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## **User Instructions for Levelized Power Generation Cost Codes Using an IBM-Type PC**

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COST CODES USING AN IBM-TYPE PC

J. J. Coen  
J. G. Delene

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## CONTENTS

	<u>Page</u>
LIST OF TABLES .....	v
LIST OF FIGURES .....	vii
ABSTRACT .....	1
1. INTRODUCTION .....	1
2. INDIVIDUAL POWER GENERATION COST CODES .....	4
3. INTEGRATED COST CODE .....	22
4. EXAMPLE CALCULATIONS .....	31
4.1 1100 MWe Nuclear (PWR) Power Plant Using Integrated Cost Code .....	31
4.2 550 MWe Coal-Fired Power Plant Using Individual Codes With MAINPWR .....	37
4.3 1100 MWe Nuclear (PWR) Power Plant Using Individual Codes Without MAINPWR .....	43
REFERENCES .....	50
DISTRIBUTION .....	51



## LIST OF TABLES

<u>Table</u>		<u>Page</u>
2.1	List of Program Files .....	4
2.2	List of Data Files .....	5
2.3	List of Output Files .....	7
2.4	Recovery Percentages .....	16



## LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
2.1	Power plant capital investment cost menu (PLANTCAP) ....	8
2.2	Nuclear power plant O&M cost menu (NUCLOM) .....	9
2.3	Coal-fired power plant O&M cost menu (COALOM) .....	10
2.4	Main menu for nuclear fuel costs (NFUEL) .....	11
2.5	Nuclear fuel price data menu .....	12
2.6	Nuclear fuel lead/lag time menu .....	12
2.7	Nuclear fuel process loss menu .....	13
2.8	Levelized coal cost menu (COALCOST) .....	14
2.9	Fixed charge rate menu (FCRATE) .....	15
2.10	Nuclear power plant power generation cost menu (LEVEL) .....	17
2.11	Coal-fired power plant power generation cost menu (LEVEL) .....	18
2.12	Capitalized investment cost menu (CAPITAL) .....	19
3.1	Main menu for integrated program (MAINPWR) .....	23
3.2	Menu for levelization routine in integrated program .....	25
3.3	Menu for capital investment cost routine in integrated program .....	26
3.4	Menu for fixed charge rate routine in integrated program .....	27
3.5	Menu for nuclear O&M cost routine in integrated program .....	28
3.6	Menu for coal-fired O&M cost routine in integrated program .....	29
3.7	Menu for nuclear fuel cost routine in integrated program .....	29
3.8	Menu for coal cost routine in integrated program .....	30
4.1	General input parameters for reference PWR/BE power plant .....	32
4.2	Capital investment cost summary for reference PWR/BE power plant .....	33
4.3	Fixed charge rate summary for reference PWR/BE power plant .....	34

4.4	Nonfuel O&M cost summary for reference PWR/BE power plant .....	35
4.5	Fuel cost summary for reference PWR/BE power plant .....	36
4.6	Total levelized power generation cost for PWR/BE power plant .....	37
4.7	Capital investment cost for reference coal-fired power plant (PLANTCAP) .....	39
4.8	Fixed charge rate calculation output for reference coal-fired power plant (FCRATE) .....	40
4.9	Nonfuel O&M costs for reference coal-fired power plant with wet limestone scrubber (COALOM) .....	41
4.10	Levelized coal cost for reference coal-fired power plant (COALCOST) .....	42
4.11	Levelized power generation costs for reference coal-fired power plant in midwest region (LEVEL) .....	43
4.12	Capital investment costs for reference PWR/BE power plant (PLANTCAP) .....	45
4.13	Fixed charge rate calculation output for reference PWR/BE power plant (FCRATE) .....	46
4.14	Nonfuel O&M costs for reference PWR/BE nuclear power plant (NUCLOM) .....	47
4.15	Fuel cycle costs for reference PWR/BE power plant (NFUEL) .....	48
4.16	Levelized power generation cost for reference PWR/BE power plant (LEVEL) .....	49

USER INSTRUCTIONS FOR LEVELIZED POWER GENERATION  
COST CODES USING AN IBM-TYPE PC

J. J. Coen  
J. G. Delene

ABSTRACT

Programs for the calculation of levelized power generation costs using an IBM or compatible PC are described. Cost calculations for nuclear plants and coal-fired plants include capital investment cost, operation and maintenance cost, fuel cycle cost, decommissioning cost, and total levelized power generation cost.

---

1. INTRODUCTION

This report describes a set of microcomputer programs for estimating power generation costs for large steam-electric power plants. These programs permit rapid evaluations using various sets of economic and technical ground rules. The levelized power generation costs that are calculated with these programs may be used to compare the relative economics of nuclear and coal-fired plants based on life cycle costs. It is anticipated that these programs will be useful for making quick analyses of power generation cost using alternative economic parameters, such as interest rate, escalation rate, inflation rate, plant lead times, capacity factor, fuel prices, etc. The two major types of electric generating plants considered are pressurized-water reactor (PWR) and pulverized coal-fired plants. Data are also provided for the Large Scale Prototype Breeder (LSPB) type liquid metal reactor. Costs for plants of either one or two units may be obtained.

The programs described in this report have their origins in several mainframe computer programs. The capital investment cost procedures are modeled after the CONCEPT-5 code;<sup>1</sup> the operation and maintenance (O&M) procedures are modeled after the OMCOST code<sup>2-3</sup>; and the nuclear fuel cycle cost procedures are based on those in the REFCO computer code.<sup>4</sup> The levelization procedures are those described in the Nuclear Energy Cost Data Base (NECDB).<sup>5</sup>

Two different types of programs are included in the code package. One diskette contains the BASIC source codes which can be loaded and run using a BASIC interpreter. Another diskette contains compiled codes which can be executed from the disk operating system (DOS). The two diskettes produce identical results, and either can be used to perform the necessary calculations. Unlike the compiled codes, the source codes can be examined and understood by the user; however, the compiled codes perform the calculations quicker than the source codes. A third diskette is a set of run-time libraries used in conjunction with the compiled codes.

The codes can be run on any IBM-Type personal computer (XT or AT) equipped with DOS version 2.1 or higher. A minimum of 64K RAM is required, along with at least one flexible disk drive. A BASIC interpreter (either BASICA or GWBASIC) is required to execute the interpreter versions of the codes, but no interpreter or compiler is necessary for the compiled versions. Any IBM-compatible printer will function correctly, but if regular size paper is used (8 1/2" wide), a small portion of the output will have to be printed using "condensed" print. Any IBM-compatible monitor (monochrome or color) can be used.

This report represents an update to an earlier version of these PC-based codes.<sup>6</sup> One new code, which integrates several of the individual codes, has been added to the package. The current code package has three main modes of operation. First, each individual code can be executed by itself to determine one aspect of the total levelized power cost, such as fuel cost or O&M cost. Secondly, the integrated code can be executed to calculate all aspects of the levelized power cost. Finally, the integrated code can be used to access an individual code which calculates one aspect of the levelized power generation cost as in the first mode of operation.

The codes have been revised to correspond to 1987 cost levels and to correspond to the methodology in the 1987 Nuclear Energy Cost Data Base (NECDB).<sup>5</sup> Extensive revisions have been made to the code structure and output in order to make the code package more useful and user-friendly. As an example, the user now has the option of either sending output to the screen, to the printer, or to be stored on a disk for

future use. Also, an attempt was made to improve the consistency of the individual codes; such as all cost of money rates and escalation rates are now entered as fractions.

Although this report is meant to be a stand-alone user guide, it does not attempt to describe in detail the basis of the calculations; the interested user should consult the NECDB<sup>5</sup> or the mainframe code reports<sup>1-4</sup> on which the PC codes are based. Chapter 2 of this report describes the operation of the individual cost codes. Chapter 3 contains the description of the integrated code and its interaction with the individual codes. Example problems using both the individual codes and the integrated code are contained in Chap. 4.

## 2. INDIVIDUAL POWER GENERATION COST CODES

A list of the individual power generation cost program files and a brief description of each are given in Table 2.1. A similar list for the data files accessed by the programs is given in Table 2.2. Each of the codes is menu driven, and most of the entries should be self explanatory.

Table 2.1. List of program files

File name	Description
PLANTCAP	Capital investment cost for nuclear plants and coal-fired plants
FCRATE	Fixed charge rate
COALOM	Levelized O&M cost for coal-fired plants
NUCLOM	Levelized O&M cost for nuclear plants
COALCOST	Levelized fuel cost for coal-fired plant
NFUEL	Levelized fuel cost for nuclear plants
LEVEL	Levelized power generation cost
CAPITAL	Capitalized cost from overnight cost
MASSGEN	Mass balance set generation for nuclear plants
MAINPWR	Driver program for PLANTCAP, FCRATE, COALOM, NUCLOM, COALCOST, NFUEL, and LEVEL

Each of the programs in Table 2.1 is supplied in two forms, a Basic source code and a compiled code. The source codes are denoted by a filename extension of .BAS (such as MAINPWR.BAS); the compiled codes are denoted by .EXE (such as MAINPWR.EXE). Both versions are included in the package in order to offer the user both the speed of the compiled versions and the flexibility of the source codes.

It is assumed that the user has some experience with DOS and BASIC. Further it is assumed that the user has an IBM-PC or compatible micro-computer.

Table 2.2. Listing of data files

Usage	File name	Description
Fuel cost for nuclear plants	PWREXB.DAT	PWR extended burnup mass balance data
	PWRSTD.DAT	PWR standard burnup mass balance data
	LSPBRCY.DAT	LSPB recycle mass balance data
	LSPBRIB.DAT	LSPB inner blanket mass balance data
	LSPBRRB.DAT	LSPB radial blanket mass balance data
	MASFIL.DAT	Data file of available mass balance sets
Capital investment cost	PWRBE12.DAT	Capital investment cost model for 1100 MWe (nominal) size PWR based on better experience cost data
	PWRME12.DAT	Capital investment cost model for 1100 MWe (nominal) size PWR based on median experience cost data
	PWRBE6.DAT	Capital investment cost model for 550 MWe (nominal) size PWR based on better experience cost data
	IPWR12.DAT	Capital investment cost model for 1100 MWe (nominal) size improved PWR
	IPWR6.DAT	Capital investment cost model for 550 MWe (nominal) size improved PWR
	APWR6.DAT	Capital investment cost model for 550 MWe (nominal) size advanced PWR
	COAL5.DAT	Capital investment cost model for 550 MWe (nominal) size pulverized coal-fired plant
O&M cost for coal-fired plants	COALWET.DAT	O&M cost model for coal-fired plants with wet scrubbers
	COALDRY.DAT	O&M cost model for coal-fired plants with dry scrubbers
	COALNOS.DAT	O&M cost model for coal-fired plants without scrubbers

The user must also have a BASIC interpreter, such as BASICA or GW-BASIC, in order to use the source codes. To execute one of the source codes, the user should load the interpreter, then load the desired program, and enter **run**.

The compiled versions can be executed directly from DOS. *Microsoft* run-time libraries, contained on a separate diskette supplied in the package, are utilized to accomplish the execution. If the user is executing the compiled versions from a hard disk where both the .EXE codes and the run-time libraries reside, typing the name of the desired code (with no filename extension) will begin the execution. If the user is running the compiled versions from floppy disks, the compiled codes should be placed in one drive and the run-time library disk in the other. Again, typing the name of the desired code will begin the execution.

If cost model data sets (designated by .DAT in Table 2.2) are needed to run the program, you will first be asked: **ENTER DISK CONTAINING COST MODELS (A,B, OR C)?** The proper letter should be entered by the user.

Next the main menu is shown on the screen. To change data, simply enter the corresponding menu number and then enter the revised data. A return without entering a number will result in a 0 (zero) for the data value (or a blank). Selection of the 0 (zero) menu item will run the program. You will be asked to enter a title after the 0 menu entry. A 99 menu entry will end the program run. Changing the default data in any of the MENUS will not alter the data files in Table 2.2.

Each menu contains an item pertaining to the output destination. After entering this number, you will be asked to select the form of output:

**SELECT OUTPUT DEVICE AS FOLLOWS:**

- 1 = PRINTER
- 2 = SCREEN
- 3 = A:(filename).DAT
- 4 = C:(filename).DAT

A selection of 3 sends the output to disk drive A; 4 sends the output to disk drive C. Each program sends disk output to a different file name as shown in Table 2.3.

Table 2.3. List of output files

File name	Output source
CAPOUT.DAT	PLANTCAP
FCR.DAT	FCRATE
NUCLOM.DAT	NUCLOM
COALOM.DAT	COALOM
NFUEL.DAT	NFUEL
COALCOST.DAT	COALCOST
LEVEL.DAT	LEVEL
CAPITAL.DAT	CAPITAL
OUTPUT.DAT	MAINPWR

Detailed information on each of the programs is as follows.

PLANTCAP: This program calculates capital investment costs using cost model information provided in data sets. Currently 7 cost models are available. These are PWRBE12, PWRME12, PWRBE6, IPWR12, IPWR6, APWR6 and COAL5. PLANTCAP replaces the PWRCAP and COALCAP codes used previously. It is essentially a simplified version of the CONCEPT code.<sup>1</sup> The cost models in the data files were derived from the Energy Economic Data Base (EEDB-9) cost models<sup>7</sup> and are for the NECDB<sup>5</sup> reference midwest region (Chicago). The cost models are divided into labor, material, and equipment costs at the two digit accounting level. Cost size scaling is done at the two digit level using CONCEPT<sup>1</sup> scale factors. Regional cost differences at the two digit level were derived from CONCEPT code runs for the various cities. The interest and escalation during construction calculation is that described in Appendix C of the NECDB.

The input menu for PLANTCAP is shown in Fig. 2.1. The values shown are the default values for the PWRBE12 model. These parameters may be

```

0 = RUN CASE, DATA ENTRY COMPLETE
1 = COST MODEL NAME                PWRBE12
2 = CONTINGENCY (fraction)         .1000
3 = CITY NUMBER                    5 CHICAGO
4 = ESCALATION RATE (fraction/year) .0500
5 = YEAR OF STEAM SUPPLY SYSTEM ORDER 1992.00
6 = YEAR OF CONSTRUCTION PERMIT     1994.00
7 = YEAR OF COMMERCIAL OPERATION    2000.00
8 = YEAR OF CONSTANT DOLLAR OUTPUT  1987.
9 = COST OF MONEY DURING CONSTRUCTION (AFUDC RATE) .1135
    CAPITALIZATION USED FOR AFUDC
        DEBT                        .500          .097
        PREFERRED STOCK             .100          .090
        COMMON EQUITY               .400          .140
10 = GENERAL INFLATION RATE (fraction) .050
11 = NET RATING PER UNIT (MWe)       1100.
12 = NUMBER OF UNITS AT SITE         1
13 = OUTPUT DESTINATION              Printer
14 = RESET DEFAULT VALUES
99 = EXIT PROGRAM

```

ENTER ITEM NUMBER:

?

Fig. 2.1. Power plant capital investment cost menu (PLANTCAP)

altered for a run by entering the item number and then entering the new value for the variable. Entering a 1 (for menu item 1) causes a list of available cost models to be displayed. A new cost model can then be selected. If menu item 3 is entered, the list of available cities and their numbers are shown. City 5 is Chicago. Item 7 is the escalation rate of construction costs; this rate includes inflation. Item 9, the cost of money during construction, is based on the capitalization fractions and nominal rates that are queried if 9 is entered. Note that item 11 is the electric rating of a single unit and not that for the entire plant.

NUCLOM: This program calculates operation and maintenance (O&M) costs for nuclear plants. It replaces the former codes PWROM and LMRM and is based on the recent revisions to the nuclear O&M costing procedures.<sup>3</sup> Three cost models are imbedded in the code. These are the better experience PWR (PWRBE), the median experience PWR (PWRME), and a large liquid metal reactor (LMRBE) based on the PWRBE cost model.

The available menu options and their default values are shown in Fig. 2.2. The salaries in item 2 are given in constant base year dollars. The base year is shown in item 4. In order to select an alternate cost model, enter a 3 and then enter the model number as detailed on the screen.

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE	
1 = ESCALATION RATE (fraction)	.05
2 = AVERAGE ONSITE STAFF COST	36000
before payroll taxes and insurance in 1987 \$	
AVERAGE OFFSITE STAFF COST	51000
before payroll taxes and insurance in 1987 \$	
3 = COST MODEL	PWRBE
4 = BASE YEAR FOR FOR COST MODEL	1987
YEAR OF PLANT STARTUP	2000
REF. YEAR FOR CONSTANT DOLLAR	1987
5 = NUMBER OF UNITS PER PLANT	1
6 = BASE LOAD CAPACITY FACTOR	.75
7 = NET RATING OF EACH UNIT (MWe)	1100
8 = INFLATION RATE	.05
9 = OUTPUT DESTINATION	Screen
10 = RESET DEFAULT VALUES	
99 = EXIT PROGRAM	

ENTER A NUMBER FROM THE MENU

?

Fig. 2.2. Nuclear power plant O&M cost menu (NUCLOM)

COALOM: This program calculates O&M costs for coal-fired plants. It replaces the former codes, WETOM, and DRYOM. It is the PC version of the coal model portions of the OMCOST code,<sup>2</sup> updated to 1987 cost levels with cost/size scaling consistent with the revised nuclear O&M models.<sup>3</sup> Three cost data models are imbedded in the code. These are for coal-fired plants with wet limestone scrubbers (COALWET), with dry lime SO<sub>2</sub> removal systems (COALDRY), and without an SO<sub>2</sub> removal system (COALNOS). The available menu options and default values are shown in Fig. 2.3. Menu item 4 refers to the sulfur content, ash content, and heating value of the coal burned in the power plant. Sulfur content is ignored for the model without an SO<sub>2</sub> removal system. The COALDRY option is recommended for analyses of low-sulfur western bituminous and sub-bituminous coal-fired plants.

NFUEL: This program calculates levelized nuclear fuel costs. It utilizes mass balance data for various reactor fuel cycles stored on separate data files. This code is based on the mainframe REFC083 code<sup>4</sup> with some modifications and updating to 1987 cost levels. The code has recently been modified to provide access in the menu to the lead and lag times and to the process loss fractions. Previously, changes to these

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

```

0 = RUN CASE, DATA ENTRY COMPLETE
1 = O AND M COST MODEL (PLANT TYPE): COALWET
2 = ESCALATION RATE (fraction) .05
3 = PLANT NET HEAT RATE, BTU/KWH(e) 9900
4 = SULFUR (fraction) .035
  ASH (fraction) .116
  HEATING VALUE (BTU/lb) 11500
5 = REFERENCE YEAR FOR COST FIGURES 1987
  YEAR OF START OF OPERATION 2000
  REFERENCE YEAR FOR CONSTANT DOLLARS 1987
6 = NUMBER OF UNITS PER PLANT 2
7 = BASE LOAD CAPACITY FACTOR .75
8 = NET RATING OF EACH UNIT (MWe) 550
9 = INFLATION RATE .05
10 = OUTPUT DESTINATION Screen
11 = RESET DEFAULT VALUES
99 = EXIT PROGRAM

```

ENTER A NUMBER FROM THE MENU

?

Fig. 2.3. Coal-fired power plant O&M cost menu (COALOM)

quantities could only be accomplished by modification of program statements. Also, the option is now available to output levelized costs by year of operation and by fuel batch.

In order to accomplish these changes the menu has been extensively revised with the price data, lead and lag times and process losses being moved to sub-menus.

The main menu for NFUEL options is shown in Fig. 2.4. The values shown in the menu are not entirely the default option set. The default for menu Item 3, Recycle Discharge Fuel is N for no. The Y option (for yes) was selected so that Item 8, the plutonium tax treatment option would appear in the menu. Item 8 is used only for recycle since it pertains to credit for discharge fuels as discussed below.

Item 1 selects the mass balance set to be used in the calculation. If a 1 is entered, a list of available mass balance sets will be shown on the screen. The name of the set to be used is then entered by the user. The code will check the name entered against the names stored in the MASFIL data file. If a name is entered that is not in MASFIL, the list of available mass balance sets will be shown on the screen again, and a new name can then be entered. Care should be taken in manipulating files not to separate (put on another disk) MASFIL from the

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

```

0 = RUN CASE, DATA ENTRY COMPLETE
1 = MASS BALANCE SET NAME PWREXB
2 = TAX DEPRECIATION OPTION 1
3 = RECYCLE DISCHARGE FUEL Y
4 = OUTPUT COSTS BY YEAR AND BATCH N
5 = GO TO PRICE DATA MENU
6 = GO TO LEAD/LAG TIME MENU
7 = GO TO PROCESS LOSS MENU
8 = PLUTONIUM TAX TREATMENT OPTION 1
9 = YEAR OF STARTUP 2000
   REFERENCE YEAR FOR CONSTANT DOLLARS 1987
10 = CAPACITY FACTOR .75
11 = INFLATION RATE .05
12 = EFFECTIVE COST OF MONEY 9.570001E-02
13 = INCOME TAX RATE .3664
14 = OUTPUT DESTINATION Screen
15 = RESET DEFAULT VALUES
99 = EXIT PROGRAM

```

ENTER A NUMBER FROM THE MENU

?

Fig. 2.4. Main menu for nuclear fuel costs (NFUEL)

mass balance set files of which it is keeping track. Deletion and addition of mass balance sets is preferably done using the MASSGEN code discussed later in this Chapter.

Selection of item 2, the tax depreciation option, gives two choices:

0 = units of production, and

1 = 5 years.

Entering 0 allows fuel to be depreciated in a given period proportionally to energy produced. Entering 1 allows fuel to be depreciated using the accelerated 5-year schedule, regardless of energy produced in any period.

If menu item 3 is N for no, then no credit is given for uranium or plutonium discharged from the fuel. If item 3 is Y for yes, then credit is taken for discharged fissile materials.

Selection of Menu Item 5 sends control to the price data menu as shown in Fig. 2.5. This is the menu for the prices and price escalation rates of the various commodities and services needed in the fuel cycle. Two numbers are entered (press return after entering each number

## PRICE DATA MENU

price in reference year and escalation rate thereafter

0 = RETURN TO MAIN MENU		
1 = BASE YEAR FOR COST DATA	1987	
2 = U308 PRICE AND ESCALATION (\$/lb)	23	.071
3 = CONVERSION PRICE AND ESCALATION (\$/kgU)	8	.0605
4 = ENRICHMENT PRICE AND ESCALATION (\$/SWU)	109	.032
5 = PLUTONIUM PRICE AND ESCALATION (\$/kg)	0	.05
6 = FABRICATION PRICE AND ESCALATION (\$/kg HM)	220	.05
7 = REPROCESSING PRICE AND ESCALATION (\$/kg HM)	0	.05
8 = WASTE DISPOSAL PRICE AND ESCALATION (mills/kWh)	1	.05

ENTER A NUMBER FROM THE MENU

?

Fig. 2.5. Nuclear fuel price data menu

separately) for each of these items. The first is the price in base year dollars (see menu Item 1 for base year) and the second is the escalation rate between the base year and the year the money is spent. Return to the main menu by entering 0 when fuel price and escalation changes are complete.

Selection of main menu item 6 sends control to the lead/lag time menu as shown in Fig. 2.6. For menu items 1 through 5, two entries are needed. These are the lead times in years relative to when the batch is loaded in the reactor for the initial core fuel, and second for the reload fuel. For items 6-10, lag times in years, relative to when the fuel is discharged from the reactor are required for the initial core

## LEAD/LAG TIME MENU FOR INITIAL CORE AND RELOAD FUEL, YEARS

0 = RETURN TO MAIN MENU		
1 = URANIUM PURCHASE LEAD TIME	2	1.5
2 = CONVERSION PURCHASE LEAD TIME	1.5	1
3 = ENRICHMENT PURCHASE LEAD TIME	1	.75
4 = PLUTONIUM PURCHASE LEAD TIME	2	1
5 = FABRICATION PURCHASE LEAD TIME	.75	.5
6 = URANIUM SALES LAG TIME	1	1
7 = CONVERSION SALES LAG TIME	1	1
8 = ENRICHMENT SALES LAG TIME	1	1
9 = PLUTONIUM SALES LAG TIME	1	1
10 = REPROCESSING COST LAG TIME	1	1
11 = TOTAL LAG TIME FOR PLUTONIUM RECYCLE, CYCLES	2	

ENTER A NUMBER FROM THE MENU

?

Fig. 2.6. Nuclear fuel lead/lag time menu

and subsequent reload fuel. Item 11 is the total time in reactor cycles for recycle from the time fuel is discharged from the reactor, until the recovered plutonium is reloaded into the reactor. Return to the main menu by entering 0.

Selection of main menu item 7 gives the process loss menu as shown Fig. 2.7. These quantities are the process loss fractions at each stage of the fuel cycle.

NFUEL main menu item 8 is the plutonium tax treatment option.

Three alternatives are available:

0 = capitalize all charge, expense all discharge;

1 = capitalize net recycle, expense net discharge; and

2 = capitalize recovery cost into recycle plutonium value.

Under option 0, all plutonium charged to the reactor is capitalized and depreciated as specified in menu Item 2. All plutonium discharged from the reactor is assumed to be sold, and the money received is treated as current income (reverse expense) for tax purposes.

Under option 1, recycled plutonium is assumed to have a zero tax depreciation basis, since it was fully depreciated in the previous cycle. The net plutonium makeup needed (purchase from others) to supplement recycled plutonium is capitalized and depreciated for tax purposes. Any excess plutonium produced over recycle requirements is sold for current income.

```

PROCESS LOSS MENU
(decimal)

0 = RETURN TO MAIN MENU
1 = CONVERSION/ENRICHMENT LOSS .005
2 = URANIUM FABRICATION LOSS .01
3 = PLUTONIUM FABRICATION LOSS .01
4 = URANIUM RECOVERY LOSS .01
5 = PLUTONIUM RECOVERY LOSS .01

ENTER A NUMBER FROM THE MENU
?
```

Fig. 2.7. Nuclear fuel process loss menu

Under option 2, it is assumed that the cost of reprocessing to recover plutonium from spent fuel is capitalized as the cost of recovered plutonium. This cost, in addition to the cost of any makeup excess plutonium, is then depreciated as specified in menu Item 2 of the main menu. Excess plutonium is sold for current income and the cost of recovery of this excess is expensed. Some care must be taken in using this option. Breeder reactor systems usually must be described with multiple mass balance sets, one for the core and perhaps axial blankets and one for each radial blanket. When using option 2, all plutonium charge and discharge (whether from core or blankets) which is used in the recycle calculation, as well as the total reprocessing throughput rate (core + blankets heavy metal) must appear in the core fuel mass balance set. This is because the blankets as well as core plutonium are recycled to the core, and the code uses the cost of this reprocessing to determine the tax basis of recycled plutonium. The LSPB mass balance data set included with the code package has been adjusted in this manner.

COALCOST: This program calculates levelized fuel cost for a coal-fired plant. The available menu options and their default values are shown in Fig. 2.8.

FCRATE: This program calculates the fixed charge rate on the capital investment. It is the same program listed in Appendix B of the

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE	
1 = PRICE OF COAL IN DOLLARS PER MILLION BTU	1.55
2 = COAL PRICE ESCALATION RATE (fraction)	0.0626
3 = REFERENCE YEAR FOR PRICE OF COAL	1987.
4 = REFERENCE YEAR FOR CONSTANT DOLLARS	1987.
5 = YEAR OF STARTUP	2000.
6 = PLANT NET HEAT RATE (BTU/kwh)	9900.
7 = PLANT LIFE (years)	30.
8 = GNP INFLATION RATE	0.050
9 = EFFECTIVE COST OF MONEY	0.0957
10 = OUTPUT DESTINATION	Screen
11 = RESET DEFAULT VALUES	
99 = EXIT PROGRAM	

ENTER A NUMBER FROM THE MENU

?

Fig. 2.8. Levelized coal cost menu (COALCOST)

NECDB. The available menu options and their default values are shown in Fig. 2.9.

For menu item 4, the N stands for normalized accounting and an F stands for flow through accounting. Three alternate tax depreciation schedules are available through menu item 5, depending on the property class:

- 1 = 5-year property,
- 2 = 15-year property, and
- 3 = 20-year utility property.

A listing of the recovery percentages for each property class is shown in Table 2.4. The 5-year class includes equipment and nuclear fuel, the 15-year class includes nuclear plants, and the 20-year class includes coal-fired plants.

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

- .0 = RUN CASE, DATA ENTRY COMPLETE
- 1 = INTERIM REPLACEMENT ESCALATION RATE (fraction) .05
- 2 = PROPERTY TAX RATE (fraction/year) .02
- 3 = INTERIM REPLACEMENT RATE (fraction/year) .005
- 4 = NORMALIZED/FLOW-THROUGH ACCOUNTING N
- 5 = TAX DEPRECIATION SCHEDULE 2  
15-YEAR PROPERTY
- 6 = PROJECT LIFE, YEARS 40
- 7 = PRINTOUT ANNUAL REVENUE REQUIREMENTS Y
- 8 = COMPRESSED PRINTOUT FOR REVENUE REQUIREMENTS N
- 9 = LEVELIZING PERIOD, YEARS 30
- 10 = INFLATION RATE (DECIMAL) .05
- 11 = INITIAL CAPITAL INVESTMENT AT STARTUP (millions nominal \$) 4012.5

ENTER OPTION NUMBER OR A 'RETURN' TO SEE REST OF MENU?

- 12 = TAX DEDUCTABLE FRACTION OF TOTAL CAPITAL INVESTMENT .7997
- 13 = EFFECTIVE INCOME TAX RATE .3664
- 14 = INTEREST RATE ON DEBT .097  
RETURN ON PREFERRED STOCK 9.000001E-02  
RETURN ON COMMON STOCK .14
- 15 = DEBT FRACTION .5  
PREFERRED STOCK FRACTION .1  
COMMON STOCK FRACTION .4
- 16 = YEAR OF STARTUP 2000
- 17 = REFERENCE YEAR FOR CONSTANT DOLLARS 1987
- 18 = TOTAL PLANT POWER LEVEL, MWe 1100
- 19 = CAPACITY FACTOR .75
- 20 = OUTPUT DEVICE Printer
- 21 = RESET DEFAULT VALUES
- 99 = EXIT PROGRAM

ENTER A NUMBER FROM THE MENU

?

Fig. 2.9. Fixed charge rate menu (FCRATE)

Table 2.4. Recovery percentages

Year	Applicable percentage for class of property		
	5 year (nuclear fuel)	15 year (nuclear plant)	20 year (coal-fired plant)
1	20.00	5.0	3.75
2	32.00	9.5	7.22
3	19.20	8.55	6.68
4	11.52	7.70	6.18
5	11.52	6.93	5.71
6	5.76	6.23	5.28
7		5.91	4.89
8		5.91	4.52
9		5.91	4.47
10		5.91	4.47
11		5.90	4.46
12		5.90	4.46
13		5.90	4.46
14		5.90	4.46
15		5.90	4.46
16		2.95	4.46
17			4.46
18			4.46
19			4.46
20			4.46
21			2.23

An entry of Y for menu item 7 will result in a printout of a breakdown of the year-by-year revenue requirements for capital. Items 7 and 8 do not appear if the screen is being used as the output device because the schedule will not fit on the screen. An entry of N for menu item 7 will suppress the printout. Since the standard print type (Epson type printer, 10 characters per inch) will result in a 10 inch wide printing

for the annual revenue requirements, those users with only a standard width printer should enter a Y for menu item 8 in order to obtain a compressed printout of this table (may not work for all printers).

Menu item 6 indicates a 40-year plant life and menu item 9 indicates a 30-year levelization period. The levelized fixed charge rate will be calculated over 30 years using only those costs incurred during the first 30 years of the plant life.

The entire fixed charge rate menu is too large to fit on a single screen listing. Therefore, the menu stops after item 11, and a menu item number may be entered here or return may be pressed to display the rest of the menu.

The initial capital investment in nominal dollars (menu item 11) can be obtained from the output of PLANTCAP or CAPITAL, as can the fraction of the cost which is deductible for income tax purposes (menu item 12).

LEVEL: This program calculates levelized power generation costs. The input menu with default values is shown in Fig. 2.10. Menu Option 15 indicates the plant type; N signifies nuclear. If C, for coal, is

```

0 = RUN CASE, DATA ENTRY COMPLETE
1 = YEAR OF FIRST COMMERCIAL OPERATION 2000
2 = RATING, MWE 1100 & UNITS/PLANT 1
3 = ANALYSIS LIFE, YEARS 30
4 = GNP INFLATION RATE .05
5 = EFFECTIVE INCOME TAX RATE .3664
6 = CAPITALIZATION      FRACTION      RATE
   DEBT                  0.500        0.097
   PREFERRED STOCK      0.100        0.090
   COMMON EQUITY        0.400        0.140
7 = REFERENCE YEAR FOR CONSTANT DOLLARS 1987
8 = DECOMMISSIONING DEBT RATE .07
9 = DECOMMISSIONING COST, MILLIONS OF 1987 $ 145
10 = CAPACITY FACTOR .75
11 = PLANT INVESTMENT COST (millions nominal $) 4012
12 = FIXED CHARGE RATE .1631
13 = LEVELIZED O&M COST (mills/kwh using 1987 $) 9.149999
14 = LEVELIZED FUEL COST (mills/kwh using 1987 $) 6.391
15 = PLANT TYPE N
16 = OUTPUT DEVICE Screen
17 = RESET DEFAULT VALUES
99 = EXIT PROGRAM
   ENTER A NUMBER FROM THE MENU
?

```

Fig. 2.10. Nuclear power plant power generation cost menu (LEVEL)

entered, the default menu changes to that shown in Fig. 2.11. There are differences in the nuclear and coal default values in menu Items 2, 9, 11, 12, 13, 14, and 15.

Menu item 2 is the unit rating and number of units. Item 9 is the decommissioning cost (millions of reference year dollars) for the total plant. Item 11, the plant investment cost, is the value calculated using PLANTCAP, or alternately CAPITAL. Item 13 is the levelized O&M cost, which is the value calculated using NUCLOM or COALOM. Item 14, the levelized fuel cost, is obtained from the NFUEL or COALCOST results.

CAPITAL: This code can be used in place of PLANTCAP if a capital cost model data file is not available for the case of interest. Like PLANTCAP, CAPITAL gives the total capitalized cost in its results. The overnight cost of the plant is required as input for CAPITAL.

The input menu with default values is shown in Fig. 2.12. A change in menu item 1 will cause an automatic change in menu Items 4, 8, and 9 in order to reflect the new plant type. If menu Item 7 is requested, the user will be asked to enter each capitalization fraction and rate of

```

0 = RUN CASE, DATA ENTRY COMPLETE
1 = YEAR OF FIRST COMMERCIAL OPERATION 2000
2 = RATING, MWE 550 & UNITS/PLANT 2
3 = ANALYSIS LIFE, YEARS 30
4 = GNP INFLATION RATE .05
5 = EFFECTIVE INCOME TAX RATE .3664
6 = CAPITALIZATION      FRACTION      RATE
   DEBT                  0.500        0.097
   PREFERRED STOCK      0.100        0.090
   COMMON EQUITY        0.400        0.140
7 = REFERENCE YEAR FOR CONSTANT DOLLARS 1987
8 = DECOMMISSIONING DEBT RATE .07
9 = DECOMMISSIONING COST, MILLIONS OF 1987 $ 25
10 = CAPACITY FACTOR .75
11 = PLANT INVESTMENT COST (millions nominal $) 2887
12 = FIXED CHARGE RATE .1651
13 = LEVELIZED O&M COST (mills/kwh using 1987 $) 5.92
14 = LEVELIZED FUEL COST (mills/kwh using 1987 $) 20.88
15 = PLANT TYPE C
16 = OUTPUT DEVICE Screen
17 = RESET DEFAULT VALUES
99 = EXIT PROGRAM
? ENTER A NUMBER FROM THE MENU

```

Fig. 2.11. Coal-fired power plant power generation cost menu (LEVEL)

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE		
1 = PLANT TYPE		NUCLEAR
2 = PLANT SIZE, MWe		1100.
3 = REFERENCE YEAR		1987.0
4 = TOTAL OVERNIGHT COST(REF. YEAR \$)		1673.0
5 = ESCALATION RATE		.0500
6 = INFLATION RATE		.0500
7 = CAPITALIZATION	FRACTION	RATE
	DEBT	.500 .097
	PREFERRED STOCK	.100 .090
	COMMON EQUITY	.400 .140
8 = CONSTRUCTION SCHEDULE		
	NSSS ORDER DATE	1992.00
	CONSTRUCTION PERMIT DATE	1994.00
	OPERATION DATE	2000.00
9 = FRACT. OF MONEY SPENT BEFORE C.P. ISSUE		.100
10 = OPTION TO RETURN TO BASE PARAMETERS		
11 = OUTPUT DESTINATION		Screen
99 = EXIT PROGRAM		

ENTER A NUMBER FROM THE MENU

?

Fig. 2.12. Capitalized investment cost menu (CAPITAL)

return separately. For menu Item 8, each date will be asked for separately. Menu Item 9 provides the fraction of the total overnight cost spent from the time of plant order until construction begins. The default values of 0.1 for nuclear and 0.05 for coal are based on the cash flow profile in the CONCEPT code.<sup>1</sup> Selection of menu Item 10 will return the menu to its default values.

**MASSGEN:** The various data files may be updated through the use of a line editor (EDLIN for example) or with word processing software. A separate program is available to create, update, or change fuel cycle mass balance data sets. MASSGEN is a program for generating, deleting, or changing fuel cycle mass balance data for use with the NFUEL program. It does not do a physics calculation but simply enters charge and discharge quantities in the proper format for use in the fuel cycle cost code.

You are first asked:

For Ending Session: Enter E

For Adding a New Mass Balance Set: Enter A

For Deleting an Existing Mass Balance Set: Enter D

For Changing an Existing Mass Balance Set: Enter C

If A is entered, the names of existing mass balance sets are shown and you are asked for the name of the new set. If the new set has the same name as an existing set, you are asked if you want to replace it with the new information. If the answer is N for no, you return to the initial menu. If the answer is Y for yes, you are asked in turn for:

**Number of batches?** (number of separate batches for which information will be provided)

**Plant capacity factor?** (fraction)

**Batches/core?** (number of cycles an average batch remains in core)

**Electric power, MWe?** (unit power rating)

You are then asked in turn for the following information for each of the "Number of batches":

**Total uranium load, kg?**

**U-235 load, kg?**

**Fissile plutonium load, kg?**

**Total uranium discharge, kg?**

**U-235 discharge, kg?**

**Fissile plutonium discharge, kg?**

**Total heavy metal charge, kg?**

**Total heavy metal discharge, kg?**

If the data are the same for the remainder of the batch as for the previous batch, entering 99999 will set the mass flows equal to the previous batch values.

When you have finished entering data for all of the number of batches specified in **Number of batches?** the information will be shown on the screen, and you will be asked whether it is correct. If it is, enter Y, and the new mass balance data will be added to the list of available data sets. If it is not, enter N, and you will be asked, **Number of batch to be corrected?** Enter the batch number, where 0 specifies the initial information. After correcting the information, the above procedure is repeated until an answer of Y is given to the **Data correct?** question.

If D is entered for the initial menu, you are shown the names of the existing mass balance sets and asked, **Name of file to be deleted?** Enter the desired file from the list. If the name entered is on the list, it will be deleted. If it is not, you will be asked, **Try again? Y or N?** If you answer Y, you get another chance, if you enter N, you will be returned to the initial menu.

If C is entered for the initial menu query, you can change an existing data set. The names of existing data sets are shown on screen and you are asked: **Change Which Mass Balance Set?** Enter name of set from list and you will be asked, **Do you Want to Change Name and Save as a New Set? (Y or N).** If you want to correct data and not create a new set, enter N, and you will move to the data change procedure. If you want to create a new data set, enter Y. You will be asked to **Enter Name of New Mass Balance Set.** Enter the new name (eight characters or less). You will now be shown the existing data and asked, **Is This Information Correct?** The procedure from this point on is the same as for correcting data discussed under the "A" option for the initial menu.

### 3. DESCRIPTION OF INTEGRATED COST CODE

The integrated cost code, MAINPWR, utilizes the individual codes described in Chap. 2. Like the individual codes, MAINPWR is menu driven. MAINPWR allows for two different modes of operation. One mode allows the execution of the individual codes in the same manner as was described in Chap. 2. The other mode is an automated execution of the different individual codes to determine the total levelized power generation cost.

The previous version of the codes used in calculating levelized power generation costs called for executing each individual code, noting the results of the code, and using these results as input to the next code. In consolidating these codes into a unified program, two basic purposes are served. First, the user does not have to keep track of the results of each code; these values are stored in memory and recalled when necessary. Secondly, many items of the input data for each of the individual codes are repetitive. The same parameter, such as general inflation rate or capacity factor, is often used in all the codes. To facilitate easier use of the codes, the consolidated code requires input of these common parameters only once. The values are stored in memory and recalled when necessary. The parameters which are common to all the codes are entered at the beginning of the execution. The parameters which are unique to a specific code are entered at the beginning of that particular routine of the consolidated code.

MAINPWR, short for main power, can be thought of as the central driver program from which branching to the individual codes occurs. Although data entry takes place in MAINPWR, no calculations are performed in this particular program.

When MAINPWR is executed, the first prompt to the user is **ENTER OPERATING DISK (A, B, OR C)**. MAINPWR can operate from either drive A, B, or C, but it cannot operate from more than one drive during the execution. Thus, other than the output file (and the runtime libraries when executing the compiled codes), all files including program MAINPWR and the other codes shown in Tables 2.1 and 2.2 must be consolidated on one disk drive. The main menu of program MAINPWR then appears on the screen.

The main menu for program MAINPWR is shown in Fig. 3.1. Selection of item 1 allows the user to calculate total levelized power generation costs, including capital investment costs, fuel costs, O&M costs, and decommissioning costs. If item 1 is selected, MAINPWR branches to program LEVEL. Item 2 allows the user to calculate capital investment costs only, and upon selection of item 2, MAINPWR branches to program PLANTCAP. Calculation of the fixed charge rate by branching to program FCRATE is accomplished by selecting item 3. Item 5 allows the user to calculate total levelized fuel costs by branching to either program NFUEL or program COALCOST, depending on the type of plant, which is specified in menu item 6. Levelized O&M costs can be calculated from either NUCLOM or COALOM, which are accessed using item 4.

Selection of items 2-5 causes execution of one of the individual codes as detailed in Chap. 2 with some modifications. Since the user has already specified the operating disk drive, the individual codes do not ask for this information. Similarly, the individual codes do not ask for the output destination, since this information is contained in the main menu of MAINPWR. Also, entering a "99" at the menu stage of each code returns the user to the main menu of program MAINPWR instead of stopping execution.

Item 6 allows the user to change the plant type. The plant type is initially nuclear, but entering a 6 at the main menu will cause the user to change the plant type. The user should enter the number of the desired selection.

#### M A I N M E N U

The following options are available at this time:

- (1) Calculate Total Levelized Power Generation Costs
- (2) Calculate Capital Investment Costs
- (3) Calculate Fixed Charge Rate
- (4) Calculate Operating & Maintenance Costs
- (5) Calculate Fuel Costs
- (6) Change Plant Type from NUCLEAR
- (7) Change Output Destination from SCREEN
- (8) Reset default values
- (99) Exit Program

Input number of desired selection

?

Fig. 3.1. Main menu for integrated program (MAINPWR)

Item 8 is the default value reset. Selection of item 8 causes all variables in the individual codes to be reset to their default values. The plant type and output destination in MAINPWR are not affected by the reset.

Selection of item 99 stops the execution of the program.

As previously stated, selection of item 1 allows the calculation of total levelized power generation costs. Two possibilities exist at this stage. In the first scenario, the user already has access to the values of capital investment cost, fixed charge rate, levelized fuel cost, and levelized O&M cost. If this is the case, the user needs only to execute LEVEL as a separate code. A more likely second scenario, however, is that the user does not know these values and will need to determine these quantities using programs PLANTCAP, FCRATE, NFUEL or COALCOST, and NUCLOM or COALOM. Recognizing these two possibilities, MAINPWR prompts the user in the following manner:

The calculation of the total levelized power generation costs requires that the levelized values of capital costs, fuel costs, and O&M costs, as well as the fixed charge rate, be known. It is possible to generate this necessary data using this program, or if these values are already known, they may be inputted separately.

Do you wish to calculate the data using the integrated program?

Y = Yes

N = No

Select the appropriate response.

?

If the user does already know the necessary values, he should respond with an N and execute program LEVEL as detailed in Chap. 2. If instead the user needs to calculate these individual costs, he should respond with a Y to use the integrated code and automatically branch to LEVEL, PLANTCAP, FCRATE, NUCLOM or COALOM, NFUEL or COALCOST, and LEVEL (again). To do so, the user should respond with a Y.

Upon entering a Y, the user sees the menu for the levelization routine appear on the screen. This menu, shown in Fig. 3.2, is a modified menu for program LEVEL. MAINPWR has automatically branched to

generate this necessary data using this program, or if these values are already known, they may be inputted separately.

Do you wish to calculate the data using the integrated program?

Y = Yes

N = No

Select the appropriate response.

?

If the user does already know the necessary values, he should respond with an N and execute program LEVEL as detailed in Chap. 2. If instead the user needs to calculate these individual costs, he should respond with a Y to use the integrated code and automatically branch to LEVEL, PLANTCAP, FCRATE, NUCLM or COALM, NFUEL or COALCOST, and LEVEL (again). To do so, the user should respond with a Y.

Upon entering a Y, the user sees the menu for the levelization routine appear on the screen. This menu, shown in Fig. 3.2, is a modified menu for program LEVEL. MAINPWR has automatically branched to program LEVEL. The default values for items 3, 4, 5, 6, 8, 9, and 10 are the values recommended in the NECDB<sup>5</sup> for either a coal-fired or a nuclear plant. The plant type does not appear in the menu; it has already been determined from the main menu of MAINPWR. A selection of item 99 at this point by the user brings back the main menu for program

#### Menu for Levelization routine

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE  
 1 = YEAR OF FIRST COMMERCIAL OPERATION 2000  
 2 = RATING, MWE 1100 & UNITS/PLANT 1  
 3 = ANALYSIS LIFE, YEARS 30  
 4 = GNP INFLATION RATE .05  
 5 = EFFECTIVE INCOME TAX RATE .3664  
 6 = CAPITALIZATION      FRACTION      RATE  
     DEBT                    0.500            0.097  
     PREFERRED STOCK      0.100            0.090  
     COMMON EQUITY        0.400            0.140  
 7 = REFERENCE YEAR FOR CONSTANT DOLLARS 1987  
 8 = DECOMMISSIONING DEBT RATE .07  
 9 = DECOMMISSIONING COST, MILLIONS OF 1987 \$ 145  
 10 = CAPACITY FACTOR .75  
 99 = EXIT PROGRAM  
 ENTER A NUMBER FROM THE MENU

?

Fig. 3.2. Menu for levelization routine in integrated program

MAINPWR. Selection of item 0 causes intermediate output to be printed and the menu for the capital investment cost routine to be displayed, as shown in Fig. 3.3.

When the menu for the capital investment cost routine is on display, control has automatically been shifted from program LEVEL to program PLANTCAP. Menu item 1 is the name of the capital investment cost model. Entering a 1 will cause a list of possible cost models to be displayed. These cost models have their roots in the EEDB-9<sup>7</sup> and are described in more detail in Chap. 2. The contingency fraction in item 2 is multiplied by the sum of the indirect and direct costs to obtain the contingency allowance. Item 3 is the city number; selection of 3 causes a list of cities to be displayed. Item 4 is the construction cost escalation rate including inflation. Items 5 and 6 should be self-explanatory. The default values for items 2, 4, 5, and 6 are the values recommended in the NECDB<sup>5</sup> for the type of plant which has been specified by the user. Selection of item 0 causes intermediate output for the capital investment cost routine to be printed. Control is next transferred to program FCRATE.

The next sequence appearing on the screen is the menu for the fixed charge rate routine, shown in Fig. 3.4. Item 3 is the fraction of the total initial capital investment that is to be allocated annually for equipment replacement. Item 1 is the annual escalation rate in the cost of this equipment. Item 7 allows the user to specify that a year-by-

Menu for Capital Investment Cost routine

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE	
1 = COST MODEL NAME	PWRBE12
2 = CONTINGENCY (fraction)	.1000
3 = CITY NUMBER	5 CHICAGO
4 = ESCALATION RATE (fraction/year)	.0500
5 = YEAR OF STEAM SUPPLY SYSTEM ORDER	1992.00
6 = YEAR OF CONSTRUCTION PERMIT	1994.00
99 = EXIT PROGRAM	

ENTER ITEM NUMBER:

?

Fig. 3.3. Menu for capital investment cost routine in integrated program

**Menu for Fixed Charge Rate routine**

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE  
 1 = INTERIM REPLACEMENT ESCALATION RATE (fraction) .05  
 2 = PROPERTY TAX RATE (fraction/year) .02  
 3 = INTERIM REPLACEMENT RATE (fraction/year) .005  
 4 = NORMALIZED/FLOW-THROUGH ACCOUNTING N  
 5 = TAX DEPRECIATION SCHEDULE 2  
     15-YEAR PROPERTY  
 6 = PROJECT LIFE, YEARS 40  
 7 = PRINTOUT ANNUAL REVENUE REQUIREMENTS Y  
 8 = COMPRESSED PRINTOUT FOR REVENUE REQUIREMENTS N  
 99 = EXIT PROGRAM

ENTER A NUMBER FROM THE MENU

?

Fig. 3.4. Menu for fixed charge rate routine in integrated program

year revenue requirement schedule is to be printed in the output. Since this schedule is not available for screen output, items 7 and 8 do not appear in the menu if the user has selected the screen as the output destination. All other menu items should be self-explanatory. The default values for items 1-6 are the values recommended in the NECDB<sup>5</sup> for the type of plant, seen in the main menu of MAINPWR. Entering a 0 causes intermediate output from the fixed charge rate routine to be printed.

The O&M routine is the next program in the series. If a nuclear plant has been specified by the user, control is transferred to program NUCLOM. If a coal plant has been specified, control is transferred to program COALOM.

The menu for nuclear O&M costs routine within the integrated program is shown in Fig. 3.5. It is a simpler menu than the stand-alone NUCLOM code. Item 1 allows the user to use the default general escalation rate, input a general escalation rate, or input separate escalation rates. All of these escalation rates include inflation. The user is cautioned that the values of the salaries in item 2 must be in constant dollars of the base year for the cost model. This cost model is item 3; the base year is item 4. The cost models are described in Chap. 2. The base year for all the cost models contained in this package is 1987. Therefore, unless new models are added, the user should always use 1987

## Menu for Nuclear O&amp;M Costs routine

```

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:
0 = RUN CASE, DATA ENTRY COMPLETE
1 = ESCALATION RATE (fraction)          .05
2 = AVERAGE ONSITE STAFF COST          36000
    before payroll taxes and
    insurance in 1987 $
    AVERAGE OFFSITE STAFF COST          51000
    before payroll taxes and
    insurance in 1987 $
3 = COST MODEL                          PWRBE
4 = BASE YEAR FOR FOR COST MODEL        1987
99 = EXIT PROGRAM
ENTER A NUMBER FROM THE MENU
?
```

Fig. 3.5. Menu for nuclear O&amp;M cost routine in integrated program

for item 4 and the staff costs in item 2 should always be in 1987 dollars.

NUCLOM's coal counterpart is program COALOM. The menu for the fossil fuel O&M cost routine, shown in Fig. 3.6, is a simplified version of the menu of program COALOM. Item 1 is the name of the O&M cost model; the available cost models are described in Chap. 2. Entering a 1 will cause a list of possible models to be displayed. Item 2 is the escalation rate of O&M costs including inflation. Item 5 is the base year for the O&M cost model in item 1. As in the nuclear case, all of the coal O&M models contained in this package are based on 1987 prices, so unless other models are added, 1987 should always be used for item 5. The other menu items should be self-explanatory.

The user should take care to avoid confusing the reference year for constant dollars and the base year for costs. The base year for costs is the year in which the costs, which serve as input, are expressed. The reference year for constant dollars is the year in which the user wishes the output to be expressed.

A menu entry of 0 for either COALOM or NUCLOM causes the O&M portion to be executed and the intermediate output to be printed. Control is then transferred to the appropriate fuel cost routine; NUCLOM branches to NFUEL while COALOM branches to COALCOST.

The menu for the nuclear fuel cycle cost routine, a derivative of the menu for NFUEL, is shown in Fig. 3.7. Item 1 is the name of the

## Menu for Coal O&amp;M costs routine

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE  
 1 = O AND M COST MODEL (PLANT TYPE): COALWET  
 2 = ESCALATION RATE (fraction) .05  
 3 = PLANT NET HEAT RATE, BTU/KWH(e) 9900  
 4 = SULFUR (fraction) .035  
     ASH (fraction) .116  
     HEATING VALUE (BTU/lb) 11500  
 5 = REFERENCE YEAR FOR COST FIGURES 1987  
 99 = EXIT PROGRAM

ENTER A NUMBER FROM THE MENU

?

Fig. 3.6. Menu for coal-fired O&M cost routine in integrated program

## Menu for Nuclear Fuel Cycle Costs routine

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE  
 1 = MASS BALANCE SET NAME PWREXB  
 2 = TAX DEPRECIATION OPTION 1  
 3 = RECYCLE DISCHARGE FUEL Y  
 4 = OUTPUT COSTS BY YEAR AND BATCH N  
 5 = GO TO PRICE DATA MENU  
 6 = GO TO LEAD/LAG TIME MENU  
 7 = GO TO PROCESS LOSS MENU  
 8 = PLUTONIUM TAX TREATMENT OPTION 1  
 99 = EXIT PROGRAM

ENTER A NUMBER FROM THE MENU

?

Fig. 3.7. Menu for nuclear fuel cost routine in integrated program

mass balance set. Entering a 1 will cause a list of possible mass balance sets to be displayed. These data sets are described in Chap. 2. The base year for the cost data can be accessed by entering a 5 which causes the price data menu to appear. Each of the menu items, including the sub-menus, is described in Chap. 2.

The menu for the fossil fuel cost routine, shown in Fig. 3.8, is a shortened version of the menu for program COALCOST. Item 1 is the price of coal given in constant dollars of the base year shown in item 3. Item 2 is the annual escalation rate of the price of coal including inflation.

## Menu for Fossil Fuel Costs routine

THE AVAILABLE MENU OPTIONS AND THEIR VALUES AT THIS TIME ARE:

0 = RUN CASE, DATA ENTRY COMPLETE	
1 = PRICE OF COAL IN DOLLARS PER MILLION BTU	1.55
2 = COAL PRICE ESCALATION RATE (fraction)	0.0626
3 = REFERENCE YEAR FOR PRICE OF COAL	1987.
99 = EXIT PROGRAM	

ENTER A NUMBER FROM THE MENU

?

Fig. 3.8. Menu for coal cost routine in integrated program

A menu selection of 0 for either of the fuel cost routines will cause the fuel cost portion to be executed and output to be printed. This printing is the last stage of intermediate output.

The final output begins by giving a summary of key parameters calculated during the different routines. This summary includes the values of the total plant capital investment cost and the fraction of the total capital investment which is tax deductible (both from the capital investment cost routine, PLANTCAP), the fixed charge rate from the fixed charge rate routine (FCRATE), the levelized O&M cost from the O&M cost routine (NUCLOM or COALOM), and the levelized fuel cost from the fuel cost routine (NFUEL or COALCOST). After the summary, the final results showing the total levelized power generation costs are printed.

In summary, the integrated program MAINPWR.BAS allows for two modes of operation. In one mode, the individual codes as detailed in Chap. 2 are accessed and executed in order to calculate one aspect of the total levelized power generation cost, such as capital investment cost or the fixed charge rate. In the other mode, by automatically branching to the individual codes, the integrated code allows the user to calculate total levelized power generation costs in both nominal and constant dollars without prior knowledge of levelized values of plant capital investment costs, fuel costs, O&M costs, and decommissioning costs.

#### 4. EXAMPLE CALCULATIONS

This section is intended to demonstrate the operation of each of the three modes of operation of the code package; to this end three examples will be presented. The first example, which demonstrates utilizing the integrated code MAINPWR to automatically link all necessary codes, is for the NECDB reference PWR power plant. The second example, which demonstrates utilizing MAINPWR to run the individual codes on a separate basis, is for the NECDB reference coal-fired power plant. The last example calculates the reference PWR power plant again, this time using the individual codes without MAINPWR.

It is assumed that the user has an IBM compatible personal computer with advanced basic (BASICA or GWBASIC) on the disk operating system and is familiar with loading and operating BASIC programs.

##### 4.1 1100 MWe Nuclear (PWR) Power Plant

The calculation of levelized power generation costs for the reference PWR Power Plant can be accomplished by running program MAINPWR, either from DOS or BASIC (see Chap. 1). After the operating drive has been selected, the main menu (see Fig. 3.1) appears on the screen. The default value for item 6, the plant type, is nuclear, so no changes need to be made in item 6. Item 1 is selected to calculate the total levelized power generation costs. The response to the prompt for run identification, which may be left blank, is in this case "Nuclear PWR Example." Since this example will demonstrate using the integrated code to automatically link the individual codes, a Y, for yes, is answered when the prompt "Do you wish to calculate these values using the integrated program?" is displayed.

The default values for each stage of the calculation have been set to the values of the reference PWR plant in the NECDB. Therefore, at the menu stage of each routine, all that is required of the user is to enter a 0 to signify that the data are correct and that the execution of that stage should begin.

Intermediate output is printed after each routine has been completed. Each stage of this output, other than the first stage, prints the input parameters that are unique to the particular routine and then gives the results of the routine. The first set of output, shown in Fig. 4.1, is a summary of the general input values from the levelization routine. The capital investment cost summary (Fig. 4.2) is then printed. The plant capital investment cost in nominal dollars and the tax deductible fraction of the total capital will be used by the code at a later time when necessary. A summary of the fixed charge rate results (Fig. 4.3) is then printed. The year-by-year schedule of revenue requirements could have been deleted from the output by changing the default value of item 7 in the fixed charge rate menu (see Fig. 3.4) from a Y to a N. The nominal fixed charge rate will be used later by the code. A summary of the annual non-fuel O&M costs (Fig. 4.4) is next. Note that the values in this output are given in constant dollars. The code uses the total levelized O&M cost (including A & G) at a later time. A summary of the nuclear fuel cycle cost, shown in Fig. 4.5, is then printed. The levelized fuel cost in constant dollars

LEVELIZED POWER GENERATION COST CODE

VERSION 09-01-1988  
 RUN DATE 09-20-1988

Summary of General Input Parameters

Nuclear PWR Example		
YEAR OF FIRST COMMERCIAL OPERATION		2000.
RATING PER UNIT (MWe)		1100.
UNITS PER PLANT		1.
CAPACITY FACTOR		0.75
ANALYSIS LIFE (years)		30.
GNP INFLATION RATE		0.050
EFFECTIVE INCOME TAX RATE		0.3664
CAPITALIZATION		
	FRACTION	RATE
DEBT	0.500	0.097
PREFERRED STOCK	0.100	0.090
COMMON EQUITY	0.400	0.140
EFFECTIVE COST OF MONEY		0.0957
CONSTANT DOLLAR LEVELIZED COST YEAR		1987.

Fig. 4.1. General input parameters for reference PWR/BE power plant

Capital Investment Cost Summary  
Nuclear PWR Example

PWRBE12 POWER PLANT		
YEAR OF STEAM SUPPLY SYSTEM ORDER		1992.00
YEAR OF CONSTRUCTION PERMIT		1994.00
YEAR OF COMMERCIAL OPERATION		2000.00
COST OF MONEY DURING CONSTRUCTION (AFUDC RATE)		.1135
ESCALATION RATE (fraction/year)		.0500
CONTINGENCY (fraction)		.1000
PLANT LOCATION		CHICAGO
-----		
DIRECT COSTS (\$MILLIONS 1987 DOLLARS)		
20 LAND	5.	
21 STRUCTURES	184.	
22 REACTOR PLANT	290.	
23 TURBINE PLANT	213.	
24 ELECTRIC PLANT	76.	
25 MISC PLANT	44.	
26 MAIN COND HEAT REJ	46.	
SUBTOTAL DIRECTS		858.
INDIRECT COSTS		
91 CONSTR SERVICES	205.	
92 HOME OFFICE ENGRG	211.	
93 FIELD OFFICE	109.	
94 OWNER COSTS	138.	
SUBTOTAL INDIRECTS		663.
SUBTOTAL DIRECTS AND INDIRECTS		1521.
CONTINGENCY ALLOWANCE		152.
TOTAL OVERNIGHT COSTS BEFORE ESCALATION		1673.
ESCALATION BEFORE STEAM SUPPLY ORDER		462.
ESCALATION AFTER STEAM SUPPLY ORDER		473.
TOTAL ESCALATED DIRECT AND INDIRECT COSTS		2609.
TOTAL INTEREST DURING CONSTRUCTION		1403.
TOTAL CAPITAL INVESTMENT		4012.
PLANT CAPITAL INVESTMENT COST		
NOMINAL DOLLARS (3647.\$/KWe)		4012.
CONSTANT 1987 DOLLARS (1934.\$/KWe)		2128.
TAX DEDUCTIBLE FRACTION IN TOTAL CAPITAL =		.7997

Fig. 4.2. Capital investment cost summary for reference PWR/BE power plant

is used later by the code. The nuclear fuel cycle output is the last stage of intermediate output.

A summary is printed next, showing all of the values that the code is using to compute the total levelized power generation costs. The final results are then printed in both nominal and constant dollars as shown in (Fig. 4.6).

Summary of Fixed Charge Rate  
Nuclear PWR Example

PROJECT LIFE (years) 40.  
 INTERIM REPLACEMENT ESCALATION RATE (fraction) 0.05  
 INITIAL CAPITAL INVESTMENT AT STARTUP, MILLION \$ 4012.  
 TAX DEDUCTABLE FRACTION OF TOTAL CAPITAL INVEST. .7997  
 PROPERTY TAX RATE (fraction/year) .02  
 INTERIM REPLACEMENT RATE (fraction/year) 0.005  
 NORMALIZED ACCOUNTING  
 ACRS CLASS: 15-YEAR PROPERTY

ANNUAL REVENUE REQUIREMENTS (MILLION DOLLARS)

YEAR	RATE BASE	RETURN ON CAP	BOOK DEPR	TAX DEPR	I TAX CURR	I TAX DEFER	PROP TAX	INTRM REPL	REVENUE REQUIR. (MILLION \$)		POWER COST (Cents/KWhe)	
									NOMNL \$	1987. \$	NOMNL \$	1987. \$
2000.	4012.0	455.4	100.3	160.4	133.0	29.4	80.2	21.1	819.4	413.8	11.34	5.73
2001.	3882.3	440.6	100.3	304.8	75.3	82.3	80.2	22.1	800.8	385.2	11.08	5.33
2002.	3699.7	419.9	100.3	274.3	79.6	71.1	80.2	23.2	774.4	354.7	10.71	4.91
2003.	3528.3	400.5	100.3	247.0	83.1	61.1	80.2	24.4	749.6	327.1	10.37	4.53
2004.	3366.9	382.1	100.3	222.3	86.1	52.1	80.2	25.6	726.5	301.9	10.05	4.18
2005.	3214.5	364.8	100.3	199.9	88.6	43.8	80.2	26.9	704.7	278.9	9.75	3.86
2006.	3070.3	348.5	100.3	189.5	87.0	40.0	80.2	28.2	684.3	257.9	9.47	3.57
2007.	2930.0	332.6	100.3	189.5	81.7	40.0	80.2	29.6	664.5	238.5	9.19	3.30
2008.	2789.7	316.6	100.3	189.5	76.5	40.0	80.2	31.1	644.8	220.4	8.92	3.05
2009.	2649.4	300.7	100.3	189.5	71.2	40.0	80.2	32.7	625.1	203.5	8.65	2.82
2010.	2509.0	284.8	100.3	189.5	65.9	40.0	80.2	34.3	605.6	187.8	8.38	2.60
2011.	2368.7	268.8	100.3	189.5	60.6	40.0	80.2	36.0	586.1	173.1	8.11	2.39
2012.	2228.4	252.9	100.3	189.5	55.4	40.0	80.2	37.8	566.7	159.4	7.84	2.21
2013.	2088.1	237.0	100.3	189.5	50.1	40.0	80.2	39.7	547.4	146.6	7.57	2.03
2014.	1947.7	221.1	100.3	189.5	44.8	40.0	80.2	41.7	528.1	134.7	7.31	1.86
2015.	1807.4	205.1	100.3	94.5	74.3	5.2	80.2	43.8	509.0	123.7	7.04	1.71
2016.	1701.9	193.2	100.3	0.0	105.0	-29.4	80.2	46.0	495.3	114.6	6.85	1.59
2017.	1631.0	185.1	100.3	0.0	102.3	-29.4	80.2	48.3	486.9	107.3	6.74	1.48
2018.	1560.0	177.1	100.3	0.0	99.6	-29.4	80.2	50.7	478.6	100.4	6.62	1.39
2019.	1489.1	169.0	100.3	0.0	97.0	-29.4	80.2	53.2	470.4	94.0	6.51	1.30
2020.	1418.2	161.0	100.3	0.0	94.3	-29.4	80.2	55.9	462.3	88.0	6.40	1.22
2021.	1347.3	152.9	100.3	0.0	91.6	-29.4	80.2	58.7	454.4	82.4	6.29	1.14
2022.	1276.4	144.9	100.3	0.0	89.0	-29.4	80.2	61.6	446.6	77.1	6.18	1.07
2023.	1205.5	136.8	100.3	0.0	86.3	-29.4	80.2	64.7	439.0	72.2	6.07	1.00
2024.	1134.6	128.8	100.3	0.0	83.7	-29.4	80.2	67.9	431.5	67.6	5.97	0.94
2025.	1063.7	120.7	100.3	0.0	81.0	-29.4	80.2	71.3	424.2	63.3	5.87	0.88
2026.	992.8	112.7	100.3	0.0	78.3	-29.4	80.2	74.9	417.0	59.2	5.77	0.82
2027.	921.8	104.6	100.3	0.0	75.7	-29.4	80.2	78.6	410.1	55.5	5.67	0.77
2028.	850.9	96.6	100.3	0.0	73.0	-29.4	80.2	82.6	403.3	52.0	5.58	0.72
2029.	780.0	88.5	100.3	0.0	70.3	-29.4	80.2	86.7	396.7	48.7	5.49	0.67

SUM OF PRESENT WORTH OF REVENUE REQUIREMENTS AT STARTUP = 6394.

	FIXED CHARGE RATE (FRACTION)	LEVELIZED POWER COST (Cents/KWhe)
NOMINAL DOLLARS	= .1631	9.05
1987 DOLLARS	= .0962	2.83

Fig. 4.3. Fixed charge rate summary for reference PWR/BE power plant

Summary of Annual Nonfuel O&M Costs  
Nuclear PWR Example

O&M COST MODEL NAME		PWRBE
ESCALATION RATE (fraction/year)		0.05
AVERAGE ONSITE STAFF COST 1987 \$/year before payroll taxes & insurance		36000.
AVERAGE OFFSITE STAFF COST 1987 \$/year before payroll taxes, insurance, and overhead		51000.
BASE YEAR FOR COST MODEL		1987.
POWER GENERATION COSTS ( 1987 \$million/year)		
-----		
ONSITE STAFF ( 520. persons)		20.59
MAINTENANCE MATERIALS		6.24
FIXED	4.75	
VARIABLE	1.48	
SUPPLIES AND EXPENSES		10.29
FIXED	8.13	
VARIABLE	2.17	
OFFSITE TECHNICAL SUPPORT ( 100. persons)		8.67
-----		
SUBTOTAL, DIRECT O&M COSTS		45.79
FIXED	42.14	
VARIABLE	3.65	
ADMINISTRATIVE AND GENERAL COSTS		20.37
PENSIONS AND BENEFITS	5.96	
NUCLEAR REGULATORY FEES	1.25	
LIABILITY INSURANCE	0.60	
PROPERTY INSURANCE	4.10	
REPLACEMENT POWER INSURANCE	1.60	
OTHER GENERAL EXPENSES	6.87	
-----		
TOTAL NONFUEL O&M COSTS		66.17
FIXED	62.5	
VARIABLE	3.7	
-----		
mills/kWh (without A&G, 1987 \$)		6.33
mills/kWh (with A&G, 1987 \$)		9.15

Fig. 4.4. Nonfuel O&M cost summary for reference PWR/BE power plant

Summary of Nuclear Fuel Costs  
Nuclear PWR Example

MASS BALANCE SET USED	PWREXB
LAG TIME (years)	0.5
NO CREDIT FOR DISCHARGED FISSILE	
BASE YEAR FOR COST DATA	1987.
REFERENCE YEAR PRICES	
U308 (\$/lb)	23.00
CONVERSION (\$/kg)	8.00
ENRICHMENT (\$/SWU)	109.00
PLUTONIUM (\$/gm)	0.00
FABRICATION (\$/Kg)	220.00
BACK END (reprocessing) (\$/kg)	0.00
WASTE DISPOSAL (mills/kwh)	1.00
PRICE ESCALATION RATES	
U308	.071
CONVERSION	.061
ENRICHMENT	.032
PLUTONIUM	.050
FABRICATION	.050
BACK END (reprocessing)	.050
WASTE DISPOSAL	.050

-----

LEVELIZED COSTS BY YEAR AND BATCH, Mills/kWh

BATCH	BATCH COST	YEAR	YEARLY COST
1	28.96	2000	15.08
2	16.13	2001	11.83
3	11.90	2002	11.37
4	9.82	2003	12.04
5	8.59	2004	13.30
6	12.70	2005	14.99
7	13.83	2006	16.04
8	15.28	2007	17.07
9	16.09	2008	18.00
10	17.03	2009	18.99
11	17.99	2010	20.01
12	18.94	2011	21.08
13	19.95	2012	22.21
14	21.02	2013	23.41
15	22.14	2014	24.68
16	23.34	2015	26.02
17	24.60	2016	27.44
18	25.94	2017	28.95
19	27.36	2018	30.54
20	28.86	2019	32.23
21	30.45	2020	34.03
22	32.13	2021	35.93
23	33.92	2022	37.94
24	35.81	2023	40.08
25	37.82	2024	42.35
26	39.95	2025	44.76
27	42.21	2026	49.06
28	44.61	2027	56.74
29	47.15	2028	71.58
30	49.85	2029	108.71
31	61.46	2030	0.00
32	80.65	2031	0.00
33	118.80	2032	0.00
34	232.79	2033	0.00

Fig. 4.5. Fuel cost summary for reference PWR/BE power plant

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 LEVELIZED FUEL CYCLE COSTS, MILLS/KWH
 

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	NOMINAL DOLLARS	1987 DOLLARS
URANIUM PURCHASE	8.399	2.627
CONVERSION PURCHASE	0.866	0.271
ENRICHMENT PURCHASE	5.485	1.716
PLUTONIUM PURCHASE	0.000	0.000
FABRICATION	2.488	0.778
URANIUM CREDIT	0.000	0.000
CONVERSION CREDIT	0.000	0.000
ENRICHMENT CREDIT	0.000	0.000
PLUTONIUM SALES	0.000	0.000
REPROCESSING	0.000	0.000
WASTE DISPOSAL	3.196	1.000
TOTAL	20.433	6.391

Fig. 4.5 (continued)

 Input for Levelized Power Generation Costs  
 Nuclear PWR Example

FIXED CHARGE RATE	0.1631
PLANT INVESTMENT COST (year 2000 \$millions)	4012.
DECOMMISSIONING FUND INTEREST RATE	0.070
DECOMMISSIONING COST (1987 \$millions)	145.
LEVELIZED O&M COST (1987 mills/kWh)	9.15
LEVELIZED FUEL COST (1987 mills/kWh)	6.39

## F I N A L R E S U L T S

## LEVELIZED POWER GENERATION COSTS (mills/kWh)

	1987 \$	NOMINAL \$
CAPITAL	28.31	90.5
O&M	9.15	29.3
FUEL	6.39	20.4
DECOM.	0.54	1.7
	-----	-----
	44.4	141.9

Fig. 4.6. Total levelized power generation cost for PWR/BE power plant

#### 4.2 550 MWe Coal-Fired Power Plant

Levelized power generation costs for the reference coal-fired power plant can be calculated by running the following sequence of programs:

1. PLANTCAP
2. FCRATE

3. COALOM
4. COALCOST
5. LEVEL

These codes can be accessed from the main menu of program MAINPWR by selecting options 2, 3, 4, 5, and 1, respectively. After completing each code, a "99" should be entered at the menu level of the particular individual code to return the user to the main menu of MAINPWR.

To start the example calculation, program MAINPWR should be executed either directly from DOS or through the BASIC interpreter (see Chapter 1). The operating disk drive then must be specified. The main menu of MAINPWR will then appear; the user should enter a 6, followed by a C in order to change the plant type to a coal-fired plant.

PLANTCAP: Selection of menu item 2 will allow the capital investment cost to be calculated using PLANTCAP. When the menu for PLANTCAP appears (see Fig. 2.1), all of the default values will be set for the reference coal-fired case. A 0 should then be entered, along with a run identification if the default values are desired by the user. Output from PLANTCAP, as seen in Fig. 4.7, shows both the input parameters and the results of the calculations. The plant capital investment cost in millions of nominal dollars (2887) will be used as input to both LEVEL and FCRATE. FCRATE will also require the tax deductible fraction of the total capital investment (.8559). Entering a "99" will cause the main menu of MAINPWR to appear on the screen.

FCRATE: Selection of item 3 of the main menu will cause FCRATE to be selected. In FCRATE, items 11 and 12 (see Fig. 2.9), the initial capital investment cost and the tax deductible fraction of the total capital investment, are from the output of PLANTCAP; these values are the default values. Item 5, the tax depreciation schedule (schedule 3: 20-year property) is correct for the coal-fired example. Note that item 18 is the total plant power level (in this case: 2 units  $\times$  550 MWe/unit = 1100 MWe). All of the data are correct for the example, so a 0 should be entered to begin execution.

Output from program FCRATE is printed, as shown in Fig. 4.8. The year-by-year revenue requirements could have been omitted by changing

## CAPITAL COST ESTIMATE

VERSION 09-01-1988  
 RUN DATE 09-20-1988

Coal-fired Example  
 NECDB-1987 COST BASIS  
 COALS POWER PLANT

YEAR OF STEAM SUPPLY SYSTEM ORDER	1994.00
YEAR OF CONSTRUCTION PERMIT	1995.75
YEAR OF COMMERCIAL OPERATION	2000.00
YEAR OF CONSTANT DOLLAR OUTPUT	1987.
COST OF MONEY DURING CONSTRUCTION (AFUDC RATE)	.1135
ESCALATION RATE (fraction/year)	.0500
GENERAL INFLATION RATE (fraction)	.050
CONTINGENCY (fraction)	.1000
NET RATING PER UNIT (MWe)	550.
NUMBER OF UNITS AT SITE	2
PLANT LOCATION	CHICAGO

  

DIRECT COSTS (\$MILLIONS 1987 DOLLARS)	
20 LAND	5.
21 STRUCTURES	108.
22 REACTOR PLANT	430.
23 TURBINE PLANT	199.
24 ELECTRIC PLANT	67.
25 MISC PLANT	35.
26 MAIN COND HEAT REJ	42.
SUBTOTAL DIRECTS	887.
INDIRECT COSTS	
91 CONSTR SERVICES	108.
92 HOME OFFICE ENGRG	43.
93 FIELD OFFICE	40.
94 OWNER COSTS	108.
SUBTOTAL INDIRECTS	298.
SUBTOTAL DIRECTS AND INDIRECTS	1185.
CONTINGENCY ALLOWANCE	118.
TOTAL OVERNIGHT COSTS BEFORE ESCALATION	1303.
ESCALATION BEFORE STEAM SUPPLY ORDER	530.
ESCALATION AFTER STEAM SUPPLY ORDER	327.
TOTAL ESCALATED DIRECT AND INDIRECT COSTS	2160.
TOTAL INTEREST DURING CONSTRUCTION	726.
TOTAL CAPITAL INVESTMENT	2887.
PLANT CAPITAL INVESTMENT COST	
NOMINAL DOLLARS (2624.\$/KWe)	2887.
CONSTANT 1987 DOLLARS (1392.\$/KWe)	1531.
TAX DEDUCTIBLE FRACTION IN TOTAL CAPITAL =	.8559

Fig. 4.7. Capital investment cost for reference coal-fired power plant (PLANTCAP)

the default value of item 7 in the menu from a Y to a N. The nominal dollar fixed charge rate (.1651) will be used as input to LEVEL. A 99 entered at the menu level than returns the user to the main menu of MAINPWR.

COALOM: Entering a 4 at the main menu of MAINPWR causes COALOM to be selected. All of the default data in the menu (see Fig. 2.3) is

FIXED CHARGE RATE

VERSION 05-13-1988  
 RUN DATE 09-20-1988

Coal-fired Example

INPUT DATA

PROJECT LIFE (years) 40.  
 LEVELIZING PERIOD (years) 30.  
 INFLATION RATE 0.05  
 INTERIM REPLACEMENT ESCALATION RATE (fraction) 0.05  
 EFFECTIVE INCOME TAX RATE .3664  
 INITIAL CAPITAL INVESTMENT AT STARTUP, MILLION \$ 2887.  
 TAX DEDUCTIBLE FRACTION OF TOTAL CAPITAL INVEST. .8559  
 INTEREST RATE ON DEBT .0970  
 RETURN ON PREFERRED STOCK .0900  
 RETURN ON COMMON STOCK .1400  
 DEBT FRACTION .5000  
 PREFERRED STOCK FRACTION .1000  
 COMMON STOCK FRACTION .4000  
 PROPERTY TAX RATE (fraction/year) .02  
 INTERIM REPLACEMENT RATE (fraction/year) 0.005  
 START OF OPERATION (YEAR) 2000.00  
 REFERENCE YEAR FOR CONSTANT DOLLARS 1987.00  
 REACTOR POWER LEVEL, MWe 1100.  
 LIFETIME AVERAGE CAPACITY FACTOR 0.75  
 NORMALIZED ACCOUNTING  
 ACRS CLASS: 20-YEAR PUBLIC UTILITY PROPERTY

ANNUAL REVENUE REQUIREMENTS (MILLION DOLLARS)

YEAR	RATE BASE	RETURN ON CAP	BOOK DEPR	TAX DEPR	I TAX CURR	I TAX DEFER	PROP TAX	INTRM REPL	REVENUE REQUIR. (MILLION \$)		POWER COST (Cents/KWhe)	
									NOMNL \$	1987. \$	NOMNL \$	1987. \$
2000.	2887.0	327.7	72.2	92.7	103.2	11.3	57.7	15.2	587.3	296.6	8.13	4.10
2001.	2803.5	318.2	72.2	178.4	68.7	42.7	57.7	15.9	575.4	276.8	7.96	3.83
2002.	2688.6	305.2	72.2	165.1	69.2	37.8	57.7	16.7	558.9	256.0	7.73	3.54
2003.	2578.6	292.7	72.2	152.7	69.6	33.3	57.7	17.5	543.1	236.9	7.51	3.28
2004.	2473.1	280.7	72.2	141.1	69.9	29.1	57.7	18.4	528.0	219.4	7.31	3.04
2005.	2371.9	269.2	72.2	130.5	70.0	25.2	57.7	19.3	513.6	203.3	7.11	2.81
2006.	2274.5	258.2	72.2	120.8	69.9	21.6	57.7	20.3	499.9	188.4	6.92	2.61
2007.	2180.7	247.5	72.2	111.7	69.7	18.3	57.7	21.3	486.7	174.7	6.73	2.42
2008.	2090.2	237.2	72.2	110.2	66.8	17.7	57.7	22.4	474.1	162.1	6.56	2.24
2009.	2000.3	227.0	72.2	110.2	63.5	17.7	57.7	23.5	461.7	150.3	6.39	2.08
2010.	1910.4	216.8	72.2	110.2	60.1	17.7	57.7	24.7	449.3	139.3	6.22	1.93
2011.	1820.5	206.6	72.2	110.2	56.7	17.7	57.7	25.9	436.9	129.0	6.05	1.79
2012.	1730.5	196.4	72.2	110.2	53.3	17.7	57.7	27.2	424.6	119.4	5.88	1.65
2013.	1640.6	186.2	72.2	110.2	49.9	17.7	57.7	28.6	412.4	110.5	5.71	1.53
2014.	1550.7	176.0	72.2	110.2	46.6	17.7	57.7	30.0	400.2	102.1	5.54	1.41
2015.	1460.8	165.8	72.2	110.2	43.2	17.7	57.7	31.5	388.1	94.3	5.37	1.30
2016.	1370.9	155.6	72.2	110.2	39.8	17.7	57.7	33.1	376.1	87.0	5.20	1.20
2017.	1280.9	145.4	72.2	110.2	36.4	17.7	57.7	34.7	364.2	80.3	5.04	1.11
2018.	1191.0	135.2	72.2	110.2	33.0	17.7	57.7	36.5	352.4	73.9	4.88	1.02
2019.	1101.1	125.0	72.2	110.2	29.7	17.7	57.7	38.3	340.6	68.1	4.71	0.94
2020.	1011.2	114.8	72.2	55.6	46.3	-2.3	57.7	40.2	328.9	62.6	4.55	0.87
2021.	941.3	106.8	72.2	0.0	64.0	-22.6	57.7	42.2	320.4	58.1	4.43	0.80
2022.	891.7	101.2	72.2	0.0	62.2	-22.6	57.7	44.3	315.0	54.4	4.36	0.75
2023.	842.2	95.6	72.2	0.0	60.3	-22.6	57.7	46.6	309.7	50.9	4.29	0.70
2024.	792.7	90.0	72.2	0.0	58.4	-22.6	57.7	48.9	304.6	47.7	4.21	0.66
2025.	743.1	84.3	72.2	0.0	56.6	-22.6	57.7	51.3	299.5	44.7	4.14	0.62
2026.	693.6	78.7	72.2	0.0	54.7	-22.6	57.7	53.9	294.6	41.8	4.08	0.58
2027.	644.0	73.1	72.2	0.0	52.9	-22.6	57.7	56.6	289.8	39.2	4.01	0.54
2028.	594.5	67.5	72.2	0.0	51.0	-22.6	57.7	59.4	285.2	36.7	3.95	0.51
2029.	544.9	61.9	72.2	0.0	49.1	-22.6	57.7	62.4	280.7	34.4	3.88	0.48

SUM OF PRESENT WORTH OF REVENUE REQUIREMENTS AT STARTUP = 4660.

	FIXED CHARGE RATE (FRACTION)	LEVELIZED POWER COST (Cents/KWhe)
NOMINAL DOLLARS =	.1651	6.60
1987 DOLLARS =	.0974	2.06

Fig. 4.8. Fixed charge rate calculation output for reference coal-fired power plant (FCRATE)

appropriate for the example, so a 0 should be entered to run COALOM. The output from COALOM, shown in Fig. 4.9, is then printed. All of the values in the output are in constant dollars. The total levelized non-fuel O&M costs with A & G in mills/kWh (5.92) will be needed by LEVEL. Entering a 99 causes the main menu for MAINPWR to appear.

SUMMARY OF ANNUAL NONFUEL O&M COSTS  
COAL-FIRED POWER PLANTS

VERSION 06-30-1988  
RUN DATE 09-20-1988

Coal-fired Example	
COST DATA MODEL USED FOR ANALYSIS	COALWET
NET RATING OF EACH UNIT (MWe)	550.
NUMBER OF UNITS PER PLANT	2.
BASE LOAD CAPACITY FACTOR	.75
ESCALATION RATE (fraction/year)	0.05
INFLATION RATE (fraction/year)	0.050
SULFUR (decimal)	.035
ASH (decimal)	.116
HEATING VALUE (BTU/lb)	11500.
THERMAL INPUT PER UNIT (Mwt)	1596.
PLANT NET HEAT RATE (BTU/kWh)	9900.
PLANT NET EFFICIENCY (decimal)	.345
YEAR OF STARTUP	2000.
REFERENCE YEAR FOR COST ESTIMATES	1987.
REFERENCE YEAR FOR CONSTANT DOLLARS	1987.
ANNUAL NET GENERATION (million kWh)	7232.
-----	
DIRECT COSTS ( 1987 \$million/year)	
STAFF ONSITE (295. PERSONS AT \$30888.)	9.11
MAINTENANCE MATERIAL	4.93
FIXED	3.78
VARIABLE	1.14
SUPPLIES AND EXPENSES	19.50
FIXED	5.30
VARIABLE - PLANT	1.05
- LIMESTONE	6.28
- ASH, FGD SLUDGE	6.88
OFFSITE SUPPORT SERVICES	1.07
INDIRECT COSTS ( 1987 \$million/year)	
ADMINISTRATIVE AND GENERAL	8.23
FRINGE BENEFITS	2.54
PROPERTY INSURANCE	0.50
OTHER AG	5.19
COSTS ( 1987 \$million/year)	
TOTAL FIXED DIRECTS AND INDIRECTS	27.5
TOTAL VARIABLE DIRECTS AND INDIRECTS	15.3
TOTAL NONFUEL OM	42.8
UNIT COSTS (mills/kWh)	
FIXED DIRECTS AND INDIRECTS	3.80
VARIABLE DIRECTS AND INDIRECTS	2.12
TOTAL NONFUEL OM (w/o AG 1987 dollars)	4.78
TOTAL NONFUEL OM (w/ AG 1987 dollars)	5.92

Fig. 4.9. Nonfuel O&M costs for reference coal-fired power plant with wet limestone scrubber (COALOM)

COALCOST: Entering a 5 at this point causes COALCOST to be selected. The default values are correct for the example case, so a 0 should be input to execute the program. The key parameter in the output of COALCOST (Fig. 4.10) is the levelized cost of coal in constant dollars (20.88 mills/kWh) that is used in LEVEL. Entering a 99 causes the main menu from MAINPWR to appear.

LEVEL: LEVEL can be accessed by entering a 1 at the main menu of MAINPWR. The user may then input a run identification or a null line. The following prompt then appears:

The calculation of the total levelized power generation costs requires that the levelized values of capital costs, fuel costs, and O&M costs, as well as the fixed charge rate, be known. It is possible to generate this necessary data using this program, or if these values are already known, they may be inputted separately.

Do you wish to calculate the data using the integrated program?

Y = Yes

N = No

Select the appropriate response.

?

Since the user does already know the values in question, an "N" should be input in response to the prompt. The menu for program LEVEL

```

L E V E L I Z E D   C O A L   C O S T
      RUN DATE 09-20-1988

INPUT DATA
-----
Coal-fired Example
PRICE OF COAL IN DOLLARS PER MILLION BTU      1.55
REFERENCE YEAR FOR PRICE OF COAL              1987
REFERENCE YEAR FOR CONSTANT DOLLARS           1987
YEAR OF PLANT STARTUP                          2000
PLANT LIFE (years)                             30
GNP INFLATION RATE                             0.050
COAL PRICE ESCALATION RATE (fraction)          0.0626
EFFECTIVE COST OF MONEY                         0.0957
PLANT NET HEAT RATE (Btu/kWh)                  9900
-----

LEVELIZED COST OF COAL                          mills/kWh
CONSTANT 1987 DOLLARS                           20.88
NOMINAL DOLLARS                                 66.75

```

Fig. 4.10. Levelized coal cost for reference coal-fired power plant (COALCOST)

then appears on the screen (see Fig. 2.11). Item 15, the plant type, has already been specified in the main menu of MAINPWR. Item 11 is the capital investment cost in millions of nominal dollars (2887) from PLANTCAP, item 12 is the fixed charge rate (.1651) from FCRATE, item 13 is the levelized O&M cost in constant dollar mills/kWh (5.92), and item 14 is the levelized coal cost in constant dollar mills/kWh (20.88). All of the data are correct for the example, so a 0 should be input. The final results are then printed as shown in Fig. 4.11.

LEVELIZED POWER GENERATION COST CODE

VERSION 09-01-1988  
RUN DATE 09-20-1988

Coal-fired Example  
PLANT TYPE COAL  
YEAR OF FIRST COMMERCIAL OPERATION 2000.  
RATING PER UNIT (MWe) 550.  
UNITS PER PLANT 2.  
CAPACITY FACTOR 0.75  
ANALYSIS LIFE (years) 30.  
GNP INFLATION RATE 0.050  
EFFECTIVE INCOME TAX RATE 0.3664

CAPITALIZATION	FRACTION	RATE
DEBT	0.500	0.097
PREFERRED STOCK	0.100	0.090
COMMON EQUITY	0.400	0.140

EFFECTIVE COST OF MONEY 0.0957  
CONSTANT DOLLAR LEVELIZED COST YEAR 1987.  
FIXED CHARGE RATE 0.1651  
PLANT INVESTMENT COST (year 2000 \$millions) 2887.  
DECOMMISSIONING FUND INTEREST RATE 0.070  
DECOMMISSIONING COST (1987 \$millions) 25.  
LEVELIZED O&M COST (1987 mills/kWh) 5.92  
LEVELIZED FUEL COST (1987 mills/kWh) 20.88

LEVELIZED POWER GENERATION COSTS (mills/kWh)

	1987 \$	NOMINAL \$
CAPITAL	20.63	66.0
O&M	5.92	18.9
FUEL	20.88	66.8
DECOM.	0.09	0.3
	-----	-----
	47.5	151.9

Fig. 4.11. Levelized power generation costs for reference coal-fired power plant in midwest region (LEVEL)

#### 4.3 1100 MWe Nuclear (PWR) Power Plant

Power generation costs may also be calculated using the set of individual PC codes, outside of program MAINPWR. This section describes

the procedure for calculating power costs with the individual codes for the reference PWR plant. The following sequence of programs is executed:

1. PLANTCAP
2. FCRATE
3. NUCLOM
4. NFUEL
5. LEVEL

All of the default values in each program will be correct for the reference plant, so the user needs only to enter a 0 to signify that the data are correct in each program

PLANTCAP: The output from PLANTCAP is shown in Fig. 4.12. The total capital investment cost in millions of nominal dollars (4012) and the tax deductible fraction in total capital (.7997) will be used as input for FCRATE. The total capital investment cost will also be used by LEVEL.

FCRATE: Output from FCRATE, which consists of two pages, is shown in Fig. 4.13. The first page lists the input parameters. The second page begins with a tabulation of the annual revenue requirements. The sum of the present worth (to startup) of the revenue requirements is shown next followed by the constant and nominal dollar Fixed Charge Rates (FCR) and cost of power [cents/kWh(e)] attributable to the capital investment. The nominal dollar FCR (0.1631) is needed for input to the LEVEL program. Note that the year-by-year power costs in the last two columns of the revenue requirements table are for the capital investment portion only. The annual revenue requirements printout may be suppressed through menu Item 7, in which case the fixed charge rates will be printed on the first page of output.

NUCLOM: Output from NUCLOM, which consists of two pages, is shown in Fig. 4.14. The input data are listed on the first page. The second page give a breakdown of the costs in millions of dollars, and finally, the cost in mills/kWh(e) with and without A&G. The value for the total non-fuel O&M cost [9.15 mills/kWh(e)] is required as input to the LEVEL Program.

## C A P I T A L C O S T E S T I M A T E

VERSION 09-01-1988  
 RUN DATE 09-20-1988

NECDB-1987 COST BASIS		
PWRBE12 POWER PLANT		
YEAR OF STEAM SUPPLY SYSTEM ORDER		1992.00
YEAR OF CONSTRUCTION PERMIT		1994.00
YEAR OF COMMERCIAL OPERATION		2000.00
YEAR OF CONSTANT DOLLAR OUTPUT		1987.
COST OF MONEY DURING CONSTRUCTION (AFUDC RATE)		.1135
ESCALATION RATE (fraction/year)		.0500
GENERAL INFLATION RATE (fraction)		.050
CONTINGENCY (fraction)		.1000
NET RATING PER UNIT (MWe)		1100.
NUMBER OF UNITS AT SITE		1
PLANT LOCATION		CHICAGO
DIRECT COSTS (\$MILLIONS 1987 DOLLARS)		
20 LAND	5.	
21 STRUCTURES	184.	
22 REACTOR PLANT	290.	
23 TURBINE PLANT	213.	
24 ELECTRIC PLANT	76.	
25 MISC PLANT	44.	
26 MAIN COND HEAT REJ	46.	
SUBTOTAL DIRECTS		858.
INDIRECT COSTS		
91 CONSTR SERVICES	205.	
92 HOME OFFICE ENGRG	211.	
93 FIELD OFFICE	109.	
94 OWNER COSTS	138.	
SUBTOTAL INDIRECTS		663.
SUBTOTAL DIRECTS AND INDIRECTS		1521.
CONTINGENCY ALLOWANCE		152.
TOTAL OVERNIGHT COSTS BEFORE ESCALATION		1673.
ESCALATION BEFORE STEAM SUPPLY ORDER		462.
ESCALATION AFTER STEAM SUPPLY ORDER		473.
TOTAL ESCALATED DIRECT AND INDIRECT COSTS		2609.
TOTAL INTEREST DURING CONSTRUCTION		1403.
TOTAL CAPITAL INVESTMENT		4012.
PLANT CAPITAL INVESTMENT COST		
NOMINAL DOLLARS	(3647.\$/KWe)	4012.
CONSTANT 1987 DOLLARS	(1934.\$/KWe)	2128.
TAX DEDUCTIBLE FRACTION IN TOTAL CAPITAL =		.7997

Fig. 4.12. Capital investment costs for reference PWR/BE power plant (PLANTCAP)

NFUEL: The three pages of output from NFUEL are shown in Fig. 4.15. A listing of the input data is given on the first page. The second page, which is optional upon selection of menu Item 4, gives the levelized costs for each fuel batch and year of operation. The final page gives a breakdown of the levelized fuel cycle cost in both nominal

FIXED CHARGE RATE

VERSION 05-13-1988  
 RUN DATE 09-20-1988

INPUT DATA

-----  
 PROJECT LIFE (years) 40.  
 LEVELIZING PERIOD (years) 30.  
 INFLATION RATE 0.05  
 INTERIM REPLACEMENT ESCALATION RATE (fraction) 0.05  
 EFFECTIVE INCOME TAX RATE .3664  
 INITIAL CAPITAL INVESTMENT AT STARTUP, MILLION \$ 4012.  
 TAX DEDUCTABLE FRACTION OF TOTAL CAPITAL INVEST. .7997  
 INTEREST RATE ON DEBT .0970  
 RETURN ON PREFERRED STOCK .0900  
 RETURN ON COMMON STOCK .1400  
 DEBT FRACTION .5000  
 PREFERRED STOCK FRACTION .1000  
 COMMON STOCK FRACTION .4000  
 PROPERTY TAX RATE (fraction/year) .02  
 INTERIM REPLACEMENT RATE (fraction/year) 0.005  
 START OF OPERATION (YEAR) 2000.00  
 REFERENCE YEAR FOR CONSTANT DOLLARS 1987.00  
 REACTOR POWER LEVEL, Mwe 1100.  
 LIFETIME AVERAGE CAPACITY FACTOR 0.75  
 NORMALIZED ACCOUNTING  
 ACRS CLASS: 15-YEAR PROPERTY  
 -----

ANNUAL REVENUE REQUIREMENTS (MILLION DOLLARS)

YEAR	REVENUE REQUIR. (MILLION \$)									POWER COST (Cents/KWhe)		
	RATE BASE	RETURN ON CAP	BOOK DEPR	TAX DEPR	I TAX CURR	I TAX DEFER	PROP TAX	INTRM REPL	NOMNL \$	1987. \$	NOMNL \$	1987. \$
2000.	4012.0	455.4	100.3	160.4	133.0	29.4	80.2	21.1	819.4	413.8	11.34	5.73
2001.	3882.3	440.6	100.3	304.8	75.3	82.3	80.2	22.1	800.8	385.2	11.08	5.33
2002.	3699.7	419.9	100.3	274.3	79.6	71.1	80.2	23.2	774.4	354.7	10.71	4.91
2003.	3528.3	400.5	100.3	247.0	83.1	61.1	80.2	24.4	749.6	327.1	10.37	4.53
2004.	3366.9	382.1	100.3	222.3	86.1	52.1	80.2	25.6	726.5	301.9	10.05	4.18
2005.	3214.5	364.8	100.3	199.9	88.6	43.8	80.2	26.9	704.7	278.9	9.75	3.86
2006.	3070.3	348.5	100.3	189.5	87.0	40.0	80.2	28.2	684.3	257.9	9.47	3.57
2007.	2930.0	332.6	100.3	189.5	81.7	40.0	80.2	29.6	664.5	238.5	9.19	3.30
2008.	2789.7	316.6	100.3	189.5	76.5	40.0	80.2	31.1	644.8	220.4	8.92	3.05
2009.	2649.4	300.7	100.3	189.5	71.2	40.0	80.2	32.7	625.1	203.5	8.65	2.82
2010.	2509.0	284.8	100.3	189.5	65.9	40.0	80.2	34.3	605.6	187.8	8.38	2.60
2011.	2368.7	268.8	100.3	189.5	60.6	40.0	80.2	36.0	586.1	173.1	8.11	2.39
2012.	2228.4	252.9	100.3	189.5	55.4	40.0	80.2	37.8	566.7	159.4	7.84	2.21
2013.	2088.1	237.0	100.3	189.5	50.1	40.0	80.2	39.7	547.4	146.6	7.57	2.03
2014.	1947.7	221.1	100.3	189.5	44.8	40.0	80.2	41.7	528.1	134.7	7.31	1.86
2015.	1807.4	205.1	100.3	94.5	74.3	5.2	80.2	43.8	509.0	123.7	7.04	1.71
2016.	1701.9	193.2	100.3	0.0	105.0	-29.4	80.2	46.0	495.3	114.6	6.85	1.59
2017.	1631.0	185.1	100.3	0.0	102.3	-29.4	80.2	48.3	486.9	107.3	6.74	1.48
2018.	1560.0	177.1	100.3	0.0	99.6	-29.4	80.2	50.7	478.6	100.4	6.62	1.39
2019.	1489.1	169.0	100.3	0.0	97.0	-29.4	80.2	53.2	470.4	94.0	6.51	1.30
2020.	1418.2	161.0	100.3	0.0	94.3	-29.4	80.2	55.9	462.3	88.0	6.40	1.22
2021.	1347.3	152.9	100.3	0.0	91.6	-29.4	80.2	58.7	454.4	82.4	6.29	1.14
2022.	1276.4	144.9	100.3	0.0	89.0	-29.4	80.2	61.6	446.6	77.1	6.18	1.07
2023.	1205.5	136.8	100.3	0.0	86.3	-29.4	80.2	64.7	439.0	72.2	6.07	1.00
2024.	1134.6	128.8	100.3	0.0	83.7	-29.4	80.2	67.9	431.5	67.6	5.97	0.94
2025.	1063.7	120.7	100.3	0.0	81.0	-29.4	80.2	71.3	424.2	63.3	5.87	0.88
2026.	992.8	112.7	100.3	0.0	78.3	-29.4	80.2	74.9	417.0	59.2	5.77	0.82
2027.	921.8	104.6	100.3	0.0	75.7	-29.4	80.2	78.6	410.1	55.5	5.67	0.77
2028.	850.9	96.6	100.3	0.0	73.0	-29.4	80.2	82.6	403.3	52.0	5.58	0.72
2029.	780.0	88.5	100.3	0.0	70.3	-29.4	80.2	86.7	396.7	48.7	5.49	0.67

SUM OF PRESENT WORTH OF REVENUE REQUIREMENTS AT STARTUP = 6394.

	FIXED CHARGE RATE (FRACTION)	LEVELIZED POWER COST (Cents/KWhe)
NOMINAL DOLLARS =	.1631	9.05
1987 DOLLARS =	.0962	2.83

Fig. 4.13. Fixed charge rate calculation output for reference PWR/BE power plant (FCRATE)

## SUMMARY OF ANNUAL NONFUEL O&amp;M COST FOR NUCLEAR POWER PLANTS

VERSION 09-01-1988  
 RUN DATE 09-20-1988

O&M COST MODEL NAME		PWRBE
UNIT NET RATING, MWe		1100.
NUMBER OF UNITS PER PLANT		1.
CAPACITY FACTOR (fraction)		.75
ESCALATION RATES, fraction		
WAGES AND SALARIES	.05	
MATERIALS AND SUPPLIES	.05	
NUCLEAR REGULATORY FEES	.05	
NUCLEAR INSURANCE	.05	
AVERAGE ONSITE STAFF COST 1987 \$/year		36000.
before payroll taxes & insurance		
AVERAGE OFFSITE STAFF COST 1987 \$/year		51000.
before payroll taxes, insurance, and overhead		
ANNUAL NET GENERATION, million kWh		7232.
YEAR OF STARTUP		2000.
BASE YEAR FOR COST MODEL		1987.
REF. YEAR FOR CONSTANT DOLLAR		1987.
INFLATION RATE		.050

-----  
 POWER GENERATION COSTS ( 1987 \$million/year)  
 -----

ONSITE STAFF ( 520. persons)		20.59
MAINTENANCE MATERIALS		6.24
FIXED	4.75	
VARIABLE	1.48	
SUPPLIES AND EXPENSES		10.29
FIXED	8.13	
VARIABLE	2.17	
OFFSITE TECHNICAL SUPPORT ( 100. persons)		8.67
SUBTOTAL, DIRECT O&M COSTS		----- 45.79
FIXED	42.14	
VARIABLE	3.65	
ADMINISTRATIVE AND GENERAL COSTS		20.37
PENSIONS AND BENEFITS	5.96	
NUCLEAR REGULATORY FEES	1.25	
LIABILITY INSURANCE	0.60	
PROPERTY INSURANCE	4.10	
REPLACEMENT POWER INSURANCE	1.60	
OTHER GENERAL EXPENSES	6.87	
TOTAL NONFUEL O&M COSTS		----- 66.17
FIXED	62.5	
VARIABLE	3.7	
mills/kWh (without A&G, 1987 \$)		6.33
mills/kWh (with A&G, 1987 \$)		9.15

Fig. 4.14. Nonfuel O&M costs for reference PWR/BE nuclear power plant (NUCLOM)

and constant dollars. The constant dollar fuel cycle cost [6.39 mills/kWh(e)] is required as input to the LEVEL Program.

LEVEL. The output from LEVEL, containing the total levelized power generation cost, is shown in Fig. 4.16. The capital investment cost,

## NUCLEAR FUEL CYCLE COST

VERSION 05-13-1988  
 RUN DATE 09-20-1988

## INPUT DATA

MASS BALANCE SET USED	PWREXB
CAPACITY FACTOR	0.75
LAG TIME (years)	0.5
NO CREDIT FOR DISCHARGED FISSILE	
BASE YEAR FOR COST DATA	1987.
REFERENCE YEAR FOR CONSTANT DOLLARS	1987
YEAR OF STARTUP	2000.
INFLATION RATE	0.05
EFFECTIVE COST OF MONEY	.0957
INCOME TAX RATE	.3664
REFERENCE YEAR PRICES	
U308 (\$/lb)	23.00
CONVERSION (\$/kg)	8.00
ENRICHMENT (\$/SWU)	109.00
PLUTONIUM (\$/gm)	0.00
FABRICATION (\$/Kg)	220.00
BACK END (reprocessing) (\$/kg)	0.00
WASTE DISPOSAL (mills/kwh)	1.00
PRICE ESCALATION RATES	
U308	.071
CONVERSION	.061
ENRICHMENT	.032
PLUTONIUM	.050
FABRICATION	.050
BACK END (reprocessing)	.050
WASTE DISPOSAL	.050

## LEVELIZED COSTS BY YEAR AND BATCH, Mills/kWh

BATCH	BATCH COST	YEAR	YEARLY COST
1	28.96	2000	15.08
2	16.13	2001	11.83
3	11.90	2002	11.37
4	9.82	2003	12.04
5	8.59	2004	13.30
6	12.70	2005	14.98
7	13.83	2006	16.04
8	15.28	2007	17.06
9	16.09	2008	18.00
10	17.02	2009	18.98
11	17.99	2010	20.01
12	18.94	2011	21.08
13	19.95	2012	22.21
14	21.01	2013	23.40
15	22.14	2014	24.67
16	23.33	2015	26.01
17	24.60	2016	27.44
18	25.94	2017	28.94
19	27.35	2018	30.54
20	28.85	2019	32.23
21	30.44	2020	34.02
22	32.13	2021	35.92
23	33.92	2022	37.94
24	35.81	2023	40.08
25	37.82	2024	42.35
26	39.95	2025	44.75
27	42.21	2026	49.05
28	44.60	2027	56.74
29	47.15	2028	71.57
30	49.85	2029	108.70
31	61.45	2030	0.00
32	80.64	2031	0.00
33	118.79	2032	0.00
34	232.77	2033	0.00

Fig. 4.15. Fuel cycle costs for reference PWR/BE power plant (NFUEL)

LEVELIZED FUEL CYCLE COSTS, MILLS/KWH

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	NOMINAL DOLLARS	1987 DOLLARS
URANIUM PURCHASE	8.399	2.627
CONVERSION PURCHASE	0.866	0.271
ENRICHMENT PURCHASE	5.485	1.715
PLUTONIUM PURCHASE	0.000	0.000
FABRICATION	2.488	0.778
URANIUM CREDIT	0.000	0.000
CONVERSION CREDIT	0.000	0.000
ENRICHMENT CREDIT	0.000	0.000
PLUTONIUM SALES	0.000	0.000
REPROCESSING	0.000	0.000
WASTE DISPOSAL	3.196	1.000
TOTAL	20.433	6.391

Fig. 4.15 (continued)

LEVELIZED POWER GENERATION COST CODE

VERSION 09-01-1988  
RUN DATE 09-20-1988

PLANT TYPE		NUCLEAR
YEAR OF FIRST COMMERCIAL OPERATION		2000.
RATING PER UNIT (Mwe)		1100.
UNITS PER PLANT		1.
CAPACITY FACTOR		0.75
ANALYSIS LIFE (years)		30.
GNP INFLATION RATE		0.050
EFFECTIVE INCOME TAX RATE		0.3664
CAPITALIZATION	FRACTION	RATE
DEBT	0.500	0.097
PREFERRED STOCK	0.100	0.090
COMMON EQUITY	0.400	0.140
EFFECTIVE COST OF MONEY		0.0957
CONSTANT DOLLAR LEVELIZED COST YEAR		1987.
FIXED CHARGE RATE		0.1631
PLANT INVESTMENT COST (year 2000 \$millions)		4012.
DECOMMISSIONING FUND INTEREST RATE		0.070
DECOMMISSIONING COST (1987 \$millions)		145.
LEVELIZED O&M COST (1987 mills/kwh)		9.15
LEVELIZED FUEL COST (1987 mills/kwh)		6.39
LEVELIZED POWER GENERATION COSTS (mills/kwh)		
	1987 \$	NOMINAL \$
CAPITAL	28.32	90.5
O&M	9.15	29.3
FUEL	6.39	20.4
DECOM.	0.54	1.7
	44.4	142.0

Fig. 4.16. Levelized power generation cost for reference PWR/BE power plant (LEVEL)

operation and maintenance cost, fuel cost, and decommissioning cost components are also summarized.

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