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SYSPLAN: Model Documentation and Users' Guide

C. J. Hostick
R. A. Hutchinson
C. Winter

January 1986

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

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Richland, Washington 99352

SUMMARY

This report describes software designed to evaluate capital investment in customer-side-of-the-meter load leveling battery systems. The microcomputer-based software was developed at the Pacific Northwest Laboratory (PNL), which is operated by Battelle Memorial Institute for the U.S. Department of Energy (DOE). Load leveling battery systems reduce a customer's monthly electrical demand charge by reducing the maximum power load supplied by the utility during the customer's peak demand. The system consists of a large array of batteries, a converter that changes AC current into DC current (or DC current into AC current), and balance-of-plant equipment and facilities required to support the battery and converter system. Using the software described in this report, the economic feasibility of load leveling systems can easily be evaluated to determine if more detailed studies are warranted.

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FIGURES

TABLES

1.0 INTRODUCTION

This document describes software designed to evaluate capital investment in customer-side-of-the-meter load leveling battery systems. The purpose of a load leveling battery system is to reduce a customer's monthly electrical demand charge by reducing the maximum power load supplied by the utility during the customer's peak demand.

Load leveling battery system equipment consists of a large array of batteries, a converter that changes AC current into DC current (or DC current into AC current), and balance-of-plant equipment and facilities required to support the battery and converter system. A diagram of a load leveling system is shown in Figure 1.1.

The impact of a load leveling battery system on a customer's power load is shown in Figure 1.2. The system is installed on the customer's side of the meter and is controlled and operated by the customer. The battery system charges during a customer's off-peak power requirement periods and discharges

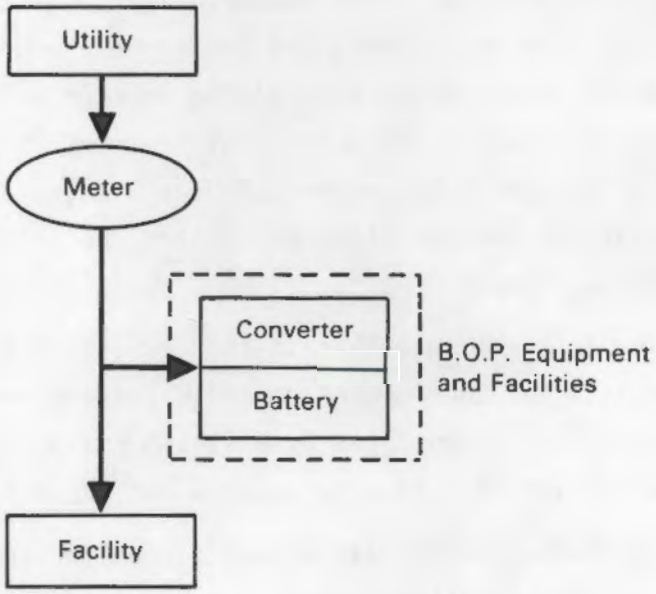


FIGURE 1.1. Diagram of Customer-Side Load Leveling Battery System

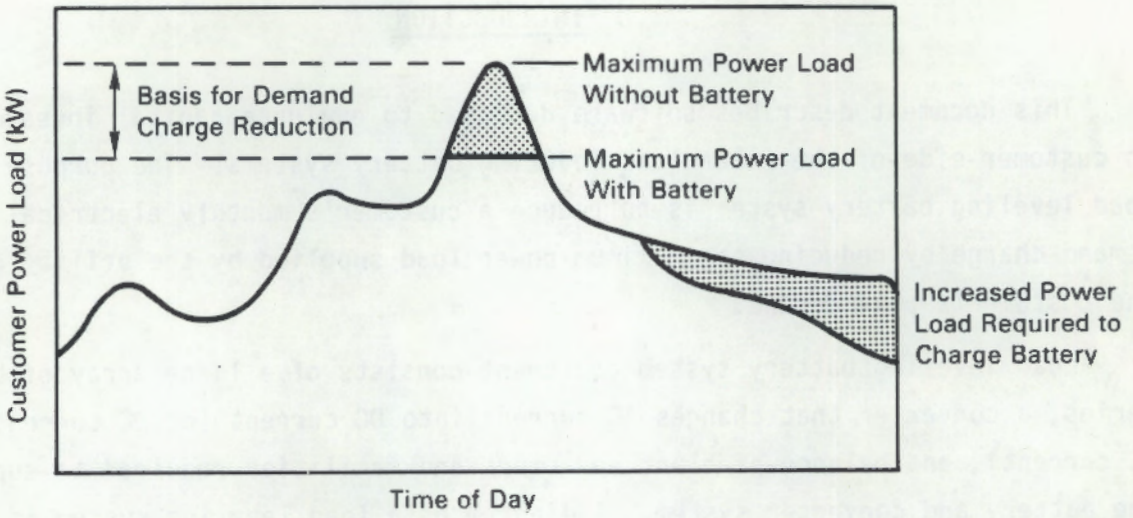


FIGURE 1.2. Illustration of the Impact of a Load Leveling Battery System on a Customer's Power Load

during the customer's peak demand periods. The economic feasibility of a load leveling battery system depends largely on the customer's load profile. Because the primary economic benefit of load leveling is a reduction in a customer's monthly demand charge, only those customers with significant demand peaks will find a load leveling system economically attractive. Load shape requirements, utility rate structures, and battery equipment cost and performance information serve as bases for determining whether a load leveling battery system is economically feasible for a particular installation. Life-cycle costs for load leveling system hardware include all costs associated with the purchasing, installation, and operation of battery, converter, and balance-of-plant facilities and equipment.

The spreadsheet software described in this report is specifically designed to evaluate these costs and the reduced demand charge benefits. The life-cycle cost analysis spreadsheet is augmented by a system sizing routine to help users identify load leveling system size requirements for their facilities.

In summary, the software provides a tool for performing scoping studies of the applicability of load leveling systems for specific facilities. This

analysis package is not a complete investment analysis, but rather a first step toward performing detailed engineering feasibility studies.

Chapter 2.0 of this report describes the three spreadsheet files that make up the load leveling system analysis software, including their operation and various macro programs. Chapter 3.0 contains definitions of the various terms used in the software. Finally, model verification and technical documentation are provided in the Appendices.

2.0 MODEL OPERATION

The load leveling system analysis software package described in this report consists of three spreadsheet files: XSIZE, SIZE, and SYSPLAN. The main life-cycle cost model is contained in the SYSPLAN spreadsheet file. A general layout of the SYSPLAN model is provided in Figure 2.1. The file XSIZE is an optional battery system sizing routine designed to help users identify load-leveling system requirements for their facilities. The output of XSIZE identifies the load-leveling system operating requirements; this information is then passed by the temporary file SIZE to the main SYSPLAN spreadsheet. These spreadsheet files are described in the following sections.

2.1 OVERVIEW

The preliminary economic analysis of customer-side-of-the-meter battery systems is completed by using the SYSPLAN spreadsheet. This spreadsheet completes a 20-year period life-cycle cost analysis based on the battery system description and cost data. The optional sizing routine, XSIZE, can be used to identify a range of battery system sizes that might be economically attractive.

The SYSPLAN and XSIZE spreadsheets have been developed with the Lotus123 software package. The third spreadsheet file, SIZE, is a temporary file used only to transfer information from XSIZE to SYSPLAN. To run SYSPLAN and the sizing routine, a user needs an IBM-PC with at least 256K of internal memory and two floppy disk drives (or one floppy disk drive and one hard disk drive). In addition, a copy of the Lotus123 software is needed to access the two spreadsheets.

Lotus123, the software with which the SYSPLAN model was developed, is a spreadsheet software copyrighted by the Lotus Development Corporation. The following Lotus123 terms are used in this manual:

- Macro
- Pointer
- Cell
- Cursor-Movement Keys

The carriage return key is referred to as <RETURN>. The escape key is indicated by <ESC>.

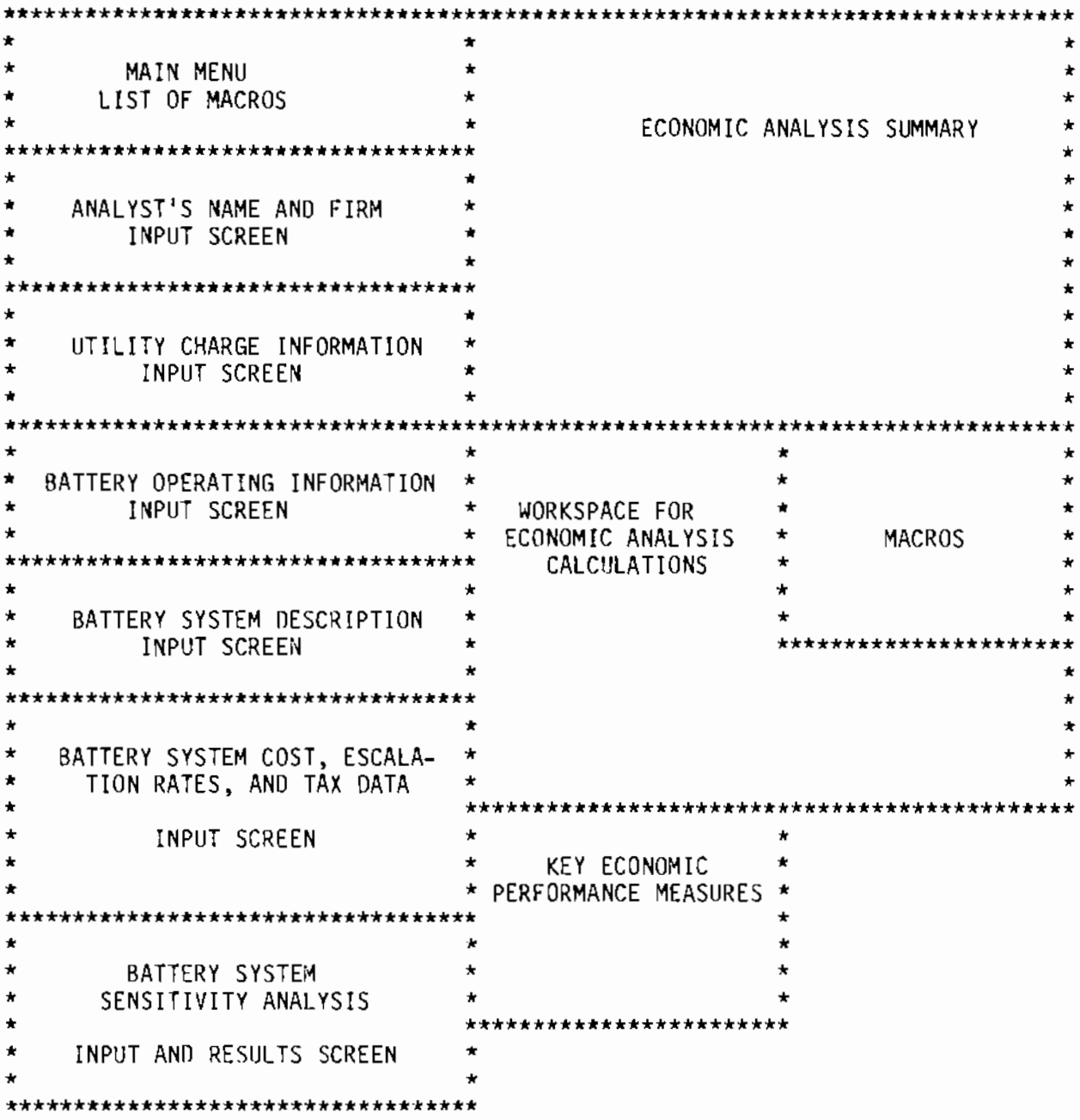


FIGURE 2.1. General Layout of SYSPLAN Model

The instructions for using SYSPLAN and the sizing routine XSIZE describe all operations specific to these spreadsheets. It is assumed, however, that users have some familiarity with the operation of Lotus123. Specifically, you should know how to access Lotus123 and retrieve spreadsheets, how to set up your printer for use with Lotus123, and how to use the Lotus Print Graph program to obtain hard copy of Lotus123 graphs. If you are unfamiliar with these operations, consult the Lotus123 manual (1983, Lotus Development Corp.), the on-line tutorial, or an experienced Lotus123 user before using SYSPLAN.

If you begin to use SYSPLAN and the sizing routine XSIZE a great deal for analysis tasks, you may wish to change these spreadsheets. For this reason, documentation of the spreadsheets' formulas, cell protection schemes and macro programs has been provided in Appendix B for the XSIZE sizing routine and in Appendix C for the main spreadsheet. Experienced Lotus123 users can use the appendices as an aid to changing the spreadsheets for particular applications.

Section 2.2 contains details for using the optional sizing routine, XSIZE. Section 2.3 provides step-by-step instructions for using the SYSPLAN spreadsheet.

2.2 XSIZE SYSTEM SIZING ROUTINE

The XSIZE system sizing routine is an optional program primarily designed to introduce the concept of load leveling using battery storage. This program helps users make initial choices about suitable battery storage applications and preliminary battery system sizes. The output consists of relevant battery operating data and utility rate information that can be loaded automatically into the life-cycle cost analysis spreadsheet SYSPLAN.

The XSIZE spreadsheet includes several simple macro programs to speed operation. These macros and their purposes are listed below, along with the Lotus123 commands you will use. Figure 2.2 shows how the spreadsheet is organized. Table 2.1 summarizes the macros used in XSIZE and shows the page number where each macro is discussed.

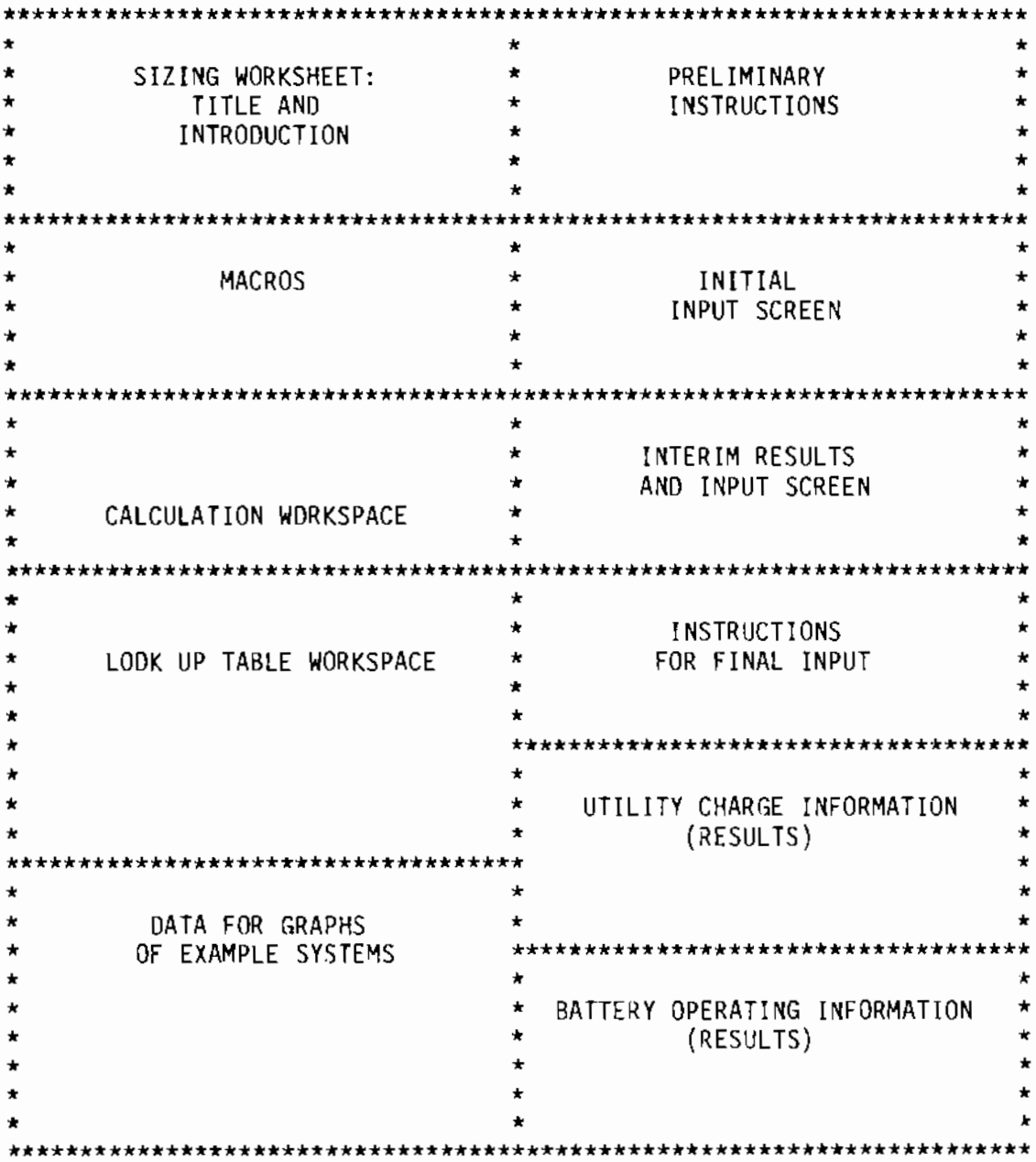


FIGURE 2.2. General Layout of XSIZE Model

TABLE 2.1. Summary of XSIZE Macros

Lotus123 Commands Used in XSIZE

/fr (File Retrieve) XSIZE - Load XSIZE model into Lotus 123

/Q (Quit) - Leave Lotus123, cursor movement, data entry

Order of Execution

- Get into Lotus123 and retrieve XSIZE (/fr)
- ALT B - begin sizing routine
- ALT C - to calculate preliminary range of limiting sizes based on economic considerations
- ALT D, ALT E - to view examples of electric load curves and choices of applicable battery system size
- ALT F - to return from graphs
- ALT O - to set up battery system specifications and other information to be passed to SYSPLAN
- ALT P - to create pass file SIZE
- /q to quit
- in case of trouble, hit the <ESCAPE> key and then the <HOME> key to return to start of routine

/fr (File Retrieve) XSIZE - Load XSIZE model into Lotus123

This Lotus123 command loads XSIZE onto the computer's screen and into its internal memory. Before the command can be given, Lotus123 must be loaded and a blank spreadsheet displayed on the screen. If you are unsure how to do this, consult a Lotus123 manual.

The exact command sequence is:

/fr XSIZE (return)

ALT A - Begin

Press the ALT key and A key simultaneously

This macro command displays the menu describing battery system economics shown by Figure 2.3. The information presented in this menu and the examples of peak shaving by battery systems serve as a tutorial explaining system benefits.

ALT-B - Example Load Curve

Press the ALT key and B key simultaneously

```
**************************************************************************
*   BATTERY LOAD-LEVELING SYSTEMS CAN REDUCE A UTILITY CUSTOMER'S        *
*   MONTHLY ENERGY DEMAND CHARGE BY SHAVING THE DEMAND PEAK.  THE        *
*   ECONOMICS OF A LOAD-LEVELING SYSTEM ARE DEPENDENT ON THE PEAK        *
*   SHAPE, WHICH DETERMINES BOTH THE POTENTIAL FOR DEMAND CHARGE         *
*   REDUCTION AND BATTERY SIZE REQUIREMENTS.  IN GENERAL, BATTERY        *
*   SYSTEM ECONOMICS ARE IMPROVED BY:                                    *
*                                                                        *
*   - HIGH DEMAND CHARGES           - SHARP, HIGH SINGLE PEAKS           *
*   - LARGER SYSTEM CAPACITIES      - SHORT DISCHARGE DURATIONS          *
*   - NEED FOR A BATTERY ALL YEAR                                        *
*                                                                        *
*   TYPE ALT B AND ALT C TO VIEW EXAMPLES OF PEAK SHAVING BY BAT-        *
*   TERY SYSTEMS.  NOTE THE LARGE POWER OUTPUT AND RELATIVELY            *
*   SMALL DISCHARGE DURATIONS INVOLVED.  THEN TYPE ALT D TO              *
*   INPUT DATA TO ESTIMATE A SIZE RANGE FOR YOUR APPLICATION.            *
**************************************************************************
```

FIGURE 2.3. Menu Description of Battery System Economics

Selecting this macro command displays the example of battery load-leveling shown in Figure 2.4.

ALT-C Example Load Curve

Press the ALT key and C key simultaneously

Selecting this macro displays the example of battery load-leveling shown in Figure 2.5.

ALT-D - Input Data to Estimate a Battery System Size Range

Press the ALT key and D key simultaneously

This macro command displays a screen that requests basic load and utility information, as shown in Figure 2.6. The <ESCAPE> key must be selected before the next macro is invoked.

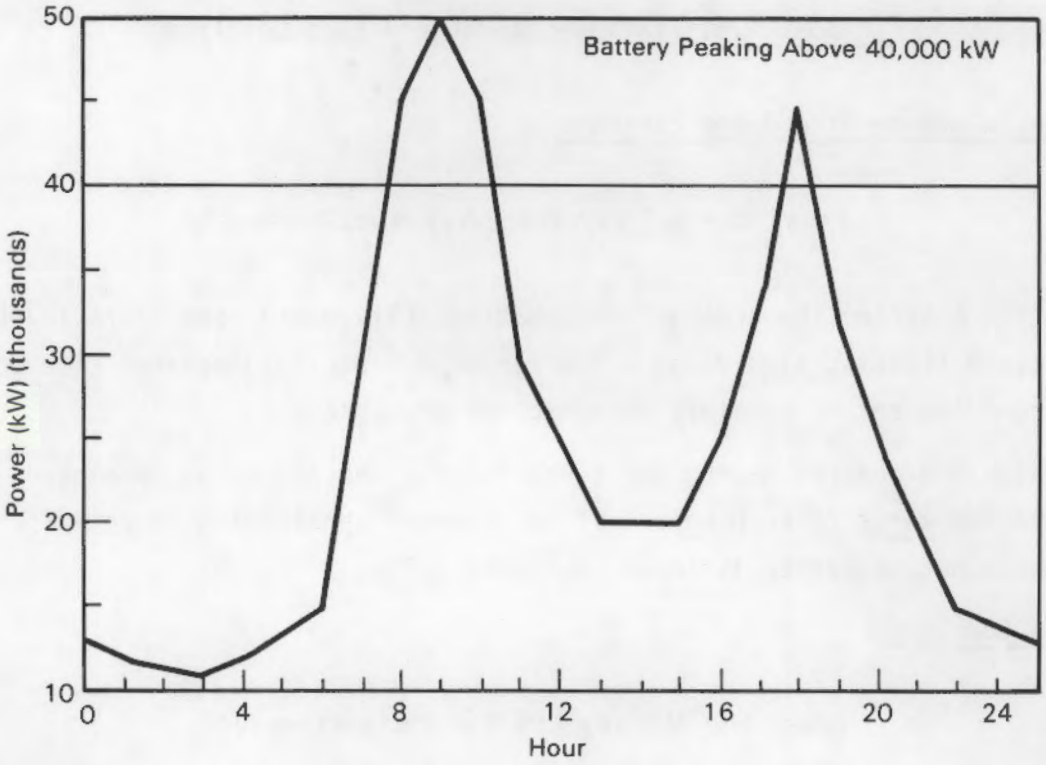


FIGURE 2.4. Example of Battery Load Leveling

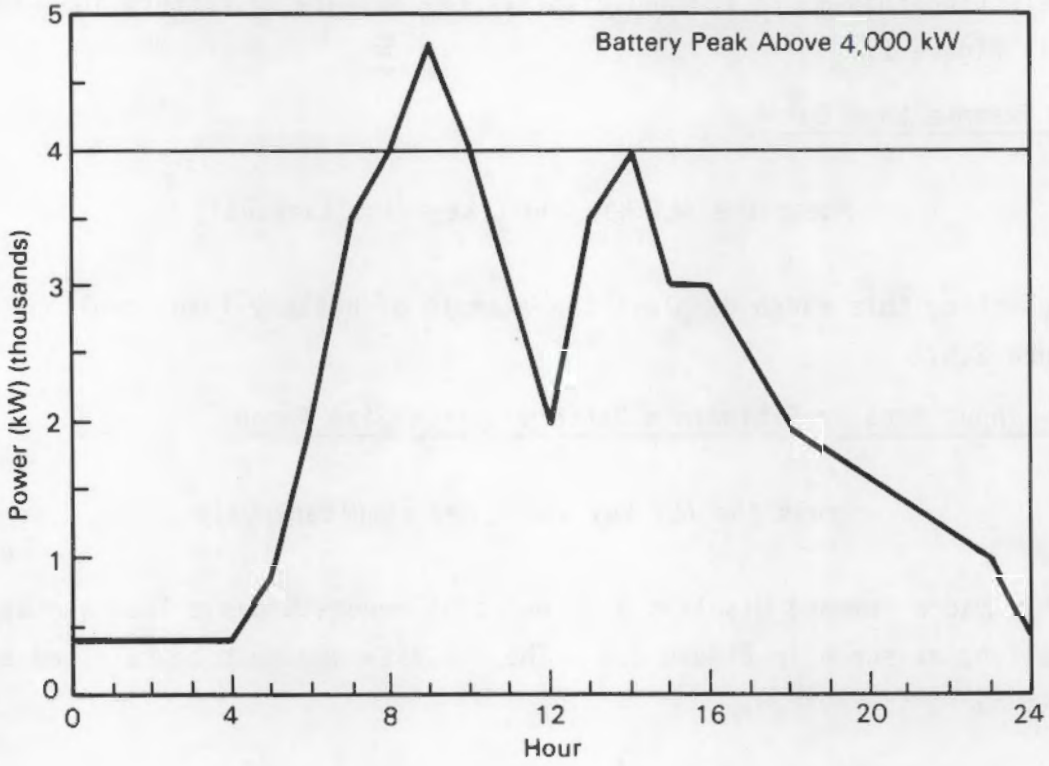


FIGURE 2.5. Example of Battery Load-Leveling

ALT-E - Calculate Size Range Estimate

Press the ALT key and E key simultaneously

After entering the economic information, this macro command is invoked to calculate a limiting size range - the range of capacity/discharge time pairs that bound the set of possibly economic battery systems.

This is a complex macro, and takes several seconds to be completed. It will produce zeros (0 kw-0 hours) if no economic application is anticipated. An example output screen is shown in Figure 2.7.

ALT-F - Continue

Press the ALT key and F key simultaneously

```
*********************************************************************
*   THE FOLLOWING INFORMATION REQUESTED FORMS THE BASIS FOR THE     *
*   OUTPUT TABLE OF YOUR UTILITY RATE DATA.  THIS INFORMATION IS    *
*   ALSO USED TO CALCULATE A CRUDE ESTIMATE OF YOUR APPLICATIONS    *
*   VIABILITY AND POSSIBLE SIZE RANGES.                             *
*                                                                   *
*   TO START, ENTER VALUES FOR THE ITEMS BELOW:                     *
*                                                                   *
*        TYPICAL DAILY PEAK (KW)              1500                  *
*        RATE TYPE (1=FLAT, 2=TIME OF DAY)       0                  *
*        ON PEAK DEMAND CHG ($/KW-MO)           10                  *
*        OFF PEAK DEMAND CHG ($/KW-MO)           0                  *
*        ON PEAK ENERGY CHG (CENTS/KWH)          4                  *
*        OFF PEAK ENERGY CHG (CENTS/KWH)         4                  *
*                                                                   *
*   PRESS THE **ESCAPE**KEY WHEN FINISHED.                          *
*   NEXT, TYPE ALT E TO CALCULATE SIZE RANGE ESTIMATE.              *
*********************************************************************
```

FIGURE 2.6. Input Screen for Sizing Routine

```
*********************************************************************
*   YOUR LIMITING SIZE RANGE ESTIMATE IS:                           *
*                                                                   *
*                          DISCHARGE    DISCHARGE                   *
*                            POWER       DURATION                   *
*                            (KW)        (HOURS)                    *
*                  FROM       500          0.5                     *
*                  TO         1500         2.1                     *
*                                                                   *
*   IF ZEROS ARE DISPLAYED, NO ECONOMIC SIZE IS ANTICIPATED FOR     *
*   YOUR APPLICATION.  YOU CAN CERTAINLY CONTINUE, HOWEVER, AND     *
*   SELECT A SIZE TO EVALUATE THE LIFE-CYCLE COSTS.                 *
*                                                                   *
*        SELECT DISCHARGE DURATION (HOURS)     2                    *
*        SELECT DISCHARGE POWER LEVEL (KW)   800                    *
*                                                                   *
*   PRESS THE **ESCAPE** KEY WHEN FINISHED.                         *
*   NEXT, TYPE ALT F TO CONTINUE.                                   *
*********************************************************************
```

FIGURE 2.7. Example Sizing Routine Size Range Estimate

Selecting this macro displays a screen (shown in Figure 2.8) describing how a table of utility charge information and battery operating information is prepared for the life-cycle cost analysis.

```
**************************************************************************
*   THIS SPREADSHEET SETS UP A TABLE OF BATTERY OPERATING DATA AND       *
*   UTILITY RATE INFORMATION TO BE USED BY THE LIFE-CYCLE COST           *
*   ANALYSIS SPREADSHEET 'SYSPLAN'.  NOTE THAT FOR EACH VALUE            *
*   MONTHLY ENTRIES HAVE BEEN MADE.  IF YOUR DEMAND AND ENERGY           *
*   CHARGES OR LOAD CURVE VARY OVER DIFFERENT SEASONS, MOVE THE          *
*   CURSOR TO THE DESIRED CELL AND ENTER THE NEW NUMBER.  ALSO, YOU      *
*   NEED TO ENTER THE NUMBER OF BATTERY DISCHARGE CYCLES PER MONTH       *
*   THAT IS EXPECTED.  TO FINISH, TYPE ALT P TO SAVE THE REVISED         *
*   TABLES FOR THE LIFE-CYCLE COST ANALYSIS.                             *
*                                                                        *
*   TYPE ALT O TO CREATE AND VIEW BATTERY OPERATING DATA AND UTILITY     *
*   RATE INFORMATION.                                                    *
**************************************************************************
```

FIGURE 2.8. Macro F Information Screen

ALT-O - Create and View Output File

Press the ALT key and O key simultaneously

This macro prepares the utility charge and battery operating information, as shown in Figure 2.9.

This macro contains all the commands necessary to set up preliminary battery system and economic specifications. This takes several seconds and involves considerable cursor movement on the screen.

Press ALT-O

Once you have set up this preliminary set of data, you can change the numbers in any way you wish. This is necessary if you have seasonal rate or operational changes, for instance. Note as well that you should input the number of cycles the battery will operate in a given month, as it is not specified by ALT-O.

If you feel that you have made an error and wish to return the data set to its original state, you can press ALT-O again. You can even go back and change data from earlier steps, using ALT-B and ALT-C and ALT-F again. Be sure the data are exactly as you wish before moving on to the next step.

UTILITY CHARGE INFORMATION

MONTH	OFF-PEAK CHARGES ENERGY CENTS/KWH	OFF-PEAK CHARGES DEMAND $/KW-MONTH	ON-PEAK CHARGES ENERGY CENTS/KWH	ON-PEAK CHARGES DEMAND $/KW-MONTH
1	4.00	0.00	4.00	10.00
2	4.00	0.00	4.00	10.00
3	4.00	0.00	4.00	10.00
4	4.00	0.00	4.00	10.00
5	4.00	0.00	4.00	10.00
6	4.00	0.00	4.00	10.00
7	4.00	0.00	4.00	10.00
8	4.00	0.00	4.00	10.00
9	4.00	0.00	4.00	10.00
10	4.00	0.00	4.00	10.00
11	4.00	0.00	4.00	10.00
12	4.00	0.00	4.00	10.00

PRESS PAGEDOWN FOR OPERATING DATA

BATTERY OPERATING INFORMATION

MONTH	PEAK SHAVED (MW)	PEAK SHAVED CYCLES	DISCHARGE CYCLE DATA (HRS)	DISCHARGE CYCLE DATA (MWHRS)
1	0.80	30.00	2.00	0.80
2	0.80	30.00	2.00	0.80
3	0.80	30.00	2.00	0.80
4	0.80	30.00	2.00	0.80
5	0.80	30.00	2.00	0.80
6	0.80	30.00	2.00	0.80
7	0.80	30.00	2.00	0.80
8	0.80	30.00	2.00	0.80
9	0.80	30.00	2.00	0.80
10	0.80	30.00	2.00	0.80
11	0.80	30.00	2.00	0.80
12	0.80	30.00	2.00	0.80

BE SURE TO ENTER CYCLE DATA
DON'T FORGET ALT P TO SAVE FILE

FIGURE 2.9. Macro O Utility Change and Battery Operating Information Tables

ALT-P Create Pass File Size Containing Output File

Press the ALT key and P key simultaneously

Selecting this macro saves the tables shown by Figure 2.9 for the life-cycle cost analysis.

This macro makes a small file of the data you have just completed specifying, including any changes you made after the ALT-O command was given.

Press ALT-P

The pass file, called SIZE, can be retrieved from the SYSPLAN worksheet. This is done as one of the input options (the RETRIEVE option) of SYSPLAN's ALT-A Input Menu.

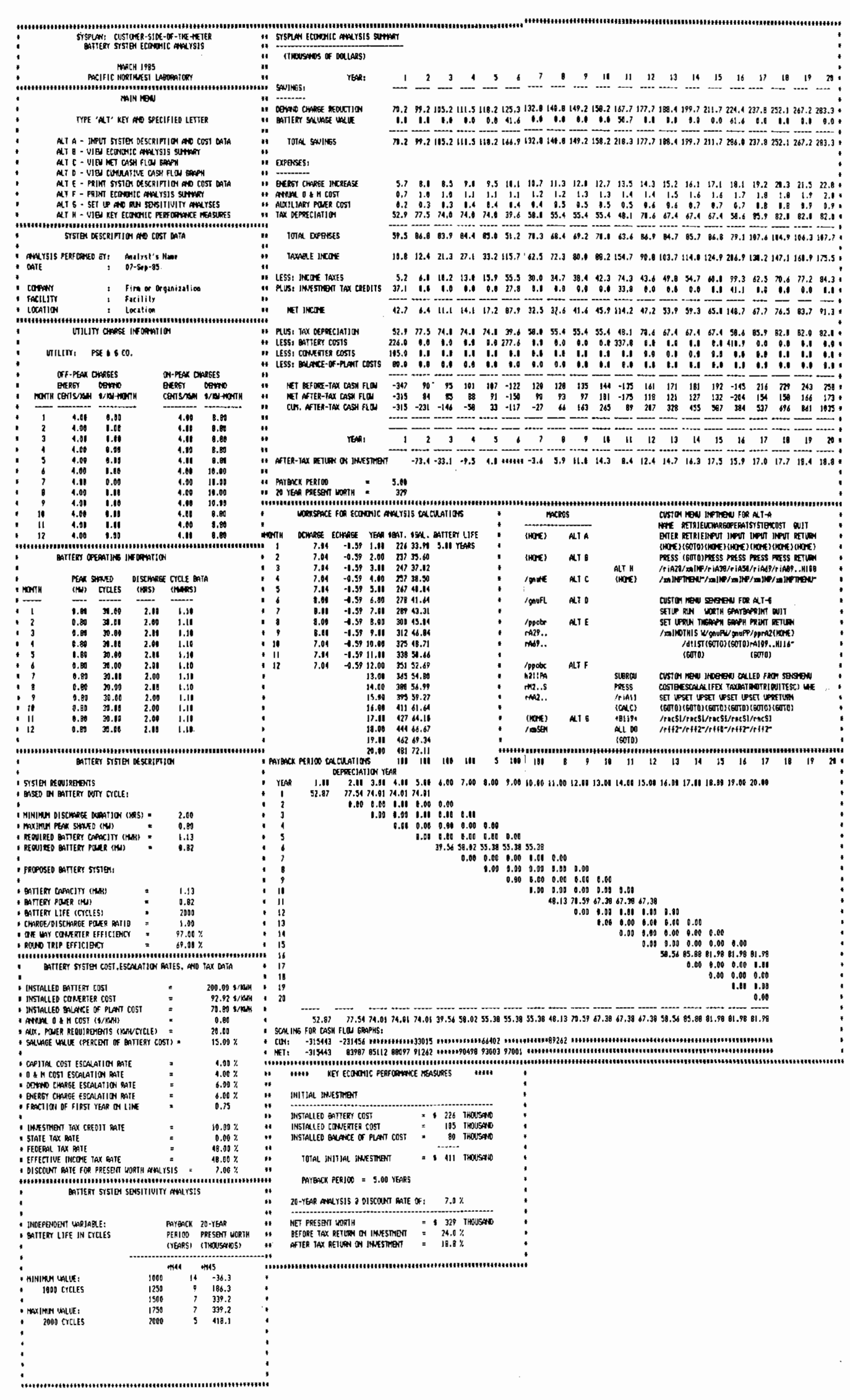
To exit from the XSIZE sizing routine use the following command:

/q - leave XSIZE battery system size specification spreadsheet.

2.3 SYSPLAN COST MODEL

The SYSPLAN model calculates the life-cycle costs of the load-leveling battery system. This program translates the system operating description and cost information into the life-cycle costs of the system. A built-in sensitivity analysis package is also included for key battery cost parameters. Results are presented in both tabular and graphical form. Figure 2.10 shows the spreadsheet layout. Table 2.2 summarizes the macros used in SYSPLAN and shows the page where each macro is discussed. These macros and their purposes are listed below, along with Lotus123 commands you will use.

/fr (File Retrieve) SYSPLAN - Load the SYSPLAN model into Lotus123.



SYSPLAN: CUSTOMER-SIDE-OF-THE-METER
BATTERY SYSTEM ECONOMIC ANALYSIS

MARCH 1985
PACIFIC NORTHWEST LABORATORY

MAIN MENU

TYPE 'ALT' KEY AND SPECIFIED LETTER

ALT A - INPUT SYSTEM DESCRIPTION AND COST DATA
ALT B - VIEW ECONOMIC ANALYSIS SUMMARY
ALT C - VIEW NET CASH FLOW GRAPH
ALT D - VIEW CUMULATIVE CASH FLOW GRAPH
ALT E - PRINT SYSTEM DESCRIPTION AND COST DATA
ALT F - PRINT ECONOMIC ANALYSIS SUMMARY
ALT G - SET UP AND RUN SENSITIVITY ANALYSES
ALT H - VIEW KEY ECONOMIC PERFORMANCE MEASURES

SYSTEM DESCRIPTION AND COST DATA

ANALYSIS PERFORMED BY: Analyst's Name
DATE : 07-Sep-85

COMPANY : Firm or Organization
FACILITY : Facility
LOCATION : Location

UTILITY CHARGE INFORMATION

UTILITY: PSE & G CO.

MONTH	OFF-PEAK CHARGES ENERGY CENTS/KWH	OFF-PEAK CHARGES DEMAND $/KW-MONTH	ON-PEAK CHARGES ENERGY CENTS/KWH	ON-PEAK CHARGES DEMAND $/KW-MONTH
1	4.00	0.00	4.00	0.00
2	4.00	0.00	4.00	0.00
3	4.00	0.00	4.00	0.00
4	4.00	0.00	4.00	0.00
5	4.00	0.00	4.00	0.00
6	4.00	0.00	4.00	10.00
7	4.00	0.00	4.00	10.00
8	4.00	0.00	4.00	10.00
9	4.00	0.00	4.00	10.00
10	4.00	0.00	4.00	0.00
11	4.00	0.00	4.00	0.00
12	4.00	0.00	4.00	0.00

BATTERY OPERATING INFORMATION

MONTH	PEAK SHAVED (MW)	CYCLES	DISCHARGE CYCLE DATA (HRS)	(MWHRS)
1	0.80	30.00	2.00	1.10
2	0.80	30.00	2.00	1.10
3	0.80	30.00	2.00	1.10
4	0.80	30.00	2.00	1.10
5	0.80	30.00	2.00	1.10
6	0.80	30.00	2.00	1.10
7	0.80	30.00	2.00	1.10
8	0.80	30.00	2.00	1.10
9	0.80	30.00	2.00	1.10
10	0.80	30.00	2.00	1.10
11	0.80	30.00	2.00	1.10
12	0.80	30.00	2.00	1.10

BATTERY SYSTEM DESCRIPTION

SYSTEM REQUIREMENTS
BASED ON BATTERY DUTY CYCLE:

MINIMUM DISCHARGE DURATION (HRS) = 2.00
MAXIMUM PEAK SHAVED (MW) = 0.80
REQUIRED BATTERY CAPACITY (MWH) = 1.13
REQUIRED BATTERY POWER (MW) = 0.82

PROPOSED BATTERY SYSTEM:

BATTERY CAPACITY (MWH) = 1.13
BATTERY POWER (MW) = 0.82
BATTERY LIFE (CYCLES) = 2000
CHARGE/DISCHARGE POWER RATIO = 1.00
ONE WAY CONVERTER EFFICIENCY = 97.00 %
ROUND TRIP EFFICIENCY = 69.00 %

BATTERY SYSTEM COST,ESCALATION RATES, AND TAX DATA

INSTALLED BATTERY COST = 200.00 $/KWH
INSTALLED CONVERTER COST = 92.92 $/KW
INSTALLED BALANCE OF PLANT COST = 78.89 $/KWH
ANNUAL O & M COST ($/KWH) = 0.00
AUX. POWER REQUIREMENTS (KW/CYCLE) = 20.00
SALVAGE VALUE (PERCENT OF BATTERY COST) = 15.00 %

CAPITAL COST ESCALATION RATE = 4.00 %
O & M COST ESCALATION RATE = 4.00 %
DEMAND CHARGE ESCALATION RATE = 6.00 %
ENERGY CHARGE ESCALATION RATE = 6.00 %
FRACTION OF FIRST YEAR ON LINE = 0.75

INVESTMENT TAX CREDIT RATE = 10.00 %
STATE TAX RATE = 0.00 %
FEDERAL TAX RATE = 48.00 %
EFFECTIVE INCOME TAX RATE = 48.00 %
DISCOUNT RATE FOR PRESENT WORTH ANALYSIS = 7.00 %

BATTERY SYSTEM SENSITIVITY ANALYSIS

INDEPENDENT VARIABLE: BATTERY LIFE IN CYCLES		PAYBACK PERIOD (YEARS)	20-YEAR PRESENT WORTH (THOUSANDS)
		#N44	#N45
MINIMUM VALUE:	1000	14	-36.3
1000 CYCLES	1250	9	186.3
	1500	7	339.2
MAXIMUM VALUE:	1750	7	339.2
2000 CYCLES	2000	5	418.1

SYSPLAN ECONOMIC ANALYSIS SUMMARY

(THOUSANDS OF DOLLARS)

YEAR:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SAVINGS:																				
DEMAND CHARGE REDUCTION	70.2	99.2	105.2	111.5	118.2	125.3	132.8	140.8	149.2	158.2	167.7	177.7	188.4	199.7	211.7	224.4	237.8	252.1	267.2	283.3
BATTERY SALVAGE VALUE	0.0	0.0	0.0	0.0	0.0	41.6	0.0	0.0	0.0	0.0	56.7	0.0	0.0	0.0	0.0	61.6	0.0	0.0	0.0	0.0
TOTAL SAVINGS	70.2	99.2	105.2	111.5	118.2	166.9	132.8	140.8	149.2	158.2	210.3	177.7	188.4	199.7	211.7	286.0	237.8	252.1	267.2	283.3
EXPENSES:																				
ENERGY CHARGE INCREASE	5.7	8.0	8.5	9.0	9.5	10.1	10.7	11.3	12.0	12.7	13.5	14.3	15.2	16.1	17.1	18.1	19.2	20.3	21.5	22.8
ANNUAL O & M COST	0.7	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	2.0
AUXILIARY POWER COST	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9
TAX DEPRECIATION	52.9	77.5	74.0	74.0	74.0	39.6	58.8	55.4	55.4	55.4	48.1	78.6	67.4	67.4	67.4	58.6	85.9	82.8	82.8	82.8
TOTAL EXPENSES	59.5	86.8	83.9	84.4	85.0	51.2	70.3	68.4	69.2	70.8	63.6	86.9	84.7	85.7	86.8	79.1	107.6	104.9	106.3	107.7
TAXABLE INCOME	10.8	12.4	21.3	27.1	33.2	115.7	62.5	72.3	80.0	88.2	154.7	90.8	103.7	114.0	124.9	206.9	130.2	147.1	160.9	175.5
LESS: INCOME TAXES	5.2	6.0	10.2	13.0	15.9	55.5	30.0	34.7	38.4	42.3	74.3	43.6	49.8	54.7	60.0	99.3	62.5	70.6	77.2	84.3
PLUS: INVESTMENT TAX CREDITS	37.1	0.0	0.0	0.0	0.0	27.8	0.0	0.0	0.0	0.0	33.8	0.0	0.0	0.0	0.0	41.1	0.0	0.0	0.0	0.0
NET INCOME	42.7	6.4	11.1	14.1	17.2	87.9	32.5	37.6	41.6	45.9	114.2	47.2	53.9	59.3	65.0	148.7	67.7	76.5	83.7	91.3
PLUS: TAX DEPRECIATION	52.9	77.5	74.0	74.0	74.0	39.6	58.8	55.4	55.4	55.4	48.1	78.6	67.4	67.4	67.4	58.6	85.9	82.8	82.8	82.8
LESS: BATTERY COSTS	226.0	0.0	0.0	0.0	0.0	277.6	0.0	0.0	0.0	0.0	337.8	0.0	0.0	0.0	0.0	410.9	0.0	0.0	0.0	0.0
LESS: CONVERTER COSTS	185.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LESS: BALANCE-OF-PLANT COSTS	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET BEFORE-TAX CASH FLOW	-347	90	95	101	107	-122	120	128	135	144	-135	161	171	181	192	-145	216	229	243	258
NET AFTER-TAX CASH FLOW	-315	84	85	88	91	-150	90	93	97	101	-175	118	121	127	132	-204	154	158	166	173
CUM. AFTER-TAX CASH FLOW	-315	-231	-146	-58	33	-117	-27	66	163	265	89	207	328	455	587	384	537	696	861	1035

YEAR:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AFTER-TAX RETURN ON INVESTMENT	-73.4	-33.1	-9.5	4.8	******	-3.6	5.9	11.8	14.3	8.4	12.4	14.7	16.3	17.5	15.9	17.0	17.7	18.4	18.8	

PAYBACK PERIOD = 5.00
20 YEAR PRESENT WORTH = 329

WORKSPACE FOR ECONOMIC ANALYSIS CALCULATIONS

#MONTH	DCHARGE	ECHARGE	YEAR	#BAT.	#SAL.	BATTERY LIFE
1	7.04	-0.59	1.00	226	33.90	5.00 YEARS
2	7.04	-0.59	2.00	237	35.60	
3	7.04	-0.59	3.00	247	37.02	
4	7.04	-0.59	4.00	257	38.50	
5	7.04	-0.59	5.00	267	40.04	
6	8.00	-0.59	6.00	278	41.64	
7	8.00	-0.59	7.00	289	43.31	
8	8.00	-0.59	8.00	300	45.04	
9	8.00	-0.59	9.00	312	46.84	
10	7.04	-0.59	10.00	325	48.71	
11	7.04	-0.59	11.00	338	50.66	
12	7.04	-0.59	12.00	351	52.69	
			13.00	365	54.80	
			14.00	380	56.99	
			15.00	395	59.27	
			16.00	411	61.64	
			17.00	427	64.10	
			18.00	444	66.67	
			19.00	462	69.34	
			20.00	481	72.11	

MACROS

(HOME)	ALT A	NAME RETRIEUCHARGOPERATSYSTEMCOST QUIT ENTER RETRIEINPUT INPUT INPUT INPUT INPUT RETURN {HOME}{GOTO}{HOME}{HOME}{HOME}{HOME}{HOME}
(HOME)	ALT B	PRESS (GOTO)PRESS PRESS PRESS PRESS RETURN
	ALT H	/riA20/xmIMP/riA30/riA50/riA69/riA89..HI08
/gnuHE	ALT C	{HOME} /xmINPTMENU"/xmIMP/xmINP/xmINP/xmINPTMENU"
/gnuFL	ALT D	CUSTOM MENU SENSMENU FOR ALT-G
		SETUP RUN WORTH GRAYBAPRINT QUIT
/ppobr	ALT E	SET UPRUN THGRAPH GRAPH PRINT RETURN
r429..		/xmIMOTHIS W/gnuPW/gnuPP/ppnA2{HOME}
rW69..		/dtlST{GOTO}{GOTO}rA109..HI16"
		{GOTO} {GOTO}
/ppobc	ALT F	
h21!PA	SUBRGU	CUSTOM MENU INDEMENU CALLED FROM SENSMENU
rM2..S	PRESS	COSTEMESCALALIFEX TAXDATAMOTRIQUITESC) WAE
rAA2..	/riA51	SET UPSET UPSET UPSET UPSET UPRETURN
	{CALC}	{GOTO}{GOTO}{GOTO}{GOTO}{GOTO}{GOTO}{GOTO}
(HOME)	ALT G	/rac$1/rac$1/rac$1/rac$1/rac$1
/xmSEN	ALL DO	/rff2"/rff2"/rff6"/rff2"/rff2"
	{GOTO}	

PAYBACK PERIOD CALCULATIONS

	100	100	100	100	5	100	100	8	9	10	11	12	13	14	15	16	17	18	19	20
DEPRECIATION YEAR																				
YEAR 1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	
1 52.87	77.54	74.01	74.01	74.01																
2	0.00	0.00	0.00	0.00	0.00															
3		0.00	0.00	0.00	0.00	0.00														
4			0.00	0.00	0.00	0.00	0.00													
5				0.00	0.00	0.00	0.00	0.00												
6					39.56	58.02	55.38	55.38	55.38											
7						0.00	0.00	0.00	0.00	0.00										
8							9.00	0.00	0.00	0.00	0.00	0.00								
9								0.00	0.00	0.00	0.00	0.00	0.00							
10									0.00	0.00	0.00	0.00	0.00	0.00						
11										48.13	70.59	67.38	67.38	67.38						
12											0.00	0.00	0.00	0.00	0.00					
13												0.06	0.00	0.00	0.00	0.00				
14													0.00	0.00	0.00	0.00	0.00			
15														0.00	0.00	0.00	0.00	0.00		
16															58.56	85.88	81.98	81.98	81.98	
17																0.00	0.00	0.00	0.00	
18																	0.00	0.00	0.00	
19																		0.00	0.00	
20																			0.00	
52.87	77.54	74.01	74.01	74.01	39.56	58.02	55.38	55.38	55.38	48.13	70.59	67.38	67.38	67.38	58.56	85.88	81.98	81.98	81.98	

SCALING FOR CASH FLOW GRAPHS:

CUM: -315443 -231456 **********33015 **********66402 **********89262 **
NET: -315443 83987 85112 88097 91262 ******90498 93003 97001 **

KEY ECONOMIC PERFORMANCE MEASURES

INITIAL INVESTMENT

INSTALLED BATTERY COST	= $ 226	THOUSAND
INSTALLED CONVERTER COST	= 185	THOUSAND
INSTALLED BALANCE OF PLANT COST	= 80	THOUSAND
TOTAL INITIAL INVESTMENT	= $ 411	THOUSAND

PAYBACK PERIOD = 5.00 YEARS

20-YEAR ANALYSIS @ DISCOUNT RATE OF: 7.0 %

NET PRESENT WORTH	= $ 329	THOUSAND
BEFORE TAX RETURN ON INVESTMENT	= 24.0 %	
AFTER TAX RETURN ON INVESTMENT	= 18.8 %	

FIGURE 2.10. SYSPLAN Spreadsheet Layout

TABLE 2.2. Summary of SYSPLAN Macros

Macro Programs Used in SYSPLAN	See Page
ALT A - INPUT SYSTEM DESCRIPTION AND COST DATA.....	2.16
Displays the Input Menu, which has the following options:	
NAME - ENTER YOUR NAME AND FIRM	
RETRIEVE - RETRIEVE UTILITY CHARGE, OPERATING DATA FROM SIZING FILE	
UCHARGE - INPUT UTILITY CHARGE INFORMATION	
OPERATING - INPUT BATTERY OPERATING INFORMATION	
SYSTEM - INPUT UTILITY SYSTEM DESCRIPTION	
COST - INPUT SYSTEM COST, ESCALATION RATES AND TAX DATA	
QUIT - RETURN TO MAIN MENU	
ALT B - VIEW ECONOMIC ANALYSIS SUMMARY.....	2.26
ALT C - VIEW NET CASH FLOW GRAPH.....	2.26
ALT D - VIEW CUMULATIVE CASH FLOW GRAPH.....	2.26
ALT E - PRINT SYSTEM DESCRIPTION AND COST DATA.....	2.29
ALT F - PRINT ECONOMIC ANALYSIS SUMMARY.....	2.29
ALT G - SET UP AND RUN SENSITIVITY ANALYSES.....	2.32
Displays the Analysis Menu, which has the following options:	
SETUP - SETUP AN INDEPENDENT VARIABLE (FIVE CHOICES): COST, ESCALATION, LIFE, TAXRATE, ROUNDTRIP EFFICIENCY	
RUN - RUN THE ANALYSIS WITH THE VARIABLE AND VALUES DISPLAYED ON SCREEN	
WORTH - GRAPH PRESENT WORTH AGAINST INDEPENDENT VARIABLE SHOWN	
GPAYBACK - GRAPH PAYBACK PERIOD AGAINST INDEPENDENT VARIABLE SHOWN	
PRINT - PRINT THE ANALYSIS RESULTS	
QUIT - RETURN TO MAIN MENU	
ALT H - VIEW KEY ECONOMIC PERFORMANCE MEASURES.....	2.38

This Lotus123 command is used to load the SYSPLAN model onto the computer's screen and into its internal memory. Before it can be issued, Lotus123 must be loaded and a blank spreadsheet displayed onscreen. If you are unsure how to do this, consult a Lotus123 manual.

To load the SYSPLAN model, use the Lotus File Retrieve command:

/frSYSPLAN<RETURN>

It does not matter whether SYSPLAN is entered with upper-case or lower-case letters. If the command is successful, SYSPLAN's Main Menu will be displayed onscreen, as shown in Figure 2.11. You are now ready to enter information describing a battery system.

The SYSPLAN spreadsheet includes several macro programs designed to ease the process of specifying and analyzing load-leveling battery systems. These macros and their purposes are described below, along with some common Lotus123 commands you will use.

Lotus123 Commands Used in SYSPLAN

/fr (File Retrieve) SYSPLAN - Load the SYSPLAN model into Lotus

F9 (CALC key) - Run the case most recently input

/gs (Graph Save) - Save a graph to file for printing/q (Quit) - Leave Lotus123

<HOME> - Home key returns to main menu

Order of Execution

- Access Lotus123 and retrieve SYSPLAN (/fr)
- ALT A - input system description for a system scenario
- F9 (CALC) to run the case
- ALT B,C,D,E,F,H to view the output
- /gs to save graphs to disk
- ALT G to run sensitivity analyses
- /q to quit
- in case of trouble, hit the <ESCAPE> key and then the <HOME> key to return to the main menu

```
*******************************************************
*        SYSPLAN:  CUSTOMER-SIDE-OF-THE-METER         *
*          BATTERY SYSTEM ECONOMIC ANALYSIS           *
*                                                     *
*                     MARCH 1985                      *
*             PACIFIC NORTHWEST LABORATORY            *
*******************************************************
*                     MAIN MENU                       *
*                                                     *
*           TO SELECT OPTION, TYPE ALT' KEY           *
*            FOLLOWED BY SPECIFIED LETTER             *
*                                                     *
*   ALT A - INPUT SYSTEM DESCRIPTION AND COST DATA    *
*   ALT B - VIEW ECONOMIC ANALYSIS SUMMARY            *
*   ALT C - VIEW NET CASH FLOW GRAPH                  *
*   ALT D - VIEW CUMULATIVE CASH FLOW GRAPH           *
*   ALT E - PRINT SYSTEM DESCRIPTION AND COST DATA    *
*   ALT F - PRINT ECONOMIC ANALYSIS SUMMARY           *
*   ALT G - SET UP AND RUN SENSITIVITY ANALYSES       *
*   ALT H - VIEW KEY ECONOMIC PERFORMANCE MEASURES    *
*******************************************************
```

FIGURE 2.11. SYSPLAN Main Menu

ALT A - Input System Description and Cost Data

This macro command is executed in order to enter information describing a battery system. ALT A should be used before running a case or looking at output.

To begin the process of entering a battery system description, press the ALT key and the letter A simultaneously. A menu will appear at the top of the screen. This menu, called the Input Menu, offers the seven options listed below:

Option	Description
NAME	ENTER YOUR NAME AND FIRM
RETRIEVE	RETRIEVE UTILITY CHARGE, OPERATING DATA FROM SIZING FILE
UCHARGE	INPUT UTILITY CHARGE INFORMATION
OPERATING	INPUT BATTERY OPERATING INFORMATION
SYSTEM	INPUT UTILITY SYSTEM DESCRIPTION
COST	INPUT SYSTEM COST, ESCALATION RATES AND TAX DATA
QUIT	RETURN TO MAIN MENU

The NAME, UCHARGE, OPERATING, SYSTEM and COST options each allow one kind of information about the battery system to be entered. The RETRIEVE option reads utility charge and operating data from the XSIZE sizing worksheet output file. It can be used along with options UCHARGE and OPERATING. To describe a battery system fully, the NAME, SYSTEM, COST, UCHARGE and OPERATING options should be chosen (RETRIEVE is optional). After each option is finished, the pointer returns to the Input Menu so that the next option may be selected. After all descriptive information has been entered, choose the QUIT option to erase the Input Menu from the top of the screen and return to the Main Menu.

An option can be selected in either of two ways. One way is to type the first letter of the option. For example, to choose the SYSTEM option in this fashion, press the letter S. The second way is to use the cursor-movement keys to position the pointer over the desired opton and press <RETURN>. To use this method of selecting SYSTEM, use the right-arrow key until SYSTEM is highlighted by the pointer, then press <RETURN>. By using the second method, the description of each option is displayed onscreen as the pointer is moved over its name. The Input Menu options are described below.

Input Menu Option NAME

This option enters your name and organization, information which will later be used as a heading for SYSPLAN's output reports. It is chosen from the Input Menu either by pressing the letter N or by highlighting NAME with the pointer and pressing <RETURN>.

When option NAME is chosen, the screen shown in Figure 2.12 is displayed. In addition, a message is written to the the top of the screen, reading:

PRESS RETURN TO BEGIN...ESCAPE (ESC) WHEN FINISHED

When you press <RETURN> as prompted, SYSPLAN moves the pointer to the first item to be entered--for this option, to the cell containing "Analyst's Name." You can change the cell's contents by typing your name and pressing <RETURN>. After <RETURN> is pressed, the new contents will be displayed in the cell.

```
*****************************************************
*         SYSTEM DESCRIPTION AND COST DATA          *
*                                                   *
*   ANALYSIS PERFORMED BY:  Analyst's Name          *
*   DATE                  :  08-Mar-85              *
*                                                   *
*   COMPANY               :  Firm or Organization   *
*   FACILITY              :  Facility               *
*   LOCATION              :  Location               *
*****************************************************
```

FIGURE 2.12. Input Menu Option NAME Screen

While the information under option NAME is being entered, the cursor-movement keys allow you to position the pointer only over those items which are to be changed. For option NAME, these items are:

- Analyst's Name
- Company
- Facility
- Location.

The current date is displayed onscreen but cannot be changed (it is generated automatically by SYSPLAN).

You can continue to make changes to the four items listed above until you are satisfied with their contents. When you are finished, press <ESC>. This moves the pointer back to the Input Menu, allowing you to select another option.

Input Menu Option RETRIEVE

This option can be used to read the information generated by the XSIZE sizing spreadsheet into the SYSPLAN spreadsheet. The sizing worksheet generates utility charge and battery operating information. The RETRIEVE option can be selected from the Input Menu either by pressing the letter R or by highlighting RETRIEVE with the pointer and pressing <RETURN>.

When the RETRIEVE option is chosen, the spreadsheet looks for the file SIZE.WKS on the disk. (SIZE.WKS is the most recent output file created from the sizing spreadsheet.) If it finds this file, it will read the information

from it into SYSPLAN. In this way, utility charge and battery operating information for a battery system are input automatically. If the SIZE.WKS file is not found, an error message will be displayed. Clear the error message by pressing <ESC>, then find the file on disk if you want to select RETRIEVE again.

When this file transfer is completed, the pointer returns to the Input Menu, allowing you to select another option. If you use the RETRIEVE option to input utility charge and operating data, you should also select UCHARGE to enter a utility name, and OPERATING to enter peak shaved in cycles data (terms are defined in Chapter 3.0). You can also use UCHARGE and OPERATING to modify the information retrieved from the sizing worksheet.

Input Menu Option UCHARGE

This option is chosen to enter the name of the utility being analyzed and information on its utility charge structure. It is chosen from the Input Menu either by pressing the letter U or by highlighting UCHARGE with the pointer and pressing <RETURN>.

When option UCHARGE is chosen, the screen shown in Figure 2.13 is displayed. In addition, a message is written to the the top of the screen, reading:

PRESS RETURN TO BEGIN...ESCAPE (ESC) WHEN FINISHED

When you press <RETURN> as prompted, SYSPLAN moves the pointer to the name of the utility being analyzed - the first item to be changed for this option. You can change the cell's contents by typing the utility's name and pressing <RETURN>. After <RETURN> is pressed, the new contents will be displayed in the cell.

While the information under option UCHARGE is being entered, the cursor-movement keys allow you to position the pointer only over those items which are to be changed. Option UCHARGE allows up to forty-nine items to be changed, as listed below:

- Name of Utility Being Analyzed
- Off-Peak Energy Charge for each month

UTILITY CHARGE INFORMATION

UTILITY: IDAHO PUBLIC POWER

	OFF-PEAK CHARGES		ON-PEAK CHARGES	
MONTH	ENERGY CENTS/KWH	DEMAND $/KW-MONTH	ENERGY CENTS/KWH	DEMAND $/KW-MONTH
1	4.00	0.00	4.00	8.80
2	4.00	0.00	4.00	8.80
3	4.00	0.00	4.00	8.80
4	4.00	0.00	4.00	8.80
5	4.00	0.00	4.00	8.80
6	4.00	0.00	4.00	10.00
7	4.00	0.00	4.00	10.00
8	4.00	0.00	4.00	10.00
9	4.00	0.00	4.00	10.00
10	4.00	0.00	4.00	8.80
11	4.00	0.00	4.00	8.80
12	4.00	0.00	4.00	8.80

FIGURE 2.13. Input Menu Option UCHARGE Screen

- Off-Peak Demand Charge for each month
- On-Peak Energy Charge for each month
- On-Peak Demand Charge for each month.

You can continue to make changes to these items until you are satisfied with their contents. When you are finished, press <ESC>. This moves the pointer back to the Input Menu, allowing you to select another option.

Input Menu Option OPERATING

This option is chosen to enter operating information for the proposed battery system. It is chosen from the Input Menu either by pressing the letter O or by highlighting OPERATING with the pointer and pressing <RETURN>.

When option OPERATING is chosen, the screen shown in Figure 2.14 is displayed. In addition, a message is written to the the top of the screen, reading:

PRESS RETURN TO BEGIN...ESCAPE (ESC) WHEN FINISHED

BATTERY OPERATING INFORMATION

MONTH	PEAK SHAVED (MW)	PEAK SHAVED CYCLES	DISCHARGE CYCLE DATA (HRS)	DISCHARGE CYCLE DATA (MWHRS)
1	0.80	30.00	2.00	1.10
2	0.80	30.00	2.00	1.10
3	0.80	30.00	2.00	1.10
4	0.80	30.00	2.00	1.10
5	0.80	30.00	2.00	1.10
6	0.80	30.00	2.00	1.10
7	0.80	30.00	2.00	1.10
8	0.80	30.00	2.00	1.10
9	0.80	30.00	2.00	1.10
10	0.80	30.00	2.00	1.10
11	0.80	30.00	2.00	1.10
12	0.80	30.00	2.00	1.10

FIGURE 2.14. Input Menu Option OPERATING Screen

When you press <RETURN> as prompted, SYSPLAN moves the pointer to the Peak Shaved (MW) amount for Month 1-- the first item to be changed for this option. You can change the cell's contents by typing a different amount and pressing <RETURN>. After <RETURN> is pressed, the new contents will be displayed in the cell.

While the information under option OPERATING is being entered, the cursor-movement keys allow you to position the pointer only over those items which are to be changed. Option OPERATING allows up to forty-eight items to be changed, as listed below:

- Peak Shaved in Megawatts for each month
- Peak Shaved in Cycles for each month
- Discharge Cycle in Hours for each month
- Discharge Cycle in Megawatt Hours for each month.

You can continue to change these items until you are satisfied with their contents. When you are finished, press <ESC>. This moves the pointer back to the Input Menu, allowing you to select another option.

Input Menu Option SYSTEM

This option is chosen in order to enter a description of the proposed battery system. It is chosen from the Input Menu either by pressing the letter S or by highlighting SYSTEM with the pointer and pressing <RETURN>.

When option SYSTEM is chosen, the screen shown in Figure 2.15 is displayed. In addition, a message is written to the top of the screen, reading:

PRESS RETURN TO BEGIN...ESCAPE (ESC) WHEN FINISHED

When you press <RETURN> as prompted, SYSPLAN moves the pointer to the Battery Capacity in Megawatts amount - the first item to be changed for this option. You can change the cell's contents hy typing a different amount and pressing <RETURN>. After <RETURN> is pressed, the new contents will be displayed in the cell.

```
**************************************************
*          BATTERY SYSTEM DESCRIPTION            *
*                                                *
*   SYSTEM REQUIREMENTS                          *
*   BASED ON BATTERY DUTY CYCLE:                 *
*                                                *
*   MINIMUM DISCHARGE DURATION (HRS) = 2.00      *
*   MAXIMUM PEAK SHAVED (MW)         = 0.80      *
*   REQUIRED BATTERY CAPACITY (MWH)  = 1.13      *
*   REQUIRED BATTERY POWER (MW)      = 0.82      *
*                                                *
*   PROPOSED BATTERY SYSTEM:                     *
*                                                *
*   BATTERY CAPACITY (MW)            = 1.13      *
*   BATTERY POWER (MW)               = 0.82      *
*   BATTERY LIFE (CYCLES)            = 2000      *
*   CHARGE/DISCHARGE POWER RATIO     = 1.00      *
*   ONE WAY CONVERTER EFFICIENCY     = 97.004    *
*   ROUND TRIP EFFICIENCY            = 69.004    *
**************************************************
```

FIGURE 2.15. Input Menu Option SYSTEM Screen

While the information under option SYSTEM is being entered, the cursor-movement keys allow you to position the pointer only over those items which are to be changed. Option SYSTEM allows up to six items to be changed:

- Battery Capacity in Megawatts
- Battery Power in Megawatts
- Battery Life in Cycles
- Charge/Discharge Power Ratio
- One Way Converter Efficiency
- Round Trip Efficiency.

The four items listed below also are displayed on this screen, but cannot be changed because they are calculated automatically by SYSPLAN:

- Minimum Discharge Duration in Hours
- Maximum Peak Shaved in Megawatts
- Required Battery Capacity in Megawatt Hours
- Required Battery Power in Megawatts.

You can continue to make changes to the first six items until you are satisfied with their contents. When you are finished, press <ESC>. This moves the pointer back to the Input Menu, allowing you to select another option.

Input Menu Option COST

This option is chosen in order to enter cost information for the proposed battery system, cost and utility charge escalation rates and tax rates to be used in the analysis. It is chosen from the Input Menu either by pressing the letter C or by highlighting COST with the pointer and pressing <RETURN>.

When option COST is chosen, the screen shown in Figure 2.16 is displayed. In addition, a message is written to the top of the screen, reading:

PRESS RETURN TO BEGIN...ESCAPE (ESC) WHEN FINISHED

When you press <RETURN> as prompted, SYSPLAN moves the pointer to Installed Battery Cost - the first item to be changed under this option. You can change

```
**********************************************************************
*    BATTERY SYSTEM COST, ESCALATION RATES, ANO TAX DATA             *
*                                                                    *
*   INSTALLED BATTERY COST                      = 200.00 $/KWH       *
*   INSTALLED CONVERTER COST                    = 92.92 $/KWH        *
*   INSTALLED BALANCE OF PLANT COST             = 70.80 $/KWH        *
*   ANNUAL O & M COST ($/KWH)                   = 0.80               *
*   AUX. POWER REQUIREMENTS (KWH/CYCLE)         = 20.00%             *
*   SALVAGE VALUE (PERCENT OF BATTERY COST)     = 15.00%             *
*                                                                    *
*   CAPITAL COST ESCALATION RATE                = 4.00%              *
*   O & M COST ESCALATION RATE                  = 4.00%              *
*   DEMAND CHARGE ESCALATION RATE               = 6.00%              *
*   ENERGY CHARGE ESCALATION RATE               = 6.00%              *
*   FRACTION OF FIRST YEAR ON LINE              = 0.75               *
*                                                                    *
*   INVESTMENT TAX CREDIT RATE                  = 10%                *
*   STATE TAX RATE                              =  0%                *
*   FEDERAL TAX RATE                            = 48%                *
*   EFFECTIVE INCOME TAX RATE                   = 48%                *
*   DISCOUNT RATE FOR PRESENT WORTH ANALYSIS    = 7%                 *
**********************************************************************
```

FIGURE 2.16. Input Menu Option COST Screen

the cell's contents by typing a different amount and pressing <RETURN>. After <RETURN> is pressed, the new contents will be displayed in the cell.

While the information under option COST is being entered, the cursor-movement keys allow you to position the pointer only over those items which are to be changed. Option COST allows up to fifteen items to be changed:

- Installed Battery Cost
- Installed Converter Cost
- Installed Balance of Plant Cost
- Annual O & M Cost
- Auxiliary Power Requirements (Megawatt Hours per Cycle)
- Salvage Value (as percent of Battery Cost)
- Capital Cost Escalation Rate
- O & M Cost Escalation Rate
- Demand Charge Escalation Rate
- Energy Charge Escalation Rate
- Fraction of First Year On Line

- Investment Tax Credit Rate
- State Tax Rate
- Federal Tax Rate
- Discount Rate for Present Worth Analysis.

The Effective Income Tax Rate is also displayed on this screen, but because it is calculated from the other tax rates it cannot be changed by the user.

You can continue to change these items until you are satisfied with their contents. When you are finished, press <ESC>. This moves the pointer back to the Input Menu, allowing you to select another option.

Input Menu Option QUIT

Option QUIT is chosen after all information describing the battery system has been entered under the other Input Menu options. It can be selected from the Input Menu either by pressing the letter Q or by highlighting QUIT with the pointer and pressing <RETURN>.

When option QUIT is chosen, the Input Menu is erased from the top of the screen, and the screen displays the Main Menu shown in Figure 2.11. You are now ready to run the case just entered.

ALT-A - Running a SYSPLAN Case

F9 (CALC key) - Run the case most recently input.

The F9 key (Lotus123 CALC key) runs a SYSPLAN case using the values most recently entered from the Input Menu (ALT A). F9 must be pressed to incorporate newly entered values into other SYSPLAN calculations. The F9 key updates the items which were displayed but not entered from the Input Menu screens. It also updates SYSPLAN's Economic Analysis Summary and provides current values for graphs and output reports.

To run a SYSPLAN case, merely press the F9 (CALC) key and wait approximately ten seconds for updated results to be displayed. F9 can be used from anywhere within the worksheet except from within the Input and Analysis Menus. (If one of these menus is displayed at the top of the screen, choose the QUIT option to return to the Main Menu, then press F9.)

After the latest case is calculated with F9, other macros can be used to display and print results; results can be expanded by performing sensitivity analyses. These capabilities are described below.

ALT B - View Economic Analysis Summary

The ALT B macro program allows users to view SYSPLAN'S Economic Analysis Summary onscreen. The Economic Analysis Summary provides an income statement, including Net and Cumulative Cash Flow amounts and Return on Investment, for each of the twenty years for which the proposed battery system is analyzed. It is created whenever the F9 (CALC) key is pressed.

To view the Economic Analysis Summary, press the ALT key and the letter B simultaneously. When ALT and B are pressed, the top left corner of the summary is displayed. This macro can be used from anywhere within the worksheet except from within the Input and Analysis Menus. (If one of these menus is displayed at the top of the screen, choose the QUIT option to return to the Main Menu, then press ALT and B.)

The Economic Analysis Summary is over two screens wide and over two screens long. To view different areas in the summary, the cursor-movement keys can be used. A quicker way to move around in the summary is to use the <PGUP> and <PGDN> keys to move up and down within the summary, <TAB> and SHIFT-<TAB> to move left and right. (Experienced Lotus123 users may wish to use the Worksheet Window command to set a vertical window at Column M of the SYSPLAN spreadsheet.)

When you are finished looking at the Economic Analysis Summary, you may wish to obtain a printed version with the ALT F macro, press <HOME> to return to the Main Menu, or invoke another macro.

ALT C - View Net Cash Flow Graph/ALT D - View Cumulative Cash Flow Graph

These two macro programs format the most recently calculated results into graphs and display them on the screen. The ALT C macro displays a graph of the net cash flow over the twenty years included in the analysis of the proposed battery system. Figure 2.17 shows an example of the net cash flow graph. The ALT D macro displays a graph of the cumulative cash flow in dollars for each of the twenty years. A sample cumulative cash flow graph is shown in Figure 2.18.

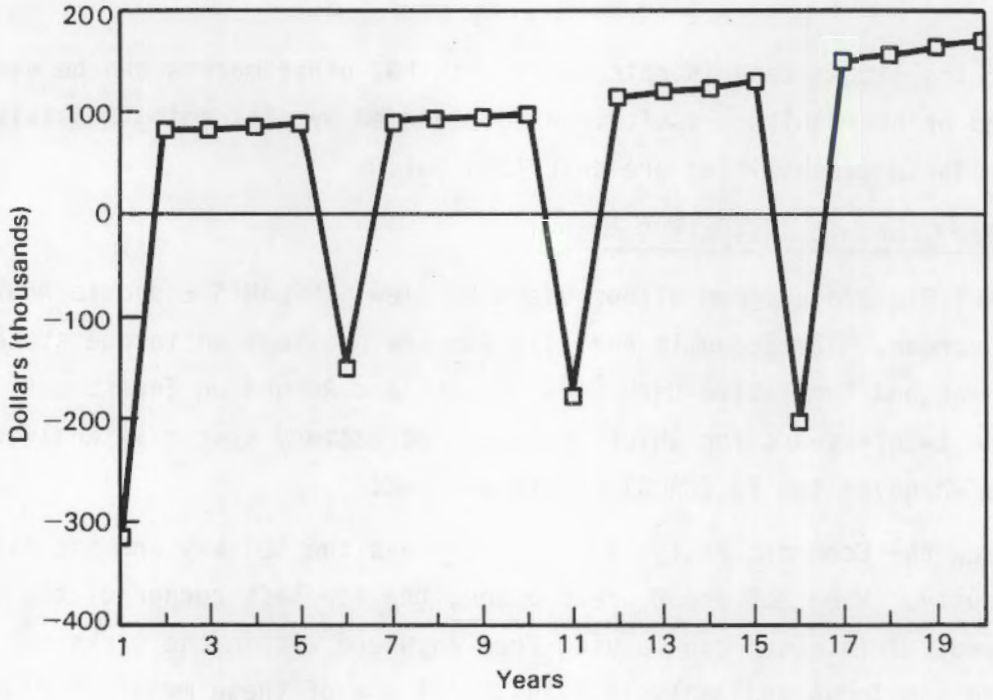


FIGURE 2.17. Net Cash Flow Graph

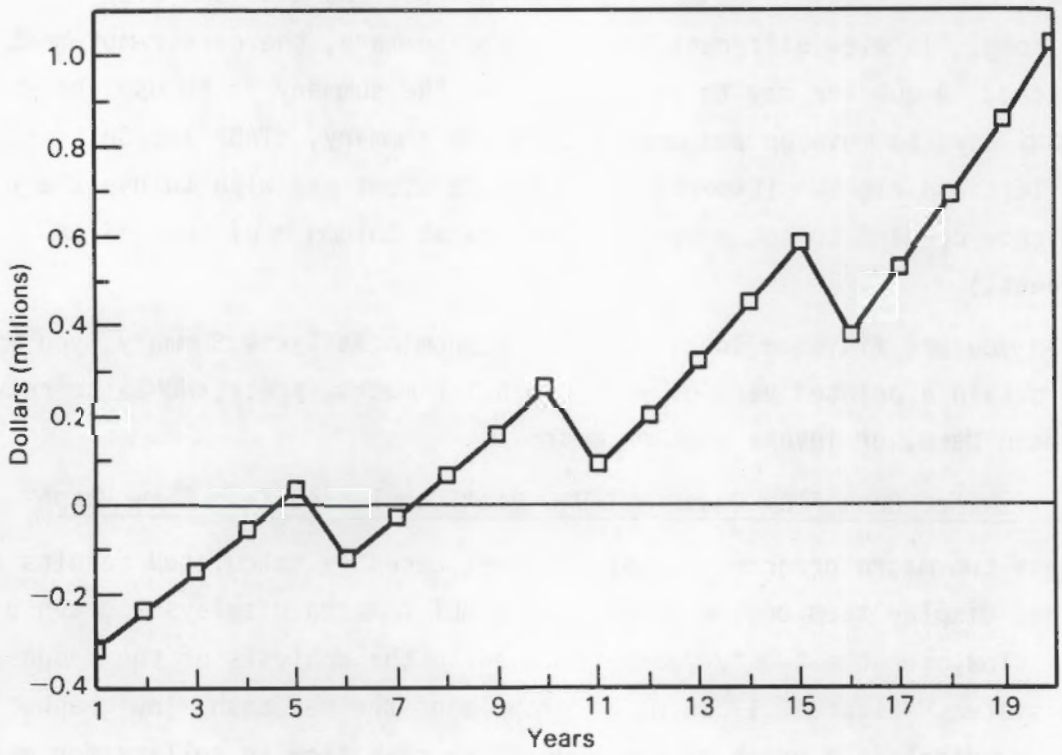


FIGURE 2.18. Cash Flow Graph

Each of these macros can be invoked from anywhere in the SYSPLAN spreadsheet except from within the Input and Analysis Menus. (If one of these menus is displayed at the top of the screen, choose the QUIT option to return to the Main Menu before attempting to display a graph.) To look at the Net Cash Flow graph, press the ALT key and the letter C simultaneously. To view the cumulative cash flow graph, press ALT and D simultaneously.

When one of these key combinations is pressed, the graph associated with it will be displayed on the screen, temporarily erasing the spreadsheet from the screen. After looking at the graph, press any key to bring the spreadsheet back onscreen. If you want to save either graph onto the disk for later printing, the next section provides details on the Lotus123 /gs (Graph Save) command which makes spreadsheet graphs available to the Lotus PrintGraph program for printing.

/gs (Graph Save) - Save a graph to file for printing

The Lotus123 /gs (Graph Save) command saves the most recently displayed graph onto the disk as a graph file. This gives the Lotus PrintGraph program access to the graph so that it can be printed after the SYSPLAN session has been concluded.

To save a graph to file, type in the command below, replacing FILENAME with the name you wish to give the graph file (this name can contain up to eight letters, but should not be given a file extension). The graph should not be displayed on the screen when you begin typing in the command.

/gsFILENAME <RETURN>

If a file FILENAME.PIC already is stored on disk, you will be asked whether you want to replace the file or to cancel the command. Press either C to cancel the /gs command or R to overwrite the old file.

The /gs command only saves the most recently seen graph to file. Thus, to save copies of both cash flow graphs requires four steps:

1. Press ALT and C for the net cash flow graph.
2. Use the /gs command to save the net cash flow graph.
3. Press ALT and D for the cumulative cash flow graph.
4. Use the /gs command to save the cash flow graph.

For more details on the Graph Save command, and for instructions for using the Lotus PrintGraph program, refer to your Lotus123 manual.

ALT E - Print System Description and Cost Data / ALT F - Print Economic Analysis Summary

These two macro programs format output reports and send them to your printer. The ALT E macro prints a two-page report showing the inputs to the proposed battery system (the items entered under the various options of the Input Menu). The first page of this report is shown in Figure 2.19. The ALT D macro prints a three-page report containing the information shown in SYSPLAN's Economic Analysis Summary (in thousands of dollars) for each of the twenty years analyzed. A sample of the first page of this report is shown in Figure 2.20. A third report, on the results of a sensitivity analysis, is printed from within the Analysis Menu.

Each of these macros can be invoked from anywhere in the SYSPLAN spreadsheet except from within the Input and Analysis Menus. (If one of these menus is displayed at the top of the screen, choose the QUIT option to return to the Main Menu before printing a report.) Before printing a report, be sure that your printer is turned on and aligned to the top of the page, and that you have recently pressed F9 (CALC) to update the spreadsheet. To print a report of the battery system description, press the ALT key and the letter E simultaneously. To print the Economic Analysis Summary, press ALT and D simultaneously.

When either of the report-printing macros is initiated, the screen display changes rapidly for a few seconds as the computer finds the information for the report. The report will begin to print. As soon as the 'READY' prompt is

SYSTEM DESCRIPTION AND COST DATA

ANALYSIS PERFORMED BY: Analyst's Name
DATE : 08-Mar-85

COMPANY : Firm or Organization
FACILITY : Facility
LOCATION : Location

UTILITY CHARGE INFORMATION

UTILITY: IOAHO PUBLIC POWER

	OFF-PEAK CHARGES		ON-PEAK CHARGES	
	ENERGY	DEMAND	ENERGY	DEMAND
MONTH	CENTS/KWH	$/KW-MONTH	CENTS/KWH	$/KW-MONTH
1	4.00	0.00	4.00	8.80
2	4.00	0.00	4.00	8.80
3	4.00	0.00	4.00	8.80
4	4.00	0.00	4.00	8.80
5	4.00	0.00	4.00	8.80
6	4.00	0.00	4.00	10.00
7	4.00	0.00	4.00	10.00
8	4.00	0.00	4.00	10.00
9	4.00	0.00	4.00	10.00
10	4.00	0.00	4.00	8.80
11	4.00	0.00	4.00	8.80
12	4.00	0.00	4.00	8.80

BATTERY OPERATING INFORMATION

	PEAK SHAVED		DISCHARGE CYCLE DATA	
MONTH	(MW)	CYCLES	(HRS)	(MWHRS)
1	0.80	30.00	2.00	1.10
2	0.80	30.00	2.00	1.10
3	0.80	30.00	2.00	1.10
4	0.80	30.00	2.00	1.10
5	0.80	30.00	2.00	1.10
6	0.80	30.00	2.00	1.10
7	0.80	30.00	2.00	1.10
8	0.80	30.00	2.00	1.10
9	0.80	30.00	2.00	1.10
10	0.80	30.00	2.00	1.10
11	0.80	30.00	2.00	1.10
12	0.80	30.00	2.00	1.10

FIGURE 2.19. Battery System Description Report

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*SYSPLAN ECONOMIC ANALYSIS SUMMARY

(THOUSANDS OF DOLLARS)

YEAR:	1	2	3	4	5	6	7
SAVINGS:							
DEMAND CHARGE REDUCTION	112.8	165.6	182.5	201.0	221.5	244.0	268.8
BATTERY SALVAGE VALUE	0	0	0	0	0	0	8.889
TOTAL SAVINGS	112.8	165.6	182.5	201.0	221.5	244.0	277.6
EXPENSES:							
ENERGY CHARGE INCREASE	3.065	4.502	4.960	5.464	6.019	6.630	7.304
ANNUAL O & M COST	0.874	1.259	1.360	1.469	1.586	1.713	1.850
AUXILIARY POWER COST	0.098	0.144	0.158	0.175	0.192	0.212	0.234
TAX DEPRECIATION	48.16	70.64	67.43	67.43	67.43	0	11.51
TOTAL EXPENSES	52.20	76.54	73.91	74.53	75.23	8.557	20.90
TAXABLE INCOME	60.60	89.14	108.6	126.5	146.2	235.4	256.7
LESS: INCOME TAXES	29.09	42.79	52.13	60.73	70.21	113.0	123.2
PLUS: INVESTMENT TAX CREDITS	33.8	0	0	0	0	0	8.081
NET INCOME	65.31	46.35	56.48	65.79	76.06	122.4	141.6
PLUS: TAX DEPRECIATION	48.16	70.64	67.43	67.43	67.43	0	11.51
LESS: BATTERY COSTS	50	0	0	0	0	0	80.81
LESS: CONVERTER COSTS	182.6	0	0	0	0	0	0
LESS: BALANCE-OF-PLANT COSTS	210.8	0	0	0	0	0	0
NET BEFORE-TAX CASH FLOW	-334.6	159.7	176.0	193.9	213.7	235.4	187.4
NET AFTER-TAX CASH FLOW	-329	116.9	123.9	133.2	143.4	122.4	72.31
CUM. AFTER-TAX CASH FLOW	-329	-212.0	-89.0	44.22	187.7	310.1	382.4

YEAR:	1	2	3	4	5	6	7
RETURN ON INVESTMENT		-64.5	-18.4	6.416	19.98	26.44	28.86

PAYBACK PERIOD = 4

20 YEAR PRESENT WORK = 1528.

FIGURE 2.20. Economic Analysis Summary Report

displayed at the top of the screen, you can press <HOME> to return to the Main Menu, run another macro or type a Lotus123 command, even if the report is still printing.

ALT G - Set up and Run Sensitivity Analyses

The ALT G macro is used to prepare for and to run sensitivity analyses for proposed battery systems. In these analyses, a range of values for a selected independent variable is specified, and the resulting values of dependent variables are calculated. All other input variables are held constant during the calculations. In the SYSPLAN spreadsheet, users choose between five independent variables, and specify the minimum and maximum values that the variables will take. After calculating three intermediate values for the independent variable, SYSPLAN gives resulting values of both the payback period for the battery system and the discounted present worth of the system.

Before running sensitivity analyses, make sure that the system description is correct by printing the description (ALT E) or using the Input Menu (ALT A). Then, to begin, press the ALT key and the letter G simultaneously. The screen shown in Figure 2.21 will appear, with a menu above it. This Analysis Menu offers the six options listed below. The descriptions can also be seen by moving the pointer among the menu options shown onscreen.

Option	Description
SETUP	SET UP AN INDEPENDENT VARIABLE (FIVE CHOICES)
RUN	RUN THE ANALYSIS WITH THE VARIABLE AND VALUES DISPLAYED ON SCREEN
WORTH	GRAPH PRESENT WORTH AGAINST INDEPENDENT VARIABLE SHOWN
GPAYBACK	GRAPH PAYBACK PERIOD AGAINST INDEPENDENT VARIABLE SHOWN
PRINT	PRINT THE ANALYSIS RESULTS
QUIT	RETURN TO THE MAIN MENU

BATTERY SYSTEM SENSITIVITY ANALYSIS

INDEPENDENT VARIABLE: INSTALLED BATTERY COST ($/KWH)		PAYBACK 20-YEAR PERIOD (YEARS)	PRESENT WORTH (THOUSANDS)
		+M43	+M45
MINIMUM VALUE:	100.00	4	484.6
100.00 DOLLARS	150.00	5	406.6
	200.00	5	328.5
MAXIMUM VALUE:	250.00	5	250.5
300.00 DOLLARS	300.00	9	172.4

FIGURE 2.21. Sensitivity Analysis Screen

An option can be selected in either of two ways. One way is to type the first letter of the option. For example, to choose the RUN option in this fashion, press the letter R. The second way is to use the cursor-movement keys to position the pointer over the desired option and press <RETURN>. To use this method of selecting RUN, use the right-arrow key until RUN is highlighted by the pointer, then press <RETURN>.

The SETUP option is used to set up an independent variable. Independent variables available for sensitivity analysis are:

- battery cost
- demand charge escalation
- battery life
- federal tax rate
- converter roundtrip efficiency.

After an independent variable has been installed, the RUN option is used to calculate the values of the two dependent variables. Results can then be printed with the PRINT option. These three steps (set up, RUN and PRINT) can be repeated as many times as needed. When no more sensitivity analyses are needed, choose the QUIT option to erase the Analysis Menu from the top of the screen and return to the Main Menu.

The Analysis Menu options are described below.

Analysis Menu Option SETUP

This Analysis Menu option is used to select and set up an independent variable for a sensitivity analysis. Only one independent variable can be used at a time. The SETUP option displays five independent variables that can be selected for the sensitivity analysis. Each can be selected by pressing the first letter of the option or by highlighting the option with the pointer and pressing <RETURN>. These options are described below:

COST - Sets up installed battery cost ($/KWH) as the independent variable

ESCALATION - Sets up demand charge escalation rate as the independent variable

LIFE - Sets up battery life in cycles as the independent variable

TAXRATE - Sets up federal tax as the independent variable

RNDTRIP - Sets up roundtrip converter efficiency as the independent variable

When any one of these options is chosen, the steps listed below are followed:

1. The name of the independent variable chosen is written onto the screen, as well as the units in which the minimum and maximum values for that variable should be entered. Also, the cells containing numeric values are reformatted if necessary.

2. A prompt is written at the top of the screen. It reads:

   PRESS RETURN TO ENTER MIN, MAX VALUES, ESCAPE (ESC) WHEN FINISHED

   Press <RETURN>. The pointer is moved to the cell for the minimum value. Enter the minimum value for the independent variable and press <RETURN>. Use any cursor-movement key to move to the cell for

the maximum value. Type in the maximum value and press <RETURN>. Either value can be changed again if necessary. When you are satisfied with both values, press <ESC>.

3. SYSPLAN copies the minimum and maximum values to the far left column of the analysis table and computes three intermediate values for the independent variable. When this operation is completed, a message is displayed at the top of the screen:

   ALL DONE!...PRESS RETURN, THEN CHOOSE THE 'RUN' OPTION

   Press <RETURN>. The Analysis Menu is displayed again at the top of the screen.

If you are satisfied with the independent variable and the values (minimum, maximum and intermediate) displayed on the screen, your next step is to choose the RUN option which calculates values for the dependent variables. However, you may set up the same or a different independent variable as many times as you wish before calculating results with the RUN option.

Analysis Menu Option RUN

This option is used to calculate the values of dependent variables, given the independent variable and values specified in option SETUP. For each value of the independent variable, the payback period and discounted present worth of the battery system are calculated. The RUN option is selected either by pressing the letter R or by highlighting RUN with the pointer and pressing <RETURN>.

When this option is chosen, the message below is written at the top of the screen.

THIS WILL TAKE 2-3 MINUTES...PRESS RETURN TO BEGIN

Press <RETURN>. While the calculations are being made, the 'WAIT' prompt flashes at the top of the screen. When they are finished, the READY prompt is displayed, the updated values of the dependent variables are displayed on the

screen, and the Analysis Menu reappears above it. If you want a printed record of the results, choose the PRINT option next.

Analysis Menu Option PRINT

This option formats a one-page output report of the most recent sensitivity analysis and sends it to your printer. A sample report is shown in Figure 2.22.

Before printing a report, be sure that your printer is turned on and aligned to the top of the page, and that you have updated the dependent variables with the RUN option. To select the PRINT option, either press the letter P or highlight PRINT with the pointer and press <RETURN>.

The report will begin to print. When the READY prompt and the Analysis Menu are displayed at the top of the screen, you can set up another sensitivity analysis with SETUP, or return to the Main Menu with the QUIT option.

SYSTEM DESCRIPTION AND COST DATA

ANALYSIS PERFORMED BY: Analyst's Name
DATE : 26-Mar-85

COMPANY : Firm or Organization
FACILITY : Facility
LOCATION : Location

BATTERY SYSTEM SENSITIVITY ANALYSIS

INDEPENDENT VARIABLE: DEMAND CHARGE ESCALATION RATE		PAYBACK PERIOD (YEARS)	20-YEAR PRESENT WORTH (THOUSANDS)
		+M43	+M45
MINIMUM VALUE: 8.00 PERCENT	8.00	10	100.8
	9.00	10	195.9
	10.00	9	303.2
MAXIMUM VALUE: 12.00 PERCENT	11.00	9	424.2
	12.00	6	560.9

FIGURE 2.22. Sensitivity Analysis Report

Analysis Menu Option WORTH

The Analysis Menu option WORTH graphs the present worth against the independent variable shown by the sensitivity analysis. An example graph showing present worth versus expected battery life is shown in Figure 2.23.

Analysis Menu Option GPAYBACK

The Analysis Menu option GPAYBACK graphs the payback period against the independent variable shown by the sensitivity analysis. An example showing payback period versus expected battery life is shown in Figure 2.24.

Analysis Menu Option QUIT

Choose option QUIT after all sensitivity analyses for the battery system have been run. It can be selected from the Analysis Menu either by pressing the letter Q or by highlighting QUIT with the pointer and pressing <RETURN>.

When option QUIT is chosen, the Analysis Menu is erased from the top of the screen, and the screen displays the Main Menu shown in Figure 2.11, allowing you to run another macro or type a Lotus123 command.

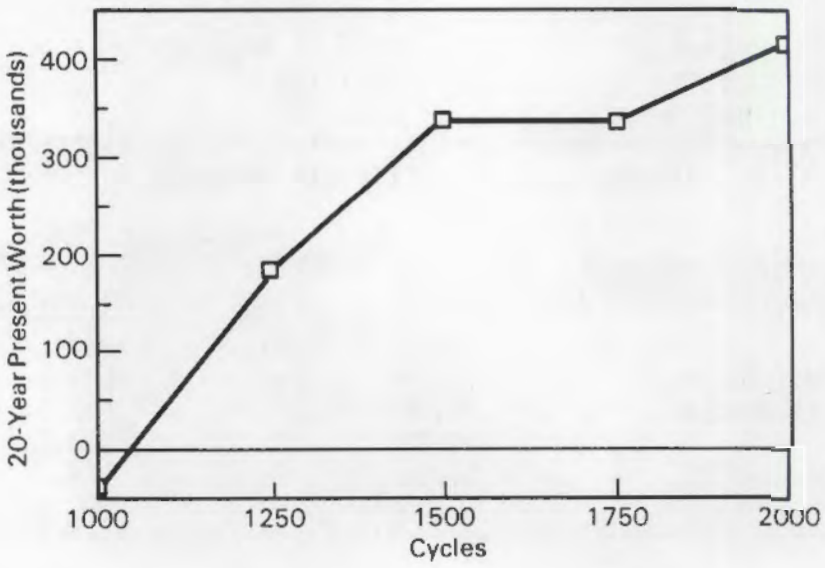

FIGURE 2.23. Example Menu Option WORTH Graph of Present Worth Versus Expected Battery Life

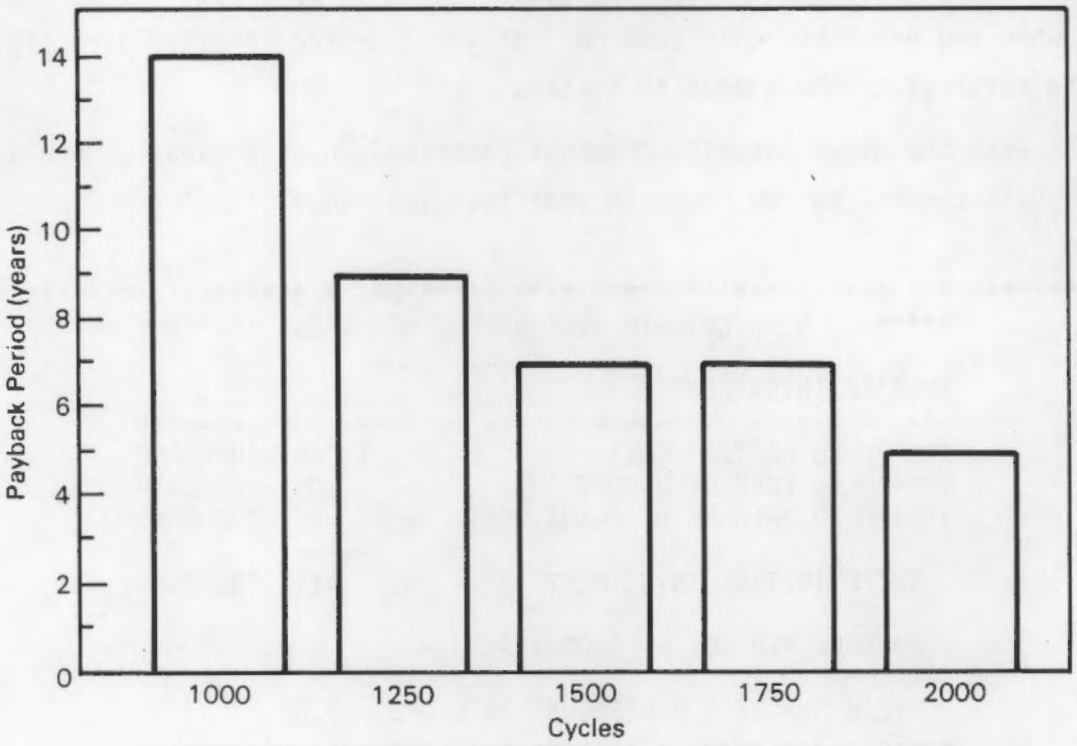

FIGURE 2.24. Example Menu Option GPAYBACK Graph of Payback Period Versus Expected Battery Life

/q (Quit) - Leave Lotus123

ALT H - View Key Economic Performance Measures

The ALT H macro displays a summary of key economic results. An example summary of key economic performance measures is shown in Figure 2.25.

This Lotus123 command is used to leave Lotus123. It should be used when you are finished with your SYSPLAN session. The SYSPLAN spreadsheet does not need to be saved when you quit.

To leave the SYSPLAN model and Lotus123, use the Quit command:

/qy

If you accessed Lotus123 through the Lotus Access System, you will be returned there when you enter the Quit command. If you accessed Lotus123 directly, you will be returned to the operating system.

As with the other Lotus123 commands described in this manual, more detail on the Quit command can be found in your Lotus123 manual.

```
*******************************************************************************
*            *****    KEY ECONOMIC PERFORMANCE MEASURES     *****              *
*                                                                             *
*            INITIAL INVESTMENT                                               *
*            ---------------------------------------------                    *
*            INSTALLED BATTERY COST            =  $ 226  THOUSAND             *
*            INSTALLED CONVERTER COST          =    105  THOUSAND             *
*            INSTALLED BALANCE OF PLANT COST   =     80  THOUSAND             *
*                                                 ------                      *
*              TOTAL INITIAL INVESTMENT        =    411  THOUSAND             *
*                                                                             *
*              PAYBACK PERIOD  =  5.00 YEARS                                  *
*                                                                             *
*            20-YEAR ANALYSIS @ DISCOUNT RATE OF:   7.0%                      *
*            ---------------------------------------------                    *
*            NET PRESENT WORTH                 =  $329  THOUSAND             *
*            BEFORE TAX RETURN ON INVESTMENT   =  24.0%                      *
*            AFTER TAX RETURN ON INVESTMENT    =  18.8%                      *
*                                                                             *
*******************************************************************************
```

FIGURE 2.25. Example Summary of Key Economic Performance Measures

3.0 DESCRIPTION OF INPUT AND OUTPUT TERMS

Each term included in the costing model and sizing routine is presented in the same order as it appears in the model. A short description and definition of each term is provided to assist the user in entering data and understanding the results.

3.1 XSIZE SIZING MODEL INPUT/OUTPUT TERMS

Terms used in the sizing model are typically identical to those in the cost model. The terms used are listed in the order in which they appear. Note all discussion of "off-peak" and "on-peak" is with respect to the customer's peak (on the load curve) which may not coincide with the utility system peak.

Typical Daily Peak (kW) - Height of peak power demand (relative to the rest of the time) of customer.

Rate Type - Flat rates incorporate constant energy charges throughout the 24 hour day. Time-of-day (TOD) rates have time-varying energy charges which are generally higher during the utility's peak demand period.

On-Peak Demand Charge - Utility monthly demand charge ($/kW-month) corresponding to the time when the customer's off-peak demand load occurs.

On-Peak Energy Charge - The utility's energy charge when the customer's off-peak occurs, in cents/kWh.

Off-Peak Energy Charge - The utility's energy charge when the customer's peak occurs, in cents/kWh.

BATTERY OPERATING INFORMATION

Discharge Duration - Time period of battery discharge (hours).

Discharge Power Level - Equivalent to the reduction in the customer's peak power demand as a result of the load leveling battery system.

Cycles - Number of charge-discharge cycles each month necessary to shave customer peak.

Discharge Energy - The approximate total energy supplied while shaving a particular peak (MWhrs). It is calculated assuming all peaks are triangular in shape.

3.2 COST MODEL INPUT/OUTPUT TERMS

UTILITY CHARGE INFORMATION:

Off-Peak Energy Charges - Cost of off-peak electricity in cents/kWh. The terms 'off-peak' and 'on-peak' refer to the customer's load profile. Therefore, the cost of off-peak electricity corresponds to the utility's energy charge when the customer's off-peak occurs.

Off-Peak Demand Charges - Utility monthly demand charge ($/kW-month) corresponding to the time when the customer's off-peak demand load occurs.

On-Peak Energy Charges - Cost of electricity in cents/kWh corresponding to the utility's energy charge when the customers peak occurs.

On-Peak Demand Charges - Utility monthly demand charge ($/kW-month) corresponding to the time when the customer's peak demand load occurs.

BATTERY OPERATING INFORMATION:

Peak Shaved (MW) -	Amount of reduction in a customer's monthly peak load as a result of the load leveling battery system.
Peak Shaved Cycles -	Number of charge-discharge cycles each month necessary to shave customer demand peak.
Discharge Cycle (Hrs) -	Duration of battery discharge per cycle.
Discharge Cycle (MWhrs) -	Energy supplied by battery per discharge cycle.

BATTERY SYSTEM DESCRIPTION SYSTEM REQUIREMENTS BASED ON BATTERY DUTY CYCLE:

Minimum Discharge Duration (hr) -	Calculated from the battery operating information, and used in determining battery system efficiency.
Maximum Peak Shaved (MW) -	Calculated from the battery operating information and used in sizing the battery system.
Required Battery Capacity (MWh) -	Calculated from the battery operating Information, and equal to the largest monthly energy discharge of the battery system divided by the one way converter efficiency.
Required Battery Power (MW) -	Calculated from the battery operating information, and equal to the largest monthly peak shaved divided by the one way converter efficiency.

BATTERY SYSTEM DESCRIPTION PROPOSED BATTERY SYSTEM:

Battery Capacity (MWh) -	Based on actual proposed system, must be equivalent to or greater than required battery capacity.

Battery Power (MW) - Based on actual proposed system, must be equivalent to or greater than required battery power.

Battery Life (cycles) - Expected battery life measured in cycles for the proposed system. It is assumed that converter life and balance of plant life is greater than the 20 year analysis period.

Charge/Discharge Power Ratio - The rate battery is charged to the rate battery is discharged. This ratio should be minimized if customers are paying off-peak demand charges.

One Way Converter Efficiency - Percent energy efficiency of the proposed battery system.

Round Trip Efficiency - Equivalent to the round trip efficiency of the battery system multiplied by the square of one-way converter efficiency. For lead-acid systems, the battery round trip efficiency will be dependent on the minimum discharge duration.

BATTERY SYSTEM COST, ESCALATION RATES, AND TAX DATA:

Installed Battery Cost - Estimate for proposed system.

Installed Converter Cost - Estimate for proposed system.

Installed Balance of Plant Cost - Estimate for proposed system.

Annual O&M cost ($/kWh) - Annual operating and maintenance costs in $/kWh for proposed system.

Auxiliary Power Requirements (kWh/cycle) - Electric energy per cycle required for operating proposed system.

Salvage Value (percent of battery cost) - Equal to a percentage of battery replacement costs for the year battery system is scrapped.

Capital Cost Escalation Rate -	Expected capital cost escalation rate, including inflation.
O&M Cost Escalation Rate -	Expected operating and maintenance cost escalation rate, including inflation.
Demand Charge Escalation Rate -	Expected demand charge escalation rate, including inflation.
Energy Charge Escalation Rate -	Expected energy charge escalation rate, including inflation.
Fraction of First year on Line -	Fraction of first year battery system is operating.
Investment Tax Credit Rate -	Appropriate investment tax credit rates (approximately 10 percent).
State Tax Rate -	Appropriate state tax rates (if any).
Federal Tax Rate -	Appropriate federal tax rate.
Effective Income Tax Rate -	Calculated automatically, equivalent to (state tax rate + (1 - state tax rate) * federal tax rate).
Discount Rate for Present Worth Analysis -	Used for calculating the present worth of the net annual cash flow for a 20 year period.

ECONOMIC ANALYSIS SUMMARY SAVINGS:

Demand Charge Reduction -	Calculated from monthly peak shaved data and demand charge information using the following expression: [yearly sum of monthly peaked shaved * on-peak demand charge - (charge discharge ratio * off-peak demand charge)] * compounded escalation rate.
Battery Salvage Value -	Calculated by taking the product of battery replacement costs for the year when battery

	end of life is reached, with the salvage value expressed as a percent.
Total Savings -	Calculated by summing demand charge reduction with battery salvage value.
EXPENSES:	
Energy Charge Increase -	Calculated from monthly battery discharge information, energy charge information, and battery system efficiency using the following expression: (yearly sum of monthly MWh per discharge * number of cycles per month * [on-peak energy charge - (off-peak energy charge * round trip efficiency)] * compounded escalation factor.
Annual O&M Cost -	Calculated by taking the product of annual O&M cost in $/kWh with the proposed battery capacity, multiplied by the compounded escalation factor.
Auxiliary Power Cost -	Calculated by taking the product of the auxiliary power requirement in kWh/cycle and the number of cycles per year with the average off-peak energy cost and the compounded energy escalation.
Tax Depreciation -	Calculated by using the ACRS Rules for 5-year property. The depreciated property base includes installed battery and converter costs, plus 50% of balance-of-plant costs, less 50% of investment tax credits. The following expressions are used:

- Depreciated property base = (1 - investment tax credit rate/2) * (battery cost + converter cost + (1/2 * balance of plant cost)).
- Depreciation Expense

  Year 1 = depreciation property base * 0.15

  Year 2 = depreciation property base * 0.22

  Year 3 = depreciation property base * 0.21

  Year 4 = depreciation property base * 0.21

  Year 5 = depreciation property base * 0.21

Total Expenses - Calculated by summing energy charge increase, annual O&M cost, auxiliary power cost, and tax depreciation.

Taxable Income - Calculated by taking total savings and subtracting total expenses.

Income Taxes - Calculated by taking the product of taxable income and the effective income tax rate.

Investment Tax Credits - Calculated by taking the product of the investment tax credit rate and the summation of total installed battery and converter costs plus 1/2 the balance of plant costs. The following expression is used:

Investment tax credit rate * (battery cost + converter cost + 1/2 * balance of plant costs).

Net Income -	Calculated by taking taxable income and subtracting income taxes and adding investment tax credits.
Battery Costs -	Calculated by taking initial total installed battery costs and escalating the costs to the year of battery replacement.
Converter Costs -	Calculated by taking initial total installed converter costs.
Balance-of-Plant Costs -	Calculated by taking initial total installed balance-of-plant costs.
Net Before-Tax Cash Flow -	Calculated by taking savings minus cash expenses income and subtracting battery, converter, and balance-of-plant costs.
Net After-Tax Cash Flow -	Calculated by adding tax depreciation to net income, and subtracting battery, converter, and balance-of-plant costs.
Cumulative After-Tax Net Cash Flow -	Calculated by summing after tax net cash flow.
After-Tax Return on Investment -	Calculated by determining the discount rate that produces a zero net present value for the yearly net cash flows.
Payback Period -	Calculated by determining the number of years until after-tax cumulative net cash flow is positive.
20 Year Present Worth -	Calculated by determining the present worth of the after-tax net cash flows for a 20 year period, given the discount rate for present worth analysis.

APPENDIX A

MODEL VERIFICATION

APPENDIX A

MODEL VERIFICATION

This chapter presents a check of the computer calculated values contained in SYSPLAN's economic analysis summary report. Hand calculations are based on the definitions provided in Chapter 3.0. These calculations for the first five years of system operation use the input data shown in Figure A.1, and adequately verify the corresponding computer calculated output values included in Figure A.2. All costs are in thousands of dollars.

DEMAND CHARGE REDUCTION

[Yearly sum of monthly peaked shaved * on-peak demand charge - (charge discharge ratio * off-peak demand charge)] * demand charge compounded escalation rate.

Year 1: $[88.32 - (1 * 0.00)] * (0.75^{(a)} * 1.06) = 70.2$

Year 2: $(70.2/0.75) * 1.06 = 99.2$

Year 3: $99.2 * 1.06 = 105.2$

Year 4: $105.2 * 1.06 = 111.5$

Year 5: $111.5 * 1.06 = 118.2$

(a) 0.75 is the fraction of first year on line.

SYSTEM DESCRIPTION AND COST DATA

ANALYSIS PERFORMED BY: Analyst's Name
DATE : 26-Jun-85

COMPANY : Firm or Organization
FACILITY : Facility
LOCATION : Location

UTILITY CHARGE INFORMATION

UTILITY: PSE & G CO.

	OFF-PEAK CHARGES		ON-PEAK CHARGES	
	ENERGY	DEMAND	ENERGY	DEMAND
MONTH	CENTS/KWH	$/KW-MONTH	CENTS/KWH	$/KW-MONTH
1	4.00	0.00	4.00	8.80
2	4.00	0.00	4.00	8.80
3	4.00	0.00	4.00	8.80
4	4.00	0.00	4.00	8.80
5	4.00	0.00	4.00	8.80
6	4.00	0.00	4.00	10.00
7	4.00	0.00	4.00	10.00
8	4.00	0.00	4.00	10.00
9	4.00	0.00	4.00	10.00
10	4.00	0.00	4.00	8.80
11	4.00	0.00	4.00	8.80
12	4.00	0.00	4.00	8.80

BATTERY OPERATING INFORMATION

	PEAK SHAVED		DISCHARGE CYCLE DATA	
MONTH	(MW)	CYCLES	(HRS)	(MWHRS)
1	0.80	30.00	2.00	1.10
2	0.80	30.00	2.00	1.10
3	0.80	30.00	2.00	1.10
4	0.80	30.00	2.00	1.10
5	0.80	30.00	2.00	1.10
6	0.80	30.00	2.00	1.10
7	0.80	30.00	2.00	1.10
8	0.80	30.00	2.00	1.10
9	0.80	30.00	2.00	1.10
10	0.80	30.00	2.00	1.10
11	0.80	30.00	2.00	1.10
12	0.80	30.00	2.00	1.10

SYSTEM DESCRIPTION AND COST DATA

ANALYSIS PERFORMED BY: Analyst's Name
DATE : 26-Jun-85

COMPANY : Firm or Organization
FACILITY : Facility
LOCATION : Location

BATTERY SYSTEM DESCRIPTION

SYSTEM REQUIREMENTS
BASED ON BATTERY DUTY CYCLE:

MINIMUM DISCHARGE DURATION (HRS)	=	2.00
MAXIMUM PEAK SHAVED (MW)	=	0.80
REQUIRED BATTERY CAPACITY (MWH)	=	1.13
REQUIRED BATTERY POWER (MW)	=	0.82

PROPOSED BATTERY SYSTEM:

BATTERY CAPACITY (MWH)	=	1.13
BATTERY POWER (MW)	=	0.82
BATTERY LIFE (CYCLES)	=	2000
CHARGE/DISCHARGE POWER RATIO	=	1.00
ONE WAY CONVERTER EFFICIENCY	=	97.00 %
ROUND TRIP EFFICIENCY	=	69.00 %

BATTERY SYSTEM COST,ESCALATION RATES, AND TAX DATA

INSTALLED BATTERY COST	=	200.00 $/KWH
INSTALLED CONVERTER COST	=	92.92 $/KWH
INSTALLED BALANCE OF PLANT COST	=	70.80 $/KWH
ANNUAL O & M COST ($/KWH)	=	0.80
AUX. POWER REQUIREMENTS (KWH/CYCLE)	=	20.00
SALVAGE VALUE (PERCENT OF BATTERY COST)	=	15.00 %
CAPITAL COST ESCALATION RATE	=	4.00 %
O & M COST ESCALATION RATE	=	4.00 %
DEMAND CHARGE ESCALATION RATE	=	6.00 %
ENERGY CHARGE ESCALATION RATE	=	6.00 %
FRACTION OF FIRST YEAR ON LINE	=	0.75
INVESTMENT TAX CREDIT RATE	=	10.00 %
STATE TAX RATE	=	0.00 %
FEDERAL TAX RATE	=	48.00 %
EFFECTIVE INCOME TAX RATE	=	48.00 %
DISCOUNT RATE FOR PRESENT WORTH ANALYSIS	=	7.00 %

FIGURE A.1.

SYSPLAN ECONOMIC ANALYSIS SUMMARY

(THOUSANDS OF DOLLARS)

YEAR:	1	2	3	4	5
SAVINGS:					
DEMAND CHARGE REDUCTION	70.2	99.2	105.2	111.5	118.2
BATTERY SALVAGE VALUE	0.0	0.0	0.0	0.0	0.0
TOTAL SAVINGS	70.2	99.2	105.2	111.5	118.2
EXPENSES:					
ENERGY CHARGE INCREASE	5.7	8.0	8.5	9.0	9.5
ANNUAL O & M COST	0.7	1.0	1.0	1.1	1.1
AUXILIARY POWER COST	0.2	0.3	0.3	0.4	0.4
TAX DEPRECIATION	52.9	77.5	74.0	74.0	74.0
TOTAL EXPENSES	59.5	86.8	83.9	84.4	85.0
TAXABLE INCOME	10.8	12.4	21.3	27.1	33.2
LESS: INCOME TAXES	5.2	6.0	10.2	13.0	15.9
PLUS: INVESTMENT TAX CREDITS	37.1	0.0	0.0	0.0	0.0
NET INCOME	42.7	6.4	11.1	14.1	17.2
PLUS: TAX DEPRECIATION	52.9	77.5	74.0	74.0	74.0
LESS: BATTERY COSTS	226.0	0.0	0.0	0.0	0.0
LESS: CONVERTER COSTS	105.0	0.0	0.0	0.0	0.0
LESS: BALANCE-OF-PLANT COSTS	80.0	0.0	0.0	0.0	0.0
NET BEFORE-TAX CASH FLOW	-400	12	21	27	33
NET AFTER-TAX CASH FLOW	-315	84	85	88	91
CUM. AFTER-TAX CASH FLOW	-315	-231	-146	-58	33

YEAR:	1	2	3	4	5
AFTER-TAX RETURN ON INVESTMENT		-73.4	-33.1	-9.5	4.0

PAYBACK PERIOD = 5.00
20 YEAR PRESENT WORTH = 329

FIGURE A.2.

BATTERY SALVAGE VALUE

Product of battery replacement costs for the year when battery end of life is reached * the salvage value expressed as a percent.

Year 1: 0.0[(a)]
Year 2: 0.0
Year 3: 0.0
Year 4: 0.0
Year 5: 0.0

(a) No salvage value for those years as battery life = 6 years

TOTAL SAVINGS

Sum of demand charge reduction and battery salvage value.

Year 1: 70.2 + 0.0 = 70.2
Year 2: 99.2 + 0.0 = 99.2
Year 3: 105.2 + 0.0 = 105.2
Year 4: 111.5 + 0.0 = 111.5
Year 5: 118.2 + 0.0 = 118.2

ENERGY CHARGE INCREASE

Yearly sum of monthly MWh per discharge * number of cycles per month * [on-peak energy charge - (off-peak energy charge ÷ round trip efficiency)] * compounded energy charge escalation factor * -1.

Year 1: 1.10 * 30 * 12 * [0.04 - (0.04 ÷ 0.69)] * 0.75 * 1.06 * -1 = 5.7
Year 2: 5.7 ÷ 0.75 * 1.06 = 8.0
Year 3: 8.0 * 1.06 = 8.5
Year 4: 8.5 * 1.06 = 9.0
Year 5: 9.0 * 1.06 = 9.5

ANNUAL O&M COST

Product of annual O&M cost in $/kWh * proposed battery capacity * compounded O&M cost escalation factor.

Year 1: 0.80 * 1.13 * 0.75 * 1.04 = 0.7
Year 2: 0.7 ÷ 0.75 * 1.04 = 0.97
Year 3: 0.97 * 1.04 = 1.01
Year 4: 1.01 * 1.04 = 1.05
Year 5: 1.05 * 1.04 = 1.09

AUXILIARY POWER COST

Product of auxiliary power requirement in kWh/cycle * the number of cycles per year * average off-peak energy cost * compounded energy escalation factor.

Year 1: 20 * 12 * 30 + 0.04 * 0.75 * 1.06 ÷ 1000 = 0.23
Year 2: 0.23 ÷ 0.75 * 1.06 = 0.32
Year 3: 0.32 * 1.06 = 0.34
Year 4: 0.34 * 1.06 = 0.36
Year 5: 0.36 * 1.06 = 0.39

TAX DEPRECIATION

Depreciated property base = (1 - investment tax credit rate/2) * (battery cost + converter cost + (1/2 * balance-of-plant cost)).

Depreciation expense for
Year 1 = base * 0.15
Year 2 = base * 0.22
Year 3 = base * 0.21
Year 4 = base * 0.21
Year 5 = base * 0.21

Year 1: (1 - 0.10/2) * (200 * 1.13 + 92.92 * 1.13 + 1/2 * 70.80 * 1.13) * 0.15 = 52.9
Year 2: 352.45 * 0.22 = 77.5

Year 3: 352.45 * 0.21 = 74.0

Year 4: 352.45 * 0.21 = 74.0

Year 5: 352.45 * 0.21 = 74.0

TOTAL EXPENSES

Sum of energy charge increase, annual O&M cost, auxiliary power cost, and tax depreciation.

Year 1: 5.7 + 0.7 + 0.23 + 52.9 = 59.5

Year 2: 8.0 + 0.97 + 0.32 + 77.5 = 86.8

Year 3: 8.5 + 1.01 + 0.34 + 74.0 = 83.9

Year 4: 9.0 + 1.05 + 0.36 + 74.0 = 84.4

Year 5: 9.5 + 1.09 + 0.39 + 74.0 = 85.0

TAXABLE INCOME

Calculated by taking total savings and subtracting total expenses.

Year 1: 70.2 - 59.5 = 10.7

Year 2: 99.2 - 86.8 = 12.4

Year 3: 105.2 - 83.9 = 21.3

Year 4: 111.5 - 84.4 = 27.1

Year 5: 118.2 - 85.0 = 33.2

INCOME TAXES

Product of taxable income * effective income tax rate.

Year 1: 10.7 * 0.48 = 5.14

Year 2: 12.4 * 0.48 = 5.95

Year 3: 21.3 * 0.48 = 10.22

Year 4: 27.1 * 0.48 = 13.0

Year 5: 33.2 * 0.48 = 15.93

INVESTMENT TAX CREDITS

Investment tax credit rate * (battery cost * converter cost + 1/2 * balance-of-plant costs).

Year 1: 0.10 * (1.13 * 200 + 1.13 * 92.92 + 1/2 * 70.80 * 1.13) = 37.1
Year 2: = 0.0[a]
Year 3: = 0.0
Year 4: = 0.0
Year 5: = 0.0

(a) No battery system costs for years 2 to 5.

NET INCOME

Taxable income - income taxes + investment tax credits.

Year 1: 10.7 - 5.14 + 37.1 = 42.66
Year 2: 12.4 - 5.95 + 0.0 = 6.45
Year 3: 21.3 - 10.22 + 0.0 = 11.08
Year 4: 27.1 - 13.0 + 0.0 = 14.1
Year 5: 33.2 - 15.93 + 0.0 = 17.27

TAX DEPRECIATION

Same as previously calculated.

Year 1: 52.9
Year 2: 77.5
Year 3: 74.0
Year 4: 74.0
Year 5: 74.0

BATTERY COST

Installed battery cost * system capacity. First year costs are not escalated.

Year 1: 200 * 1.13 = 226
Year 2: = 0.0[(a)]
Year 3: = 0.0
Year 4: = 0.0
Year 5: = 0.0

(a) No battery purchased in years 2 to 5.

CONVERTER COST

Installed converter cost * system capacity. First year's cost is not escalated and the life of the converter is assumed to be greater than 20 years.

Year 1: 92.92 * 1.13 = 105
Year 2: = 0.0
Year 3: = 0.0
Year 4: = 0.0
Year 5: = 0.0

BALANCE-OF-PLANT COST

Installed balance of plant cost * system capacity. First year's cost is not escalated and the life of balance of plant equipment is assumed to be greater than 20 years.

Year 1: 70.80 * 1.13 = 80.0
Year 2: = 0.0
Year 3: = 0.0
Year 4: = 0.0
Year 5: = 0.0

NET BEFORE-TAX CASH FLOW

Total savings - (energy change increase + annual O&M cost + auxiliary power cost) - (battery cost + converter cost + balance-of-plant cost)

Year 1: 70.2 - 6.6 - (226 + 105 + 80) = -347
Year 2: 99.2 - 9.3 - 0.0 = 90
Year 3: 105.2 - 9.8 - 0.0 = 95
Year 4: 111.5 - 10.5 - 0.0 = 101
Year 5: 118.2 - 11.0 - 0.0 = 107

NET AFTER-TAX CASH FLOW

Net income + tax depreciation - (battery cost + converter cost + balance-of-plant cost).

Year 1: 42.66 + 52.9 - (226 + 105 + 80.0) = -315.4
Year 2: 6.45 + 77.5 - 0.0 = 83.95
Year 3: 11.08 + 74.0 - 0.0 = 85.08
Year 4: 14.1 + 74.0 - 0.0 = 88.1
Year 5: 17.27 + 74.0 - 0.0 = 91.27

CUMULATIVE AFTER-TAX CASH FLOW

Summation of after-tax net cash flow.

Year 1: -315.4 = -315.4
Year 2: -315.4 + 83.95 = -231.5
Year 3: -315.4 + 83.95 + 85.08 = -146.4
Year 4: -315.4 + 83.95 + 85.08 + 88.1 = -58.3
Year 5: -315.4 + 83.95 + 85.08 + 88.1 + 91.27 = 32.97

AFTER-TAX RETURN ON INVESTMENT

Discount rate that produces a zero net present value for the yearly net cash flows.

Present worth = -315 + 84 * (0.9615) + 85 * (0.9246) + 88 * (0.8890)
+ 91 * (0.8548) = 0.375, or approximately zero

PAYBACK PERIOD

Number of years until cumulative after-tax net cash flow is positive.

Year 5: Cumulative after-tax cash flow = 33

∴ Payback period = 5.00 years

20 YEAR PRESENT WORTH

Present worth of the net cash flows for a 20 year period, given the discount rate for the present worth analysis.

@ at discount rate of 7.00 percent:

Year 1 present worth = -315 * (0.9346)
Year 2 present worth = 84 * (0.8734)
Year 3 present worth = 85 * (0.8163)
Year 4 present worth = 88 * (0.7629)
Year 5 present worth = 91 * (0.7130)
Year 6 present worth = -150 * (0.6664)
Year 7 present worth = 90 * (0.6228)
Year 8 present worth = 93 * (0.5820)
Year 9 present worth = 97 * (0.5439)
Year 10 present worth = 101 * (0.5084)
Year 11 present worth = -175 * (0.4751)
Year 12 present worth = 118 * (0.4440)
Year 13 present worth = 121 * (0.4150)
Year 14 present worth = 127 * (0.3878)
Year 15 present worth = 132 * (0.3625)
Year 16 present worth = -204 * (0.3387)
Year 17 present worth = 154 * (0.3166)
Year 18 present worth = 158 * (0.2959)
Year 19 present worth = 166 * (0.2765)

Year 20 present worth = 173 * (0.2584)

Total present worth = 328.28 or approximately 329 thousand

APPENDIX B

TECHNICAL DOCUMENTATION FOR XSIZE SIZING MODEL

APPENDIX B

TECHNICAL DOCUMENTATION FOR XSIZE SIZING MODEL

The documentation in this appendix is not needed for normal use of the XSIZE sizing routine but rather for those who wish to modify the spreadsheet. It includes a spreadsheet map, a description of the cell protection used, hardcopy of selected formulas, and details of the macro programs used.

A spreadsheet map for XSIZE is shown as Figure B.1. In this map, the different areas of the spreadsheet are labeled by their purpose. In addition, the cell locations of each area are included.

CELL PROTECTION

Cell protection is the default in XSIZE, with cells unprotected only as needed. Cells into which users enter data are all unprotected. In the calculation workspace area, the "selected table" cells are unprotected so that they can be copied and shown to users elsewhere in the spreadsheet. Finally, a few cells have been unprotected so that they are highlighted on the screen; these contain important instructions for the user.

If the XSIZE spreadsheet is altered, it is likely that the cell protection scheme also will need to be modified.

SPREADSHEET FORMULAS

Much of the XSIZE worksheet contains instructions and explanations for users, with a few cells used for data entry. XSIZE contains only a few formulas which are evaluated to obtain results. These are shown below.

Formulas are found in four parts of the worksheet. The limiting size range displayed to the user is calculated from the selected range cells in the calculation workspace. These formulas, in turn, are based on the "selected table," which is selected and copied by the ALT E macro.

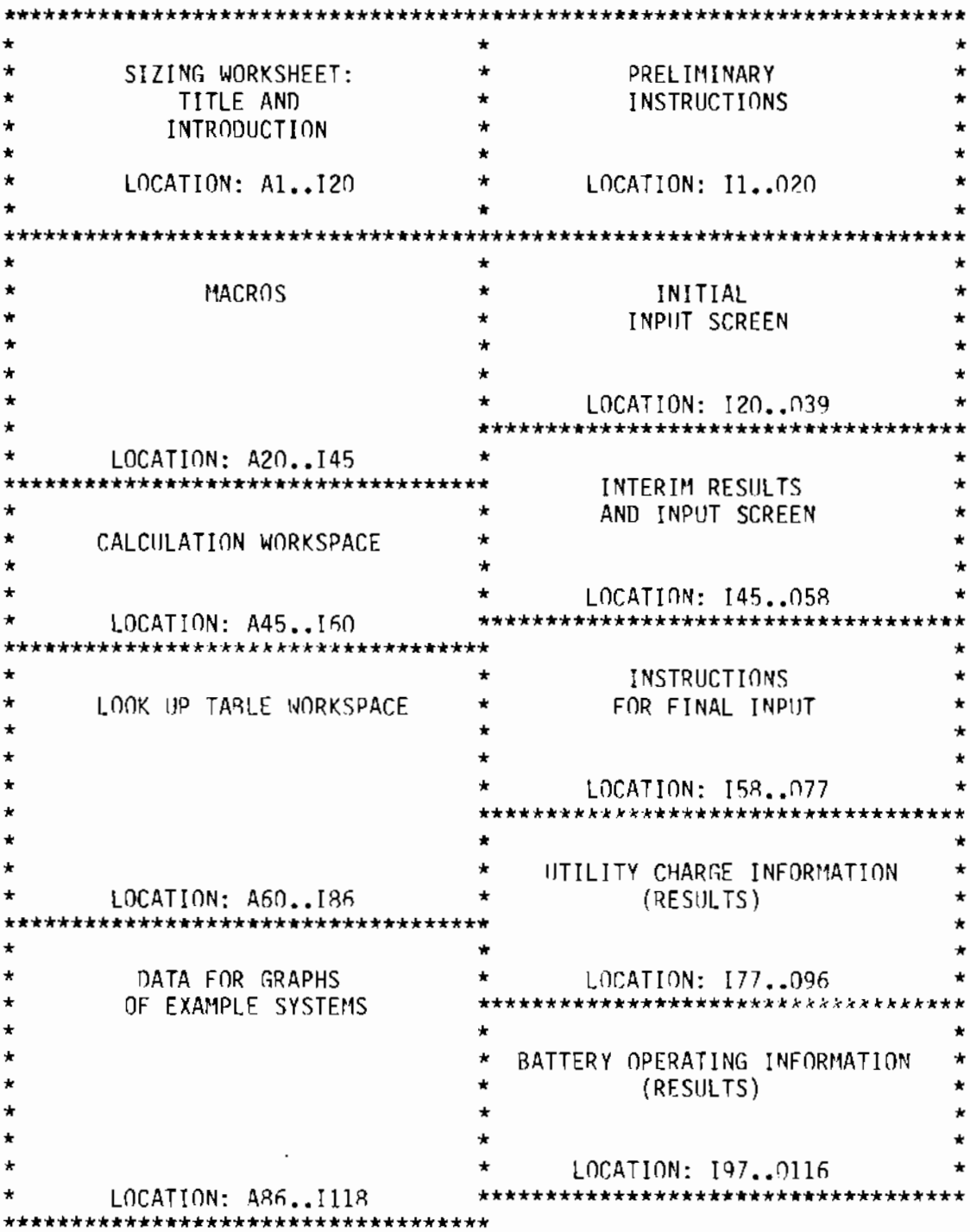

FIGURE B.1. XSIZE Spreadsheet Map

Formulas are also used in the utility charge and battery operating information screens. These formulas are written to the proper cells by the ALT O macro and then evaluated. This is done so that the user can enter other values later. The utility charge formulas copy the charge data entered earlier by the user, while battery operating and formulas are based upon the discharge duration and power level also entered by the user.

```
K41: 'YOUR LIMITING SIZE RANGE ESTIMATE IS:
L43: 'DISCHARGE POWER
N43: 'DISCHARGE DURATION
K45: 'FROM
L45: @IF(O28<D49,0,$D49)
M45: '  KW
N45: @IF(L45=0,0,$C49)
O45: '  HOURS
K47: 'TO
L47: @IF(L45=0,0,@IF(O28<D49,0,$O28))
N47: (F1) @IF(L47=0,0,C50-((E50-@LOG(O28))/(E50-E49))*(C50-C49))

B46: 'WORKSPACE
C47: 'SELECTED RANGE
C48: 'hours
D48: 'kw
E48: 'log kw
C49: @VLOOKUP((O30-O31),B53..F56,2)
D49: @VLOOKUP((O30-O31),B53..F56,1)
E49: @LOG(D49)
C50: @VLOOKUP((O30-O31),B53..F56,4)
D50: @VLOOKUP((O30-O31),B53..F56,3)
E50: @LOG(D50)

K78: '      UTILITY CHARGE INFORMATION
K80: 'OFF-PEAK CHARGES
N80: 'ON-PEAK CHARGES
K81: 'ENERGY   DEMAND
N81: 'ENERGY  DEMAND
K82: 'CENTS/KWH $/KW-MO.
N82: 'CENTS/KWH $/KW-MO.
J83: 'MONTH
J84: 1
K84: U +O$33
L84: U +O$31
N84: U +O$32
O84: U +O$30
J85: 2
K85: U +O$33
L85: U +O$31
```

```
N85: U +O$32
O85: U +O$30

K97: '   BATTERY OPERATING INFORMATION
K99: '      PEAK SHAVED
M99: 'DISCHARGE CYCLE DATA
K100: "MW
L100: "CYCLES
M100: "HOURS
N100: "MWH
J101: "MONTH
J102: 1
K102: U +O$54/1000
L102: U '
M102: U +O$53
N102: U +K102*M102/2
J103: 2
K103: U +O$54/1000
L103: U '
M103: U +O$53
N103: U +K103*M103/2
```

MACROS

Size estimates are arrived at in XSIZE by the execution of a series of macro programs. These macros are listed and described in Table B.1, where they are shown in the order in which the user executes.

TABLE B.1. XSIZE macros

Range Name	Macro	Description
\A	B22: 'ALT A D22: ' MOVES TO INTRODUCTORY SCREEN C22: '{HOME}{GOTO}J1~{LEFT}	Displays the initial instructions screen to inform the user how to begin data entry.
\B	B29: 'ALT B D29: ' VIEW GRAPH C29: '/gnuCOMMUTER~q	Displays the example graph COMMUTER.
\C	B31: 'ALT C D31: ' VIEW GRAPH C31: '/gnuMACHINE~q	Displays the example graph MACHINE.
\D	B43: 'ALT D D43: ' ENTER CHARGES, PEAK FOR CALCULATIONS C43: '{HOME}{GOTO}I21~{UP}/riI20..039~	Displays the screen where users enter peak and charge information, then pauses for user input.
\E	B24: 'ALT E D24: ' SELECT SIZE RANGE, RATE OF RETURN C24: '/xi030-031>5#AND#029=2~ /cB65..F68~B53~{CALC}/xgC27~ C25: '/xi029=1~/cB79..F82~B53~{CALC}/xgC27~ C26: '/cB72..F75~B53~{CALC}~ D27: ' SELECT YOUR OWN DURATION, POWER LEVEL C27: '/ruB53..F56~{PGDN}{UP}/riI39..058~	Depending upon the entered values for rate type and demand charges, this macro selects one of three possible size ranges and copies it to the "selected table" area of the worksheet. The {CALC} instruction copies the size range to the interim results screen, where the user may view and alter it.
\F	B33: ' ALT F D33: ' GO TO INSTRUCTION SCREEN FOR PASS TABLES C33: ' {PGDN}{UP}	Displays the final instruction screen, (where users are directed to use ALT O to create pass file information).

TABLE B.1. Contd

Range Name	Macro	Description
\O	B35: 'ALT O D35: ' INSERT FORMULAS FOR UTILITY CHARGE, O36: ' OPERATING OATA SCREENS C35: '{GOTO}K84~+O$33~{RIGHT}+O$31~ /c{LEFT}~L85..K95~ C36: '{RIGHT}{RIGHT}+O$32~{RIGHT}+O$30~ /c{LEFT}~O85..N95~ C37: '{GOTO}K102~+O$54/1000~{RIGHT}~ {RIGHT}+O$53~ C38: '{RIGHT}+K102*M102/2~/c{LEFT}{LEFT} {LEFT}~N103..K113~ C39: '{CALC}{GOTO}I77~{GOTO}K84~	Creates the screens containing utility charge and battery operating information. To do this, appropriate formulas are inserted in the proper cells, then copied to other cells. The {CALC} instruction causes current values to be evaluated for the two screens, which are then displayed to the user.
\P	B41: ' ALT P D41: ' SAVE FILE FOR SYSPLAN C41: ' /fxvSIZE~K84..O113~r	Extracts data from the utility charge and operating information screens, then saves it to the file SIZE.WKS, which can be retrieved by the SYSPLAN model.

APPENDIX C

TECHNICAL DOCUMENTATION FOR SYSPLAN COST MODEL

APPENDIX C

TECHNICAL DOCUMENTATION FOR SYSPLAN COST MODEL

The documentation included in this appendix should not be needed for normal use of the SYSPLAN spreadsheet. It is included mainly as an aid to Lotus123 programmers who wish to make changes to the spreadsheet. The appendix includes a description of the cell protection scheme used, a map of the spreadsheet, hardcopy of selected formulas, printouts and explanations of macro programs, and a description of some of the Lotus123 ranges used in SYSPLAN.

The spreadsheet map is shown in Figure C.1. It is similar to the map presented earlier in this document as Figure 2.1, but also includes the cell locations of the various input screens and output areas.

CELL PROTECTION

In the current version of the SYSPLAN spreadsheet, cell protection is the default; the entire spreadsheet is protected, and cells or ranges are unprotected as needed. If the SYSPLAN spreadsheet is changed, it is likely that changed cells will have to be protected or unprotected.

On the input screens (accessed by the ALT-A macro and custom menu INPTMENU), only those cells containing user-entered information are unprotected.

Several items on the sensitivity analysis screen are unprotected. Unprotected cells include those containing the name of the independent variable, and its minimum and maximum values. The table of independent and dependent variable values is also unprotected.

The remainder of the SYSPLAN spreadsheet (the Main Menu, Economic Analysis Summary, Key Economic Performance Measures, workspace and macros) is protected.

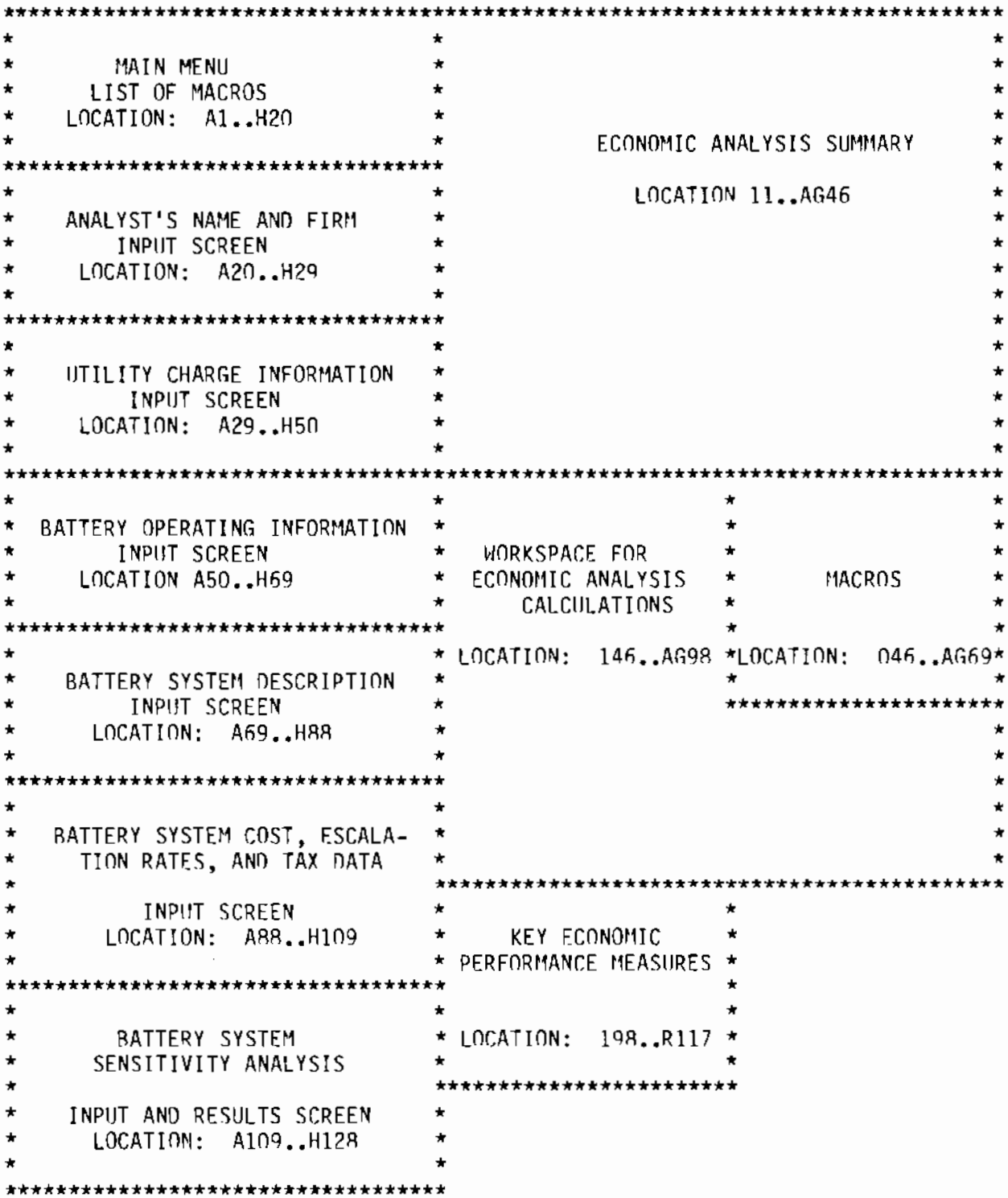

FIGURE C.1. SYSPLAN Spreadsheet Map

SPREADSHEET FORMULAS

Selected formulas from the SYSPLAN spreadsheet are shown on the following pages; they are accompanied by the cell labels that identify them.

The only formulas shown from the input screens are those calculated items that are not entered by the user. These are the battery system requirements figures, and the effective income tax rate.

The label for each item in the Economic Analysis Summary is shown, along with the formula(s) for its calculation for the first one or two years. The calculations for many of the economic analysis numbers differ for the first and subsequent years. When they differ, the formulas for both the first and second years of the analysis are shown. When the calculations for all years are the same, only the first year is shown.

Labels and formulas are shown for all items included in the Key Economic Performance Measures area of the spreadsheet. These items are copied from other parts of the spreadsheet so that the user can view them all on one screen.

The workspace area of the spreadsheet contains items calculated for each month of the year and items calculated for each year of the analysis. Formulas for the first two months or for the first two years are included. The depreciation calculations occupy a 20 by 20 matrix of cells within the workspace. For this series of calculations, formulas from a 2 by 6 segment from the upper left corner of the larger matrix are shown. Other formulas included from the workspace are battery life in years, payback period calculations and scaling calculations for the FLOW (cumulative cash flow) and NETCF (net cash flow) graphs.

```
C70: '     BATTERY SYSTEM DESCRIPTION
B72: 'SYSTEM REQUIREMENTS
B73: 'BASED ON BATTERY DUTY CYCLE:
B75: 'MINIMUM DISCHARGE DURATION (HRS) =
F75: @MIN(E56..E67)
B76: 'MAXIMUM PEAK SHAVED (MW)         =
F76: @MAX(C56..C67)
B77: 'REQUIRED BATTERY CAPACITY (MWH)  =
F77: (F2) @MAX(F56..F67)/F86*100
B78: 'REQUIRED BATTERY POWER (MW)      =
F78: (F2) +F76/F86*100
```

```
B89: '     BATTERY SYSTEM COST,ESCALATION RATES, AND TAX DATA
B107: 'EFFECTIVE INCOME TAX RATE              =
G107: (+G105/100+(1-G105/100)*G106/100)*100

I2: '*  SYSPLAN ECONOMIC ANALYSIS SUMMARY
I4: '*    (THOUSANDS OF DOLLARS)
I6: '*                        YEAR:
M6: (F0) 1
N6: (F0) 2
I7: '*  SAVINGS:
I9: '*  DEMAND CHARGE REDUCTION
M9: (F1) @SUM(J50..J61)*G102*(G100/100+1)
N9: (F1) +M9*(G100/100+1)/G102
I10: '*  BATTERY SALVAGE VALUE
M10: (F1) 0
N10: (F1) @IF(((N6-1)/$050-@INT((N6-1)/$050))=0,N51,0)
I12: '*     TOTAL SAVINGS
M12: (F1) @SUM(M9..M10)
I14: '*  EXPENSES:
I16: '*  ENERGY CHARGE INCREASE
M16: (F1) @SUM(K50..K61)*G102*(G101/100+1)*-1
N16: (F1) +M16*(G101/100+1)/G102
I17: '*  ANNUAL O & M COST
M17: (F1) +$F82*$G94*$G102*($G99/100+1)
N17: (F1) +$F82*G94*($G99/100+1)*($G99/100+1)
I18: '*  AUXILIARY POWER COST
M18: (F1) +G95*@SUM(D56..D67)*@SUM(C38..C49)/12/100*(G101/100+1)*G102/1000
N18: (F1) +M18/$G102*($G101/100+1)
I19: '*  TAX DEPRECIATION
M19: (F1) +J94
I21: '*     TOTAL EXPENSES
M21: (F1) @SUM(M16..M19)
I23: '*     TAXABLE INCOME
M23: (F1) +M12-M21
I25: '*  LESS: INCOME TAXES
M25: (F1) +M23*$G107/100
I26: '*  PLUS: INVESTMENT TAX CREDITS
M26: (F1) +$G104/100*(M31+M32+0.5*M33)
I28: '*     NET INCOME
M28: (F1) +M23-M25+M26
I30: '*  PLUS: TAX DEPRECIATION
M30: (F1) +J94
I31: '*  LESS: BATTERY COSTS
M31: (F1) +M50
N31: (F1) @IF(((N6-1)/$050-@INT((N6-1)/$050))=0,M51,0)
I32: '*  LESS: CONVERTER COSTS
M32: (F1) +$G92*$F82
N32: (F1) 0
I33: '*  LESS: BALANCE-OF-PLANT COSTS
M33: (F1) +G93*F82
N33: (F1) 0
```

```
I35: '*     NET BEFORE-TAX CASH FLOW
M35: (F0) +M23-@SUM(M31..M33)
I36: '*     NET AFTER-TAX CASH FLOW
M36: (F0) +M28+M30-M31-M32-M33
I37: '*     CUM. AFTER-TAX CASH FLOW
M37: (F0) +M36
N37: (F0) +M37+N36
I42: '*  AFTER-TAX RETURN ON INVESTMENT
M42: '
N42: (F1) @IRR(0.5,$M36..N36)*100
I44: '*  PAYBACK PERIOD          =
M44: @MIN(M70..AF70)
I45: '*  20 YEAR PRESENT WORTH   =
M45: (F0) @NPV(+G108/100,M36..AF36)

J99: '**     KEY ECONOMIC PERFORMANCE MEASURES      *****
I101: '*     INITIAL INVESTMENT
I103: '*     INSTALLED BATTERY COST
0103: (F0) +G91*F$82
P103: ' THOUSAND
I104: '*     INSTALLED CONVERTER COST
0104: (F0) +G92*F$82
I105: '*     INSTALLED BALANCE OF PLANT COST
0105: (F0) +G93*F$82
I107: '*        TOTAL INITIAL INVESTMENT
0107: (F0) @SUM(0103..0105)
J109: 'PAYBACK PERIOD  =
L109: +M44
M109: 'YEARS
I111: '*     20-YEAR ANALYSIS @ DISCOUNT RATE OF:
0111: (F1) +G108
P111: '%
I113: '*     NET PRESENT WORTH
0113: (F0) +M45
P113: ' THOUSAND
I114: '*     BEFORE TAX RETURN ON INVESTMENT
0114: (F1) @IRR(0.5,M35..AF35)*100
P114: '%
I115: '*     AFTER TAX RETURN ON INVESTMENT
0115: (F1) +AF42
P115: '%

J47: 'WORKSPACE FOR ECONOMIC ANALYSIS CALCULATIONS
I49: 'MONTH
I50: '   1
I51: '   2
J49: 'DCHARGE
J50: +$C56*($G38-$F$85*$D38)
J51: +$C57*($G39-$F$85*$D39)
K49: 'ECHARGE
K50: +$F56*$D56*($F38/100-($C38/100)/($F$87/100))
```

```
K51: +$F57*$D57*($F39/100-($C39/100)/($F$87/100))
L49: ' YEAR
L50: 1
L51: 2
M49: '$BAT.
M50: (F0) +F82*G91
M51: (F0) +M50*(G$98/100+1)+M50*(G98/100)*(1-G102)
N49: '$SAL.
N50: +$M50*$G$96/100
N51: +$M51*$G$96/100
O49: 'BATTERY LIFE
P50: 'YEARS
O50: @INT(F84/@SUM(D56..D67))
I70: ' PAYBACK PERIOD CALCULATIONS
M70: (G) @IF(M37>0,M40,100)
N70: (G) @IF(N37>0,N40,100)
K71: 'DEPRECIATION YEAR
I72: '   YEAR
J72: 1
K72: 2
L72: 3
M72: 4
N72: 5
O72: 6
I73: '    1
J73: ((1-$G$104/100/2)*($M$31+$M$32+(0.5*$M$33)))*0.15
K73: +$J$73/0.15*0.22
L73: +J73/0.15*0.21
M73: +L73
N73: +L73
I74: '    2
K74: ((1-$G$104/100/2)*($N$31+$N$32+(0.5*$N$33)))*0.15
L74: +$K$74/0.15*0.22
M74: +K74/0.15*0.21
N74: +M74
O74: +M74
J94: +J73
K94: @SUM(K73..K74)
L94: @SUM(L73..L75)
M94: @SUM(M73..M76)
N94: @SUM(N73..N77)
O94: @SUM(O74..O78)
P94: @SUM(P75..P79)
I95: ' SCALING FOR CASH FLOW GRAPHS:
J96: (F0) +M37*1000
J97: (F0) +M36*1000
```

MACROS AND RANGES

The SYSPLAN spreadsheet includes several macro programs, including two that call custom menus. The macros that do not call custom menu allow for output and graphs to be viewed, and for the printing of reports. One custom menu (INPTMENU) allows for data input by the user, the other (SENSMENU) for specifying and calculating sensitivity analysis tables. A third custom menu, INDEMENU, is called directly from the SENSMENU menu, and allows independent variables to be specified for sensitivity analyses.

Table C.1 gives a description of each macro listed in SYSPLAN's main menu. Table C.2 lists the options available from the INPTMENU custom menu (data input). The menu options for sensitivity analyses are described in Tables C.3 (SENSMENU) and C.4 (INDEMENU). Each includes the range names, where applicable, and copies of the macro codes and descriptions of each.

The sensitivity analysis features also make use of several named ranges. These are listed and described in Table C.5.

TABLE C.1. Description of SYSPLAN Macros

Range Name	Macro	Description
\A	U49: 'ALT A - INPUT SYSTEM DESCRIPTION S49: '{HOME}/xmINPTMENU~	Calls the INPTMENU custom menu for data input.
\B	U51: 'ALT B - VIEW SUMMARY S51: '{HOME}{GOTO}I1~	Moves to the top left hand corner of the Economic Analysis Summary.
\C	U53: 'ALT C - VIEW NET CASH FLOW GRAPH S53: '/gnuNETCF~q	Calls up the NETCF graph to view Net Cash Flow.
\D	U55: 'ALT D - VIEW CUM.CASH FLOW GRAPH S55: '/gnuFLOW~q	Calls up the FLOW graph to view Cumulative Cash Flow.
\E	U57: 'ALT E - PRINT SYSTEM DESCRIPTION S57: '/ppohrA20..H28~q S58: 'rA29..H69~gp S59: 'rA69..H109~gpcbq	Sets borders for the System Description report, prints the appropriate ranges, clears borders and quits.
\F	U61: 'ALT F - PRINT SUMMARY S61: '/ppobcI2..145~ S62: 'h@||PAGE # OF 3~q S63: 'rM2..S45~gprT2..Z42~gp S64: 'rAA2..AF42~gpcaomr80~qq	Sets borders and header for the Economic Analysis Summary, prints the appropriate ranges, clears all options and quits.
\G	U66: 'ALT G - SENSITIVITY ANALYSES S66: '{HOME}{GDTO}A109~ S67: '/xmSENSMENU~	Calls the SENSMENU custom menu for sensitivity analyses.
\H	W54: 'ALT H - VIEW PERFORMANCE MEASURES W55: '{HOME}{GOTO}I98~	Moves to the Key Economic Performance Measures screen.

TABLE C.2. Description of Custom Menu INPTMENU

Range Name	Macro	Description
INPTMENU	(Located in cells Y48..AE49)	Custom menu INPTMENU encompasses the options listed below. It is called by the ALT-A macro, and is used for data input.
	Y48: 'NAME Y49: 'ENTER YOUR NAME AND FIRM Y50: '{HOME}{PGDN}{UP} Y51: 'PRESS RETURN TO BEGIN... ESCAPE (ESC) WHEN FINISHED{?}{ESC} Y52: '/riA20..H29~ Y53: '/xmINPTMENU~	Positions the pointer, displays a prompt, allows for input of name and firm data, then returns to INPTMENU.
	Z48: 'RETRIEVE Z49: 'RETRIEVE UTILITY CHARGE, OPERATING DATA FROM SIZING FILE Z50: '{GOTO}C38~/fcceSIZE~/rpE38..E49~ Z51: '{GOTO}A30~ Z52: '/xmINPTMENU~	Positions the pointer, retrieves the SIZE pass file from the sizing worksheet into the appropriate sections of SYSPLAN (utility charge and operating screens), and returns to INPTMENU.
	AA48: 'UCHARGE AA49: 'INPUT UTILITY CHARGE INFORMATION AA50: '{HOME}{GOTO}A30~ AA51: 'PRESS RETURN TO BEGIN... ESCAPE (ESC) WHEN FINISHED{?}{ESC} AA52: '/riA30..H49~ AA53: '/xmINPTMENU~	Positions the pointer, displays a prompt, allows for input or editing of utility charge information, then returns to INPTMENU.
	AB48: 'OPERATING AB49: 'INPUT BATTERY OPERATING INFORMATION AB50: '{HOME}{GOTO}A50~ AB51: 'PRESS RETURN TO BEGIN... ESCAPE (ESC) WHEN FINISHED{?}{ESC} AB52: '/riA50..H69~ AB53: '/xmINPTMENU~	Positions the pointer, displays a prompt, allows for input or editing of battery operating information, then returns to INPTMENU.

TABLE C.2. Contd

Range Name	Macro	Description
	AC48: 'SYSTEM AC49: 'INPUT BATTERY SYSTEM DESCRIPTION AC50: '{HOME}{GOTO}A69~ AC51: 'PRESS RETURN TO BEGIN... ESCAPE (ESC) WHEN FINISHED{?}{ESC} AC52: '/riA69..H88~ AC53: '/xmINPTMENU~	Positions the pointer, displays a prompt, allows for input of a battery system description, then returns to INPTMENU.
	AD48: 'COST AD49: 'INPUT SYSTEM COST, ESCALATION RATES AND TAX DATA AD50: '{HOME}{GOTO}A89~ AD51: 'PRESS RETURN TO BEGIN... ESCAPE (ESC) WHEN FINISHED{?}{ESC} AD52: '/riA89..H108~ AD53: '/xmINPTMENU~	Positions the pointer, displays a prompt, allows for input of system cost, escalation rates and tax information, then returns to INPTMENU.
	AE48: 'QUIT AE49: 'RETURN TO MAIN MENU AE50: '{HOME}	Exits from INPTMENU and returns to the Main Menu.

TABLE C.3. Description of Custom Menu SENSMENU

Range Name	Macro	Description
SENSMENU	(Located in cells Y56..AD57)	Custom menu SENSMENU encompasses the options listed below. It is originally called by the ALT-G macro, and is used for performing sensitivity analyses.
	Y56: 'SETUP Y57: 'SET UP AN INDEPENDENT VARIABLE (FIVE CHOICES) Y58: '/xmINDEMENU~	Calls subsidiary menu INDEMENU, which allows users to select one of five possible independent variables for sensitivity analyses.
	Z56: 'RUN Z57: 'RUN THE ANALYSIS WITH THE VARIABLE AND VALUES DISPLAYED ONSCREEN Z58: 'THIS WILL TAKE 2-3 MINUTES.... PRESS RETURN TO BEGIN {?}{ESC} Z59: '/dt1STABLE~SINDEP~ Z60: '{GOTO}A109~/xmSENSMENU~	Displays a message, calculates a sensitivity analysis table in the range STABLE using the input value SINDEP, then returns to SENSMENU.
	AA56: 'WORTH AA57: 'GRAPH PRESENT WORTH AGAINST INDEPENDENT VARIABLE SHOWN AA58: '/gnuPWSENS~q AA59: '{GOTO}A109~/xmSENSMENU~	Calls up the PWSENS graph, which plots the present worth of the battery system against the values of the current independent variable.
	AB56: 'PAYBACK AB57: 'GRAPH PAYBACK PERIOD AGAINST INDEPENDENT VARIABLE SHOWN AB58: '/gnuPPSENS~q AB59: '{GOTO}A109~/xmSENSMENU~	Calls up the PPSENS graph, which plots the payback period of the battery system against the values of the current independent variable.
	AC56: 'PRINT AC57: 'PRINT THE ANALYSIS RESULTS AC58: '/pprA20..H28~g AC59: 'rA109..H116~grA118..H128~gpq AC60: '{GOTO}A109~/xmSENSMENU~	Sets borders for the sensitivity analysis report, prints the appropriate range, clears the borders and returns to SENSMENU.
	AD56: 'QUIT AD57: 'RETURN TO THE MAIN MENU AD58: '{HOME}	Exits from SENSMENU and returns to the Main Menu.

TABLE C.4. Description of Custom Menu INDEMENU

Range Name	Macro	Description
INDEMENU	(Located in cells Y63..AD64)	Custom menu INDEMENU allows the user to select one of five possible independent variables for sensitivity analyses. It is called only from the SENSMENU menu.
	Y63: 'COST Y64: 'SET UP INSTALLED BATTERY COST ($/KWH) AS THE INDEPENDENT VARIABLE Y65: '{GOTO}B114~INSTALLED BATTERY COST ($/KWH)~/rndSINDEP~ Y66: '/rncSINDEP~G91~/rff2~SINVALS~ {GOTO}C119~DOLLARS~/c~C122~ Y67: '/rff2~SOUTVALS~/xcSMAKEVALS~	Writes 'Installed Battery Cost ($/KWH)' as the independent variable name, deletes and recreates range SINDEP indicating the variable's original location in the spreadsheet, formats the cells containing independent variable values, writes labels indicating that they are to be entered in dollars, then calls subroutine SMAKEVALS.
	Z63: 'ESCALATION Z64: 'SET UP DEMAND CHARGE ESCALATION RATE AS THE INDEPENDENT VARIABLE Z65: '{GOTO}B114~DEMAND CHARGE ESCALATION RATE~/rndSINDEP~ Z66: '/rncSINDEP~G100~/rff2~SINVALS~ {GOTO}C119~PERCENT~/c~C122~ Z67: '/rff2~SOUTVALS~/xcSMAKEVALS~	Writes 'Demand Charge Escalation Rate' as the independent variable name, deletes and recreates the range SINDEP, formats the cells containing independent variable values, writes labels indicating that they are to be entered as percentages, then calls subroutine SMAKEVALS.

TABLE C.4. Contd

Range Name	Macro	Description
	AA63: 'LIFE AA64: 'SET UP BATTERY LIFE IN CYCLES AS THE INDEPENDENT VARIABLE AA65: '{GOTO}B114~BATTERY LIFE IN CYCLES~/rndSINDEP~ AA66: '/rncSINDEP~F84~/rff0~SINVALS~{GOTO}C119~CYCLES~/c~C122~ AA67: '/rff0~SOUTVALS~/xcSMAKEVALS~	Writes 'Battery Life in Cycles' as the independent variable name, deletes and recreates the range SINDEP, formats the cells containing independent variable values, writes labels indicating that they are to be entered in cycles, then calls subroutine SMAKEVALS.
	AB63: 'TAXRATE AB64: 'SET UP FEDERAL TAX RATE AS THE INDEPENDENT VARIABLE AB65: '{GOTO}B114~FEDERAL TAX RATE~/rndSINDEP~ AB66: '/rncSINDEP~G106~/rff2~SINVALS~{GOTO}C119~PERCENT~/c~C122~ AB67: '/rff2~SOUTVALS~/xcSMAKEVALS~	Writes 'Federal Tax Rate' as the independent variable name, deletes and recreates the range SINDEP, formats the cells containing independent variable values, writes labels indicating that they are to be entered as percentages, then calls subroutine SMAKEVALS.
	AC63: 'RNDTRIP AC64: 'SET UP ROUND TRIP CONVERTER EFFICIENCY AS THE INDEPENDENT VARIABLE AC65: '{GOTO}B114~ROUND TRIP CONVERTER EFFICIENCY~/rndSINDEP~ AC66: '/rncSINDEP~F87~/rff2~SINVALS~{GOTO}C119~PERCENT~/c~C122~ AC67: '/rff2~SOUTVALS~/xcSMAKEVALS~	Writes 'Round Trip Converter Efficiency' as the independent variable name, deletes and recreates the range SINDEP, formats the cells containing independent variable values, writes labels indicating that they are to be entered in percentages, then calls subroutine SMAKEVALS.
	AD63: 'QUIT AD64: 'RETURN TO PREVIOUS MENU AD65: '{GOTO}A109~/xmSENSMENU~	Returns the user to the SENSMENU custom menu, thus allowing sensitivity analysis results to be calculated.

TABLE C.4. Contd

Range Name	Macro	Description
SMAKEVALS	W62: 'SUBROUTINE SMAKEVALS CALLED FROM INDEMENU OPTIONS W63: 'PRESS RETURN TO ENTER MIN,MAX VALUES, ESCAPE (ESC) WHEN DONE {?}{ESC} W64: '/riA115..B128~{GOTO}E118~+B119{CALC}{DOWN}+B119+(B122-B119)*0.25 W65: '{CALC}{DOWN}+B119+(B122-B119)*0.5{CALC}{DOWN} W66: '+B119+(B122-B119)*0.75{CALC}{DOWN}+B122{CALC} W67: 'ALL DONE! ..PRESS RETURN, CHOOSE 'QUIT' OPTION THEN 'RUN' OPTION{?}{ESC} W68: '{GOTO}A109~/xmINDEMENU~	This subroutine is called by each of the INDEMENU options used to specify an independent variable. It begins by displaying a message and allowing input of minimum and maximum values for the chosen independent variable. It then copies them into the sensitivity analysis table, computes three intermediate values, displays a message and returns to INDEMENU.

TABLE C.5. Description of Named Ranges

Range Name	Location	Description
SINDEP	Varies	This range is deleted and created each time that an independent variable is set up for sensitivity analysis from SENSMENU. If battery cost is specified, the range location will be cell G91; the range location will be cell F100 for demand charge escalation rate and cell F84 for battery life. Cell F87 is used for round trip converter efficiency; cell G106 if federal tax rate is chosen as the independent variable.
SINVALS	B119..B122	This range includes the minimum and maximum values for the chosen independent variable that are entered by the user.
SOUTVALS	E118..E122	This range encompasses the five values of the independent variable which appear in the left column of the sensitivity analysis table.
STABLE	E117..G122	This range is the scope of the sensitivity analysis table computed by SENSMENU option RUN.
STITLE	B114	This cell contains the name of the independent variable currently being used for sensitivity analyses. Used in the PPSENS and PWSENS graphs.
SUNITS	C119	This cell contains the name of the unit being used to describe values of the independent variable currently in use for sensitivity analyses. Used in the PPSENS and PWSENS graphs.

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