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ACRUEX CORP MOUNTAIN VIEW CA ENERGY AND ENVIRONMENTAL DIV F/G 10/3  
APPLICATION POTENTIAL OF ENERGY SYSTEMS AT NAVY SITES. VOLUME I--ETC(U)  
JAN 80 S J ANDERSON, M D JACKSON, S J CHAMYS N68305-78-C-0009

UNCLASSIFIED

CEL-CR-80.006-VOL-2

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CIVIL ENGINEERING LABORATORY  
Naval Construction Battalion Center  
Port Hueneme, California 93043

Sponsored by  
Naval Material Command

LEVEL III

9 Final rept. Mar 78 - Oct 79

6 APPLICATION POTENTIAL OF ENERGY SYSTEMS AT NAVY SITES.  
VOLUME II. NAVY ENERGY SITING (NES) COMPUTER PROGRAM.  
USER'S MANUAL.

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An Investigation Conducted by  
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FOREWORD

This user's manual documents the Navy Energy Siting (NES) code developed by Acurex Corporation, Energy and Environmental Division, Mountain View, California for the Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California. This work was performed on Contract N68305-78-C-0009.

This user's manual represents Volume II of the Final Report. It provides the information necessary to understand input requirements and program macro logic of the NES code.

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SECTION 1  
INTRODUCTION

1.1 PURPOSE

The Navy Energy Siting (NES) code was developed to determine, at various naval sites, the optimum mix of alternate energy and commercially purchased energy that will meet all the site's energy demands. The optimum mix meets the energy demands within given site constraints at the lowest cost.

The code handles three types of energy demands: electricity, space heating and hot water (combined), and process steam. Alternate energy models are designed to satisfy a single demand, with the exception of a cogeneration model which can satisfy two energy demands concurrently.

1.2 PROCESSING PERFORMED BY THE OPTIMIZATION PROGRAM

The code uses a gradient projection method to determine the optimum mix of systems that minimize energy cost. The gradient projection routines were provided by the Civil Engineering Laboratory while the alternate energy models and supporting routines were developed by Acurex.

During each iteration, the optimization routine selects a mix of alternate energy systems which reduces total energy costs relative to the system mix selected during the previous iteration. Total energy cost is determined by totaling the annualized life-cycle costs of each alternate energy system and commercial energy costs. The amount of commercial

energy that must be purchased (electricity, space heating, hot water, and process steam) is calculated by deducting the energy produced by the alternate energy sources from the total demand. This iterative procedure continues until a minimum annual cost is determined.

### 1.3 RESTRICTIONS AND LIMITATIONS

Restrictions and limitations associated with use of the NES code are listed below:

- The user is restricted to three energy demands and the alternate energy models currently programmed in the optimization code. The list of alternate energy models is given in Table 1-1.
- When selecting starting values for the alternate energy models the user should pick values which do not exceed energy demands, site area, and coal and refuse constraints on the first iteration. If the demands are greatly exceeded the optimization process does not converge.
- The user should select reasonable upper and lower bounds on the number of systems for each alternate energy model because the difference between the bounds determines the step size for the first iteration.

TABLE 1-1. ALTERNATE ENERGY MODELS LIST

Subroutine Name	Model Name	Model No.	Description
EVAL01	SLHTG	1	Solar thermal for space heating and hot water.
EVAL02	RDFHTG	2	Refuse derived fuel for space heating and hot water.
EVAL03	RDFSTM	3	Refuse derived fuel for process steam.
EVAL04	RDFELE	4	Refuse derived fuel for electricity.
EVAL05	FBCHTG	5	Fluidized bed combustion for space heating and hot water.
EVAL06	FBCSTM	6	Fluidized bed combustion for process steam.
EVAL07	FBCELE	7	Fluidized bed combustion for electricity.
EVAL08	GEOSTM	8	Geothermal for process steam.
EVAL09	GEOELE	9	Geothermal for electricity.
EVAL10	WD5	10	5 kW wind generator for electricity.
EVAL11	WD200	11	200 kW wind generator for electricity.
EVAL12	WD1500	12	1500 kW wind generator for electricity.
EVAL13	PHVELE	13	Photovoltaic for electricity.
EVAL14	CCLHTG	14	Conventional coal for space heating and hot water.
EVAL15	CCLSTM	15	Conventional coal for process steam.
EVAL16	CCELE	16	Conventional coal for electricity.
EVAL17	CCLCOG	17	Conventional coal for cogeneration of process steam and electricity.

## SECTION 2

### HOW TO USE THE CODE

The input necessary to run the NES code is broken into three categories: site data, model data, and run specification data. The deck structure is depicted in Figure 2-1.

The site input data is site dependent data which changes from site to site. This data includes site energy demand profiles, site insolation profiles, site wind profiles, and general site inputs such as commercial energy costs, commercial energy purchase limits, and availability of coal and refuse.

The model input data is model dependent data required by each alternate energy model to compute energy produced, cost, and area required. This data includes such parameters as capital cost, fuel cost, efficiency, and area factors. A complete list of parameters for each alternate energy model is given in Volume I, Appendix A. Actual data required is described subsequently in Tables 2-6 to 2-9.

The run specification input data specifies which alternate energy models are to be considered in a particular run.

#### 2.1 SITE DATA

For simplicity, the site input data consist of a fixed number on input records (cards). The code assumes that all site data is present. Therefore all data cards must be present, although some may be blank if

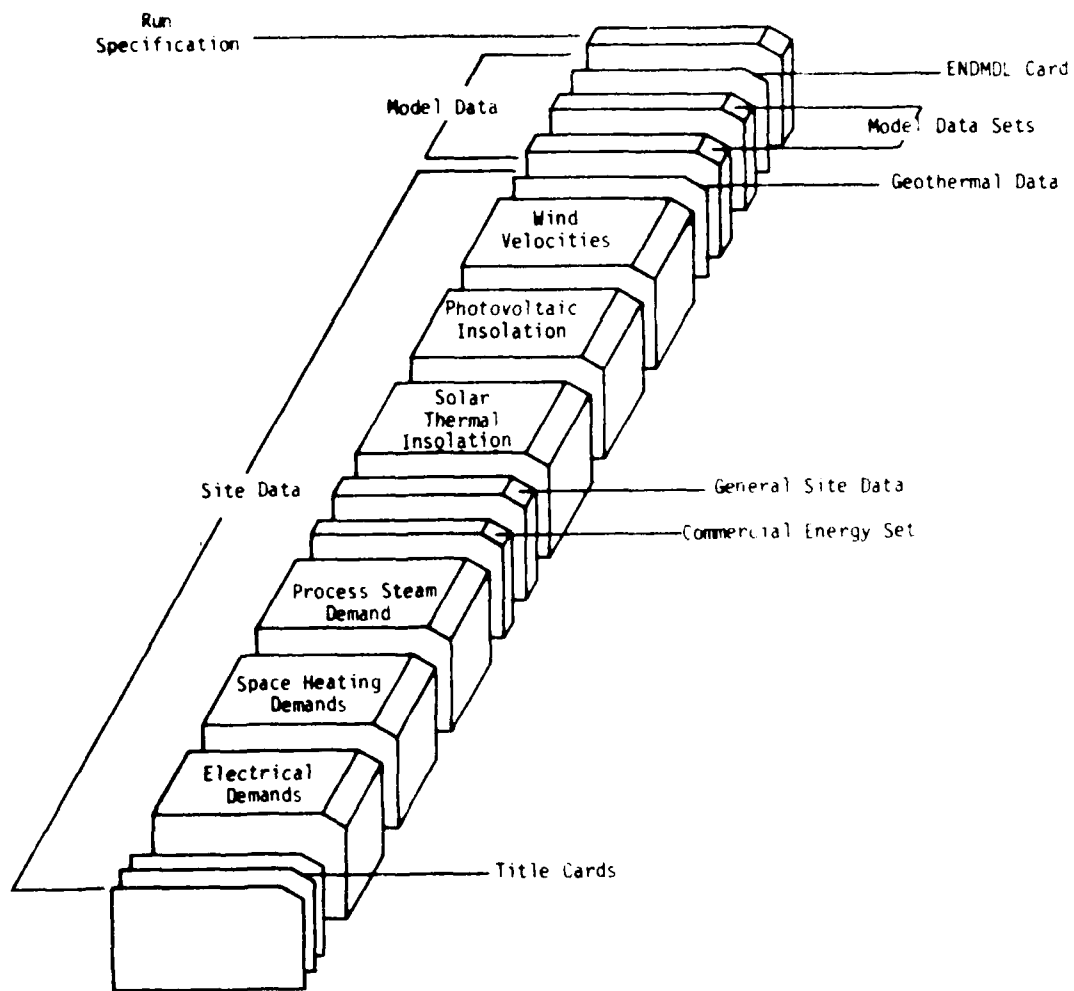


Figure 2-1. Input data deck set up.

the data is not to be used in a particular run. For example, if the user is considering only electrical demand, then data for the other two demands need not be input, but the blank data cards must be present.

The site data is divided into seven subsets and the order in which they occur in the code is as follows:

- PROBLEM TITLE SET (3 cards)
- ENERGY DEMAND SETS (36 cards each)
- COMMERCIAL ENERGY SET (4 cards)
- GENERAL DATA SET (6 cards)
- INSOLATION DATA SETS (36 cards each)
- WIND VELOCITY DATA SET (36 cards)
- GEOTHERMAL DATA SET (1 card)

Each subset is described in detail below.

Unless otherwise specified, the user may assume that all numeric input data is contained in floating point fields of width 10 columns, in which E format is acceptable (E10.0). Furthermore, it is assumed that all yearly input profiles begin in January and end in December.

#### 2.1.1 Problem Title Set

This data set consists of three cards describing the case. Columns 1 through 78 are available on each card (Figure 2-2) and the information is printed at the beginning of the run. Format for these cards is (13A6).

#### 2.1.2 Energy Demand Sets

Alternate energy models compete in three energy demand sectors: electrical, space heating and hot water (combined), and process steam. Each energy demand set consists of 36 cards which contain 12 monthly-average days of hourly demand data. Each card represents 8 hours of demand. Therefore three cards make up a daily profile of 24 hours

FORTRAN Coding Form

FORMAN STATEMENT

Three Card Title Set	78 Characters per Card	1	2	3	4	5	6	7	8
Hour		9	10	11	12	13	14	15	16
		17	18	19	20	21	22	23	24
That is 12 sets (days) per demand (3 demands)									
*This is the same format used for the insolation profiles and the wind profile									
Commercial energy set									
Commercial energy cost	Inflation rate	Maintenance and operating cost	Efficiency	Capital cost	Hourly purchase cost	Yearly purchase limit			

Repeat this three card set 12 times for each 24 hour demand profile

Figure 2-2. Format for the title, demand, and commercial energy card sets.

(Figure 2-2). All cards must be present for all three demands but only the demand sets being modeled need to have actual data input.

Format for each card in the energy demand sets is (8E10.0).

Table 2-1 indicates the sequence and units of the demand inputs.

### 2.1.3 Commercial Energy Set

This set of four cards (only the first three cards are used) contains information about the commercial energy purchased to satisfy the three energy demands. The cards are input in the same order described for the energy demand. The fourth is left blank. Each card is identically formatted and described in Figure 2-2 and Table 2-2.

### 2.1.4 General Data Set

This data consists of six cards containing general information about the site. A summary of this information and its use follows. Card formats are described in Table 2-3 and in Figure 2-3.

#### Card 1

The quantity of coal (tons/day) available for the coal combustion energy models is limited. Also, capital cost of coal combustion systems depends upon the sulfur content of the coal. The amounts (tons/day) and the particular type of coal (high or low sulfur) available at a site is input on card 1.

TABLE 2-1. ENERGY DEMAND SETS

Number	Demand	Units of Input
1	Electrical	MWh's
2	Space heating and hot water	MBtu's
3	Process steam	MBtu's

TABLE 2-2. COMMERCIAL ENERGY SET<sup>a</sup>

Column	Input	Units
1 - 10	Commercial energy cost	(\$/MWh) Electrical (\$/MBtu) Space heating (\$/MBtu) Process steam
11 - 20	Differential inflation rate	(%) expressed as a fraction
21 - 30	Maintenance and operation cost	(%) expressed as a fraction
31 - 40	Efficiency	(%) expressed as a fraction
41 - 50	Capital cost	(\$)
51 - 60	Purchase limit	(MWh/hr) Electrical (MBtu/hr) Space heating (MBtu/hr) Process steam
61 - 70	Purchase limit	(MWh/yr) Electrical (MBtu/yr) Space heating (MBtu/yr) Process steam

<sup>a</sup>Format (7E10.4)

TABLE 2-3. CARD FORMAT FOR GENERAL DATA SET

Card/Column	Format	Input
Card 1		
11 - 20	E10.0	Coal quantity (tons/day)
26 - 32	A6	Coal quality ("high" or "low")
Card 2		
11 - 20	E10.0	Land area available (ft <sup>2</sup> )
Card 3		
11 - 20	E10.0	Refuse available (tons/day)
Card 4		
1 - 20	E10.0	Discount interest rate (% expressed as a fraction)
Card 5		
1 - 80	8E10.0	Ambient temperature (°F) January - August
Card 6		
1 - 40	4E10.0	Ambient temperature (°F) September - December



### Card 2

Card 2 contains the land area ( $\text{ft}^2$ ) available for siting alternate energy systems.

### Card 3

Similar to coal, refuse is limited at each site. The amount available (tons/day) is input on card 3.

### Card 4

The discount (interest) rate (percent expressed as a fraction) used in the uniform annual cost function (see Volume I, Section 2.3) is given on card 4.

### Cards 5 to 6

These cards contain the monthly average temperatures ( $^{\circ}\text{F}$ ) representing one year of data. These data are used by Subroutine FCHART to determine the amount of energy supplied by the solar thermal model.

#### 2.1.5 Insolation Data Sets

There are two insolation data sets (36 cards each): one for the solar thermal model and one for the photovoltaic model. Each data set contains hourly insolation profiles for 12 average days representing 12 months of the year. Identical to demand data card (see Figure 2-2), each card contains 8 hours of data with three cards comprising a 24-hour profile. The units of input are ( $\text{Btu}/\text{ft}^2/\text{hr}$ ). The format for each card is (8E10.0).

#### 2.1.6 Wind Data Set

The wind data set consists of 36 cards representing the hourly wind velocity profiles for the site. The set contains profiles for 12 monthly average days, 24 hours for each day (Figure 2-2). Each card contains 8 hours of data, formatted (8E10.0). Units of input are (MPH).

### 2.1.7 Geothermal Data Set

Three inputs are needed for the geothermal model: geothermal pool quality (LIQUID or VAPOR), geothermal pool size (MBTU), and geothermal pool temperature (DEG C). The format for this data is given in Table 2-4 and illustrated in Figure 2-4.

### 2.2 MODEL DATA SETS

The model data sets consist of input for each alternate energy model. Unlike the site data, model data should be input only if the model is a candidate model in the run. The order of input determines the sequence in which the models are called to satisfy demands. The alternate energy models currently available in the code were listed in Table 1-1.

The data set required by each model consist of five cards. The format for these data sets was standardized as much as possible to simplify input procedures. The standard format is illustrated in Figure 2-5.

The user should review the alternate energy models described in Volume I, Appendix A before using the tables. The first card of each

TABLE 2-4. CARD FORMAT FOR GEOTHERMAL MODEL

Column	Format	Input
1 - 6	A6	"LIQUID or VAPOR" Vapor sets geothermal efficiency at 20% Liquid sets geothermal efficiency based on pool temperature Efficiency = $2.308E-04 * \text{Temp } (^{\circ}\text{C}) + 0.0392$
11 - 20	E10.0	Pool size (MBtu)
21 - 30	E10.0	Pool temperature ( $^{\circ}\text{C}$ )





model data set contains the abbreviated name for the energy model. The abbreviated names were given in Table 1-1. The remaining four cards in the model data set are described in Tables 2-5 through 2-8. The tables are set up in a matrix format where each table describes a particular card in the data set. The rows of the matrix describe a particular field on the card. The columns in the matrix represent each of the alternate energy models.

These columns are labeled by the abbreviated names of the models. The body of the matrix contains the units and/or description of inputs for that model. All fields described in these tables are formatted for input (E10.0). For example, for card 2 of SLHTG (solar heating model), four parameters should be input: two capital cost factors, a maintenance and operating cost, and an exponent.

The code recognizes the end of the alternate energy model data set when it sees ENDMDL (end model) in columns 1 - 6. This causes the code to stop searching for model data and to look for a run specification data set (Figure 2-1).

### 2.3 THE RUN SPECIFICATION DATA SET

The run specification data set identifies the conditions of the run: the energy demands and the alternate energy models to be considered. This data set consists of four cards. Card 1 specifies the demands to be considered, while cards 2 and 3 specify models to be used. Card 4 specifies a print option.

The user must provide all necessary input for the energy demands and alternate energy models being considered. If an alternate energy model is requested and no data was input, the program will terminate with

TABLE 2-5. DESCRIPTION OF REQUIRED DATA AND CARD FORMAT FOR MODEL COST DATA

Card 2

Input Parameter Units of input appear under model name if data is used	Columns	Model Name and Model Number							
		SLMTHG 1	RDFHTG 2	RDFSTM 3	RDFELE 4	FBCHTG 5	FBGSTM 6	FBCELE 7	GEOSTM 8
Capital Cost Factor	1-10	(\$)	(\$/ton/day)	(\$/ton/day)	(\$/ton/day)				
Capital Cost Factor	11-20	(\$/ft <sup>2</sup> )			(\$/MI)				
Fuel Cost	21-30								
Fuel Inflation Rate	31-40					(\$)*	(\$)*	(\$)*	
Maintenance and Operation Cost	41-50	Fraction of annualized capital cost	(\$/ton)	(\$/ton)	(\$/ton)			Fraction of annualized capital cost	Fraction of annualized capital cost
Exponent	51-60	1	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless
Transportation Cost	61-70		(\$)	(\$)	(\$)				
Revenue Recovered	71-80		(\$/ton)	(\$/ton)	(\$/ton)				

\*Percent expressed as a fraction.

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TABLE 2-5. Concluded

Card 2

Input Parameter Units of input appear under model name if data is used	Columns	Model Name and Model Number																
		GE0LE 9	M05 10	M0200 11	M01500 12	PHVELE 13	CCLHTG 14	CCLSTM 15	CCELE 16	CCLCOG 17								
Capital Cost Factor	1-10	(\$/MM)	(\$/unit)	(\$/unit)	(\$/unit)	(\$)												
Capital Cost Factor	11-20					(\$/ft <sup>2</sup> )												
Fuel Cost	21-30																	
Fuel Inflation Rate	31-40									(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>	(%) <sup>a</sup>
Maintenance and Operation Cost	41-50		(\$/unit)	(\$/unit)	(\$/unit)	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost	Fraction of annualized capital cost
Exponent	51-60	Dimensionless				Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless
Transportation Cost	61-70																	
Revenue Recovered	71-80																	

<sup>a</sup>Percent expressed as a fraction.

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TABLE 2-6. DESCRIPTION OF REQUIRED DATA AND CARD FORMAT FOR MODEL PERFORMANCE DATA

Card 3

Input Parameter Units of input appear under name if data is used	Columns	Model Name and Model Number							
		SLTHTG 1	RDFHTG 2	RDFSTM 3	RDFELE 4	FBCHTG 5	FBCSTM 6	FBCELE 7	GEOSTM 8
Efficiency	1-10	<del>X</del>	(Btu delivered /Btu input)	(Btu delivered /Btu input)	(Btu delivered /Btu input)	(Btu delivered /Btu input)	(MMH delivered /MMH input)	(Btu delivered /Btu input)	(Btu delivered /Btu input)
Load Factor	11-20	<del>X</del>	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless	Dimensionless
Fuel Cost	21-30	104 ft <sup>2</sup> system	(ft <sup>2</sup> / MBtu/yr)	(ft <sup>2</sup> / MBtu/yr)	(ft <sup>2</sup> / MMH/yr)	(ft <sup>2</sup> / MBtu/yr)	(ft <sup>2</sup> / MMH/yr)	(ft <sup>2</sup> / MBtu/yr)	(ft <sup>2</sup> / MBtu/yr)

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TABLE 2-6. Concluded

Card 3

Input Parameter Units of input appear under model name if data is used	Columns	Model Name and Model Number									
		GEDELE 9	MDS 10	MD200 11	MD1500 12	PIVELE 13	CCLHTG 14	CCLSTM 15	CCELE 16	CCLD06 17	
Efficiency	1-10		Performance Factor				(MMH delivered/MMH insolation)	(Btu delivered /Btu input)	(Btu delivered/ Btu input)	(MMH delivered/ MMH input)	
Load Factor	11-20										Dimension less
Area Factor	21-30		(ft <sup>2</sup> /unit) capacity	(ft <sup>2</sup> /unit)	(ft <sup>2</sup> /unit)	(10 <sup>3</sup> ft <sup>2</sup> / system)		(ft <sup>2</sup> / MBtu/yr)	(ft <sup>2</sup> / MBtu/yr)	(ft <sup>2</sup> / MMH/yr)	(ft <sup>2</sup> /ton/ day)

\*See model description; Volume I, Appendix A.

TABLE 2-7. DESCRIPTION OF REQUIRED DATA AND CARD FORMAT FOR MODEL STARTING VALUES AND BOUNDS

Card 4

Input Parameter Units of input appear under model name if data is used	Columns	Model Name and Model Number							
		SLTHTG 1	RDFHTG 2	RDFSTM 3	RDFELE 4	FBCHTG 5	FBCSTM 6	FBCELE 7	GEOSTM 8
Minimum Number of Systems	1-10	10 <sup>4</sup> ft <sup>2</sup> systems	Tons refuse per day	Tons refuse per day	Tons refuse per day	Tons coal per day	Tons coal per day	Tons coal per day	(MBtu/yr)
Maximum Number of Systems	11-20	10 <sup>4</sup> ft <sup>2</sup> systems	Tons refuse per day	Tons refuse per day	Tons refuse per day	Tons coal per day	Tons coal per day	Tons coal per day	*(MBtu/yr)
Start Number of Systems	21-30	10 <sup>4</sup> ft <sup>2</sup> systems	Tons refuse per day	Tons refuse per day	Tons refuse per day	Tons coal per day	Tons coal per day	Tons coal per day	(MBtu/yr)

\*if maximum number of systems input for geothermal equals zero, the model will calculate its own maximum.

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TABLE 2-8. DESCRIPTION OF REQUIRED DATA AND CARD FORMAT -- MISCELLANEOUS MODEL INPUT  
Card 5

Input Parameter Units of input appear under model name if data is used	Columns	Model Name and Model Number							
		SLMTG 1	ROFHTG 2	ROFSTM 3	ROFELE 4	FBCHTG 5	FBCELE 6	FBCELE 7	GEOSTM 8
Field 1	1-10	F1=0.81 See model descript.	Revenue recovered inflation rate (%) <sup>a</sup>	Revenue recovered inflation rate (%) <sup>a</sup>	Revenue recovered inflation rate (%) <sup>a</sup>	Capital cost high sulfur (\$/MWh/yr)	Capital cost high sulfur (\$/MWh/yr)	Capital cost high sulfur (\$/MWh/yr)	
Field 2	11-20	F2=0.73 See model descript.	Maint. & oper. inflation rate (%) <sup>a</sup>	Maint. & oper. inflation rate (%) <sup>a</sup>	Maint. & oper. inflation rate (%) <sup>a</sup>	Coal quality high sulfur (Btu/lbm)	Coal quality high sulfur (Btu/lbm)	Coal quality high sulfur (Btu/lbm)	
Field 3	21-30		Transportation cost inflation rate (%) <sup>a</sup>	Transportation cost inflation rate (%) <sup>a</sup>	Transportation cost inflation rate (%) <sup>a</sup>	Coal costs high sulfur (\$/ton)	Coal costs high sulfur (\$/ton)	Coal costs high sulfur (\$/ton)	
Field 4	31-40					Capital cost low sulfur (\$/MWh/yr)	Capital cost low sulfur (\$/MWh/yr)	Capital cost low sulfur (\$/MWh/yr)	
Field 5	41-50					Coal quality low sulfur (Btu/lbm)	Coal quality low sulfur (Btu/lbm)	Coal quality low sulfur (Btu/lbm)	
Field 6	51-60					Coal cost low sulfur (\$/ton)	Coal cost low sulfur (\$/ton)	Coal cost low sulfur (\$/ton)	

<sup>a</sup>Percent is expressed as a fraction.

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TABLE 2-8. Concluded

Card 5

Input Parameter Units of Input appear under model name if data is used	Columns	Model Name and Model Number								
		GEDELE 9	MD5 10	MD200 11	MD1500 12	PHVELE 13	CCLHTG 14	CCLSTM 15	CCELE 16	CCLCOG 17
Field 1	1-10		Maintenance & operating inflation rate (%) <sup>a</sup>	Maintenance & operating inflation rate (%) <sup>a</sup>			Capital cost high sulfur (\$/MBtu/yr)	Capital cost high sulfur (\$/MBtu/yr)	Capital cost high sulfur (\$/MBtu/yr)	Capital cost high sulfur (\$/MBtu/yr)
Field 2	11-20						Coal quality high sulfur (Btu/lbm)	Coal quality high sulfur (Btu/lbm)	Coal quality high sulfur (Btu/lbm)	Coal quality high sulfur (Btu/lbm)
Field 3	21-30						Coal costs high sulfur (\$/ton)	Coal costs high sulfur (\$/ton)	Coal costs high sulfur (\$/ton)	Coal costs high sulfur (\$/ton)
Field 4	31-40						Capital cost low sulfur (\$/MBtu/yr)	Capital cost low sulfur (\$/MBtu/yr)	Capital cost low sulfur (\$/MBtu/yr)	Capital cost low sulfur (\$/MBtu/yr)
Field 5	41-50						Coal quality low sulfur (Btu/lbm)	Coal quality low sulfur (Btu/lbm)	Coal quality low sulfur (Btu/lbm)	Coal quality low sulfur (Btu/lbm)
Field 6	51-60						Coal cost low sulfur (\$/ton)	Coal cost low sulfur (\$/ton)	Coal cost low sulfur (\$/ton)	Coal cost low sulfur (\$/ton)

<sup>a</sup>Percent expressed as a fraction.

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a diagnostic error message. Similarly, if a demand or alternate energy model name is not recognized, the program will terminate with a message.

### 2.3.1 Card Formats

#### Card 1

Card 1 specifies the energy demand to be considered. The energy demand six character names appear left justified in any of three fields: columns 1 - 6, columns 8 - 13, columns 15 - 19.

The energy demand names are as follows:

- ELECTR Electrical
- SPCHTG Space heating and hot water
- PROSTM Process steam

#### Cards 2 and 3

The alternate energy model names appear left justified in any of 10 fields on each card. The order of model names input determines the calling sequence of the models considered. The fields begin in columns 1, 8, 15, 22, 29, 36, 43, 50, 57, 64. Only those alternate energy models being considered appear on these cards. The six character model names are listed in Table 1-1. Both cards must be input even if one is blank.

#### Card 4

Print option flag is specified on this card.

Table 2-9 describes the output generated for various values of the print option flag. A print option flag of a particular value will generate information for that value as well as information for flags of lower value. For example, if the user specifies Flag 1, he will receive all the output associated with the Flags -1, 0, and 1. Needless to say, considerable output is produced for a print option flag other than -1.

TABLE 2-9. PRINT OPTION FLAG OUTPUTS

Flag	Printed Output
-1	Input data. Initialization data. Results summary.
0	Overall status of the optimization process. Status after each evaluation of alternate energy models. Partial derivatives. Objective function.
1	Point to be projected onto constraints.
2	Status of energy demands after evaluation of alternate energy models. Values of various constraints. Matrixes, vectors and solutions used during optimization.

<u>Column</u>	<u>Format</u>	<u>Input</u>
1 - 2	I2	PRINT OPTION FLAG  (-1, 0, 1 or 2)

SECTION 3  
DESCRIPTION OF OUTPUT

The printed output generated by the Navy Energy Siting code fall into the following categories: input, summary of results, debug and diagnostics.

All site model and run specification input data is printed at the beginning of the run. A summary of optimum results is printed at the end of the run. As an option, a debug printout monitors the status of the optimization process ( $Flag \geq 0$ ). This debug printout indicates the status of each alternate energy model, costs of alternate energy produced, cost of commercial energy purchased, and total cost of energy supplied (objective function). The debug option generates considerable output and is not recommended unless it is necessary to monitor the optimization process.

In addition, a set of diagnostic error messages were incorporated into the code. These are listed below.

3.1 DIAGNOSTIC MESSAGES

\*\*\*ERROR DEATH\*\*\*CARD READ ERROR"

Usually a result of improper deck set up, a card missing, or a card out of sequence.

\*\*\*ERROR DEATH\*\*\*PREMATURE END OF DATA"

End of deck reached before all data is read. Check deck for missing data.

"\*\*\*ERROR DEATH\*\*\*MODEL NOT RECOGNIZED"

When trying to input model data, the model name was not recognized.

"\*\*\*ERROR DEATH\*\*\*DATA FOR A MODEL INPUT TWICE"

Self-explanatory.

"NO DATA FOR MODEL"

A model has been requested for which no data has been input.

"(Name) IS NOT IN THE LIST"

Check run specification data. A demand or model requested is not recognized.

"NO MATCH ON THE n VALUES"

Check run specification data, no demands or models recognized.

"ERROR ON INPUT"

Check run specification data.

SECTION 4  
PROGRAM LOGIC DESCRIPTION

This section presents a description of the Navy Energy Siting (NES) code structure and logic flow. Included in this section is a flow chart describing the major processes performed by the code.

The Navy Energy Siting code is driven by the main program ENSITE, which calls various subroutines designed to handle the major processes performed. The code can be broken into three major components: input/output, optimization and the set of alternate energy models.

The input process consists of reading three types of data; site data, model data and the run specification data. All input/output variables are stored in labeled common blocks, which allow subroutines easy access to large blocks of information.

The optimization portion of the program consists of a set of subroutines supplied by the Civil Engineering Laboratory. These routines use a gradient projection technique to determine the optimum mix of alternate energy systems.

The alternate energy models are the individual subroutines designed to model the various alternate energy systems.

#### 4.1 INPUT/OUTPUT

The main program ENSITE, as shown in Figure 4-1, calls three subroutines to load the input data: INSITE, INMODL, RUNSPC. The data are

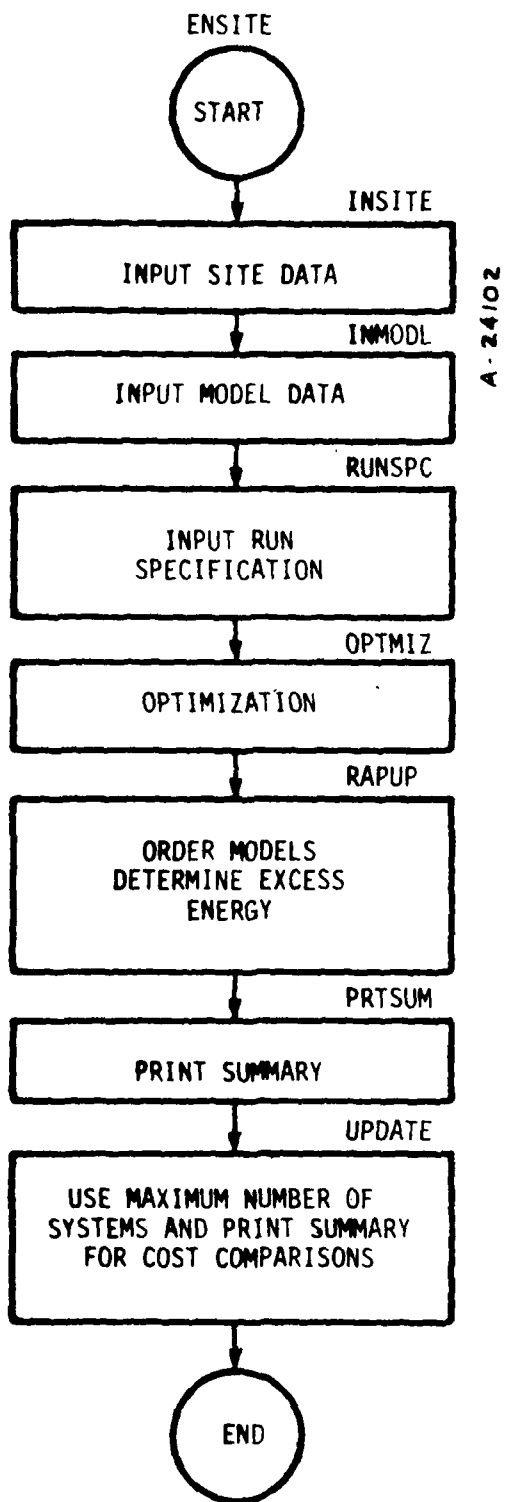


Figure 4-1. Navy Energy Siting code.

stored in labeled common blocks accessible to all routines. Subroutine INSITE reads the site dependent input data and stores it in the labeled common SITE and FUELSC. The site data consists of the demand data: electricity, heating, process steam, insolation and wind velocity profiles. Also included are geothermal reservoir data, commercial energy costs, inflation rates, and crunch factors.

Subroutine INMODL reads the model input data and stores the input in the labeled common block MODEL. The model input consists of data necessary for each alternate energy model. This data includes capital cost factors, fuel costs, fuel inflation rates, maintenance and operating costs, exponents, transportation cost, revenue from recovered material (RDF), efficiency factors, load factors, area factors, minimum and maximum number of systems, and starting values for number of systems. Not every alternate energy system requires all the input parameters mentioned, but all parameters are available to each model.

Subroutine RUNSPC reads input data, specifying which energy demand is to be satisfied and which alternate energy models are to be considered.

The output processes are handled by a wide range of subroutines, each designed to print a variety of information. All site, model and run specification data are printed. During the iterative steps of the optimization process, various levels of information are also printed indicating the progress of the optimization program. Once the optimization is complete, there is a summary printout that lists the mix of systems used, costs and energy produced.

#### 4.2 OPTIMIZATION

The optimization process uses the gradient projection technique to minimize total energy costs. Subroutine OPTMIZ (NONLIN) initiates the

program by calling subroutine INPUT which loads some fixed inputs and the minimum, maximum and starting points (number of systems) for each model (see Figure 4-2). This information is stored in labeled common LINCOM. The optimization process calls EVAL to compute alternate energy cost and commercial energy cost.

Subroutine CSUM and PARTL are also called during the optimization process to check constraints and compute the partial derivatives of the constraints. Once the costs and value of constraints are determined, the optimization routines adjust the mix of alternate energy systems accordingly, to minimize costs and not violate the various constraints. This process is repeated until a minimum is reached.

#### 4.3 EVAL (ALTERNATE ENERGY SYSTEMS)

The EVAL subroutine calls the individual alternate energy models ( $EVAL_n$ ) and the commercial energy routine (COSTCE) to determine total cost to satisfy all energy demands (Figure 4-3). Each alternate energy model ( $EVAL_n$ ), given the number of systems to evaluate ( $X_i$ ), computes energy produced, area required for systems, and cost of energy produced. This information is passed back to the main subroutine EVAL.

To determine the demand for commercial energy, EVAL calls the LOADDM subroutine before calling the alternate energy models. This moves the energy demands stored in common to the working array DMANDW. Each model called produces energy on an hourly basis, decrements the working demand array (energy produced is subtracted from the demand); the remaining energy demand is the commercial energy requirement. EVAL then calls the COSTCE subroutine to determine the cost of purchasing commercial energy that meets the demand not satisfied by the alternate energy models. Finally, EVAL returns the total cost to satisfy the annual energy demand to the OPTMIZ driver.

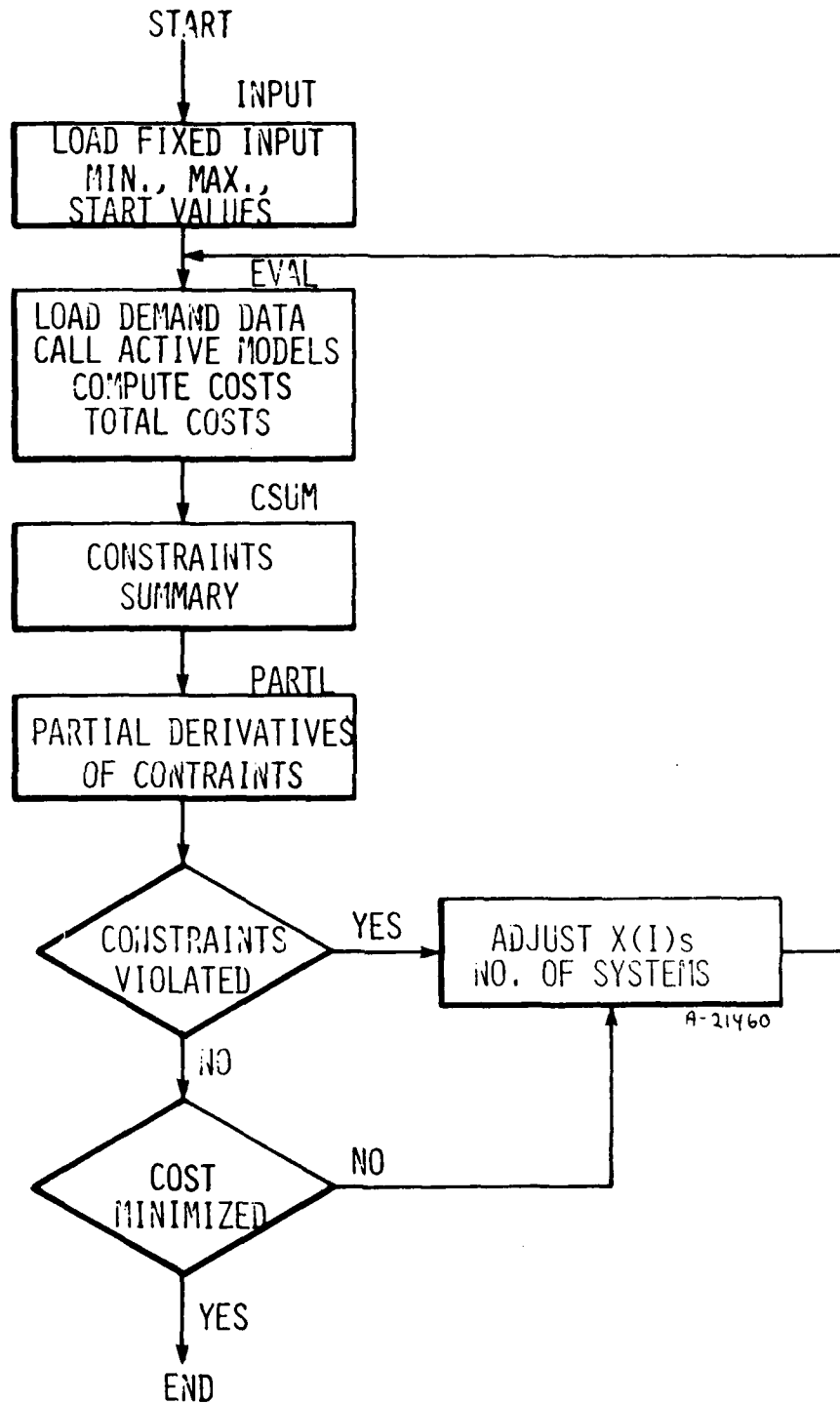


Figure 4-2. OPTMIZ flow chart.

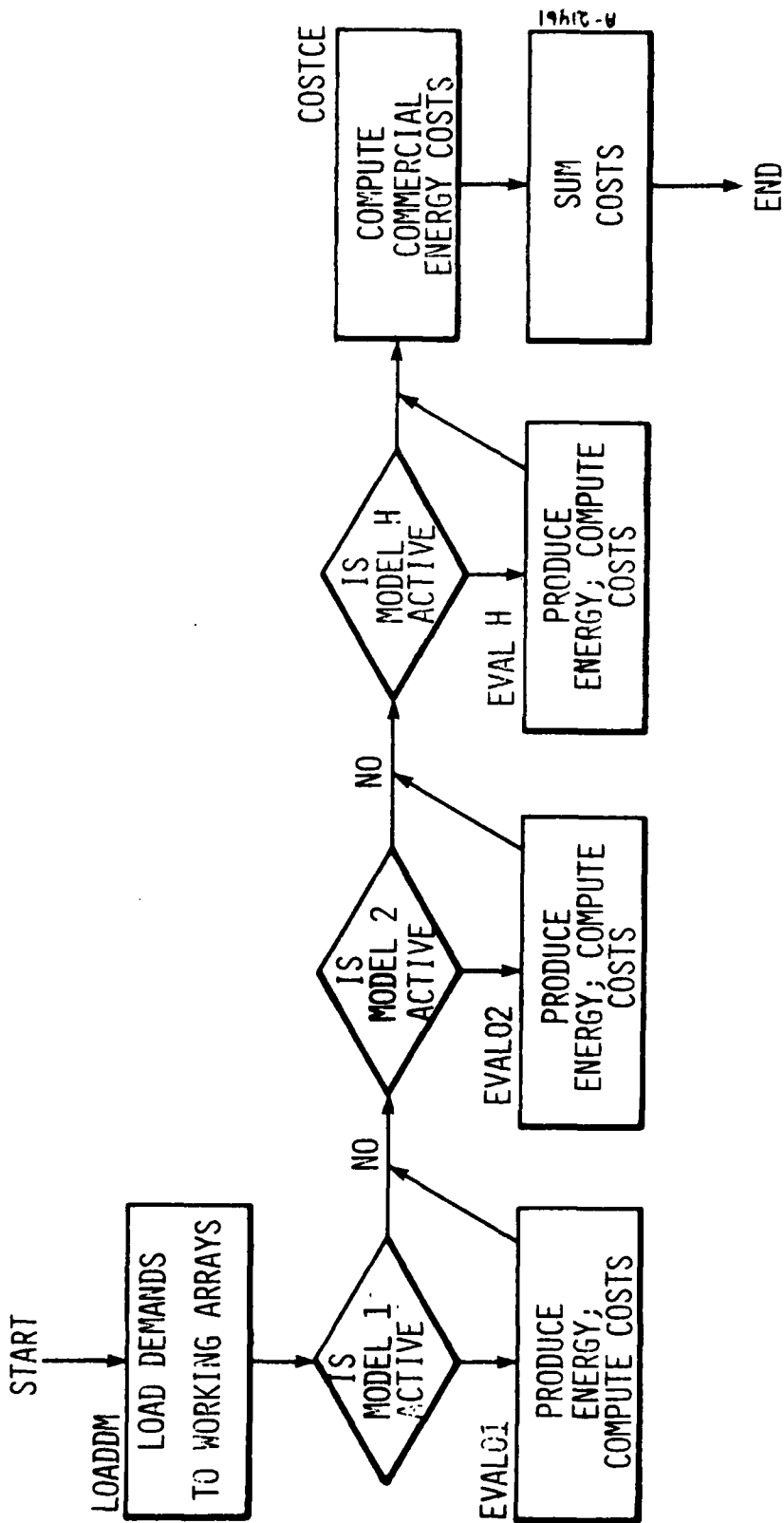


Figure 4-3. EVAL flow chart.

#### 4.4 COMMON BLOCK STORAGE

Most of the communication between subroutines is through labeled common blocks. In this section, the nature of the data contained in each labeled common is described.

The most important common is the labeled common MODEL which contains all input and output of the alternate energy models. The common block structure is illustrated in Figure 4-4. Essentially, each model has a block of storage equivalenced to the AMODEL array in labeled common MODEL. This storage is positional for each alternate energy model according to the MTYPE function.

Most of the communication between subroutines is done through labeled common blocks. A general description of the use and contents of these common blocks is:

Common/CMMRCL/: working storage for commercial energy parameters. These parameters are used to store the cost and amount of commercial energy purchased.

Common/CNTRLS/: model and demand names, working storage for number and names of models, and demands considered. This common block also contains values describing the demands that are satisfied by each alternate energy model.

Common/COSTS/: working storage for costs of energy produced by alternate energy models and commercial energy costs.

Common/ENRGY/: storage for energy produced by alternate energy models. Each model stores the energy produced hourly into any of three demand sectors.

Common/FUELSC/: storage for site input related to commercial energy purchases.

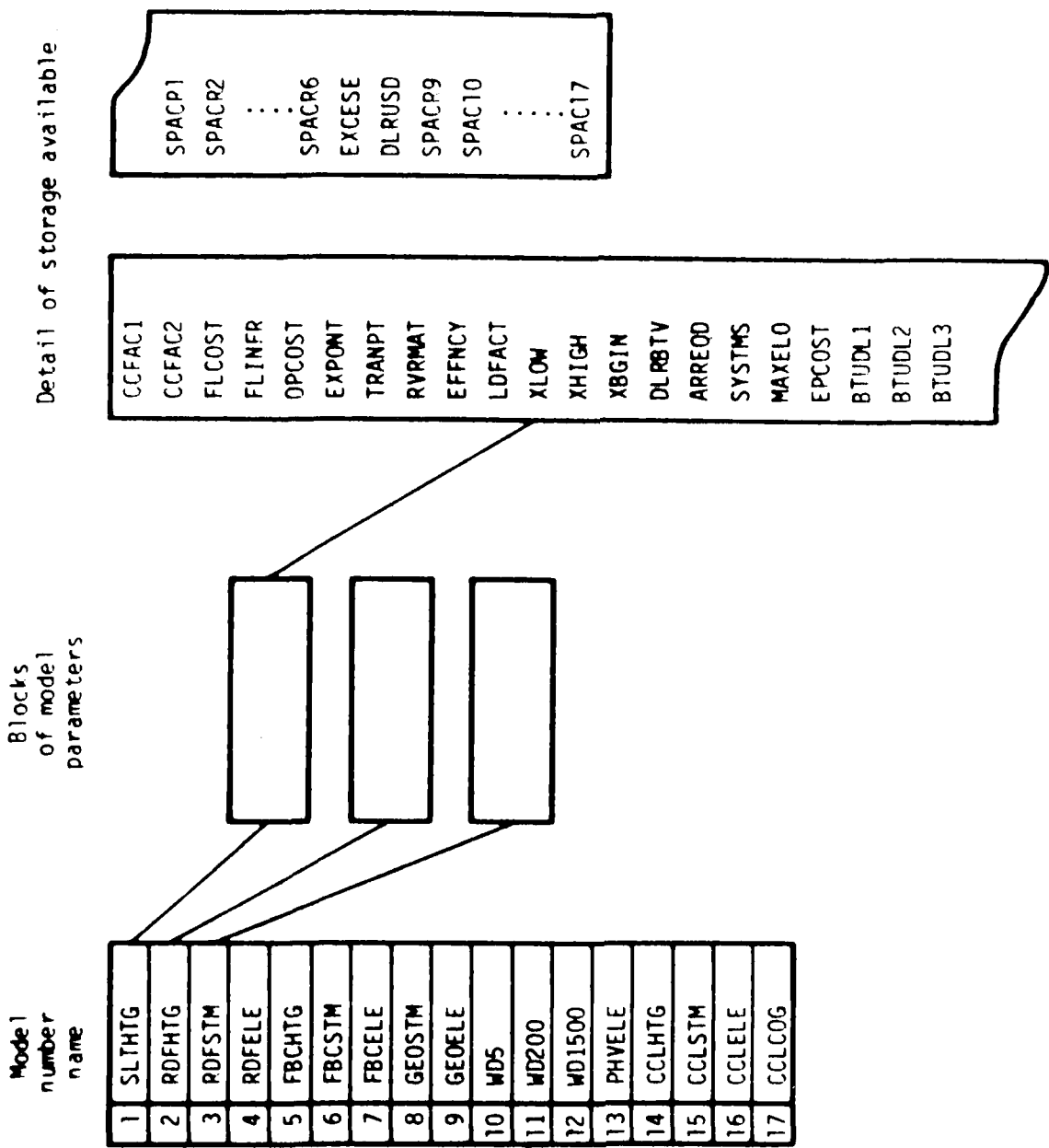


Figure 4-4. Common block structure for alternate energy model parameters.

- Common/HEADNG/: expanded names for demands, used in output headings.
- Common/IO/: variables related to input/output and logical variables related to end and error conditions.
- Common/LINCOM/: input data defined in INPUT that is transmitted to the optimization routines.
- Common/MODEL/: a large single dimension array (AMODEL) equivalenced to individual model parameters (Figure 4-4).
- Common/NDAYS/: storage for data such as number of days in each month and total number of days in the year.
- Common/SITE/: storage for site input data and working demand arrays.
- Common/USER/: storage for equality and inequality constraints and partials of constraints.

SECTION 5  
SUBROUTINE DESCRIPTIONS

This section describes the routines developed by Acurex to supplement the optimizing routines supplied by the Civil Engineering Laboratory.

Block Data BLKDAT: various data elements used by the code. Names of models and demand can be found here in arrays MODLS and DMANDS, respectively.

Subroutine BLKOUT: used to print the various yearly demand, insolation, and wind profiles used by the code.

Subroutine COSTCE: computes annual cost of commercial energy to meet demands left by alternate energy models.

Subroutine CSUM: loads the BSUM array with values of the equality constraints, and loads the BSUMNT array with values of the inequality constraints. The code currently has three inequality constraints on area, coal, and refuse availability. The sum of area used by the alternate energy models must be less or equal to the area available at the site. The total amount of refuse used by the RDF models must not exceed the amount available at the site. The amount of

coal used by alternate energy models must not exceed the coal available at the site.

Subroutine DETEXC: determines excess energy produced by each model. The models are ordered according to energy cost so that the cheapest energy is used first.

Main Program ENSITE: driver routine for the Navy Energy Siting Code.

Subroutine ERROUT: contains various input error messages used by code. Control is not returned to calling routine and code terminates.

Subroutine EVAL: executive driver for the individual alternate energy models. EVAL calls LOADDM to load demands into working array and then calls each model to determine energy produced and compute costs.

Subroutine EVAL<sub>n</sub>: corresponds to the various alternate energy models called by the EVAL routine. Each EVAL<sub>n</sub>, where n corresponds to the model numbers (see alternate energy models list Table 1-1), models a particular type of alternate energy system. Given the system size (e.g., ton/day, 10,000 ft<sup>2</sup> solar panels), the models determine the amount of energy delivered to a particular demand or set of demands (cogeneration). Also, capital cost, maintenance cost, fuel cost, and area required are computed.

Subroutine FCHART: uses f-chart method to determine the amount of energy supplied by the solar thermal model.

Subroutine INMODL: recognizes model name in the input deck and calls MODLIN to input model data.

Subroutine INPTCL: a special input routine called in addition to INPUT (see description) for all models which use coal as a fuel. It sets the capital cost factor and fuel cost to correct values depending on coal quality (high or low sulfur content).

Subroutine INPT08: a special input routine called in addition to INPUT (see description) when geothermal model EVAL08 is a candidate model. It computes maximum potential thermal energy.

Subroutine INPT09: a special input routine called, in addition to INPUT (see description), when geothermal model EVAL09 is a candidate model. It computes maximum potential electrical energy.

Subroutine INPTXX: called by INPUT to load minimum, maximum and starting X values (number of systems) for the alternate energy models.

Subroutine INPUT: initializes data for starting the optimization process. It loads this data into the common block, LINCOM, which transmits the data to the optimization routines. The variables used and their meaning are as follows:

XL(50) -- lower bound estimate for the number of systems  
XB(50) -- starting values for the number of systems  
XH(50) -- upper bound estimate for the number of systems

KNT(50) -- array used by the system only  
 KON(50) -- array used by the system only  
 N -- number of models being considered  
 CMM -- -1 minimize cost  
 NLINEQ -- number of equality constraints  
 NNOTEQ -- number of inequality constraints  
 TOLCON -- allowable violation of constraints, approximately  
 $((XH(1)) - XL(1)) * 10^{-7}$ , never 0.0  
 IOUT -- output flag: -1 -- answer only, 0, 1 or 2 -- more  
 debugging information  
 ITER -- used by the system only  
 ITERMX -- used by the system only

It also calls INPTXX to load the starting values  
 XL, XH, XB for each alternate energy model. If a  
 particular model, for example geothermal, requires  
 additional calculations at this stage, INPUT calls  
 additional input subroutines designed specifically  
 for that model.

Subroutine INSITE: reads the various site dependent data. That data  
 includes the energy demand profiles, weather  
 profiles, commercial energy data set, and general  
 data set.

Subroutine ITRPRT: used to print progress of optimization during the  
 iterative process. This print output is initiated  
 when IOUT is greater than -1.

Subroutine LOADDM: called by EVAL to load energy demand profiles into the working demand arrays.

Function MATBIT: called to determine the demand a particular model satisfies. Each model has a value in the ISTSFY array which, when broken down into bit representation, will identify the demand(s) the model will satisfy.

Subroutine MATCH: called by RUNSPC to determine from input which demand or model is being requested.

Subroutine MAXVAL: a general utility routine that determines the maximum value contained in an array.

Subroutine MODLIN: called by INMODL to read data for the model named on lead card of model input data set.

Subroutine MODOUT: called to output the model data in a readable format.

Function MTYPE: used to determine the subscript of model data when given the model number (see Table 2-1 for model numbers). This is done because of the complex structure of the model data contained in the labeled common MODEL. The user should refer to Section 4.4 (common block storage) and Figure 4-4 (common block structure for alternate energy model parameters).

Subroutine OPTMIZ

(NONLIN): the gradient projection optimization technique, supplied by the Civil Engineering Laboratory.

Subroutine ORDER: used to reorder model calling sequence according to cost.

Subroutine PARTL(X): loads the FPC array with the partial derivatives of the constraints, with respect to the number of systems. For example,  $FPC(I,J)$  = partial derivative of constraint J with respect to number of systems I.

Subroutine PRTLIN: called by MODOUT to print various lines of alternate energy model output.

Subroutine PRTSUM: called to give a summary printout after the optimum is reached.

Subroutine RAPUP: duplicates last call to EVAL with models reordered.

Subroutine RUNSPC: reads run specification input data deck and determines whether data are available for models requested.

Subroutine SCRIPT: returns the proper subscripts to be used in referencing working arrays when given the month, hour, model, and demand.

Subroutine SETOUT: called to set up output for ITRPRT.

Function UAC: computes uniform annual cost, given model initial capital costs, and inflation rates.

Subroutine UPDATE: sets up the last call to EVAL, applying the maximum number of systems for each demand to the other models in that demand. This is done so that cost comparisons can be made across models. An additional summary printout shows the results of UPDATE.

## SECTION 6

### SAMPLE RUN

Presented in this section is a sample run which was run on a CDC 7600 Computer. For this run the following is presented:

- A brief description of the nature of the run and solution
- A listing of the input data deck
- A listing of the output generated

The goal of this run was to determine the optimum mix of alternate energy systems and commercially produced energy at the Norfolk Naval Base which satisfies the three energy demands: space heating and hot water (SPCHTG), process steam (PROSTM), and electricity (ELECTR).

The candidate models for this run are refuse derived fuel for each demand (RDFHTG, RDFSTM, RDFELE), fluidized bed combustion for each demand (FBCHTG, FBCSTM, FBCELE); conventional coal for each demand (CCLHTG, CCLSTM, CCLELE); plus the co-generation model (CCLCOG) for electricity and steam, solar thermal for heating (SLTHTG), photovoltaic for electricity (PHVELE), and three wind electric models sized at 5 kW, 200 kW, 1500 kW, (WD5, WD200, WD1500).

The input deck and results are listed. Note that the print flag for this run was set at -1 (card 320 of input deck).

The output generated shows all demand, insolation and wind profiles input. Next, the geothermal, commercial, and general site data are

printed. Once all site data is printed, each of the model's data is printed as it is read from the input deck. Then the run specification is read, checked, and printed. The demand numbers and model numbers are printed for those demands and models being considered. Each of the model's lower bound, starting point and upper bound are listed in order of the models input sequence. The optimization process is not printed when a print option flag of -1 is used. The end of the optimization is indicated by the printing of "BEST RESULTS OBTAINED," a summary printout follows.

The summary printout shows the demand left to be satisfied by oil-fired boilers for the heating and process steam demand and purchased electricity. Then the energy produced by each model for the optimum mix and a summary printout for each demand, indicating the models selected (optimum mix) is listed. Finally, for cost comparison, a summary printout for each demand is listed using the same number of systems for each model within a demand sector.

The results for the sample run show the optimum mix to be:

- Space heating and hot water
  - Fluidized bed combustion: 295.4 (tons/day)
- Process steam
  - Refuse derived fuel: 6.7 (tons/day)
  - Fluidized bed combustion: 70.95 (tons/day)
  - Conventional coal cogeneration: 206.9 (tons/day)

Electricity

- Fluidized bed combustion: 553.4 (tons/day)
- Conventional coal cogeneration: 206.9 (tons/day)

NOTE: Cogeneration competes in two demand sectors. Thus, 206.9 (tons/day) is the total amount of coal consumed: 206.9 (tons/day) is not consumed in each demand sector.



NOTE: Cogeneration competes in two demand sectors. Thus, 206.9 (tons/day) is the total amount of coal consumed: 206.9 (tons/day) is not consumed in each demand sector.



103.	129.6	114.3	104.1	91.07	91.07	157.5	225.8
104.	272.7	280.8	275.5	303.9	501.1	277.9	215.6
105.	194.7	189.6	192.4	210.5	189.6	174.5	183.5
106.	134.0	118.1	107.5	94.10	94.10	242.1	225.5
107.	281.8	290.0	284.7	314.0	311.1	287.1	228.8
108.	201.2	195.9	194.8	217.5	192.9	185.5	149.0
109.	129.6	114.3	104.1	91.07	91.07	157.5	225.8
110.	272.7	280.8	275.5	303.9	301.1	277.9	215.6
111.	194.7	189.6	192.4	210.5	189.6	174.5	183.5
112.	43.51	0.06	0.0	1.0	0.0	9,9999	1,100
113.	2.89	0.08	0.50	0.80	12601.	9,9994	1,300
114.	2.89	0.08	0.50	0.80	16435.	9,9999	1,300

9.9999 E30 HIGH  
13.89 E06  
120.

119.	0.10	45.09	44.89	62.34	64.58	77.71	79.40	75.20
120.	59.95	59.12	55.07	47.10	.0000	.0000	743.5	143.7
121.	74.57	.0000	.0000	.0000	.0000	.0000	159.4	143.7
122.	.0000	182.8	203.5	215.3	203.5	182.8	.0000	.0000
123.	139.4	.0000	.0000	.0000	.0000	.0000	74.48	121.2
124.	749.3	.0000	.0000	.0000	.0000	.0000	156.8	121.2
125.	.0000	190.0	216.7	230.7	216.7	150.0	.0000	.0000
126.	156.8	.0000	.0000	.0000	.0000	.0000	54.59	116.5
127.	94.46	.0000	.0000	.0000	.0000	.0000	170.7	116.5
128.	.0000	217.6	254.2	272.5	254.2	217.6	.0000	.0000
129.	170.7	.0000	.0000	.0000	.0000	.0000	54.13	101.7
130.	54.39	.0000	.0000	.0000	.0000	.0000	165.8	101.7
131.	.0000	221.9	264.8	285.7	264.8	221.9	.0000	.0000
132.	165.8	.0000	.0000	.0000	.0000	.0000	21.36	80.32
133.	34.13	.0000	.0000	.0000	.0000	.0000	141.1	80.32
134.	.0000	195.4	236.9	256.9	236.9	195.4	.0000	.0000
135.	141.1	.0000	.0000	.0000	.0000	.0000	14.53	61.20
136.	21.36	.0000	.0000	.0000	.0000	.0000	111.5	61.20
137.	.0000	156.9	191.7	208.4	191.7	156.9	.0000	.0000
138.	111.5	.0000	.0000	.0000	.0000	.0000	17.94	72.06
139.	14.33	.0000	.0000	.0000	.0000	.0000	179.1	72.06
140.	.0000	180.3	219.5	238.2	219.5	180.3	.0000	.0000
141.	129.1	.0000	.0000	.0000	.0000	.0000	46.40	46.00
142.	17.94	.0000	.0000	.0000	.0000	.0000	144.5	46.00
143.	.0000	196.0	235.3	254.4	235.3	196.0	.0000	.0000
144.	144.5	.0000	.0000	.0000	.0000	.0000	41.84	101.8
145.	26.40	.0000	.0000	.0000	.0000	.0000	155.2	101.8
146.	.0000	201.6	237.1	254.8	237.1	201.6	.0000	.0000
147.	155.2	.0000	.0000	.0000	.0000	.0000	50.24	140.9
148.	41.84	.0000	.0000	.0000	.0000	.0000	164.9	140.9
149.	.0000	233.8	268.6	286.6	268.6	233.8	.0000	.0000
150.	169.5	.0000	.0000	.0000	.0000	.0000	527.5	158.7
151.	90.24	.0000	.0000	.0000	.0000	.0000	103.2	158.7
152.	.0000	212.9	238.5	252.6	238.5	212.9	.0000	.0000
153.	103.2	.0000	.0000	.0000	.0000	.0000	.0000	.0000

FROM GOEX...



205.	7.424	6.229	4.616	2.475	1.126	2.475	4.010	4.028
206.	1.807	4.948	5.371	6.756	7.914	6.943	10.07	10.08
207.	12.21	15.43	15.54	20.17	15.54	15.43	12.21	10.08
208.	10.07	8.943	7.414	6.756	5.571	5.948	1.07	1.074
209.	3.246	1.105	3.568	1.105	3.246	4.619	4.074	7.217
210.	6.241	9.369	10.17	11.51	12.73	14.84	17.46	14.04
211.	12.73	11.51	10.17	7.369	6.241	7.217	4.074	4.074
212.	7.684	6.860	5.697	4.512	2.884	7.481	8.000	7.481
213.	2.089	4.512	5.697	6.860	7.684	7.012	9.014	11.15
214.	12.37	14.48	19.11	14.48	12.37	11.15	9.014	4.012
215.	5.087	3.465	1.324	5.755	1.324	3.465	5.087	6.273
216.	7.835	8.460	5.588	10.39	11.74	12.95	15.06	17.68
217.	15.06	12.95	11.74	10.39	9.588	6.460	7.835	6.273
218.	1.957	1.209	1.957	4.098	5.720	6.906	8.069	4.098
219.	10.22	11.03	12.36	13.58	15.69	20.32	15.69	15.50
220.	12.36	11.03	10.22	9.053	8.069	6.906	5.720	4.098
221.	2.567	4.708	6.330	7.516	8.074	7.705	11.84	11.64
222.	12.97	14.19	16.30	20.93	16.30	14.19	12.97	11.64
223.	10.63	9.703	6.674	7.516	6.330	4.708	2.567	1.819
224.	2.847	1.013	3.154	4.777	5.762	7.125	8.149	9.277
225.	10.08	11.42	12.64	14.74	19.37	14.74	12.64	11.42
226.	10.08	9.277	8.149	7.125	5.762	4.777	3.154	1.013
227.	1.680	2.429	4.569	6.192	7.378	6.540	4.569	10.49
228.	11.50	12.85	14.05	16.16	20.79	16.16	14.05	12.85
229.	11.50	10.69	9.565	8.540	7.378	6.192	4.569	2.429
230.	NONE							
231.	SLHTG							
232.	85000.	35.00	0.0	0.0	0.20	1.0	0.0	0.0
233.	0.35	0.0	25000.					
234.	0.0	350.	10.					
235.	0.61	0.73						
236.	MOFHTG							
237.	27000.	0.0	0.0	0.0	16.57	1.0	0.0	7.86
238.	0.54	0.90	327.1					
239.	0.0	350.	10.					
240.	0.	0.	0.					
241.	MOFSYM							
242.	27000.	0.0	0.0	0.0	10.57	1.0	0.0	7.86
243.	0.486	0.90	327.1					
244.	0.0	500.	10.					
245.	0.	0.	0.					
246.	MOFELE							
247.	27000.	250000.	0.0	0.0	16.57	1.0	0.0	7.86
248.	0.23	0.90	327.1					
249.	0.0	1000.	15.					
250.	0.	0.	0.					
251.	GEOSTM							
252.	125.77	0.0	0.0	0.0	0.0	0.05	0.0	0.0
253.	0.720	0.90	6.0933					
254.	0.0	0.0	60000.					
255.								

256.	CCLELF	U.0	U.0	0.0	0.0	0.0	0.0	0.0
257.	U.0	U.90	U.0	4.170	U.0	U.0	U.0	U.0
258.	U.0	U.0	U.0	5.00	U.0	U.0	U.0	U.0
259.	U.0	U.0	U.0	U.0	U.0	U.0	U.0	U.0
260.	WD5	1000.	1000.	375.	375.	375.	375.	375.
261.	15000.	U.0	U.0	300.	300.	300.	300.	300.
262.	U.000755	15.	15.	15.	15.	15.	15.	15.
263.	U.0	1000.	1000.	15000.	15000.	15000.	15000.	15000.
264.	U.0	1000.	1000.	15.	15.	15.	15.	15.
265.	WD200	U.0	U.0	16000.	16000.	16000.	16000.	16000.
266.	500000.	U.0	U.0	15.	15.	15.	15.	15.
267.	U.0	1000.	1000.	15000.	15000.	15000.	15000.	15000.
268.	U.0	1000.	1000.	15.	15.	15.	15.	15.
269.	WD1500	U.0	U.0	35000.	35000.	35000.	35000.	35000.
270.	1500000.	U.0	U.0	15.	15.	15.	15.	15.
271.	U.0	1000.	1000.	112500.	112500.	112500.	112500.	112500.
272.	U.0	1000.	1000.	15.	15.	15.	15.	15.
273.	U.0	1000.	1000.	15.	15.	15.	15.	15.
274.	U.0	1000.	1000.	15.	15.	15.	15.	15.
275.	U.0	1000.	1000.	15.	15.	15.	15.	15.
276.	CCLELF	U.0	U.0	402.94	402.94	402.94	402.94	402.94
277.	U.0	U.90	U.0	10.	10.	10.	10.	10.
278.	U.0	350.	350.	39.53	39.53	39.53	39.53	39.53
279.	U.0	12510.	12510.	2/1.77	2/1.77	2/1.77	2/1.77	2/1.77
280.	CCLELF	U.0	U.0	0.05	0.05	0.05	0.05	0.05
281.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
282.	U.0	350.	350.	10.	10.	10.	10.	10.
283.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12
284.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
285.	U.0	350.	350.	10.	10.	10.	10.	10.
286.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12
287.	CCLELF	U.0	U.0	0.05	0.05	0.05	0.05	0.05
288.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
289.	U.0	350.	350.	10.	10.	10.	10.	10.
290.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12
291.	CCLELF	U.0	U.0	0.05	0.05	0.05	0.05	0.05
292.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
293.	U.0	350.	350.	10.	10.	10.	10.	10.
294.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12
295.	CCLELF	U.0	U.0	0.05	0.05	0.05	0.05	0.05
296.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
297.	U.0	350.	350.	10.	10.	10.	10.	10.
298.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12
299.	CCLELF	U.0	U.0	0.05	0.05	0.05	0.05	0.05
300.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
301.	U.0	350.	350.	10.	10.	10.	10.	10.
302.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12
303.	CCLELF	U.0	U.0	0.05	0.05	0.05	0.05	0.05
304.	U.0	U.90	U.0	402.94	402.94	402.94	402.94	402.94
305.	U.0	350.	350.	10.	10.	10.	10.	10.
306.	U.0	12510.	12510.	294.12	294.12	294.12	294.12	294.12

307.	0.37	0.90	402.94	0.65	0.70	0.65	0.60	0.0
308.	0.0	1000.	15.					
310.	1.621	E0612510.	59.55	1.021	E069930.	31.74		
311.	PHVELE							
312.	0.0	32.20	0.0	0.0	0.20	1.0	0.0	0.0
313.	0.10	1.0	2500.					
314.	0.0	1000.	15.					
315.								
316.	ENDMD1							
317.	SPCMTG PKOSTM ELECTR							
318.	MDFELE,FBCELE,							
319.	SLTHTG,RDFTHTG,FBCHTG,CCLHTG,MDFSIP,FBESTM,							
320.								

.MD200 .MD1500.PHVELE.CCLELE.CCLC06  
 .CCLSTM,

-1





PROCESS STEAM

INPUT ENERGY DEMAND (MMBTU/HK)

MONTH HOURS

MONTH	HOURS	1-8	9-16	17-24	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
JAN	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	260.60	260.60	275.50	303.90	303.90	303.90	303.90	303.90	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50
FEB	1-8	143.50	126.50	126.50	115.20	100.80	100.80	100.80	100.80	100.80	152.30	250.00
	9-16	302.00	310.70	310.70	305.00	336.40	336.40	336.40	336.40	307.60	267.50	238.70
	17-24	215.50	209.90	209.90	213.00	233.00	233.00	233.00	233.00	198.60	192.90	181.10
MAR	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	280.60	280.60	275.50	303.90	303.90	303.90	303.90	277.80	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50
APR	1-8	134.00	118.10	118.10	107.50	94.100	94.100	94.100	94.100	94.100	142.10	235.30
	9-16	281.80	290.00	290.00	284.70	314.00	314.00	314.00	314.00	287.10	249.70	222.80
	17-24	201.20	195.90	195.90	198.80	217.50	217.50	217.50	217.50	185.30	180.00	167.00
MAY	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	280.60	280.60	275.50	303.90	303.90	303.90	303.90	277.80	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50
JUN	1-8	134.00	118.10	118.10	107.50	94.100	94.100	94.100	94.100	94.100	142.10	235.30
	9-16	281.80	290.00	290.00	284.70	314.00	314.00	314.00	314.00	287.10	249.70	222.80
	17-24	201.20	195.90	195.90	198.80	217.50	217.50	217.50	217.50	185.30	180.00	167.00
JUL	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	280.60	280.60	275.50	303.90	303.90	303.90	303.90	277.80	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50
AUG	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	280.60	280.60	275.50	303.90	303.90	303.90	303.90	277.80	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50
SEP	1-8	134.00	118.10	118.10	107.50	94.100	94.100	94.100	94.100	94.100	142.10	235.30
	9-16	281.80	290.00	290.00	284.70	314.00	314.00	314.00	314.00	287.10	249.70	222.80
	17-24	201.20	195.90	195.90	198.80	217.50	217.50	217.50	217.50	185.30	180.00	167.00
OCT	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	280.60	280.60	275.50	303.90	303.90	303.90	303.90	277.80	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50
NOV	1-8	134.00	118.10	118.10	107.50	94.100	94.100	94.100	94.100	94.100	142.10	235.30
	9-16	281.80	290.00	290.00	284.70	314.00	314.00	314.00	314.00	287.10	249.70	222.80
	17-24	201.20	195.90	195.90	198.80	217.50	217.50	217.50	217.50	185.30	180.00	167.00
DEC	1-8	129.60	114.30	114.30	104.10	91.070	91.070	91.070	91.070	91.070	137.50	225.80
	9-16	272.70	280.60	280.60	275.50	303.90	303.90	303.90	303.90	277.80	241.60	215.60
	17-24	194.70	189.60	189.60	192.40	210.50	210.50	210.50	210.50	179.30	174.20	165.50



PHOTOVOLTAIC INSULATION PROFILE (BTU/FT<sup>2</sup>HR)

MONTH	HOURS	1-8	9-16	17-24	0.	149.00	148.90	0.	152.20	148.90	0.	149.00	0.	159.70	211.60
JAN	1-8	0.	159.70	0.	0.	149.00	148.90	0.	152.20	148.90	0.	149.00	0.	159.70	211.60
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FEB	1-8	0.	150.50	0.	0.	149.50	153.20	0.	157.70	153.20	0.	149.50	0.	270.70	165.90
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MAR	1-8	0.	179.80	0.	0.	167.60	196.40	0.	205.40	196.40	0.	167.60	0.	154.50	172.90
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APR	1-8	0.	192.00	0.	0.	207.90	221.60	0.	250.70	221.60	0.	207.90	0.	114.40	170.10
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MAY	1-8	0.	177.40	0.	0.	196.30	211.40	0.	220.60	211.40	0.	196.30	0.	95.560	150.50
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
JUN	1-8	0.	129.80	0.	0.	144.90	156.80	0.	164.00	156.80	0.	144.90	0.	66.280	106.20
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
JUL	1-8	0.	160.20	0.	0.	178.20	192.40	0.	201.10	192.40	0.	178.20	0.	83.810	134.70
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
AUG	1-8	0.	163.20	0.	0.	178.30	190.90	0.	199.00	190.90	0.	178.30	0.	95.290	141.90
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SEP	1-8	0.	156.40	0.	0.	165.60	174.50	0.	181.10	174.50	0.	165.60	0.	116.80	145.50
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OCT	1-8	0.	207.20	0.	0.	209.20	215.90	0.	222.60	215.90	0.	209.20	0.	271.70	215.90
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NOV	1-8	0.	186.90	0.	0.	177.30	178.20	0.	182.50	178.20	0.	177.30	0.	106.90	234.20
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DEC	1-8	0.	196.60	0.	0.	178.90	177.10	0.	180.50	177.10	0.	178.90	0.	196.60	266.20
	9-16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	17-24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

INPUT WIND VELOCITY PROFILE (MPH)  
MONTH HOURS

JAN	1-8	6.4690	7.6540	8.8170	9.9410	10.970	11.770	13.110	14.330
	9-16	16.440	21.060	16.440	14.330	13.110	11.770	10.970	9.9410
	17-24	8.8170	7.6540	6.4690	4.8460	2.7050	1.9570	2.7050	4.8460
FEB	1-8	1.8880	2.6360	4.7770	6.4000	7.5850	8.7480	9.7720	10.900
	9-16	11.710	13.040	14.260	16.370	20.940	16.370	14.260	13.040
	17-24	11.710	10.900	9.7720	8.7480	7.5850	6.4000	4.7770	2.6360
MAR	1-8	3.2570	5.3980	7.0210	8.2070	9.3690	10.390	11.520	12.330
	9-16	13.660	14.880	16.990	21.620	16.990	14.880	13.660	12.330
	17-24	11.520	10.390	9.3690	8.2070	7.0210	5.3980	3.2570	2.5090
APR	1-8	7.4240	8.5860	9.6110	10.740	11.540	12.880	14.100	16.210
	9-16	20.830	16.210	14.100	12.880	11.540	10.740	9.6110	8.5860
	17-24	7.4240	6.2380	4.6160	2.4750	1.7260	2.4750	4.6160	6.2380
MAY	1-8	1.8070	3.9480	5.5710	6.7560	7.9190	8.9430	10.070	10.880
	9-16	12.210	13.430	15.540	20.170	15.540	13.430	12.210	10.880
	17-24	10.070	8.9430	7.9190	6.7560	5.5710	3.9480	1.8070	1.0550
JUN	1-8	3.2460	1.1050	3.5680	1.1050	3.2460	4.8690	6.0340	7.4170
	9-16	8.2410	9.3640	10.170	11.510	12.730	14.840	19.460	14.840
	17-24	12.730	11.510	10.170	9.3640	8.2410	7.2170	6.0340	4.8690
JUL	1-8	7.8840	6.8600	5.6970	4.5120	2.8890	7.8810	0.	7.4810
	9-16	2.8890	4.5120	5.6970	6.8600	7.8840	9.0120	9.8180	11.150
	17-24	12.370	14.480	19.110	14.480	12.370	11.150	9.8180	9.0120
AUG	1-8	5.0870	3.4650	1.3240	5.7550	1.3240	3.4650	5.0870	6.2730
	9-16	7.4350	8.4600	9.5880	10.390	11.730	12.950	15.060	19.680
	17-24	15.060	12.950	11.730	10.390	9.5880	8.4600	7.4350	6.2730
SEP	1-8	1.9570	1.2090	1.9570	4.0980	5.7200	6.9060	8.0690	9.0950
	9-16	10.220	11.030	12.360	13.580	15.690	20.320	15.690	13.580
	17-24	12.360	11.030	10.220	9.0930	8.0690	6.9060	5.7200	4.0950
OCT	1-8	2.5670	4.7080	6.3300	7.5160	8.6790	9.7030	10.830	11.640
	9-16	12.970	14.190	16.300	20.930	16.300	14.190	12.970	11.640
	17-24	10.830	9.7030	8.6790	7.5160	6.3300	4.7080	2.5670	1.8190
NOV	1-8	2.6470	1.0130	3.1540	4.7770	5.9620	7.1250	8.1490	9.2770
	9-16	10.080	11.420	12.640	14.740	19.370	14.740	12.640	10.080
	17-24	10.080	9.2770	8.1490	7.1250	5.9620	4.7770	3.1540	1.0130
DEC	1-8	1.6800	2.4290	4.5690	6.1920	7.3780	8.5400	9.5650	10.690
	9-16	11.500	12.830	14.050	16.160	20.790	16.160	14.050	12.830
	17-24	11.500	10.690	9.5650	8.5400	7.3780	6.1920	4.5690	2.4290

GEOTHERMAL POOL INPUT DATA

GEOTHERMAL POOL QUALITY NONE  
 GEOTHERMAL POOL SIZE (MBTU) -0.  
 GEOTHERMAL POOL TEMPERATURE (DEG C) -0.

GEOTHERMAL DATA

DEMAND	COST (\$/MMH)	INFLATION RATE	COMMERCIAL ENERGY EFFICIENCY	CAPITAL COST (\$)	MAINT. & OPER.	PURCHASE LIMIT (MMH /YR)
ELECTR	43.510	.60000E-01	1.0000	0.	0.	.99999E+31
DEMAND	COST (\$/MBTU)	INFLATION RATE	COMMERCIAL ENERGY EFFICIENCY	CAPITAL COST (\$)	MAINT. & OPER.	PURCHASE LIMIT (MBTU/YR)
SPCHTG	2.8900	.80000E-01	.80000	12661.	.50000	.99999E+31
DEMAND	COST (\$/MBTU)	INFLATION RATE	COMMERCIAL ENERGY EFFICIENCY	CAPITAL COST (\$)	MAINT. & OPER.	PURCHASE LIMIT (MBTU/YR)
PROSTM	2.8900	.80000E-01	.80000	16433.	.50000	.99999E+31

COMMERCIAL ENERGY DATA

GENERAL SITE INPUT DATA

AMBIENT TEMPERATURES (DEG F)	39.95	45.09	62.34	68.38	77.71
MOUF AREA AVAILABLE (SQ FT)	79.40	76.20	59.12	55.07	47.10
LAND AREA AVAILABLE (SQ FT)	.13890E+08				
NUMBER OF PEOPLE AT SITE	-0.				
TONS OF REFUSE	120.00				
DISCOUNT INTEREST RATE	.10000				
COAL COST *NOT USED*	-0.				
QUANTITY OF COAL (TONS)	.99999E+31				
QUALITY OF COAL -SULFUR*	HIGH				

GENERAL SITE DATA

INDICATES THAT MODEL FBCHTG HAS BEEN INPUT

PRINTOUT OF MODEL FBCHTG DATA

MODLIN - FBCHTG  
 INPUT DATA FOR FBCHTG MODEL

PERFORMANCE :  
 - EFFICIENCY (BTU DELIVERED / BTU INPUT) = .450000  
 - AREA FACTOR (FT\*\*2/(TON/DAY)) = 402.940  
 - LOAD FACTOR = .900000  
 HIGH SULFUR CONTENT  
 - COAL QUALITY (BTU/LBM) = 12510.0  
 - COAL QUALITY (BTU/LBM) = 9930.00  
 COST :  
 HIGH SULFUR CONTENT  
 - CAPITAL COST FACTOR (\$/MBTU/YR) = 487.100  
 LOW SULFUR CONTENT  
 - CAPITAL COST FACTOR (\$/MBTU/YR) = 487.100  
 - OP. AND MAINT. COST (AS ANNUALIZED CAP. COST) = .500000  
 - EXPONENT = .650000  
 MODLIN - FBCHTG

INPUT DATA FOR FBCHTG MODEL

PERFORMANCE :  
 - EFFICIENCY (BTU DELIVERED / BTU INPUT) = .765000  
 - AREA FACTOR (FT\*\*2/(TON/DAY)) = 402.940  
 - LOAD FACTOR = .900000  
 HIGH SULFUR CONTENT  
 - COAL QUALITY (BTU/LBM) = 12510.0  
 - COAL QUALITY (BTU/LBM) = 9930.00  
 COST :  
 HIGH SULFUR CONTENT  
 - CAPITAL COST FACTOR (\$/MBTU/YR) = 950.000  
 LOW SULFUR CONTENT  
 - CAPITAL COST FACTOR (\$/MBTU/YR) = 950.000  
 - OP. AND MAINT. COST (AS ANNUALIZED CAP. COST) = .500000  
 - EXPONENT = .650000  
 MODLIN - FBCHTG

INPUT DATA FOR FBCHTG MODEL

PERFORMANCE :  
 - EFFICIENCY (BTU DELIVERED / BTU INPUT) = .570000  
 - AREA FACTOR (FT\*\*2/(MM/HR)) = 402.940  
 - LOAD FACTOR = .900000  
 HIGH SULFUR CONTENT  
 - COAL QUALITY (BTU/LBM) = 12510.0  
 - COAL QUALITY (BTU/LBM) = 9930.00  
 COST :  
 HIGH SULFUR CONTENT  
 - CAPITAL COST FACTOR (\$/MW) = .162100E+07  
 LOW SULFUR CONTENT  
 - CAPITAL COST FACTOR (\$/MW) = .162100E+07  
 - OP. AND MAINT. COST (AS ANNUALIZED CAP. COST) = .500000  
 - EXPONENT = .650000

MODLIN - SLMTG

INPUT DATA FOR SLMTG MODEL

PERFORMANCE :

- EFFICIENCY IS DETERMINED BY THE FCMAT METHOD.  
PLEASE CONSULT MODEL DESCRIPTION.
- AREA FACTOR = 25000.0

COST :

- AREA DEPENDENT CAPITAL COST (\$/FT\*\*2) = 35.0000
- NON AREA DEPENDENT CAPITAL COST (\$) = 85000.0
- MAINTENANCE COST (8 ANNUALIZED CAP. COST) = .200000

MODLIN - RDMFTG

INPUT DATA FOR RDMFTG MODEL

PERFORMANCE :

- EFFICIENCY (BTU DELIVERED / BTU INPUT) = .540000
- AREA FACTOR (FT\*\*2/(TON/DAY)) = 327.100
- LOAD FACTOR = .900000

COST :

- CAPITAL COST FACTOR (\$/(TON/DAY)) = 27000.0
- OPERATING AND MAINTENANCE COST (\$/TON) = 18.5700
- REVENUE FROM RECOVERED MATERIAL (\$/TON) = 7.800000
- TRANSPORTATION COST (\$) = 0.
- EXPONENT = 1.00000

MODLIN - RDFSFM

INPUT DATA FOR RDFSFM MODEL

PERFORMANCE :

- EFFICIENCY (BTU DELIVERED / BTU INPUT) = .486000
- AREA FACTOR (FT\*\*2/(TON/DAY)) = 327.100
- LOAD FACTOR = .900000

COST :

- CAPITAL COST FACTOR (\$/(TON/DAY)) = 27000.0
- OPERATING AND MAINTENANCE COST (\$/TON) = 18.5700
- REVENUE FROM RECOVERED MATERIAL (\$/TON) = 7.800000
- TRANSPORTATION COST (\$) = 0.
- EXPONENT = 1.00000

MODLIN - RDFELE

INPUT DATA FOR RDFELE MODEL

PERFORMANCE :

- EFFICIENCY (BTU DELIVERED / BTU INPUT) = .230000
- AREA FACTOR (FT\*\*2/(TON/DAY)) = 327.100
- LOAD FACTOR = .900000

COST :

- CAPITAL COST FACTOR (\$/(TON/DAY)) = 27000.0
- CAPITAL COST ELECTRIC GENERATOR (\$/MW) = 250000.
- OPERATING AND MAINTENANCE COST (\$/TON) = 8.5700
- REVENUE FROM RECOVERED MATERIAL (\$/TON) = 7.800000
- TRANSPORTATION COST (\$) = 0.
- EXPONENT = 1.00000

MOGLIN - GE0ELE

INPUT DATA FOR GEOSTP MODEL

PERFORMANCE :  
- EFFICIENCY (BTU DELIVERED / BTU INPUT) = .720000  
- AREA FACTOR (FT<sup>2</sup>/MW/TM) = 0.09930  
- LOAD FACTOR = .900000

CGST :  
- CAPITAL COST FACTOR (\$/MBTU/YR) = 125.770  
- OPERATING AND MAINTENANCE COST IS A FUNCTION OF THE SIZE OF PLANT. PLEASE CONSULT THE MODEL DESCRIPTION.  
- EXPONENT = .050000  
MOGLIN - GE0ELE

INPUT DATA FOR GE0ELE MODEL

PERFORMANCE :  
- EFFICIENCY IS A FUNCTION OF RESERVOIR TEMP. PLEASE CONSULT MODEL DESCRIPTION.  
- AREA FACTOR (FT<sup>2</sup>/MW CAPACITY) = 21700.  
- LOAD FACTOR = .900000

CGST :  
- CAPITAL COST FACTOR (\$/MW) = .250000E+07  
- OPERATING AND MAINTENANCE COST IS A FUNCTION OF THE SIZE OF PLANT. PLEASE CONSULT THE MODEL DESCRIPTION.  
- EXPONENT = .050000  
MOGLIN - WD5

INPUT DATA FOR WD5 MODEL

PERFORMANCE :  
- EFFICIENCY IS A LINEAR FUNCTION OF THE MONTHLY WIND VELOCITY. PLEASE CONSULT MODEL.  
- AREA FACTOR (FT<sup>2</sup>/UNIT) = 300.000

CGST :  
- CAPITAL COST (\$/UNIT) 15000.0  
- ANNUAL MAINTENANCE COST (\$/UNIT) = 375.000  
MOGLIN - WD200

INPUT DATA FOR WD200 MODEL

PERFORMANCE :  
- EFFICIENCY IS A LINEAR FUNCTION OF THE MONTHLY WIND VELOCITY. PLEASE CONSULT MODEL.  
- AREA FACTOR (FT<sup>2</sup>/UNIT) = 16000.0

CGST :  
- CAPITAL COST (\$/UNIT) 50000.  
- ANNUAL MAINTENANCE COST (\$/UNIT) = 15000.0

MODEL - M01500

INPUT DATA FOR M01500 CODE

PERFORMANCE

- EFFICIENCY IS A LINEAR FUNCTION OF THE HOURLY WIND VELOCITY. PLEASE CONSULT MODEL
- AREA FACTOR (FT\*\*2/UNIT) = 33000.0

COST

- CAPITAL COST (\$/UNIT) = 1500000.0
- ANNUAL MAINTENANCE COST (\$/UNIT) = 50000.0

MODEL PARAMS

EXP. DATA FOR COAL FUELED MODEL

PERFORMANCE

- EFFICIENCY (BTU DELIVERED / BTU INPUT) = 0.4000
- AREA FACTOR (FT\*\*2/MBTU/YR) = 402500.0
- LOAD FACTOR = 1900000
- HIGH SULFUR CONTE
- COAL QUALITY (BTU/LB) = 12500
- LOW SULFUR CONTE
- COAL QUALITY (BTU/LB) = 9500

COST

- HIGH SULFUR CONTE
- CAPITAL COST FACTOR (\$/MBTU) = 55.000
- LOW SULFUR CONTE
- CAPITAL COST FACTOR (\$/MBTU/YR) = 17.000
- OP. AND MAINT. COST (\$/ANNUALIZED UNIT COST) = 0.000
- EXPONENT = 1.500

MODEL PARAMS

INPUT DATA FOR GAS FUELED MODEL

PERFORMANCE

- EFFICIENCY (BTU DELIVERED / BTU INPUT) = 0.4000
- AREA FACTOR (FT\*\*2/MBTU/YR) = 402500.0
- LOAD FACTOR = 1900000
- HIGH SULFUR CONTE
- COAL QUALITY (BTU/LB) = 12500
- LOW SULFUR CONTE
- COAL QUALITY (BTU/LB) = 9500

COST

- HIGH SULFUR CONTE
- CAPITAL COST FACTOR (\$/MBTU/YR) = 274.340
- LOW SULFUR CONTE
- CAPITAL COST FACTOR (\$/MBTU/YR) = 294.120
- OP. AND MAINT. COST (\$/ANNUALIZED CAP. COST) = .500000
- EXPONENT = .750000

THIS TABLE IS BEING PRINTED PRACTICABLY  
FROM COAL FUELED MODEL

MOULIN - CCLLEL

INPUT DATA FOR CCLLEL MODEL

PERFORMANCE :

- EFFICIENCY (BTU DELIVERED / HTU INPUT) = .360000  
- AREA FACTOR (FT\*\*2/(TON/DAY)) = 402.940  
- LOAD FACTOR = .900000  
HIGH SULFUR CONTENT  
- COAL QUALITY (BTU/LBM) = 12510.0  
LOW SULFUR CONTENT  
- COAL QUALITY (BTU/LBM) = 9930.00

COST :

HIGH SULFUR CONTENT  
CAPITAL COST FACTOR (\$/MW/YR) = 1212.50  
LOW SULFUR CONTENT  
CAPITAL COST FACTOR (\$/MW/YR) = 1299.80  
- CAPITAL COST ELECTRIC GENERATOR (\$/MW) = 250000.  
- OP. AND MAINT. COST (% ANNUALIZED CAP. COST) = .500000  
- EXPONENT = .750000

MOULIN - CCLC06

INPUT DATA FOR CCLC06 MODEL

PERFORMANCE :

- EFFICIENCY (BTU DELIVERED / BTU INPUT) = .631000  
- AREA FACTOR (MMH DELIVERED / MMH INPUT) = .100000  
- LOAD FACTOR = .900000  
HIGH SULFUR CONTENT  
- COAL QUALITY (BTU/LBM) = 12510.0  
LOW SULFUR CONTENT  
- COAL QUALITY (BTU/LBM) = 9930.00

COST :

HIGH SULFUR CONTENT  
CAPITAL COST FACTOR (\$/MBTU/YR) = 197.350  
LOW SULFUR CONTENT  
CAPITAL COST FACTOR (\$/MBTU/YR) = 202.360  
- OP. AND MAINT. COST (% ANNUALIZED CAP. COST) = .500000  
- EXPONENT = .800000

MOULIN - PHVELE

INPUT DATA FOR PHVELE MODEL

PERFORMANCE :

- EFFICIENCY (MMH DELIVERED / MMH INSULATION) = .100000  
- AREA FACTOR = 2500.00

COST :

- AREA DEPENDENT CAPITAL COST (\$/FT\*\*2) = 38.2000  
- NON AREA DEPENDENT CAPITAL COST (\$) = 0.  
- MAINTENANCE COST (% ANNUALIZED CAP. COST) = .200000



BEST RESULTS OBTAINED \_\_\_\_\_ NUMBER OF ITERATIONS FOR THIS RUN

504	0	OBJECTIVE FUNCTION	.07763033E+00		
		INDEPENDENT VARIABLES			
0.	.55350134E+03	0.	0.	0.	0.
.20600502E+03	0.	0.	.29544066E+03	0.	0.
0.					0.
		VALUE OF INEQUALITY CONSTRAINTS			
.1433027E+00	.11329030E+03		.99999000E+31		.67056906E+01
					0.
					.70953803E+02

EXCELSION

(THE OPTIMUM MIX HAS BEEN FOUND  
SUMMARY OF RESULTS FOLLOWS)







ENERGY PRODUCED BY ALL MODELS TO SATISFY --- SPACE HEATING AND HOT WATER  
 AP. \* BEFORE NUMBER INDICATES AN EXCESS OF  
 ENERGY WAS PRODUCED BY THE MODEL

	TOTAL	COMMERCIAL	SLTHTG	ROFHTG	CCLHTG	FBCHTG
JAN	.5019E+06	.3071E+06	0.	0.	0.	.1948E+06
FEB	.3632E+06	.1673E+06	0.	0.	0.	.1759E+06
MAR	.2720E+06	.7722E+05	0.	0.	0.	.1948E+06
APR	.1005E+06	0.	0.	0.	0.	.1005E+06
MAY	.0102E+05	0.	0.	0.	0.	.0102E+05
JUN	.3711E+05	0.	0.	0.	0.	.3711E+05
JUL	.2619E+05	0.	0.	0.	0.	.2619E+05
AUG	.1425E+05	0.	0.	0.	0.	.1425E+05
SEP	.2652E+05	0.	0.	0.	0.	.2652E+05
OCT	.6736E+05	0.	0.	0.	0.	.6736E+05
NOV	.2237E+06	.3520E+05	0.	0.	0.	.1005E+06
DEC	.0909E+06	.2461E+06	0.	0.	0.	.1948E+06

ENERGY PRODUCED BY ALL MODELS TO SATISFY --- PROCESS STEAM  
 AM \* BEFORE NUMBER INDICATES AN EXCESS OF  
 ENERGY WAS PRODUCED BY THE MODEL

	TOTAL	COMMERCIAL	CCLSTM	RDFTM	FRCSTM	CCLCOG
JAN	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05
FEB	.1441E+06	.2063E+05	0.	821.3	.3803E+05	.7650E+05
MAR	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05
APR	.1441E+06	.2300E+05	0.	879.9	.4074E+05	.7937E+05
MAY	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05
JUN	.1441E+06	.2300E+05	0.	879.9	.4074E+05	.7937E+05
JUL	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05
AUG	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05
SEP	.1441E+06	.2300E+05	0.	879.9	.4074E+05	.7937E+05
OCT	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05
NOV	.1441E+06	.2300E+05	0.	879.9	.4074E+05	.7937E+05
DEC	.1441E+06	.2067E+05	0.	909.3	.4210E+05	.8030E+05

ELECTRICITY

ENERGY PRODUCED BY ALL MODELS TO SATISFY ---  
 AN \* BEFORE NUMERUM INDICATES AN EXCESS OF  
 ENERGY WAS PRODUCED BY THE MODEL

	TOTAL	COMMERCIAL	RDFELE	WD5	WD200	WD1500	PMVELE	CCLELE	CCLCOG	FOCELE
JAN	.3907E+05 245.5	0.	0.	0.	0.	0.	0.	0.	5078.	*.3375E+05
FEB	.3732E+05 812.5	0.	0.	0.	0.	0.	0.	0.	4586.	*.3194E+05
MAR	.3933E+05 320.5	0.	0.	0.	0.	0.	0.	0.	5078.	*.3399E+05
APR	.4254E+05 1767.	0.	0.	0.	0.	0.	0.	0.	4914.	*.3585E+05
MAY	.4247E+05 1204.	0.	0.	0.	0.	0.	0.	0.	5078.	*.3611E+05
JUN	.5212E+05 5977.	0.	0.	0.	0.	0.	0.	0.	4914.	*.4123E+05
JUL	.5133E+05 4994.	0.	0.	0.	0.	0.	0.	0.	5078.	*.4126E+05
AUG	.5012E+05 4438.	0.	0.	0.	0.	0.	0.	0.	5078.	*.4060E+05
SEP	.4503E+05 2791.	0.	0.	0.	0.	0.	0.	0.	4914.	*.3732E+05
OCT	.4295E+05 1449.	0.	0.	0.	0.	0.	0.	0.	5078.	*.3642E+05
NOV	.4004E+05 887.8	0.	0.	0.	0.	0.	0.	0.	4914.	*.3424E+05
DEC	.4133E+05 902.5	0.	0.	0.	0.	0.	0.	0.	5078.	*.3535E+05

ELECTRICITY

----- OPTIMIZED RESULT -----

ENERGY SOURCE SYSTEM UNITS	NUMBER OF SYSTEMS	DELIVERED ENERGY (MMH)	INITIAL CAPITAL COST (M\$)	ANNUALIZED COST (M\$)	DELIVERED ENERGY COST (\$/MMH)	AREA REQUIRED (FT**2)	EXCESS ENERGY (MMH)	PRODUCED ENERGY COST (\$/MMH)
ROFELE TONS REFUSE	0.	0.	0.	0.	0.	0.	0.	0.
MO3 100 MW SIZE	0.	0.	0.	0.	0.	0.	0.	0.
MO200 200 MW SIZE	0.	0.	0.	0.	0.	0.	0.	0.
MO1500 1500 MW SIZE	0.	0.	0.	0.	0.	0.	0.	0.
PHVELE 1000 FT**2	0.	0.	0.	0.	0.	0.	0.	0.
CCELLE TONS COAL	0.	0.	0.	0.	0.	0.	0.	0.
*CCLCOG TONS COAL	206.9	.5979E+05	15.59	7.324	21.54	.6336E+05	0.	17.90
FBCLE TONS COAL	553.4	.4380E+06	25.53	16.92	38.63	.2230E+06	.1099E+06	30.88
COMMERCIAL		.2567E+05	0.	1.984	76.71			

\* INDICATES A CO-GENERATION MODEL.

MODELS WITH NON ZERO NUMBERS OF SYSTEMS  
HAVE BEEN SELECTED FOR OPTIMUM MIX

PROCESS STEAM

----- OPTIMIZED RESULT -----

ENERGY SOURCE SYSTEM UNITS	NUMBER OF SYSTEMS	DELIVERED ENERGY (MBTU)	INITIAL CAPITAL COST (M\$)	ANNUALIZED COST (M\$)	DELIVERED ENERGY COST (\$/MBTU)	AREA REQUIRED (FT <sup>2</sup> ×2)	EXCESS ENERGY (MBTU)	PRODUCED ENERGY COST (\$/MBTU)
CCLSTM TONS COAL	0.	0.	0.	0.	0.	0.	0.	0.
ADFSTM TONS WEFUSE	6.706	.1071E+05	.2012	.4052E-01	4.532	2193.	0.	4.532
F8CSTM TONS COAL	70.95	.4957E+06	5.121	2.474	4.992	.2089E+05	0.	4.992
CCCLC06 TONS COAL	206.9	.9567E+06	15.99	7.324	6.510	.0336E+05	.2355E+06	5.246
COMMERCIAL		.2656E+06	2.342	2.407	9.364			

\* INDICATES A CO-GENERATION MODEL.

MODELS WITH NON ZERO NUMBERS OF SYSTEMS  
HAVE BEEN SELECTED FOR OPTIMUM MIX

SPACE HEATING AND HOT WATER

---- OPTIMIZED RESULT ----

ENERGY SOURCE SYSTEM UNITS	NUMBER OF SYSTEMS	DELIVERED ENERGY (MBTU)	INITIAL CAPITAL COST (M\$)	ANNUALIZED COST (M\$)	DELIVERED ENERGY COST (\$/MBTU)	AREA REQUIRED (FT <sup>2</sup> )	EXCESS ENERGY (MBTU)	PRODUCED ENERGY COST (\$/MBTU)
SLHTG 10000 FT <sup>2</sup>	0.	0.	0.	0.	0.	0.	0.	0.
RFHTG TONS REFUSE	0.	0.	0.	0.	0.	0.	0.	0.
CCLHTG TONS COAL	0.	0.	0.	0.	0.	0.	0.	0.
FBCHTG TONS COAL	295.4	.1390E+07	12.94	0.919	6.410	.1190E+06	.9037E+06	3.889
COMMERCIAL		.8529E+06	5.226	7.608	0.919			

\* INDICATES A CO-GENERATION MODEL.

MODELS WITH NON ZERO NUMBERS OF SYSTEMS  
HAVE BEEN SELECTED FOR OPTIMUM MIX

THE FOLLOWING SUMMARY USES THE SAME NUMBER OF SYSTEMS IN EACH DEMAND SECTOR FOR COST COMPARISONS. NOTE THAT COGENERATION MODELS MAY BE THE SAME IN ONLY ONE DEMAND SECTOR.

.....  
 SUMMARY USING MAX NO. OF SYSTEMS  
 .....

SPACE HEATING AND HOT WATER

---- OPTIMIZED RESULT ----

ENERGY SOURCE SYSTEM UNITS	NUMBER OF SYSTEMS	DELIVERED ENERGY (MBTU)	INITIAL CAPITAL COST (M\$)	ANNUALIZED COST (M\$)	DELIVERED ENERGY COST (\$/MBTU)	AREA REQUIRED (FT <sup>2</sup> )	EXCESS ENERGY (MBTU)	PRODUCED ENERGY COST (\$/MBTU)
SLMT6 10000 FT <sup>2</sup>	295.4	.9027E+06	103.5	13.68	15.16	.7386E+07	0.	15.16
ADFMT6 TONS WEFUSE	295.4	.2771E+06	8.863	2.138	7.715	.9664E+09	.2470E+06	4.079
CCLMT6 TONS COAL	295.4	.8082E+06	16.17	9.452	11.69	.1190E+06	.1485E+07	4.121
FBCMT6 TONS COAL	295.4	.2547E+06	12.94	6.919	35.02	.1190E+06	.2039E+07	3.889
COMMERCIAL		0.	0.	0.	0.			

\* INDICATES A CO-GENERATION MODEL.

PROCESS STEAM

----- OPTIMIZED RESULT -----

ENERGY SOURCE SYSTEM UNITS	NUMBER OF SYSTEMS	DELIVERED ENERGY (MBTU)	INITIAL CAPITAL COST (M\$)	ANNUALIZED COST (M\$)	DELIVERED ENERGY COST (\$/MBTU)	AREA REQUIRED (FT <sup>2</sup> )	EXCESS ENERGY (MBTU)	PRODUCED ENERGY COST (\$/MBTU)
CCLSTM TONS COAL	206.9	.1306E+07	12.38	6.793	5.202	.8336E+05	.1396E+06	4.700
RD4STM TONS REFUSE	206.9	.1927E+06	6.207	1.497	7.767	.6767E+05	.1376E+06	4.532
FBLSTM TONS COAL	206.9	.2303E+06	10.27	6.444	27.98	.8336E+05	.1215E+07	4.459
*CCLCOG TONS COAL	553.4	.7451E+07	34.26	18.36	3994.	.2230E+06	.3189E+07	4.916
COMMERCIAL		0.	0.	0.	0.			

\* INDICATES A CO-GENERATION MODEL.

ELECTRICITY

---- OPTIMIZED RESULT ----

ENERGY SOURCE SYSTEM UNITS	NUMBER OF SYSTEMS	DELIVERED ENERGY (MWH)	INITIAL CAPITAL COST (M\$)	ANNUALIZED COST (M\$)	DELIVERED ENERGY COST (\$/MWH)	AREA REQUIRED (FT**2)	EXCESS ENERGY (MWH)	PRODUCED ENERGY COST (\$/MWH)
RDPELE TONS REFUSE	553.4	.1225E+06	20.49	4.432	56.18	.1819E+06	0.	56.18
WD 100 MW SIZE	553.4	.1815E+06	830.1	112.2	618.2	.1660E+08	.3567E+05	516.7
WD200 200 MW SIZE	553.4	.5700E+05	277.0	38.82	681.0	.6854E+07	.1024E+06	243.6
WD1500 1500 MW SIZE	553.4	126.7	431.0	153.8	.1214E+07	.1826E+08	.4730E+06	325.1
PHVELE 1000 FT**2	553.4	3946.	17.82	2.356	597.0	.1385E+07	6864.	217.9
CCLELE TONS COAL	553.4	.1572E+06	42.79	19.77	125.7	.2230E+06	.3758E+06	57.09
*CCCLUG TONS COAL	553.4	1347.	34.26	18.36	.1363E+05	.2230E+06	.1586E+06	16.78
FBCELE TONS COAL	553.4	.2980E-07	25.53	16.92	.567E+15	.2230E+06	.5479E+06	50.88
COMMERCIAL		0.	0.	0.	0.			

\* INDICATES A CO-GENERATION MODEL.  
AFTER UPDATE  
RUNSPC