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USER'S MANUAL FOR LEVELIZED POWER GENERATION COST USING A MICROCOMPUTER

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L. C. Fuller

ABSTRACT

Microcomputer programs for the estimation of levelized electrical power generation costs are described. Procedures for light-water reactor plants and coal-fired plants include capital investment cost, operation and maintenance cost, fuel cycle cost, nuclear decommissioning cost, and levelized total generation cost. Programs are written in Pascal and are run on an Apple II Plus microcomputer.

Keywords: microcomputer, Pascal, power generation cost, coal-fired power plants, light-water reactor plants, economic evaluations, power plant economics, operation and maintenance cost, capital investment cost, fuel cycle cost, levelized cost.

1. INTRODUCTION

This report describes a set of microcomputer programs for estimating power generation costs for 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 lifetime costs. It is anticipated that these programs will be useful for determining the sensitivity of power generation cost to such parameters as interest rate, escalation rate, inflation rate, lead times, capacity factor, fuel prices, and year of commercial operation.

Two major types of electric generating plants considered are pressurized-water reactor (PWR) and coal-fired. Costs for one through four units per plant may be obtained. This report describes a procedure for estimating levelized power generation cost, which is based on Ref. 1 and

the CONCEPT-5, OMCOST, and REFCO codes (Refs. 2, 3, and 4). Each of these codes was developed independently and as such may differ in level of detail in a given area. The OMCOST code for operation and maintenance (O&M) costs includes the option of scrubbing for flue gas desulfurization (FGD), and further it allows the selection of a wet limestone FGD or a dry FGD system. The CONCEPT-5 code for capital investment costs does not contain the option of dry scrubbers, but the cost difference could be forced through the use of NAMELIST data. Inconsistencies of this type will become more apparent when the input data for each routine is described.

The programs were developed using Pascal on an Apple II Plus microcomputer with 48K memory and a 16K language card. Programs are stored on floppy disks. Output is split between a video monitor and an Epson MX-100 impact printer. Example problem output is included in Appendixes A and B, and a listing of the programs is included in Appendix C.

2. POWER GENERATION COST METHODOLOGY

Power generation cost consists of several components: capital investment cost, operation and maintenance cost, and fuel or fuel cycle cost. Nuclear plants incur an additional cost to pay for decommissioning.

The comparative analysis of power generation cost may be done using either a constant or current dollar analysis. This package calculates levelized power generation cost using the methodology recommended in the Nuclear Energy Cost Data Base (NECDB) of Ref. 1. This methodology explicitly considers inflation and differential escalation rates. Market rates of return are used directly; the inflation component is not removed.

The rate of price change may be divided into a general inflation component as measured by the Gross National Product Implicit Price Deflator (IPD) and a differential escalation component (real cost escalation resulting from new regulations, changes in efficiency, etc.). The price or cost in any year is related to that in the reference year by the following relationship:

$$C_m = C_0 (1 + i)^m (1 + g)^m = C_0 (1 + r)^m$$

where

C_m = cost, m years removed from reference year,

C_0 = cost in reference year,

i = general inflation rate,

g = differential escalation rate, and

r = overall rate of price change.

The methodology seeks a single levelized price, which will produce the same present worth of revenues as the stream of actual yearly prices. Levelized power generation cost can then be expressed in either constant dollars or in current dollars. Current (or nominal) dollar levelized price remains constant over facility life in "then-current" or "as-spent" dollars even though buying power of the dollar varies with time. In contrast, constant dollar levelized price is an equivalent price referenced to a given year's purchasing power. Constant dollar and current dollar levelized prices represent two methods of expressing the same value. The reader is referred to Ref. 1 for further discussion of the levelized cost methodology.

3. PACKAGE ORGANIZATION

All uncompiled models are contained on floppy disk volume COST1: and identified with the word TEXT as for example COST1:PWRCAPC.TEXT. In the following discussion, it is assumed that the user has compiled each file from disk COST1 and stored it on disk COST2, e.g., COST1:FILENAME.TEXT to COST2:FILENAME.CODE. The user is referred to Ref. 6 for the required procedure. It is anticipated that users may wish to use a cost model in as-compiled form, or they may wish to make changes to parameters within the model, which are not read as input data before running a code. To execute a code in its as-compiled form, it is only necessary to inform the operating system of the name of the CODE file to be executed and respond at the keyboard with the required input data. To alter parameters, which are not requested as input data, it is necessary to bring the TEXT file into computer workspace, do the required editing, compile, and then execute the new CODE file.

There are three capital investment cost models. PWRCAPC and COALCAPC are specifically intended to model PWR and coal-fired plants, respectively. CAPCOST allows the user to input overnight direct and indirect costs for different plant types for an input base size and base year. The models will then calculate capital investment cost for one to four units at various plant locations, interest rates, escalation rates, sizes, and dates. The text files are:

COST1:PWRCAPC.TEXT
 COST1:COALCAPC.TEXT
 COST1:CAPCOST.TEXT

for the PWR, coal-fired, and overnight cost input versions, respectively. The compiled versions are:

COST2:PWRCAPC.CODE
 COST2:COALCAPC.CODE
 COST2:CAPCOST.CODE

There are three operation and maintenance cost models: PWROM, WETOM, and DRYOM for the following plant types: PWR, coal-fired with wet FGD system, and coal-fired with dry FGD system. The text files are:

COST1:PWROM.TEXT
 COST1:WETOM.TEXT
 COST1:DRYOM.TEXT

The compiled files are:

COST2:PWROM.CODE
 COST2:WETOM.CODE
 COST2:DRYOM.CODE

A nuclear fuel cycle cost code is included in text form as COST1:NFUEL.TEXT and in compiled form as COST2:NFUEL.CODE. A coal fuel cost code is included in text form as COST1:COALCOST.TEXT and in compiled form as COST2:COALCOST.CODE.

Levelized cost for PWR, coal-fired, or other plants may be obtained through the use of LEVEL, which is stored in text form as COST1:LEVEL.TEXT and in compiled form as COST2:LEVEL.CODE.

LEVEL requires a fixed charge rate as part of its input, which may be obtained through the use of FCRATE, which is stored in text form as COST1:FCRATE.TEXT and in compiled form as COST2:FCRATE.CODE.

Figure 3.1 shows the relationship among the ten Pascal programs. Any of the programs may be run separately. All that is required is the appropriate set of input data. Most of the input data required by LEVEL can be obtained by running other programs. However, LEVEL may also be run without the use of any other program from the package. Each routine requires menu-driven input and produces line printer output. The user then selects the appropriate output from the capital investment cost code, O&M code, fuel cost code, and fixed charge rate code to provide input for LEVEL.

4. DISCUSSION OF COST MODELS

4.1 Capital Investment Cost

The capital investment cost models are simplified versions of CONCEPT-5 methodology (Ref. 2). Output from CONCEPT runs was used to establish a base cost model for the PWR plant and for the coal-fired plant. The base year (1982) model by two-digit account and cost category (equipment, labor, or material) is the starting point for all calculations. Indirect costs are also taken from CONCEPT output. For the PWR and coal-fired models the cost-size scaling factors are taken from the CONCEPT models for all direct and indirect costs. This does not apply to CAPCOST since directs and indirects before escalation are supplied as input data by the user.

Direct and indirect costs are escalated from the base year for the cost model to the year of steam supply purchase using an escalation rate, which may be changed by the user. There is no extrapolation of historical escalation data as in CONCEPT. A contingency allowance, which may be changed by the user, is added to the total direct and indirect costs before construction period escalation and interest are calculated.

The calculation of interest and escalation during construction utilizes a smooth trigonometric S-curve to simulate the construction cash flow curve. The S-curve is skewed to the right or to the left as the year of construction permit is changed for fired steam supply system

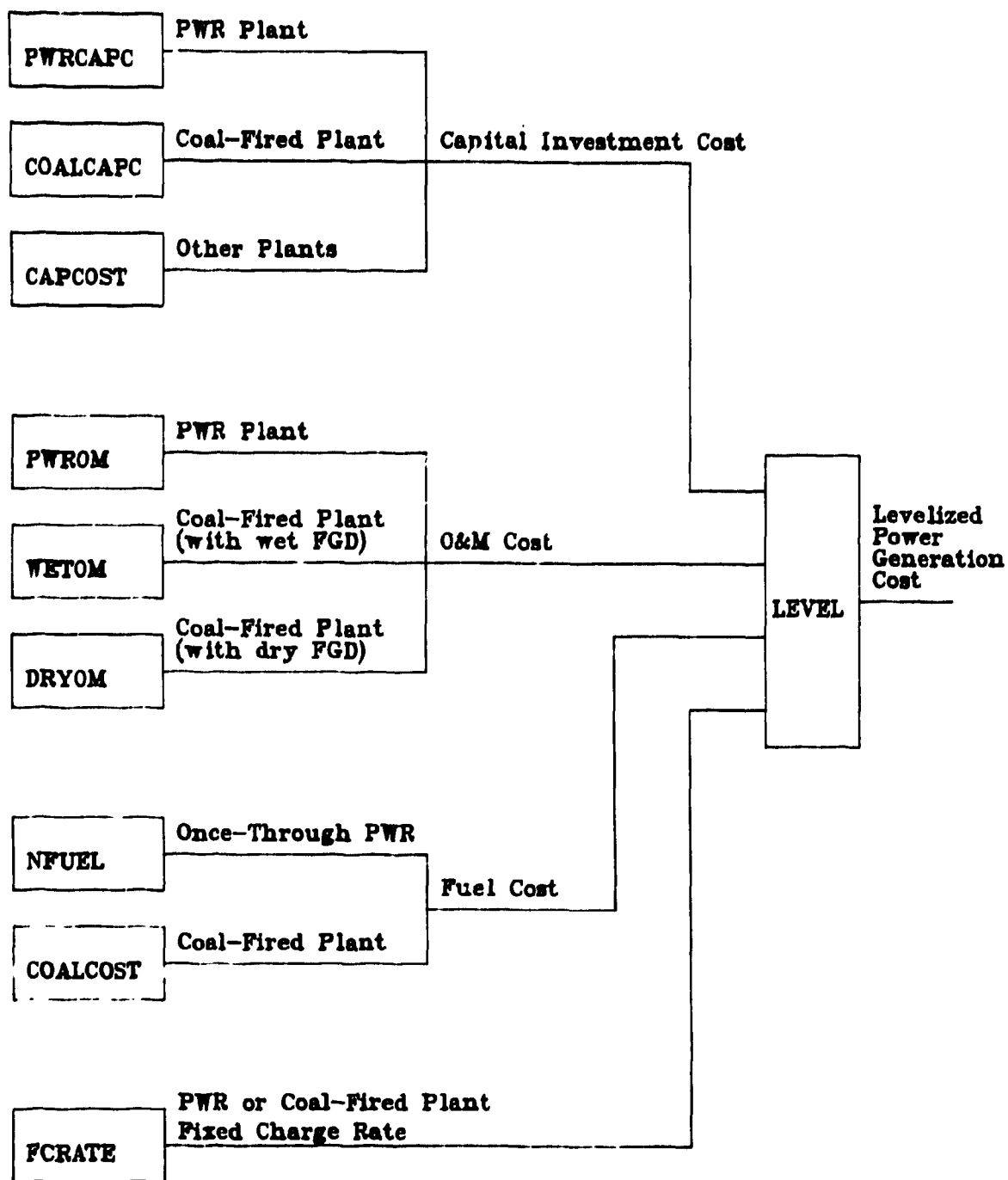


Fig. 3.1. Relationship among microcomputer programs to calculate levelized power generation cost.

purchase date and operation date. Virtually all difference between the results of a CONCEPT run and the results of a PWRCAPC or COALCAPC run are due to differences in the construction S-curve used, since the CONCEPT code utilizes tabular data for each two-digit-level account to simulate construction cash flows.

Site dependent effects are included through the use of plant location (city) multipliers. CONCEPT runs were made using base case conditions except for the use of the ten cities taken from Ref. 5. These locations are representative of the ten Energy Information Administration (EIA) regions. The correction for a new location is made by the use of multipliers, which relate bottom line capital investment cost (direct and indirect) at a new location to bottom line cost at the reference Middletown location.

After making adjustment for plant location, capital investment costs for one through four units per plant are printed out. Again, multiple unit costs were obtained from CONCEPT runs and converted to multipliers for use here. First, a stand-alone CONCEPT case was run. Then a two-unit case was run. The multipliers for three- and four-unit cases were obtained by considering the third and fourth unit costs are equal to that of a second unit of a two-unit plant.

While it is expected that the user will normally input only plant size, construction dates, interest rate, escalation rate, contingency percentage, and location, it is possible to edit a copy of a capital investment cost model and simulate changes to items such as labor intensity (manhours per kW), overtime, etc. This would require either calculations external to the program or perhaps CONCEPT runs, which could provide data as a basis for editing of a Pascal program.

4.2 Operation and Maintenance Cost

The operation and maintenance cost models (PWROM, WETOM, and DRYOM) follow the procedures outlined in Ref. 3 with few exceptions. No changes have been made to the OMCOST equations, and the variable names have been retained. The user can consult Ref. 3 for a detailed description of the algorithms. The user should be able to reproduce the sample

problems from the OMCOST report with the exception of Administrative and General costs. These were revised downward since the publication of Ref. 3.

Memory limitations for the Apple II Plus place restraints on program and procedure sizes that are not present with OMCOST for the IBM mainframe system. In the interest of keeping program size within bounds, separate models were developed for the PWR plant and coal-fired plants with wet FGD and dry FGD systems. The present arrangement requires that the user specify the model to be executed.

In OMCOST, a table of staff requirements is printed out for the plant type selected the first time a particular plant type is selected. This detailed table showing number of persons in the plant manager's office, operations, maintenance, and technical and engineering is not included in these Pascal models. Only the subtotals required to calculate on-site staff costs, maintenance material costs, and cost of off-site support services are included. The input data variables from OMCOST used to set wage rate, percentage operator fringe benefits, and plant supervision percentage are not input data variables in the Pascal programs. The program must be edited if these changes are required. The 1982 costs are adjusted by an appropriate escalation rate to convert the costs to the year under study.

Maintenance materials are assumed to have a cost proportional to maintenance staff with factors included to determine the fixed and variable portions of materials.

Supplies and expenses include consumables [such as water, lubricants, chemicals, gases, office supplies, radioactive and non-radioactive waste management, FGD reagent (lime or limestone), and data processing services]. Supplies and expenses have fixed and variable components. It is assumed that there are no economies of scale for fixed supplies in multiple unit plants, therefore an annual dollar amount is assigned for fixed supplies. PWR values are about double those for coal-fired plants. There is a basic variable supplies calculation for each plant type, in which a given mills/kWh constant is multiplied by the annual net generation. There are adders for the coal-fired plant accounts for reagent cost and ash and sludge disposal cost.

The PWR model assumes the requirement of safety, environmental, and health physics inspections. These fees vary linearly with the number of units per plant. Costs of activities by personnel not assigned full time to the plant site are included as Off-site Support Services.

The Administrative and General category contains overhead costs including administrative and general salaries, legal expenses, payment for outside services not applicable to direct accounts, pensions, and insurance (including nuclear liability). The basic administrative and general expense is assumed to be 15 percent of direct costs for PWR plants and 10 percent of direct costs for coal-fired plants. The insurance expenses are all either linear or constant functions of the number of units per plant.

For most applications of the Pascal O&M cost models, it is assumed that one escalation rate for all cost categories will be sufficient. Although the Pascal models include individual escalation rates for wages, materials, supplies, and various types of insurance, the user cannot enter these individual rates through menu input. A user wishing to investigate a change in a specific escalation rate (such as wages) must edit the program. Editing is also required to change wage rates, fringe benefit and supervision percentages, cost of lime or limestone, sulfur removal percentage, and ash disposal cost.

4.3 Nuclear Fuel Cycle Cost

The nuclear fuel cycle cost code is a simplified version of the REFCO code described in Ref. 4. In its present form, the Pascal nuclear fuel cycle program NFUEL can only be applied to a once-through PWR cycle. Recycle would be possible if the required input data is provided and the mass balance is adjusted, but the mass balance change would involve editing of the program. Costs may be adjusted for year of start-up, capacity factor, lead and lag times, inflation rate, effective cost of capital, and tax rates. The unit cost for each component of the fuel cycle may be changed as may the escalation rate for each component. The components considered are the cost of U_3O_8 , conversion, enrichment, plutonium, fabrication, reprocessing, and waste disposal. Uranium, conversion, and enrichment credits for discharged fuel are set equal to zero

as are plutonium sales and reprocessing costs, thus there are provisions for more cost components than are presently used. Material losses during the various processing steps are considered. Any of the cost categories may be expensed or capitalized. If they are capitalized, or proportioned, the tax depreciation is assumed to be proportional to the energy generated by a batch within a period or cycle. Batch costs are accumulated to determine total lifetime cost.

There is no documentation directly applicable to the simplified nuclear fuel cycle program, but Ref. 4 provides information of value to the Pascal NFUEL program. The output does not provide a complete list of all variables used. It is necessary to refer to a listing of the program to determine characteristics of the fuel cycle being costed. Both compilation and execution of NFUEL are slow. If any editing is done, the program must be recompiled, requiring five minutes of compilation time. For a single run of a previously compiled version, more than one minute of execution time is required.

4.4 Coal Fuel Cost

The coal fuel cost code COALCOST employs the method illustrated in Ref. 1. The user inputs a coal price in dollars per million Btu, a reference year for coal price input, the year of plant startup, the plant life, the effective cost of capital, the overall inflation rate, the real cost escalation rate, and the plant net heat rate in Btu/kWh. Output consists of the constant dollar levelized cost in mills/kWh.

4.5 Fixed Charge Rate

The levelized fixed charge rate code FCRATE is based on the methodology described in Ref. 1. The user inputs the project life and levelizing period, a general inflation factor, an interim replacement escalation factor, the effective tax rate (combined state and federal), capital investment cost, the tax deductible fraction of the capital investment cost (ratio of direct and indirect costs other than capitalized interest to total capitalized cost including interest), the investment

tax credit rate, capital rates and ratios, and the tax depreciation schedule to be used. The user has the option of including or excluding year-by-year printout of return, rate base, taxes, and revenue requirements. Both current dollar and constant dollar rates are displayed.

4.6 Levelized Cost

The levelized cost code LEVEL is based on the methodology developed in Ref. 1. The method uses the discounted cash flow approach, whereby levelized life cycle costs are obtained. The results are expressed in both constant and current dollars. Levelized constant dollars or current dollars may be used as figures of merit for comparison of the overall attractiveness of competing alternatives. LEVEL does not give year-by-year revenue requirements.

The levelized costs may be expressed in dollars indexed to a reference year's buying power (constant dollars) or in terms of a levelized cost, which remains unchanged (in current dollars) over the life of the plant. However, the calculations are performed in current dollars and then converted to constant dollars. The user is referred to Ref. 1 for a discussion of the mathematical basis and relationship between constant and current dollar levelized costs.

5. INPUT DATA FOR SAMPLE PROBLEMS

To determine cost of power for a PWR plant, it is necessary to run the capital investment cost model PWRCAPC, the O&M cost model PWROM, the fuel cycle cost model NFUEL, the fixed charge rate model FCRATE, and the levelized cost model LEVEL. The following input data reproduces the sample problem output as given in Appendix A. The numbers to the right of the word description indicate those models which require the data. The key to the models is as follows:

- 1 - PWRCAPC
- 2 - PWROM
- 3 - NFUEL
- 4 - FCRATE
- 5 - LEVEL

6 = COALCAPC
 7 = WETOM
 8 = COALCOST

As an example, year of first commercial operation, which is followed by 1, 2, 3, and 5, is used in PWRCAPC, PWROM, NFUEL, and LEVEL.

YEAR OF STEAM SUPPLY SYSTEM PURCHASE (1)
 1983
 YEAR OF CONSTRUCTION PERMIT (1)
 1988
 YEAR OF FIRST COMMERCIAL OPERATION (1, 2, 3, 5)
 1995
 INTEREST RATE DURING CONSTRUCTION (PCT/YR) (1)
 9.0
 ESCALATION RATE DURING CONSTRUCTION (PCT/YR) (1)
 7.0
 CONTINGENCY (PCT) (1)
 15.0
 NET RATING PER UNIT (MWE) (1, 2, 5)
 1100
 CITY NUMBER (1)
 5 (CHICAGO)
 NUMBER OF UNITS PER PLANT (2, 5)
 1
 BASE LOAD CAPACITY FACTOR (DECIMAL) (2, 3, 5)
 0.65
 O&M COST ESCALATION RATE (PCT/YR) (2)
 6.0
 PLANT NET HEAT RATE (BTU/KWH) (2)
 10700
 LAG TIME FOR RECEIPTS (YEARS) (3)
 0.50
 CREDIT FOR DISCHARGED FISSILE? (3)
 NO
 GNP INFLATION RATE (DECIMAL) (3, 5)
 0.06
 EFFECTIVE COST OF MONEY (DECIMAL) (3)
 0.090
 COMBINED STATE & FEDERAL INCOME TAX RATE (DECIMAL) (3, 4)
 0.4816
 BASE YEAR FOR FUEL COST DATA (3)
 1982
 REFERENCE YEAR PRICE FOR U308 (\$/LB) (3)
 32.20
 REFERENCE YEAR PRICE FOR CONVERSION (\$/KG) (3)
 8.00
 REFERENCE YEAR PRICE FOR ENRICHMENT (\$/SWU) (3)
 130.00
 REFERENCE YEAR PRICE FOR PLUTONIUM (\$/GM) (3)
 0.0

REFERENCE YEAR PRICE FOR FABRICATION (\$/KG) (3)
 180.00
 BACK END (REPROCESSING) (\$/KG) (3)
 0.0
 WASTE DISPOSAL (MILLS/KWH) (3)
 1.0
 PRICE ESCALATION RATE U308 (DECIMAL) (3)
 0.092
 PRICE ESCALATION RATE CONVERSION (DECIMAL) (3)
 0.06
 PRICE ESCALATION RATE ENRICHMENT (DECIMAL) (3)
 0.06
 PRICE ESCALATION RATE PLUTONIUM (DECIMAL) (3)
 0.06
 PRICE ESCALATION RATE FABRICATION (DECIMAL) (3)
 0.06
 PRICE ESCALATION RATE BACK END, REPROCESSING (DECIMAL) (3)
 0.06
 PRICE ESCALATION RATE WASTE DISPOSAL (DECIMAL) (3)
 0.06
 YEAR-BY-YEAR PRINTOUT REQUESTED (4)
 Y
 LEVELIZING PERIOD (YEARS) (4)
 30
 INFLATION FACTOR (1 + DECIMAL RATE) (4)
 1.06
 INTERIM REPLACEMENT ESCALATION FACTOR (1 + DECIMAL RATE) (4)
 1.06
 TOTAL INITIAL CAPITAL INVESTMENT (4)
 1000
 TAX DEDUCTIBLE FRACTION OF TOTAL CAPITAL INVESTMENT (4)
 0.647
 INVESTMENT TAX CREDIT RATE (4)
 0.08
 PROPERTY TAX RATE (4)
 0.02
 INTERIM REPLACEMENT RATE (4)
 0.01
 NORMALIZED OR FLOW-THROUGH ACCOUNTING (4)
 N
 TEFRA DEPRECIATION SCHEDULE (4)
 10-YEAR PROPERTY
 PLANT TYPE (5)
 N (NUCLEAR)
 PLANT LIFE (YEARS) (4, 5)
 30
 REAL (DIFFERENTIAL) COST ESCALATION RATE (DECIMAL) (5)
 0.01
 STATE INCOME TAX RATE (DECIMAL) (5)
 0.04
 FEDERAL INCOME TAX RATE (DECIMAL) (5)
 0.46

RETURN ON COMMON STOCK (DECIMAL) (4, 5)
 0.14
 COMMON STOCK FRACTION (4, 5)
 0.38
 INTEREST RATE ON DEBT (DECIMAL) (4, 5)
 0.10
 DEBT FRACTION (4, 5)
 0.50
 RETURN ON PREFERRED STOCK (DECIMAL) (4, 5)
 0.09
 CONSTANT DOLLAR LEVELIZED COST YEAR (5)
 1983.0
 FIXED CHARGE RATE (DECIMAL, CURRENT DOLLAR) (5)
 0.183
 PLANT INVESTMENT COST AT FIRST COMMERCIAL OPERATION
 FOR ALL UNITS (from PWRCAPC) (\$MILLIONS) (5)
 4945.4
 FEDERAL GOVERNMENT DEBT RATE FOR DECOMMISSIONING
 FUNDS (DECIMAL) (5)
 0.085
 DECOMMISSIONING COST IN CONSTANT DOLLAR LEVELIZED
 COST YEAR (\$MILLIONS) (5)
 130.0
 O&M COST IN CONSTANT DOLLAR LEVELIZED COST YEAR
 (from PWROM) (MILLS/KWH) (5)
 6.61
 FUEL COST IN CONSTANT DOLLAR LEVELIZED COST YEAR
 COST DATA (from NFUEL) (MILLS/KWH) (5)
 11.208

To determine cost of power generation for a coal-fired plant the user may execute the capital investment cost model COALCAPC, one of the O&M cost models (WETOM or DRYOM), the coal fuel cost model COALCOST, the fixed charge rate model FCRATE, and then the levelized cost model LEVEL. The following input data reproduces the sample problem output as given in Appendix B.

YEAR OF STEAM SUPPLY SYSTEM PURCHASE (6)
 1987
 YEAR OF CONSTRUCTION PERMIT (6)
 1990
 YEAR OF FIRST COMMERCIAL OPERATION (5, 6, 7, 8)
 1995
 INTEREST RATE DURING CONSTRUCTION (PCT/YR) (6)
 9.0
 ESCALATION RATE DURING CONSTRUCTION (PCT/YR) (6)
 7.0
 CONTINGENCY (PCT) (6)
 15.0

NET RATING PER UNIT (MWE) (5, 6, 7)
 550
 CITY NUMBER (6)
 5 (CHICAGO)
 NUMBER OF UNITS PER PLANT (5, 7)
 2
 BASE LOAD CAPACITY FACTOR (DECIMAL) (5, 7)
 0.65
 O&M COST ESCALATION RATE (PCT/YR) (7)
 6.0
 PLANT NET HEAT RATE (BTU/KWH) (7, 8)
 9900
 SULFUR (PERCENT) (7)
 3.5
 ASH (PERCENT) (7)
 11.6
 HEATING VALUE (BTU/LB) (7)
 11000.0
 REFERENCE YEAR FOR PRICE OF COAL (8)
 1983
 PRICE OF COAL (\$/MBTU) (8)
 1.60
 COAL REAL COST ESCALATION RATE (DECIMAL) (8)
 0.015
 EFFECTIVE COST OF MONEY (DECIMAL) (8)
 0.09
 YEAR-BY-YEAR PRINTOUT REQUESTED (4)
 Y
 LEVELIZING PERIOD (YEARS) (4)
 30
 INFLATION FACTOR (1 + DECIMAL RATE) (4)
 1.06
 INTERIM REPLACEMENT ESCALATION FACTOR (1 + DECIMAL RATE) (4)
 1.06
 COMBINED FEDERAL AND STATE INCOME TAX RATE (DECIMAL) (4)
 0.4816
 TOTAL INITIAL CAPITAL INVESTMENT (4)
 1000
 TAX DEDUCTIBLE FRACTION OF TOTAL CAPITAL INVESTMENT (4)
 0.753
 INVESTMENT TAX CREDIT RATE (4)
 0.08
 PROPERTY TAX RATE (4)
 0.02
 INTERIM REPLACEMENT RATE (4)
 0.01
 NORMALIZED OR FLOW-THROUGH ACCOUNTING (4)
 N
 TEFRA DEPRECIATION SCHEDULE (4)
 15-YEAR PUBLIC UTILITY PROPERTY
 PLANT TYPE (5)
 C (COAL-FIRED)

PLANT LIFE (YEARS) (4, 5, 8)
 30
 GNP INFLATION RATE (DECIMAL) (5, 8)
 0.06
 REAL (DIFFERENTIAL) COST ESCALATION RATE (DECIMAL) (5)
 0.01
 STATE INCOME TAX RATE (DECIMAL) (5)
 0.04
 FEDERAL INCOME TAX RATE (DECIMAL) (5)
 0.46
 RETURN ON COMMON STOCK (DECIMAL) (4, 5)
 0.14
 COMMON STOCK FRACTION (4, 5)
 0.38
 INTEREST RATE ON DEBT (DECIMAL) (4, 5)
 0.10
 DEBT FRACTION (4, 5)
 0.50
 RETURN ON PREFERRED STOCK (DECIMAL) (4, 5)
 0.09
 CONSTANT DOLLAR LEVELIZED COST YEAR (5)
 1983.0
 FIXED CHARGE RATE (DECIMAL, CURRENT DOLLAR) (5)
 0.182
 PLANT INVESTMENT COST AT FIRST COMMERCIAL OPERATION
 FOR ALL UNITS (from COALCAPC) (\$MILLIONS) (5)
 3061.1
 O&M COST IN CONSTANT DOLLAR LEVELIZED COST YEAR
 (from WETOM) (MILLS/KWH) (5)
 5.17
 FUEL COST IN CONSTANT DOLLAR LEVELIZED COST YEAR
 COST DATA (MILLS/KWH) (5)
 23.4

6. JOB SUBMISSION TO THE APPLE II PLUS

It is assumed that the user has an Apple II Plus computer with 48 K bytes of memory and a Language System installed in the computer. In addition to the diskettes provided with this package (COST1: and COST2:), it is assumed that the user has diskettes APPLE1: and APPLE2: for booting-up the system. It is further assumed that two disk drives and a printer are attached. The following brief explanation of the boot-up procedure is for dual-drive boot-up.

Turn on the console (display screen) power switch. Turn on the printer power switch. If the computer power switch at the back lower

left is on, turn it off. When it is off, the POWER light at the lower left corner of the keyboard is also off. Insert the APPLE1: diskette in drive 1. This is done by lifting the drive door, holding the diskette in the right hand, palm up, with the thumb on the printed label, inserting the diskette carefully into the drive, and lowering the door until it snaps shut. Insert the APPLE2: diskette in drive 2. Turn on the computer power switch. The boot-up procedure from this point on is automatic. The POWER light will come on. The red IN USE lights on the disk drives will alternately come on, the drives will click and spin, messages relating to APPLE II Pascal will appear on the screen, and the following line will appear:

```
COMMAND: E(DIT, R(UN, F(ILE, C(OMP, L(IN
```

Pascal has now been booted-up and is waiting for your selection.

Let us assume that the first sample case is to be run using the compiled models from diskette COST2:. Note that reference to diskette volume requires the colon as part of the volume name (i.e., COST2:). Remove the APPLE2: diskette from drive 2. Insert COST2: in drive 2. Type F for FILER. There is no need to type RETURN after typing F. Type V for VOLUMES to show the volumes on line. This displays a list of input and output devices connected. What is important is that APPLE1: and COST2: are on line. Quit the FILER by typing Q for QUIT.

We are now ready to execute a code file. The COMMAND prompt line is too long to fit on the APPLE screen. Typing CTRL and A at the same time (we will call this CTRL-A) moves the APPLE window back and forth. Type CTRL-A, and you will see an option X(ecute for execute. Type X. The response will be hidden until you again type CTRL-A. Type CTRL-A. It says EXECUTE WHAT FILE? Let us first run the PWR CODE files, beginning with the PWR capital investment cost code. Type COST2:PWRCAPC followed by RETURN. Note that the X command assumes a file terminating in the word CODE, therefore the response could be either COST2:PWRCAPC or COST2:PWRCAFC.CODE. (You could also have typed #5:PWRCAPC or #5:PWRCAPC.CODE since #5 refers to the volume in drive 2). Select a number from the menu other than 0 or 99. To reproduce the sample problem, your responses should match the previous list of input. Years may be entered as integer, fixed point, or floating point numbers. Try this

by selecting menu item 1 and responding to YEAR OF STEAM SYSTEM PURCHASE with integer 1983, selecting menu item 2 and responding to YEAR OF CONSTRUCTION PERMIT with 1988.0, and selecting menu item 3 and responding to YEAR OF COMMERCIAL OPERATION with 1.995E3.

You may continue to answer the questions following the listing above, but a few words of caution are in order. There is some inconsistency in the form of input between models. Be careful to observe the prompt line for such input as interest rate. One model may prompt for percentage (i.e., 10.0) while another model may prompt for a decimal (i.e., 0.10). You may continue to check out the use of the menu using the data listed earlier. When the menu shows your data to be correct, enter 0, and the case will execute.

While calculations are taking place, there are periods of time when there is no apparent activity on the CRT screen. This could lead the user to believe that calculations are complete when in fact they are not. If the form feed on the printer is pressed before calculations are complete, printer output for a single case will be split between two pages. To avoid this problem, a message 'calculations taking place' will appear on the screen. At the end of a case the words 'case complete' will appear. Check your result. If there was an error in data entry and you wish to run a corrected case, make your selection from the menu, and run the case by typing a 0. When your output is just the way you want it, enter 99 to exit the PWR capital investment cost program, and proceed to the PWR O&M cost code.

The COMMAND prompt now appears at the top of the screen. Type CTRL-A, and you will see the option X(ecute for execute. Type X. The response will be hidden until you type CTRL-A. Type CTRL-A. Once again it says EXECUTE WHAT FILE? Respond with COST2:PWROM recalling that the extension .CODE can be included or omitted. Be sure that the printer has not been turned off. Execution cannot take place with the printer off. The menu for the PWR O&M cost program is self explanatory except that if levelized cost is to be calculated later using COST2:LEVEL.CODE, constant dollar levelized cost year should be input as the YEAR OF OPERATION. Although the plant may be operated in 1995, levelized costs in 1983 dollars will be calculated using 1983 O&M costs as input. Model

LEVEL takes the operation and maintenance cost for 1983 and inflates it as required to the actual year or years of operation (1995 and beyond). The reference to year of operation is for use of PWROM as a stand-alone O&M cost code, where cost for a specific year is normally desired.

If you select menu item 5, you are asked if you want to use the default general escalation rate. If the answer is N for no, you are asked if you want to input a general escalation rate. If the answer to this is also N, a series of individual escalation rates, which have previously been assigned within the model, will be used. For the PWROM model the escalation rates include wages, commercial liability insurance, government liability insurance, cost of fuels, inspections, reviews, materials, supplies and expenses, property insurance, and replacement power insurance. Any of these values can be changed by editing a text file but may not be changed through use of the menu.

Note that the BASE LOAD CAPACITY FACTOR prompted for should be input as a decimal (i.e., 0.65). Compare the values shown on the menu with the sample data previously listed. When you are satisfied that the input matches the sample input data, type 0 to run the case. Compare the output against the sample output. If it is satisfactory, type 99 and proceed to the fuel cycle cost code NFUEL.

The command prompt now appears at the top of the screen. Type X for execute. In response to EXECUTE WHAT FILE? respond with COST2:NFUEL. The sample problem may be reproduced using the default data by typing 0 with no data changes. When it prompts for YEAR OF STARTUP, this is synonymous with YEAR OF FIRST COMMERCIAL OPERATION. Capacity factor is input as a decimal. Again, be sure that the printer is turned on. Turning the printer off will leave the monitor in an apparent hung condition until the printer is turned on. The LAG TIME FOR RECEIPTS of revenues may be input as a decimal fraction of a year or as a real or integer value greater than one year. CREDIT FOR DISCHARGED FISSILE (Y OR N) questions whether a credit should be included for plutonium and uranium recovered in reprocessing. The reference year price for plutonium defaults to zero.

The inflation rate called for in menu item 5 is a decimal estimate of the IPD over the plant lifetime. The EFFECTIVE COST OF MONEY is the weighted-average after tax cost of capital considered to consist of common stock, preferred stock, and debt. Program LEVEL uses individual fractions and returns for each capital component and the marginal tax rate to calculate the effective cost of money. NFUEL assumes that the after tax cost of capital is known. It is suggested that the user of NFUEL might want to start with an estimated cost of money and then adjust the results after running LEVEL. Item 7, INCOME TAX RATE, is the combined state and federal rate, which is calculated in LEVEL from state and federal income tax rates.

Reference year prices (menu items 9 through 15) prompt for the correct units of price. The PRICE ESCALATION RATES called for represent the combination of the inflation rate and a real cost escalation rate. In the example, all prices other than U_3O_8 are assumed to rise in line with the general inflation rate. Compare the output with the sample case. If it is satisfactory, type 99, and proceed to the levelized cost code.

With the command prompt on the screen type X for execute. In response to EXECUTE WHAT FILE? type COST2:LEVEL. LEVEL applies to both LWR and coal-fired plants, therefore menu item 1 calls for plant type as either N for nuclear or C for coal-fired. Plant type defaults to nuclear. While the capital investment cost code printed costs for one through four units for all runs, LEVEL requires that the user input the number of units or accept the default values of single unit for LWR or two units for coal-fired plants. The inflation and escalation rates called for are the expected change in the IPD and the real (differential) escalation rate. Financial returns and capitalization fractions are those required to calculate effective (after tax) cost of money.

It is suggested that the user might want to make a first run using default data (i.e., type 0) followed by a practice case with the maximum amount of input. Input each menu item number, and respond with the data from Sect. 5. Once again menu item 99 exits the program. The results of both of the above cases should be identical and should agree with the sample problem output included in Appendixes A and B. Compare your output with the sample problem output. Careful inspection of the output

should enable you to find any differences and to rerun the example to produce identical output.

It was pointed out earlier that the Pascal programs do not ask for as much input data as the original IBM Fortran programs due to size limitations. It was also pointed out that the variables do exist within the Pascal programs to change many other variables from the original IBM routines. The CONCEPT Fortran program and the REFCO Fortran program were too large to be translated directly to Pascal, but the OMCOST Fortran program allowed for direct translation into three Pascal segments.

It is not practical to describe the features of the Apple Pascal EDITOR within this user's manual. Thus the reader is referred to Refs. 6, 7, and 8 for further information on the Apple II Plus system and Apple Pascal.

Appendix A

SAMPLE PROBLEM OUTPUT FOR PWR PLANT

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

VERSION 19-OCT-83

EEEDB PHASE V, 1/82 REGULATORY STATUS

PWR POWER PLANT

YEAR STEAM SUPPLY SYSTEM PURCHASE 1983.00

YEAR CONSTRUCTION PERMIT 1988.00

YEAR OF COMMERCIAL OPERATION 1995.00

INTEREST RATE DURING CONST. (PCT/YR) 9.0

ESCALATION RATE (PCT/YR) 7.0

CONTINGENCY (PCT) 15.0

NET RATING PER UNIT (MWE) 1100

DIRECT COSTS (\$MILLIONS)

20 LAND	5.4
21 STRUCTURES	272.8
22 REACTOR PLANT	307.9
23 TURBINE PLANT	239.5
24 ELECTRIC PLANT	118.2
25 MISC PLANT	38.7
26 MAIN COND HT RJ	46.6

SUBTOTAL DIRECTS 1028.9

INDIRECT COSTS

91 CONSTR SERVICES	136.9
92 HOME OFFICE ENG	289.0
93 FIELD OFFICE	140.3
94 OWNER COSTS	163.0

SUBTOTAL INDIRECTS 729.3

SUBTOTAL DIRECT & INDIRECT 1758.2

CONTINGENCY ALLOWANCE 263.7

TOTAL DIRECT AND INDIRECT COSTS BEFORE ESC. 2022.0

ESCALATION DURING CONSTRUCTION 1203.5

TOTAL ESCALATED DIRECT & INDIRECT COSTS 3225.5

TOTAL INTEREST DURING CONSTRUCTION 1809.0

TOTAL PLANT CAPITAL INVESTMENT (MIDDLETOWN) 5034.5

PLANT LOCATION ADJUSTMENT (CHICAGO) -89.1

1 UNIT PLANT CAPITAL INVESTMENT (	4496 \$/KWE)	4945.4
2 UNIT PLANT CAPITAL INVESTMENT (	3865 \$/KWE)	8503.7
3 UNIT PLANT CAPITAL INVESTMENT (	3671 \$/KWE)	12113.8
4 UNIT PLANT CAPITAL INVESTMENT (	3574 \$/KWE)	15724.0

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

VERSION 22-NOV-83

INPUT DATA

PLANT TYPE	NUCLEAR
YEAR STEAM SUPPLY SYSTEM PURCHASE	1983.00
YEAR CONSTRUCTION PERMIT	1988.00
YEAR OF COMMERCIAL OPERATION	1995.00
INTEREST RATE DURING CONSTRUCTION (PCT/YR)	9.0
ESCALATION RATE (PCT/YR)	7.0
CONTINGENCY (PCT)	15.0
NET RATING PER UNIT (MWE)	1100
PLANT LOCATION	CHICAGO
BASE YEAR FOR DIRECT AND INDIRECT COST INPUT	1982.00
BASE SIZE FOR DIRECT AND INDIRECT COST INPUT	1139
DIRECT COSTS AT BASE SIZE/YEAR (\$MILLIONS)	981.7
INDIRECT COSTS AT BASE SIZE/YEAR (\$MILLIONS)	690.0

OVERNIGHT COSTS (YEAR SSS PURCHASE, \$MILLIONS)

DIRECT COSTS	1029.3
INDIRECT COSTS	729.4
SUBTOTAL DIRECT & INDIRECT COSTS	1758.7
CONTINGENCY ALLOWANCE	263.8
TOTAL DIRECT & INDIRECT COSTS BEFORE ESC.	2022.5
ESCALATION DURING CONSTRUCTION	1203.9
TOTAL ESCALATED DIRECT & INDIRECT COSTS	3226.4
TOTAL INTEREST DURING CONSTRUCTION	1809.5
TOTAL PLANT CAPITAL INVESTMENT (MIDDLETOWN)	5035.9
PLANT LOCATION ADJUSTMENT (CHICAGO)	-89.1
1 UNIT PLANT CAPITAL INVESTMENT (4497 \$/KWE)	4946.8
2 UNIT PLANT CAPITAL INVESTMENT (3866 \$/KWE)	8506.1
3 UNIT PLANT CAPITAL INVESTMENT (3672 \$/KWE)	12117.2
4 UNIT PLANT CAPITAL INVESTMENT (3575 \$/KWE)	15728.3

SUMMARY OF ANNUAL NONFUEL O&M COST FOR PWR
POWER PLANT

VERSION 19-OCT-83

NET RATING OF EACH UNIT (MWE)	1100
NUMBER OF UNITS PER PLANT	1
BASE LOAD CAPACITY FACTOR	0.65
ESCALATION RATE (PCT/YR)	6.00
THERMAL INPUT PER UNIT (MWT)	3449
PLANT NET HEAT RATE (BTU/KWH)	10700
PLANT NET EFFICIENCY (PCT)	31.9
ANNUAL NET GENERATION (MILLION KWH)	6268
YEAR OF ESTIMATE	1983

DIRECT COSTS. (\$MILLION/YEAR)

STAFF ONSITE	15.72
(401 PERSONS AT \$ 39191.3)	
MAINTENANCE MATERIAL	4.56
FIXED	3.59
VARIABLE	0.97
SUPPLIES AND EXPENSES	5.75
FIXED	5.09
VARIABLE	0.66
FEEs, INSPECTIONS, REVIEWS	0.52
OFFSITE SUPPORT SERVICES	3.92

INDIRECT COSTS (\$MILLION/YEAR)

ADMINISTRATIVE AND GENERAL	10.96
COMMERCIAL LIABILITY INSURANCE	0.42
RETROSPECTIVE PREMIUM	0.01
GOVERNMENT LIABILITY INSURANCE	0.02
PROPERTY INSURANCE (PRIMARY)	2.12
PROPERTY INSURANCE (EXCESS)	1.70
REPLACEMENT POWER INSURANCE	2.12
OTHER A&G	4.57

COSTS (\$MILLION/YEAR)

TOTAL FIXED DIRECTS AND INDIRECTS	39.8
TOTAL VARIABLE DIRECTS AND INDIRECTS	1.6
TOTAL ANNUAL NONFUEL O&M	41.4

UNIT COSTS (MILLS/KWH)

FIXED DIRECTS AND INDIRECTS	6.35
VARIABLE DIRECTS AND INDIRECTS	0.26
TOTAL NONFUEL O&M	6.61

INPUT DATA:

YEAR OF STARTUP	1995.0
CAPACITY FACTOR	0.65
LAG TIME (YEARS)	0.50
NO CREDIT FOR DISCHARGED FISSILE	
BASE YEAR FOR COST DATA	1982.0
INFLATION RATE	0.060
EFFECTIVE COST OF MONEY	0.0900
INCOME TAX RATE	0.4816

REFERENCE YEAR PRICES

U308 (\$/LB)	32.20
CONVERSION (\$/KG)	8.00
ENRICHMENT (\$/SWU)	130.00
PLUTONIUM (\$/GM)	0.00
FABRICATION (\$/KG)	180.00
BACK END (REPROCESSING) (\$/KG)	0.00
WASTE DISPOSAL (MILLS/KWH)	1.00

PRICE ESCALATION RATES

U308	0.092
CONVERSION	0.060
ENRICHMENT	0.060
PLUTONIUM	0.060
FABRICATION	0.060
BACK END (REPROCESSING)	0.060
WASTE DISPOSAL	0.060

 LEVELIZED FUEL CYCLE COSTS, MILLS/KWH

VERSION 30-DEC-83

	CURRENT DOLLARS	CONSTANT DOLLARS
URANIUM PURCHASE	23.881	5.741
CONVERSION PURCH.	1.063	0.255
ENRICHMENT PURCH.	13.201	3.173
PLUTONIUM PURCHASE	0.000	0.000
FABRICATION	4.323	1.039
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	4.159	1.000
	46.627	11.208

VERSION 17-OCT-83

INPUT DATA

PROJECT LIFE, YEARS	30
LEVELIZING PERIOD, YEARS	30
INFLATION FACTOR (1 + RATE)	1.06
INTERIM REPLACEMENT ESCALATION FACTOR	1.06
EFFECTIVE INCOME TAX RATE	0.4816
TOTAL INITIAL CAPITAL INVESTMENT, \$	1000.0
TAX DEDUCTABLE FRACTION OF TOTAL CAPITAL INVESTMENT	0.6470
INVESTMENT TAX CREDIT RATE	0.08
INTEREST RATE ON DEBT	0.1000
RETURN ON PREFERRED STOCK	0.0900
RETURN ON COMMON STOCK	0.1400
DEBT FRACTION	0.5000
PREFERRED STOCK FRACTION	0.1200
COMMON STOCK FRACTION	0.3800
PROPERTY TAX RATE	0.02
INTERIM REPLACEMENT RATE	0.01
NORMALIZED ACCOUNTING	
ACRS CLASS: 10-YEAR PROPERTY	

YEAR	RATE BASE	RETURN ON CAP	BOOK DEPR	TAX DEPR	INC CURR	TAX DEFER	PROP TAX	INTRM REPL	REV CURR\$	REQ CONST\$
1	948.2	108.1	33.3	51.8	52.8	14.5	20.0	10.6	239.3	225.8
2	902.1	102.8	33.3	90.6	31.3	33.2	20.0	11.2	232.0	206.5
3	837.2	95.4	33.3	77.6	33.7	27.0	20.0	11.9	221.4	185.9
4	778.6	88.8	33.3	64.7	36.5	20.8	20.0	12.6	211.9	167.9
5	726.3	82.8	33.3	64.7	33.3	20.8	20.0	13.4	203.6	152.2
6	673.9	76.8	33.3	64.7	30.2	20.8	20.0	14.2	195.3	137.7
7	621.5	70.8	33.3	58.2	30.2	17.7	20.0	15.0	187.1	124.4
8	572.2	65.2	33.3	58.2	27.3	17.7	20.0	15.9	179.5	112.6
9	523.0	59.6	33.3	58.2	24.4	17.7	20.0	16.9	171.9	101.7
10	473.7	54.0	33.3	58.2	21.4	17.7	20.0	17.9	164.3	91.8
11	424.4	48.4	33.3	0.0	46.6	-10.4	20.0	19.0	156.9	82.6
12	403.2	46.0	33.3	0.0	45.3	-10.4	20.0	20.1	154.3	76.7
13	382.0	43.5	33.3	0.0	44.0	-10.4	20.0	21.3	151.9	71.2
14	360.8	41.1	33.3	0.0	42.8	-10.4	20.0	22.6	149.5	66.1
15	339.5	38.7	33.3	0.0	41.5	-10.4	20.0	24.0	147.1	61.4
16	318.3	36.3	33.3	0.0	40.2	-10.4	20.0	25.4	144.9	57.0
17	297.1	33.9	33.3	0.0	39.0	-10.4	20.0	26.9	142.7	53.0
18	275.9	31.5	33.3	0.0	37.7	-10.4	20.0	28.5	140.7	49.3
19	254.7	29.0	33.3	0.0	36.5	-10.4	20.0	30.3	138.7	45.8
20	233.4	26.6	33.3	0.0	35.2	-10.4	20.0	32.1	136.8	42.7
21	212.2	24.2	33.3	0.0	33.9	-10.4	20.0	34.0	135.1	39.7
22	191.0	21.8	33.3	0.0	32.7	-10.4	20.0	36.0	133.4	37.0
23	169.8	19.4	33.3	0.0	31.4	-10.4	20.0	38.2	131.9	34.5
24	148.6	16.9	33.3	0.0	30.2	-10.4	20.0	40.5	130.5	32.2
25	127.3	14.5	33.3	0.0	28.9	-10.4	20.0	42.9	129.3	30.1
26	106.1	12.1	33.3	0.0	27.6	-10.4	20.0	45.5	128.2	28.2
27	84.9	9.7	33.3	0.0	26.4	-10.4	20.0	48.2	127.2	26.4
28	63.7	7.3	33.3	0.0	25.1	-10.4	20.0	51.1	126.4	24.7
29	42.4	4.8	33.3	0.0	23.8	-10.4	20.0	54.2	125.8	23.2
30	21.2	2.4	33.3	0.0	22.6	-10.4	20.0	57.4	125.4	21.8

SUM OF THE PRESENT WORTH OF THE REVENUE REQUIREMENTS AT

(8.992 % COST OF MONEY)

1876.8

(2.823 % COST OF MONEY)

1876.8

FIXED CHARGE RATE

CURRENT DOLLAR RATE = 0.1826

CONSTANT DOLLAR RATE = 0.0936

VERSION 19-OCT-83

PLANT TYPE	NUCLEAR
YEAR OF FIRST COMMERCIAL OPERATION	1995.0
RATING PER UNIT (MWE)	1100.0
UNITS PER PLANT	1
PLANT LIFE	30.0
INFLATION RATE	0.06
REAL COST ESCALATION RATE	0.01
STATE INCOME TAX RATE	0.0400
FEDERAL INCOME TAX RATE	0.4600
EFFECTIVE INCOME TAX RATE	0.4816
RETURN ON COMMON STOCK	0.14
COMMON STOCK FRACTION	0.38
INTEREST RATE ON DEBT	0.10
DEBT FRACTION	0.50
RETURN ON PREFERRED STOCK	0.09
PREFERRED STOCK FRACTION	0.12
EFFECTIVE COST OF MONEY	0.090
CONSTANT DOLLAR LEVELIZED COST YEAR	1983.0
FIXED CHARGE RATE	0.183
PLANT INVESTMENT COST (1995.0 \$MILLIONS)	4945.4
CAPACITY FACTOR	0.65
FEDERAL GOVERNMENT DEBT RATE	0.085
DECOMMISSIONING COST (1983.0 \$MILLIONS)	130.0
LEVELIZED O&M COST (1983.0 MILLS/KWH)	6.61
LEVELIZED FUEL COST (1983.0 MILLS/KWH)	11.21

LEVELIZED POWER GENERATION COSTS
MILLS/KWH

	CONSTANT	CURRENT
CAPITAL	36.8	144.5
OPERATION & MAINT.	6.6	25.9
FUEL	11.2	44.0
DECOMMISSIONING	0.5	1.9
	55.1	216.4

Appendix B

SAMPLE PROBLEM OUTPUT FOR COAL-FIRED PLANT

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

VERSION 19-OCT-83

EEDB PHASE V, 1/82 REGULATORY STATUS

COAL-FIRED POWER PLANT

YEAR STEAM SUPPLY SYSTEM PURCHASE 1987.00

YEAR CONSTRUCTION PERMIT 1990.00

YEAR OF COMMERCIAL OPERATION 1995.00

INTEREST RATE DURING CONST. (PCT/YR) 9.0

ESCALATION RATE (PCT/YR) 7.0

CONTINGENCY (PCT) 15.0

NET RATING PER UNIT (MWE) 550

DIRECT COSTS (\$MILLIONS)

20 LAND 7.0

21 STRUCTURES 83.5

22 REACTOR PLANT 288.7

23 TURBINE PLANT 128.3

24 ELECTRIC PLANT 58.2

25 MISC PLANT 19.9

26 MAIN COND HT RJ 24.1

SUBTOTAL DIRECTS 609.7

INDIRECT COSTS

91 CONSTR SERVICES 53.9

92 HOME OFFICE ENG 35.2

93 FIELD OFFICE 30.3

94 OWNER COSTS 74.8

SUBTOTAL INDIRECTS 194.2

SUBTOTAL DIRECT & INDIRECT 803.9

CONTINGENCY ALLOWANCE 120.6

TOTAL DIRECT AND INDIRECT COSTS BEFORE ESC. 924.5

ESCALATION DURING CONSTRUCTION 344.2

TOTAL ESCALATED DIRECT & INDIRECT COSTS 1268.7

TOTAL INTEREST DURING CONSTRUCTION 426.4

TOTAL PLANT CAPITAL INVESTMENT (MIDDLETOWN) 1695.1

PLANT LOCATION ADJUSTMENT (CHICAGO) -43.4

1 UNIT PLANT CAPITAL INVESTMENT (3003 \$/KWE) 1651.7

2 UNIT PLANT CAPITAL INVESTMENT (2783 \$/KWE) 3061.1

3 UNIT PLANT CAPITAL INVESTMENT (2574 \$/KWE) 4247.4

4 UNIT PLANT CAPITAL INVESTMENT (2470 \$/KWE) 5433.8

SUMMARY OF ANNUAL NONFUEL O&M COST FOR
COAL-FIRED POWER PLANT WITH WET LIMESTONE
FGD SYSTEM

VERSION 19-OCT-83

NET RATING OF EACH UNIT (MWE)	550
NUMBER OF UNITS PER PLANT	2
BASE LOAD CAPACITY FACTOR	0.65
ESCALATION RATE (PCT/YR)	6.00
SULFUR (PCT)	3.50
ASH (PCT)	11.60
HEATING VALUE (BTU/#)	11000.0
THERMAL INPUT PER UNIT (MWT)	1596
PLANT NET HEAT RATE (BTU/KWH)	9900
PLANT NET EFFICIENCY (PCT)	34.5
ANNUAL NET GENERATION (MILLION KWH)	6268
YEAR OF ESTIMATE	1983

DIRECT COSTS (\$MILLION/YEAR)

STAFF ONSITE	10.09
(295 PERSONS AT \$ 34214.6)	
MAINTENANCE MATERIAL	4.23
FIXED	3.35
VARIABLE	0.88
SUPPLIES AND EXPENSES	13.79
FIXED	4.66
VAR. - PLANT	0.80
- LIMESTONE	4.71
- ASH, FGD SLUDGE	3.62
OFFSITE SUPPORT SERVICES	1.18

INDIRECT COSTS (\$MILLION/YEAR)

ADMINISTRATIVE AND GENERAL	3.14
PROPERTY INSURANCE	0.21
OTHER A&G	2.93

COSTS (\$MILLION/YEAR)

TOTAL FIXED DIRECTS AND INDIRECTS	22.4
TOTAL VARIABLE DIRECTS AND INDIRECTS	10.0
TOTAL ANNUAL NONFUEL O&M	32.4

UNIT COSTS (MILLS/KWH)

FIXED DIRECTS AND INDIRECTS	3.58
VARIABLE DIRECTS AND INDIRECTS	1.60
TOTAL NONFUEL O&M	5.17

L E V E L I Z E D C O A L C O S T

VERSION 2-DEC-83

INPUT DATA

REFERENCE YEAR FOR PRICE OF COAL	1983.0
PRICE OF COAL IN DOLLARS PER MILLION BTU	1.60
YEAR OF PLANT STARTUP	1995.0
PLANT LIFE	30.0
GNP INFLATION RATE	0.060
REAL COST ESCALATION RATE	0.015
EFFECTIVE COST OF MONEY	0.090
PLANT NET HEAT RATE (BTU/KWH)	9900.0

CONSTANT DOLLAR LEVELIZED COST OF COAL	
IN 1983.0 DOLLARS	23.3 MILLS/KWH

VERSION 17-OCT-83

INPUT DATA

PROJECT LIFE, YEARS	30
LEVELIZING PERIOD, YEARS	30
INFLATION FACTOR (1 + RATE)	1.06
INTERIM REPLACEMENT ESCALATION FACTOR	1.06
EFFECTIVE INCOME TAX RATE	0.4816
TOTAL INITIAL CAPITAL INVESTMENT, \$	1000.0
TAX DEDUCTABLE FRACTION OF TOTAL CAPITAL INVESTMENT	0.7530
INVESTMENT TAX CREDIT RATE	0.08
INTEREST RATE ON DEBT	0.1000
RETURN ON PREFERRED STOCK	0.0900
RETURN ON COMMON STOCK	0.1400
DEBT FRACTION	0.5000
PREFERRED STOCK FRACTION	0.1200
COMMON STOCK FRACTION	0.3800
PROPERTY TAX RATE	0.02
INTERIM REPLACEMENT RATE	0.01
NORMALIZED ACCOUNTING	
ACRS CLASS: 15-YEAR PUBLIC UTILITY PROPERTY	

YEAR	RATE BASE	RETURN ON CAP	BOOK DEPR	TAX DEPR	INC CURR	TAX DEFER	PROP TAX	INTRM SUPPL	REV CURR\$	REQ CONST\$
1	939.8	107.1	33.3	37.7	57.5	6.0	20.0	10.6	234.6	221.3
2	902.4	102.9	33.3	75.3	37.1	24.2	20.0	11.2	228.7	203.6
3	846.9	96.5	33.3	67.8	37.5	20.5	20.0	11.9	219.8	184.5
4	795.0	90.6	33.3	60.2	38.0	16.9	20.0	12.6	211.5	167.5
5	746.8	85.1	33.3	52.7	38.8	13.3	20.0	13.4	203.9	152.4
6	702.1	80.0	33.3	52.7	36.1	13.3	20.0	14.2	197.0	138.8
7	657.5	75.0	33.3	45.2	37.1	9.7	20.0	15.0	190.1	126.4
8	616.5	70.3	33.3	45.2	34.6	9.7	20.0	15.9	183.9	115.4
9	575.5	65.6	33.3	45.2	32.2	9.7	20.0	16.9	177.7	105.2
10	534.5	60.9	33.3	45.2	29.8	9.7	20.0	17.9	171.6	95.8
11	493.5	56.3	33.3	45.2	27.3	9.7	20.0	19.0	165.6	87.2
12	452.5	51.6	33.3	45.2	24.9	9.7	20.0	20.1	159.6	79.3
13	411.5	46.9	33.3	45.2	22.4	9.7	20.0	21.3	153.7	72.1
14	370.5	42.2	33.3	45.2	20.0	9.7	20.0	22.6	147.9	65.4
15	329.6	37.6	33.3	45.2	17.6	9.7	20.0	24.0	142.1	59.3
16	288.6	32.9	33.3	0.0	36.9	-12.1	20.0	25.4	136.4	53.7
17	269.3	30.7	33.3	0.0	35.7	-12.1	20.0	26.9	134.6	50.0
18	250.1	28.5	33.3	0.0	34.6	-12.1	20.0	28.5	132.9	46.6
19	230.8	26.3	33.3	0.0	33.5	-12.1	20.0	30.3	131.3	43.4
20	211.6	24.1	33.3	0.0	32.3	-12.1	20.0	32.1	129.8	40.5
21	192.4	21.9	33.3	0.0	31.2	-12.1	20.0	34.0	128.3	37.8
22	173.1	19.7	33.3	0.0	30.0	-12.1	20.0	36.0	127.0	35.3
23	153.9	17.5	33.3	0.0	28.9	-12.1	20.0	38.2	125.9	33.0
24	134.7	15.4	33.3	0.0	27.7	-12.1	20.0	40.5	124.8	30.8
25	115.4	13.2	33.3	0.0	26.6	-12.1	20.0	42.9	123.9	28.9
26	96.2	11.0	33.3	0.0	25.5	-12.1	20.0	45.5	123.2	27.1
27	76.9	8.8	33.3	0.0	24.3	-12.1	20.0	48.2	122.6	25.4
28	57.7	6.6	33.3	0.0	23.2	-12.1	20.0	51.1	122.1	23.9
29	38.5	4.4	33.3	0.0	22.0	-12.1	20.0	54.2	121.8	22.5
30	19.2	2.2	33.3	0.0	20.9	-12.1	20.0	57.4	121.8	21.2

SUM OF THE PRESENT WORTH OF THE REVENUE REQUIREMENTS AT

(8.992 % COST OF MONEY)

1868.4

(2.823 % COST OF MONEY)

1868.4

FIXED CHARGE RATE

CURRENT DOLLAR RATE = 0.1817

CONSTANT DOLLAR RATE = 0.0931

VERSION 19-OCT-83

PLANT TYPE	COAL-FIRED
YEAR OF FIRST COMMERCIAL OPERATION	1995.0
RATING PER UNIT (MWE)	550.0
UNITS PER PLANT	2
PLANT LIFE	30.0
INFLATION RATE	0.06
REAL COST ESCALATION RATE	0.01
STATE INCOME TAX RATE	0.0400
FEDERAL INCOME TAX RATE	0.4600
EFFECTIVE INCOME TAX RATE	0.4816
RETURN ON COMMON STOCK	0.14
COMMON STOCK FRACTION	0.38
INTEREST RATE ON DEBT	0.10
DEBT FRACTION	0.50
RETURN ON PREFERRED STOCK	0.09
PREFERRED STOCK FRACTION	0.12
EFFECTIVE COST OF MONEY	0.090
CONSTANT DOLLAR LEVELIZED COST YEAR	1983.0
FIXED CHARGE RATE	0.182
PLANT INVESTMENT COST (1995.0 \$MILLIONS)	3061.1
CAPACITY FACTOR	0.65
LEVELIZED O&M COST (1983.0 MILLS/KWH)	5.17
LEVELIZED FUEL COST (1983.0 MILLS/KWH)	23.40

LEVELIZED POWER GENERATION COSTS
MILLS/KWH

	CONSTANT	CURRENT
CAPITAL	22.7	88.9
OPERATION & MAINT.	5.2	20.3
FUEL	23.4	91.9
	51.2	201.1

SUMMARY OF ANNUAL NONFUEL O&M COST FOR
COAL-FIRED POWER PLANT WITH DRY
FGD SYSTEM

VERSION 19-OCT-83

NET RATING OF EACH UNIT (MWE)	550
NUMBER OF UNITS PER PLANT	2
BASE LOAD CAPACITY FACTOR	0.65
ESCALATION RATE (PCT/YR)	6.00
SULFUR (PCT)	0.50
ASH (PCT)	7.30
HEATING VALUE (BTU/#)	8200.0
THERMAL INPUT PER UNIT (MWT)	1576
PLANT NET HEAT RATE (BTU/KWH)	9780
PLANT NET EFFICIENCY (PCT)	34.9
ANNUAL NET GENERATION (MILLION KWH)	6268
YEAR OF ESTIMATE	1983
DIRECT COSTS (\$MILLION/YEAR)	
STAFF ONSITE	9.20
(269 PERSONS AT \$ 34214.6)	
MAINTENANCE MATERIAL	3.38
FIXED	2.67
VARIABLE	0.71
SUPPLIES AND EXPENSES	8.16
FIXED	4.66
VAR. - PLANT	0.80
- LIME	0.97
- ASH, FGD SLUDGE	1.72
OFFSITE SUPPORT SERVICES	1.18
INDIRECT COSTS (\$MILLION/YEAR)	
ADMINISTRATIVE AND GENERAL	2.40
PROPERTY INSURANCE	0.21
OTHER A&G	2.19
COSTS (\$MILLION/YEAR)	
TOTAL FIXED DIRECTS AND INDIRECTS	20.1
TOTAL VARIABLE DIRECTS AND INDIRECTS	4.2
TOTAL ANNUAL NONFUEL O&M	24.3
UNIT COSTS (MILLS/KWH)	
FIXED DIRECTS AND INDIRECTS	3.21
VARIABLE DIRECTS AND INDIRECTS	0.67
TOTAL NONFUEL O&M	3.88

43/44

Appendix C

PROGRAM LISTINGS

```

(*$S+*)
PROGRAM PWRCAPC; (* COST1;PWRCAPC.TEXT *)

(*=====*)
(*
(* PWRCAPC
(*
(* CAPITAL INVESTMENT COST FOR
(* LIGHT-WATER-REACTOR PLANTS
(*
(* A SIMPLIFIED ALGORITHM BASED ON:
(* C.R.HUDSON
(* CONCEPT-5 USER'S MANUAL
(* ORNL-5470
(*
(*=====*)

USES
  TRANSCEND, APPLESTUFF;

CONST
  V = '      ';
  VV = '      ';
  VVV = '      ';
  VVVV = '      ';
  VVVVV = '      ';
  BASESIZE = 1139.0;
  BASEYEAR = 1982.0;
  PI = 3.14159;
  REF = 5822.0;

VAR
  Z : INTERACTIVE;

  NUM, COUNT, UNITS ,NOYEAR, ACCOUNT, CITYNUMBER: INTEGER;

  EQUIPMENT, LABOR, MATERIAL, SCALER, COST : ARRAY[20..26] OF REAL;

  DOLKW, MULT2, NEWNUMBER : ARRAY[1..4] OF REAL;

  INDIRECT, SCALEIND, COSTIND : ARRAY[91..94] OF REAL;

  TITLE : ARRAY [20..26] OF STRING[18];

  TITLE2 : ARRAY [91..94] OF STRING[18];

  TITLE3 : ARRAY [1..11] OF STRING[13];

  R, X, Y,
  BE, EM,
  XXI,
  MULT, SIZE, SUB1, SUB2, SUB3, SUB4, WINT,

```

```

ESCVR, ESFAC, WOBEG, WOFND, FORVR,
AVWCAP, CAPINT, ESCBEG, ESCEND, ESCTOT,
LOCADJ, NEWLOC, RCOUNT, YEAROP, YEARSS,
ESCRATE,
CONALLOW, ESFACTOR, INTEREST,
YEARPERMIT,
CONTINGENCY : REAL;

```

```

ANSWER : CHAR;

```

```

FUNCTION UPARROW(X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP(Y * LN(X))
END;

```

```

PROCEDURE INIT01;
BEGIN
  YEARSS := 1983.0;
  YEARPERMIT := 1988.0;
  YEAROP := 1995.0;
  INTEREST := 9.0;
  ESCRATE := 7.0;
  CONTINGENCY := 15.0;
  CITYNUMBER := 5;
  SIZE := 1100.0
END;

```

```

PROCEDURE INIT02;
BEGIN
  TITLE3[1] := 'MIDDLETOWN';
  TITLE3[2] := 'ATLANTA';
  TITLE3[3] := 'BALTIMORE';
  TITLE3[4] := 'BOSTON';
  TITLE3[5] := 'CHICAGO';
  TITLE3[6] := 'DALLAS';
  TITLE3[7] := 'DENVER';
  TITLE3[8] := 'KANSAS CITY';
  TITLE3[9] := 'NEW YORK';
  TITLE3[10] := 'SAN FRANCISCO';
  TITLE3[11] := 'SEATTLE';
END;

```

```

PROCEDURE INIT03;
BEGIN
  EQUIPMENT[20] := 5.00;
  EQUIPMENT[21] := 10.818;
  EQUIPMENT[22] := 200.974;
  EQUIPMENT[23] := 163.640;
  EQUIPMENT[24] := 28.672;
  EQUIPMENT[25] := 14.700;
  EQUIPMENT[26] := 22.056;

```

```

LABOR[20] := 0.0;
LABOR[21] := 171.920;
LABOR[22] := 76.493;
LABOR[23] := 56.865;
LABOR[24] := 69.892;
LABOR[25] := 18.631;
LABOR[26] := 19.227;
MATERIAL[20] := 0.00;
MATERIAL[21] := 76.687;
MATERIAL[22] := 16.332;
MATERIAL[23] := 9.676;
MATERIAL[24] := 13.450;
MATERIAL[25] := 3.189;
MATERIAL[26] := 3.452
END;

PROCEDURE INIT04;
BEGIN
  SCALER[20] := 0.0;
  SCALER[21] := 0.5;
  SCALER[22] := 0.6;
  SCALER[23] := 0.8;
  SCALER[24] := 0.4;
  SCALER[25] := 0.3;
  SCALER[26] := 0.8;
  INDIRECT[91] := 130.0;
  INDIRECT[92] := 272.0;
  INDIRECT[93] := 133.0;
  INDIRECT[94] := 155.0;
  SCALEIND[91] := 0.450;
  SCALEIND[92] := 0.200;
  SCALEIND[93] := 0.400;
  SCALEIND[94] := 0.500;
  MULT2[1] := 1.0;
  MULT2[2] := (5761.0+4250.0) / REF;
  MULT2[3] := (5761.0+4250.0+4250.0) / REF;
  MULT2[4] := (5761.0+4250.0+4250.0+4250.0) / REF
END;

PROCEDURE INIT05;
BEGIN
  TITLE[20] := '20 LAND';
  TITLE[21] := '21 STRUCTURES';
  TITLE[22] := '22 REACTOR PLANT';
  TITLE[23] := '23 TURBINE PLANT';
  TITLE[24] := '24 ELECTRIC PLANT';
  TITLE[25] := '25 MISC PLANT';
  TITLE[26] := '26 MAIN COND HT RJ';
  TITLE2[91] := '91 CONSTR SERVICES';
  TITLE2[92] := '92 HOME OFFICE ENG';
  TITLE2[93] := '93 FIELD OFFICE';
  TITLE2[94] := '94 OWNER COSTS';
END;

```

```
PROCEDURE CITYMULT;
BEGIN
```

```
  CASE CITYNUMBER OF
```

```
    1 : MULT := 1.0;
    2 : MULT := 5256.0 / REF;
    3 : MULT := 5423.0 / REF;
    4 : MULT := 5802.0 / REF;
    5 : MULT := 5719.0 / REF;
    6 : MULT := 5467.0 / REF;
    7 : MULT := 5472.0 / REF;
    8 : MULT := 5547.0 / REF;
    9 : MULT := 6008.0 / REF;
   10 : MULT := 6221.0 / REF;
   11 : MULT := 5867.0 / REF;
```

```
  END
END;
```

```
PROCEDURE MEN1;
BEGIN
```

```
  Writeln('THE AVAILABLE MENU OPTIONS AND THEIR');
  Writeln('VALUES AT THIS TIME ARE:');
  Writeln;
  Writeln('0 = RUN CASE, DATA ENTRY COMPLETE');
  Writeln('1 = YEAR OF STEAM SUPPLY SYSTEM');
  Writeln('   PURCHASE      ',VV,YEARSS:6:1);
  Writeln('2 = YEAR OF CONSTRUCTION');
  Writeln('   PERMIT      ',VVV,YEARPERMIT:6:1);
  Writeln('3 = YEAR OF COMMERCIAL');
  Writeln('   OPERATION    ',VV,YEAROP:6:1);
  Writeln('4 = INTEREST RATE      ',VV,INTEREST:4:1);
  Writeln('5 = ESCALATION RATE    ',VV,ESCRATE:4:1);
  Writeln('6 = CONTINGENCY PERCENTAGE ',CONTINGENCY:4:1);
  Writeln('7 = PLANT SIZE (MWE)     ',V,ROUND(SIZE):4);
  Writeln('8 = CITY NUMBER      ',VVV,CITYNUMBER);
  Writeln('99 = EXIT PROGRAM')
```

```
END;
```

```
PROCEDURE X1;
BEGIN
```

```
  Writeln(' INPUT YEAR OF STEAM SUPPLY SYSTEM PURCHASE');
  Readln(YEARSS)
```

```
END;
```

```
PROCEDURE X2;
BEGIN
```

```
  Writeln(' YEAR OF CONSTRUCTION PERMIT');
  Readln(YEARPERMIT)
```

```
END;
```

```

PROCEDURE X3;
BEGIN
    WRITELN(' YEAR OF COMMERCIAL OPERATION');
    READLN(YEAROP)
END;

PROCEDURE X4;
BEGIN
    WRITELN(' INTEREST RATE DURING CONSTRUCTION');
    WRITELN(V, '(PCT/YR)');
    READLN(INTEREST)
END;

PROCEDURE X5;
BEGIN
    WRITELN(' ESCALATION RATE (PCT/YR)');
    READLN(ESCRATE)
END;

PROCEDURE X6;
BEGIN
    WRITELN(' CONTINGENCY PERCENTAGE');
    READLN(CONTINGENCY)
END;

PROCEDURE X7;
BEGIN
    WRITELN(' INPUT NET RATING PER UNIT (MWE)');
    READLN(SIZE)
END;

PROCEDURE X8;
BEGIN
    FOR COUNT := 1 TO 11 DO
        WRITELN(COUNT, ' ', TITLE3[COUNT]);
        WRITELN(' ENTER CITY NUMBER');
        READLN(CITYNUMBER)
    END;

PROCEDURE MEN2;
BEGIN
    WRITELN('ENTER A NUMBER FROM THE MENU');
    READLN(NUM);
    CASE NUM OF
        0: ;
        1: X1;
        2: X2;
        3: X3;
        4: X4;
        5: X5;
        6: X6;

```

```

7: X7;
8: X8;
99: EXIT(PROGRAM);
END;
WRITELN
END;

```

```

PROCEDURE WRITEIT1;
BEGIN

```

```

WRITELN(Z,V,' CAPITAL COST ESTIMATE');
WRITELN(Z);
WRITELN(Z,VV,' VERSION 19-OCT-83');
WRITELN(Z);
WRITELN(Z,V,' EEDR PHASE V, 1/82 REGULATORY STATUS');
WRITELN(Z,V,' PWR POWER PLANT');
WRITELN(Z,V,' YEAR STEAM SUPPLY SYSTEM PURCHASE', YEARSS:7:2);
WRITELN(Z,V,' YEAR CONSTRUCTION PERMIT ',V,YEARPERMIT:7:2);
WRITELN(Z,V,' YEAR OF COMMERCIAL OPERATION',V,YEAROP:7:2);
WRITELN(Z,V,' INTEREST RATE DURING CONST. (PCT/YR) ', INTEREST:4:1);
WRITELN(Z,V,' ESCALATION RATE (PCT/YR) ',VV,ESCRATE:4:1);
WRITELN(Z,V,' CONTINGENCY (PCT) ',VV,CONTINGENCY:4:1);
WRITELN(Z,V,' NET RATING PER UNIT (MWE) ',VV,ROUND(SIZE):4)
END;

```

```

PROCEDURE SCALEIT1;
BEGIN

```

```

WRITELN('<<< CALCULATIONS TAKING PLACE >>>');
SUB1 := 0.0;
SUB2 := 0.0;
ESFACTOR := UPARROW((1.0+ESCRATE/100.0),
(YEARSS-BASEYEAR));
WRITELN(Z);
WRITELN(Z,V,' DIRECT COSTS ($MILLIONS)');
FOR ACCOUNT := 20 TO 26 DO
BEGIN
COST[ACCOUNT] := (EQUIPMENT[ACCOUNT] + LABOR[ACCOUNT] +
MATERIAL[ACCOUNT]) * UPARROW((SIZE / BASESIZE), SCALER[ACCOUNT]) *
ESFACTOR;
WRITELN(Z,V,' ',TITLE[ACCOUNT],VV,COST[ACCOUNT]:8:1);
SUB1 := SUB1 + COST[ACCOUNT];
END; (* FOR ACCOUNT *)
WRITELN(Z,V,' SUBTOTAL DIRECTS ',VVVV,V,SUB1:8:1);
WRITELN(Z)
END;

```

```

PROCEDURE SCALEIT2;
BEGIN

```

```

WRITELN(Z,V,' INDIRECT COSTS');
FOR ACCOUNT := 91 TO 94 DO

```

```

BEGIN
  COSTIND[ACCOUNT] :=
    INDIRECT[ACCOUNT] *
    UPARROW((SIZE / BASESIZE), SCALEIND[ACCOUNT]) * ESFACTOR;
  WRITELN(Z,V,' ',TITLE2[ACCOUNT],VVV,COSTIND[ACCOUNT]:8:1);
  SUB2 := SUB2 + COSTIND[ACCOUNT];
END; (* FOR ACCOUNT *)
WRITELN(Z,V,' SUBTOTAL INDIRECTS ',VVVV,SUB2:8:1);
WRITELN(Z);
SUB3 := (SUB1 + SUB2);
WRITELN(Z,V,' SUBTOTAL DIRECT & INDIRECT ',VVVV,
  SUB3:8:1);
WRITELN(Z);
CONALLOW := CONTINGENCY * SUB3 / 100.0;
WRITELN(Z,V,' CONTINGENCY ALLOWANCE ',VVVV,
  CONALLOW:8:1);
SUB4 := SUB3 + CONALLOW
END;

PROCEDURE INTESC;
BEGIN
  XX1 := (0.095 / 0.3333) * ((YEARPERMIT - YEARSS) / (YEAROP - YEARSS));
  EM := PI / (1.0 - XX1);
  BE := PI / 2.0 - EM;
  NOYEAR := ROUND(YEAROP-YEARSS);
  CAPINT := 0.0;
  ESCTOT := 0.0;
  ESCBEG := 0.0;
  ESFAC := (1.0+ESCRATE/200.0) / (1.0+ESCRATE/100.0);
  WOBEG := 0.0;
  FOR COUNT := 1 TO NOYEAR DO
    BEGIN
      RCOUNT := COUNT;
      X := RCOUNT / NOYEAR;
      IF X < XX1 THEN X := XX1;
      R := EM * X + BE;
      Y := 0.5 * SIN(R) + 0.5;
      WOEND := SUB4 * Y;
      ESFAC := (1.0 + ESCRATE/100.0) * ESFAC;
      ESCYR := (WOEND-WOBEG) * (ESFAC - 1.0);
      ESCBEG := ESCTOT + WOBEG;
      WOBEG := WOEND;
      ESCTOT := ESCTOT + ESCYR;
      ESCEND := WOEND + ESCTOT;
      AVWCAP := (ESCBEG+ESCEND)/2.0 + CAPINT;
      FORYR := AVWCAP * INTEREST/100.0;
      CAPINT := CAPINT + FORYR;
      WINT := ESCEND + CAPINT;
      LOCADJ := WINT * (MULT-1.0);
      NEWLOC := WINT + LOCADJ;
      FOR UNITS := 1 TO 4 DO

```

```

        BEGIN
            NEWNUMBER[UNITS] := NEWLOC * MULT2[UNITS];
            DOLKW[UNITS] := NEWNUMBER[UNITS] * 1000.0 / (SIZE * UNITS);
        END; (* FOR UNITS *)
    END (* FOR COUNT *)
END; (* INTESC *)

PROCEDURE WRITEIT2;
BEGIN
    WRITELN(Z);
    WRITELN(Z,V,' TOTAL DIRECT AND INDIRECT COSTS BEFORE ESC.      ',WOEND:8:1);
    WRITELN(Z);
    WRITELN(Z,V,' ESCALATION DURING CONSTRUCTION      ',VVV,ESCTOT:8:1);
    WRITELN(Z);
    WRITELN(Z,V,' TOTAL ESCALATED DIRECT & INDIRECT COSTS      ',V,ESSEND:8:1);
    WRITELN(Z);
    WRITELN(Z,V,' TOTAL INTEREST DURING CONSTRUCTION      ',VV,CAPINT:8:1);
    WRITELN(Z);
    WRITELN(Z,V,' TOTAL PLANT CAPITAL INVESTMENT (MIDDLETOWN)      ',WINT:8:1)
END;

PROCEDURE WRITEIT3;
BEGIN
    WRITELN(Z);
    WRITELN(Z,V,' PLANT LOCATION ADJUSTMENT (' ,TITLE3[CITYNUMBER],') ',
    V,LOCADJ:8:1);
    WRITELN(Z);
    WRITELN(Z,V,' 1 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[1]):6,' $/KWE) ',NEWNUMBER[1]:8:1);
    WRITELN(Z,V,' 2 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[2]):6,' $/KWE) ',NEWNUMBER[2]:8:1);
    WRITELN(Z,V,' 3 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[3]):6,' $/KWE) ',NEWNUMBER[3]:8:1);
    WRITELN(Z,V,' 4 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[4]):6,' $/KWE) ',NEWNUMBER[4]:8:1);

    WRITELN;
    WRITELN('<<<  CASE COMPLETE  >>>');
END;

BEGIN
    REWRITE(Z, 'PRINTER:');

    INIT01;
    INIT02;
    INIT03;
    INIT04;
    INIT05;

```

```
REPEAT
  REPEAT
    MEN1;
    MEN2;
  UNTIL NUM = 0;

  CITYMULT;

  WRITEIT1;

  SCALEIT1;
  SCALEIT2;

  INTESC;

  WRITEIT2;
  WRITEIT3;
  PAGE(Z);
UNTIL NUM = 99
END.
```

```
(*$S+*)
PROGRAM COALCAPC; (* COST1:COALCAPC.TEXT *)
```

```
(*=====*)
(*                                     *)
(* COALCAPC                           *)
(*                                     *)
(* CAPITAL INVESTMENT COST FOR        *)
(* COAL-FIRED POWER PLANTS            *)
(*                                     *)
(* A SIMPLIFIED ALGORITHM BASED ON:   *)
(* C.R.HUDSON                         *)
(* CONCEPT-5 USER'S MANUAL          *)
(* ORNL-5470                          *)
(*                                     *)
(*=====*)
```

```
USES
    TRANSCEND, APPLESTUFF;
```

```
CONST
    V = '          ';
    VV = '          ';
    VVV = '          ';
    VVVV = '          ';
    VVVVV = '          ';
    BASESIZE = 795.0;
    BASEYEAR = 1982.0;
    PI = 3.14159;
    REF = 1718.0;
```

```
VAR
    Z : INTERACTIVE;

    NUM, COUNT, UNITS, NOYEAR, ACCOUNT, CITYNUMBER : INTEGER;

    EQUIPMENT, LABOR, MATERIAL, SCALER, COST : ARRAY[20..26] OF REAL;

    DOIKW, MULT2, NEWNUMBER : ARRAY[1..4] OF REAL;

    INDIRECT, SCALEIND, COSTIND : ARRAY[91..94] OF REAL;

    TITLE : ARRAY [20..26] OF STRING;

    TITLE2 : ARRAY [91..94] OF STRING;

    TITLE3 : ARRAY [1..11] OF STRING;

    R, X, Y,
    BE, EM,
    XX1,
    MULT, SIZE, SUB1, SUB2, SUB3, SUB4, WINT,
```

```

ESCVR, ESFAC, WOBEG, WOEND, FORVR,
AVWCAP, CAPINT, ESCBEG, ESCEND, ESCTOT,
LOCADJ, NEWLOC, RCOUNT, YEAROP, YEARSS,
ESCRATE,
CONALLOW, ESFACTOR, INTEREST,
YEARPERMIT,
CONTINGENCY : REAL;

```

```

REPLY : CHAR;

```

```

FUNCTION UPARROW(X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP(Y * LN(X))
END;

```

```

PROCEDURE INIT01;
BEGIN
  YEARSS := 1987.0;
  YEARPERMIT := 1990.0;
  YEAROP := 1995.0;
  INTEREST := 9.0;
  ESCRATE := 7.0;
  CONTINGENCY := 15.0;
  CITYNUMBER := 5;
  SIZE := 550.0
END;

```

```

PROCEDURE INIT02;
BEGIN
  TITLE3[1] := 'MIDDLETOWN' ;
  TITLE3[2] := 'ATLANTA' ;
  TITLE3[3] := 'BALTIMORE' ;
  TITLE3[4] := 'BOSTON' ;
  TITLE3[5] := 'CHICAGO' ;
  TITLE3[6] := 'DALLAS' ;
  TITLE3[7] := 'DENVER' ;
  TITLE3[8] := 'KANSAS CITY' ;
  TITLE3[9] := 'NEW YORK' ;
  TITLE3[10] := 'SAN FRANCISCO';
  TITLE3[11] := 'SEATTLE' ;
END;

```

```

PROCEDURE INIT03;
BEGIN
  EQUIPMENT[20] := 5.00;
  EQUIPMENT[21] := 1.882;
  EQUIPMENT[22] := 170.128;
  EQUIPMENT[23] := 90.682;
  EQUIPMENT[24] := 16.542;
  EQUIPMENT[25] := 8.479;
  EQUIPMENT[26] := 12.902;
  LABOR[20] := 0.0;
  LABOR[21] := 30.808;

```

```

LABOR[22] := 63.680;
LABOR[23] := 25.259;
LABOR[24] := 22.673;
LABOR[25] := 5.746;
LABOR[26] := 9.118;
MATERIAL[20] := 0.00;
MATERIAL[21] := 40.547;
MATERIAL[22] := 23.323;
MATERIAL[23] := 4.893;
MATERIAL[24] := 10.849;
MATERIAL[25] := 1.284;
MATERIAL[26] := 2.236
END;

```

```

PROCEDURE INIT04;
BEGIN

```

```

    SCALER[20] := 0.0;
    SCALER[21] := 0.56358;
    SCALER[22] := 0.60373;
    SCALER[23] := 0.75544;
    SCALER[24] := 0.50817;
    SCALER[25] := 0.24621;
    SCALER[26] := 0.93104;
    INDIRECT[91] := 48.0;
    INDIRECT[92] := 31.0;
    INDIRECT[93] := 28.0;
    INDIRECT[94] := 67.0;
    SCALEIND[91] := 0.60528;
    SCALEIND[92] := 0.57591;
    SCALEIND[93] := 0.70016;
    SCALEIND[94] := 0.620;
    MULT2[1] := 1.0;
    MULT2[2] := (1307.0+1877.0) / REF;
    MULT2[3] := (1234.0+1307.0+1877.0) / REF;
    MULT2[4] := (1234.0+1234.0+1307.0+1877.0) / REF
END;

```

```

PROCEDURE INIT05;
BEGIN

```

```

    TITLE[20] := '20 LAND           ';
    TITLE[21] := '21 STRUCTURES      ';
    TITLE[22] := '22 REACTOR PLANT  ';
    TITLE[23] := '23 TURBINE PLANT  ';
    TITLE[24] := '24 ELECTRIC PLANT ';
    TITLE[25] := '25 MISC PLANT     ';
    TITLE[26] := '26 MAIN COND HT RJ';
    TITLE2[91] := '91 CONSR SERVICES';
    TITLE2[92] := '92 HOME OFFICE ENG';
    TITLE2[93] := '93 FIELD OFFICE   ';
    TITLE2[94] := '94 OWNER COSTS    '
END;

```

```
PROCEDURE CITYMULT;
```

```
BEGIN
```

```
  CASE CITYNUMBER OF
```

```
    1 : MULT := 1.0;
    2 : MULT := 1574.0 / REF;
    3 : MULT := 1609.0 / REF;
    4 : MULT := 1734.0 / REF;
    5 : MULT := 1674.0 / REF;
    6 : MULT := 1632.0 / REF;
    7 : MULT := 1614.0 / REF;
    8 : MULT := 1634.0 / REF;
    9 : MULT := 1733.0 / REF;
   10 : MULT := 1834.0 / REF;
   11 : MULT := 1722.0 / REF;
```

```
  END
```

```
END;
```

```
PROCEDURE MEN1;
```

```
BEGIN
```

```
  Writeln('THE AVAILABLE MENU OPTIONS AND THEIR');
  Writeln('VALUES AT THIS TIME ARE:');
  Writeln;
  Writeln('0 = RUN CASE, DATA ENTRY COMPLETE');
  Writeln('1 = YEAR OF STEAM SUPPLY SYSTEM');
  Writeln('  PURCHASE      ',VV,YEARSS:6:1);
  Writeln('2 = YEAR OF CONSTRUCTION');
  Writeln('  PERMIT      ',VVV,YEARPERMIT:6:1);
  Writeln('3 = YEAR OF COMMERCIAL');
  Writeln('  OPERATION    ',VV,YEAROP:6:1);
  Writeln('4 = INTEREST RATE      ',VV,INTEREST:4:1);
  Writeln('5 = ESCALATION RATE    ',VV,ESCRATE:4:1);
  Writeln('6 = CONTINGENCY PERCENTAGE ',CONINGENCY:4:1);
  Writeln('7 = PLANT SIZE (MWE)      ',V,ROUND(SIZE):4);
  Writeln('8 = CITY NUMBER      ',VVV,CITYNUMBER);
  Writeln('99 = EXIT PROGRAM');
```

```
END;
```

```
PROCEDURE X1;
```

```
BEGIN
```

```
  Writeln(' INPUT YEAR OF STEAM SUPPLY SYSTEM');
  Writeln(' PURCHASE');
  READLN(YEARSS)
```

```
END;
```

```
PROCEDURE X2;
```

```
BEGIN
```

```
  Writeln(' YEAR OF CONSTRUCTION PERMIT');
  READLN(YEARPERMIT)
```

```
END;
```

```

PROCEDURE X3;
BEGIN
  WRITELN(' YEAR OF COMMERCIAL OPERATION');
  READLN(YEAROP)
END;

```

```

PROCEDURE X4;
BEGIN
  WRITELN(' INTEREST RATE DURING CONSTRUCTION ');
  WRITELN(V, '(PCT/YEAR)');
  READLN(INTEREST)
END;

```

```

PROCEDURE X5;
BEGIN
  WRITELN(' ESCALATION RATE (PCT/YR)');
  READLN(ESCRATE)
END;

```

```

PROCEDURE X6;
BEGIN
  WRITELN(' CONTINGENCY PERCENTAGE');
  READLN(CONTINGENCY)
END;

```

```

PROCEDURE X7;
BEGIN
  WRITELN(' INPUT NET RATING PER UNIT (MWE)');
  READLN(SIZE)
END;

```

```

PROCEDURE X8;
BEGIN
  FOR COUNT := 1 TO 11 DO
    WRITELN(COUNT, ' ', TITLE3[COUNT]);
  WRITELN(' ENTER CITY NUMBER');
  READLN(CITYNUMBER)
END;

```

```

PROCEDURE MEN2;
BEGIN
  WRITELN('ENTER A NUMBER FROM THE MENU');
  READLN(NUM);
  CASE NUM OF
    0: ;
    1: X1;
    2: X2;
    3: X3;
    4: X4;
    5: X5;
    6: X6;
    7: X7;
    8: X8;

```

```

      99: EXIT(PROGRAM);
    END;
    Writeln
  END;

```

```

PROCEDURE WRITEIT1;
BEGIN

```

```

  Writeln(Z,V,' CAPITAL COST ESTIMATE');
  Writeln(Z);
  Writeln(Z,VV,' VERSION 19-OCT-83');
  Writeln(Z);
  Writeln(Z,V,' EETB PHASE V, 1/82 REGULATORY STATUS');
  Writeln(Z,V,' COAL-FIRED POWER PLANT');
  Writeln(Z,V,' YEAR STEAM SUPPLY SYSTEM PURCHASE', YEARSS:7:2);
  Writeln(Z,V,' YEAR CONSTRUCTION PERMIT ',V,YEARPERMIT:7:2);
  Writeln(Z,V,' YEAR OF COMMERCIAL OPERATION',V,YEAROP:7:2);
  Writeln(Z,V,' INTEREST RATE DURING CONST. (PCT/YR) ', INTEREST:4:1);
  Writeln(Z,V,' ESCALATION RATE (PCT/YR) ',VV,ESCRATE:4:1);
  Writeln(Z,V,' CONTINGENCY (PCT) ',VVV,CONTINGENCY:4:1);
  Writeln(Z,V,' NET RATING PER UNIT (MWE) ',VV,ROUND(SIZE):4);
END;

```

```

PROCEDURE SCALEIT1;
BEGIN

```

```

  Writeln('<<< CALCULATIONS TAKING PLACE >>>');
  SUB1 := 0.0;
  SUB2 := 0.0;
  ESFACTOR := UPARROW((1.0+ESCRATE/100.0),
    (YEARSS-BASEYEAR));
  Writeln(Z);
  Writeln(Z,V,' DIRECT COSTS ($MILLIONS)');
  FOR ACCOUNT := 20 TO 26 DO
    BEGIN
      COST[ACCOUNT] := (EQUIPMENT[ACCOUNT] + LABOR[ACCOUNT] +
        MATERIAL[ACCOUNT]) * UPARROW((SIZE / BASESIZE), SCALER[ACCOUNT]) *
        ESFACTOR;
      Writeln(Z,V,' ',TITLE[ACCOUNT],VVV,COST[ACCOUNT]:8:1);
      SUB1 := SUB1 + COST[ACCOUNT];
    END; (* FOR ACCOUNT *)
  Writeln(Z,V,' SUBTOTAL DIRECTS ',VVVVV,V,SUB1:8:1);
  Writeln(Z);
END;

```

```

PROCEDURE SCALEIT2;
BEGIN

```

```

  Writeln(Z,V,' INDIRECT COSTS');
  FOR ACCOUNT := 91 TO 94 DO
    BEGIN
      COSTIND[ACCOUNT] :=
        INDIRECT[ACCOUNT] *
        UPARROW((SIZE / BASESIZE),SCALEIND[ACCOUNT]) * ESFACTOR;

```

```

        WRITELN(Z,V,'          ',TITLE2[ACCOUNT],VVV,COSTIND[ACCOUNT]:8:1);
        SUB2 := SUB2 + COSTIND[ACCOUNT];
    END; (* FOR ACCOUNT *)
    WRITELN(Z,V,' SUBTOTAL INDIRECTS      ',VVVV,SUB2:8:1);
    WRITELN(Z);
    SUB3 := (SUB1 + SUB2);
    WRITELN(Z,V,' SUBTOTAL DIRECT & INDIRECT ',VVVV,
        SUB3:8:1);
    WRITELN(Z);
    CONALLOW := CONTINGENCY * SUB3 / 100.0;
    WRITELN(Z,V,' CONTINGENCY ALLOWANCE      ',VVVV,
        CONALLOW:8:1);
    SUB4 := SUB3 + CONALLOW
END;

PROCEDURE INTESC;
BEGIN
    XX1 := (0.13177 / 0.3333) * ((YEARPERMIT - YEARSS) / (YEAROP - YEARSS));
    EM := PI / (1.0 - XX1);
    BE := PI / 2.0 - EM;
    NOYEAR := ROUND(YEAROP-YEARSS);
    CAPINT := 0.0;
    ESCTOT := 0.0;
    ESCBEG := 0.0;
    ESFAC := (1.0+ESCRATE/200.0) / (1.0+ESCRATE/100.0);
    WOBEG := 0.0;
    FOR COUNT := 1 TO NOYEAR DO
        BEGIN
            RCOUNT := COUNT;
            X := RCOUNT / NOYEAR;
            IF X < XX1 THEN X := XX1;
            R := EM * X + BE;
            Y := 0.5 * SIN(R) + 0.5;
            WOEND := SUB4 * Y;
            ESFAC := (1.0 + ESCRATE/100.0) * ESFAC;
            ESCYR := (WOEND-WOBEG) * (ESFAC - 1.0);
            ESCBEG := ESCTOT + WOBEG;
            WOBEG := WOEND;
            ESCTOT := ESCTOT + ESCYR;
            ESCEND := WOEND + ESCTOT;
            AVWCAP := (ESCBEG+ESCEND)/2.0 + CAPINT;
            FORYR := AVWCAP * INTEREST/100.0;
            CAPINT := CAPINT + FORYR;
            WINT := ESCEND + CAPINT;
            LOCADJ := WINT * (MULT-1.0);
            NEWLOC := WINT + LOCADJ;
            FOR UNITS := 1 TO 4 DO
                BEGIN
                    NEWNUMBER[UNITS] := NEWLOC * MULT2[UNITS];
                    DOLKW[UNITS] := NEWNUMBER[UNITS] * 1000.0 / (SIZE * UNITS);
                END; (* FOR UNITS *)
            END (* FOR COUNT *)
        END; (* INTESC *)

```

```
PROCEDURE WRITEIT2;
BEGIN
```

```
  Writeln(Z);
  Writeln(Z,V,' TOTAL DIRECT AND INDIRECT COSTS BEFORE ESC.    ',
    WEND:8:1);
  Writeln(Z);
  Writeln(Z,V,' ESCALATION DURING CONSTRUCTION ',VVV,ESCTOT:8:1);
  Writeln(Z);
  Writeln(Z,V,' TOTAL ESCALATED DIRECT & INDIRECT COSTS    ',V,ESCEND:8:1);
  Writeln(Z);
  Writeln(Z,V,' TOTAL INTEREST DURING CONSTRUCTION    ',VV,CAPINT:8:1);
  Writeln(Z);
  Writeln(Z,V,' TOTAL PLANT CAPITAL INVESTMENT (MIDDLETOWN)    ',
    WINT:8:1)
END;
```

```
PROCEDURE WRITEIT3;
BEGIN
```

```
  Writeln(Z);
  Writeln(Z,V,' PLANT LOCATION ADJUSTMENT (' ,TITLE3[CITYNUMBER],') ',
    V,LOCADJ:8:1);
  Writeln(Z);
  Writeln(Z,V,' 1 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[1]):6,' $/KWE) ',NEWNUMBER[1]:8:1);
  Writeln(Z,V,' 2 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[2]):6,' $/KWE) ',NEWNUMBER[2]:8:1);
  Writeln(Z,V,' 3 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[3]):6,' $/KWE) ',NEWNUMBER[3]:8:1);
  Writeln(Z,V,' 4 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[4]):6,' $/KWE) ',NEWNUMBER[4]:8:1);
  Writeln;
  Writeln('<<<    CASE COMPLETE    >>>')
END;
```

```
BEGIN
```

```
  REWRITE(Z, 'PRINTER:');
```

```
  INIT01;
  INIT02;
  INIT03;
  INIT04;
  INIT05;
```

```
  REPEAT
```

```
    REPEAT
```

```
      MEN1;
```

```
      MEN2;
```

```
    UNTIL NUM = 0;
```

```
  CITYMULT;
```

```
  WRITEIT1;
```

```
SCALEIT1;  
SCALEIT2;  
  
INTESC;  
  
WRITEIT2;  
WRITEIT3;  
PAGE(Z);  
UNTIL NUM = 99  
END.
```

```

(*$$S+*)
PROGRAM CAPCOST; (* COST1:CAPCOST.TEXT *)

(*=====*)
(*
(* CAPCOST
(*
(* CAPITAL INVESTMENT COST
(*
(*
(* A SIMPLIFIED ALGORITHM BASED ON:
(* C.R.HUDSON
(* CONCEPT-5 USER'S MANUAL
(* ORNL-5470
(*
(*=====*)

USES
  TRANSCEND, APPLESTUFF;

CONST
  V = '      ';
  VV = '      ';
  VVV = '      ';
  VVVV = '      ';
  VVVVV = '      ';
  PI = 3.14159;

VAR
  Z : INTERACTIVE;

  NUM, COUNT, UNITS ,NOYEAR, ACCOUNT, CITYNUMBER: INTEGER;

  DOLKW, MULT2, NEWNUMBER : ARRAY[1..4] OF REAL;

  TITLE3 : ARRAY [1..11] OF STRING[13];

  R, X, Y,
  BE, EM,
  REF, XX1,
  MULT, SIZE, SUB1, SUB2, SUB3, SUB4, WINT,
  ESCYR, ESFAC, OSUB1,OSUB2, WOBEG, WOEND, FORYR,
  AVWCAP, CAPINT, ESCBEG, ESCEND, ESCTOT,
  LOCADJ, NEWLOC, RCOUNT, SCALER, YEAROP, YEARSS,
  ESCRATE,
  BASESIZE, BASEYEAR, CONALLOW, ESFACTOR, INTEREST, SCALEIND,
  YEARPERMIT,
  CONTINGENCY : REAL;

  TYPEP : CHAR;

FUNCTION UPARROW(X, Y : REAL) : REAL;

```

```
BEGIN
  UPARROW := EXP(Y * LN(X))
END;
```

```
PROCEDURE INIT01;
BEGIN
  BASESIZE := 1139.0;
  BASEYEAR := 1982.0;
  YEARSS := 1983.0;
  YEARPERMIT := 1988.0;
  YEAROP := 1995.0;
  INTEREST := 9.0;
  ESCRATE := 7.0;
  CONTINGENCY := 15.0;
  CITYNUMBER := 5;
  SIZE := 1100.0;
  SUB1 := 981.7;
  SUB2 := 690.0;
  TYPEP := 'N'
END;
```

```
PROCEDURE INIT02;
BEGIN
  TITLE3[1] := 'MIDDLETOWN';
  TITLE3[2] := 'ATLANTA';
  TITLE3[3] := 'BALTIMORE';
  TITLE3[4] := 'BOSTON';
  TITLE3[5] := 'CHICAGO';
  TITLE3[6] := 'DALLAS';
  TITLE3[7] := 'DENVER';
  TITLE3[8] := 'KANSAS CITY';
  TITLE3[9] := 'NEW YORK';
  TITLE3[10] := 'SAN FRANCISCO';
  TITLE3[11] := 'SEATTLE';
END;
```

```
PROCEDURE INIT03;
BEGIN
  SCALER := 0.583561;
  SCALEIND := 0.346719;
  REF := 5822.0;
  MULT2[1] := 1.0;
  MULT2[2] := (5761.0+4250.0) / REF;
  MULT2[3] := (5761.0+4250.0+4250.0) / REF;
  MULT2[4] := (5761.0+4250.0+4250.0+4250.0) / REF;
END;
```

```
PROCEDURE INIT04;
BEGIN
  SCALER := 0.62141;
  SCALEIND := 0.62141;
  REF := 1718.0;
```

```

MULT2[1] := 1.0;
MULT2[2] := (1307.0+1877.0) / REF;
MULT2[3] := (1234.0+1307.0+1877.0) / REF;
MULT2[4] := (1234.0+1234.0+1307.0+1877.0) / REF
END;

```

```

PROCEDURE CITYMUL1;
BEGIN
  CASE CITYNUMBER OF
    1 : MULT := 1.0;
    2 : MULT := 5256.0 / REF;
    3 : MULT := 5423.0 / REF;
    4 : MULT := 5802.0 / REF;
    5 : MULT := 5719.0 / REF;
    6 : MULT := 5467.0 / REF;
    7 : MULT := 5472.0 / REF;
    8 : MULT := 5547.0 / REF;
    9 : MULT := 6008.0 / REF;
    10 : MULT := 6221.0 / REF;
    11 : MULT := 5867.0 / REF;
  END
END;

```

```

PROCEDURE CITYMUL2;
BEGIN
  CASE CITYNUMBER OF
    1 : MULT := 1.0;
    2 : MULT := 1574.0 / REF;
    3 : MULT := 1609.0 / REF;
    4 : MULT := 1734.0 / REF;
    5 : MULT := 1674.0 / REF;
    6 : MULT := 1632.0 / REF;
    7 : MULT := 1614.0 / REF;
    8 : MULT := 1634.0 / REF;
    9 : MULT := 1733.0 / REF;
    10 : MULT := 1834.0 / REF;
    11 : MULT := 1722.0 / REF;
  END
END;

```

```

PROCEDURE MEN1;
BEGIN
  WRITELN('THE AVAILABLE MENU OPTIONS AND THEIR');
  WRITELN('VALUES AT THIS TIME ARE:');
  WRITELN;
  WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
  WRITELN('1 = YEAR OF STEAM SUPPLY SYSTEM');
  WRITELN('  PURCHASE ',VVVV,YEARSS:6:1);
  WRITELN('2 = YEAR OF CONSTRUCTION');
  WRITELN('  PERMIT ',VVVV,YEARPERMIT:6:1);
  WRITELN('3 = YEAR OF COMMERCIAL');

```

```

WRITELN(' OPERATION',VVVV,YEAROP:6:1);
WRITELN('4 = INTEREST RATE ',VVV,INTEREST:4:1);
WRITELN('5 = ESCALATION RATE ',VVV,ESCRATE:4:1);
WRITELN('6 = CONTINGENCY PERCENTAGE ',V,CONTINGENCY:4:1);
WRITELN('7 = PLANT SIZE (MWE) ',VV,ROUND(SIZE):4);
WRITELN('8 = CITY NUMBER ',VVVV,CITYNUMBER)
END;

```

```

PROCEDURE MEN2;
BEGIN
  WRITELN('9 = BASE SIZE FOR CAP. COST INPUT (MWE)');
  WRITELN(V,VVVV,' ',BASESIZE:6:1);
  WRITELN(' BASE YEAR FOR CAP. COST INPUT ');
  WRITELN(V,VVVV,' ',BASEYEAR:6:1);
  WRITELN(' BASE YEAR/SIZE DIRECTS ($MILLIONS)');
  WRITELN(V,VVVV,' ',SUB1:6:1);
  WRITELN(' BASE YEAR/SIZE INDIRECTS ($MILLIONS)');
  WRITELN(V,VVVV,' ',SUB2:6:1);
  WRITELN('10 = PLANT TYPE ',VVVV,TYPEP);
  WRITELN('99 = EXIT PROGRAM')
END;

```

```

PROCEDURE X1;
BEGIN
  WRITELN(' INPUT YEAR OF STEAM SUPPLY SYSTEM');
  WRITELN(' PURCHASE');
  READLN(YEARSS)
END;

```

```

PROCEDURE X2;
BEGIN
  WRITELN(' YEAR OF CONSTRUCTION PERMIT');
  READLN(YEARPERMIT)
END;

```

```

PROCEDURE X3;
BEGIN
  WRITELN(' YEAR OF COMMERCIAL OPERATION');
  READLN(YEAROP)
END;

```

```

PROCEDURE X4;
BEGIN
  WRITELN(' INTEREST RATE DURING CONSTRUCTION');
  WRITELN(V,' (PCT/YR)');
  READLN(INTEREST)
END;

```

```

PROCEDURE X5;
BEGIN
  WRITELN(' ESCALATION RATE (PCT/YR)');
  READLN(ESCRATE)
END;

```

```

PROCEDURE X6;
BEGIN
    WRITELN(' CONTINGENCY PERCENTAGE');
    READLN(CONTINGENCY)
END;

PROCEDURE X7;
BEGIN
    WRITELN(' INPUT NET RATING PER UNIT (MWE)');
    READLN(SIZE)
END;

PROCEDURE X8;
BEGIN
    FOR COUNT := 1 TO 11 DO
        WRITELN(COUNT, ' ', TITLE3[COUNT]);
        WRITELN(' ENTER CITY NUMBER');
        READLN(CITYNUMBER)
    END;

PROCEDURE X9;
BEGIN
    WRITELN(' INPUT BASE SIZE FOR CAPITAL COST');
    READLN(BASESIZE);
    WRITELN(' INPUT BASE YEAR FOR CAPITAL COST');
    READLN(BASEYEAR);
    WRITELN(' INPUT DIRECT $MILLIONS');
    READLN(SUB1);
    WRITELN(' INPUT INDIRECT $MILLIONS');
    READLN(SUB2)
END;

PROCEDURE X10;
BEGIN
    WRITELN(' INPUT PLANT TYPE:');
    WRITELN(V, 'N = NUCLEAR');
    WRITELN(V, 'C = COAL-FIRED');
    READ(TYPEP)
END;

PROCEDURE MEN3;
BEGIN
    WRITELN(' ENTER A NUMBER FROM THE MENU');
    READLN(NUM);
    CASE NUM OF
        0: ;
        1: X1;
        2: X2;
        3: X3;
        4: X4;
        5: X5;
        6: X6;
    
```

```

7: X7;
8: X8;
9: X9;
10: X10;
99: EXIT(PROGRAM);
END;
WRITELN
END;

```

```
PROCEDURE WRITEIT1;
```

```
BEGIN
```

```

WRITELN(Z,VV,'CAPITAL COST ESTIMATE');
WRITELN(Z);
WRITELN(Z,VVV,'VERSION 22-NOV-83');
WRITELN(Z);
WRITELN(Z,V,'INPUT DATA');
WRITELN(Z,V,'-----');
WRITELN(Z);
IF (TYPEP = 'N') THEN
  WRITELN(Z,V,'PLANT TYPE',VV,VVVV,'NUCLEAR')
ELSE
  WRITELN(Z,V,'PLANT TYPE',VV,VVVV,'COAL-FIRED');
WRITELN(Z,V,'YEAR STEAM SUPPLY SYSTEM PURCHASE ',VV, YEARSS:7:2);
WRITELN(Z,V,'YEAR CONSTRUCTION PERMIT ',VVV, YEARPERMIT:7:2);
WRITELN(Z,V,'YEAR OF COMMERCIAL OPERATION ',VVV, YEAROP:7:2);
WRITELN(Z,V,'INTEREST RATE DURING CONSTRUCTION (PCT/YR) ',V, INTEREST:4:1);
WRITELN(Z,V,'ESCALATION RATE (PCT/YR) ',VVVV, ESCRATE:4:1)

```

```
END;
```

```
PROCEDURE WRITEIT2;
```

```
BEGIN
```

```

WRITELN(Z,V,'CONTINGENCY (PCT) ',V,VVVV,CONTINGENCY:4:1);
WRITELN(Z,V,'NET RATING PER UNIT (MWE) ',VVVV, ROUND(SIZE):4);
WRITELN(Z,V,'PLANT LOCATION ',VVVV,TITLE3[CITYNUMBER]);
WRITELN(Z,V,'BASE YEAR FOR DIRECT AND INDIRECT COST INPUT ',BASEYEAR:7:2);
WRITELN(Z,V,'BASE SIZE FOR DIRECT AND INDIRECT COST INPUT ',V,ROUND(BASESIZE):4);
WRITELN(Z,V,'DIRECT COSTS AT BASE SIZE/YEAR ($MILLIONS) ',SUB1:7:1);
WRITELN(Z,V,'INDIRECT COSTS AT BASE SIZE/YEAR ($MILLIONS) ',SUB2:7:1);
WRITELN(Z);
WRITELN(Z,V,'-----')

```

```
END;
```

```
PROCEDURE SCALEIT1;
```

```
BEGIN
```

```

WRITELN('<<< CALCULATIONS TAKING PLACE >>>');
ESFACTOR := UPARROW((1.0+ESCRATE/100.0),
  (YEARSS-BASEYEAR));
WRITELN(Z);
IF (TYPEP = 'N') THEN SCALER := 0.583561;
IF (TYPEP = 'C') THEN SCALER := 0.62141;
OSUB1 := (SUB1) *
  UPARROW((SIZE / BASESIZE), SCALER) *
  ESFACTOR;

```

```

WRITELN(Z,V,' OVERNIGHT COSTS (YEAR SSS PURCHASE, $MILLIONS)');
WRITELN(Z);
WRITELN(Z,VV,' DIRECT COSTS      ',VVVV,OSUB1:8:1);
WRITELN(Z)
END;

```

```

PROCEDURE SCALEIT2;
BEGIN
  IF (TYPEP = 'N') THEN SCALEIND := 0.346719;
  IF (TYPEP = 'C') THEN SCALEIND := 0.62141;
  OSUB2 :=
    SUB2 *
    UPARROW((SIZE / BASESIZE),SCALEIND)
    * ESFACTOR;
  WRITELN(Z,VV,' INDIRECT COSTS      ',VVVV,OSUB2:8:1);
  WRITELN(Z);
  SUB3 := (OSUB1 + OSUB2);
  WRITELN(Z,VV,' SUBTOTAL DIRECT & INDIRECT COSTS',VV,
    SUB3:8:1);
  WRITELN(Z);
  CONALLOW := CONTINGENCY * SUB3 / 100.0;
  WRITELN(Z,VV,' CONTINGENCY ALLOWANCE ',VVVV,
    CONALLOW:8:1);
  SUB4 := SUB3 + CONALLOW
END;

```

```

PROCEDURE INTESC;
BEGIN
  IF (TYPEP = 'N') THEN
    XX1 := (0.095 / 0.3333) * ((YEARPERMIT - YEARSS) / (YEAROP - YEARSS));
  IF (TYPEP = 'C') THEN
    XX1 := (0.13177 / 0.3333) * ((YEARPERMIT - YEARSS) / (YEAROP - YEARSS));
  EM := PI / (1.0 - XX1);
  BE := PI / 2.0 - EM;
  NOYEAR := ROUND(YEAROP-YEARSS);
  CAPINT := 0.0;
  ESCTOT := 0.0;
  ESCBEG := 0.0;
  ESFAC := (1.0+ESCRATE/200.0) / (1.0+ESCRATE/100.0);
  WOBEG := 0.0;
  FOR COUNT := 1 TO NOYEAR DO
    BEGIN
      RCOUNT := COUNT;
      X := RCOUNT / NOYEAR;
      IF X < XX1 THEN X := XX1;
      R := EM * X + BE;
      Y := 0.5 * SIN(R) + 0.5;
      WOEND := SUB4 * Y;
      ESFAC := (1.0 + ESCRATE/100.0) * ESFAC;
      ESCYR := (WOEND-WOBEG) * (ESFAC - 1.0);
      ESCBEG := ESCTOT + WOBEG;
    END
  END;

```

```

      WOBEG := WOEND;
      ESCTOT := ESCTOT + ESCYR;
      ESCEND := WOEND + ESCTOT;
      AVWCAP := (ESCOTOT+ESCEND)/2.0 + CAPINT;
      FORYR := AVWCAP * INTEREST/100.0;
      CAPINT := CAPINT + FORYR;
      WINT := ESCEND + CAPINT;
      LOCADJ := WINT * (MULT-1.0);
      NEWLOC := WINT + LOCADJ;
      FOR UNITS := 1 TO 4 DO
        BEGIN
          NEWNUMBER[UNITS] := NEWLOC * MULT2[UNITS];
          DOLKW[UNITS] := NEWNUMBER[UNITS] * 1000.0 / (SIZE * UNITS);
        END; (* FOR UNITS *)
      END (* FOR COUNT *)
    END; (* INTESC *)

PROCEDURE WRITEIT3;
BEGIN
  Writeln(Z);
  Writeln(Z,V,' TOTAL DIRECT & INDIRECT COSTS BEFORE ESC. ',WOEND:8:1);
  Writeln(Z);
  Writeln(Z,V,' ESCALATION DURING CONSTRUCTION ',VV,ESCTOT:8:1);
  Writeln(Z);
  Writeln(Z,V,' TOTAL ESCALATED DIRECT & INDIRECT COSTS ',V,ESCEND:8:1);
  Writeln(Z);
  Writeln(Z,V,' TOTAL INTEREST DURING CONSTRUCTION ',VV,CAPINT:8:1);
  Writeln(Z);
  Writeln(Z,V,' TOTAL PLANT CAPITAL INVESTMENT (MIDDLETOWN) ',WINT:8:1)
END;

PROCEDURE WRITEIT4;
BEGIN
  Writeln(Z);
  Writeln(Z,V,' PLANT LOCATION ADJUSTMENT (' ,TITLE3[CITYNUMBER],') ',
    V,LOCADJ:8:1);
  Writeln(Z);
  Writeln(Z,V,' 1 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[1]):6,' $/KWE) ',NEWNUMBER[1]:8:1);
  Writeln(Z,V,' 2 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[2]):6,' $/KWE) ',NEWNUMBER[2]:8:1);
  Writeln(Z,V,' 3 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[3]):6,' $/KWE) ',NEWNUMBER[3]:8:1);
  Writeln(Z,V,' 4 UNIT PLANT CAPITAL INVESTMENT',
    ' (' ,ROUND(DOLKW[4]):6,' $/KWE) ',NEWNUMBER[4]:8:1);

  Writeln;
  Writeln('<<< CASE COMPLETE >>>')
END;

```

```

BEGIN
  REWRITE(Z, 'PRINTER:');

  INIT01;
  INIT02;

  REPEAT
    REPEAT
      MEN1;
      MEN2;
      MEN3;
    UNTIL NUM = 0;

    IF (TYPEP = 'N') THEN INIT03;
    IF (TYPEP = 'C') THEN INIT04;
    IF (TYPEP = 'N') THEN CITYMUL1;
    IF (TYPEP = 'C') THEN CITYMUL2;

    WRITEIT1;
    WRITEIT2;

    SCALEIT1;
    SCALEIT2;

    INTESC;

    WRITEIT3;
    WRITEIT4;
    PAGE(Z);
  UNTIL NUM = 99
END.

```

```
(*$S+*)
PROGRAM NFUEL; (* COST1:NFUEL.TEXT *)
```

```
(*=====*)
(* *)
(* NFUEL *)
(* *)
(* NUCLEAR FUEL CYCLE COST FOR *)
(* LIGHT-WATER-REACTOR PLANT *)
(* *)
(* THIS PROGRAM IS THE RESULT OF A *)
(* FORTRAN TO PASCAL TRANSLATION OF *)
(* 'FUEL' BY J.G.DELENE TO NFUEL *)
(* BY L.C.FULLER *)
(* *)
(*=====*)
```

```
USES
  TRANSCEND;
```

```
CONST
  V = ' ';
  VV = ' ';
  VVV = ' ';
  VVVV = ' ';
  VVVVV = ' ';
  CVLS = 0.005;
  FBLS = 0.01;
  PUFLS = 0.01;
  URPLS = 0.01;
  PUPLS = 0.01;
  EF = 0.00711;
  ZERO = 0;
  ONE = 1;
  TWO = 2;
  FOUR = 4;
  FIVE = 5;
  SIX = 6;
  SEVEN = 7;
  NINE = 9;
  TEN = 10;
  ELEVEN = 11;
  TWELVE = 12;
  FIFTY = 50;
```

```
VAR
  X : INTERACTIVE;
  (* NOTE: THIS VARIABLE WILL BE USED WHEREVER PRINTER OUTPUT IS NEEDED*)

  M, IM, KK, NB, NBT, NCY, NUM, NORD, NLIFE, NBCCORE : INTEGER;
```

```

EP, TF, XC, ADJ, CVU, PRC, RDT, SWU, TOT,
TXR, VAL, XCY, XDT, XLD, CAPF, CRFC,
CRFN, CUMS, DISC, ESLG, FMAS, PWRA, PWRR, RDIS,
SLAG, TAIL, TMAS, TOTC, TREF, UORE, XBCR, BLEAD, POWER, RATIO,
TLIFE, TSTRT, TXTRM, CAPREF, CYCLEN, EFFCOM, RINFLA : REAL;

```

```

CLEV, CONL, CUML, FACT1: ARRAY[ONE..ELEVEN] OF REAL;

```

```

ICAP: ARRAY[ONE..ELEVEN] OF INTEGER;

```

```

ALEAD : ARRAY[ONE..ELEVEN, ONE..TWO] OF REAL;

```

```

AA : ARRAY[ONE..SEVEN, ONE..FIFTY] OF REAL;

```

```

QUAN, FLOSS: ARRAY[ONE..TEN] OF REAL;

```

```

DT, PSB, TIN, TOUT : ARRAY[ONE..FIFTY] OF REAL;

```

```

ESC, PCREF : ARRAY[ONE..SEVEN] OF REAL;

```

```

REPLY, ANSWER : CHAR;

```

```

TITLE : ARRAY [ONE..ELEVEN] OF STRING[18];

```

```

FUNCTION UPARROW (X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP (Y * LN (X))
END;

```

```

FUNCTION VFUN(EE : REAL) : REAL;
BEGIN
  VFUN := (TWO*EE-ONE)*LN(EE/(ONE-EE))
END;

```

```

PROCEDURE INIT00;
BEGIN
  TSTRT := 1995.0;
  CAPF := 0.65;
  SLAG := 0.5;
  ANSWER := 'N';
  RINFLA := 0.06;
  EFFCOM := 0.090;
  TXR := 0.4816;
  TREF := 1982.0;
  PCREF[1] := 32.2;
  PCREF[2] := 8.0;
  PCREF[3] := 130.0;
  PCREF[4] := ZERO;
  PCREF[5] := 180.0;
  PCREF[6] := ZERO;
  PCREF[7] := ONE;

```

```

    ESC[1] := 0.092;
    ESC[2] := 0.06;
    ESC[3] := 0.06;
    ESC[4] := 0.06;
    ESC[5] := 0.06;
    ESC[6] := 0.06;
    ESC[7] := 0.06
END;

```

```

PROCEDURE INIT01;
BEGIN
    NBCORE := 3;
    TLIFE := 30.0;
    CAPREF := 0.75;
    CUMS := ZERO;
    NCRD := ZERO;
    TAIL := 0.002;
    POWER := 1212.0
END;

```

```

PROCEDURE INIT02;
BEGIN
    ALEAD[1,1] := 1.75;
    ALEAD[2,1] := 1.42;
    ALEAD[3,1] := 1.25;
    ALEAD[4,1] := 1.00;
    ALEAD[5,1] := 0.50;
    ALEAD[6,1] := -1.00;
    ALEAD[7,1] := -1.00;
    ALEAD[8,1] := -1.00;
    ALEAD[9,1] := -1.00;
    ALEAD[10,1] := -5.00;
    ALEAD[11,1] := 0.00;
    ALEAD[1,2] := 1.00;
    ALEAD[2,2] := 0.67;
    ALEAD[3,2] := 0.50;
    ALEAD[4,2] := 1.00;
    ALEAD[5,2] := 0.25;
    ALEAD[6,2] := -1.00;
    ALEAD[7,2] := -1.00;
    ALEAD[8,2] := -1.00;
    ALEAD[9,2] := -1.00;
    ALEAD[10,2] := -5.00;
    ALEAD[11,2] := 0.00
END;

```

```

PROCEDURE INIT03;
BEGIN
    AA[1,1] := 34119.0;
    AA[2,1] := 565.0;
    AA[4,1] := 33567.0;
    AA[5,1] := 243.0;

```

```

AA[6,1] := 157.0;
AA[1,2] := 32235.0;
AA[2,2] := 711.0;
AA[4,2] := 31243.0;
AA[5,2] := 214.0;
AA[6,2] := 176.0;
AA[1,3] := 32962.0;
AA[2,3] := 925.0;
AA[4,3] := 31657.0;
AA[5,3] := 244.0;
AA[6,3] := 206.0;
AA[1,4] := 34119.0;
AA[2,4] := 1071.0;
AA[4,4] := 32708.0;
AA[5,4] := 304.0;
AA[6,4] := 227.0;
AA[1,5] := 34545.0;
AA[2,5] := 1028.0;
AA[4,5] := 33101.0;
AA[5,5] := 271.0;
AA[6,5] := 228.0
END;

```

```

PROCEDURE INIT04;
BEGIN
  AA[1,6] := 34119.0;
  AA[2,6] := 984.0;
  AA[4,6] := 32728.0;
  AA[5,6] := 261.0;
  AA[6,6] := 223.0;
  AA[1,7] := 34119.0;
  AA[2,7] := 1058.0;
  AA[4,7] := 32703.0;
  AA[5,7] := 295.0;
  AA[6,7] := 226.0;
  AA[1,8] := 34545.0;
  AA[2,8] := 1026.0;
  AA[4,8] := 33115.0;
  AA[5,8] := 274.0;
  AA[6,8] := 228.0;
  AA[1,9] := 34119.0;
  AA[2,9] := 1028.0;
  AA[4,9] := 32704.0;
  AA[5,9] := 278.0;
  AA[6,9] := 225.0;
  AA[1,10] := 34119.0;
  AA[2,10] := 1028.0;
  AA[4,10] := 32704.0;
  AA[5,10] := 278.0;
  AA[6,10] := 225.0;
  AA[1,11] := 34545.0;
  AA[2,11] := 1041.0;

```

```

AA[4,11] := 33112.0;
AA[5,11] := 282.0;
AA[6,11] := 228.0
END;

```

```

PROCEDURE INITITLE;
BEGIN
  TITLE[1] := 'URANIUM PURCHASE  ';
  TITLE[2] := 'CONVERSION PURCH.  ';
  TITLE[3] := 'ENRICHMENT PURCH.  ';
  TITLE[4] := 'PLUTONIUM PURCHASE';
  TITLE[5] := 'FABRICATION          ';
  TITLE[6] := 'URANIUM CREDIT          ';
  TITLE[7] := 'CONVERSION CREDIT  ';
  TITLE[8] := 'ENRICHMENT CREDIT  ';
  TITLE[9] := 'PLUTONIUM SALES      ';
  TITLE[10] := 'REPROCESSING          ';
  TITLE[11] := 'WASTE DISPOSAL      '
END;

```

```

PROCEDURE MEN1;
BEGIN
  WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
  WRITELN('1 = YEAR OF STARTUP   ',VV,TSIRT:5:1);
  WRITELN('2 = CAPACITY FACTOR',VV,CAPF:3:2);
  WRITELN('3 = LAG TIME FOR RECEIPTS   ',V,SLAG:3:2);
  WRITELN('4 = DISCHARGE FISSILE CREDIT',VV,ANSWER);
  WRITELN('5 = INFLATION RATE',VV,RINFLA:4:3);
  WRITELN('6 = EFFECTIVE COST OF MONEY ',V,EFFCOM:5:3);
  WRITELN('7 = INCOME TAX RATE      ',VV,TXR:5:4);
  WRITELN('8 = BASE YEAR FOR COST DATA',V,TREF:5:1)
END;

```

```

PROCEDURE MEN2;
BEGIN
  WRITELN('9 = U3O8 PRICE & ESCALATION',PCREF[1]:5:2,
    ESC[1]:5:3);
  WRITELN('10 = CONVERSION PR. & ESC.  ',PCREF[2]:5:2,
    ESC[2]:5:3);
  WRITELN('11 = ENRICHMENT PR. & ESC.',PCREF[3]:5:2,
    ESC[3]:5:3);
  WRITELN('12 = PLUTONIUM PR. & ESC.   ',PCREF[4]:5:2,
    ESC[4]:5:3);
  WRITELN('13 = FABRICATION PR. & ESC',PCREF[5]:5:2,
    ESC[5]:5:3);
  WRITELN('14 = REPROCESS. PR. & ESC.  ',PCREF[6]:5:2,
    ESC[6]:5:3);
  WRITELN('15 = WASTE DISP. PR. & ESC. ',PCREF[7]:5:2,
    ESC[7]:5:3);
  WRITELN('99 = EXIT PROGRAM')
END;

```

```

PROCEDURE X1;
BEGIN
  WRITELN('INPUT YEAR OF STARTUP');
  READLN(TSTRT)
END;

PROCEDURE X2;
BEGIN
  WRITELN('INPUT CAPACITY FACTOR');
  WRITELN('AS A DECIMAL');
  READLN(CAPF)
END;

PROCEDURE X3;
BEGIN
  WRITELN('INPUT LAG TIME FOR RECEIPTS');
  WRITELN('YEARS (AS A DECIMAL)');
  READLN(SLAG)
END;

PROCEDURE X4;
BEGIN
  WRITELN('CREDIT FOR DISCHARGED FISSILE?');
  WRITELN('ANSWER Y OR N');
  READLN(ANSWER);
  IF(ANSWER = 'Y') THEN NCRD := 1
  ELSE NCRD := 0
END;

PROCEDURE X5;
BEGIN
  WRITELN('INPUT INFLATION RATE (DECIMAL)');
  READLN(RINFLA)
END;

PROCEDURE X6;
BEGIN
  WRITELN('INPUT EFFECTIVE COST OF MONEY');
  WRITELN('(DECIMAL)');
  READLN(EFFCOM)
END;

PROCEDURE X7;
BEGIN
  WRITELN('INPUT INCOME TAX RATE (DECIMAL)');
  READLN(TXR)
END;

PROCEDURE X8;
BEGIN
  WRITELN('INPUT BASE YEAR FOR COST DATA');
  READLN(TREF)
END;

```

```
PROCEDURE X9;  
BEGIN  
  WRITELN('INPUT U3O8 PRICE ($/LB) ');  
  READLN(PCREF[1]);  
  WRITELN('INPUT U3O8 ESCALATION RATE (DECIMAL)');  
  READLN(ESC[1])  
END;  
  
PROCEDURE X10;  
BEGIN  
  WRITELN('INPUT CONVERSION PRICE ($/KG) ');  
  READLN(PCREF[2]);  
  WRITELN('INPUT CONVERSION ESCALATION RATE');  
  WRITELN(' (DECIMAL)');  
  READLN(ESC[2])  
END;  
  
PROCEDURE X11;  
BEGIN  
  WRITELN('INPUT ENRICHMENT PRICE ($/SWU) ');  
  READLN(PCREF[3]);  
  WRITELN('INPUT ENRICHMENT ESCALATION RATE');  
  WRITELN(' (DECIMAL)');  
  READLN(ESC[3])  
END;  
  
PROCEDURE X12;  
BEGIN  
  WRITELN('INPUT PLUTONIUM PRICE ($/GM) ');  
  READLN(PCREF[4]);  
  WRITELN('INPUT PLUTONIUM ESCALATION RATE');  
  WRITELN(' (DECIMAL)');  
  READLN(ESC[4])  
END;  
  
PROCEDURE X13;  
BEGIN  
  WRITELN('INPUT FABRICATION PRICE ($/KG) ');  
  READLN(PCREF[5]);  
  WRITELN('INPUT FABRICATION ESCALATION RATE');  
  WRITELN(' (DECIMAL)');  
  READLN(ESC[5])  
END;  
  
PROCEDURE X14;  
BEGIN  
  WRITELN('INPUT REPROCESSING PRICE ($/KG) ');  
  READLN(PCREF[6]);  
  WRITELN('INPUT REPROCESSING ESCALATION RATE');  
  WRITELN(' (DECIMAL)');  
  READLN(ESC[6])  
END;
```

```

PROCEDURE X15;
BEGIN
  WRITELN('INPUT WASTE DISPOSAL PRICE (MILLS/KWH) ');
  READLN(PCREF[7]);
  WRITELN('INPUT WASTE DISPOSAL ESCALATION RATE');
  WRITELN('(DECIMAL)');
  READLN(ESC[7])
END;

```

```

PROCEDURE MEN3;
BEGIN
  WRITELN;
  WRITELN('ENTER A NUMBER FROM THE MENU');
  READLN(NUM);
  CASE NUM OF
    0: ;
    1: X1;
    2: X2;
    3: X3;
    4: X4;
    5: X5;
    6: X6;
    7: X7;
    8: X8;
    9: X9;
    10: X10;
    11: X11;
    12: X12;
    13: X13;
    14: X14;
    15: X15;
    99: EXIT(PROGRAM);
  END;
  WRITELN
END;

```

```

PROCEDURE WRITEIT0;
BEGIN
  WRITELN(X);
  WRITELN(X,V,'INPUT DATA:');
  WRITELN(X,V,'----- ');
  WRITELN(X);
  WRITELN(X,V,' YEAR OF STARTUP ',VVVV,TSIRT:7:1);
  WRITELN(X,V,' CAPACITY FACTOR ',VVVV,CAPF:4:2)
END;

```

PROCEDURE WRITEIT1;

BEGIN

 WRITELN(X,V,' LAG TIME (YEARS) ',VVVV,SLAG:4:2);

 IF (ANSWER = 'Y') THEN

 WRITELN(X,V,' CREDIT FOR DISCHARGED FISSILE')

 ELSE

 WRITELN(X,V,' NO CREDIT FOR DISCHARGED FISSILE')

END;

PROCEDURE WRITEIT2;

BEGIN

 WRITELN(X,V,' BASE YEAR FOR COST DATA ',VVV,TREF:7:1);

 WRITELN(X,V,' INFLATION RATE ',VVVV,RINFLA:4:3);

 WRITELN(X,V,' EFFECTIVE COST OF MONEY ',VVV,EFFCOM:7:4);

 WRITELN(X,V,' INCOME TAX RATE ',VVVV,TXR:6:4)

END;

PROCEDURE WRITEIT3;

BEGIN

 WRITELN(X);

 WRITELN(X,V,' REFERENCE YEAR PRICES');

 WRITELN(X,VV,' U3O8 (\$/LB) ',VVVV,POREF[1]:6:2);

 WRITELN(X,VV,' CONVERSION (\$/KG) ',VVV,POREF[2]:6:2);

 WRITELN(X,VV,' ENRICHMENT (\$/SWU) ',VVV,POREF[3]:6:2);

 WRITELN(X,VV,' PLUTONIUM (\$/GM) ',VVV,POREF[4]:6:2);

 WRITELN(X,VV,' FABRICATION (\$/KG) ',VVV,POREF[5]:6:2);

 WRITELN(X,VV,' BACK END (REPROCESSING) (\$/KG) ',V,POREF[6]:6:2);

 WRITELN(X,VV,' WASTE DISPOSAL (MILLS/KWH) ',VV,POREF[7]:6:2)

END;

PROCEDURE WRITEIT4;

BEGIN

 WRITELN(X);

 WRITELN(X,V,' PRICE ESCALATION RATES');

 WRITELN(X,VV,' U3O8 ',VVVV,ESC[1]:6:3);

 WRITELN(X,VV,' CONVERSION ',VVVV,ESC[2]:6:3);

 WRITELN(X,VV,' ENRICHMENT ',VVVV,ESC[3]:6:3);

 WRITELN(X,VV,' PLUTONIUM ',VVVV,ESC[4]:6:3);

 WRITELN(X,VV,' FABRICATION ',VVVV,ESC[5]:6:3);

 WRITELN(X,VV,' BACK END (REPROCESSING) ',VV,ESC[6]:6:3);

 WRITELN(X,VV,' WASTE DISPOSAL ',VVVV,ESC[7]:6:3)

END;

PROCEDURE CALC01;

BEGIN

 WRITELN('<<< CALCULATIONS TAKING PLACE >>>');

 WRITELN;

 CYCLEN := CAPREF/CAPF;

 NLIFE := ROUND(TLIFE / CYCLEN);

 NET := NBCCORE - 1 + NLIFE;

 PWRA := POWER * CAPF * 0.00876;

```

DISC := LN(ONE+EFFCOM);
ESLG := EXP(-SLAG*DISC);
FOR M := ONE TO NINE DO ICAP[M] := 0;
ICAP[10] := ONE;
ICAP[11] := -ONE;
FOR M := ONE TO ELEVEN DO CUML[M] := ZERO;
FLOSS[1] := ONE/((ONE-CVLS)*(ONE-FBLS));
FLOSS[2] := ONE/(ONE-FBLS);
FLOSS[3] := FLOSS[2];
FLOSS[4] := ONE/(ONE-PUFLS);
FLOSS[5] := ONE;
FLOSS[6] := (ONE-URPLS);
FLOSS[7] := FLOSS[6];
FLOSS[8] := FLOSS[6];
FLOSS[9] := (ONE-PUPLS);
FLOSS[10] := ONE
END; (* CALC01 *)

PROCEDURE AAARRAY;
BEGIN
  FOR NB := TWELVE TO NBT DO
    FOR IM := ONE TO SEVEN DO
      AA[IM,NB] := AA[IM,NB-NBCORE];
    FOR NB := ONE TO NBT DO
      BEGIN
        AA[3,NB] := ZERO;
        AA[7,NB] := AA[1,NB]+AA[3,NB]
      END (* FOR NB *)
    END;

PROCEDURE BATCH;
BEGIN
  NCY := 0;
  NB := ONE;
  WHILE NB <= NBT DO
    BEGIN
      IF (NB <= NBCORE) THEN
        BEGIN
          NCY := NCY + 1;
          TIN[NB] := ZERO;
          IF (NB = 1) THEN TOUT[NB] := CYCLEN;
          IF (NB > 1) THEN TOUT[NB] := TOUT[NB-1] + CYCLEN;
        END; (* IF NB <= *)
      IF (NB > (NBT-NBCORE)) THEN
        BEGIN
          IF (NB <> (NBT-NBCORE+1)) THEN NCY := NCY - ONE;
          TIN[NB] := TIN[NB-1] + CYCLEN;
          TOUT[NB] := TLIFE;
        END; (* IF NB > *)
      IF (NB > NBCORE) AND (NB <= (NBT-NBCORE)) THEN

```

```

      BEGIN
        TIN[NB] := TIN[NB-ONE]+CYCLEN;
        TOUT[NB] := TOUT[NB-ONE]+CYCLEN;
      END; (* IF NB > NBCORE *)
      XCY := NCY;
      XBCR := NBCORE;
      RATIO := XCY/XBCR;
      PSB[NB] := PWRA * RATIO * CYCLEN;
      DT[NB] := TOUT[NB] - TIN[NB];
      NB := NB + ONE;
    END (* WHILE NB <= *)
  END; (* BATCH *)

PROCEDURE CALCONST;
BEGIN
  XDT := DISC * DT[NBCORE];
  TXTRM := TXR * ESLG * (ONE-EXP(-XDT)) / XDT;
  FOR M := ONE TO TEN DO
    IF (ICAP[M] = ZERO) THEN
      BEGIN
        XLD := DISC * ALEAD[M,2];
        IF M >= SIX THEN XLD := XLD + XDT;
        FACT1[M] := (EXP(XLD)-TXTRM) / (ONE-TXR);
      END (* IF ICAP *)
    END;

PROCEDURE USE;
BEGIN
  EP := AA[2,NB] / AA[1,NB];
  FMAS := (EP-TAIL)/(EF-TAIL);
  TMAS := FMAS - ONE;
  SWU := TMAS*VFUN(TAIL)+VFUN(EP)-FMAS*VFUN(EF);
  QUAN[1] := FMAS * 2.5944 * AA[1,NB];
  QUAN[2] := FMAS * AA[1,NB];
  QUAN[3] := SWU * AA[1,NB]
END;

PROCEDURE USE2;
BEGIN
  EP := AA[5,NB] / AA[4,NB];
  FMAS := (EP-TAIL)/(EF-TAIL);
  TMAS := FMAS - ONE;
  SWU := TMAS*VFUN(TAIL)+VFUN(EP)-FMAS*VFUN(EF);
  QUAN[6] := FMAS * 2.5944 * AA[4,NB];
  QUAN[7] := FMAS * AA[4,NB];
  QUAN[8] := SWU * AA[4,NB]
END;

PROCEDURE MAIN1;
BEGIN
  TF := TIN[NB]+TSTRT-TREF;
  USE;

```

```

QUAN[4] := AA[3,NB];
QUAN[5] := AA[7,NB];
QUAN[6] := ZERO;
QUAN[7] := ZERO;
QUAN[8] := ZERO;
IF NORD <> ZERO THEN USE2;
QUAN[10] := AA[7,NB]
END;

```

```

PROCEDURE MAIN2;
BEGIN
  IF M >= SIX THEN TF := TOUT[NB]+TSTRT-TREF;
  IF NB<=NBCORE THEN
    BLEAD := ALEAD[M,1]
  ELSE
    BLEAD := ALEAD[M,2];
  IF M <= NINE THEN
    IF M <> FIVE THEN
      KK := M MOD FIVE
    ELSE
      KK := FIVE
    ELSE
      KK := M - FOUR;
  PRC := PCREF[KK]*UPARROW((ONE+ESC[KK]),(TF-BLEAD))
END; (* MAIN2 *)

```

```

PROCEDURE BEGINEND;
BEGIN
  XDT := DISC * DT[NB];
  PWRR := VAL * EXP(-DISC*TIN[NB])*(EXP(DISC*BLEAD)-TXR*ESLG*
    (ONE-EXP(-XDT))/XDT)/(ONE-TXR)
END;

```

```

PROCEDURE CAPITAL;
BEGIN
  IF (NB < NBCORE) THEN BEGINEND;
  IF (NB >= NBCORE) AND (NB <= (NBT-NBCORE)) THEN
    PWRR := VAL*EXP(-DISC*TIN[NB])*FACT1[M];
  IF (NB > (NBT-NBCORE)) THEN BEGINEND
END;

```

```

PROCEDURE EXPENSE;
BEGIN
  PWRR := VAL * EXP(-DISC*(TIN[NB]-BLEAD));
  IF (M >= SIX) THEN PWRR := PWRR * EXP(-DISC*DT[NB])
END;

```

```

PROCEDURE PRODUCTION;
BEGIN
  RDIS := DISC - LN(ONE+ESC[7]);
  PWRR :=PCREF[7]*PSB[NB]*EXP(-RDIS*(TIN[NB]+SLAG)) * (ONE-EXP(-RDIS*
    DT[NB]))/(RDIS*DT[NB]);
  PWRR := PWRR*UPARROW((ONE+ESC[7]),(TSTRT-TREF))
END;

```

```

PROCEDURE MAINLOOP;
BEGIN
  FOR NB := ONE TO NBT DO
    BEGIN
      MAIN1;
      FOR M := ONE TO ELEVEN DO
        BEGIN
          MAIN2;
          IF (M <> ELEVEN) THEN
            BEGIN
              VAL := QUAN[M] * PRC * FLOSS[M] / 1000000.0;
              IF (ICAP[M] = ZERO) THEN CAPITAL;
              IF (ICAP[M] = ONE) THEN EXPENSE;
            END; (* IF M <> *)
            IF (ICAP[M] = -1) THEN PRODUCTION;
            IF (M>=SIX) AND (M<=NINE) THEN PWRR := -PWRR;
            CUML[M] := CUML[M] + PWRR;
          END; (* FOR M *)
          RDT := DISC * DT[NB];
          CUMS := CUMS + PSB[NB] * EXP(-DISC * (TIN[NB] + SLAG)) * (ONE - EXP(-RDT)) / RDT;
        END (* FOR NB *)
      END; (* MAINLOOP *)

```

```

PROCEDURE HEADING;
BEGIN
  WRITELN(X);
  WRITELN(X, VV, '-----');
  WRITELN(X, VV, 'LEVELIZED FUEL CYCLE COSTS, MILLS/KWH');
  WRITELN(X, VV, '-----');
  WRITELN(X);
  WRITELN(X, VVV, '    VERSION 30-DEC-83');
  WRITELN(X);
  WRITELN(X, VVVV, '    CURRENT ', V, 'CONSTANT');
  WRITELN(X, VVVV, '    DOLLARS ', V, 'DOLLARS');
  WRITELN(X);
END;

```

```

PROCEDURE LEVEL;
BEGIN
  CRFN := EFFCOM / (ONE - UPARROW((ONE + EFFCOM), (-TLIFE)));
  XC := (ONE + EFFCOM) / (ONE + RINFLA) - ONE;
  CRFC := XC / (ONE - UPARROW((ONE + XC), (-TLIFE)));
  ADJ := (CRFC / CRFN) * UPARROW((ONE + RINFLA), (TREF - TSTRT));
  TOT := ZERO;
  TOTC := ZERO;
  FOR M := ONE TO ELEVEN DO
    BEGIN
      CLEV[M] := CUML[M] / CUMS;
      TOT := TOT + CLEV[M];
      CONL[M] := ADJ * CLEV[M];
      TOTC := TOTC + CONL[M];
    END
  END;

```

```

        WRITELN(X,V,TITLE[M],V,CLEV[M]:8:3,V,CONL[M]:8:3);
    END; (* FOR M *)
    WRITELN(X);
    WRITELN(X,VVVV,' ',TOT:8:3,V,TOTC:8:3);
    WRITELN('<<< CASE COMPLETE >>>')
END; (* LEVEL *)

```

```

BEGIN

```

```

    REWRITE(X, 'PRINTER:');

```

```

    INIT00;

```

```

    REPEAT

```

```

        INIT01;

```

```

        INIT02;

```

```

        INIT03;

```

```

        INIT04;

```

```

        INITITLE;

```

```

    REPEAT

```

```

        MEN1;

```

```

        MEN2;

```

```

        MEN3;

```

```

    UNTIL NUM = 0;

```

```

    WRITEIT0;

```

```

    WRITEIT1;

```

```

    WRITEIT2;

```

```

    WRITEIT3;

```

```

    WRITEIT4;

```

```

    CALC01;

```

```

    AAARRAY;

```

```

    BATCH;

```

```

    CALCONST;

```

```

    MAINLOOP;

```

```

    HEADING;

```

```
LEVEL;  
PAGE(X);  
UNTIL NUM = 99  
END.
```

```

(*$S+*)
PROGRAM PWRDM; (* COST1:PWRDM.TEXT *)

(*=====*)
(*
(* PWRDM
(*
(* NONFUEL OPERATION AND MAINTENANCE
(* COST FOR LIGHT-WATER-REACTOR
(* PLANTS
(*
(*
(* BASED ON:
(* M.L.MYERS,L.C.FULLER,&H.I.BOWERS
(* NONFUEL O&M COSTS FOR LARGE
(* STEAM ELECTRIC POWER PLANTS-1982
(* ORNL/TM-8324
(*
(*=====*)

USES
  TRANSCEND;

CONST
  V = ' ';
  VV = ' ';
  VVV = ' ';
  VVVV = ' ';
  VVVVV = ' ';
  FORTYR = 2080.0;
  WAGERT = 10.45;
  FRINGE = 35.0;
  SUPER = 20.0;
  PENPCT = 5.0;
  BASEYR = 1982.0;
  FULLYR = 8766.0;
  FIXFAC = 0.75;
  VARFAC = 0.25;
  SUPEXF = 4800.0;
  VSEMIL = 0.1;
  BASECF = 0.80;
  PROPRT = 0.40;
  COVER = 500000.0;
  MILLION = 1000000.0;
  OVERTHO = 1.0E-3;
  THOUSAND = 1.0E3;
  HUNDRED = 1.0E2;

VAR
  X : INTERACTIVE;
  (* NOTE: THIS VARIABLE WILL BE USED WHEREVER PRINTER OUTPUT IS NEEDED*)

  STAFF, STAFF3, STAFF4 : ARRAY[1..4] OF INTEGER;

```

```

NUM, IESC, UNITS : INTEGER;

MANCOS, ETANET, ANNGEN, MWN, PLTFAC, COSTAF, BASM, FIXMNT, VARMT, TOTMNT,
VSEBAS, FIXSE, SUPEXP, FEEINS, SUPORT, COMINS, MWT, COVINS, RETRO,
RPOWER, PRIMUL, EXMUL, PROPIN, AIM, PRIMAR, EXCESS, DIRECT, ADMGEN, TOTFIX,
TOTVAR, TOTAL, FIXMIL, VARMT, TOTMIL, YEAR, ESCGEN,
FSWAGE, FSWATL, ESCSUP, ESFEES, ESCINS, ESGINS, ESCPIN, FSCPOW, HIRATE : REAL;

ANSWER : CHAR;

FUNCTION UPARROW (X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP (Y * LN (X))
END;

FUNCTION INFLATE(E: REAL) : REAL;
BEGIN
  INFLATE := UPARROW((1.0+E/HUNDRED), (YEAR-BASEYR))
END;

FUNCTION F(Z:REAL):REAL;
BEGIN
  F := 1.0 + Z / HUNDRED
END;

FUNCTION MINIMUM(A,B:REAL) : REAL;
BEGIN
  IF A < B THEN MINIMUM := A ELSE MINIMUM := B
END;

PROCEDURE INIT01;
BEGIN
  STAFF[1] := 401;
  STAFF[2] := 543;
  STAFF[3] := 715;
  STAFF[4] := 865;
  STAFF3[1] := 122;
  STAFF3[2] := 195;
  STAFF3[3] := 278;
  STAFF3[4] := 351;
  STAFF4[1] := 50;
  STAFF4[2] := 59;
  STAFF4[3] := 74;
  STAFF4[4] := 83;
  MWN := 1100.0;
  UNITS := 1;
  PLTFAC := 0.65;
  YEAR := 1983.0;
  IESC := 1;
  HIRATE := 10700.0
END;

```

```
PROCEDURE INIT02;
BEGIN
```

```
    ESWAGE := 8.0;
    ESMATL := 10.0;
    ESCSUP := 10.0;
    ESFEES := 8.0;
    ESCINS := 6.0;
    ESGINS := 0.0;
    ESCPIN := 6.0;
    ESCPOW := 9.0;
    ESCGEN := 6.0
```

```
END;
```

```
PROCEDURE RETOESC;
BEGIN
```

```
    IESC := 2;
    ESWAGE := ESCGEN;
    ESMATL := ESCGEN;
    ESCSUP := ESCGEN;
    ESFEES := ESCGEN;
    ESCINS := ESCGEN;
    ESGINS := ESCGEN;
    ESCPIN := ESCGEN;
    ESCPOW := ESCGEN
```

```
END;
```

```
PROCEDURE MEN1;
BEGIN
```

```
    WRITELN('THE AVAILABLE MENU OPTIONS AND THEIR');
    WRITELN('VALUES AT THIS TIME ARE:');
    WRITELN;
    WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
    WRITELN('1 = NET RATING OF EACH UNIT (MWE) ',ROUND(MWN):4);
    WRITELN('2 = NUMBER OF UNITS PER PLANT ',V,UNITS);
    WRITELN('3 = BASE LOAD CAPACITY FACTOR ',PLTFAC:4:2);
    WRITELN('4 = YEAR OF OPERATION ',VV,ROUND(YEAR):4);
    IF IESC = 1 THEN WRITELN('5 = ESCALATION RATES -- VARIOUS');
    IF IESC = 2 THEN WRITELN('5 = ESCALATION RATE (PCT) ',V,ESCGEN:4:2);
    WRITELN('6 = PLANT NET HEAT RATE ',V,ROUND(HTRATE));
    WRITELN('99 = EXIT PROGRAM')
```

```
END;
```

```
PROCEDURE X1;
BEGIN
```

```
    WRITELN(' INPUT MWE NET RATING PER UNIT');
    READLN(MWN)
```

```
END;
```

```
PROCEDURE X2;
BEGIN
```

```
    WRITELN(' INPUT NUMBER OF UNITS PER PLANT');
    READLN(UNITS)
```

```
END;
```

```

PROCEDURE X3;
BEGIN
    WRITELN(' INPUT BASE LOAD CAPACITY FACTOR');
    WRITELN(' (AS A DECIMAL)');
    READLN(PLTFAC)
END;

PROCEDURE X4;
BEGIN
    WRITELN(' INPUT YEAR OF OPERATION');
    READLN(YEAR)
END;

PROCEDURE X5;
BEGIN
    WRITELN(' DO YOU WANT TO USE THE DEFAULT');
    WRITELN(' GENERAL ESCALATION RATE? (Y OR N)');
    READLN(ANSWER);
    IF ANSWER = 'Y' THEN REDOESC
    ELSE
        BEGIN
            WRITELN(' DO YOU WANT TO INPUT A');
            WRITELN(' GENERAL ESCALATION RATE? (Y OR N)');
            READLN(ANSWER);
            IF ANSWER = 'Y' THEN
                BEGIN
                    WRITELN(' INPUT ESCALATION RATE (PCT)');
                    READLN(ESCCEN);
                    REDOESC;
                END
            ELSE
                ESC := 1;
            END
        END
END;

PROCEDURE X6;
BEGIN
    WRITELN(' INPUT PLANT NET HEAT RATE (BTU/KWH)');
    READLN(HTRATE)
END;

PROCEDURE MEN2;
BEGIN
    WRITELN('ENTER A NUMBER FROM THE MENU');
    READLN(NUM);
    CASE NUM OF
        0: ;
        1: X1;
        2: X2;
        3: X3;
        4: X4;
    
```

```

5: X5;
6: X6;
99: EXIT(PROGRAM);
END;
WRITELN
END;

PROCEDURE WRITEIT1;
BEGIN
  WRITELN(X,V,' SUMMARY OF ANNUAL NONFUEL O&M COST FOR PWR');
  WRITELN(X,VVV,'POWER PLANT');
  WRITELN(X);
  WRITELN(X,VVV,' VERSION 19-OCT-83');
  WRITELN(X);
  WRITELN(X,V,' NET RATING OF EACH UNIT (MWE)      ',V,ROUND(MWN):4);
  WRITELN(X,V,' NUMBER OF UNITS PER PLANT ',VVV,UNITS);
  WRITELN(X,V,' BASE LOAD CAPACITY FACTOR  ',VV,PLTFAC:4:2);
  IF IESC = 1 THEN
    WRITELN(X,V,' INDIVIDUAL ESCALATION RATES USED');
  IF IESC = 2 THEN
    WRITELN(X,V,' ESCALATION RATE (PCT/YR)      ',VV,ESCOEN:4:2)
  END;
END;

PROCEDURE PRELIM2;
BEGIN
  ETANET := 3412.14 * HUNDRED / HIRATE;
  MWT := MWN * HUNDRED / ETANET;
  ANNGEN := (MWN * FULLYR * PLTFAC * UNITS / THOUSAND);
  WRITELN(X,V,' THERMAL INPUT PER UNIT (MWT)      ',V,ROUND(MWT):5);
  WRITELN(X,V,' PLANT NET HEAT RATE (BTU/KWH)      ',V,ROUND(HIRATE):5);
  WRITELN(X,V,' PLANT NET EFFICIENCY (PCT) ',VV,ETANET:5:1);
  WRITELN(X,V,' ANNUAL NET GENERATION (MILLION KWH) ',ROUND(ANNGEN):5);
  WRITELN(X,V,' YEAR OF ESTIMATE ',VVVV,ROUND(YEAR):4)
END;

PROCEDURE STAFFING;
BEGIN
  MANCOS := FORTYR * WAGERT * F(FRIDGE) * F(SUPER) * F(PENPCT)
    * INFLATE(ESWAGE);
  COSTAF := STAFF[UNITS] * MANCOS / MILLION;
  WRITELN(X);
  WRITELN(X,VV,' DIRECT COSTS ($MILLION/YEAR)');
  WRITELN(X,V,' STAFF ONSITE ',VVVV,COSTAF:8:2);
  WRITELN(X,VV,' (',STAFF[UNITS],', PERSONS AT $',
    MANCOS:8:1,')')
END;

PROCEDURE MAINT;
BEGIN
  BASM := STAFF3[UNITS] * (MANCOS / MILLION) * UPARROW(((HUNDRED+ESMATL)/
    (HUNDRED+ESWAGE)),(YEAR-BASEYR));
  FIXMNT := FIXFAC * BASM;

```

```

VARMNT := VARFAC * BASM * (PLTFAC / BASECF);
TOTMNT := FIXMNT + VARMNT;
WRITELN(X);
WRITELN(X,V,' MAINTENANCE MATERIAL ',VV,TOTMNT:8:2);
WRITELN(X,VV,' FIXED ',VVVV,FIXMNT:8:2);
WRITELN(X,VV,' VARIABLE ',VVVV,VARMNT:8:2)
END;

```

```

VSEBAS := VSEMIL * (ANNGEN / THOUSAND)
* INFLATE(ESCSUP);
FIXSE := (SUPEXF / THOUSAND) * UNITS * INFLATE(ESCSUP);
SUPEXP := FIXSE + VSEBAS;
WRITELN(X);
WRITELN(X,V,' SUPPLIES AND EXPENSES',VV,SUPEXP:8:2);
WRITELN(X,VV,' FIXED ',VVVV,FIXSE:8:2);
WRITELN(X,VV,' VARIABLE ',VVVV,VSEBAS:8:2)
END;

```

```

PROCEDURE FEES;
BEGIN
  FEEINS := OVERTHOU * (219.0 + 269.0 * UNITS) *
    INFLATE(ESFEES);
  WRITELN(X);
  WRITELN(X,V,' FEES, INSPECTIONS, REVIEWS',V,FEEINS:8:2)
END;

```

```

PROCEDURE OFFSITE;
BEGIN
  SUPORT := STAFF4[UNITS] * MANCOS * 2.0 / MILLION;
  WRITELN(X);
  WRITELN(X,V,' OFFSITE SUPPORT SERVICES ',V,SUPORT:8:2)
END;

```

```

PROCEDURE ADMININGEN;
BEGIN
  COMINS := OVERTHOU * (239.68+161.21*UNITS) * INFLATE(ESCINS);
  RETRO := OVERTHOU * (10.0*UNITS)*INFLATE(ESCINS);
  COVINS := OVERTHOU * (6.0*MINIMUM(MWT,3000.0)) * (UNITS/1000.0)
    * INFLATE(ESGINS);
  PRIMUL := 0.18+0.82*UNITS;
  EXCMUL := 0.86+0.14*UNITS;
  PRIMAR := OVERTHOU * (PRIMUL*PROPRT*COVER/HUNDRED) * INFLATE(ESCPIN);
  EXCESS := OVERTHOU * (EXCMUL*0.8*PROPRT*COVER/HUNDRED) * INFLATE(ESCPIN);
  PROPIN := PRIMAR + EXCESS;
  RPOWER := UNITS*2.0 * INFLATE(ESCPW);
  DIRECT := COSTAF+TOTMNT+SUPEXP+FEEINS +SUPORT;
  ADM := 15.0*DIRECT/HUNDRED;
  ADMGEN := COMINS+RETRO+COVINS+PRIMAR+ EXCESS+RPOWER+ADM
END;

```

```
PROCEDURE ADMINOUT;
```

```
BEGIN
```

```
  WRITELN(X);
```

```
  WRITELN(X,VV,'    INDIRECT COSTS ($MILLION/YEAR) ');
```

```
  WRITELN(X,V,' ADMINISTRATIVE AND GENERAL',V,ADMGEN:8:2);
```

```
  WRITELN(X,VV,' COMMERCIAL LIABILITY INSURANCE ',COMINS:8:2);
```

```
  WRITELN(X,VV,' RETROSPECTIVE PREMIUM',VV,RETRO:8:2);
```

```
  WRITELN(X,VV,' GOVERNMENT LIABILITY INSURANCE ',GOVINS:8:2);
```

```
  WRITELN(X,VV,' PROPERTY INSURANCE (PRIMARY) ',PRIMAR:8:2);
```

```
  WRITELN(X,VV,' PROPERTY INSURANCE (EXCESS) ',EXCESS:8:2);
```

```
  WRITELN(X,VV,' REPLACEMENT POWER INSURANCE ',RPOWER:8:2);
```

```
  WRITELN(X,VV,' OTHER A&G ',VVVV,ADM:8:2)
```

```
END;
```

```
PROCEDURE FINAL;
```

```
BEGIN
```

```
  TOTFIX := COSTAF+FIXMNT+FEEINS+ADMGEN+FIXSE+SUPPORT;
```

```
  TOTVAR := VARINT+VSEBAS;
```

```
  TOTAL := TOTFIX+TOTVAR;
```

```
  FIXMIL := THOUSAND * TOTFIX / ANNGEN;
```

```
  VARMIL := THOUSAND * TOTVAR / ANNGEN;
```

```
  TOTMIL := THOUSAND * TOTAL / ANNGEN;
```

```
  WRITELN(X);
```

```
  WRITELN(X,VV,'COSTS ($MILLION/YEAR) ');
```

```
  WRITELN(X,V,' TOTAL FIXED DIRECTS AND INDIRECTS ',TOTFIX:8:1);
```

```
  WRITELN(X,V,' TOTAL VARIABLE DIRECTS AND INDIRECTS',TOTVAR:8:1);
```

```
  WRITELN(X,V,' TOTAL ANNUAL NONFUEL O&M ',VV,TOTAL:8:1);
```

```
  WRITELN(X);
```

```
  WRITELN(X,VV,'UNIT COSTS (MILLS/KWH)');
```

```
  WRITELN(X,V,' FIXED DIRECTS AND INDIRECTS ',VV,FIXMIL:6:2);
```

```
  WRITELN(X,V,' VARIABLE DIRECTS AND INDIRECTS ',V,VARMIL:6:2);
```

```
  WRITELN(X,V,' TOTAL NONFUEL O&M ',VVVV,TOTMIL:6:2);
```

```
  WRITELN('<<< CASE COMPLETE >>>')
```

```
END;
```

```
BEGIN
```

```
  REWRITE(X, 'PRINTER:');
```

```
  INIT01;
```

```
  INIT02;
```

```
  REPEAT
```

```
    REPEAT
```

```
      MEN1;
```

```
      MEN2;
```

```
    UNTIL NUM = 0;
```

```
  WRITEIT1;
```

```
  PRELIM2;
```

STAFFING;
MAINT;
SUPPLIES;
FEES;
OFFSITE;
ADMINGEN;
ADMINOUT;
FINAL;
PAGE(X);
UNTIL NUM = 99
END.

```

(*$S+*)
PROGRAM WETOM; (* COST1:WETOM.TEXT *)

(*=====*)
(*                                     *)
(* WETOM                               *)
(*                                     *)
(* NONFUEL OPERATION AND MAINTENANCE *)
(* COST FOR COAL-FIRED POWER PLANTS *)
(* WITH WET SCRUBBERS                *)
(*                                     *)
(* BASED ON:                          *)
(*   M.L.MYERS,L.C.FULLER,&H.I.BOWERS *)
(*   NONFULL O&M COSTS FOR LARGE     *)
(*   STEAM ELECTRIC POWER PLANTS-1982 *)
(*   ORNL/TM-8324                    *)
(*                                     *)
(* -----*)

```

USES

TRANSCEND;

CONST

```

V = ' ';
VV = ' ';
VVV = ' ';
VVVV = ' ';
VVVVV = ' ';
DASH = 5.0;
SLURY = 5.0;
COSLMS = 12.5;
XLIMSS = 4.0;
FORTYR = 2080.0;
WAGERT = 10.45;
FRINGE = 35.0;
SUPER = 10.0;
BASEYR = 1982.0;
FULLYR = 8766.0;
FIXFAC = 0.62;
PCTSRM = 90.0;
PCTSUL = 3.5;
SLUSUL = 4.0;
VARFAC = 0.20;
SUPEXF = 2200.0;
VSEMIL = 0.12;
BASECF = 0.80;
MILLION = 1.0E6;
OVERTHOU = 1.0E-3;
THOUSAND = 1.0E3;
HUNDRED = 1.0E2;

```

```

VAR
  X : INTERACTIVE;
  (* NOTE: THIS VARIABLE WILL BE USED WHEREVER PRINTER OUTPUT IS NEEDED*)

  STAFF, STAFF3, STAFF4 : ARRAY[1..4] OF INTEGER;

  NUM, IESC, UNITS : INTEGER;

  MANCOS, ETANET, ANNGEN, MWN, PLTFAC, COSTAF, BASM, FIXMNT, VARVNT, TOTMNT,
  VSEBAS, FIXSE, SUPEXP, TONCOL, SUPORT, MWT, PROPIN, ADM, DIRECT, ADMGEN,
  TOTFIX, TOTVAR, TOTAL, DDASH, FIXMIL, VARMIL, TOTMIL, TONSUL,
  SULREM, SLURRY, DISPOS, TONLMS, COLIMS, CLIMES, VARSE, YEAR, ESCGEN,
  ESSLUR, ESLIMS, ESWAGE, ESWATL, ESCSUP, ESCPIN, SUL, ASH, BTU, HIRATE : REAL;

  REPLY, ANSWER : CHAR;

FUNCTION UPARROW (X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP (Y * LN (X))
END;

FUNCTION INFLATE(E : REAL) : REAL;
BEGIN
  INFLATE := UPARROW((1.0+E/HUNDRED), (YEAR-BASEYR))
END;

FUNCTION F(Z:REAL):REAL;
BEGIN
  F := 1.0 + Z / HUNDRED
END;

FUNCTION MINIMUM(A,B:REAL) : REAL;
BEGIN
  IF A < B THEN MINIMUM := A ELSE MINIMUM := B
END;

PROCEDURE INIT01;
BEGIN
  STAFF[1] := 234;
  STAFF[2] := 295;
  STAFF[3] := 368;
  STAFF[4] := 440;
  STAFF3[1] := 118;
  STAFF3[2] := 158;
  STAFF3[3] := 200;
  STAFF3[4] := 242;
  STAFF4[1] := 19;
  STAFF4[2] := 23;
  STAFF4[3] := 30;
  STAFF4[4] := 36;
  MWN := 550;
  UNITS := 2;

```

```

    PLTFAC := 0.65;
    YEAR := 1983.0;
    IESC := 1
END;

```

```

PROCEDURE INIT02;
BEGIN
    ESSLUR := 10.0;
    ESLIMS := 10.0;
    ESWAGE := 8.0;
    ESMATL := 10.0;
    ESCSUP := 10.0;
    ESCPIN := 6.0;
    ESCGEN := 6.0;
    ASH := 11.6;
    BTU := 11000.0;
    SUL := 3.5;
    HTRATE := 9900.0
END;

```

```

PROCEDURE REDOESC;
BEGIN
    IESC := 2;
    ESSLUR := ESCGEN;
    ESLIMS := ESCGEN;
    ESWAGE := ESCGEN;
    ESMATL := ESCGEN;
    ESCSUP := ESCGEN;
    ESCPIN := ESCGEN
END;

```

```

PROCEDURE MEN1;
BEGIN
    WRITELN('THE AVAILABLE MENU OPTIONS AND THEIR');
    WRITELN('VALUES AT THIS TIME ARE:');
    WRITELN;
    WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
    WRITELN('1 = NET RATING OF EACH UNIT (MWE) ',ROUND(MWN):4);
    WRITELN('2 = NUMBER OF UNITS PER PLANT ',V,UNITS);
    WRITELN('3 = BASE LOAD CAPACITY FACTOR ',PLTFAC:4:2);
    WRITELN('4 = YEAR OF OPERATION ',VV,ROUND(YEAR):4);
    IF IESC = 1 THEN WRITELN('5 = ESCALATION RATES -- VARIOUS');
    IF IESC = 2 THEN WRITELN('5 = ESCALATION RATE (PCT) ',V,ESCGEN:4:2);
    WRITELN('6 = PLANT NET HEAT RATE ',VV,ROUND(HTRATE));
    WRITELN('7 = SULFUR (PCT) ',VVV,SUL:4:2);
    WRITELN('      ASH (PCT) ',VVV,ASH:4:2);
    WRITELN('      HEATING VALUE (BTU/#) ',V,BTU:6:1);
    WRITELN('99 = EXIT PROGRAM')
END;

```

```

PROCEDURE X1;
BEGIN
  WRITELN(' INPUT MWE NET RATING PER UNIT');
  READLN(MWN)
END;

PROCEDURE X2;
BEGIN
  WRITELN(' INPUT NUMBER OF UNITS PER PLANT');
  READLN(UNITS)
END;

PROCEDURE X3;
BEGIN
  WRITELN(' INPUT BASE LOAD CAPACITY FACTOR');
  WRITELN(' (AS A DECIMAL)');
  READLN(PLTFAC)
END;

PROCEDURE X4;
BEGIN
  WRITELN(' INPUT YEAR OF OPERATION');
  READLN(YEAR)
END;

PROCEDURE X5;
BEGIN
  WRITELN(' DO YOU WANT TO USE THE DEFAULT');
  WRITELN(' GENERAL ESCALATION RATE? (Y OR N)');
  READLN(ANSWER);
  IF ANSWER = 'Y' THEN REDOESC
  ELSE
    BEGIN
      WRITELN(' DO YOU WANT TO INPUT A');
      WRITELN(' GENERAL ESCALATION RATE? (Y OR N)');
      READLN(ANSWER);
      IF ANSWER = 'Y' THEN
        BEGIN
          WRITELN(' INPUT ESCALATION RATE (PCT)');
          READLN(ESCGEN);
          REDOESC;
        END
      ELSE
        IESC := 1;
    END
  END;

PROCEDURE X6;
BEGIN
  WRITELN(' INPUT PLANT NET HEAT RATE (BTU/KWH)');
  READLN(HIRATE)
END;

```

```

PROCEDURE X7;
BEGIN
  Writeln(' INPUT SULFUR (PCT)');
  Readln(SUL);
  Writeln(' INPUT ASH (PCT)');
  Readln(ASH);
  Writeln(' INPUT HEATING VALUE (BTU/#)');
  Readln(BTU)
END;

```

```

PROCEDURE MEN2;
BEGIN
  Writeln('ENTER A NUMBER FROM THE MENU');
  Readln(NUM);
  CASE NUM OF
    0: ;
    1: X1;
    2: X2;
    3: X3;
    4: X4;
    5: X5;
    6: X6;
    7: X7;
    99: EXIT(PROGRAM);
  END;
  Writeln
END;

```

```

PROCEDURE WRITEIT1;
BEGIN
  Writeln(X,V,' SUMMARY OF ANNUAL NONFUEL O&M COST FOR');
  Writeln(X,V,' COAL-FIRED POWER PLANT WITH WET LIMESTONE');
  Writeln(X,VVV,' FGD SYSTEM');
  Writeln(X);
  Writeln(X,VV,' VERSION 19-OCT-83');
  Writeln(X);
  Writeln(X,V,' NET RATING OF EACH UNIT (MWE) ',V,ROUND(MWN):4);
  Writeln(X,V,' NUMBER OF UNITS PER PLANT ',VV,UNITS);
  Writeln(X,V,' BASE LOAD CAPACITY FACTOR ',VV,PLTFAC:4:2);
  IF IESC = 1 THEN Writeln(X,V,' INDIVIDUAL ESCALATION RATES USED');
  IF IESC = 2 THEN Writeln(X,V,' ESCALATION RATE (PCT/YR) ',VV,ESCOGEN:4:2);
  Writeln(X,V,' SULFUR (PCT)',VVVV,SUL:4:2);
  Writeln(X,V,' ASH (PCT) ',VVVV,ASH:4:2);
  Writeln(X,V,' HEATING VALUE (BTU/#) ',VV,BTU:6:1)
END;

```

```

PROCEDURE PRELIM;
BEGIN
  ETANET := 3412.14 * HUNDRED / HIRATE;
  MWT := MWN * HUNDRED / ETANET;
  ANNGEN := (MWN * FULLYR * PLTFAC * UNITS / THOUSAND);
  Writeln(X,V,' THERMAL INPUT PER UNIT (MWT) ',V,ROUND(MWT):5);

```

```

WRITELN(X,V,' PLANT NET HEAT RATE (BTU/KWH) ',V,ROUND(HIRATE):5);
WRITELN(X,V,' PLANT NET EFFICIENCY (PCT) ',VV,ETANET:5:1);
WRITELN(X,V,' ANNUAL NET GENERATION (MILLION KWH) ',ROUND(ANNGEN):5);
WRITELN(X,V,' YEAR OF ESTIMATE ',VVVV,ROUND(YEAR):4)
END;

```

PROCEDURE STAFFING;

```
BEGIN
```

```

MANCOS := FORTYR * WAGERT * F(FRIDGE) * F(SUPER) * INFLATE(ESWAGE);
COSTAF := STAFF[UNITS] * MANCOS / MILLION;
WRITELN(X);
WRITELN(X,VVV,'DIRECT' COSTS ($MILLION/YEAR)');
WRITELN(X,V,' STAFF ONSITE ',VVVV,COSTAF:8:2);
WRITELN(X,VV,' (' ,STAFF[UNITS], ' PERSONS AT $ ',MANCOS:8:1,')')
END;

```

PROCEDURE MAINT;

```
BEGIN
```

```

BASM := STAFF3[UNITS] * (MANCOS / MILLION)
      * UPARROW(((HUNDRED+ESMATL)/(HUNDRED+ESWAGE)), (YEAR-BASEYR));
FIXMNT := FIXFAC * BASM;
VARMNT := VARFAC * BASM * (PLTFAC / BASECF);
TOIMNT := FIXMNT + VARMNT;
WRITELN(X);
WRITELN(X,V,' MAINTENANCE MATERIAL ',VV,TOIMNT:8:2);
WRITELN(X,VV,' FIXED ',VVVV,FIXMNT:8:2);
WRITELN(X,VV,' VARIABLE ',VVVV,VARMNT:8:2)
END;

```

PROCEDURE SUPPLIES;

```
BEGIN
```

```

VSEBAS := VSEMIL * ANNGEN * INFLATE(ESCSUP) * OVERTHOU;
TONCOL := ANNGEN * HIRATE * 1.0E6 / (BTU * 2000.0);
DDASH := DASH * INFLATE(ESSLUR);
TONSUL := TONCOL * PCTSUL / HUNDRED;
SULREM := TONSUL * PCTSRM / HUNDRED;
SLURRY := SLURY * INFLATE(ESSLUR);
TONLMS := SULREM * XLIMSS;
COLIMS := COSLMS * INFLATE(ESLIMS);
CLIMES := TONLMS * COLIMS / MILLION;
DISPOS := SULREM * S'USUL * SLURRY / MILLION + TONCOL*(ASH/HUNDRED)*
        DDASH / MILLION;
FIXSE := OVERTHOU * SUPEXF * UNITS * INFLATE(ESCSUP);
VARSE := VSEBAS + CLIMES + DISPOS;
SUPEXP := FIXSE + VARSE;
WRITELN(X);
WRITELN(X,V,' SUPPLIES AND EXPENSES ',VV,SUPEXP:8:2);
WRITELN(X,VV,' FIXED ',VVVV,FIXSE:8:2);
WRITELN(X,VV,' VAR. - PLANT ',VVVV,VSEBAS:8:2);
WRITELN(X,VV,' - LIMESTONE ',VVV,CLIMES:8:2);
WRITELN(X,VV,' - ASH, FGD SLUDGE ',VV,DISPOS:8:2)
END;

```

```
PROCEDURE OFFSITE;
```

```
BEGIN
```

```
  SUPORT := STAFF4[UNITS] * MANCOS * 1.5 / MILLION;
```

```
  WRITELN(X);
```

```
  WRITELN(X,V,' OFFSITE SUPPORT SERVICES',VV, SUPORT:8:2)
```

```
END;
```

```
PROCEDURE AIMINGEN;
```

```
BEGIN
```

```
  PROPIN := OVERTHOU * UNITS * HUNDRED * INFLATE(ESCPIN);
```

```
  DIRECT := COSTAF+TOTMNT+SUPEXP+SUPPORT;
```

```
  ADM := 10.0*DIRECT/HUNHMT;
```

```
  ADMGEN := PROPIN+ADM;
```

```
  WRITELN(X);
```

```
  WRITELN(X,VV,'    INDIRECT COSTS ($MILLION/YEAR)');
```

```
  WRITELN(X,V,' ADMINISTRATIVE AND GENERAL ',V,ADMGEN:8:2);
```

```
  WRITELN(X,VV,' PROPERTY INSURANCE ',VVV,PROPIN:8:2);
```

```
  WRITELN(X,VV,' OTHER A&G',VVVV,ADM:8:2)
```

```
END;
```

```
PROCEDURE FINAL;
```

```
BEGIN
```

```
  TOTFIX := COSTAF+FIXMNT+ADMGEN+FIXSE+SUPPORT;
```

```
  TOTVAR := VARVMT+VARSE;
```

```
  TOTAL := TOTFIX+TOTVAR;
```

```
  FIXMIL := THOUSAND * TOTFIX / ANNGEN;
```

```
  VARVIL := THOUSAND * TOTVAR / ANNGEN;
```

```
  TOTMIL := THOUSAND * TOTAL / ANNGEN;
```

```
  WRITELN(X);
```

```
  WRITELN(X,VV,'    COSTS ($MILLION/YEAR)');
```

```
  WRITELN(X,V,' TOTAL FIXED DIRECTS AND INDIRECTS ',V,TOTFIX:8:1);
```

```
  WRITELN(X,V,' TOTAL VARIABLE DIRECTS AND INDIRECTS ',TOTVAR:8:1);
```

```
  WRITELN(X,V,' TOTAL ANNUAL NONFUEL O&M',VVV,TOTAL:8:1);
```

```
  WRITELN(X);
```

```
  WRITELN(X,VV,' UNIT COSTS (MILLS/KWH)');
```

```
  WRITELN(X,V,' FIXED DIRECTS AND INDIRECTS ',VV,FIXMIL:6:2);
```

```
  WRITELN(X,V,' VARIABLE DIRECTS AND INDIRECTS ',VV,VARVIL:6:2);
```

```
  WRITELN(X,V,' TOTAL NONFUEL O&M ',VVVV,TOTMIL:6:2);
```

```
  WRITELN('<<< CASE COMPLETE >>>')
```

```
END;
```

```
BEGIN
```

```
  REWRITE(X, 'PRINTER:');
```

```
  INIT01;
```

```
  INIT02;
```

```
REPEAT
  REPEAT
    MEN1;
    MEN2;
  UNTIL NUM = 0;

  WRITEIT1;

  PROJ.M;

  STAFFING;

  MAINT;

  SUPPLIES;

  OFFSITE;

  ADMINGEN;

  FINAL;

  PAGE(X);

  UNTIL NUM = 99
END.
```

```

(*$S+*)
PROGRAM DRYOM; (* COST1:DRYOM.TEXT *)

(*=====*)
(*
{ : DRYOM
(*
(* NONFUEL OPERATION AND MAINTENANCE *)
(* COST FOR COAL-FIRED POWER PLANTS *)
(* WITH DRY SCRUBBERS *)
(*
(* BASED ON:
(* M.L.MYERS,L.C.FULLER,&H.I.BOWERS *)
(* NONFUEL O&M COSTS FOR LARGE *)
(* STEAM ELECTRIC POWER PLANTS-1982 *)
(* ORNL/TM-8324 *)
(*
(*=====*)

```

```

USES
  TRANSCEND;

```

```

CONST
  V = '      ';
  VV = '      ';
  VVV = '      ';
  VVVV = '      ';
  VVVVV = '      ';
  DAS1 = 5.0;
  SLURY = 5.0;
  COSLM = 70.0;
  XLIMS = 1.0;
  FORTYR = 2080.0;
  WAGERT = 10.45;
  FRINGE = 35.0;
  SUPER = 10.0;
  BASEYR = 1982.0;
  FULLYR = 8766.0;
  FIXFAC = 0.55;
  PCTSRM = 70.0;
  PCTSUL = 0.5;
  SLUSUL = 4.0;
  VARFAC = 0.18;
  SUPEXP = 2200.0;
  VSEMIL = 0.12;
  BASECF = 0.80;
  MILLION = 1.0E6;
  OVERTHO = 1.0E-3;
  THOUSAND = 1.0E3;
  HUNDRED = 1.0E2;

```

```

VAR
  X : INTERACTIVE;
  (* NOTE: THIS VARIABLE WILL BE USED WHEREVER PRINTER OUTPUT IS NEEDED*)

  STAFF, STAFF3, STAFF4 : ARRAY[1..4] OF INTEGER;

  NUM, IESC, UNITS : INTEGER;

  MANCOS, ETANET, ANNGEN, MWN, PLTFAC, COSTAF, BASM, FIXMNT, VARVNT, TOTMNT,
  VSEBAS, FIXSE, SUPFXP, TONCOL, SUPORT, MWI, PROPIN, ADM, DIRECT, ADMGEN,
  TOTFIX, TOTVAR, TOTAL, DDASH, FIXMIL, VARMIL, TOTMIL, TONSUL,
  SULREM, SLURRY, DISPOS, TONLM, COLIM, CLIME, VARSE, YEAR, ESCGEN,
  ESSLUR, ESLIM, ESWAGE, ESMATL, ESCSUP, ESCPIN, ASH, SUL, BTU, HTRATE : REAL;

  REPLY, ANSWER : CHAR;

FUNCTION UPARROW (X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP (Y * LN (X))
END;

FUNCTION INFLATE(E : REAL) : REAL;
BEGIN
  INFLATE := UPARROW((1.0+E/HUNDRED), (YEAR-BASEYR))
END;

FUNCTION F(Z:REAL):REAL;
BEGIN
  F := 1.0 + Z / HUNDRED
END;

FUNCTION MINIMUM(A,B:REAL) : REAL;
BEGIN
  IF A < B THEN MINIMUM := A ELSE MINIMUM := B
END;

PROCEDURE INIT01;
BEGIN
  STAFF[1] := 216;
  STAFF[2] := 269;
  STAFF[3] := 334;
  STAFF[4] := 398;
  STAFF3[1] := 105;
  STAFF3[2] := 142;
  STAFF3[3] := 181;
  STAFF3[4] := 220;
  STAFF4[1] := 19;
  STAFF4[2] := 23;
  STAFF4[3] := 30;
  STAFF4[4] := 36;
  MWN := 550;

```

```

    UNITS := 2;
    PLTFAC := 0.65;
    YEAR := 1983.0;
    IESC := 1
END;

PROCEDURE INIT02;
BEGIN
    ESSLUR := 10.0;
    ESLIM := 10.0;
    ESWAGE := 8.0;
    ESMATL := 10.0;
    ESCSUP := 10.0;
    ESCPIN := 6.0;
    ESCOGEN := 6.0;
    ASH := 7.3;
    BTU := 8200.0;
    SUL := 0.5;
    HIRATE := 9780.0
END;

```

```

PROCEDURE REDOESC;
BEGIN
    IESC := 2;
    ESSLUR := ESCOGEN;
    ESLIM := ESCOGEN;
    ESWAGE := ESCOGEN;
    ESMATL := ESCOGEN;
    ESCSUP := ESCOGEN;
    ESCPIN := ESCOGEN
END;

```

```

PROCEDURE MEN1;
BEGIN
    WRITELN('THE AVAILABLE MENU OPTIONS AND THEIR');
    WRITELN('VALUES AT THIS TIME ARE:');
    WRITELN;
    WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
    WRITELN('1 = NET RATING OF EACH UNIT (MWE) ',ROUND(MWN):4);
    WRITELN('2 = NUMBER OF UNITS PER PLANT ',V,UNITS);
    WRITELN('3 = BASE LOAD CAPACITY FACTOR ',PLTFAC:4:2);
    WRITELN('4 = YEAR OF OPERATION ',VV,ROUND(YEAR):4);
    IF IESC = 1 THEN WRITELN('5 = ESCALATION RATES -- VARIOUS');
    IF IESC = 2 THEN WRITELN('5 = ESCALATION RATE (PCT) ',V,ESCOGEN:4:2);
    WRITELN('6 = PLANT NET HEAT RATE ',VV,ROUND(HIRATE));
    WRITELN('7 = SULFUR (PCT) ',VVV,SUL:4:2);
    WRITELN('    ASH (PCT) ',VVV,ASH:4:2);
    WRITELN('    HEATING VALUE (BTU/#) ',V,BTU:6:1);
    WRITELN('99 = EXIT PROGRAM')
END;

```

```

PROCEDURE X1;
BEGIN
  WRITELN(' INPUT MWE NET RATING PER UNIT');
  READLN(MWN)
END;

PROCEDURE X2;
BEGIN
  WRITELN(' INPUT NUMBER OF UNITS PER PLANT');
  READLN(UNITS)
END;

PROCEDURE X3;
BEGIN
  WRITELN(' INPUT BASE LOAD CAPACITY FACTOR ');
  WRITELN(' (AS A DECIMAL)');
  READLN(PLTFAC)
END;

PROCEDURE X4;
BEGIN
  WRITELN(' INPUT YEAR OF OPERATION');
  READLN(YEAR)
END;

PROCEDURE X5;
BEGIN
  WRITELN(' DO YOU WANT TO USE THE DEFAULT');
  WRITELN(' GENERAL ESCALATION RATE? (Y OR N)');
  READLN(ANSWER);
  IF ANSWER = 'Y' THEN REDOESC
  ELSE
    BEGIN
      WRITELN(' DO YOU WANT TO INPUT A');
      WRITELN(' GENERAL ESCALATION RATE? (Y OR N)');
      READLN(ANSWER);
      IF ANSWER = 'Y' THEN
        BEGIN
          WRITELN(' INPUT ESCALATION RATE (PCT)');
          READLN(ESCGEN);
          REDOESC;
        END
      ELSE
        IESC := 1;
    END
  END;

PROCEDURE X6;
BEGIN
  WRITELN(' INPUT PLANT NET HEAT RATE (BTU/KWH)');
  READLN(HIRATE)
END;

```

```

PROCEDURE X7;
BEGIN
    WRITELN(' INPUT SULFUR (PCT)');
    READLN(SUL);
    WRITELN(' INPUT ASH (PCT)');
    READLN(ASH);
    WRITELN(' INPUT HEATING VALUE (BTU/#)');
    READLN(BTU)
END;

PROCEDURE MEN2;
BEGIN
    WRITELN('ENTER A NUMBFR FROM THE MENU');
    READLN(NUM);
    CASE NUM OF
        0: ;
        1: X1;
        2: X2;
        3: X3;
        4: X4;
        5: X5;
        6: X6;
        7: X7;
        99: EXIT(PROGRAM);
    END;
    WRITELN
END;

PROCEDURE WRITEIT1;
BEGIN
    WRITELN(X,V,' SUMMARY OF ANNUAL NONFUEL O&M COST FOR');
    WRITELN(X,VV,' COAL-FIRED POWER PLANT WITH DRY');
    WRITELN(X,VVV,' FGD SYSTEM');
    WRITELN(X);
    WRITELN(X,VV,' VERSION 19-OCT-83');
    WRITELN(X);
    WRITELN(X,V,' NET RATING OF EACH UNIT (MWE) ',V,ROUND(MWN):4);
    WRITELN(X,V,' NUMBER OF UNITS PER PLANT ',VVV,UNITS);
    WRITELN(X,V,' BASE LOAD CAPACITY FACTOR ',VV,PLTFAC:4:2);
    IF IESC = 1 THEN
        WRITELN(X,V,' INDIVIDUAL ESCALATION RATES USED');
    IF IESC = 2 THEN
        WRITELN(X,V,' ESCALATION RATE (PCT/YR) ',VV,ESCOGEN:4:2);
    WRITELN(X,V,' SULFUR (PCT)',VVVV,SUL:4:2);
    WRITELN(X,V,' ASH (PCT) ',VVVV,ASH:4:2);
    WRITELN(X,V,' HEATING VALUE (BTU/#) ',VV,BTU:6:1)
END;

```

PROCEDURE PRELIM2;

BEGIN

```

    ETANET := 3412.14 * HUNDRED / HIRATE;
    MWT := MMN * HUNDRED / ETANET;
    ANNGEN := (MMN * FULLYR * PLTFAC * UNITS / THOUSAND);
    WRITELN(X,V,' THERMAL INPUT PER UNIT (MWT)      ',V,ROUND(MWT):5);
    WRITELN(X,V,' PLANT NET HEAT RATE (BTU/KWH)      ',V,ROUND(HIRATE):5);
    WRITELN(X,V,' PLANT NET EFFICIENCY (PCT) ',VV,ETANET:5:1);
    WRITELN(X,V,' ANNUAL NET GENERATION (MILLION KWH) ',ROUND(ANNGEN):5);
    WRITELN(X,V,' YEAR OF ESTIMATE ',VVVV,ROUND(YEAR):4)

```

END;

PROCEDURE STAFFING;

BEGIN

```

    MANCOS := FORTYR * WAGER1 * F(FRIDGE) * F(SUPER) * INFLATE(ESWAGE);
    COSTAF := STAFF[UNITS] * MANCOS / MILLION;
    WRITELN(X);
    WRITELN(X,VVV,'DIRECT COSTS ($MILLION/YEAR)');
    WRITELN(X,V,' STAFF ONSITE ',VVVV,COSTAF:8:2);
    WRITELN(X,VV,' (' ,STAFF[UNITS], ' PERSONS AT $',MANCOS:8:1,')')

```

END;

PROCEDURE MAINT;

BEGIN

```

    BASM := STAFF3[UNITS] * (MANCOS / MILLION)
           * UPARROW(((HUNDRED+ESMATL)/(HUNDRED+ESWAGE)), (YEAR-BASEYR));
    FIXMNT := FIXFAC * BASM;
    VARVMT := VARFAC * BASM * (PLTFAC / BASECF);
    TOTMNT := FIXMNT + VARVMT;
    WRITELN(X);
    WRITELN(X,V,' MAINTENANCE MATERIAL      ',VV,TOTMNT:8:2);
    WRITELN(X,VV,' FIXED      ',VVVVV,FIXMNT:8:2);
    WRITELN(X,VV,' VARIABLE ',VVVVV,VARVMT:8:2)

```

END;

PROCEDURE SUPPLIES;

BEGIN

```

    VSEBAS := VSEMIL * ANNGEN * INFLATE(ESCSUP) * OVERTHOU;
    TONCOL := ANNGEN * HIRATE * 1.0E6 / (BTU * 2000.0);
    DDASH := DASH * INFLATE(ESSLUR);
    TONSUL := TONCOL * PCTSUL / HUNDRED;
    SULREM := TONSUL * PCTSRM / HUNDRED;
    SLURRY := SLURY * INFLATE(ESSLUR);
    TONLM := SULREM * XLIMS;
    COLIM := COSLM * INFLATE(ESLIM);
    CLIME := TONLM * COLIM / MILLION;
    DISPOS := SULREM * SLUSUL * SLURRY / MILLION + TONCOL*(ASH/HUNDRED)*
              DDASH / MILLION;
    PIXSE := OVERTHOU * SUPEXP * UNITS * INFLATE(ESCSUP);
    VARSE := VSEBAS + CLIME + DISPOS;
    SUPEXP := PIXSE + VARSE;

```

```

WRITELN(X);
WRITELN(X,V,' SUPPLIES AND EXPENSES ',VV,SUPEXP:8:2);
WRITELN(X,VV,' FIXED ',VVVV,FIXSE:8:2);
WRITELN(X,VV,' VAR. - PLANT ',VVVV,VSERAS:8:2);
WRITELN(X,VV,' - LIME ',VVVV,CLIME:8:2);
WRITELN(X,VV,' - ASH, FGD SLUDGE ',VV,DISPOS:8:2)
END;

PROCEDURE OFFSITE;
BEGIN
  SUPORT := STAFF4[UNITS] * MANCOS * 1.5 / MILLION;
  WRITELN(X);
  WRITELN(X,V,' OFFSITE SUPPORT SERVICES',VV,SUPORT:8:2);
END;

PROCEDURE ADMININGEN;
BEGIN
  PROPIN := OVERTHOU * UNITS * HUNDRED * INFLATE(ESCPIN);
  DIRECT := COSTAF+TOTMNT+SUPEXP+SUPORT;
  ADM := 10.0*DIRECT/HUNDRED;
  ADMGEN := PROPIN+ADM;
  WRITELN(X);
  WRITELN(X,VV,' INDIRECT COSTS ($MILLION/YEAR)');
  WRITELN(X,V,' ADMINISTRATIVE AND GENERAL ',V,ADMGEN:8:2);
  WRITELN(X,VV,' PROPERTY INSURANCE ',VVV,PROPIN:8:2);
  WRITELN(X,VV,' OTHER A&G',VVVV,ADM:8:2)
END;

PROCEDURE FINAL;
BEGIN
  TOTFIX := COSTAF+FIXMNT+ADMGEN+
    FIXSE+SUPORT;
  TOTVAR := VARVMT+VARSE;
  TOTAL := TOTFIX+TOTVAR;
  FIXMIL := THOUSAND * TOTFIX / ANNGEN;
  VARVMT := THOUSAND * TOTVAR / ANNGEN;
  TOTMIL := THOUSAND * TOTAL / ANNGEN;
  WRITELN(X);
  WRITELN(X,VVV,' COSTS ($MILLION/YEAR)');
  WRITELN(X,V,' TOTAL FIXED DIRECTS AND INDIRECTS ',V,TOTFIX:8:1);
  WRITELN(X,V,' TOTAL VARIABLE DIRECTS AND INDIRECTS ',TOTVAR:8:1);
  WRITELN(X,V,' TOTAL ANNUAL NONFUEL O&M',VVV,TOTAL:8:1);
  WRITELN(X);
  WRITELN(X,VV,' UNIT COSTS (MILLS/KWH)');
  WRITELN(X,V,' FIXED DIRECTS AND INDIRECTS ',VV,FIXMIL:6:2);
  WRITELN(X,V,' VARIABLE DIRECTS AND INDIRECTS ',VV,VARVMT:6:2);
  WRITELN(X,V,' TOTAL NONFUEL O&M ',VVVV,TOTMIL:6:2);
  WRITELN('<<< CASE COMPLETE >>>')
END;

```

```
BEGIN
    REWRITE(X, 'PRINTER:');
    INIT01;
    INIT02;
    REPEAT
        REPEAT
            MEN1;
            MEN2;
        UNTIL NUM = 0;

        WRITEIT1;

        PRELIM2;

        STAFFING;

        MAINT;

        SUPPLIES;

        OFFSITE;

        ALMINGEN;

        FINAL;

        PAGE(X);

    UNTIL NUM = 99
END.
```

```

(*$S+*)
PROGRAM COALCOST; (* COST1:COALCOST.TEXT *)

(*=====*)
(*                                     *)
(* COALCOST                           *)
(*                                     *)
(* LEVELIZED COAL COST                *)
(*                                     *)
(* BASED ON:                          *)
(*   NUCLEAR ENERGY COST DATA BASE *)
(*   METHODOLOGY                      *)
(*                                     *)
(*=====*)

USES
  TRANSCEND;

CONST
  V = '          ';
  VV = '          ';
  VVV = '          ';
  VVVV = '          ';
  VVVVV = '          ';

VAR
  Z : INTERACTIVE;

  NUM,
  ILIFE,
  YEARSTOREF : INTEGER;

  FO,
  HIRATE, POFBAR, TAWACM,
  REFYEAR,
  PLANTLIFE, YEARSTART,
  DOLLARMBTU,
  REALESGRATE,
  OVERALLESGRATE,
  GNPINFLATIONRATE : REAL;

FUNCTION UPARROW(X, Y : REAL) : REAL;
BEGIN
  UPARROW := EXP(Y * LN(X))
END;

FUNCTION USPWF(IRATE,RYEAR:REAL):REAL;
BEGIN
  USPWF := ((UPARROW((1.0+IRATE),RYEAR)-1.0)/
    (IRATE*UPARROW((1.0+IRATE),RYEAR)))
END;

```

```

FUNCTION CRF(IRATE,RYEAR:REAL):REAL;
BEGIN
  CRF := 1.0 / USPWF(IRATE,RYEAR)
END;

```

```

FUNCTION DEF(R,I,X:REAL;YEARSTOREF,ILIFE:INTEGER):REAL;
BEGIN
  DEF := (CRF(((X-1)/(1.0+I))),ILIFE)/CRF(((X-R)/(1.0+R))),ILIFE))
    * UPARROW(((1.0+R)/(1.0+I)),YEARSTOREF)
END;

```

```

PROCEDURE INIT0;
BEGIN
  REFYEAR := 1983.0;
  DOLLARMBTU := 1.60;
  YEARSTART := 1995.0;
  PLANTLIFE := 30.0;
  HIRATE := 9900.0;
  TAWACM := 0.09;
  CNPINFLATIONRATE := 0.06;
  REALESCRATE := 0.015;
  YEARSTOREF := 12;
END;

```

```

PROCEDURE MEN1;
BEGIN
  WRITELN('THE AVAILABLE MENU OPTIONS AND THEIR');
  WRITELN('VALUES AT THIS TIME ARE:');
  WRITELN;
  WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
  WRITELN('1 = REFERENCE YEAR FOR PRICE OF');
  WRITELN('    COAL      ',VVVV,REFYEAR:6:1);
  WRITELN('2 = PRICE OF COAL IN DOLLARS PER');
  WRITELN('    MILLION BTU      ',VVV,DOLLARMBTU:6:2);
  WRITELN('3 = YEAR OF STARTUP ',VVV,YEARSTART:1:1);
  WRITELN('4 = PLANT LIFE      ',VVV,PLANTLIFE:1:1);
  WRITELN('5 = CNP INFLATION RATE ',VV,CNPINFLATIONRATE:6:3);
  WRITELN('6 = REAL COST ESCALATION RATE',V,REALESCRATE:6:3);
  WRITELN('7 = PLANT NET HEAT RATE (BTU/KWH)',HIRATE:1:1);
  WRITELN('8 = EFFECTIVE COST OF MONEY ',V,TAWACM:6:3);
  WRITELN('99 = EXIT PROGRAM')
END;

```

```

PROCEDURE X1;
BEGIN
  WRITELN(' INPUT REFERENCE YEAR FOR PRICE OF');
  WRITELN(' COAL');
  READLN(REFYEAR);
  YEARSTOREF := ROUND(YEARSTART - REFYEAR);
END;

```

```

PROCEDURE X2;
BEGIN
  WRITELN(' INPUT PRICE OF COAL IN REFERENCE');
  WRITELN(' YEAR DOLLARS PER MILLION BTU');
  READLN(DOLLARMBTU)
END;

PROCEDURE X3;
BEGIN
  WRITELN(' INPUT CONSTANT DOLLAR LEVELIZED');
  WRITELN(' COST YEAR');
  READLN(YEARSTART);
  YEARSTOREF := ROUND(YEARSTART - REFYEAR);
END;

PROCEDURE X4;
BEGIN
  WRITELN(' INPUT PLANT LIFE (YEARS)');
  READLN(PLANTLIFE);
END;

PROCEDURE X5;
BEGIN
  WRITELN(' INPUT GNP INFLATION RATE (DECIMAL)');
  READLN(GNPINFLATIONRATE)
END;

PROCEDURE X6;
BEGIN
  WRITELN(' INPUT REAL ESCALATION RATE (DECIMAL)');
  READLN(REALESCRATE);
END;

PROCEDURE X7;
BEGIN
  WRITELN(' INPUT PLANT NET HEAT RATE (BTU/KWH)');
  READLN(HIRATE)
END;

PROCEDURE X8;
BEGIN
  WRITELN(' INPUT EFFECTIVE COST OF MONEY (DECIMAL)');
  READLN(TAWACM)
END;

PROCEDURE MEN2;
BEGIN
  WRITELN('ENTER A NUMBER FROM THE MENU');
  READLN(NUM);
  CASE NUM OF
    0: ;
    1: X1;

```

```

2: X2;
3: X3;
4: X4;
5: X5;
6: X6;
7: X7;
8: X8;
99: EXIT(PROGRAM);
END;
WRITELN
END;

PROCEDURE WRITEIT1;
BEGIN
  WRITELN(Z,V,' LEVELIZED COAL COST ');
  WRITELN(Z);
  WRITELN(Z,VVV,' VERSION 2-DEC-83');
  WRITELN(Z);
  WRITELN(Z,V,' INPUT DATA');
  WRITELN(Z,V,' -----');
  WRITELN(Z);
  WRITELN(Z,V,' REFERENCE YEAR FOR PRICE OF COAL      ',VV,REFYEAR:6:1);
  WRITELN(Z,V,' PRICE OF COAL IN DOLLARS PER MILLION BTU    ',V,DOLLARMBTU:6:2);
  WRITELN(Z,V,' YEAR OF PLANT STARTUP ',VVVV,YEARSTART:1:1);
  WRITELN(Z,V,' PLANT LIFE      ',VVVVV,V,PLANTLIFE:1:1);
  WRITELN(Z,V,' GNP INFLATION RATE      ',VVVV,GNPINFLATIONRATE:7:3);
  WRITELN(Z,V,' REAL COST ESCALATION RATE ',VVVV,REALESCRATE:7:3);
  WRITELN(Z,V,' EFFECTIVE COST OF MONEY   ',VVVV,TAWACM:7:3);
  WRITELN(Z,V,' PLANT NET HEAT RATE (BTU/KWH)   ',VVV,HIRATE:1:1)
END;

PROCEDURE CALC;
BEGIN
  WRITELN(Z);
  WRITELN(Z,V,' -----');
  FO := DOLLARMBTU * HIRATE * 1.0E-6 * 1.0E+3;
  WRITELN(Z);
  ILIFE := ROUND(PLANTLIFE);
  OVERALLESCRATE := (1.0+REALESCRATE) *
    (1.0+GNPINFLATIONRATE) - 1.0;
  POFBAR := FO * DEF(OVERALLESCRATE,
    GNPINFLATIONRATE,TAWACM,YEARSTOREF,ILIFE);
  WRITELN(Z,V,' CONSTANT DOLLAR LEVELIZED COST OF COAL');
  WRITELN(Z,V,' IN ',REFYEAR:1:1,' DOLLARS ',
    VVV,POFBAR:1:1,' MILLS/KWH');
  WRITELN(Z);
  WRITELN(Z,V,' -----')
END;

```

```
BEGIN
  REWRITE(Z, 'PRINTER:');
  INIT01;
  REPEAT
    REPEAT
      MEN1;
      MEN2;
    UNTIL NUM = 0;
  WRITEIT1;
  CALC;
  PAGE(Z);
  UNTIL NUM = 99
END.
```

```

(*$S+*)
PROGRAM FCRATE; (* COST1:FCRATE.TEXT *)

(*=====*)
(*                                     *)
(* FCRATE                             *)
(*                                     *)
(* FIXED CHARGE RATE                  *)
(*                                     *)
(* TRANSLATION OF A FORTRAN PROGRAM  *)
(* BY J.G.DELENE TO PASCAL BY        *)
(* L.C.FULLER                         *)
(*                                     *)
(*=====*)

USES
  TRANSCEND;

CONST
  V = '          ';
  VV = '          ';
  VV = '          ';
  VVV = '          ';
  VVVV = '          ';

VAR
  X : INTERACTIVE;
  (* NOTE: THIS VARIABLE WILL BE USED WHENEVER PRINTER OUTPUT IS NEEDED *)

  F, T,
  DB, PC, PX, TC, TD,
  BLF, BYR, COM, CRC, CRF, DSL, FCR, FIR, PTR, RIR, PWC, PWF, ROC,
  AITC, CORR, CLRR, DCAP, DIOC, DISC, ECOM, ECON, FFAC,
  REVC, RINV, RITC, XITC,
  EQINT, TXCAP, XPROP, XREPL : REAL;

  I, NDP, NLF, NYR, NUM : INTEGER;

  RT, FR : ARRAY[1..3] OF REAL;

  TEFFRA: ARRAY[1..36,1..4] OF REAL;

  CREV, PROP, REPL,
  REASE : ARRAY[1..36] OF REAL;

  NORM, ANSWER : CHAR;

FUNCTION UPARROW(X,Y:REAL):REAL;
BEGIN
  UPARROW := EXP(Y * LN(X))
END;

```

```
PROCEDURE INIT01;
BEGIN
```

```
  NLF := 30;
  NYR := 30;
  F := 1.06;
  FIR := 1.06;
  T := 0.4816;
  RINV := 1000.0;
  FFAC := 0.6470;
  RITC := 0.08;
  RT[1] := 0.1;
  RT[2] := 0.09;
  RT[3] := 0.14;
  FR[1] := 0.50;
  FR[2] := 0.12;
  FR[3] := 0.38;
  PTR := 0.02;
  RIR := 0.01;
  NORM := 'N';
  NDP := 3;
```

```
END;
```

```
PROCEDURE INIT02;
BEGIN
```

```
  TEFRA[1,1] := 0.25;
  TEFRA[2,1] := 0.38;
  TEFRA[3,1] := 0.37;
  FOR I := 4 TO 36 DO TEFRA[I,1] := 0.0;
  TEFRA[1,2] := 0.15;
  TEFRA[2,2] := 0.22;
  TEFRA[3,2] := 0.21;
  TEFRA[4,2] := 0.21;
  TEFRA[5,2] := 0.21;
  FOR I := 6 TO 36 DO TEFRA[I,2] := 0.0;
  TEFRA[1,3] := 0.08;
  TEFRA[2,3] := 0.14;
  TEFRA[3,3] := 0.12;
  TEFRA[4,3] := 0.10;
  TEFRA[5,3] := 0.10;
  TEFRA[6,3] := 0.10;
  TEFRA[7,3] := 0.09;
  TEFRA[8,3] := 0.09;
  TEFRA[9,3] := 0.09;
  TEFRA[10,3] := 0.09;
  FOR I := 11 TO 36 DO TEFRA[I,3] := 0.0;
END;
```

```
PROCEDURE INIT03;
BEGIN
```

```
  TEFRA[1,4] := 0.05;
  TEFRA[2,4] := 0.10;
  TEFRA[3,4] := 0.09;
```

```

TEFRA[4,4] := 0.08;
TEFRA[5,4] := 0.07;
TEFRA[6,4] := 0.07;
TEFRA[7,4] := 0.06;
TEFRA[8,4] := 0.06;
TEFRA[9,4] := 0.06;
TEFRA[10,4] := 0.06;
TEFRA[11,4] := 0.06;
TEFRA[12,4] := 0.06;
TEFRA[13,4] := 0.06;
TEFRA[14,4] := 0.06;
TEFRA[15,4] := 0.06;
FOR I := 16 TO 36 DO TEFRA[I,4] := 0.0;
END;

PROCEDURE LOOKAT;
BEGIN
  REPEAT
    WRITELN('DO YOU WANT YEAR BY YEAR PRINTOUT OF');
    WRITELN('RETURN, RATE BASE, TAXES, REV. REQ.?');
    WRITELN('ANSWER Y OR N');
    READLN(ANSWER);
  UNTIL (ANSWER = 'Y') OR (ANSWER = 'N');
END;

PROCEDURE MEN1;
BEGIN
  WRITELN(
    'THE AVAILABLE MENU OPTIONS AND THEIR';
    'VALUES AT THIS TIME ARE:');
  WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
  WRITELN('1 = PROJECT LIFE, YEARS',VV,NLF:2);
  WRITELN('    LEVELIZING PERIOD, YEARS',VV,NYR:2);
  WRITELN('2 = INFLATION FACTOR (1 + RATE)    ',F:4:2);
  WRITELN('3 = INTERIM REPLACE. ESCAL. FACTOR ',FIR:4:2);
  WRITELN('4 = EFFECTIVE INCOME TAX RATE    ',T:6:4);
  WRITELN('5 = TOTAL INITIAL CAPITAL INVESTMENT, $');
  WRITELN(VVVV,V,'    ',RINV:6:1);
  WRITELN('6 = TAX DEDUCTABLE FRACTION OF TOTAL');
  WRITELN('    CAPITAL INVESTMENT ',VV,FFAC:6:4);
  WRITELN('7 = INVESTMENT TAX CREDIT RATE',V,RITC:4:2);
  WRITELN('8 = INTEREST RATE ON DEBT    ',V,RT[1]:6:4);
  WRITELN('    RETURN ON PREF. STOCK    ',V,RT[2]:6:4);
  WRITELN('    RETURN ON COMMON STOCK   ',V,RT[3]:6:4);
END;

PROCEDURE MEN2;
BEGIN
  WRITELN('9 = DEBT FRACTION          ',V,FR[1]:6:4);
  WRITELN('    PREFERRED STOCK FRACTION',V,FR[2]:6:4);
  WRITELN('    COMMON STOCK FRACTION   ',V,FR[3]:6:4);
  WRITELN('10 = PROPERTY TAX RATE     ',VV,PIR:4:2);

```

```

WRITELN('11 = INTERIM REPL. RATE ',VV,RIR:4:2);
WRITELN('12 = NORMALIZED/FLOW-THROUGH ACCTG. ',NORM);
WRITELN('13 = TEFRA DEPRECIATION SCHEDULE ',V,NDP:1);
IF (NDP = 1) THEN WRITELN(VVV,'3-YEAR PROPERTY');
IF (NDP = 2) THEN WRITELN(VVV,'5-YEAR PROPERTY');
IF (NDP = 3) THEN WRITELN(VVV,'10-YEAR PROPERTY');
IF (NDP = 4) THEN WRITELN(V,'15-YEAR PUBLIC UTILITY PROPERTY');
WRITELN('99 = EXIT PROGRAM');
END;

```

```

PROCEDURE X1;
BEGIN
  WRITELN('INPUT PROJECT LIFE, YEARS');
  READLN(NLF);
  WRITELN('INPUT LEVELIZING PERIOD, YEARS');
  READLN(NYR);
END;

```

```

PROCEDURE X2;
BEGIN
  WRITELN('INPUT INFLATION FACTOR (1 + F)');
  READLN(F);
END;

```

```

PROCEDURE X3;
BEGIN
  WRITELN('INPUT INTERIM. REPL. ESCAL. FACT. (1 + F)');
  READLN(FIR);
END;

```

```

PROCEDURE X4;
BEGIN
  WRITELN('INPUT EFFECTIVE INCOME TAX RATE');
  READLN(T);
END;

```

```

PROCEDURE X5;
BEGIN
  WRITELN('INPUT TOTAL CAPITAL INVESTMENT');
  READLN(RINV);
END;

```

```

PROCEDURE X6;
BEGIN
  WRITELN('INPUT DEDUCTABLE FRACTION OF TOTAL');
  WRITELN('CAPITAL INVESTMENT');
  READLN(FFAC);
END;

```

```

PROCEDURE X7;
BEGIN
  WRITELN('INPUT INVESTMENT TAX CREDIT RATE');
  WRITELN('AS A DECIMAL FRACTION');
  READLN(RITC);
END;

PROCEDURE X8,
BEGIN
  WRITELN('INPUT INTEREST RATE ON DEBT');
  WRITELN('AS A DECIMAL FRACTION');
  READLN(RT[1]);
  WRITELN('INPUT RETURN ON PREFERRED STOCK');
  WRITELN('AS A DECIMAL FRACTION');
  READLN(RT[2]);
  WRITELN('INPUT RETURN ON COMMON STOCK');
  WRITELN('AS A DECIMAL FRACTION');
  READLN(RT[3]);
END;

PROCEDURE X9;
BEGIN
  WRITELN('INPUT DEBT FRACTION (DECIMAL)');
  READLN(FR[1]);
  WRITELN('INPUT PREFERRED STOCK FRACTION');
  READLN(FR[2]);
  FR[3] := 1.0 - FR[1] - FR[2];
END;

PROCEDURE X10;
BEGIN
  WRITELN('INPUT PROPERTY TAX RATE');
  WRITELN('AS A DECIMAL FRACTION');
  READLN(PTR);
END;

PROCEDURE X11;
BEGIN
  WRITELN('INPUT INTERIM REPL. RATE');
  WRITELN('AS A DECIMAL FRACTION');
  READLN(RIR);
END;

PROCEDURE X12;
BEGIN
  REPEAT
    WRITELN('INPUT N FOR NORMALIZED');
    WRITELN('    OR F FOR FLOW-THROUGH ACCOUNTING');
    READLN(NORM);
  UNTIL (NORM = 'N') OR (NORM = 'F');
END;

```

```

PROCEDURE X13;
BEGIN
  WRITELN('INPUT 1 FOR 3-YEAR PROPERTY');
  WRITELN('      2 FOR 5-YEAR PROPERTY');
  WRITELN('      3 FOR 10-YEAR PROPERTY');
  WRITELN('      4 FOR 15-YEAR PUBL. UTIL. PROPERTY');
  READLN(NDP);
END;

```

```

PROCEDURE MEN3;
BEGIN
  WRITELN('ENTER A NUMBER FROM THE MENU');
  READLN(NUM);
  CASE NUM OF
    0: ;
    1: X1;
    2: X2;
    3: X3;
    4: X4;
    5: X5;
    6: X6;
    7: X7;
    8: X8;
    9: X9;
    10: X10;
    11: X11;
    12: X12;
    13: X13;
    99: EXIT(PROGRAM);
  END;
  WRITELN;
END;

```

```

PROCEDURE SECT01;
BEGIN
  EQINT := FR[2] * RT[2] + FR[3] * RT[3];
  COM := FR[1] * RT[1] + EQINT;
  PWF := 1.0 + (COM - T * FR[1] * RT[1]);
  DCAP := FFAC * RINV;
  ECOM := (PWF - 1.0) * 100.0;
  PWC := 1.0 + (PWF - F) / F;
  ECON := (PWC - 1.0) * 100.0;
  BLF := NLF;
  BYR := NYR;
  XITC := DCAP * RITC;
  DSL := DCAP / BLF;
  DB := RINV / BLF;
  FX := 0.0;
  PC := 0.0;
  IF (NORM = 'N') THEN AITC := XITC / BLF;

```

```

XREPL := RIR * RINV;
XPROP := PTR * RINV;
END;

```

```

PROCEDURE YEAR1;

```

```

BEGIN

```

```

  IF (NORM = 'F') THEN

```

```

    BEGIN

```

```

      RBASE[1] := RINV;

```

```

      TC := T * (DB - TXCAP + EQINT * RBASE[1]) /
        (1.0 - T) - XITC / (1.0 - T);

```

```

    END;

```

```

  IF (NORM = 'N') THEN

```

```

    BEGIN

```

```

      TD := T * (TXCAP - DSL);

```

```

      RBASE[1] := RINV - XITC;

```

```

      TC := T * (DB - TXCAP + EQINT * RBASE[1] + TD) / (1.0 - T);

```

```

    END;

```

```

END;

```

```

PROCEDURE LATER;

```

```

BEGIN

```

```

  IF (NORM = 'F') THEN

```

```

    BEGIN

```

```

      RBASE[1] := RBASE[1-1] - DB;

```

```

      TC := T * (DB - TXCAP + EQINT * RBASE[1]) /
        (1.0 - T);

```

```

    END;

```

```

  IF (NORM = 'N') THEN

```

```

    BEGIN

```

```

      RBASE[1] := RBASE[1-1] - (DB + TD) + AITC;

```

```

      TD := T * (TXCAP - DSL);

```

```

      TC := T * (DB - TXCAP + EQINT * RBASE[1] + TD) / (1.0 - T);

```

```

    END;

```

```

END;

```

```

PROCEDURE SECT03;

```

```

BEGIN

```

```

  ROC := COM * RBASE[1];

```

```

  REPL[1] := XREPL * UPARROW(FIR,1);

```

```

  PROP[1] := XPROP;

```

```

  CREV[1] := ROC + DB + TD + TC + REPL[1] + PROP[1];

```

```

  REVC := CREV[1] * UPARROW(F,(-1));

```

```

  DISC := UPARROW(PWF,(-1));

```

```

  PX := CREV[1] * UPARROW(PWF,(-1)) + PX;

```

```

  DICC := UPARROW(PWC,(-1));

```

```

  PC := PC + REVC * DICC;

```

```

  CRF := (PWF - 1.0) / (1.0 - DISC);

```

```

  CLRR := PX * CRF / RINV;

```

```

  CRC := (PWC - 1.0) / (1.0 - DICC);

```

```

  CORR := PC * CRC / RINV;

```

```

END;

```

PROCEDURE SECT07;

BEGIN

```

WRITELN(X,'      RATE  RETURN  BOOK   TAX      INC TAX      PROP  INIRM'
,'      REV REQ  ');
WRITELN(X,'YEAR  BASE  ON CAP  LEPR   DEPR   CURR DEPR   TAX   REPL '
,'  CURR$  CONST$');
WRITELN(X);

```

END;

PROCEDURE SECT08;

BEGIN

```

WRITELN(X);
WRITELN(X,'SUM OF THE PRESENT WORTH OF THE REVENUE REQUIREMENTS AT');
WRITELN(X);
WRITELN(X,' (' ,ECON:6:3,' % COST OF MONEY)',VVVV,VV,PX:8:1);
WRITELN(X);
WRITELN(X,' (' ,ECON:6:3,' % COST OF MONEY)  ',VVVV,VV,PC:8:1);

```

END;

PROCEDURE SECT02;

BEGIN

```

IF (ANSWER = 'Y') THEN SECT07;
FOR I := 1 TO NYR DO

```

 BEGIN

```

    TXCAP := DCAP * TEFRA[I,NDP];

```

```

    IF (I = 1) THEN YEAR1;

```

```

    IF (I > 1) THEN LATER;

```

```

    SECT03;

```

```

    IF (ANSWER = 'Y') THEN

```

```

        WRITELN(X,I:2,'      ',REBASE[I]:7:1,ROC:7:1,DB:7:1,TXCAP:7:1,

```

```

        TC:7:1,TD:7:1,PROP[I]:7:1,REPL[I]:7:1,CREV[I]:7:1,

```

```

        REVC:7:1);

```

```

    END;

```

```

IF (ANSWER = 'Y') THEN SECT08;

```

END;

PROCEDURE SECT04;

BEGIN

```

CRF := (PWF - 1.0)/(1.0 - UPARROW(PWF,(-BYR)));

```

```

FCR := PX * CRF / RINV;

```

```

WRITELN(X);

```

```

WRITELN(X,'FIXED CHARGE RATE');

```

```

WRITELN(X);

```

```

WRITELN(X,VV,'CURRENT DOLLAR RATE = ',FCR:7:4);

```

```

WRITELN(X);

```

```

WRITELN(X,VV,'CONSTANT DOLLAR RATE = ',CCRR:7:4);

```

END;

PROCEDURE SECT05;

BEGIN

```

    WRITELN(X,VV,'VERSION 17-OCT-83');
    WRITELN(X);
    WRITELN(X,'INPUT DATA');
    WRITELN(X,'-----');
    WRITELN(X);
    WRITELN(X,'PROJECT LIFE, YEARS ',VVVV,NLF:2);
    WRITELN(X,'LEVELIZING PERIOD, YEARS ',VVVV,NYR:2);
    WRITELN(X,'INFLATION FACTOR (1 + RATE) ',VVV,F:4:2);
    WRITELN(X,'INTERIM REPLACEMENT ESCALATION FACTOR ',V,FIR:4:2);
    WRITELN(X,'EFFECTIVE INCOME TAX RATE ',VVV,T:6:4);
    WRITELN(X,'TOTAL INITIAL CAPITAL INVESTMENT, $ ',V,RINV:6:1);
    WRITELN(X,'TAX DEDUCTABLE FRACTION OF TOTAL');
    WRITELN(X,'CAPITAL INVESTMENT ',VVVV,FFAC:6:4);
    WRITELN(X,'INVESTMENT TAX CREDIT RATE ',VVV,RITC:4:2);
    WRITELN(X,'INTEREST RATE ON DEBT',VVVV,RT[1]:6:4);
    WRITELN(X,'RETURN ON PREFERRED STOCK ',VVV,RT[2]:6:4);
    WRITELN(X,'RETURN ON COMMON STOCK ',VVV,RT[3]:6:4);

```

END;

PROCEDURE SECT06;

BEGIN

```

    WRITELN(X,'DEBT FRACTION ',VVVV,FR[1]:6:4);
    WRITELN(X,'PREFERRED STOCK FRACTION ',VVV,FR[2]:6:4);
    WRITELN(X,'COMMON STOCK FRACTION',VVV,FR[3]:6:4);
    WRITELN(X,'PROPERTY TAX RATE ',VVVV,PTR:4:2);
    WRITELN(X,'INTERIM REPLACEMENT RATE ',VVV,RIR:4:2);
    IF (NORM = 'N') THEN WRITELN(X,'NORMALIZED ACCOUNTING');
    IF (NORM = 'F') THEN WRITELN(X,'FLOW-THROUGH ACCOUNTING');
    IF (NDP = 1) THEN WRITELN(X,'ACRS CLASS: 3-YEAR PROPERTY');
    IF (NDP = 2) THEN WRITELN(X,'ACRS CLASS: 5-YEAR PROPERTY');
    IF (NDP = 3) THEN WRITELN(X,'ACRS CLASS: 10-YEAR PROPERTY');
    IF (NDP = 4) THEN WRITELN(X,'ACRS CLASS: 15-YEAR PUBLIC UTILITY PROPERTY');

```

END;

BEGIN

```

    REWRITE(X,'PRINTER:');
    INIT01;
    INIT02;
    INIT03;
    LOOKAT;
    REPEAT
        REPEAT
            MEN1;
            MEN2;
            MEN3;
        UNTIL NUM = 0;
    SECT05;
    SECT06;
    IF (ANSWER = 'Y') THEN PAGE(X);

```

```
    SECT01;  
    SECT02;  
    SECT04;  
    PAGE(X);  
UNTIL NUM = 99  
END.
```

```

(*$S+*)
PROGRAM LEVEL; (* COST1:LEVEL.TEXT *)

(*=====*)
(*                                     *)
(* LEVEL                                     *)
(*                                     *)
(* LEVELIZED POWER GENERATION COSTS      *)
(* FOR LIGHT-WATER-REACTOR AND COAL-     *)
(* FIRED POWER PLANTS                     *)
(*                                     *)
(* BASED ON:                             *)
(*   NUCLEAR ENERGY COST DATA BASE     *)
(*   METHODOLOGY DOE/NE-0044             *)
(*                                     *)
(*=====*)

USES
  TRANSCEND;

CONST
  V = '      ';
  VV = '      ';
  VVV = '      ';
  VVVV = '      ';
  VVVVV = '      ';
  VVVVVV = '      ';

VAR
  X : INTERACTIVE;
  (* NOTE: THIS VARIABLE WILL BE USED WHEREVER PRINTER OUTPUT IS NEEDED *)

  PBAR, PWRR,
  IECON, PCBAR, PFBAR, PORAR, RATIO,
  EFRAC, EFRAC, FCRATE, PDCBAR, PFRAC,
  POCBAR, POFBAR, POMBAR, RATING, TAWAOM, TSTATE, YEAROP,
  ERETURN, ERETURN, POCBAR, POCMBAR, PRETURN, PWPOWER, TOTCURR,
  TFEDERAL, TOTCONST,
  CAPFACTOR, CAPINVEST, PLANLIFE, YEARCONST,
  TEFFECTIVE, YEARSTOREF,
  FEDEBTRATE, REALESCRATE,
  CNPINFLATIONRATE: REAL;

  NUM, YEAR, ILIFE, UNITS : INTEGER;

  TYPEP, ANSWER : CHAR;

  P,R,S : ARRAY[1..40] OF REAL;

FUNCTION UPARROW(X,Y:REAL):REAL;
BEGIN
  UPARROW := EXP(Y * LN(X))
END;

```

```

FUNCTION USPWF(IRATE,RYEAR:REAL):REAL;
BEGIN
  USPWF := ((UPARROW((1.0+IRATE),RYEAR)-1.0)/
    (IRATE*UPARROW((1.0+IRATE),RYEAR)))
END;

FUNCTION CRF(IRATE,RYEAR:REAL):REAL;
BEGIN
  CRF := 1.0 / USPWF(IRATE,RYEAR)
END;

FUNCTION SFF(IRATE,RYEAR:REAL):REAL;
BEGIN
  SFF := IRATE / (UPARROW((1.0+IRATE),RYEAR)-1.0)
END;

PROCEDURE INIT01;
BEGIN
  TYPEP := 'N';
  YEAROP := 1995.0;
  RATING := 1100.0;
  UNITS := 1;
  PLANTLIFE := 30.0;
  GNPINFLATIONRATE:= 0.06;
  REALESRATE:= 0.01;
  TSTATE := 0.04;
  TFEDERAL := 0.46;
  ERETURN := 0.14;
  EFRACT := 0.38;
  BRETURN := 0.10;
  BFRACT := 0.50;
  PRETURN := 0.09
END;

PROCEDURE INIT02;
BEGIN
  YEARCONST := 1983.0;
  FCRATE := 0.183;
  CAPINVEST := 4945.4;
  CAPFACTOR := 0.65;
  FEDEBTRATE := 0.085;
  DECOM := 130.0;
  POOMEAR := 6.61;
  POFRAR := 11.208
END;

PROCEDURE INIT03;
BEGIN
  RATING := 550.0;
  UNITS := 2;
  FCRATE := 0.182;

```

```

CAPINVEST := 3061.1;
DECOM := 0.0;
POOMBAR := 5.17;
POFBAR := 3.4
END;

PROCEDURE MEN1;
BEGIN
  WRITELN(
    'THE AVAILABLE MENU OPTIONS AND THEIR');
  WRITELN('VALUES AT THIS TIME ARE:');
  WRITELN('0 = RUN CASE, DATA ENTRY COMPLETE');
  WRITELN('1 = PLANT TYPE',VVVV,TYPEP);
  WRITELN('2 = YEAR OF FIRST COMML. OPER.      ',YEAROP:6:1);
  WRITELN('3 = RATING ',RATING:6:1,' & UNITS/PLANT ',V,UNITS);
  WRITELN('4 = PLANT LIFE ',VVVV,PLANTLIFE:4:1);
  WRITELN('5 = GNP INFLATION RATE ',VV,GNPINFLATIONRATE:6:2);
  WRITELN('6 = REAL COST ESCALATION RATE',V,REALESCRATE:6:2);
  WRITELN('7 = STATE INCOME TAX RATE      ',V,TSTATE:4:2);
  WRITELN('8 = FEDERAL INCOME TAX RATE      ',V,TFEDERAL:4:2);
  WRITELN('9 = RETURN ON COMMON STOCK      ',V,ERETURN:4:2);
  WRITELN('10 = COMMON STOCK FRACTION      ',V,EFRACT:4:2);
  WRITELN('11 = INTEREST RATE ON DEBT      ',V,BRETURN:4:2)
END;

PROCEDURE MEN2;
BEGIN
  WRITELN('12 = DEBT FRACTION      ',VV,BFRACT:4:2);
  WRITELN('13 = RETURN ON PREFERRED STOCK',V,PRETURN:4:2);
  WRITELN('14 = REF. YEAR FOR CONST. $ COSTS',YEARCONST:6:1);
  WRITELN('15 = FIXED CHARGE RATE ',VV,FCRATE:6:3);
  WRITELN('16 = PLANT INVESTMENT COST ',V,CAPINVEST:6:1);
  WRITELN('17 = CAPACITY FACTOR      ',VV,CAPFACTOR:6:2);
  WRITELN('18 = DECOMMISSIONING DEBT RATE      ',FEDDEBTRATE:6:3);
  WRITELN('19 = DECOMMISSIONING COST      ',V,DECOM:6:1);
  WRITELN('20 = O&M COST ',VVVV,POOMBAR:6:1);
  WRITELN('21 = FUEL COST',VVVV,POFBAR:6:1);
  WRITELN('99 = EXIT PROGRAM')
END;

PROCEDURE X1;
BEGIN
  WRITELN('INPUT PLANT TYPE:');
  WRITELN(V,'N = NUCLEAR');
  WRITELN(V,'C = COAL-FIRED');
  READ(TYPEP);
  IF TYPEP = 'C' THEN
    BEGIN
      WRITELN;
      WRITELN('DO YOU WANT TO RESET TO COAL-FIRED');
      WRITELN('DEFAULT VALUES? ANSWER Y OR N');
    END
  END

```

```

        READLN(ANSWER);
        IF ANSWER = 'Y' THEN INIT03;
    END)
END;

```

```

PROCEDURE X2;
BEGIN
    WRITELN('INPUT YEAR OF FIRST COMMERCIAL');
    WRITELN('OPERATION');
    READLN(YEAROP)
END;

```

```

PROCEDURE X3;
BEGIN
    WRITELN('INPUT RATING (MWE)');
    READLN(RATING);
    WRITELN('INPUT NUMBER OF UNITS PER PLANT');
    READLN(UNITS)
END;

```

```

PROCEDURE X4;
BEGIN
    WRITELN('INPUT PLANT LIFE (YEARS)');
    READLN(PLANTLIFE)
END;

```

```

PROCEDURE X5;
BEGIN
    WRITELN('INPUT GNP INFLATION RATE (DECIMAL)');
    READLN(GNPINFLATIONRATE)
END;

```

```

PROCEDURE X6;
BEGIN
    WRITELN('INPUT REAL ESCALATION RATE (DECIMAL)');
    READLN(REALESCRATE)
END;

```

```

PROCEDURE X7;
BEGIN
    WRITELN('INPUT STATE INCOME TAX RATE (DECIMAL)');
    READLN(TSTATE)
END;

```

```

PROCEDURE X8;
BEGIN
    WRITELN('INPUT FEDERAL INCOME TAX RATE (DECIMAL)');
    READLN(TFEDERAL)
END;

```

```

PROCEDURE X9;
BEGIN
  WRITELN('INPUT RETURN ON COMMON STOCK (DECIMAL)');
  READLN(ERETURN)
END;

PROCEDURE X10;
BEGIN
  WRITELN('INPUT COMMON STOCK FRACTION (DECIMAL)');
  READLN(EFRACT)
END;

PROCEDURE X11;
BEGIN
  WRITELN('INPUT INTEREST RATE ON DEBT (DECIMAL)');
  READLN(BRETURN)
END;

PROCEDURE X12;
BEGIN
  WRITELN('INPUT DEBT FRACTION (DECIMAL)');
  READLN(BFRACT)
END;

PROCEDURE X13;
BEGIN
  WRITELN('INPUT RETURN ON PREFERRED STOCK (DECIMAL)');
  READLN(PRETURN)
END;

PROCEDURE X14;
BEGIN
  WRITELN('INPUT YEAR FOR CONSTANT DOLLAR COSTS');
  READLN(YEARCONST)
END;

PROCEDURE X15;
BEGIN
  WRITELN('INPUT FIXED CHARGE RATE (DECIMAL)');
  READLN(FCRATE)
END;

PROCEDURE X16;
BEGIN
  WRITELN('INPUT PLANT INVESTMENT COST AT YEAR');
  WRITELN('OF FIRST COMMERCIAL OPERATION');
  WRITELN('(', YEAROP:1:1, ' $MILLIONS)');
  READLN(CAPINVEST)
END;

```

```

PROCEDURE X17;
BEGIN
  WRITELN('INPUT CAPACITY FACTOR (DECIMAL)');
  READLN(CAPFACTOR)
END;

PROCEDURE X18;
BEGIN
  WRITELN('INPUT FEDERAL GOVERNMENT DEBT RATE');
  WRITELN('(DECIMAL)');
  READLN(FEDDEBT RATE)
END;

PROCEDURE X19;
BEGIN
  WRITELN('INPUT DECOMMISSIONING COST IN');
  WRITELN(YEARCONST:1:1, ' $MILLIONS');
  READLN(DECOM)
END;

PROCEDURE X20;
BEGIN
  WRITELN('INPUT CONSTANT DOLLAR LEVELIZED O&M COST');
  WRITELN(' IN ', YEARCONST:1:1, ' MILLS/KWH');
  READLN(POCMBAR)
END;

PROCEDURE X21;
BEGIN
  WRITELN('INPUT CONSTANT DOLLAR LEVELIZED');
  WRITELN('FUEL COST');
  WRITELN(' IN ', YEARCONST:1:1, ' MILLS/KWH');
  READLN(POFBRAR)
END;

PROCEDURE MEN3;
BEGIN
  WRITELN('ENTER A NUMBER FROM THE MENU');
  READLN(NUM);
  CASE NUM OF
    0: ;
    1: X1;
    2: X2;
    3: X3;
    4: X4;
    5: X5;
    6: X6;
    7: X7;
    8: X8;
    9: X9;
    10: X10;
  
```

```

11: X11;
12: X12;
13: X13;
14: X14;
15: X15;
16: X16;
17: X17;
18: X18;
19: X19;
20: X20;
21: X21;
99: EXIT(PROGRAM);
END;
WRITELN
END;

PROCEDURE CALC01;
BEGIN
  WRITELN('<<< CALCULATIONS TAKING PLACE >>>');
  ILIFE := ROUND(PLANILIFE);
  TEFFECTIVE := TSTATE + (1.0-TSTATE) * TFEDERAL;
  PFRAC := 1.0 - EFRAC - BFRAC;
  TAWACM := EFRAC * ERETURN + BFRAC *
    ERETURN * (1.0 - TEFFECTIVE) +
    PFRAC * PRETURN;
  YEARSTOREF := YEAROP - YEARCONST;
  FOR YEAR := 1 TO ILIFE DO
    BEGIN
      S[YEAR] := 1.0;
      P[YEAR] := 1.0;
    END;
  PWRR := 0.0;
  PWPOWER := 0.0;
  FOR YEAR := 1 TO ILIFE DO
    BEGIN
      P[YEAR] := P[YEAR] *
        UPARROW((1.0+GNPINFLATIONRATE),YEAR) *
        UPARROW((1.0+REALESCRATE),YEAR);
      R[YEAR] := P[YEAR] * S[YEAR];
      PWRR := PWRR + R[YEAR] /
        UPARROW((1.0+TAWACM),YEAR);
      PWPOWER := PWPOWER + S[YEAR] /
        UPARROW((1.0+TAWACM),YEAR);
    END;
  PBAR := PWRR / PWPOWER
END;

PROCEDURE CALC02;
BEGIN
  PCBAR := UPARROW((1.0+GNPINFLATIONRATE),-YEARSTOREF) * PBAR *
    (CRF((TAWACM-GNPINFLATIONRATE)/(1.0+GNPINFLATIONRATE)),
    PLANILIFE) / (CRF(TAWACM,PLANILIFE));

```

```

RATIO := POBAR / PBAR;
PCBAR := PCRATE * CAPINVEST * 1.0E6 /
(8760.0 * RATING * UNITS * CAPFACTOR);
POCBAR := RATIO * PCBAR;
POMBAR := POOMBAR / RATIO;
PFBAR := POFBAR / RATIO;
IF (TYPEP = 'N') THEN
  BEGIN
    PDCBAR := SFF(FEDDEBRATE,PLANTLIFE) *
      UPARROW((1.0+GNPINFLATIONRATE),(YEARSTOREF+PLANTLIFE)) *
      DECOM * 1000.0E6 /
      (8760.0 * CAPFACTOR * RATING * UNITS * 1000.0);
    PODCBAR := RATIO * PDCBAR;
  END
ELSE
  BEGIN
    PDCBAR := 0;
    PODCBAR := 0;
  END;
TOTCURR := PCBAR + POMBAR + PFBAR +
  PDCBAR;
TOTCONST := POCBAR + POOMBAR + POFBAR +
  PODCBAR;
END;

PROCEDURE SECT80;
BEGIN
  WRITELN(X,VVVV,'VERSION 19-OCT-83');
  WRITELN(X);
  IF (TYPEP = 'N') THEN
    WRITELN(X,V,'PLANT TYPE',VV,VVVVV,'NUCLEAR')
  ELSE
    WRITELN(X,V,'PLANT TYPE',VV,VVVVV,'COAL-FIRED');
  WRITELN(X,V,'YEAR OF FIRST COMMERCIAL OPERATION',
    VV,YEAROP:1:1);
  WRITELN(X,V,'RATING PER UNIT (MWE) ',VVVV,RATING:1:1);
  WRITELN(X,V,'UNITS PER PLANT ',VVVVV,UNITS:1);
  WRITELN(X,V,'PLANT LIFE ',VVVVVV,PLANTLIFE:1:1);
  WRITELN(X);
END;

PROCEDURE SECT81;
BEGIN
  WRITELN(X,V,'INFLATION RATE ',VVVVV,GNPINFLATIONRATE:6:2);
  WRITELN(X,V,'REAL COST ESCALATION RATE ',VVV,REALESORATE:6:2);
  WRITELN(X);
  WRITELN(X,V,'STATE INCOME TAX RATE ',VVVV,TSTATE:6:4);
  WRITELN(X,V,'FEDERAL INCOME TAX RATE ',VVVV,TFEDERAL:6:4);
  WRITELN(X,V,'EFFECTIVE INCOME TAX RATE ',VVV,TEFFECTIVE:6:4);
END;

```

PROCEDURE SECT85;

BEGIN

```

WRITELN(X);
WRITELN(X,V,'RETURN ON COMMON STOCK ',VVVV,ERETURN:4:2);
WRITELN(X,V,'COMMON STOCK FRACTION ',VVVV,EFRACT:4:2);
WRITELN(X,V,'INTEREST RATE ON DEBT ',VVVV,BRETUR:4:2);
WRITELN(X,V,'DEBT FRACTION ',VVVV,BFRACT:4:2);
WRITELN(X,V,'RETURN ON PREFERRED STOCK ',VVV,PRETURN:4:2);
WRITELN(X,V,'PREFERRED STOCK FRACTION',VVVV,PFRACT:4:2);
WRITELN(X,V,'EFFECTIVE COST OF MONEY ',VVVV,TAWACM:5:3);
WRITELN(X);
WRITELN(X,V,'CONSTANT DOLLAR LEVELIZED COST YEAR ',V,YEARCONST:1:1);
WRITELN(X,V,'FIXED CHARGE RATE ',VVVV,FCRATE:5:3);
WRITELN(X,V,'PLANT INVESTMENT COST (' ,YEAROP:1:1,
' $MILLIONS) ',CAPINVEST:6:1);
WRITELN(X,V,'CAPACITY FACTOR ',VVVV,CAPFACTOR:4:2)

```

END;

PROCEDURE SECT90;

BEGIN

IF (TYPEP = 'N') THEN

BEGIN

```

WRITELN(X,V,
'FEDERAL GOVERNMENT DEBT RATE ',VVV,FEDTERIRATE:5:3);
WRITELN(X,V,
'DECOMMISSIONING COST (' ,YEARCONST:1:1,' $MILLIONS) ',DECOM:7:1)

```

END;

```

WRITELN(X,V,
'LEVELIZED O&M COST (' ,YEARCONST:1:1,' MILLS/KWH) ',V,POCMBAR:5:2);
WRITELN(X,V,
'LEVELIZED FUEL COST (' ,YEARCONST:1:1,' MILLS/KWH) ',V,POFBAR:5:2)

```

END;

PROCEDURE SECT95;

BEGIN

```

WRITELN(X);
WRITELN(X,VV,'LEVELIZED POWER GENERATION COSTS');
WRITELN(X,VVVV,'MILLS/KWH');
WRITELN(X);
WRITELN(X,VVVV,'CONSTANT ',',CURRENT');
WRITELN(X);
WRITELN(X,V,'CAPITAL ',V,V,POCBAR:6:1,V,PCBAR:6:1);
WRITELN(X,V,'OPERATION & MAINT. ',POCMBAR:6:1,V,PCMBAR:6:1);
WRITELN(X,V,'FUEL ',VVV,POFBAR:6:1,V,PFBAR:6:1);
IF (TYPEP = 'N') THEN
WRITELN(X,V,'DECOMMISSIONING',V,PODCBAR:6:1,V,PDCHAR:6:1);
WRITELN(X);
WRITELN(X,VVVV,TOTCONST:6:1,V,TOTCURR:6:1);
WRITELN(X);
WRITELN('<<< CASE COMPLETE >>>')

```

END;

```
BEGIN
  REWRITE(X, 'PRINTER:');
  INIT01;
  INIT02;
  REPEAT
    REPEAT
      MEN1;
      MEN2;
      MEN3;
    UNTIL NUM = 0;
    CALC01;
    CALC02;
    SECT80;
    SECT81;
    SECT85;
    SECT90;
    SECT95;
    PAGE(X);
  UNTIL NUM = 99
END.
```

ACKNOWLEDGMENTS

The Apple Pascal<TM> system incorporates UCSD Pascal<TM> and Apple extensions for graphics and other functions. UCSD Pascal was developed largely by the Institute for Information Science at the University of California at San Diego, under the direction of Kenneth L. Bowles. "UCSD PASCAL" is a trademark of The Regents of The University of California. Use thereof in conjunction with any goods or services is authorized by specific license only and is an indication that the associated product or service has met quality assurance standards prescribed by the University. "Apple" and "Apple Pascal" are trademarks of Apple Computer Inc. Any unauthorized use thereof is contrary to the laws of the State of California or of the Federal Government.

The procedures described in this report for the calculation of levelized power generation cost cannot be run without the purchase of suitable Apple hardware and software. No Apple Pascal software has been copied to disks. There is no intention to provide a self-contained set of software, and indeed the user cannot "boot-up" the system without purchase of suitable software from Apple.

REFERENCES

1. J. G. Delene et al, *Nuclear Energy Cost Data Base - A Reference Data Base for Nuclear and Coal-Fired Power Plant Power Generation Cost Analysis*, DOE/NE-0044/2 (March 1984).
2. C. R. Hudson II, *CONCEPT-5 Users Manual*, ORNL-5470 (January 1979).
3. M. L. Myers, L. C. Fuller, and H. I. Bowers, *Nonfuel Operation and Maintenance Costs for Large Steam-Electric Power Plants - 1982*, NUREG/CR-2844, ORNL/TM-8324 (September 1982).
4. J. G. Delene and O. W. Hermann *REFCO-83 User's Manual*, NUREG/CR-3800, ORNL/TM-9186 (June 1984).
5. G. R. Smolen et al., *Regional Projections of Nuclear and Fossil Electric Power Generation Costs*, ORNL/TM-8958 (December 1983).
6. Apple II, Apple Pascal, Operating System Reference Manual, Apple Computer Inc.
7. A. Luehrmann & H. Peckham, *Apple Pascal, A Hands-On Approach*, McGraw-Hill (1981).
8. Apple II Reference Manual, Apple Computer Inc.

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