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BUCKS--Economic Analysis Model of Solar Electric Power Plants

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BUCKS - ECONOMIC ANALYSIS MODEL OF SOLAR ELECTRIC POWER PLANTS

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Abstract

BUCKS is a computer model designed for economic analysis of solar electric power plants. The model determines the levelized life-cycle revenue per unit output from the plant that will be sufficient to compensate for the fixed and variable costs, pay interest to bondholders, and provide return to stockholders. Cost scaling relationships for solar plant subsystems have been developed which allow BUCKS in conjunction with a plant performance model to perform a number of cost benefit calculations.

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INTRODUCTION

BUCKS is a computer model developed for economic analysis of solar thermal central receiver technology in utility networks and for comparative evaluation of alternate plant designs. The model described in this report calculates power production costs for a single solar thermal central receiver power plant. An extended version of BUCKS which is being developed will include the impact of solar electric plants on utility network economics.

The model calculates levelized busbar energy cost. This is the constant revenue per unit output required over the plant lifetime to compensate for its fixed and variable costs, pay interest to stockholders, and provide return to shareholders. It does not include transmission and distribution costs or other indirect utility costs.

BUCKS is used in conjunction with two other models developed at Sandia Laboratories as a part of the Central Receiver Solar Thermal Electric Program. MIRVAL (Reference 1) provides heliostat field efficiencies as a function of sun position to the plant performance model, STEAEC (Reference 2). Plant performance and subsystem sizes are then calculated by STEAEC and used by BUCKS to compute the plant levelized busbar energy cost. Figure 1 depicts the relation of the models. BUCKS was designed to interface with these models, but can be used in conjunction with any plant annual performance model.

The basic inputs and components of the model are shown in Figure 2. The required input information to BUCKS includes cost estimates for the reference plant, and performance information for the subject plant. The reference plant is one for which detailed cost estimates are available. The subject plant represents a variation in size from the reference plant but maintains the basic design concept.

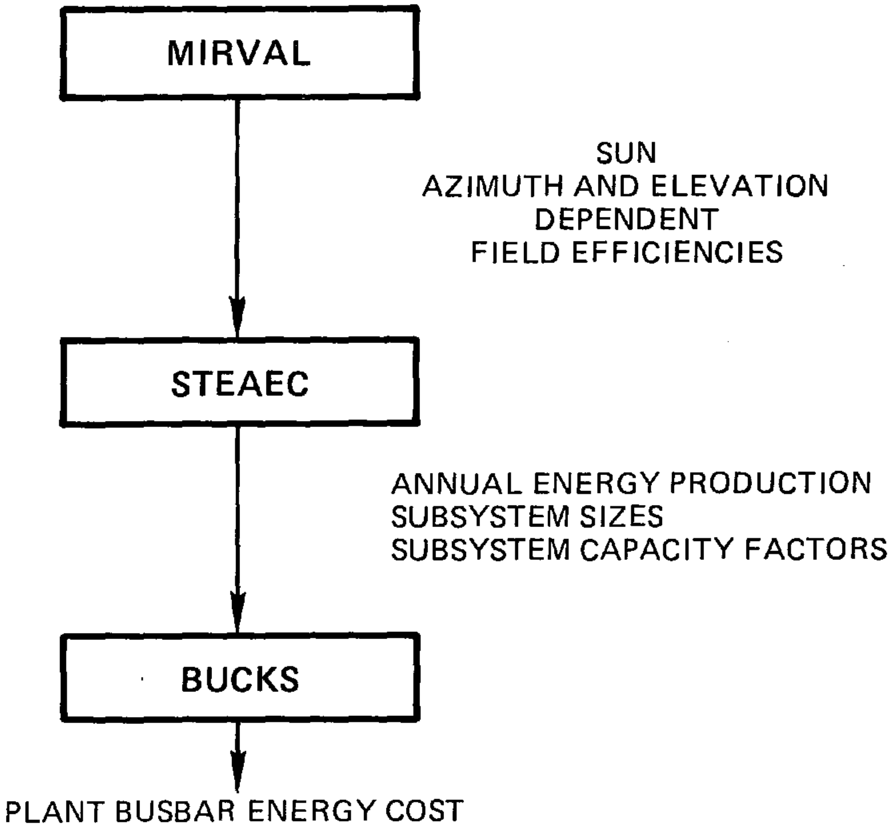

Figure 1

Solar Thermal Electric Power Plant Analysis Models

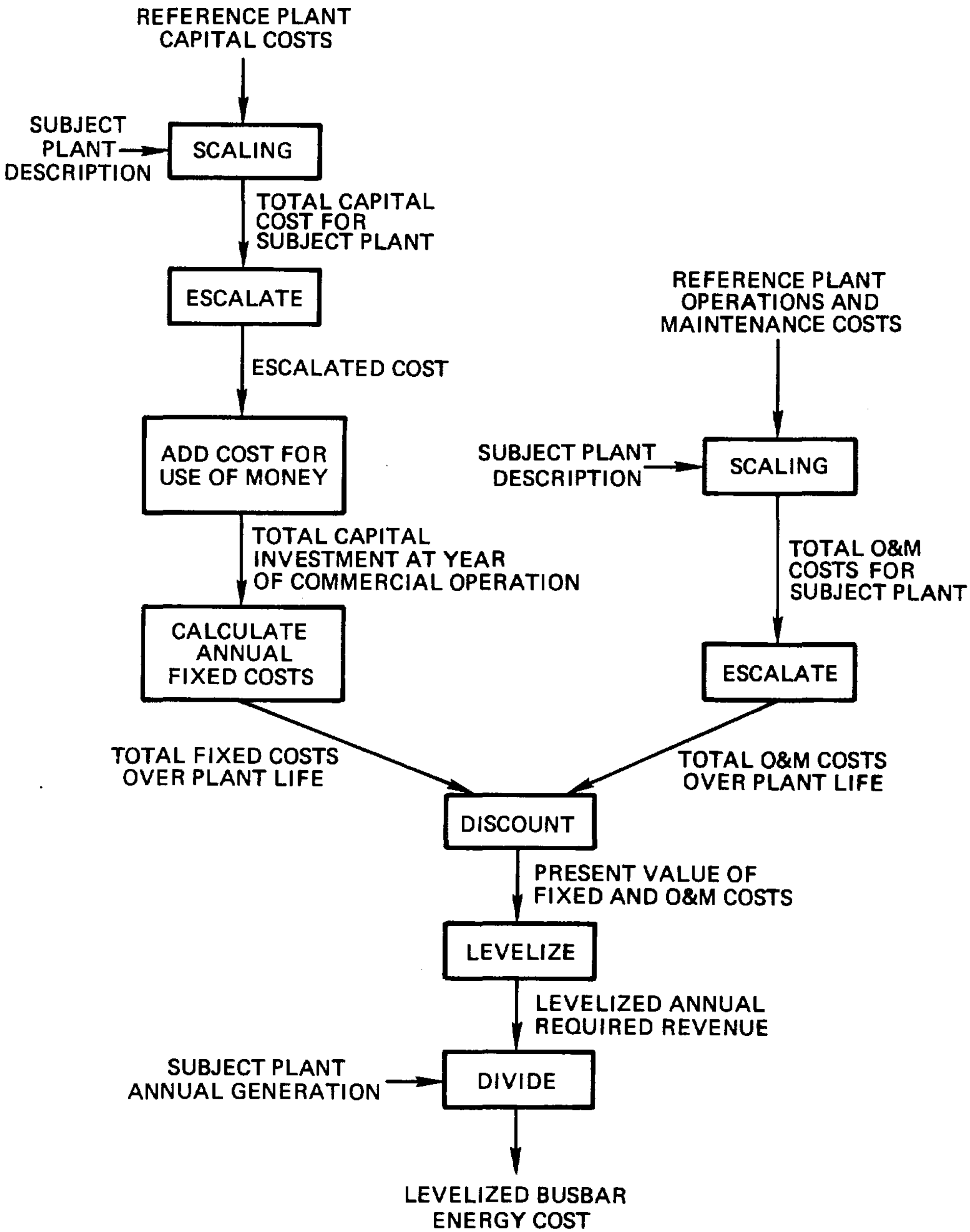

Figure 2

BUCKS

The model scales the reference plant estimates for both capital costs and operations and maintenance (O&M) costs to the subject plant size. The costs are then escalated to the time when they are required for payment on a plant expense. The escalated O&M costs are the total O&M costs accrued over the plant life. The escalated capital cost is added to the cost for use of money during the construction period to give the total capital investment at the year of commercial operation. This capital investment cost is added to additional fixed costs to give the total fixed costs over the plant life. Fixed costs are those which are independent of the plant annual generation level such as capital investment, depreciation income tax allowance, and insurance and property tax. Both the total fixed and O&M costs are then discounted and levelized to give the levelized annual required revenue. This estimate is normalized to the estimated annual generation to give the levelized busbar energy cost.

MODELING METHODOLOGY

BUCKS uses the levelized required revenue approach to calculate busbar energy cost. The levelized revenue required to compensate for the fixed and variable costs, pay interest to bondholders, and provide return to stockholders is calculated from estimates of plant cost and performance.

The steps involved in this calculation are as follows:

1) the required reference plant and subject plant information is supplied to the model
2) the capital investment costs are scaled to the subject plant size
3) the total investment in the plant at the start of commercial operation is calculated including cost escalation and the cost for use of money during construction
4) the levelized annual fixed cost revenue is calculated including all fixed annual expenses
5) the annual operations and maintenance costs are scaled appropriately and escalated to the year when the expenses are incurred
6) the levelized annual variable cost revenue is calculated (the terminology "variable cost" refers to annual operations and maintenance expenses even though these expenses may not be a function of the plant's annual electrical output)
7) the levelized busbar energy cost for the plant is calculated as the sum of the levelized fixed and variable costs divided by the net annual generation from the plant; it does not include transmission and distribution costs.

Each of these steps will now be described in more detail. Included in these discussions are the required equations and their derivation. The nomenclature as it is used in these discussions is defined in each section. Included is a correlation, where applicable, with the corresponding FORTRAN variable shown in parentheses after the definition.

A. Capital Investment Cost Scaling

Nomenclature

COSTS(i): Input reference plant capital investment cost for item i (COSTS(i))

CCOSTS(i): Cost of item i scaled to the subject plant size (CCOSTS(i))

CONT: Contingency allowance for the subject plant (COSTS(60))

FRCON: Fraction of total plant cost estimated as contingency

In the analysis of solar plant designs it is often desirable to investigate a range of solar subsystem sizes - collector field size, receiver capacity and thermal storage capacity. It is necessary, therefore, to scale the cost estimates. A linear scaling model is assumed using an appropriate scaling parameter for each cost.

$$\text{CCOSTS(i)} = \frac{\text{subject plant parameter value}}{\text{reference plant parameter value}} \times \text{COSTS(i)}$$

The solar related cost items and their associated scaling parameters are shown in Table 1.

Table 1

Solar Related Costs

Cost Item	Scaling Parameter
Collector field	Square meters of reflective surface
Receiver units	MW(t) peak receiver capacity
Receiver feed and return piping	MW(t) peak receiver capacity
Towers and foundations	$(\text{Tower height})^2 \equiv$ square meters of reflective surface
Receiver/Tower Design	Fixed cost
Feed pumps	MW(t) peak receiver capacity
Thermal storage Tank equipment Foundations Media Instrumentation	MW(t)-hr storage capacity
Thermal storage Piping from receiver Charging heat exchangers	MW(t) charging rate
Thermal storage Piping to turbine Discharging heat exchangers	MW(t) discharging rate
Thermal Storage Media piping	MW(t) charge plus discharge rates
Thermal Storage Design	Fixed cost
Master Control	Fixed cost

The cost items which usually are independent of the solar subsystem designs, i.e., nonsolar related cost items, and their associated scaling parameters are shown in Table 2.

Table 2

Other Plant Costs

Cost Item	Scaling Parameter
Site preparation	Square meters of reflective surface
Turbine building	MWe gross peak output
Other buildings	Fixed costs
Turbine plant equipment	MWe gross peak output
Electrical plant equipment	MWe gross peak output
Maintenance & handling equipment	Plant direct cost
Miscellaneous plant equipment	Fixed cost
Transmission plant equipment	MWe gross peak output
Distributables	Nonsolar related costs
Spare parts	Plant direct cost
Architectural engineer services	Nonsolar related costs
Construction manager	Fixed cost
Solar integrator & design	Fixed cost
Plant startup and checkout	Fixed cost

Contingency is estimated as a fraction of the total plant cost:

$$CONT = FRCON \times \sum_{i} CCOSTS(i)$$

The total cost of the plant in base year dollars is the sum of all these costs:

$$CI = \sum_{i} CCOSTS(i) + CONT$$

B. Plant Investment at Year of Commercial Operation

The total plant investment cost at the year of first commercial operation has two distinct components:

1) The capital cost escalated to the beginning of construction, and
2) The cost of interest and escalation during the period of construction. Since the plant is built over a period of years, the cost of unbuilt or unbought portions of plant equipment continues to escalate during construction. Additionally, the plant constructor is receiving payouts at regular intervals and the utility is thus paying interest on the money it is using during construction. This cost is calculated in three parts by BUCKS:
   a. Additional cost due to escalation from the beginning of construction to the time of payment to the constructor
   b. Interest compounded quarterly attributable to the capital cost at beginning of construction
   c. Interest on the escalation from the beginning of construction

Capital Cost Escalation

Nomenclature

CI: Capital investment in base year dollars (CI)

ESCI: Capital investment escalated to the start of plant construction (ESCI)

EDC: Additional cost due to escalation during construction (EDC)

e_y: Capital cost escalation rate for year y (CESC(•))

YTC: Number of years from the base year to the start of construction (YTC)

c_i: Value of the payout in the i^{th} time period in start-of-construction dollars; Σc_i = ESCI

t_i: Years after start of construction to i^{th} payout

M: Number of payout periods

The escalation of the plant capital investment to the time of payout is broken into two components: escalation to the start of construction, ESCI, and escalation during construction, EDC. The escalation to the start of construction is calculated as:

$$ESCI = CI \prod_{y}^{YTC} (1+e_y)$$

The cost of escalation during construction can be expressed as

$$EDC = \sum_{i=1}^{M} c_i \, (1+e_{y(i)})^{t_i} - \sum_{i=1}^{M} c_i$$

The escalation rate, $e_{y(i)}$, is assumed to be constant from the start of construction to the time the payment is made. The rate is assumed to be that of the year in which the payment is made. In BUCKS this calculation is further simplified by assuming equal payout amounts, and 100 payout periods of equal length, thus

$$EDC = ESCI \left[\frac{1}{100} \sum_{i=1}^{100} (1+e_{y(i)})^{t_i} - 1 \right]$$

To investigate alternate payout distributions with BUCKS will require modifications of the calculation of escalation and cost of money during construction.

Cost of Money During Construction

Nomenclature

IDC: Interest during construction on the investment in start-of-construction dollars; i.e., assuming constant dollars over the construction period (IDC)

IES: Interest on escalation during construction (IES)

x: Effective cost of money to the utility; the interest rate for use of money (ECOM)

YIC: Number of years in the construction period (YIC)

During the construction period as the capital cost is paid out, a cost for the use of that money is charged against the total capital investment cost for the plant. The cost for money is broken into two parts: interest during construction on the investment in constant dollars, IDC, and interest on the escalation during construction, IES. The interest is assumed to be compounded quarterly.

Interest during construction in start-of-construction dollars (i.e., constant dollars) is calculated as the difference between the capital with and without interest:

$$\mathrm{IDC} = \sum_{i=1}^{M} c_i \,(1+x/4)^{4(\mathrm{YIC}-t_i)} - \sum_{i=1}^{M} c_i$$

This calculation is simplified in BUCKS assuming equal payout amounts and a nominal 100 payout periods of equal length:

$$\mathrm{IDC} = \mathrm{ESCI}\ \frac{1}{100}\left[\sum_{i=1}^{100} (1+x/4)^{4(\mathrm{YIC}-t_i)} - 1\right]$$

The interest on escalation during construction is calculated as the difference between interest during construction including escalation, and interest on the unescalated capital investment. Assuming equal payout amounts and 100 payout periods of equal length, the interest on escalation can be expressed as:

$$\mathrm{IES} = \frac{\mathrm{ESCI}}{100}\left[\sum_{i=1}^{100} (1+e_{y(i)})^{t_i}\,(1+x/4)^{4(\mathrm{YIC}-t_i)} - \sum_{i=1}^{100} (1+e_{y(i)})^{t_i}\right] - \mathrm{IDC}$$

C. Operations and Maintenance Cost During Plant Lifetime

Nomenclature

XMED: Cost for media replacement in base year dollars (XMED)

TMED: Total cost for all media in the storage subsystem in base year dollars (FOTEMP)

REP: Estimated fraction of the media that should be replaced if the entire storage unit were charged the entire year (DGRADE)

XMWH2: Number of megawatt-hours of storage which is filled each hour, integrated over the year (XMWH2)

IYHR: Number of hours in a year (IYHR)

SMWTH: Thermal storage subsystem maximum thermal capacity (SMWTH)

F_{OM}: Operations and maintenance costs for the plant in base year dollars (FOTEMP)

ES: Escalation rate for operations and maintenance costs (ES)

YCO: Year of commercial operation (YEAR)

The solar plant operations and maintenance costs for all but the thermal storage media replacement cost are estimated from input cost information scaled to the desired subsystem size. The cost per unit value of the scaling parameter (XONM), the scaling parameter to be used (indicated by ISIZE), and the frequency of the operations and maintenance task (that is the number of times in the plant lifetime) (FREQ) are supplied as input to the model. Based on this input and the subject plant subsystem sizes, the cost in base year dollars for operations and maintenance in each year of the plant life is calculated. All of these costs are assumed to be independent of the plant net electrical output.

For thermal storage designs which require usage dependent partial replacement of the thermal storage media, the annual charge for the replacement media is calculated and added to the operations and maintenance cost for the plant. The cost for media replacement in base year dollars can be expressed as:

$$XMED = TMED \times REP \times \frac{XMWH2}{IYHR \times SMWTH}$$

The replacement cost is proportional to the fraction of the time that a part of the storage capacity is charged, integrated over the year.

The total operations and maintenance cost for the plant in a year y during the operational lifetime is expressed as follows:

$$O_y = (1 + ES)^{(YTC + YIC)} (1 + ES)^{(y - YEAR)} (F_{OM} + XMED)$$

D. Levelized Required Revenue Analysis

The levelized annual required revenue is the constant annual revenue required over the lifetime of a plant to compensate for its fixed and variable costs, pay interest to bondholders, and provide return to shareholders. The estimated revenue can be factored into two components: that due to fixed costs and to variable costs. The derivation of the levelized required revenue and its components will now be shown.

Levelized Required Revenue

Nomenclature

R: Annual levelized revenue required for a plant to compensate for its fixed and variable costs, pay interest to bondholders, and provide return to shareholders (AMVAL(6))

A_y: Property insurance and taxes on the unit in year y (XINS)

O_y: Operations and maintenance costs for year y

D_y: Depreciation charge for the unit in year y (D)

B_y: Interest paid to bondholders on the unit in year y

S_y: Return to shareholders on the unit in year y

T_y: Income taxes on the unit's profits in year y, including federal, state, and local income taxes

P_y: Principal outstanding on the unit at the end of year y

r_s: Rate of return to shareholders (RSTK)

r_b: Rate of return on bonds (RDBT)

f_s: Fraction of capitalization financed by shareholders (FRSTK)

f_b: Fraction of capitalization financed by debt (FRDBT)

t: Composite income tax rate on corporate profits including federal, state, and local income taxes (TAXR)

a: Property insurance and tax rate (CTIN)

N: Planned life of the unit (N)

d_y: Fraction of capital investment depreciated in year y (see discussion below)

I_o: Total capital investment in the unit at the start of commercial operation

FC: Levelized required fixed cost revenue

VC: Levelized required variable cost revenue

Using this nomenclature, the computation of annual levelized revenue requirements can be analyzed as follows. The principal outstanding at the start of commercial operation is I_o. The principal outstanding at the end of year y is given by

(1) $$P_y = P_{(y-1)} + A_y + O_y + B_y + S_y + T_y - R$$

The annual levelized revenue requirement is chosen so that the principal outstanding after the last year of commercial operation is zero.

The interest on debt and return to shareholders on the unit for year y are given by

(2) $$B_y = r_b f_b P_{(y-1)}$$

(3) $$S_y = r_s f_s P_{(y-1)}$$

Income tax on the unit's net revenue for the year y is given by

(4) $$T_y = t[R - A_y - O_y - D_y - B_y]$$

Depreciation, and property insurance and taxes on the unit for year y are expressed as

(5) $$D_y = d_y I_o$$

(6) $$A_y = aI_o$$

Depreciation schedules are discussed below.

Using equations (1) through (6), a recursive equation for the principal outstanding may be written as follows:

(7) $$P_y = (1+x)P_{(y-1)} + (1-t)\ aI_o + (1-t)O_y - td_y I_o - (1-t)R$$

where

(8) $$P_o = I_o$$

(9) $$x = r_s f_s + (1-t)r_b f_b$$

Equation (7) can be solved recursively for P_N, tne principal outstanding at the end of the plant's life, which must be zero for the utility to remain solvent. Setting P_N to zero and solving for R, gives the levelized annual revenue required.

(10) $$R = \frac{I_o\left\{a \sum_{y=1}^{N} \frac{1}{(1+x)^y} + \frac{1}{1-t} - \frac{t}{1-t} \sum_{y=1}^{N} \frac{d_y}{(1+x)^y}\right\} + \sum_{y=1}^{N} \frac{O_y}{(1+x)^y}}{\sum_{y=1}^{N} \frac{1}{(1+x)^y}}$$

For a given set of economic assumptions the first term in this expression called the levelized fixed cost, is a constant fraction of the total plant investment:

$$FC = I_0 \times \frac{\left\{ a \sum_{y=1}^{N} \frac{1}{(1+x)^y} + \frac{1}{1-t} - \frac{t}{1-t} \sum_{y=1}^{N} \frac{d_y}{(1+x)^y} \right\}}{\sum_{y=1}^{N} \frac{1}{(1+x)^y}}$$

The fraction is referred to as the fixed charge rate and is comprised of the following:

$$\frac{a \sum_{y=1}^{N} \frac{1}{(1+x)^y}}{\sum_{y=1}^{N} \frac{1}{(1+x)^y}}$$

Insurance and property tax

$$\frac{\frac{1}{1-t}}{\sum_{y=1}^{N} \frac{1}{(1+x)^y}}$$

Before-tax revenue required for the total plant investment

$$\frac{\frac{t}{1-t} \sum_{y=1}^{N} \frac{d_y}{(1+x)^y}}{\sum_{y=1}^{N} \frac{1}{(1+x)^y}}$$

Income tax savings due to depreciation

The second term in the levelized required revenue is the levelized variable cost:

$$VC = \frac{\sum_{y=1}^{N} \frac{O_y}{(1+x)^y}}{\sum_{y=1}^{N} \frac{1}{(1+x)^y}}$$

Depreciation

The annual depreciation charge can be calculated using any of four alternate schedules: straight line, sinking fund, sum-of-the-year digits, and double declining balance. The model assumes the double declining balance method as default.

For straight line depreciation, the annual rate is constant over the lifetime:

$$d_y = \frac{1}{N}$$

For the sinking fund rate, the annual charge for depreciation plus the return on the undepreciated investment is chosen to be a constant value, such that the plant will be fully depreciated at the end of life.

$$d_y = \frac{X(1+X)^{y-1}}{(1+X)^N-1}$$

The sum-of-the-year digits depreciation rate is an accelerated depreciation schedule. The investment is depreciated more rapidly in the first years of service.

$$d_y = \frac{2(N-y+1)}{N(N+1)}$$

The double declining balance depreciation rate is also an accelerated depreciate schedule.

$$d_y = \begin{cases} (1-2/N)^{y-1}\ \frac{2}{N} & \text{for } y \leq \frac{N}{2} \\ \frac{1}{N} & \text{for } y > \frac{N}{2} \end{cases}$$

Levelized Busbar Energy Cost

Nomenclature

HR: Annual net energy generated from the unit (PHR)

BBEC: Levelized busbar energy cost (BBEC)

The levelized busbar energy cost for the plant is cost per unit output which must be charged over the plant lifetime to compensate for all fixed and variable costs, pay interest to bondholders, and provide return to shareholders. It is calculated as follows:

$$BBEC = \frac{FC + VC}{HR}$$

SUBPROGRAM DESCRIPTION

Note: A microfiche copy of the program can be found at the end of this document.

A. Main Program ECON

The main program reads the subject plant performance information, sizes, and storage utilization information. The economic parameters (FRSTK, FRDBT, RSTK, RDBT, TAXR, YIC) and capital cost escalation rates (CESC, CYRESC, YEAR) are defined. Based on this data, the effective cost of money (ECOM) is calculated, and the busbar energy cost is calculated with a call to subroutine BUCKS.

B. Subroutine BUCKS

The subroutine BUCKS contains the required input cost information for reference plant capital investment, and operations and maintenance. The subroutine allows the specification of capital cost information for up to three alternate designs of the power plant subsystems. The capital cost for each design can be specified in terms of up to 60 cost items. These constraints result from FORTRAN variable dimensions and would require little program modification to alter. The arrays BCOST and XOCOST contain the cost estimates, and BSIZE contains the reference plant subsystem sizes. Based on a user defined indicator variable, ISUBTYP, the appropriate reference plant cost information is selected, and stored in the array COSTS. Any user defined variations on these estimates for sensitivity analyses are made at this time. Through the use of the arrays INUMB, VALUE and FACT, the user can analyze the busbar energy cost of the unit assuming variations from the defined reference plant cost information. To look at the sensitivity of a particular cost, the cost item is located in the array COSTS (see Tables B-1 and B-2). This position is then specified in an element of the array INUMB. The user can vary the reference plant cost by two methods:

1) An alternate value of the reference plant cost can be specified in the element of the array VALUE corresponding to the element of array INUMB used.

2) A multiplier to be applied to the base cost estimate can be specified in the element of the array FACT, corresponding to the element of the array INUMB used.

The arrays INUMB, VALUE, and FACT are dimensioned to accept a maximum of fifteen cost variations. The desired cost variations should be defined in the first elements of the arrays and the remaining elements set to zero.

The required operations and maintenance cost information includes cost estimates, frequency estimates, and indicator variables to define the arrays XONM, FREQ, ISIZE. The plant busbar energy cost is calculated with a call to subroutine DOLLAR.

C. Subroutine PRINTER

The subject plant sizes, and assumed economic parameter values are printed out by this routine.

D. Subroutine PRINT3

This routine prints out the components of levelized annual cost (AMVAL) and levelized busbar energy cost (BBEC). The components are discussed in the output description.

E. Subroutine SOLCAP

This routine calculates in base year dollars the capital investment cost for the total plant and by subsystems. The costs are assumed to scale linearly. Each item in array COSTS is scaled to the subject plant size and stored in CCOSTS. Tables 3 and 4 explain the linear scaling model for each cost item. Shown in these tables are the locations in the arrays COSTS and CCOSTS which contain the cost estimates, and the FORTRAN variables used for scaling; i.e., the ratio of subject to reference plant parameters. Further definition of the elements of COSTS and CCOSTS are in Tables B-1 and B-2.

F. Subroutine DOLLAR

This subroutine first calculates all components in the total cost of the unit at the year of commercial operation. The escalated cost of the unit is calculated by subroutines SOLCAP, SOLESC, and EDC. Interest during construction is calculated by subroutines IDC and IES, depreciation is calculated by subroutine DEPREC, and insurance and property tax are calculated by subroutine INSU. These costs are discounted to the present value at the start of commercial operation by subroutine PRESVAL. The present values are levelized over the plant lifetime by subroutine AMORT. The levelized operations and maintenance costs are calculated by subroutine OPEX. The sum of these levelized costs is the constant annual revenue required to pay all costs associated with the unit. This cost is normalized to the estimated annual generation (i.e., busbar energy cost) by subroutine CCAL.

G. Subroutine SOLESC

This routine escalates the capital investment cost to the start of construction.

H. Subroutine EDC

This routine calculates the additional cost due to escalation during construction.

I. Subroutine IDC

This routine calculates interest during construction based on constant dollars.

Table 3
Solar Related Costs

Cost Item	Location in ARRAYS COSTS & CCOSTS	Scaling Parameter	Ratio of Subject to Reference Plant Parameter; FORTRAN VARIABLES
Collector field	12-22	Square meters of reflective surface	SQM/SQMTR
Receiver units	23	MW(t) peak capacity	SMWTH/RECMW
Receiver feed and return piping	24	MW(t) peak receiver capacity	SMWTH/RECMW
Towers and foundation	26-27	$(\text{Tower height})^2 \equiv$ square meters of reflective surface	SQM/SQMTR
Receiver/Tower Design	25	Fixed cost	
Feed pumps	45	MW(t) peak receiver capacity	SMWTH/RECMW
Thermal storage		MW(t)-hr storage capacity	SMWHR/TSSMW
Tank equipment	29		
Foundations	38		
Media	40		
Instrumentation	37		
Thermal storage		MW(t) charging rate	CHGRT/CHGEMW
Piping from receiver	32		
Charging heat exchanger	36		
Thermal storage		MW(t) discharging rate	DCHGRT/DCHGEMW
Piping to turbine	33		
Discharging heat exchangers	35		
Thermal storage media piping	30	MW(t) charge plus discharge rates	$\frac{(\text{CHGRT+DCHGRT})}{(\text{CHGEMW+DCHGEMW})}$
Thermal storage design	39	Fixed cost	
Master control	48	Fixed cost	

Table 4
Other Plant Costs

Cost Item	Location in ARRAYS COSTS & CCOSTS	Scaling Parameter	Ratio of Subject to Reference Plant Parameter; FORTRAN VARIABLES
Site preparation	1	Square meters of reflective surface	SQM/SQMTR
Turbine building	2	MWe gross peak output	PMX/PKMWE
Other buildings	3-8,10	Fixed costs	
Turbine plant equipment	41-44,46	MWe gross peak output	PMX/PKMWE
Electrical plant equipment	47	MWe gross peak output	PMX/PKMWE
Maintenance & handling equipment	49	Direct cost	CCOSTS(12-47)* / COSTS(12-47)
Miscellaneous plant equipment	50	Fixed cost	
Transmission plant equipment	51	MWe gross peak output	PMX/PKMWE
Distributables	52	Nonsolar related costs	CCOSTS(1-10,41-51)* / COSTS(1-10,41-51)
Spare parts	53	Plant direct cost	CCOSTS(12-47)* / COSTS(12-47)
Architectural engineer services	54	Nonsolar related costs	CCOSTS(1-10,41-51)* / COSTS(1-10,41-51)
Construction manager	55	Fixed cost	
Solar integrator & Design	56-58	Fixed cost	
Plant startup and checkout	59	Fixed cost	

*Indicates ratios of sums of costs; i.e.,

$$\frac{\text{CCOSTS(1-10,41-51)}}{\text{COSTS(1-10,41-51)}} = \frac{\sum_{i=1}^{10} \text{CCOSTS(i)} + \sum_{i=41}^{51} \text{CCOSTS(i)}}{\sum_{i=1}^{10} \text{COSTS(i)} + \sum_{i=41}^{51} \text{COSTS(i)}}$$

J. Subroutine IES

This routine calculates the additional cost due to interest on the escalation during construction.

K. Subroutine DEPREC

This routine calculates the annual depreciation charge for a capital investment by any of four methods. The variable, ID, which is initialized in subroutine BUCKS, determines which method should be used.

L. Subroutine OPEX

This routine calculates the annual operations and maintenance costs over the plant lifetime. For all but the thermal storage media replacement cost, the cost estimate in dollars per unit (XONM) is scaled by the specified size parameter (ISIZE). Based on the frequency over the plant lifetime (FREQ) and the escalation rate (ES) the total plant operation and maintenance costs are calculated. The escalated thermal storage media replacement costs are calculated and added in. The present value of the operations and maintenance costs is calculated by subroutine DISC, and then levelized by subroutine AMORT.

M. Subroutine INSU

This subroutine calculates insurance and property tax.

N. Subroutine PRESVAL

This subroutine calculates the present value of the capital-investment-associated costs: the before-tax revenue required for the capital cost and the income tax effect due to depreciation. The subroutine DISC is used to calculate the present value.

O. Subroutine AMORT

Given a present value, this routine calculates the equal annual amount over the plant lifetime which has equivalent present value for the assumed effective cost of money. That is, it levelizes the present value in equal annual amounts over the plant lifetime.

P. Subroutine CCAL

This routine calculates the cost per unit of electrical energy generated (i.e., the busbar energy cost).

Q. Subroutine DISC

This routine calculates the present value of a stream of cash flows.

INPUT AND OUTPUT

The data required for BUCKS is of two types: plant performance and size information, and cost and economic data. The subject plant performance and size information is read by the main program ECON from the input file, TAPE7. The variables are read in as follows:

```
      READ(7,7) PHR,SQM,SMWTH,PMX,SOLOAD,CHGRT,DCHGRT,SMWHR,IYHR,XMWH2
    7 FORMAT(2(4F20.2,/),I5,F20.2)
```

and are defined as follows:

PHR	Annual net electrical generation from the plant (MW_e-hr)
SQM	Collector field reflective surface area (square meters)
SMWTH	Receiver peak input capacity (MW_t)
PMX	Peak gross electrical capacity of the plant (MW_e)
SOLOAD	Annual electrical energy required by the plant from the utility network (MW_e-hr)
CHGRT	Thermal storage peak charging rate (MW_t)
DCHGRT	Thermal storage peak discharge rate (MW_t)
SMWHR	Thermal storage capacity (MW_t-hr)
IYHR	Number of hours in the year
XMWH2	Number of hours in the year that each MW_t-hr of storage capacity is charged (MW_t-hr-hr)

The cost and economic information are provided by FORTRAN data statements. In the main program ECON, the following data is defined. The number after the variable is the dimension:

CESC(10) - Capital cost escalation rates of each of ten time periods, expressed as a percent.

CYRESC(11) - Years which delineate time periods during which the capital cost escalation rates apply; CYRESC(1) is the base year of the cost estimates; CESC(I) is the rate which applies for years greater than CYRESC(I), yet less than or equal to CYRESC(I+1)

TAXR - Composite income tax rate

YIC - Number of years required for construction of the plant

FRSTK - Fraction of capitalization from stock

FRDBT - Fraction of capitalization from debt

RSTK - Rate of return on stock

RDBT - Interest rate on debt

ISUBTYP(5) - Integer indicator for which of three alternate designs for each of five subsystems is being evaluated: collector, receiver, thermal storage, master control, and electric power generating system (i.e., indicates which cost estimates in BCOST and sizes in BSIZE to be used in the analysis)

YEAR - Year in which the plant starts commercial operation

INUMB(15), VALUE(15), FACT(15) - Data required for variations of the maximum of 15 reference plant cost estimates for sensitivity analyses; INUMB gives the location in the array COSTS (see Tables B-1 and B-2), VALUE gives the new value to be assumed, and/or FACT gives the multiplier to be applied to the old value (see the description of Subroutine BUCKS).

The subroutine BUCKS contains the following data:

ID - Integer indicating which depreciation schedule is to be assumed

BSIZE(3,6) - Base sizes associated with the base cost estimates for each of three designs for 6 subsystems: collector size, storage capacity, charge rate, discharge rate, gross electrical output, receiver capacity

BCOST(3,33) - Base cost estimates for each of three designs for each of 33 solar related cost items which are listed in Table B-1. Also shown in Table B-1 is the location of the item in the matrix COSTS which is required for parameter sensitivity analyses using INUMB, VALUE, & FACT

XOCOST(3,27) - Reference plant cost estimates for each of three designs for each of 27 nonsolar related cost items which are listed in Table B-2. Also shown in this table is the location of the item in the matrix COSTS which is required for parameter sensitivity analyses using INUMB, VALUE, & FACT

FREQ(7) - Frequency (number of occurrences in the plant lifetime) for a maximum of seven operations and maintenance tasks

XONM(7) - Cost per unit for each of seven operations and maintenance tasks in base year dollars

ISIZE(7) - Integer indicating for which size parameter to use in scaling each of seven operations and maintenance tasks: 1 - collector size, 2 - storage capacity, 3 - charge rate, 4 - discharge rate, 5 - gross turbine capacity, 6 - receiver capacity, 7 - fixed cost per plant

The subroutine DOLLAR contains the following data:

N - Estimated plant lifetime

The subroutine SOLCAP contains the following data:

FRCON - Fraction of plant cost estimated for contingency

The subroutine INSU contains the following data:

CTIN - Insurance and property tax as a fraction of capital investment

The subroutine OPEX contains the following data:

ES - Operations and maintenance cost escalation rate

DGRADE(3) - Maximum thermal storage media replacement fraction assuming the storage unit is charged the entire year; values for each of three designs

The program output format is shown in Figure 3. The first section describes which alternate design of each subsystem was analyzed. The second section shows the subsystem sizes, the plant performance estimates, and the economic assumptions. The third section shows a breakdown of plant capital cost in base year dollars. The last section shows busbar energy cost data for the total plant and for each subsystem.

Line 1: Name of plant type and/or subsystem

Capital investment at year of commercial operation in that year dollars (XINV)

Capital investment including cost for use of money during construction in base year dollars (CITOT)

Line 2-8: The following two costs are shown for each line:

AMVAL - Levelized annual charge (dollars per MWe gross turbine capacity)

BBEC - Levelized busbar energy cost (mills/KWe-hr)

The components of total busbar energy cost shown in the output are:

INVEST TAX - Before-tax cost for capital investment (AMVAL(1) and BBEC(1))

DEPTAX - Credit due to the depreciation-tax effect (AMVAL(2) and BBEC(2))

INS - Property tax and insurance AMVAL(3) and BBEC(3))

FIX-OM - Fixed operations and maintenance costs (AMVAL(4) and BBEC(4))

VARO-M - Variable operations and maintenance costs (AMVAL(5) and BBEC(5))

TOTAL - Total busbar energy cost (AMVAL(6) and BBEC(6))

```
COLLECTOR       TEST
RECEIVER        TEST
THERMAL ST      TEST
MCS             TEST
EPGS-BOP        TEST
PLANT SIZES
  .100000E+07 SQ METERS OF MIRRORS  .250000E+04 MWHR OF STORAGE  .650000E+03 MWTH FOR RECEIVER
  .350000E+03  MW(T) CHARGE RATE    .250000E+03 MW(T) DISCHARGE RATE   100,000  MWE GROSS PEAK OUTPU
PLANT PERFORMANCE
  SOLAR GENERATION    .400000E+06     ANNUAL STORED ENERGY    .500000E+07
ECONOMIC ASSUMPTIONS
  YEAR OF FIRST COMMERCIAL OPERATION 1977.
  DEPRECIATION METHOD     DD BALANCE
  EFFECTIVE COST OF MONEY    .075

LAND/SITE   .227273E+07
BUILDINGS   .265909E+07
COLLECTOR   .195341E+09
RECEIVER   .639375E+08
TOWER   .335227E+08
THERMAL STORAGE   .474861E+08
    CAPACITY   .284375E+08
    CHARGE/DISCHARGE   .170486E+08
    DESIGN   .200000E+07
FEED PUMPS   .101563E+07
MASTER CONTROL   .200000E+07
EPGS   .220909E+08
OTHER EQUIP   .357165E+07
DISTRIB/INDIRECTS   .201339E+08
CONTINGENCY   .591047E+08
TOTAL PLANT   .453136E+09
XMED   .562500E+07

TOTAL PLANT
  $  5586022.11 PER GROSS MWE INSTALLED  $  5586022.11 PER GROSS MWE,BASE YEARS
                         AMVAL                  BBEC
INVEST-TAX     $     .945951E+06        .236488E+03 MILLS
DEPTAX         $     .229271E+06        .573178E+02 MILLS
INS            $     .251371E+05        .628427E+01 MILLS
FIX O-M        $     .538845E+05        .134711E+02 MILLS
VAR O-M        $   0.                  0.           MILLS
TOTAL          $     .795701E+06        .198925E+03 MILLS

COLLECTOR
  $  2408060.70 PER GROSS MWE INSTALLED  $  2408060.70 PER GROSS MWE,BASE YEARS
                         AMVAL                  BBEC
INVEST-TAX     $     .407787E+06        .101947E+03 MILLS
DEPTAX         $     .988358E+05        .247090E+02 MILLS
INS            $     .108363E+05        .270907E+01 MILLS
FIX O-M        $     .171491E+05        .428727E+01 MILLS
VAR O-M        $   0.                  0.           MILLS
TOTAL          $     .336936E+06        .842341E+02 MILLS

RECEIVER
  $   788188.11 PER GROSS MWE INSTALLED  $   788188.11 PER GROSS MWE,BASE YEARS
                         AMVAL                  BBEC
INVEST-TAX     $     .133474E+06        .333684E+02 MILLS
DEPTAX         $     .323502E+05        .808755E+01 MILLS
INS            $     .354685E+04        .886712E+00 MILLS
FIX O-M        $     .557345E+04        .139336E+01 MILLS
VAR O-M        $   0.                  0.           MILLS
TOTAL          $     .110244E+06        .275610E+02 MILLS
```

Figure 3

Program Output

TOWER

$ 413250.67 PER GROSS MWE INSTALLED $ 413250,67 PER GROSS MWE,BASE YEAR$

		AMVAL	BBEC	
INVEST-TAX	$	.699809E+05	.174952E+02	MILLS
DEPTAX	$	.169614E+05	.424034E+01	MILLS
INS	$	.185963E+04	.464907E+00	MILLS
FIX O-M	$	0.	0.	MILLS
VAR O-M	$	0.	0.	MILLS
TOTAL	$	.548792E+05	.137198E+02	MILLS

THERMAL ST

$ 585383.98 PER GROSS MWE INSTALLED $ 585383.98 PER GROSS MWE,BASE YEAR$

		AMVAL	BBEC	
INVEST-TAX	$	.991304E+05	.247826E+02	MILLS
DEPTAX	$	.240264E+05	.600659E+01	MILLS
INS	$	.263423E+04	.658557E+00	MILLS
FIX O-M	$	.131555E+05	.328887E+01	MILLS
VAR O-M	$	0.	0.	MILLS
TOTAL	$	.908937E+05	.227234E+02	MILLS

FEED PUMPS

$ 12520.09 PER GROSS MWE INSTALLED $ 12520.09 PER GROSS MWE,BASE YEAR$

		AMVAL	BBEC	
INVEST-TAX	$	.212018E+04	.530046E+00	MILLS
DEPTAX	$	.513872E+03	.128468E+00	MILLS
INS	$	.563404E+02	.140851E-01	MILLS
FIX O-M	$	0.	0.	MILLS
VAR O-M	$	0.	0.	MILLS
TOTAL	$	.166265E+04	.415663E+00	MILLS

MASTER CTL

$ 24654.96 PER GROSS MWE INSTALLED $ 24654.96 PER GROSS MWE,BASE YEAR$

		AMVAL	BBEC	
INVEST-TAX	$	.417513E+04	.104378E+01	MILLS
DEPTAX	$	.101193E+04	.252983E+00	MILLS
INS	$	.110947E+03	.277368E-01	MILLS
FIX O-M	$	0.	0.	MILLS
VAR O-M	$	0.	0.	MILLS
TOTAL	$	.327415E+04	.818537E+00	MILLS

ALL OTHERS

$ 1353963.60 PER GROSS MWE INSTALLED $ 1353963.60 PER GROSS MWE,BASE YEAR$

		AMVAL	BBEC	
INVEST-TAX	$	.229284E+06	.573209E+02	MILLS
DEPTAX	$	.555717E+05	.138929E+02	MILLS
INS	$	.609284E+04	.152321E+01	MILLS
FIX O-M	$	.180065E+05	.450163E+01	MILLS
VAR O-M	$	0.	0.	MILLS
TOTAL	$	.197811E+06	.494528E+02	MILLS

APPENDIX A

Logical Unit Assignments and External Library Routines

The plant performance and size information is read from the input file, defined as TAPE7.

No external library routines are required.

APPENDIX B

Sample Problem Input and Output

The plant performance and size information used in the sample problem is as follows:

PLHR	400,000.
SQM	1,000,000.
SMWTH	650.
PMX	100.
SOLOAD	0.
CHGRT	350.
DCHGRT	250.
SMWHR	2,500.
IYHR	8,760.
XMWH2	5,000,000.

The cost and economic information which is included in data statements and FORTRAN statements as described in the input description are initialized as shown below for the sample problem. Also shown is a corresponding mathematical variable if used in the methodology description.

FORTRAN Variable	Mathematical Variable	Sample Problem Value
CESC(10)	e_y	(*)=0.0[1]
CYRESC(1)		(1)=1977.
		(2)=3000.
		(>2)=0.[2]

[1]An asterisk indicates that all elements are defined alike.

[2]A ">" symbol indicates that all remaining elements are defined alike.

FORTRAN Variable	Mathematical Variable	Sample Problem Value
TAXR	t	.50
YIC	YIC	5.5
FRSTK	f_s	.5
FRDBT	f_b	.5
RSTK	r_s	.11
RDBT	r_b	.08
ISUBTYP(5)		(*)=1
YEAR		1977.
INUMB(15)		(*)=0
FACT(15)		(*)=0.0
VALUE(15)		(*)=0.0
BSIZE(3,6)		(1,1)=880,000.0
		(1,2)= 1600.0
		(1,3)= 240.0
		(1,4)= 300.0
		(1,5)= 110.0
		(1,6)= 640.0
		(>2,*)= 0.0
BCOST(3,33)		(See Table B-1)
XOCOST(3,27)		(See Table B-2)
FREQ(7)		(1) thru (5) = 30.
		(>5)= 0.
XONM(7)		(1)= 50,000.
		(2)= 500.
		(3)= 50.
		(4)= 1.
		(5)=1,000,000.

FORTRAN Variable	Mathematical Variable	Sample Problem Value
		(>5)= 0.
ISIZE(7)		(1)=7
		(2)=6
		(3)=2
		(4)=1
		(5)=7
		(>5)=0
N	N	30
CTIN	a	.0045
ES	e_i	.05
DGRADE(3)	R	(1)=.5
		(>1)=0.

The sample problem output is shown in Figure 3 and described in the input and output section.

TABLE B-1

BCOST - Base Solar-Related Cost Estimates

BCOST Second Dimension Position	Cost Item	COSTS Array Position	Sample Problem Value $(X10^3)$
1	Thermal Storage Shed	9	0.0
2	Thermal Storage Media Only with Storage Requirements	11	3600.
3	Heliostat Reflective Unit	12	70000.
4	Drive Unit	13	60000.
5	Sensor/Calibration	14	1000.
6	Field Control	15	20000.
7	(Blank - Array Position Unused)	16	0.
8	Foundation & Site	17	7500.
9	Design-Engineering	18	2000.
10	(Blank)	19	0.
11	Packing & Shipping	20	900.
12	Assembly & Installation	21	9500.
13	Lightning Protection	22	1000.
14	Receiver Unit	23	50000.
15	Receiver Feed and Return Piping	24	10000.
16	Design-Receiver, Piping, Tower	25	3000.
17	Tower & Platform	26	20000.
18	Tower Foundation & Site	27	9500.
19	(Blank)	28	0.

BCOST Second Dimension Position	Cost Item	COSTS Array Position	Sample Problem Value ($X10^3$)
20	Thermal Storage Tank Equipment	29	10000.
21	Circulation Equipment	30	5500.
22	(Blank)	31	0.
23	Piping from Receiver	32	300.
24	Piping to Turbine	33	600.
25	(Blank)	34	0.
26	Discharging Equipment	35	5000.
27	Charging Equipment	36	4000.
28	Instrumentation & Control	37	500.
29	Foundation & Site	38	700.
30	Design	39	2000.
31	Storage Material	40	7000.
32	Receiver Feed Pumps	45	1000.
33	Master Control Equipment	48	2000.

TABLE B-2

XOCOST - Base NonSolar Related

XOCOST Second Dimension Position	Cost Item	COSTS Array Position	Sample Problem Value $(X10^3)$
1	Land & Yard Work	1	2000.
2	Turbine Building	2	1000.
3	Administration Building	3	700.
4	Miscellaneous Buildings	4	50.
5	Warehouse	5	0.
6	Maintenance Building	6	700.
7	Water Treatment Building	7	300.
8	Sewage Treatment Building	8	0.
9	Control Building	10	0.
10	Turbine Generator	41	15000.
11	Heat Rejection Equipment	42	3000.
12	Condensing System	43	300.
13	Feedwater Heating Equipment	44	1000.
14	Water Treatment Equipment	46	1000.
15	Electrical Plant	47	4000.
16	Maintenance & Handling Equipment	49	1000.
17	Miscellaneous Equipment	50	2000.
18	Transmission Plant	51	500.
19	Distributables	52	5000.

XOCOST Second Dimension Position	Cost Item	COSTS Array Position	Sample Problem Value (X10^3)
20	Spare Parts	53	2000.
21	A&E Services	54	6000.
22	Construction Manager	55	4000.
23	Solar Integrator	56	1500.
24	Solar Design	57	0.
25	Master Control Design	58	0.
26	Startup & Checkout	59	2000.
27	(Blank)		0.

References

1. P. Leary and J. D. Hankins, User's Guide for MIRVAL - A Computer Code For Comparing Designs of Heliostat - Receiver Optics for Central Receiver Solar Power Plants, Sandia Laboratories. SAND77-8280.

2. J. B. Woodard and G. J. Miller, STEAEC - Solar Thermal Electric Annual Energy Calculation, Sandia Laboratories. SAND77-8278.

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```
      PROGRAM ECON(INPUT,OUTPUT,TAPE7)
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     *              ISSUED BY SANDIA LABORATORIES
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C     * JANUARY, 1978.
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
      DIMENSION CESC(10),CYRESC(11)
      DIMENSION ISL(5),ICL(3)
      DIMENSION ISUBTYP(5)
      COMMON/CESCAL/CESC,CYRESC
      COMMON/FINANC/ECOM,TAXR,YIC
      COMMON/CHCOST/INUMB(15),VALUE(15),FACT(15)
      COMMON/SIZES/SOM,SMWHR,CHGRT,DCHGRT,PMX,SMWTH
      DATA ISL/10HCOLLECTOR ,10HRECEIVER  ,10HTHERMAL ST,10HMCS       ,
     110HEPGS-BOP  /
      DATA ICL/10HTEST      ,10H          ,10H          /
C
C                 INITIALIZATION OF INPUT DATA
C
      DATA CESC/10*0./
      DATA CYRESC/1977.,3000.,9*0./
      DATA TAXR,YIC/.5,.5,.5/
      DATA FRSTK,FRDBT,RSTK,RDBT/.5,.5,.11,.08/
      DATA ISUBTYP/5*1/
      DATA YEAR/1977./
      REWIND 7
      ECOM=RSTK*FRSTK+(1.-TAXR)*RDBT*FRDBT
      READ (7,110) PHR,SOM,SMWTH,PMX,SOLOAD,CHGRT,DCHGRT,SMWHR,IYHR,XMWH
     12
  110 FORMAT (2(4F20.2/),I5,F20.2)
      PRINT 120
  120 FORMAT (1H1)
      DO 140 I=1,5
      PRINT 130, ISL(I),ICL(ISUBTYP(I))
  130 FORMAT (1X,A10,5X,A10)
  140 CONTINUE
      DO 150 IC=1,15
      INUMB(IC)=0
      VALUE(IC)=0.
      FACT(IC)=0.
  150 CONTINUE
      CALL BLCKS (PMX,PHR,SOM,SMWHR,SMWTH,CHGRT,DCHGRT,IYHR,YEAR,ISUBTYP
     1,XMWH2)
```

```
         PROGRAM ECON          73/74    OPT=1                                   FTN 4.6+439         01/26/78  14.17.06          PAGE      2

                         STOP                                                                        000670
                         END                                                                         000680



      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS        DEF LINE       REFERENCES
 6166   ECON           1

VARIABLES       SN   TYPE              RELOCATION
     0   CESC        REAL        ARRAY    CESCAL        REFS        21          24     DEFINED        34
     2   CHORT       REAL                 SIZES         REFS        27          56     DEFINED        42
    12   CYRESC      REAL        ARRAY    CESCAL        REFS        21          24     DEFINED        35
     3   DCHORT      REAL                 SIZES         REFS        27          56     DEFINED        42
     0   ECOM        REAL                 FINANC        REFS        25     DEFINED        41
    36   FACT        REAL        ARRAY    CHCOST        REFS        26     DEFINED        54
  6232   FROBT       REAL                               REFS        41     DEFINED        37
  6231   FRSTK       REAL                               REFS        41     DEFINED        37
  6304   I           INTEGER                            REFS      2*48     DEFINED        47
  6313   ICL         INTEGER     ARRAY                  REFS        22          48     DEFINED        30
     0   INUMB       INTEGER     ARRAY    CHCOST        REFS        26     DEFINED        52
  6305   IQ          INTEGER                            REFS        52          53          54     DEFINED        51
  6306   ISL         INTEGER     ARRAY                  REFS        22          48     DEFINED        28
  6316   ISUBTYP     INTEGER     ARRAY                  REFS        23          48          56     DEFINED        38
  6302   IYHR        INTEGER                            REFS        56     DEFINED        42
  6300   PHR         REAL                               REFS        56     DEFINED        42
     4   PMK         REAL                 SIZES         REFS        27          56     DEFINED        42
  6234   ROBT        REAL                               REFS        41     DEFINED        37
  6233   RSTK        REAL                               REFS        41     DEFINED        37
     1   SMAHR       REAL                 SIZES         REFS        27          56     DEFINED        42
     5   SMWTH       REAL                 SIZES         REFS        27          56     DEFINED        42
  6301   SOLOAD    * REAL                             DEFINED       42
     0   SUM         REAL                 SIZES         REFS        27          56     DEFINED        42
     1   TAXR        REAL                 FINANC        REFS        25          41     DEFINED        36
    11   VALUE       REAL        ARRAY    CHCOST        REFS        26     DEFINED        53
  6303   YMAH2       REAL                               REFS        56     DEFINED        42
  6235   YEAR        REAL                               REFS        56     DEFINED        39
     2   YIC         REAL                 FINANC        REFS        25     DEFINED        36

FILE NAMES           MODE
     0   INPUT
  2043   OUTPUT      FMT                   WRITES       45         48
  4106   TAPE7       FMT                    READS       42     MOTION         40

EXTERNALS            TYPE    ARGS         REFERENCES
       BLCKS                   11                56

STATEMENT LABELS                  DEF LINE    REFERENCES
  6255   100       FMT                44          42
  6264   200       FMT                46          45
  6273   300       FMT                49          48
     0   400                          50          47
     0   500                          55          51
```

```
LOOPS  LABEL   INDEX     FROM-TO    LENGTH    PROPERTIES
 6173   140     I         47 50       11B                EXT REFS
 6206   150     IO        51 55        3B      INSTACK

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
       DESCAL       21              0 CESC    (10)            10 CXRESC (11)
       FINANC        3              0 ECOM    (1)              1 TAXR   (1)               2 YCC    (1)
       CHCOST       45              0 INUMB   (15)            15 VALUE  (15)             30 FACT   (15)
       SIDES         6              0 SQM     (1)              1 SMWHP  (1)               2 CHGRT  (1)
                                    3 OCHGRT  (1)              4 PMX    (1)               5 SMWTH  (1)

STATISTICS
  PROGRAM LENGTH                  152B      106
  BUFFER LENGTH                  6151B     3177
  CM LABELED COMMON LENGTH        113B       75
```

```
      SUBROUTINE BUCKS (PMX PHR SOM SMWHR IMWTH CHORT DCHORT,IYHP YEAR,I000690
     1SUBTYP XMWH2)                                                     000700
      DIMENSION FREQ(7) XONM(7) ISIZE 7                                 000710
      DIMENSION COSTS(60)                                               000720
      DIMENSION ISUBTYP(5).BSIZE(3 6  BCOST 3 27) XCOST(3 27)           000730
      COMMON/ODATA/FREQ XONM ISIZE                                      000740
      COMMON/FINANC/ECOM.TAXR YIC                                       000750
      COMMON/CHCOST/INUMB(15).VALUE(15) FACT 15                         000760
      COMMON/PLTCOST/SOMTR.TSSMW.PKMWE CHGEMW DCHGEMW.RECMW.COSTS       000770
      DATA IOPT1 IOPT2.IOPT3.IOPT4/                                     000780
      DATA ID/4/                                                        000790
C                                                                       000800
C         REFERENCE PLANT SIZES FOR EACH OF 3 DESIGNS FOR.COLLECTOR.    000810
C                STORAGE CHARGE DISCHARGE GROSS PEAK RECEIVER PEAK      000820
C                                                                       000830
      DATA BSIZE/880000..2*0..1600. 2*0. 240..2*0. 300..2*0..110..2*0.. 000840
     1640..2*0./                                                        000850
C                                                                       000860
C              REFERENCE PLANT COST ESTIMATES FOR EACH OF 3 DESIGNS     000870
C                                                                       000880
      DATA BCOST/3*0..3600.E03.2*0. 70000.E03 2*0..60000.E03.2*0..      000890
     111000.E03 2*0. 20000.E03.2*0..3*0. 7500.E03.2*0..2000.E03,2*0..   000900
     23*0..900.E03.2*0..9500.E03.2*0. 1000.E03.2*0..50000.E03,2*0..     000910
     310000.E03 2*0..3000.E03.2*0..20000.E03.2*0..9500.E03,5*0..        000920
     410000.E03 2*0. 5500.E03 2*0. 3*0. 300.E03 2*0..600.E03,2*0..      000930
     53*0..5000.E03.2*0. 4000.E03.2*0..500.E03.2*0. 700.E03.2*0..       000940
     62000.E03 2*0..7000.E03.2*0..1000.E03.2*0..2000.E03.2*0./          000950
      DATA XCOST/2000.E03.2*0..1000.E03.2*0. 700.E03.2*0..50.E03,2*0..  000960
     13*0. 700.E03 2*0. 300.E03.2*0..6*0. 15000.E03.2*0..3000.E03,2*0.. 000970
     2300.E03 2*0..1000.E03.2*0..1000.E03 2*0..4000.E03.2*0..1000.E03.  000980
     32*0. 2000.E03 2*0..500.E03.2*0..5000.E03,2*0..2000.E03.2*0..      000990
     46000.E03 2*0..4000.E03.2*0..1500.E03 2*0..6*0..2000.E03.5*0./     001000
      DATA FREQ/5*30. 2*0./                                             001010
C         FREQ MUST BE A NUMBER WHICH CAN DIVIDE N  THE PLANT           001020
C            LIFE  WITH NO REMAINDER                                    001030
      DATA XONM/.60E05 500..50..1.0.1.E06.2*0./                         001040
      DATA ISIZE/7.6 2 1 7 2*0/                                         001050
      SOMTR=BSIZE(ISUBTYP(1).1)                                         001060
      TSSMW=BSIZE(ISUBTYP(3).2)                                         001070
      PKMWE=BSIZE(ISUBTYP(5) 5)                                         001080
      CHGEMW=BSIZE(ISUBTYP(3) 3)                                        001090
      DCHGEMW=BSIZE(ISUBTYP(3).4)                                       001100
      RECMW=BSIZE(ISUBTYP(2) 6)                                         001110
C                                                                       001120
C                INITIALIZE REFERENCE PLANT COSTS FOR DESIGN BEING      001130
C                                  ANALYZED                             001140
C                                                                       001150
      IK=ISUBTYP(5)                                                     001160
      DO 110 I=1 8                                                      001170
      COSTS(I)=XCOST(IK.I)                                              001180
  110 CONTINUE                                                          001190
      COSTS(10)=XCOST(IK.9)                                             001200
      DO 120 I=10 13                                                    001210
      J=I+31                                                            001220
      COSTS(J)=XCOST(IK I)                                              001230
  120 CONTINUE                                                          001240
      DO 130 I=16 27                                                    001250
```

```
      J=I+33
      COSTS(J)=XOCOST(IK,I)
  130 CONTINUE
      COSTS(46)=XOCOST(IK,14)
      COSTS(47)=XOCOST(IK,15)
      COSTS(9)=BCOST(ISUBTYP(3),1)
      COSTS(11)=BCOST(ISUBTYP(3),2)
      DO 140 I=3,13
      J=I+9
      COSTS(J)=BCOST(ISUBTYP(1),I)
  140 CONTINUE
      DO 150 I=14,19
      J=I+9
      COSTS(J)=BCOST(ISUBTYP(2),I)
  150 CONTINUE
      DO 160 I=20,31
      J=I+9
      COSTS(J)=BCOST(ISUBTYP(3),I)
  160 CONTINUE
      COSTS(48)=BCOST(ISUBTYP(4),33)
      COSTS(45)=BCOST(ISUBTYP(2),32)
      DO 170 I=1,20
         IF (INUMB(I).LE.0) GO TO 170
      IF (VALUE(I).GT.0.) COSTS(INUMB(I))=VALUE(I)
      IF (FACT(I).GT.0.) COSTS(INUMB(I))=FACT(I)*COSTS(INUMB(I))
  170 CONTINUE
      CALL PRINTER (YEAR,CHGRT,DCHGRT,ID,PMX,PHR,XMWH2,SOM,SMWHR,SMWTH,I
     1OPT1,ECOM)
      XKH=PHR/PMX
      CALL DOLLAR (YEAR,XKH,PMX,CHGRT,DCHGRT,IYHR,ID,SOM,SMWHR,SMWTH,IOP
     1T2,ECOM,TAXR,XIC,ISUBTYP,XMWH2,IOPT3,IOPT4)
      RETURN
      END
```

```
   SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE     REFERENCES
    3  BUCKS        1            89

VARIABLES      SN  TYPE            RELOCATION
  306  BCOST      REAL     ARRAY                REFS      5       63       64       67       71       75       77
                                                  78   DEFINED    21
  263  BSIZE      REAL     ARRAY                REFS      5       38       39       40       41       42       43
                                              DEFINED    16
    3  CHGEMA     REAL            PLTCOST       REFS      9   DEFINED     41
    0  CHGRT      REAL            F.P.          REFS     84       87   DEFINED     1
    6  COSTS      REAL     ARRAY  PLTCOST       REFS      4        9       82  DEFINED      50       52       55
                                                  59     61       62       63       64       67       71       75
                                                  77     78       81       82
    4  DCHGEMA    REAL            PLTCOST       REFS      9   DEFINED     42
    0  DCHGRT     REAL            F.P.          REFS     84       87   DEFINED     1
    0  ECOM       REAL            FINANC        REFS      7       84       87
   36  FACT       REAL     ARRAY  CHCOST        REFS      8     2*82
```

```
      SUBROUTINE BLOCKS       73/74    OPT=1                          FTN 4.6+439        01/26/78  14.17.06        PAGE      3

VARIABLES         SN   TYPE              RELOCATION
    0  FRED        REAL          ARRAY     ODATA          REFS          3          6      DEFINED        33
  260  I           INTEGER                                REFS       2*50         54           55        58           59           66           67
                                                           71                     74           75        80         3*81         4*82
                                                     DEFINED          44          53           57        65           69           73           79
  256  ID          INTEGER                                REFS          44          87      DEFINED        11
  257  IK          INTEGER                                REFS          50          52           55        59           61           62
                                                     DEFINED          44
    0  INUMB       INTEGER       ARRAY     CHCOST         REFS          8           80           81      2*82
  252  IOPT1       INTEGER                                REFS          44     DEFINED           10
  253  IOPT2       INTEGER                                REFS          87     DEFINED           10
  254  IOPT3       INTEGER                                REFS          87     DEFINED           10
  255  IOPT4       INTEGER                                REFS          87     DEFINED           10
   16  ISIZE       INTEGER       ARRAY     ODATA          REFS          3            6      DEFINED        37
    0  ISUBTYP     INTEGER       ARRAY      F.P.          REFS          5           38           39        40           41           42           43
                                                            49          53          64           67        71           75           77           78
                                                            87     DEFINED           1
    0  IYHR        INTEGER                  F.P.          REFS          87     DEFINED            1
  261  L           INTEGER                                REFS          55          59           67        71           75
                                                     DEFINED          54          58           66        70           74
    0  PHR         REAL                     F.P.          REFS          84          86      DEFINED         1
    2  PKMWE       REAL                    PLTCOST        REFS          9      DEFINED           40
    0  PMW         REAL                     F.P.          REFS          84          86           87   DEFINED            1
    5  RECMW       REAL                    PLTCOST        REFS          9      DEFINED           43
    0  SMWHR       REAL                     F.P.          REFS          84          87      DEFINED         1
    0  SMWTH       REAL                     F.P.          REFS          84          87      DEFINED         1
    0  SQM         REAL                     F.P.          REFS          84          87      DEFINED         1
    0  SUMTR       REAL                    PLTCOST        REFS          9      DEFINED           38
    1  TAXR        REAL                    FINANC         REFS          7           87
    1  TSSMW       REAL                    PLTCOST        REFS          9      DEFINED           39
   17  VALUE       REAL          ARRAY     CHCOST         REFS          8         2*81
  262  VKH         REAL                                   REFS          87     DEFINED           86
    0  VMWHD       REAL                     F.P.          REFS          84          87      DEFINED         1
  462  VOCOST      REAL          ARRAY                    REFS          5           50           52        55           59           61           62
                                                     DEFINED          28
    7  VONY        REAL          ARRAY     ODATA          REFS          3            6      DEFINED        36
    0  YEAR        REAL                     F.P.          REFS          84          87      DEFINED         1
    2  YID         REAL                    FINANC         REFS          7           87

EXTERNALS              TYPE    ARGS          REFERENCES
       DOLLAR                   15                87
       PRINTER                  12                84

STATEMENT LABELS               DEF LINE    REFERENCES
    0  110                         51           49
    0  120                         56           53
    0  130                         60           57
    0  140                         68           65
    0  150                         72           69
    0  160                         76           73
   47  170                         83           79           80

LOOPS   LABEL      INDEX       FROM-TO       LENGTH     PROPERTIES
   26   110         I           49 51          3B         INSTACK
   40   120         I           53 56          5B         INSTACK
   50   130         I           57 60          5B         INSTACK
   64   140         I           65 68          5B         INSTACK
   74   150         I           69 72          5B         INSTACK
```

```
      SUBROUTINE BUCKS        73/74    OPT=1                          FTN 4.6+439         01/26/78  14.17.36        PAGE       4

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
  122  160      I          73  76        5B     INSTACK
  140  170      I          79  83       10B        OPT

COMMON BLOCKS   LENGTH    MEMBERS - BIAS NAME(LENGTH)
       CDATA        21              0 FREQ     (7)             7 YDNM     (7)               14 ISIZE    (7)
       FINANC        3              0 ECOM     (1)             1 TAYR     (1)                2 YIC      (1)
       CHCOST       45              0 INUMB    (15)           15 VALUE    (15)              30 FACT     (15)
       PLTCOST      66              0 SQMTR    (1)             1 ISSMW    (1)                2 PKMWE    (1)
                                    3 CHGEMW   (1)             4 DCHGEMW  (1)                5 RECMW    (1)
                                    6 COSTS    (60)

STATISTICS
  PROGRAM LENGTH                     571B      377
  CM LABELED COMMON LENGTH           207B      135
```

```
      SUBROUTINE PRINTER (YEAR CHORT DCHORT ID PMX PHR XMWH2 SOM SMWHR  S001590
     1MWTH IOPT) ECOM)                                                   001600
      DIMENSION IDLAB(4)                                                 001610
      DATA (IDLAB(I) I=1,4)/10HSTRGT LINE 10HSUM FUND 10HSOY DIGIT ,10 001620
     1HDD BALANCE/                                                       001630
         IF ((IOPT).LT.1) GO TO 160                                      001640
      PRINT 110, SOM SMWHR SMWTH CHORT DCHORT PMX                        001650
  110 FORMAT (1X 11HPLANT SIZES,/ 1X E13.6 20H SQ METERS OF MIRRORS,     001660
     1 E13.6 16H MWHR OF STORAGE E13.6 16H MWTH FOR RECEIVER,/ 1H        001670
     2 E13.6 2X,'MW(T) CHARGE RATE' 2X E13.6 1X 'MW(T) DISCHARGE RATE',  001680
     3 2X F8.3,2X,'MWE GROSS PEAK OUTPUT')                               001690
      PRINT 120, PHR XMWH2                                               001700
  120 FORMAT (1X,'PLANT PERFORMANCE' /                                   001710
     1 3X 'SOLAR GENERATION' 1X E13.6,5X 'ANNUAL STORED ENERGY'          001720
     2 1X E13.6)                                                         001730
      PRINT 130  YEAR                                                    001740
  130 FORMAT (1X 'ECONOMIC ASSUMPTIONS' / 3X 'YEAR OF FIRST COMMERCIAL 0001750
     1PERATION' F6.0)                                                    001760
      PRINT 140, IDLAB(ID)                                               001770
  140 FORMAT (3X 19HDEPRECIATION METHOD 5X,A10)                          001780
      PRINT 150  ECOM                                                    001790
  150 FORMAT (3X 'EFFECTIVE COST OF MONEY' 1X F6.3)                      001800
  160 CONTINUE                                                           001810
      RETURN                                                             001820
      END                                                                001830
```

```
SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   3  PRINTER         1            24

VARIABLES      SN  TYPE             RELOCATION
   0  CHORT        REAL                  F.P.     REFS      7    DEFINED      1
   0  DCHORT       REAL                  F.P.     REFS      7    DEFINED      1
   0  ECOM         REAL                  F.P.     REFS     21    DEFINED      1
   0  ID           INTEGER               F.P.     REFS     19    DEFINED      1
 140  IDLAB        INTEGER    ARRAY               REFS      3        19    DEFINED      4
   0  IOPT         INTEGER               F.P.     REFS      6    DEFINED      1
   0  PHR          REAL                  F.P.     REFS     12    DEFINED      1
   0  PMX          REAL                  F.P.     REFS      7    DEFINED      1
   0  SMWHR        REAL                  F.P.     REFS      7    DEFINED      1
   0  SMWTH        REAL                  F.P.     REFS      7    DEFINED      1
   0  SOM          REAL                  F.P.     REFS      7    DEFINED      1
   0  XMWH2        REAL                  F.P.     REFS     12    DEFINED      1
   0  YEAR         REAL                  F.P.     REFS     16    DEFINED      1

FILE NAMES        MODE
     OUTPUT       FMT                  WRITES      7       12       16       19       21

STATEMENT LABELS                 DEF LINE    REFERENCES
   36  110        FMT                8          7
   77  120        FMT               13         12
  107  130        FMT               17         16
```

STATEMENT LABELS			DEF LINE	REFERENCES
124	[illegible]	FMT	[illegible]	19
130	[illegible]	FMT	22	21
14	160		23	6

STATISTICS
PROGRAM LENGTH 146B 102

VARIABLES	SN	TYPE	RELOCATION							
				152	154	160	162	164		
0	TOTCOST	REAL	F.P.	REFS	10	DEFINED	1	32		
1	TSSMA	REAL	PLTCOST	REFS	7	20	34	42	43	45

```
      SUBROUTINE DOLLAR (YEAR,XKH,PMX,CHGRT,DCHGRT,IYHR,ID,SOM,SMWHR,SMW
     1TH,IOPT2,ECOM,TAXR,YIC,ISUBTYP,XMWH2,IOPT3,IOPT4)
      DIMENSION D(30),SUBCOST(7),XOSUBCT(7),FOSUBCT(7)
C
C         ***DIMENSION OF D MUST BE CHANGED***
C         ***IF PLANT LIFE IS CHANGED FROM 30***
C
      DIMENSION CISUB(7),SAMVAL(6),SBBEC(6)
      DIMENSION ILAB(7)
      DIMENSION PV(2),AMVAL(6),BBEC(6)
      DIMENSION ISUBTYP(1)
      DATA N/30/
      DATA (ILAB(I),I=1,7)/10HCOLLECTOR ,10HRECEIVER  ,10HTOWER     ,
     110HTHERMAL ST,10HFEED PUMPS,10HMASTER CTL,10HALL OTHERS/
C
C                POWER PRODUCTION COST CALCULATION
C
      YTC=YEAR-YIC
      CALL SOLCAP (CI,SOM,PMX,CHGRT,DCHGRT,SMWHR,SMWTH,XMED,CISUB,IOPT3)
      CI=CI/PMX
      XMED=XMED/PMX
      CALL IDC (CI,CIDC,ECOM,YIC)
      CALL SOLESC (YTC,CI,ESCI)
      CALL EDC (ESCI,YEAR,YIC,AEDC)
      CALL IDC (ESCI,AIDC,ECOM,YIC)
      CALL IES (ESCI,YIC,YEAR,ECOM,AIES,AIDC)
      CITOT=CI+CIDC
      XINV=ESCI+AEDC+AIDC+AIES
      DO 110 I=1,7
      CISUB(I)=CISUB(I)/PMX
      CALL IDC (CISUB(I),CIDC,ECOM,YIC)
      CALL SOLESC (YTC,CISUB(I),SUBCOST(I))
      CALL EDC (SUBCOST(I),YEAR,YIC,AEDC)
      CALL IDC (SUBCOST(I),AIDC,ECOM,YIC)
      CALL IES (SUBCOST(I),YIC,YEAR,ECOM,AIES,AIDC)
      CISUB(I)=CISUB(I)+CIDC
      SUBCOST(I)=SUBCOST(I)+AEDC+AIDC+AIES
  110 CONTINUE
      CALL INSU (XINV,XINS)
      CALL OPEX (XOM,YEAR,FOM,ECOM,IYHR,XMED,ISUBTYP,XMWH2,FOSUBCT,XOSUB
     1CT,N)
      CALL DEPREC (ID,N,D,ECOM,XINV)
      CALL PRESVAL (D,TAXR,PV,ECOM,XINV,N)
      CALL AMORT (PV,ECOM,AMVAL,2,N)
      AMVAL(3)=XINS
      AMVAL(4)=FOM
      AMVAL(5)=XOM
      AMVAL(6)=AMVAL(1)+AMVAL(2)+AMVAL(3)+AMVAL(4)+AMVAL(5)
      CALL COAL (AMVAL,XKH,BBEC,6)
      PRINT 120
  120 FORMAT (1X,*TOTAL PLANT*)
      CALL PRINTB (AMVAL,BBEC,IOPT2,XINV,CITOT)
C
C                POWER PRODUCTION COAT FOR EACH SOLAR SUBSYSTEM
C
      DO 140 I=1,7
      CALL INSU (SUBCOST(I),XINS)
```

```
            CALL DEPREC (ID N.D.ECOM SUBCOST(I))                      002410
            CALL PRESVAL (D.TAXR.PV.ECOM SUBCOST(I) N)                002420
            CALL AMORT (PV.ECOM.SAMVAL 2 N)                           002430
            SAMVAL(3)=XINS                                            002440
            SAMVAL(4)=FOSUBCT(I)                                      002450
            SAMVAL(5)=XOSUBCT(I)                                      002460
            SAMVAL(6)=SAMVAL(1)+SAMVAL(2)+SAMVAL(3)+SAMVAL(4)+SAMVAL(5) 002470
            CALL CCAL (SAMVAL.XKH SBBEC.6)                            002480
            PRINT 130. ILAB(I)                                        002490
      130   FORMAT (/.1X.A10)                                         002500
            CALL PRINT3 (SAMVAL.SBBEC IOPT4 SUBCOST(I) DISUB(I))      002510
      140   CONTINUE                                                  002520
            RETURN                                                    002530
            END                                                       002540
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS		DEF LINE	REFERENCES
3	DOLLAR	1	70

VARIABLES		SN TYPE		RELOCATION								
515	AEDC	REAL			REFS	24	28	33	37			
516	AIDC	REAL			REFS	25	26	28	34	35	37	
517	AIES	REAL			REFS	26	28	35	37			
645	AMVAL	REAL	ARRAY		REFS	10	44	5*48	49	52		
					DEFINED	45	46	47	48			
653	BBEC	REAL	ARRAY		REFS	10	49	52				
0	CHGRT	REAL		F.P.	REFS	19	DEFINED	1				
511	CI	REAL			REFS	19	20	22	23	27		
					DEFINED	20						
513	DIDC	REAL			REFS	22	27	31	36			
611	DISUB	REAL	ARRAY		REFS	8	19	30	31	32	36	68
					DEFINED	30	36					
520	DITOT	REAL			REFS	52	DEFINED	27				
526	D	REAL	ARRAY		REFS	3	42	43	58	59		
0	DCHGRT	REAL		F.P.	REFS	19	DEFINED	1				
0	ECOM	REAL		F.P.	REFS	22	25	26	31	34	35	40
					42	43	44	58	59	60		
					DEFINED	1						
514	ESCT	REAL			REFS	23	24	25	26	28		
525	FCM	REAL			REFS	40	46					
602	FOSUBCT	REAL	ARRAY		REFS	3	40	62				
522	I	INTEGER			REFS	2*30	31	2*32	33	34	35	2*36
					2*37	57	58	59	62	63	66	2*68
					DEFINED	29	56					
0	ID	INTEGER		F.P.	REFS	42	58	DEFINED	1			
634	ILAB	INTEGER	ARRAY		REFS	9	66	DEFINED	13			
0	IOPT2	INTEGER		F.P.	REFS	52	DEFINED	1				
0	IOPT3	INTEGER		F.P.	REFS	19	DEFINED	1				
0	IOPT4	INTEGER		F.P.	REFS	68	DEFINED	1				
0	ISUBTYP	INTEGER	ARRAY	F.P.	REFS	11	40	DEFINED	1			
0	IYHR	INTEGER		F.P.	REFS	40	DEFINED	1				
477	N	INTEGER			REFS	40	42	43	44	58	59	60

```
VARIABLES      SN   TYPE            RELOCATION
                                                   DEFINED     12
     0  PMX       REAL                 F.P.          REFS       9       20       21       30    DEFINED       1
   643  PV        REAL       ARRAY                   REFS       1       43       44       59       60
   620  SAMVAL    REAL       ARRAY                   REFS       8       60     5*64       65       68
                                                   DEFINED     47       62       63       64
   626  SBBED     REAL       ARRAY                   REFS       8       65       68
     0  SMWHR     REAL                 F.P.          REFS      12  DEFINED        1
     0  SMWTH     REAL                 F.P.          REFS      12  DEFINED        1
     0  SOM       REAL                 F.P.          REFS      13  DEFINED        1
   564  SUBCOST   REAL       ARRAY                   REFS       4       32       33       34       35       37       57
                                                       58      59       68  DEFINED       37
     0  TAXR      REAL                 F.P.          REFS      43       59  DEFINED        1
   523  XINS      REAL                               REFS      39       45       57       61
   521  XINV      REAL                               REFS      39       42       43       52    DEFINED      28
     0  XKH       REAL                 F.P.          REFS      49       65  DEFINED        1
   512  XMED      REAL                               REFS      19       21       40  DEFINED       21
     0  XMWHD     REAL                 F.P.          REFS      40  DEFINED        1
   524  XOM       REAL                               REFS      43       47
   573  XOSUBCT   REAL       ARRAY                   REFS       3       40       63
     0  YEAR      REAL                 F.P.          REFS      18       24       26       33       35       40
                                                   DEFINED      1
     0  YID       REAL                 F.P.          REFS      19       22       24       25       26       31       33
                                                       34      35  DEFINED        1
   510  YTD       REAL                               REFS      23       32  DEFINED       18

FILE NAMES          MODE
        OUTPUT      FMT                    WRITES       50       66

EXTERNALS              TYPE     ARGS          REFERENCES
        AMORT                    5              44       60
        COAL                     4              49       65
        DEPREC                   5              42       58
        EDC                      4              24       33
        IDC                      4              22       25       31       34
        IES                      6              26       35
        INSU                     2              39       57
        OPEN                    11              40
        PRESVAL                  6              43       59
        PRINT3                   5              52       68
        SOLCAP                  10              19
        SOLESC                   3              23       32

STATEMENT LABELS                    DEF LINE     REFERENCES
     0   110                            38          29
   476   120         FMT                51          50
   504   130         FMT                67          66
     0   140                            69          56

LOOPS   LABEL     INDEX         FROM-TO      LENGTH      PROPERTIES
   470   110       I             29 38         43B                EXT REFS
   534   140       I             56 69         47B                EXT REFS

STATISTICS
  PROGRAM LENGTH                    736B       478
```

```
      SUBROUTINE PRINT3 (AMVAL,BBEC,IOPT2,XINV,CI)                         002550
      DIMENSION AMVAL(1),BBEC(1),ILAB(6)                                   002560
      DATA (ILAB(I),I=1,6)/10HINVEST [illegible]                           002570
     *10HFIX O+M   ,10HVAR O+M   ,[illegible]                              002580
      IF (IOPT2.LT.1) GO TO 150                                            002590
      PRINT 110, XINV,CI                                                   002600
  110 FORMAT (1X,2X,1H$,F12.2,* PER [illegible] F12.2                      002610
     1 * PER [illegible] MWE BASE YEAR)*)                                  002620
      PRINT 120                                                            002630
  120 FORMAT ([illegible] 5HAMVAL,15X,4HBBEC)                              002640
      DO 140 I=1,6                                                         002650
      PRINT 130, ILAB(I),AMVAL(I),BBEC(I)                                  002660
  130 FORMAT (1X,A10,4X,1H$,E15.6,4X,[illegible])                          002670
  140 CONTINUE                                                             002680
  150 CONTINUE                                                             002690
      RETURN                                                               002700
      END                                                                  002710
```

```
        SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS       DEF LINE       REFERENCES
    3  PRINT3           1            16

VARIABLES       SN   TYPE              RELOCATION
    0  AMVAL        REAL        ARRAY     F.P.        REFS        2          12     DEFINED       1
    0  BBEC         REAL        ARRAY     F.P.        REFS        2          12     DEFINED       1
    0  CI           REAL                  F.P.        REFS        6    DEFINED        1
  102  I            INTEGER                           REFS     3*12    DEFINED       11
  103  ILAB         INTEGER     ARRAY                 REFS        2          12     DEFINED       3
    0  IOPT2        INTEGER               F.P.        REFS        5    DEFINED        1
    0  XINV         REAL                  F.P.        REFS        6    DEFINED        1

FILE NAMES          MODE
     OUTPUT      FMT                       WRITES        6           9          12

STATEMENT LABELS                DEF LINE    REFERENCES
   46  110      FMT                 7           6
   63  120      FMT                10           9
   75  130      FMT                13          12
    0  140                         14          11
   37  150                         15           5

LOOPS  LABEL     INDEX       FROM-TO      LENGTH      PROPERTIES
   24  140        I            11 14         13B                  EXT REFS

STATISTICS
  PROGRAM LENGTH                   123B        83
```

```
      SUBROUTINE SOLCAP (TOTCOST,SQM,PMX,CHGRT,DCHGRT,SMWHR,SMWTH,XMED,S002720
     1UBCOST,IOPT3)                                                     002730
C                                                                       002740
C           SOLAR PLANT COSTS SCALED T[illegible] PLANT SIZE            002750
C                                                                       002760
      DIMENSION CCOSTS(60),SUBCOST(7)                                   002770
      COMMON/PLTCOST/SQMTR,TSSMW,PKMWE,CHGEMW,DCHGEMW,RECMW,COSTS(60)   002780
      DATA FRCON/.15/                                                   002790
C                                                                       002800
C          CALCULATE THE COST OF THE [illegible] PLANT                  002810
C                                                                       002820
      CCOSTS(1)=COSTS(1)/SQMTR*SQM                                      002830
      CCOSTS(2)=COSTS(2)/PKMWE*PMX                                      002840
      CCOSTS(3)=COSTS(3)                                                002850
      CCOSTS(4)=COSTS(4)                                                002860
      CCOSTS(5)=COSTS(5)                                                002870
      CCOSTS(6)=COSTS(6)                                                002880
      CCOSTS(7)=COSTS(7)                                                002890
      CCOSTS(8)=COSTS(8)                                                002900
      CCOSTS(9)=COSTS(9)                                                002910
      CCOSTS(10)=COSTS(10)                                              002920
      CCOSTS(11)=COSTS(11)/TSSMW*SMWHR                                  002930
      DO 110 I=12,22                                                    002940
      CCOSTS(I)=COSTS(I)/SQMTR*SQM                                      002950
  110 CONTINUE                                                          002960
      DO 120 I=23,24                                                    002970
      CCOSTS(I)=COSTS(I)/RECMW*SMWTH                                    002980
  120 CONTINUE                                                          002990
      CCOSTS(25)=COSTS(25)                                              003000
      DO 130 I=26,27                                                    003010
      CCOSTS(I)=COSTS(I)/SQMTR*SQM                                      003020
  130 CONTINUE                                                          003030
      CCOSTS(28)=COSTS(28)                                              003040
      CCOSTS(29)=COSTS(29)/TSSMW*SMWHR                                  003050
      CCOSTS(30)=COSTS(30)/(CHGEMW+DCHGEMW)*(CHGRT+DCHGRT)              003060
      CCOSTS(31)=COSTS(31)                                              003070
      CCOSTS(32)=COSTS(32)/CHGEMW*CHGRT                                 003080
      CCOSTS(33)=COSTS(33)/DCHGEMW*DCHGRT                               003090
      CCOSTS(34)=COSTS(34)                                              003100
      CCOSTS(35)=COSTS(35)/DCHGEMW*DCHGRT                               003110
      CCOSTS(36)=COSTS(36)/CHGEMW*CHGRT                                 003120
      CCOSTS(37)=COSTS(37)/TSSMW*SMWHR                                  003130
      CCOSTS(38)=COSTS(38)/TSSMW*SMWHR                                  003140
      CCOSTS(39)=COSTS(39)                                              003150
      CCOSTS(40)=COSTS(40)/TSSMW*SMWHR                                  003160
      DO 140 I=41,44                                                    003170
      CCOSTS(I)=COSTS(I)/PKMWE*PMX                                      003180
  140 CONTINUE                                                          003190
      CCOSTS(45)=COSTS(45)/RECMW*SMWTH                                  003200
      CCOSTS(46)=COSTS(46)/PKMWE*PMX                                    003210
      CCOSTS(47)=COSTS(47)/PKMWE*PMX                                    003220
      TCC=0.                                                            003230
      DO 150 I=12,47                                                    003240
      TCC=TCC+COSTS(I)                                                  003250
  150 CONTINUE                                                          003260
      TCCN=0.                                                           003270
      DO 160 I=12,47                                                    003280
```

```
      TDCN=TDCN+CCOSTS(I)
  160 CONTINUE
      CCOSTS(48)=COSTS(48)
      CCOSTS(49)=COSTS(49)/TDC*TDCN
      CCOSTS(50)=COSTS(50)
      CCOSTS(51)=COSTS(51)/PKMWE*PMX
      TNS=0.
      DO 170 I=1,10
      TNS=TNS+COSTS(I)
  170 CONTINUE
      DO 180 I=41,51
      TNS=TNS+COSTS(I)
  180 CONTINUE
      TNSN=0.
      DO 190 I=1,10
      TNSN=TNSN+CCOSTS(I)
  190 CONTINUE
      DO 200 I=41,51
      TNSN=TNSN+CCOSTS(I)
  200 CONTINUE
      CCOSTS(52)=COSTS(52)/TNS*TNSN
      CCOSTS(53)=COSTS(53)/TDC*TDCN
      CCOSTS(54)=COSTS(54)/TNS*TNSN
      CCOSTS(55)=COSTS(55)
      CCOSTS(56)=COSTS(56)
      CCOSTS(57)=COSTS(57)
      CCOSTS(58)=COSTS(58)
      CCOSTS(59)=COSTS(59)
      TOT=0.
      DO 210 I=1,59
      TOT=TOT+CCOSTS(I)
  210 CONTINUE
      TOT=TOT-CCOSTS(11)
      CCOSTS(60)=TOT*FRCON
      TOTCOST=TOT+CCOSTS(60)
      XMED=CCOSTS(11)
      SUBCOST(1)=0.
      DO 220 I=12,22
      SUBCOST(1)=SUBCOST(1)+CCOSTS(I)
  220 CONTINUE
      SUBCOST(2)=CCOSTS(23)+CCOSTS(24)+CCOSTS(25)
      SUBCOST(3)=CCOSTS(26)+CCOSTS(27)
      SUBCOST(4)=0.
      DO 230 I=29,40
      SUBCOST(4)=SUBCOST(4)+CCOSTS(I)
  230 CONTINUE
      SUBCOST(5)=CCOSTS(45)
      SUBCOST(6)=CCOSTS(48)
      SUBCOST(7)=TOTCOST
      DO 240 I=1,6
      SUBCOST(7)=SUBCOST(7)-SUBCOST(I)
  240 CONTINUE
         IF (IOPTBULT(1)) GO TO 470
      PRINT 250, CCOSTS(1)
  250 FORMAT (/,1X,*LAND/SITE*,1X,E13.6)
      TOT=0.
      DO 260 I=2,10
```

```
              TOT=TOT+CCOSTS(I)                                         003860
      260     CONTINUE                                                  003870
              PRINT 270, TOT                                            003880
      270     FORMAT (1X,*BUILDINGS*,1X,E13.6)                          003890
              PRINT 280, SUBCOST(1)                                     003900
      280     FORMAT (1X,*COLLECTOR*,1X,E13.6)                          003910
              PRINT 290, SUBCOST(2)                                     003920
      290     FORMAT (1X,*RECEIVER*,1X,E13.6)                           003930
              PRINT 300, SUBCOST(3)                                     003940
      300     FORMAT (1X,*TOWER*,1X,E13.6)                              003950
              PRINT 310, SUBCOST(4)                                     003960
      310     FORMAT (1X,*THERMAL STORAGE*,1X,E13.6)                    003970
              TOT=CCOSTS(29)+CCOSTS(37)+CCOSTS(38)+CCOSTS(40)           003980
              PRINT 320, TOT                                            003990
      320     FORMAT (5X,*CAPACITY*,1X,E13.6)                           004000
              TOT=0.                                                    004010
              DO 330 I=30,36                                            004020
              TOT=TOT+CCOSTS(I)                                         004030
      330     CONTINUE                                                  004040
              PRINT 340, TOT                                            004050
      340     FORMAT (5X,*CHARGE/DISCHARGE*,1X,E13.6)                   004060
              PRINT 350, CCOSTS(39)                                     004070
      350     FORMAT (5X,*DESIGN*,1X,E13.6)                             004080
              PRINT 360, SUBCOST(5)                                     004090
      360     FORMAT (1X,*FEED PUMPS*,1X,E13.6)                         004100
              PRINT 370, SUBCOST(6)                                     004110
      370     FORMAT (1X,*MASTER CONTROL*,1X,E13.6)                     004120
              TOT=0.                                                    004130
              DO 380 I=41,47                                            004140
              TOT=TOT+CCOSTS(I)                                         004150
      380     CONTINUE                                                  004160
              TOT=TOT-CCOSTS(45)                                        004170
              PRINT 390, TOT                                            004180
      390     FORMAT (1X,*EPGS*,1X,E13.6)                               004190
              TOT=CCOSTS(49)+CCOSTS(50)+CCOSTS(51)                      004200
              PRINT 400, TOT                                            004210
      400     FORMAT (1X,*OTHER EQUIP*,1X,E13.6)                        004220
              TOT=0.                                                    004230
              DO 410 I=52,59                                            004240
              TOT=TOT+CCOSTS(I)                                         004250
      410     CONTINUE                                                  004260
              PRINT 420, TOT                                            004270
      420     FORMAT (1X,*DISTRIB/INDIRECTS*,1X,E13.6)                  004280
              PRINT 430, CCOSTS(60)                                     004290
      430     FORMAT (1X,*CONTINGENCY*,1X,E13.6)                        004300
              TOT=0.                                                    004310
              DO 440 I=1,60                                             004320
              TOT=TOT+CCOSTS(I)                                         004330
      440     CONTINUE                                                  004340
              TOT=TOT-CCOSTS([illegible])                               004350
              PRINT [illegible], TOT                                    004360
      450     FORMAT (1X,*TOTAL PLANT*,1X,E13.6)                        004370
              PRINT 460, CCOSTS([illegible])                            004380
      460     FORMAT (1X,*XMED*,1X,E13.6)                               004390
      470     CONTINUE                                                  004400
              RETURN                                                    004410
              END                                                       004420
```

```
       SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3  SOLCAP          1          170

VARIABLES       SN  TYPE            RELOCATION
  647  CCOSTS     REAL         ARRAY                REFS      [illegible]    58     73     76     86     90     92
                                                       93     [illegible]  3*98   2*99    102    104    105    111
                                                      115     [illegible]   132    136    144    146  3*149    154
                                                      158     [illegible]   164    167  DEFINED   12     13     14
                                                       16     [illegible]    17     18     19     20     21     22
                                                       24     [illegible]    29     31     33     34     35     36
                                                       37     38     39     40     41     42     43     44
                                                       45     47     49     50     51     60     61     62
                                                       63     78     79     80     81     82     83     84
                                                       85     91
    3  CHGEMW     REAL                     PLTCOST     REFS      7     35     37     41
    0  CHGRT      REAL                     F.P.        REFS     35     37     41  DEFINED    1
    6  COSTS      REAL         ARRAY       PLTCOST     REFS      7     12     13     14     15     16     17
                                                       18     19     20     21     22     24     27     29
                                                       31     33     34     35     36     37     38     39
                                                       40     41     42     43     44     45     47     49
                                                       50     51     54     60     61     62     63     66
                                                       69     78     79     80     81     82     83     84
                                                       85
    4  DCHGEMW    REAL                     PLTCOST     REFS      7     35     38     40
    0  DCHGRT     REAL                     F.P.        REFS     35     38     40  DEFINED    1
  437  FRCON      REAL                                 REFS     91  DEFINED     8
  641  I          INTEGER                              REFS   2*24   2*27   2*31   2*47     54     58     66
                                                       69     73     76     88     96    102    108    115
                                                      132    144    154    162  DEFINED   23     26     30
                                                       46     53     57     65     68     72     75     87
                                                       95    101    107    114    131    143    153    161
    0  IOPT3      INTEGER                  F.P.        REFS    110  DEFINED     1
    2  PKMWE      REAL                     PLTCOST     REFS      7     13     47     50     51     63
    0  PMX        REAL                     F.P.        REFS     13     47     50     51     63
                                                  DEFINED      1
    5  RECMW      REAL                     PLTCOST     REFS      7     27     49
    0  SMWHR      REAL                     F.P.        REFS     22     34     42     43     45
                                                  DEFINED      1
    0  SMWTH      REAL                     F.P.        REFS     27     49  DEFINED    1
    0  SOM        REAL                     F.P.        REFS     12     24     31  DEFINED    1
    1  SOMTR      REAL                     PLTCOST     REFS      7     12     24     31
    0  SUBCOST    REAL         ARRAY       F.P.        REFS      6     96    102  2*108    119    121    123
                                                      125    138    140  DEFINED    1     94     96     98
                                                       99    100    102    104    105    106    108
  642  TCC        REAL                                 REFS     54     61     79  DEFINED   52     54
  643  TCCN       REAL                                 REFS     58     61     79  DEFINED   56     58
  644  TNS        REAL                                 REFS     66     69     78     80  DEFINED   64     66
                                                       69
  645  TNSN       REAL                                 REFS     73     76     78     80  DEFINED   71     73
                                                       76
  646  TOT        REAL                                 REFS     88     90     91     92    115    117    128
                                                      132    134    144    146    147    150    154    156
                                                      162    164    165  DEFINED   86     88     90    113
                                                      115    127    130    132    142    144    146    149
```

```
        SUBROUTINE SOLCAP      73/74    OPT=1                                    FTN 4.6+439          01/26/78  14.17.06         PAGE      5

VARIABLES       SN  TYPE              RELOCATION
                                                        160          164          166          162          164
        0  TOTCOST    REAL               F.P.          REFS          16       DEFINED          1           92
        0  TSSYM      REAL               PLTCOST       REFS           1            22          34           42           43           46
        0  YMED       REAL               F.P.       DEFINED                        93

FILE NAMES           MODE
           OUTPUT     FMT                WRITES          11           17          119          121          123          125          128          134
                                           136          138           1           143          150          156          156          165          167

STATEMENT LABELS                    DEF LINE   REFERENCES
        0   110                          25          23
        0   120                          28          26
        0   130                          32          30
        0   140                          48          46
        0   150                          55          53
        0   160                          59          57
        0   170                          67          65
        0   180                          70          68
        0   190                          74          72
        0   200                          77          75
        0   210                          89          87
        0   220                          97          95
        0   230                         103         101
        0   240                         109         107
      438   250       FMT               112         111
        0   260                         116         114
      448   270       FMT               118         117
      456   280       FMT               120         119
      466   290       FMT               122         121
      476   300       FMT               124         123
      506   310       FMT               126         125
      516   320       FMT               129         128
        0   330                         133         131
      526   340       FMT               135         134
      536   350       FMT               137         136
      546   360       FMT               139         138
      556   370       FMT               141         140
        0   380                         145         143
      566   390       FMT               148         147
      576   400       FMT               151         150
        0   410                         155         153
      606   420       FMT               157         156
      616   430       FMT               159         158
        0   440                         163         161
      626   450       FMT               166         165
      636   460       FMT               168         167
      431   470                         169         170

LOOPS   LABEL      INDEX       FROM-TO     LENGTH     PROPERTIES
   35    110         I          23  25        4B        INSTACK
   45    120         I          26  28        4B        INSTACK
   55    130         I          30  32        4B        INSTACK
  [illegible]  140   I          46  48        4B        INSTACK
  142    150         I          53  55        3B        INSTACK
   [illegible]  160  I          57  59        3B        INSTACK
   [illegible]  170  I          65  67        3B        INSTACK
  [illegible]  180   I          68  70        3B        INSTACK
```

```
        SUBROUTINE DEPREC      73/74    OPT=1                                    FTN 4.6+439          01/26/78  14.17.06         PAGE

                          SUBROUTINE DEPREC (ID,N,D,R,XINV)                                   005270
                          DIMENSION D(50)                                                     005280
                 C                                                                            005290
```

```
LOOPS  LABEL   INDEX     FROM-TO     LENGTH    PROPERTIES
  201  190     I          72  74         3B      INSTACK
  207  200     I          75  77         3B      INSTACK
  234  210     I          87  89         3B      INSTACK
  251  220     I          95  97         3B      INSTACK
  267  230     I         101 103         3B      INSTACK
  303  240     I         107 109         3B      INSTACK
  316  260     I         114 116         3B      INSTACK
  345  330     I         131 133         3B      INSTACK
  364  380     I         143 145         3B      INSTACK
  404  410     I         153 155         3B      INSTACK
  417  440     I         161 163         3B      INSTACK

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
       PLTCOST      66             0 SOMTR   (1)                    1 TSSMW   (1)                    2 PKMWE   (1)
                                   3 CHGEMW  (1)                    4 DCHGEMW(1)                     5 RECMW   (1)
                                   6 COSTS   (60)

STATISTICS
  PROGRAM LENGTH                    743B      483
  CM LABELED COMMON LENGTH          102B       66
```

```
   1                 SUBROUTINE SOLESC (YTC,CI,ESCI)                                   004430
               C                                                                       004440
               C                 SOLAR PLANT COST AT START OF CONSTRUCTION             004450
               C                                                                       004460
   5                 COMMON/CESCAL/CESC(10),CYRESC(11)                                 004470
                     ESCI=CI                                                           004480
                     YEAR=YTC                                                          004490
                     IF (YEAR.LT.CYRESC(1)) ESCI=ESCI*(1.+CESC(1)/100.)**(YEAR-CYRESC(1004500
                    1))                                                                004510
  10                 DO 120 I=1,10                                                     004520
                     J=I+1                                                             004530
                        IF (CYRESC(J).LE.0.) GO TO 120                                 004540
                        IF (YEAR.GT.CYRESC(J)) GO TO 110                               004550
                     XYR=YEAR-CYRESC(I)                                                004560
  15                    IF (YEAR.LT.CYRESC(I)) GO TO 120                               004570
                     ESCI=ESCI*(1.+CESC(I)/100.)**XYR                                  004580
                        GO TO 120                                                      004590
               110   CONTINUE                                                          004600
                     XYR=CYRESC(J)-CYRESC(I)                                           004610
  20                 ESCI=ESCI*(1.+CESC(I)/100.)**XYR                                  004620
               120   CONTINUE                                                          004630
                     RETURN                                                            004640
                     END                                                               004650



      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3  SOLESC         1           22

VARIABLES       SN  TYPE            RELOCATION
    0  CESC        REAL        ARRAY    CESCAL        REFS         5          8         16          20
    0  CI          REAL                   F.P.        REFS         6    DEFINED          1
   12  CYRESC      REAL        ARRAY    CESCAL        REFS         5        2*8         12          13          14          15        2*19
    0  ESCI        REAL                   F.P.        REFS         8         16         20     DEFINED           1           6           8
                                                          16      20
   63  I           INTEGER                            REFS        11         14         15          16          19          20
                                                   DEFINED        10
   64  J           INTEGER                            REFS        12         13         19     DEFINED          11
   65  XYR         REAL                               REFS        16         20    DEFINED          14          19
   62  YEAR        REAL                               REFS       2*8         13         14          15     DEFINED           7
    0  YTC         REAL                   F.P.        REFS         7    DEFINED          1

STATEMENT LABELS                 DEF LINE    REFERENCES
   44  110                          19          13
   53  120                          21          10          12          15          17

LOOPS   LABEL     INDEX      FROM-TO      LENGTH     PROPERTIES
   30   120        I          10 21        26B                  EXT REFS

COMMON BLOCKS    LENGTH      MEMBERS - BIAS NAME(LENGTH)
        CESCAL        21               0 CESC    (10)                  10 CYRESC  (11)
```

```
STATISTICS
  PROGRAM LENGTH                  75B       61
  CM LABELED COMMON LENGTH        25B       21
```

```
                SUBROUTINE EDC (ESCI,YCO,YIC,AEDC)                      004660
        C                                                               004670
        C               ESCALATION DURING CONSTRUCTION                  004680
        C                                                               004690
                COMMON/CESCAL/CESC(10),CYRESC(11)                       004700
                XSUM=0.                                                 004710
                T=YIC/100.                                              004720
                DO 120 I=1,100                                          004730
                YEAR=YCO-YIC+T                                          004740
                K1=0                                                    004750
                DO 110 I1=1,10                                          004760
                J1=I1+1                                                 004770
                IF ((YEAR.LT.CYRESC(J1)).AND.(K1.LE.0)) K1=I1           004780
          110   CONTINUE                                                004790
                E=CESC(K1)                                              004800
                XSUM=XSUM+(1.+E/100.)**T                                004810
                T=T+(YIC/100.)                                          004820
          120   CONTINUE                                                004830
                ESCF=XSUM/100.-1.                                       004840
                AEDC=ESCI*ESCF                                          004850
                RETURN                                                  004860
                END                                                     004870
```

```
     SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3  EDC            1            21

VARIABLES        SN  TYPE             RELOCATION
     0  AEDC         REAL                 F.P.     DEFINED      1      20
     0  CESC         REAL        ARRAY   CESCAL      REFS       5      15
    12  CYRESC       REAL        ARRAY   CESCAL      REFS       5      13
    71  E            REAL                            REFS      16   DEFINED     15
    72  ESCF         REAL                            REFS      20   DEFINED     19
     0  ESCI         REAL                 F.P.       REFS      20   DEFINED      1
    64  I          * INTEGER                       DEFINED      8
    67  I1           INTEGER                         REFS      12      13   DEFINED     11
    70  J1           INTEGER                         REFS      13   DEFINED     12
    66  K1           INTEGER                         REFS      13      15   DEFINED     10      13
    63  T            REAL                            REFS       9      16      17   DEFINED      7      17
    62  XSUM         REAL                            REFS      16      19   DEFINED      6      16
     0  YCO          REAL                 F.P.       REFS       9   DEFINED      1
    65  YEAR         REAL                            REFS      13   DEFINED      9
     0  YIC          REAL                 F.P.       REFS       7       9      17   DEFINED      1

STATEMENT LABELS                 DEF LINE    REFERENCES
     0  110                         14          11
     0  120                         18           8

LOOPS   LABEL    INDEX       FROM-TO     LENGTH    PROPERTIES
  61    120      I             8  18       30B                 EXT REFS  NOT INNER
  60    110      I1           11  14        6B      INSTACK
```

```
COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
      CESCAL        21                  0 CESC    (10)

STATISTICS
  PROGRAM LENGTH                104B       68
  CM LABELED COMMON LENGTH       25B       21
```

```
      SUBROUTINE IDC          73/74    OPT=1                                   FTN 4.6+439          01/26/78  14.17.56          PAGE      1

  1                      SUBROUTINE IDC (ESCI,AIDC,ECOM,YIC)                              004880
                C                                                                         004890
                C             INTEREST DURING CONSTRUCTION                                004900
                C                                                                         004910
  5                      T=YIC/100.                                                       004920
                         ZUM=0.                                                           004930
                         DO 110 I=1,100                                                   004940
                         ZUM=ZUM+(1.+ECOM/4.)**(4.*(YIC-T))                               004950
                         T=T+YIC/100.                                                     004960
 10             110      CONTINUE                                                         004970
                         XINT=ZUM/100.-1.                                                 004980
                         AIDC=XINT*ESCI                                                   004990
                         RETURN                                                           005000
                         END                                                              005010



      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3  IDC            1           13

VARIABLES      SN  TYPE             RELOCATION
    0  AIDC         REAL                F.P.       DEFINED        1        12
    0  ECOM         REAL                F.P.         REFS         8    DEFINED        1
    0  ESCI         REAL                F.P.         REFS        12    DEFINED        1
   51  I          * INTEGER                        DEFINED        7
   47  T            REAL                             REFS         8         9    DEFINED        5         9
   52  XINT         REAL                             REFS        12    DEFINED       11
    0  YIC          REAL                F.P.         REFS         5         8         9    DEFINED        1
   53  ZUM          REAL                             REFS         8        11    DEFINED        6         8

STATEMENT LABELS                  DEF LINE    REFERENCES
    0  110                           10           7

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   21   110       I           7 10        13B                EXT REFS

STATISTICS
  PROGRAM LENGTH                    64B       52
```

```
      SUBROUTINE IES (ESCI,YIC,YCO,ECOM,AIES,AIDC)               005020
C                                                                005030
C           INTEREST ON ESCALATION DURING CONSTRUCTION           005040
C                                                                005050
      COMMON/CESCAL/CESC(10),CYRESC(11)                          005060
      XSUM1=0.                                                   005070
      XSUM2=0.                                                   005080
      T=YIC/100.                                                 005090
      DO 120 I=1,100                                             005100
      N=I                                                        005110
      YEAR=YCO-YIC+FLOAT(N)                                      005120
      K1=0                                                       005130
      DO 110 I1=1,10                                             005140
      J1=I1+1                                                    005150
      IF ((YEAR.LT.CYRESC(J1)).AND.(K1.LE.0)) K1=I1              005160
  110 CONTINUE                                                   005170
      E=CESC(K1)                                                 005180
      XSUM1=XSUM1+((1.+E/100.)**T)                               005190
      XSUM2=XSUM2+((1.+E/100.)**T)*((1.+ECOM/4.)**(4.*(YIC-T)))  005200
      T=T+(YIC/100.)                                             005210
  120 CONTINUE                                                   005220
      XIES=(XSUM2-XSUM1)/100.                                    005230
      AIES=XIES*ESCI-AIDC                                        005240
      RETURN                                                     005250
      END                                                        005260
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS	DEF LINE	REFERENCES
3 IES	1	24

VARIABLES		SN TYPE		RELOCATION								
[illegible]	AIDC	REAL		F.P.	REFS	23	DEFINED	1				
[illegible]	AIES	REAL		F.P.	DEFINED	1	23					
[illegible]	CESC	REAL	ARRAY	CESCAL	REFS	5	17					
[illegible]	CYRESC	REAL	ARRAY	CESCAL	REFS	5	15					
116	E	REAL			REFS	18	19	DEFINED	17			
[illegible]	ECOM	REAL		F.P.	REFS	19	DEFINED	1				
[illegible]	ESCI	REAL		F.P.	REFS	23	DEFINED	1				
[illegible]		* INTEGER			DEFINED	9						
[illegible]	I1	INTEGER			REFS	14	15	DEFINED	13			
[illegible]	J1	INTEGER			REFS	15	DEFINED	14				
[illegible]	K1	INTEGER			REFS	15	17	DEFINED	12	15		
[illegible]	N	INTEGER			REFS	11	DEFINED	10				
[illegible]	T	REAL			REFS	10	18	2*19	20	DEFINED	8	20
[illegible]	XIES	REAL			REFS	23	DEFINED	22				
[illegible]	XSUM1	REAL			REFS	18	22	DEFINED	6	18		
[illegible]	XSUM2	REAL			REFS	19	22	DEFINED	7	19		
[illegible]	YCO	REAL		F.P.	REFS	11	DEFINED	1				
[illegible]	YEAR	REAL			REFS	15	DEFINED	11				
	YIC	REAL		F.P.	REFS	8	11	19	20	DEFINED	1	

```
INLINE FUNCTIONS   TYPE   ARGS        DEF LINE  REFERENCES
     FLOAT        REAL      1  INTRIN               11

STATEMENT LABELS              DEF LINE   REFERENCES
   0  110                        16          13
   0  120                        21           9

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   22  120       I          9 21       46B                 EXT REFS  NOT INNER
   33  110       J         13 16        6B     INSTACK

COMMON BLOCKS   LENGTH     MEMBERS - BIAS NAME(LENGTH)
     CESCAL        21                0 CESC    (10)                 10 LYRESC (11)

STATISTICS
  PROGRAM LENGTH                  136B       94
  CM LABELED COMMON LENGTH         25B       21
```

```
      SUBROUTINE DEPREC (ID,N,D,R,XINV)
      DIMENSION D(50)
C
C                 DEPRECIATION BY ANY OF FOUR METHODS
C
         IF (ID-2) 110,130,150
C        ***STRAIGHT LINE METHOD***
  110 CONTINUE
      DO 120 J=1,N
      D(J)=XINV/FLOAT(N)
  120 CONTINUE
      RETURN
C        ***SINKING FUND METHOD***
  130 CONTINUE
      A=R/((1.0-(1.0/((1.0+R)**N)))
      DO 140 J=1,N
      D(J)=A*XINV/((1.0+R)**(N-J+1))
  140 CONTINUE
      RETURN
  150 CONTINUE
         IF (ID.GT.3) GO TO 170
C        ***SUM-OF-YEARS DIGIT METHOD***
      B=2.0/FLOAT(N*(N+1))
      DO 160 J=1,N
      D(J)=B*FLOAT(N-J+1)*XINV
  160 CONTINUE
      RETURN
C        ***DOUBLE DECLINING BALANCE METHOD***
  170 CONTINUE
      C=2.0/FLOAT(N)
      M=INT(FLOAT(N)/2.0)
      F=0.0
      DO 180 J=1,M
      D(J)=XINV*C*((1.0-C)**(J-1))
      F=F+D(J)
  180 CONTINUE
      M=M+1
      DO 190 J=M,N
      D(J)=(XINV-F)/FLOAT(N-M+1)
  190 CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS	DEF LINE	REFERENCES			
3 DEPREC	1	12	19	27	41

VARIABLES	SN	TYPE		RELOCATION								
[illegible] A		REAL			REFS	17	DEFINED	15				
[illegible] B		REAL			REFS	25	DEFINED	23				
[illegible] C		REAL			REFS	2*34	DEFINED	30				
[illegible] D		REAL	ARRAY	F.P.	REFS	2	35	DEFINED	1	10	17	25

```
      SUBROUTINE DEPREC      73/74    OPT=1                              FTN 4.6+439        01/26/78  14.17.06        PAGE      2

VARIABLES      SN  TYPE          RELOCATION
                                                     34         39
  [illegible]  F         REAL                        REFS       35        39        DEFINED     32         35
  0  ID         INTEGER             F.P.             REFS        6        2[illegible]  DEFINED  [illegible]
  135  I        INTEGER                              REFS  [illegible]  2*[illegible]  2*25   2*34   35   39
                                                   DEFINED       9        [illegible]6    24          33         38
  [illegible]  M         INTEGER                     REFS       33        [illegible]    38          39     DEFINED    31     37
  0  N          INTEGER             F.P.             REFS        9        [illegible]    15          [illegible]6   17   2*23   24
                                                     25         3[illegible]  3[illegible]  38       39     DEFINED  [illegible]
  0  R          REAL                F.P.             REFS   2*[illegible]  [illegible]  DEFINED  [illegible]
  0  [illegible]  REAL              F.P.             REFS   [illegible]  [illegible]    25          34         39
                                                   DEFINED  [illegible]

INLINE FUNCTIONS    TYPE    ARGS        DEF LINE  REFERENCES
       FLOAT        REAL      [illegible]  INTRIN     [illegible]   [illegible]   [illegible]   30     31     39
       INT          INTEGER   [illegible]  INTRIN     3[illegible]

STATEMENT LABELS                 DEF LINE    REFERENCES
   0  [illegible]      INACTIVE       8          6
   0  [illegible]                    [illegible] 9
   32  [illegible]                   [illegible]4    6
   0  [illegible]                    [illegible]8   16
   62  [illegible]                   2[illegible]    6
   0  [illegible]                    26          24
   [illegible]2  [illegible]         29          2[illegible]
   0  [illegible]                    36          33
   0  [illegible]                    4[illegible]   38

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
  26   [illegible]   [illegible]      9 [illegible]      2B    INSTACK
  4[illegible]  [illegible]  [illegible]  16 18     11B                EXT REFS
  64   [illegible]   [illegible]     24 26        4B    INSTACK
  [illegible]  [illegible]  [illegible]  33 36     12B                EXT REFS
  [illegible]24  [illegible]  [illegible]  38 4[illegible]  2B    INSTACK

STATISTICS
  PROGRAM LENGTH               [illegible]60B      [illegible]12
```

```
                 SUBROUTINE INSU (XINV,XINS)
           C
           C            INSURANCE AND PROPERTY TAX FOR REMOTE SITED PLANTS
           C
                 DATA CTIN/.0045/
                 XINS=XINV*CTIN
                 RETURN
                 END
```

```
    SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3  INSU           1             7

VARIABLES     SN  TYPE           RELOCATION
   10  CTIN       REAL                         REFS        6    DEFINED      5
    0  XINS       REAL                F.P.   DEFINED             6
    0  XINV       REAL                F.P.     REFS        6    DEFINED      1

STATISTICS
  PROGRAM LENGTH                  11B       9
```

```
      SUBROUTINE OPEX (XOM,YEAR,FOM,EOM,IYHR,XMED,ISUBTYP,XMWH2,FOSUBCT
     1 ,XOSUBCT,N)
C
C              OPERATIONS AND MAINTENANCE COSTS
C
      DIMENSION XOSUBCT(1),SUB(7,30),X(30),FOSUBCT(1)
      DIMENSION FOTEMP(30),ISUBTYP(5)
C
C          ***CHANGE DIMENSION OF SUB + FOTEMP***
C          ***IF CHANGING THE PLANT LIFE FROM [illegible] YEARS***
C
      DIMENSION DGRADE(3)
      COMMON/ODATA/FREQ(7),XONM(7),ISIZE(7)
      COMMON/SIZES/SOM,SMWHR,CHORT,DCHORT,PMX,[illegible]
      COMMON /PWOPEX/PWFOM,PWXOM,PWSUB(7)
      COMMON/CESCAL/CESC(10),CYRESC(10)
      XOM=0.
      FOM=0.
      ES=.05
C                INPUT INFORMATION
C     XONM-COST PER UNIT
C     FREQ-NUMBER OF TIMES DURING PLANT LIFETIME
C     ISIZE--INDICATES WHICH SIZE TO SCALE O/M COSTS ON
C       1=SOM 2=SMWHR 3=CHORT 4=DCHORT 5=[illegible] 6=SMWTH 7=FIXED
      DATA DGRADE/.5,2*0./
      II=YEAR-CYRESC(1)+1.0.+.5
      IF (YEAR.LT.CYRESC(1)) II=IFIX(CYRESC(1)+1.0-YEAR+.5)
      DO 120 I=1,7
      DO 110 J=1,N
      SUB(I,J)=0.0
  110 CONTINUE
  120 CONTINUE
      DO 130 I=1,N
      K=ISUBTYP(3)
      FOTEMP(I)=DGRADE(K)*XMWH2/(FLOAT(IYHR)*SMWHR)*XMED*(1.+ES)**(I+II)
      SUB(4,I)=FOTEMP(I)
  130 CONTINUE
      DO 230 I=1,7
      IF (FREQ(I).LE.0.) GO TO 230
      K=0
      KSTEP=IFLOAT(N)/FREQ(I)+.5
  140 CONTINUE
      K=K+KSTEP
      IF (K.GT.N) GO TO 230
      IF (ISIZE(I).EQ.1) GO TO 150
      IF (ISIZE(I).EQ.2) GO TO 160
      IF (ISIZE(I).EQ.3) GO TO 170
      IF (ISIZE(I).EQ.4) GO TO 180
      IF (ISIZE(I).EQ.5) GO TO 190
      IF (ISIZE(I).EQ.6) GO TO 200
      IF (ISIZE(I).EQ.7) GO TO 210
  150 SIZE=SOM
      SUB(I,K)=SUB(I,K)+SIZE*XONM(I)*(1.+ES)**(K+II)/PMX
      GO TO 220
  160 SIZE=SMWHR
      SUB(I,K)=SUB(I,K)+SIZE*XONM(I)*(1.+ES)**(K+II)/PMX
      GO TO 220
```

```
      170   SIZE=CHGRT                                                      006340
            SUB(4,K)=SUB(4,K)+(SIZE*XONM(I)*(1.+ES)**(K+I))/PMX             006350
               GO TO 220                                                    006360
      180   SIZE=DCHGRT                                                     006370
            SUB(4,K)=SUB(4,K)+(SIZE*XONM(I)*(1.+ES)**(K+I))/PMX             006380
               GO TO 220                                                    006390
      190   SIZE=PMX                                                        006400
            SUB(7,K)=SUB(7,K)+(SIZE*XONM(I)*(1.+ES)**(K+I))/PMX             006410
               GO TO 220                                                    006420
      200   SIZE=SMWTH                                                      006430
            SUB(2,K)=SUB(2,K)+(SIZE*XONM(I)*(1.+ES)**(K+I))/PMY             006440
               GO TO 220                                                    006450
      210   SIZE=1.                                                         006460
            SUB(7,K)=SUB(7,K)+(SIZE*XONM(I)*(1.+ES)**(K+I))/PMX             006470
      220   CONTINUE                                                        006480
            FOTEMP(K)=FOTEMP(K)+(SIZE*XONM(I)*(1.+ES)**(K+I))/PMX           006490
               GO TO 140                                                    006500
      230   CONTINUE                                                        006510
            CALL DISC (FOTEMP,ECOM,N,DISCT)                                 006520
            PWXOM=0.                                                        006530
            PWFOM=DISCT                                                     006540
            CALL AMORT (DISCT,ECOM,FOM,1,N)                                 006550
            XOM=0.                                                          006560
            DO 250 I=1,7                                                    006570
            DO 240 J=1,N                                                    006580
            X(J)=SUB(I,J)                                                   006590
      240   CONTINUE                                                        006600
            CALL DISC (X,ECOM,N,DISCT)                                      006610
            PWSUB(I)=DISCT                                                  006620
            CALL AMORT (DISCT,ECOM,FOSUBT(I),1,N)                           006630
            FOSUBT(I)=0.                                                    006640
      250   CONTINUE                                                        006650
            RETURN                                                          006660
            END                                                             006670
```

SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS		DEF LINE	REFERENCES
3	OPEX	1	90

VARIABLES		SN TYPE		RELOCATION									
0	CESD	REAL	ARRAY	DESCAL	REFS	16							
2	CHGRT	REAL		SIZES	REFS	14	58						
12	CYRESD	REAL	ARRAY	DESCAL	REFS	16	26	2*27					
3	DCHGRT	REAL		SIZES	REFS	14	61						
[illegible]	DGRADE	REAL	ARRAY		REFS	12	35	DEFINED	25				
[illegible]	DISCT	REAL			REFS	76	78	79	85	86	87		
0	ECOM	REAL		F.P.	REFS	76	79	85	87	DEFINED	1		
[illegible]	ES	REAL			REFS	35	53	56	59	62	65	68	
						71	73	DEFINED	19				
0	FOM	REAL		F.P.	REFS	79	DEFINED	1	18				
0	FOSUBT	REAL	ARRAY	F.P.	REFS	6	87	DEFINED	1				
[illegible]	FOTEMP	REAL	ARRAY		REFS	7	36	73	76	DEFINED	35	73	

```
      SUBROUTINE OPEX        73/74    OPT=1                                      FTN 4.6+439         01/26/78  14.17.06          PAGE      3

VARIABLES      SN   TYPE            RELOCATION
    0   FREQ        REAL        ARRAY     ODATA          REFS        13          39          41
  345   I           INTEGER                              REFS        30        2*35        2*36          39          41          45          46
                                                           47        48          49          50          51          53          56          59
                                                           62        65          68          71          73          83          86          87
                                                           88   DEFINED          28          33          38          81
   16   ISIZE       INTEGER     ARRAY     ODATA          REFS        13          45          46          47          48          49          50
                                                           51
    0   ISUBTYP     INTEGER     ARRAY      F.P.          REFS         1          34     DEFINED           1
    0   IYHR        INTEGER                F.P.          REFS        36     DEFINED           1
  344   II          INTEGER                              REFS        16          53          56          59          62          65          68
                                                           71        73     DEFINED          26          27
  346   J           INTEGER                              REFS        30        2*83     DEFINED          29          82
  347   K           INTEGER                              REFS        35          43          44        3*53        3*56        3*59        3*62
                                                         3*65      3*68        3*71        3*73     DEFINED          34          40          43
  350   KSTEP       INTEGER                              REFS        43     DEFINED          41
    0   N           INTEGER                F.P.          REFS        29          33          41          44          76          79          82
                                                           85        87     DEFINED           1
    4   PMX         REAL                  SIZES          REFS        14          53          56          59          62          64          65
                                                           68        71          73
    0   PWFDY       REAL                  PWOPEX         REFS        15     DEFINED          78
    2   PWSUB       REAL        ARRAY     PWOPEX         REFS         5     DEFINED          86
    1   PWKDY       REAL                  PWOPEX         REFS        15     DEFINED          77
  351   SIDE        REAL                                 REFS        53          56          59          62          65          68          71
                                                           73   DEFINED          52          55          58          61          64          67
                                                           70
    1   SMWHR       REAL                  SIZES          REFS        14          35          55
    5   SMWTH       REAL                  SIZES          REFS        14          67
    0   SDY         REAL                  SIZES          REFS        14          52
  353   SUB         REAL        ARRAY                    REFS         6          53          56          59          62          65          68
                                                           71        83     DEFINED          30          36          53          56          59
                                                           62        65          68          71
  675   V           REAL        ARRAY                    REFS         6          85     DEFINED          83
    0   XMED        REAL                   F.P.          REFS        35     DEFINED           1
    0   XMWHR       REAL                   F.P.          REFS        35     DEFINED           1
    0   XDY         REAL                   F.P.       DEFINED         1          17          80
    7   YDNY        REAL        ARRAY     ODATA          REFS        13          53          56          59          62          65          68
                                                           71        73
    0   YDSUBT      REAL        ARRAY      F.P.          REFS         6     DEFINED           1          88
    0   YEAR        REAL                   F.P.          REFS        26        2*27     DEFINED           1

EXTERNALS            TYPE    ARGS         REFERENCES
        AMORT                  5               79          87
        DISC                   4               76          85

INLINE FUNCTIONS     TYPE    ARGS          DEF LINE   REFERENCES
        FLOAT        REAL      1  INTRIN                   35          41

STATEMENT LABELS                    DEF LINE    REFERENCES
    0   100                            31           29
    0   120                            32           28
    0   130                            37           33
   74   140                            42           74
  113   150                            52           45
  126   160                            55           46
  141   170                            58           47
  154   180                            61           48
  167   190                            64           49
```

```
STATEMENT LABELS                    DEF LINE    REFERENCES
  [illegible]  200                     67          50
  [illegible]  210                     70          51
  [illegible]  220                     72          54          57          60          63          66          69
  240  230                             75          38          39          44
    [illegible]  240                   84          82
    [illegible]  250                   89          81

LOOPS  LABEL    INDEX       FROM-TO     LENGTH     PROPERTIES
  31   [illegible]   [illegible]      28  32        13B                       NOT INNER
  36   [illegible]   [illegible]      29  31         2B       INSTACK
  46   [illegible]   [illegible]      33  37        17B                       EXT REFS
  65   230   [illegible]      38  75       156B                       EXT REFS
 [illegible]  250   [illegible]      81  89        27B                       EXT REFS  NOT INNER
 [illegible]  240   [illegible]      82  84         3B       INSTACK

COMMON BLOCKS   LENGTH      MEMBERS - BIAS NAME(LENGTH)
       [illegible]        [illegible]                0 FREQ   [illegible]               [illegible]                  14 ISIZE   [illegible]
       [illegible]          6                0 SGM    [illegible]               [illegible]                   2 CHGRT   [illegible]
                                      3 DCHGRT [illegible]               4 [illegible]                   5 SMWTH   [illegible]
       [illegible]          9                0 PWFOM  [illegible]               [illegible]                   2 PWSUB   [illegible]
       [illegible]        [illegible]                0 CESC   [illegible]               [illegible]

STATISTICS
  PROGRAM LENGTH                   [illegible]B      53[illegible]
  CM LABELED COMMON LENGTH          [illegible]B       57
```

```
 1                   SUBROUTINE PRESVAL (D,TAXR,PV,ECOM,XINV,N)                    006680
               C                                                                   006690
               C              PRESENT VALUE OF COSTS ASSOCIATED WITH CAPITAL INVESTMENT006700
               C                                                                   006710
 5                   DIMENSION D(1),TAXD(30),PV(2)                                 006720
               C                                                                   006730
               C       ***CHANGE THE DIMENSION OF TAXD***                          006740
               C       ***IF CHANGING THE PLANT LIFE FROM 30***                    006750
               C                                                                   006760
10                   DO 110 I=1,2                                                  006770
                     PV(I)=0.0                                                     006780
               110   CONTINUE                                                      006790
                     PV(1)=(XINV/(1.-TAXR))                                        006800
                     DO 120 I=1,N                                                  006810
15                   TAXD(I)=(TAXR*D(I)/(1.-TAXR))                                 006820
               120   CONTINUE                                                      006830
                     CALL DISC (TAXD,ECOM,N,PV(2))                                 006840
                     RETURN                                                        006850
                     END                                                           006860
```

```
    SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS     DEF LINE     REFERENCES
    3  PRESVAL       1            18

VARIABLES     SN  TYPE         RELOCATION
    1  D          REAL      ARRAY    F.P.      REFS       5     15   DEFINED     1
    4  ECOM       REAL               F.P.      REFS      17   DEFINED      1
   47  I          INTEGER                      REFS      11   2*15   DEFINED    10      14
    6  N          INTEGER            F.P.      REFS      14     17   DEFINED     1
    3  PV         REAL      ARRAY    F.P.      REFS       5     17   DEFINED     1      11      13
   50  TAXD       REAL      ARRAY              REFS       5     17   DEFINED    15
    2  TAXR       REAL               F.P.      REFS      13   2*15   DEFINED     1
    5  XINV       REAL               F.P.      REFS      13   DEFINED      1

EXTERNALS          TYPE   ARGS        REFERENCES
    DISC                    4             17

STATEMENT LABELS              DEF LINE   REFERENCES
    0  110                       12          10
    0  120                       16          14

LOOPS   LABEL    INDEX      FROM-TO     LENGTH    PROPERTIES
    7   110      I           10 12        2B       INSTACK
   25   120      I           14 16        3B       INSTACK

STATISTICS
  PROGRAM LENGTH                  1  68B       70
```

```
                 SUBROUTINE AMORT (PV,ECOM,AMVAL,K,N)                   006870
      C                                                                 006880
      C                AMORTIZE IN EQUAL ANNUAL PAYMENTS                006890
      C                                                                 006900
                 DIMENSION PV(1),AMVAL(1)                               006910
                 DEM=0.0                                                006920
                 DO 110 I=1,N                                           006930
                 DEM=DEM+(1.0/((1.0+ECOM)**I))                          006940
      110        CONTINUE                                               006950
                 DO 120 I=1,K                                           006960
                 AMVAL(I)=PV(I)/DEM                                     006970
      120        CONTINUE                                               006980
                 RETURN                                                 006990
                 END                                                    007000


    SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3   AMORT         1              13

VARIABLES       SN   TYPE            RELOCATION
    0   AMVAL      REAL        ARRAY     F.P.       REFS        5    DEFINED      1       11
   41   DEM        REAL                             REFS        6        11   DEFINED       6       8
    0   ECOM       REAL                  F.P.       REFS        8    DEFINED      1
   42   I          INTEGER                          REFS        8      2*11   DEFINED       7      10
    0   K          INTEGER               F.P.       REFS       10    DEFINED      1
    0   N          INTEGER               F.P.       REFS        7    DEFINED      1
    0   PV         REAL        ARRAY     F.P.       REFS        5        11   DEFINED       1

STATEMENT LABELS             DEF LINE   REFERENCES
    0   110                      9          7
    0   120                     12         10

LOOPS   LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   17   110        I         7  9       10B                 EXT REFS
   33   120        I        10 12       3B      INSTACK

STATISTICS
  PROGRAM LENGTH                  55B      45
```

```
                  SUBROUTINE CCAL (AMVAL,XKWHR,BBEC,K)                     007010
      C                                                                    007020
      C                  COST PER UNIT ENERGY OUTPUT                       007030
      C                                                                    007040
                  DIMENSION AMVAL(1),BBEC(1)                               007050
                  DO 110 I=1,K                                             007060
                  BBEC(I)=AMVAL(I)/XKWHR                                   007070
         110      CONTINUE                                                 007080
                  RETURN                                                   007090
                  END                                                      007100
```

```
     SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
   3  CCAL            1              9

VARIABLES     SN  TYPE             RELOCATION
    0  AMVAL      REAL        ARRAY      F.P.        REFS          5          7    DEFINED          1
    0  BBEC       REAL        ARRAY      F.P.        REFS          5     DEFINED          1          7
   17  I          INTEGER                            REFS        2*7     DEFINED          6
    0  K          INTEGER                F.P.        REFS          6     DEFINED          1
    0  XKWHR      REAL                   F.P.        REFS          7     DEFINED          1

STATEMENT LABELS               DEF LINE   REFERENCES
    0  110                         8           6

LOOPS  LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
   13  110      I            6  8         2B       INSTACK

STATISTICS
  PROGRAM LENGTH                  20B       16
```

```
                  SUBROUTINE DISC (X,ECOM,N,DISCT)                              007110
          C                                                                     007120
          C             DISCOUNTED CASH FLOW                                    007130
          C                                                                     007140
                  DIMENSION X(1)                                                007150
                  DISCT=0.0                                                     007160
                  DO 110 I=1,N                                                  007170
                  DISCT=DISCT+X(I)/(1.+ECOM)**I                                 007180
            110   CONTINUE                                                      007190
                  RETURN                                                        007200
                  END                                                           007210
```

```
      SYMBOLIC REFERENCE MAP (R=3)

ENTRY POINTS      DEF LINE      REFERENCES
    3  DISC          1             10

VARIABLES      SN   TYPE             RELOCATION
    0  DISCT        REAL                 F.P.       REFS         1    DEFINED      1        6        8
    0  ECOM         REAL                 F.P.       REFS         8    DEFINED      1
   32  I            INTEGER                         REFS        2*8   DEFINED      7
    0  N            INTEGER              F.P.       REFS         7    DEFINED      1
    0  X            REAL        ARRAY    F.P.       REFS         5         8    DEFINED      1

STATEMENT LABELS                 DEF LINE    REFERENCES
    0  110                           9           7

LOOPS   LABEL    INDEX      FROM-TO     LENGTH     PROPERTIES
   21    110      I           7  9        10B              EXT REFS

STATISTICS
  PROGRAM LENGTH                  43B       35
```