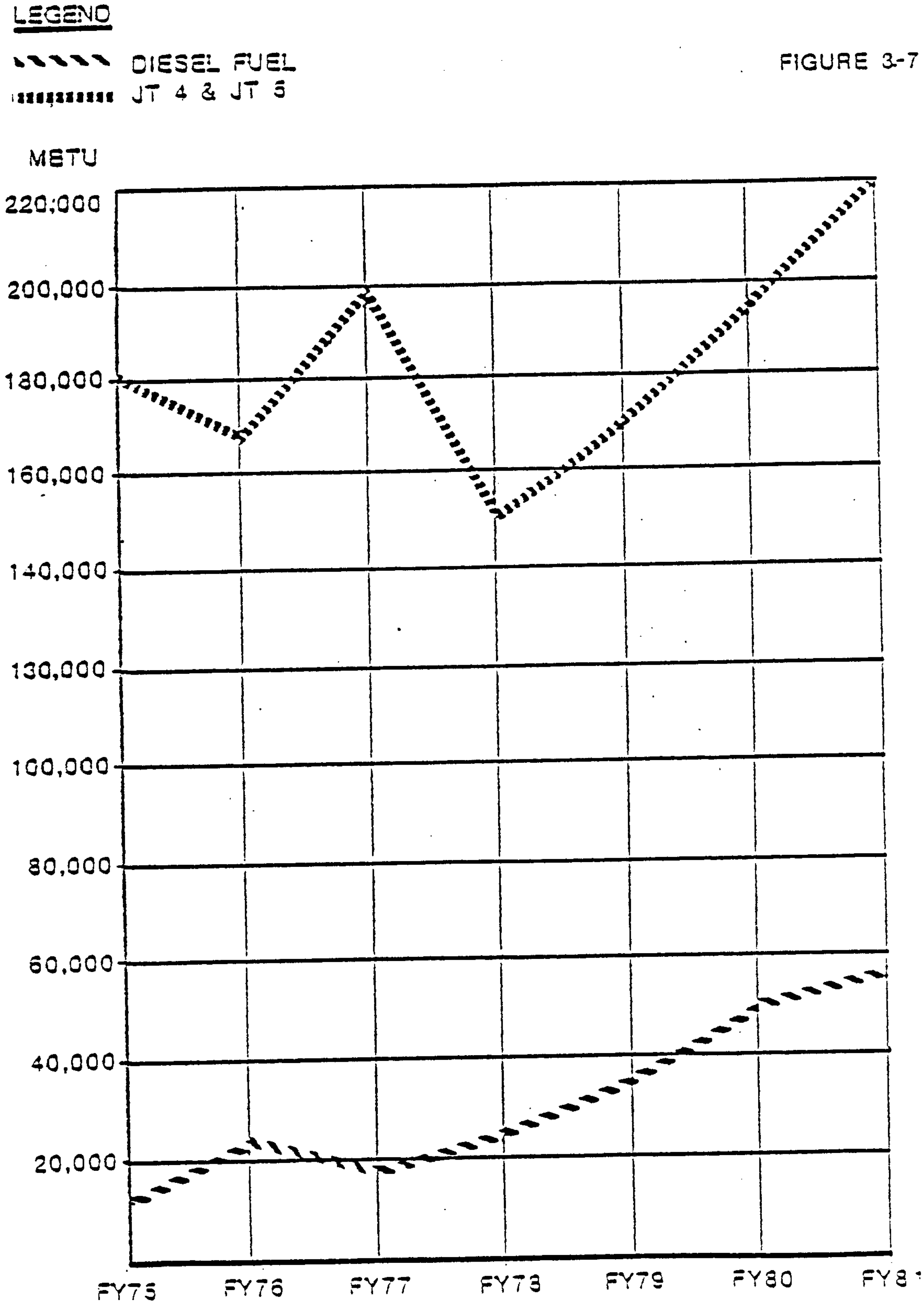
LEGEND

- 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

Since the gross area remained substantially constant over the period, an additional scale on the right of both graphs allows the energy curves to be read in terms of annual consumption per unit of gross area.

All energy curves show a noticable decline from FY 75 to FY 76. This correlates with a fall in employment, reflecting a decline in plant activity over that year.

Figure 3-7 shows diesel fuel and jet fuel consumption mainly for the record.

## 3.4 Central Boiler Plant - Thermal Load Profile

The central boiler plant uses No. 6 fuel oil and interruptible natural gas.

### 3.4.1 Tabular Information

Month by month breakdowns showing No. 6 fuel oil, interruptible natural gas, total boiler fuel (in MBTU) and percentage of yearly use are shown for FY81, FY80 and FY79 (the last three available years) in Tables 3.4.1-1, 3.4.1-2 and 3.4.1-3, respectively.

TABLE 3.4.1-1
FY81 BOILER FUEL CONSUMPTION

| MONTH | NO. 6 OIL | INT. GAS | TOT. MBTU | % YEARLY USE |
|---|---|---|---|---|
| Oct. 80 | 0 | 18,531 | 18,531 | 6.2 |
| Nov. 80 | 0 | 24,523 | 24,523 | 8.2 |
| Dec. 80 | 30,481 | 56,757 | 56,757 | 18.9 |
| Jan. 81 | 49,173 | 49,173 | 49,173 | 16.4 |
| Feb. 81 | 38,264 | 0 | 38,264 | 12.7 |
| Mar. 81 | 23,508 | 12,214 | 35,722 | 11.9 |
| Apr. 81 | 0 | 24,333 | 24,333 | 8.1 |
| May 81 | 0 | 13,442 | 13,442 | 4.5 |
| June 81 | 0 | 11,614 | 11,614 | 3.9 |
| July 81 | 0 | 9,747 | 9,747 | 3.2 |
| Aug. 81 | 0 | 8,840 | 8,840 | 2.9 |
| Sep. 81 | 0 | 9,470 | 9,470 | 3.2 |
| Totals | 141,426 | 158,990 | 300,416 | 100 |

TABLE 3.4.1-2
FY80 BOILER FUEL CONSUMPTION

| MONTH | NO. 6 OIL | INT. GAS | TOT. MBTU | % YEARLY USE |
|---|---|---|---|---|
| Oct. 79 | 1,784 | 29,436 | 31,220 | 9.3 |
| Nov. 79 | 0 | 36,545 | 36,545 | 10.9 |
| Dec. 79 | 0 | 41,940 | 41,940 | 12.5 |
| Jan. 80 | 0 | 49,519 | 49,519 | 14.7 |
| Feb. 80 | 25,188 | 22,290 | 47,478 | 14.1 |
| Mar. 80 | 0 | 43,008 | 43,008 | 12.8 |
| Apr. 80 | 0 | 28,372 | 28,372 | 8.4 |
| May 80 | 0 | 20,773 | 20,773 | 6.2 |
| June 80 | 0 | 14,820 | 14,820 | 4.4 |
| July 80 | 0 | 8,154 | 8,154 | 2.4 |
| Aug. 80 | 0 | 4,760 | 4,760 | 1.4 |
| Sep. 80 | 0 | 9,934 | 9,934 | 3.0 |
| Totals | 26,972 | 309,551 | 336,523 | 100 |

TABLE 3.4.1-3
FY79 BOILER FUEL CONSUMPTION

| MONTH | NO. 6 OIL | INT. GAS | TOT. MBTU | % YEARLY USE |
|---|---|---|---|---|
| Oct. 78 | 21,684 | 0 | 21,684 | 6.5 |
| Nov. 78 | 38,078 | 2 | 38,080 | 11.4 |
| Dec. 78 | 48,120 | 0 | 48,120 | 14.4 |
| Jan. 79 | 54,686 | 0 | 54,686 | 16.4 |
| Feb. 79 | 50,672 | 0 | 50,672 | 15.2 |
| Mar. 79 | 22,036 | 0 | 22,036 | 6.6 |
| Apr. 79 | 306 | 24,637 | 24,943 | 7.5 |
| May 79 | 0 | 15,879 | 15,879 | 4.8 |
| June 79 | 0 | 13,933 | 13,933 | 4.2 |
| July 79 | 0 | 14,211 | 14,211 | 4.3 |
| Aug. 79 | 0 | 12,529 | 12,529 | 3.8 |
| Sep. 79 | 0 | 16,968 | 16,968 | 5.1 |
| Totals | 235,582 | 98,519 | 333,741 | 100 |

### 3.4.2 Graphic Information

Month by month boiler fuel consumption (MBTU) for FY81, FY80, FY79 is plotted in Figures 3-8, 3-9, and 3-10 respectively.

FIGURE 3-8

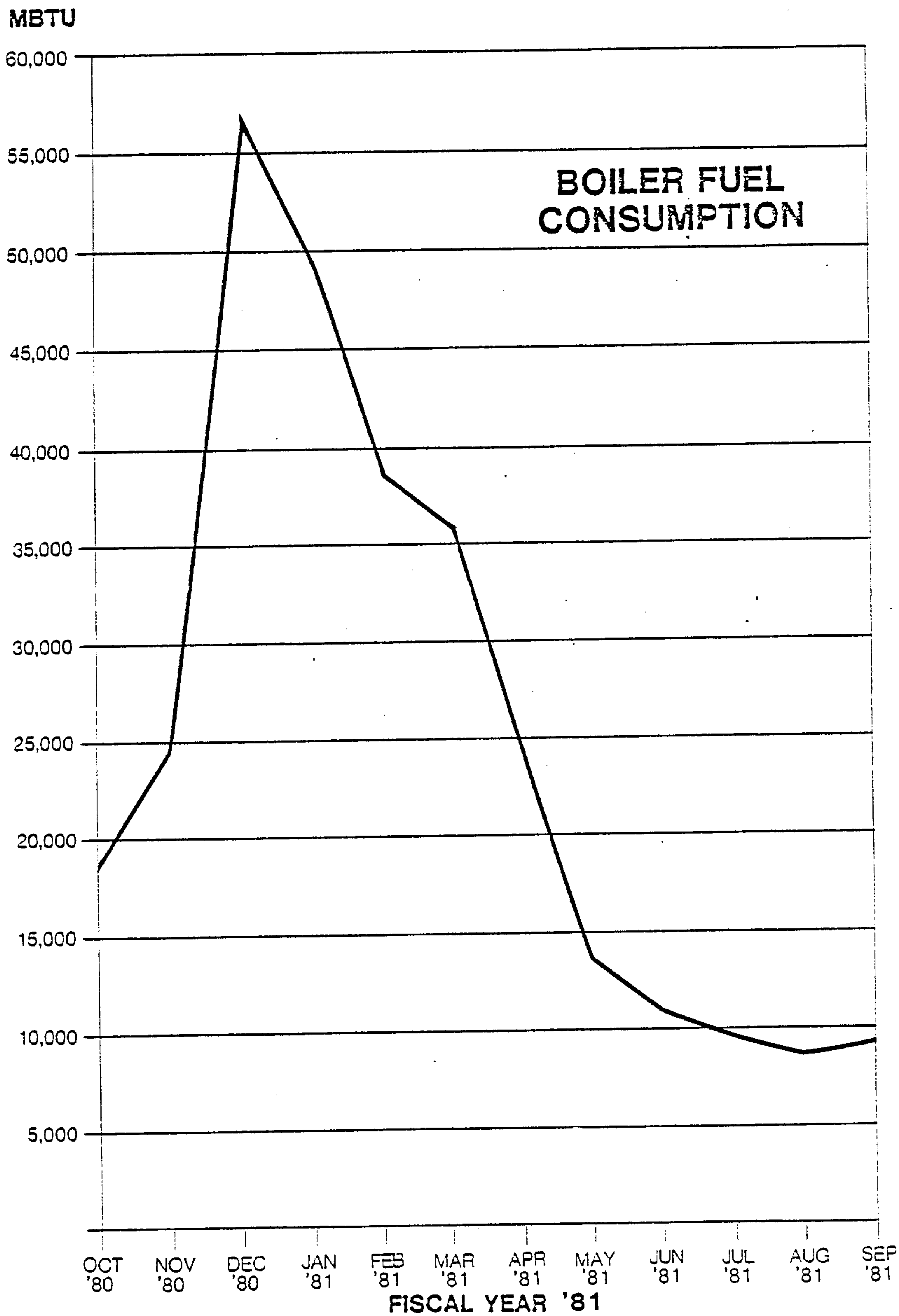

MBTU
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
BOILER FUEL CONSUMPTION
OCT '80
NOV '80
DEC '80
JAN '81
FEB '81
MAR '81
APR '81
MAY '81
JUN '81
JUL '81
AUG '81
SEP '81
FISCAL YEAR '81

FIGURE 3-9

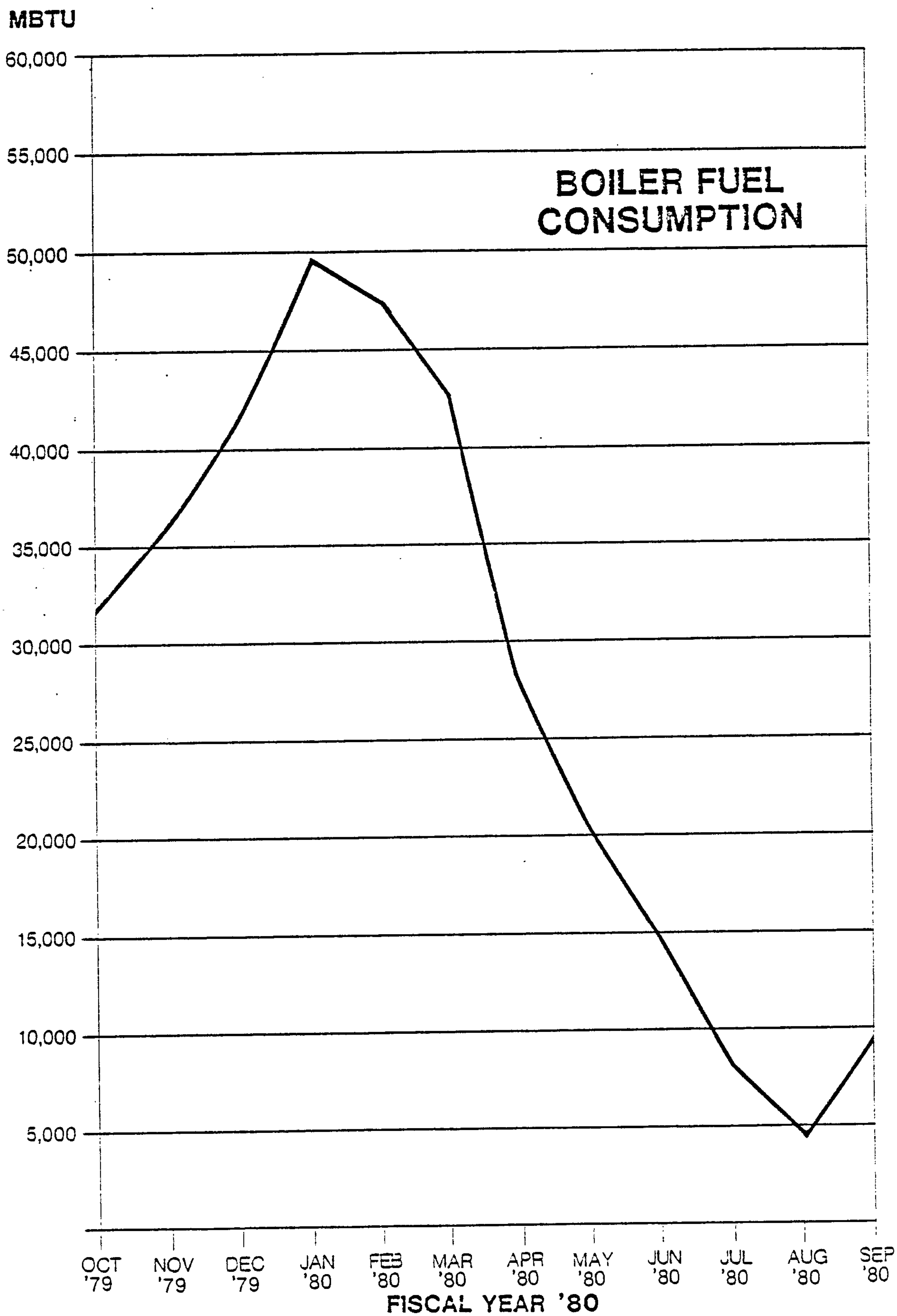
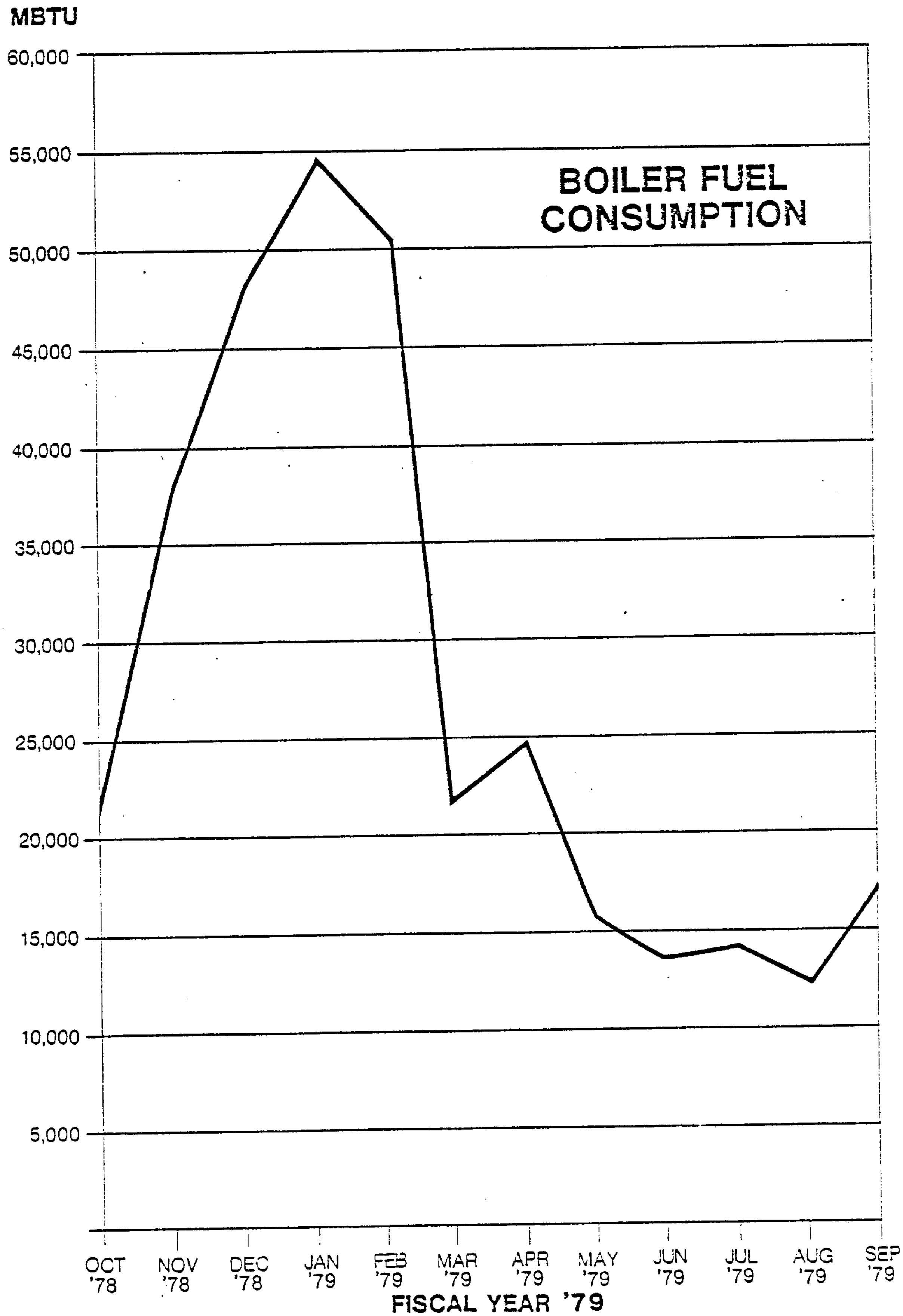

MBTU
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
BOILER FUEL CONSUMPTION
OCT '79
NOV '79
DEC '79
JAN '80
FEB '80
MAR '80
APR '80
MAY '80
JUN '80
JUL '80
AUG '80
SEP '80
FISCAL YEAR '80

FIGURE 3-10


MBTU
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
BOILER FUEL CONSUMPTION
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 '79

3.5 **Energy Costs**

Table 3.5 summarizes energy costs for electricity, interruptible natural gas and No. 6 fuel oil at SAEP.

Energy Costs
Table 3.5

| Energy Source | Cost Per Unit FY 81 | Cost Per MBTU FY 81 $ | Cost Per MBTU Escalated To FY 84 $ |
|---|---|---|---|
| Electricity | 0.082 $/KWH | 7.07 | 10.76 |
| Interruptible Natural Gas | 0.043 $/CCF | 4.47 | 7.71 |
| No. 6 Oil | 0.87 $/Gal | 6.01 | 9.15 |

The energy costs were derived in the following manner:

o Fuel consumption and costs for FY81 were obtained from base utility records.

o Cost per unit of each fuel is the total yearly cost divided by the total yearly consumption.

o Cost per MBTU (FY81) is based on the following conversion factors:

1 KWH = 0.0116 MBTU
1 CCF of Natural Gas = 0.1031 MBTU
1 GAL of No. 6 Oil = 0.144 MBTU

o Cost per MBTU (FY84) is based on the following annual escalation rates:

Electricity 15%
Natural Gas 20%
Fuel Oil 15%

The annual escalation rates are obtained from the Norfolk District ECIP Criteria dated November 10, 1980 - Appendix B, Table 2.

## 4.0 Energy and Cost Savings

### 4.1 Predicted Energy Savings from Recommended Projects

Predicted energy savings from recommended ECIP projects and "in-house" projects, in MBTU/YR, are listed below in Table 4-1 for electricity, No. 6 oil, interruptible natural gas and source energy.

TABLE 4-1
MBTU/YR ENERGY SAVINGS FROM RECOMMENDED PROJECTS

| PROJECT | INCREMENT | ELEC | NO. 6 | GAS | SOURCE |
|---|---|---|---|---|---|
| Summer Boiler | E | 1,720 | 0 | 9,375 | 11,095 |
| Waste Oil | E | - 218 | 12,000 | 0 | 11,782 |
| Wall Insul. | G* | 83 | 5,511 | 6,214 | 11,808 |
| Storm Windows | A | 1,580 | 2,920 | 0 | 4,500 |
| DHW Heaters | G* | 8 | 2 | 3 | 13 |
| Light Fixtures | A | 576 | 0 | 0 | 576 |
| Screw Chiller | G* | 2,556 | 0 | 0 | 2,556 |
| Anti-Strat. Unit Heater | A | -1,385 | 6,016 | 6,784 | 11,415 |
| DHW Pipe Insul. | A | 108 | 157 | 177 | 442 |
| Roof Rehabilitation | In-House | 0 | 14,500 | 14,500 | 29,000 |
| Condensate System Rehab. | In-House | 0 | 3,150 | 3,150 | 6,300 |
| HPS Lighting | In-House | 55,000 | 0 | 0 | 55,000 |
| Rehab. Bldg. 3A | In-House | 0 | 100 | 0 | 100 |
| Kalwall | In-House | 0 | 3,750 | 3,750 | 7,500 |
| Econ. Fin-Tube & O2 Trim | B | | 9,747 | | |
| TOTALS | - | 60,028 | 57,853 | 43,953 | 161,834 |

*This is normally an Increment A item, but SIR is less than 1.0.

### 4.2 Energy Savings - Percent Reduction from Base Year FY75

Percent reduction for each individual energy source and total source energy are listed in Table 4-2 below.

TABLE 4-2
ENERGY SAVINGS PERCENT REDUCTION
FROM BASE YEAR FY75

| FUEL | FY75 - MBTU | SAVINGS - MBTU | % REDUCTION |
|---|---|---|---|
| Elec. | 496,886 | 60,028 | 12 |
| 6 Oil | 243,847 | 57,853 | 24 |
| Gas | 186,702 | 43,953 | 24 |
| Source* | 1,154,036 | 161,834 | 14 |

*Total does not add due to process related fuels such as jet fuel, diesel, firm gas, etc.

## 4.3 Anticipated Monetary Savings and Construction Costs

Annual dollar savings and construction costs for each of the ECIP projects are listed in Table 4-4, below.

TABLE 4-4
ANNUAL DOLLAR SAVINGS AND CONSTRUCTION COSTS

| PROJECT | $/YR SAVED | CWE-84 |
|---|---|---|
| Summer Boiler | 90,788 | 253,878 |
| Waste Oil | 88,554 | 840,739 |
| Wall Insulation | 116,481 | 2,319,000 |
| Storm Windows | 50,263 | 303,015 |
| DHW Heaters | 147 | 17,934 |
| Light Fixtures | 7,125 | 13,870 |
| Screw Chiller | 31,617 | 2,010,729 |
| Anti-Strat Unit Heater | 108,907 | 890,969 |
| DHW Pipe Insualation | 4,624 | 19,265 |
| Econ Fintube & 02 Trim | 102,538 | 351,576 |
| TOTALS | 601,049 | 7,020,975 |

The simple amortization for the above projects is (7,020,975/601,044) 11.7 years. The SIR is (21,231,402/7,020,975) 3.0.

5.0 **Increment D**

5.1 **Scope**

The purpose of Increment D is to determine the feasibility of new cogeneration and solid waste plants utilizing solid fuels, supplemented, as feasible, with refuse derived fuels (RDF) and waste oil fuels. Programming documents (DD Forms 1391 and PDBs) are required for feasible projects.

Solid waste and RDF plants are not part of this contract. Refer to Detailed Scope of Work and DACA65-81-C-0024 supplementary contract of July 82 for further details. The Scope of Work is in the Appendix-Section B.

5.2 **Projects Investigated**

The projects investigated under this Increment are listed in Table 5-1, below.

TABLE 5-1
INCREMENT D-PROJECTS INVESTIGATED

- o Cogeneration from Central Boiler Plant
- o Cogeneration/High and Low Temperature Heat Recovery From Engine Test Cells
- o Cogeneration/High Temperature Heat Recovery From Engine Test Cells

5.3 **Brief Description of Projects Investigated**

5.3.1 **Cogeneration from Central Boiler Plant**

The present central boiler plant cannot meet cogeneration requirements. The present 100 psig steam output would have to become the turbine outlet pressure in order to maintain current heating and process requirements. The turbine inlet pressure (i.e., boiler output pressure) would have to be 600 psig. In addition, the cogeneration boiler would have to utilize coal. (See Increment D definition Section 4.1.)

5.3.2 **Cogeneration/High and Low Temperature Heat Recovery**

Test engines fall into one of two categories: production engines or development engines. These engines are test in one of 31 test cells. Twenty-eight of these cells are located in Building 16.

Energy input to the test engines is represented by jet or diesel fuel. Energy output is transmitted along a shaft which is connected to a water brake. Losses (i.e., the difference between energy input and output) are represented by high temperature exhaust.

This subject has been studied by AVCO-LYCOMING personnel. A copy of an "in-house" report on engine test cell heat recovery has been reproduced and is in the Appendix-Section F.

### 5.3.3 Cogeneration/High Temperature Heat Recovery

The objective of this project is to utilize heat from test engine exhaust to supply high pressure steam to generate electricity and back-pressure steam to operate a steam absorption chiller. The absorption chiller is required to provide 800 tons of refrigeration for Bldg. 10.

## 5.4 Results and Conclusions

There are no recommended projects under this Increment.

6.0 **Increment E**

6.1 **Scope**

The purpose of Increment E is to determine the feasibility of installing central plants firing solid fuels serving all or discrete parts of the installation.

Stratford Army Engine Plant is currently served by a central boiler plant. When this is the case, the scope of work calls for Increment E to consist of an engineerig report and economic analysis of converting the existing central plant to solid fuels (coal).

6.2 **Projects Investigated**

The projects investigated under this Increment are listed in Table 6-1, below.

TABLE 6-1
INCREMENT E PROJECTS INVESTIGATED

- o Central Boiler Plant Coal Conversion
- o Waste-Oil Burner for Central Boiler Plant
- o Single Fuel (Interruptible Natural Gas) Firetube Package Boiler for Summer Use
- o Dual Fuel (Interruptible Natural Gas and Waste Oil) Watertube Package Boiler for Summer Use

6.3 **Recommended Projects**

The recommended projects under this Increment are the Waste Oil Burner for the Central Boiler Plant and the Single Fuel Firetube Package Boiler for Summer Use.

6.4 **Brief Description of Recommended Projects**

6.4.1 **Waste Oil Burner for Central Boiler Plant**

SAEP generates waste oil, mainly from machine tools, at a rate of 10,000 gallons per month. With filtration, chemical treatment, and a supplementary burner this oil can be used as a boiler plant fuel. Using waste oil as a boiler fuel has several benefits:

- o SAEP currently pays $0.30/gal to dispose of the waste oil.
- o Consumption of traditional boiler fuels (No. 6 Oil and Int. Nat. Gas) is reduced.

- o Waste Oil Recovery is a partial solution to the long range waste disposal problem at SEAP and in the rest of the Town of Stratford.

### 6.4.2 Single Fuel Firetube Package Boiler for Summer Use

The central boiler plant consists of 3 units @ 60,000 lbs steam/hr output. The average summer (May-September) steam demand is 10,300 lb/hr. Running the central plant at such low summer loads is extremely inefficient.

This project proposes a summer shutdown of the central boiler plant. A single fuel (Int. Nat. Gas) firetube 17,250 lb/hr (500 boiler horsepower) package boiler will be able to meet the anticipated 10,300 lb/hr summer steam demand. The basis for the energy savings is the increased efficiency at this load for the package boiler. In addition, there will be an electric energy savings due to a reduction in the electrical auxiliary loads (boiler feedwater pumps and induced draft fans).

## 6.5 Brief Description of Projects Considered But Not Recommended

### 6.5.1 Boiler Plant Coal Conversion

The primary objective of boiler plant coal conversion is to reduce dependence on petroleum fuels. An additional benefit is that coal is significantly cheaper than fuel oil (in this case $10.52/MBTU vs $4.07 MBTU).

### 6.5.2 Dual Fuel Watertube Package Boiler For Summer Use

The basic objective of this project is the same as that of the single fuel fire tube package boiler which was previously discussed in Section 5.3. Additional savings would result from the burning of waste oil which would otherwise cost $0.30/gal to dispose of. However, this additional savings is more than offset by the cost of additional controls, piping, pumps, physical and chemical treatment and frequent cleaning of burners. In addition, 10,000 gal/mo amounts to only 550 lbs steam/hr which is 2% of the anticipated summer load. It was agreed during a field visit/meeting at SAEP on 10/21/83 to delete waste oil from the summer package boiler. When the summer boiler is in operation, waste oil will be kept in an on-site storage tank.

## 6.6 Economic Analysis of Recommended Projects

Recommended Increment E Projects listing MBTU/YR saved, $/YR saved, CWE-84, SIR, ECR and SAP (Years) are listed in Table 6-2, below.

TABLE 6-2

INCREMENT E - RECOMMENDED PROJECTS

| DESCRIPTION | MBTU/YR | $/YR | CWE-84 | SIR | ECR | SAP |
|---|---|---|---|---|---|---|
| Waste Oil - Cent. Plant | 11,782 | 88,554 | 840,739 | 1.6 | 14.0 | 18.6 |
| Firetube Pkg. Boiler | 11,095 | 90,788 | 253,878 | 6.3 | 43.7 | 2.8 |
| TOTAL/AVG | 22,877 | 179,342 | 1,094,617 | 2.7 | 20.7 | 6.1 |

7.0 **Energy Plan**

7.1 **Summary of Results**

1. With the implementation of the recommended projects from Increments D, E, F outlined in this report, plus prior work from Increments A, B, G; source energy consumption per unit area will be reduced by 14%. This does not meet the DARCOM goal of 24%. If process fuels are eliminated from the analysis, a 23% reduction of source energy per unit area can be achieved.

2. Using a base year of FY75, there will be the following reduction in overall energy use:

   - o Electricity 12%
   - o No. 6 Oil 24%
   - o Int. Natural Gas 24%
   - o Source Energy 14%

3. The recommended ECIP projects from this analysis will result in an annual dollar savings of $601,044, a construction cost of $7,020,975, will have a simple amortization period of 11.7 years and a SIR OF 3.0.

7.2 **Unit Energy Consumption and the DARCOM Goal**

Figure 7-1, on the following page, shows actual unit consumption (KBTU/GSF-YR) from FY75 through FY81 and projected unit consumption from FY82 through FY85. The DARCOM goal is represented by a straight line from FY75 through FY85 showing a 2% reduction per year over a ten year period (an overall reduction of 20%).

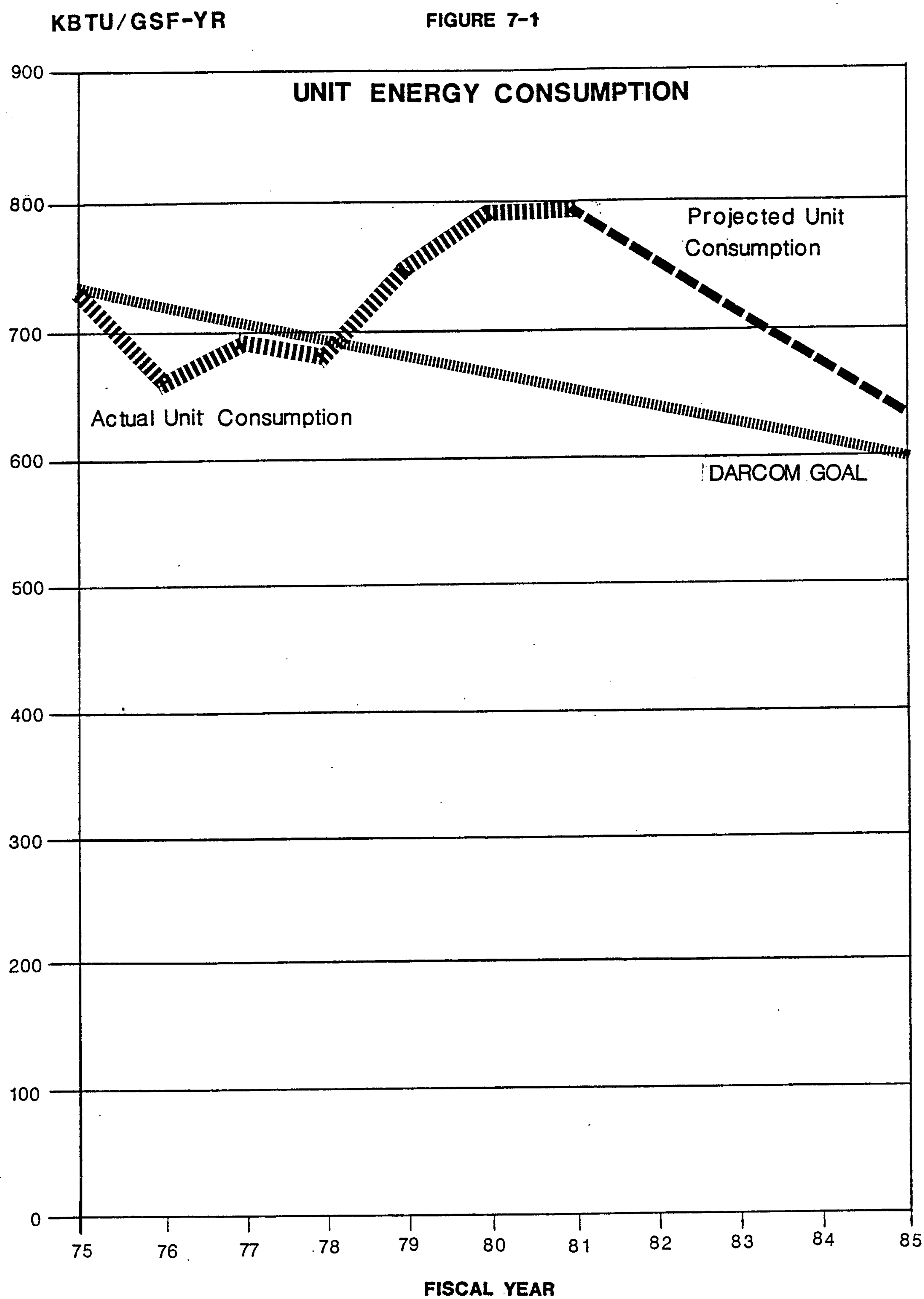
Historical unit consumption from FY75 through FY81 is listed in Table 7-1, below.

TABLE 7-1
UNIT ENERGY CONSUMPTION FY75 THROUGH FY81

| YEAR | KBTU/GSF-YR |
|---|---|
| FY75 | 739 |
| FY76 | 659 |
| FY77 | 693 |
| FY78 | 689 |
| FY79 | 748 |
| FY80 | 790 |
| FY81 | 793 |

The unit energy consumption savings for FY85 is calculated as follows:

FIGURE 7-1


KBTU/GSF-YR
UNIT ENERGY CONSUMPTION
900
800
700
600
500
400
300
200
100
0
Projected Unit
Consumption
Actual Unit Consumption
DARCOM GOAL
75
76
77
78
79
80
81
82
83
84
85
FISCAL YEAR

161,834 MBTU x 1,000 KBTU/MBTU ÷ 1,560,764 SQ. FT.

= 103.7 KBTU/GSF-YR

The percent reduction is:

(103.7/739) x 100 = 14%

This does not meet the DARCOM goal (a 20% reduction from FY75 to FY85) of 147.8 KBTU/GSF-YR saved.

The simple amortization for the above projects is (7,020,975/601,044) 11.7 years. The SIR is 3.0.

## 7.3 Recommended Projects

### 7.3.1 Increments D, E, F

Recommended projects from Increments D, E, F are outlined in Table 7-2, below.

**TABLE 7-2**

**RECOMMENDED PROJECTS - INCREMENTS D, E, F**

| PROJECT | MBTU/ YR SAVED | $/YR SAVED | LIFE-CYCLE SAVINGS | CWE-84 | SIR | SAP (YRS) |
|---|---|---|---|---|---|---|
| Summer Boiler | 11,095 | 90,788 | 1,527,583 | 253,878 | 6.3 | 2.8 |
| Waste Oil | 11,783 | 88,554 | 1,784,663 | 840,739 | 1.6 | 18.6 |
| **TOTAL/AVG** | **22,877** | **179,342** | **3,312,246** | **1,094,617** | **2.7** | **6.1** |

### 7.3.2 Increments A,B,G

Recommended projects from Increments A,B,G is outlined in Table 7-3, below.

## TABLE 7-3

RECOMMENDED PROJECTS - INCREMENTS A, B, G

| PROJECT | MBTU/ YR SAVED | $/YR SAVED | LIFE-CYCLE SAVINGS | CWE-84 | SIR | SAP (YRS) |
|---|---|---|---|---|---|---|
| Storm Wind. | 4,500 | 50,503 | 666,633 | 303,015 | 2.2 | 6.0 |
| DHW HTRS. | 13 | 147 | 1,790 | 17,934 | 0.1 | 122.0 |
| Light Fix. | 576 | 7,125 | 74,898 | 13,870 | 5.4 | 2.0 |
| Screw Chiller | 2,556 | 31,617 | 402,145 | 2,010,729 | 0.2 | 63.6 |
| Unit Heaters | 11,415 | 108,907 | 1,603,745 | 890,969 | 1.8 | 8.2 |
| Pipe Insul. | 442 | 4,624 | 59,720 | 19,265 | 3.1 | 4.2 |
| Ecom & O2 Trim | 9,747 | 102,538 | 1,687,565 | 351,576 | 4.8 | 3.4 |
| **TOTAL/AVG** | **29,249** | **305,461** | **4,496,496** | **3,496,496** | **1.4** | **10.0** |