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TWO COMPUTER CODES (REFCO AND POW76)
FOR CALCULATING THE FUEL CYCLE COST
OF A NUCLEAR POWER REACTOR

Royes Salmon

OAK RIDGE NATIONAL LABORATORY

operated by

UNION CARBIDE CORPORATION

for the

U.S. ATOMIC ENERGY COMMISSION

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Oak Ridge, Tennessee
Operated by
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1

TWO COMPUTER CODES (REFCO AND POW76) FOR CALCULATING THE
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Royes Salmon

ABSTRACT

The computer codes described in this report are an outgrowth of the POWERCO code, described in ORNL-3944 and ORNL-4116. All three codes use the discounted cash flow method for calculating levelized costs. In POWERCO, this method was used to calculate the levelized power cost, and subsequently to determine the four components of power cost, representing the contributions of plant capital, nonfuel working capital, fuel cycle cost, and operating and maintenance expense. REFCO and POW76 are designed to calculate the third of these components, the fuel cycle cost.

Both codes were developed from the discounted cash flow equation for fuel cycle cost given in ORNL-4116. The interest rate used for discounting is the weighted average interest rate on debt and equity, adjusted downward to account for the income tax deduction due to bond interest. In POW76, the discounting procedure is based on discrete time periods, typically one month in length. Cash expenditures and incomes are assigned to the end of the month in which they occur. REFCO uses continuous discounting, so that each expenditure or income is discounted from the precise time at which it occurs. Because of the slight loss of precision inherent in discrete discounting, REFCO is superior to POW76 for the evaluation of small changes in the timing of fuel cycle events. Another advantage of REFCO is that fuel cycle costs are calculated for each batch of fuel both individually and cumulatively through each batch. Also, tax deductible fuel expense can be calculated on a batchwise basis in REFCO, in keeping with present industry practice. REFCO also has provision for parametric studies of the effect of price escalation.

REFCO can also be used to calculate the "equilibrium" fuel cycle cost of a reactor by supplying input data for a single equilibrium batch.

FORTTRAN listings of both codes and the results of example problems are included.

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1. INTRODUCTION

Two previous reports have described the use of the discounted cash flow method for the calculation of the levelized power cost of a nuclear power station.^{1,2} The second of these showed that the levelized power cost can be separated into four components representing the contributions of plant capital, nonfuel working capital, fuel cycle cost, and operating and maintenance expense. The present report is concerned with the calculation of the levelized fuel cycle cost. It describes two computer codes, REFCO and POW76, for making this calculation. POW76 uses discrete time periods; REFCO uses continuous discounting.

The starting point for the development of both codes is the expression for fuel cycle cost shown on p. 17 of ORNL-4116,² which was based on the discounted cash flow procedure using discrete time periods such as years or months. POW76 uses this expression directly, except that the overall time span is extended to include preoperation and postoperation periods. Cash expenses incurred during these periods are assigned to the month in which they actually occurred. Tax-deductible fuel expense is prorated over the life of the reactor according to the energy produced. Property taxes and property insurance are based on some fraction of the value of the initial core. Tax treatment is thus identical with that used in POWERCO.^{1,2}

In REFCO, the fuel cycle cost expression referred to above is modified to use continuous discounting. This improves the speed of the calculation and eliminates the slight loss of precision associated with the assignment of costs to discrete time periods. Thus REFCO is more sensitive than POW76 for detecting the effects of small changes in the timing of events in the fuel cycle.

Another change in REFCO is that provision is made for internal calculation of the expenditures for fuel cycle services. Input data are required describing the mass balance history of the reactor and giving the unit prices of fuel cycle materials and services as a function of time. This makes the code useful for studying the effect of changing prices or varying fuel enrichments and exposures.

The income tax calculation in REFCO has been revised to reflect current industry practice. Tax-deductible fuel expense is calculated on a fuel batch basis. Cash expenses and credits are collected for each batch of fuel and are prorated over the residence time of the batch in the reactor in accordance with its energy production. For purposes of comparison, REFCO also has an option in which the tax calculation is the same as that used in POW76.

REFCO calculates fuel cycle costs on both a single batch and a cumulative batch basis. When all of the batches in the reactor lifetime are included, the cumulative batch cost corresponds to the overall levelized fuel cycle cost described in ORNL-4116, except for small differences due to continuous discounting and the tax modification.

The use of REFCO is recommended in preference to that of POW76 for the following reasons: (1) continuous discounting permits more precise handling of small time differences when comparing alternative fuel cycles; (2) fuel cycle cost can be calculated for each batch or for as many batches as desired; and (3) income tax calculations are closer to current practice.

Example problems are included to show the results of applying POW76 and REFCO to typical light water reactor fuel cycle cost calculations. The effects of both decreasing and escalating prices of fuel cycle services are illustrated.

Preparation of input data for REFCO and POW76 is described in Appendixes A and B. FORTRAN listings of the codes are given in Appendixes C and D. Example computer outputs are shown in Appendixes E and F.

Notation used in this report is listed at the back, and is consistent with that used in ORNL-3944 and ORNL-4116.

2. CASH FLOW METHOD FOR THE CALCULATION OF LEVELIZED FUEL CYCLE COST

Calculation of the levelized power cost by the computer code POWERCO was described in ORNL-3944.¹ This cost represents the constant price per

unit of energy that the owner would have to charge over the life of the reactor in order to recover his investment with a specified after-tax rate of return and pay all of the operating expenses of the facility, including taxes. The levelized power cost was calculated by a discounted cash flow procedure. As shown in ORNL-4116,² the same method can be used to obtain the levelized fuel cycle cost. The only modification necessary is to omit from the power cost equation all expenses except those made in connection with the fuel cycle. For the case in which debt and equity remain in a constant ratio throughout the project life, this leads to the following expression for the levelized fuel cycle cost in mills/kWhr:

$$U_F = \frac{k_f V_o + \sum P_{n,vs} (J_n - k_m F_n)}{10^{-9} (1 - k_e) \sum P_{n,vs} Z_n} \quad (1)$$

This is Eq. (3.30) of ORNL-4116. V_o is the cost of the initial core. For period n , J_n is the cash fuel cycle expenditure (not including taxes), F_n is the tax-deductible fuel expense, and Z_n is the electrical energy produced in kWhr. The constants k_f , k_m , and k_e are derived from the tax rates. $P_{n,vs}$ is the discount factor for period n at the interest rate i_{vs} , as defined by the equation

$$P_{n,vs} = (1 + i_{vs})^{-n}.$$

The steps leading to Eq. (1) will be briefly reviewed. It was assumed in ORNL-3944 that the recovery of an investment with interest was governed by a set of rules which could be treated as axioms. These axioms, by simple mathematical manipulation, lead directly to the present-worth criterion, the discounted cash flow method, and all of the related procedures. For cases involving both debt and equity capital, the assumed rules were as follows:

1. The bond interest for a given period is equal to the bond interest rate per period, multiplied by the outstanding bonded indebtedness at the start of the period.
2. The return on equity for a given period is equal to the after-tax earning rate on equity per period, multiplied by the outstanding (unrecovered) equity at the start of the period.

3. The cash income at the end of a given period is divided into five portions:

- (a) Part goes to pay the cash expenses for that period, including taxes. Depreciation is not included, since it is not a cash expense.
- (b) Part goes to pay bond interest.
- (c) Part goes to return on equity.
- (d) Part goes toward reduction of the outstanding debt.
- (e) The remainder goes toward reduction of the outstanding equity capital.

4. At the end of the final period, the outstanding debt and equity capital must both be reduced to zero.

In ORNL-3944, the gradual recovery of capital in accordance with these rules was depicted in the form of a "payout" table. It was then shown (pp. 46-49 of ORNL-3944) that algebraic formulation of these rules led to the present-worth criterion, which states that the total present worth of the incomes must equal that of the cash expenditures, including investments. In the proportional case (constant debt/equity ratio), the interest rate to be used in the present-worth calculations was shown to be the weighted average cost of money i_a , where

$$i_a = bi_b + (1 - b) i_e. \quad (2)$$

It was also shown, however, that because of the tax-deductible status of interest paid on debt, the use of the present-worth criterion in the form stated above led to an equation for the levelized power cost that could be solved only by trial and error. For this reason, a modified present-worth criterion which eliminates the bond interest term from the equation was derived (pp. 49-52 of ORNL-3944). The modified criterion states that the total present worth of the incomes is equal to that of the pseudo cash expenditures, using the interest rate i_v . The pseudo expenditures were defined as what the cash expenditures would be if the tax deduction for bond interest were not claimed. The modified weighted-

average interest rate i_v was given by

$$i_v = b (1 - k_t) i_b + (1 - b) i_e . \quad (3)$$

In ORNL-4116, because of the inclusion of taxes other than the federal income tax, the interest rate was modified slightly and became

$$i_{vs} = b (1 - k_m) i_b + (1 - b) i_e , \quad (4)$$

in which the combined tax constant k_m takes the place of the federal income tax rate k_t . The value of k_m was defined by the relation $1 - k_m = (1 - k_t)(1 - k_s)$, in which k_t and k_s are the federal and state income tax rates.

The modified present-worth criterion leads to expressions such as Eq. (1), which permit direct calculation of the levelized power cost and its components. It must not be thought, however, that the total present worth of the incomes is equal to that of the actual cash expenditures at the interest rate i_v or i_{vs} . The use of the actual cash expenditures (meaning that the actual taxes are included) requires the use of the interest rate i_a . The only purpose of i_v or i_{vs} is to facilitate calculation of the levelized cost. Once this has been done, the incomes and actual taxes for each period can be determined. Following this, one can readily verify that the present worth of the incomes is equal to that of the actual expenditures at the interest rate i_a , not i_v or i_{vs} .

It should also be noted that, although taxes are part of the cash expenditures, Eq. (1) does not show taxes explicitly. The initial core V_0 and the cash fuel expenditures J_n do not include taxes paid. Taxes are accounted for indirectly through the constants k_f , k_m , and k_e . The taxes that are implicitly included in Eq. (1) are the pseudo taxes rather than the actual taxes. This is necessary whenever i_v or i_{vs} is used as the discount rate.

To summarize, the foundation of the logical structure described here is not the present-worth criterion. The starting point is a set of axioms which describe the financial rules governing the recovery of an investment. The present-worth criterion is derived from these axioms; thus

its validity depends on theirs. The discounted cash flow procedure is simply an algorithm based on the present-worth criterion.

2.1 Extension of Eq. (1) to Preoperational Periods

In the derivation of Eq. (1), a distinction was made between the expenditures involved in the procurement of the initial core, V_0 , and those cash expenditures (exclusive of taxes and property insurance) made subsequent to the purchase of the initial core, which are represented by the J_n 's. Discount factors were calculated with respect to the time of initial reactor startup. Expenditures for the initial core were assumed to include interest up to the point of reactor startup and were therefore assigned a discount factor of 1. These were included in the V_0 term. Equation (1) accommodates postoperational periods without difficulty; all that is necessary is to use a plant capacity factor of zero. To obtain more precise handling of preoperational charges, it is necessary to modify the equation so that the J_n terms include expenditures made in connection with procurement of the initial core, as well as those made subsequently. To accomplish this, Eq. (1) may be rewritten as follows:

$$U_F = \frac{(k_f - 1) V_0 + \sum P_{n,vs} (J'_n - k_{mn})}{10^{-9} (1 - k_e) \sum P_{n,vs} Z_n} \quad (5)$$

Here, the cash expenditures for initial core procurement (excluding taxes) are included in the J'_n terms. Each of these has a present-worth factor $P_{n,vs}$ appropriate to the time point at which the expenditure was actually made. The time span covered by the summation sign includes the periods in which initial procurement expenditures are made. The term $(k_f - 1) V_0$ now represents the total present worth of property taxes and property insurance on the value of the initial core but does not include procurement of the core itself.

To evaluate $k_f - 1$, use is made of the following relations from ORNL-4116:

$$k_f = 1 + (1 - k_t) k_c \sum P_{n,vs} \quad (6)$$

$$k_c = (1 - k_s) (k_b + k_v f_c) . \quad (7)$$

Recalling that $(1 - k_t) (1 - k_s) = 1 - k_m$, it can be seen that

$$k_f - 1 = (1 - k_m) (k_b + k_v f_c) \sum P_{n,vs} . \quad (8)$$

The constants k_b , k_v , and f_c were defined in ref. (2) as follows:

k_b = property insurance rate,

k_v = property tax rate,

f_c = fraction of core value used for property tax assessment.

Equation (5) forms the basis for the computer code POW76. In this code, both expenditures and incomes are assumed to occur at the end of the time period in which they occur. The first cash expenditure is assigned to the end of period 1. If the lead time ahead of reactor start-up is 2 years and monthly time periods are being used, this would mean that the reactor starts up at the end of period 25. Thus the first period that has a nonzero capacity factor is period 26.

3. CONTINUOUS DISCOUNTING

Equations (1) and (5) were developed on the basis of discrete time periods, such as months or years, and discounting was based on discrete present worth or discount factors of the form

$$P_{n,vs} = (1 + i_{vs})^{-n} , \quad (9)$$

in which n is the number of time periods from the present date to the time at which payment is made. Fuel cycle cost comparisons involving slight time displacements cannot be made accurately by this method unless the length of the time period is quite small. For example, fuel cooling times of 100 and 120 days cannot be compared by Eq. (5) if the smallest time period is a month. Such difficulties can be avoided by the use of continuous discounting, in which time is treated as a continuous variable. The purpose of this section is to modify Eq. (5) for continuous

discounting. The approach used here is to imagine a limit process by which the length of a time period becomes smaller and smaller but remains discrete. Thus, let the length of the time period be divided by a large number M . Assuming that the length of a period was originally one year, then the new length of a period will be $1/M$ years, and there will be Mt time periods in a space of t years. The new interest rate per period will not be i_{vs}/M , because continuous compounding would then make the annual interest greater than i_{vs} . Instead, an equivalent annual interest rate g must be found, such that

$$(1 + i_{vs})^{-t} = (1 + \frac{g}{M})^{-Mt} . \quad (10)$$

Thus the equivalent annual rate g gives the same annual interest as the rate i_{vs} . For continuous compounding, let M increase without limit. Then, to keep the annual compounding rate equal to $1 + i_{vs}$, it is necessary that

$$(1 + i_{vs})^{-t} = \lim_{M \rightarrow \infty} (1 + \frac{g}{M})^{-Mt} \quad (11)$$

or

$$(1 + i_{vs})^{-t} = e^{-gt} . \quad (12)$$

It follows from Eq. (12) that

$$g = \ln (1 + i_{vs}), \quad (13)$$

and the discount factor P_t for a sum paid at time t is given by

$$P_t = e^{-gt} . \quad (14)$$

The reason for approaching continuous discounting in this particular way is that, in order to use Eq. (5), it is essential to preserve the logic by which this equation was originally developed. Equation (5) is a statement of the modified present worth criterion, which was derived from the basic rules for repayment of an investment using discrete time periods. Since the limit process described by Eq. (11) can be defined in terms of discrete time periods at every stage, the proof of the modified present

worth criterion given on pp. 46-52 of ref. 1 is still applicable, and its use with continuous discounting is therefore valid.

To modify Eq. (5) for continuous discounting, it is necessary only to attach appropriate continuous discount factors to the V_0 , J_n' , $k_m F_n$, and Z_n terms. The J_n' terms, which represent cash expenditures for U_3O_8 , UF_6 , toll enrichment, fuel fabrication, reprocessing, etc., with credits for recovered materials, can each be associated with a specific time at which the expenditure is made. The present worth factor for such payments is given by Eq. (14). If payments for an operation are made in several installments, then each installment can be represented by its own J_n' . Thus there is no limit to the degree of detail obtainable, assuming, of course, that the accounting data are available. For quantities such as property taxes and insurance $(k_f - 1)V_0$, income tax credits $k_m F_n$, and sale of electricity Z_n , the same procedure could be followed, assuming that the time points corresponding to these payments could be assigned. Considering the purpose of the continuous model, however, it is better to treat taxes, insurance, tax credits, and incomes as being continuously paid or received. This has the advantage of avoiding any discontinuities, and thus permits consistent comparison of alternative fuel cycles that show only slight differences in timing. Continuous income from the sale of electricity is assumed to be received only during the periods when the plant is actually running.

3.1 Uniform Continuous Discount Factors

As indicated above, it is desirable to consider certain expenses and incomes as being continuously paid or received at a constant rate over some time interval. The development of uniform continuous discount factors for this purpose now follows.

Suppose that a cash flow is being received at the uniform rate of q dollars per year during the time interval from t_1 to t_2 . An expression is desired for the total present worth of this income referred to time zero. The cash received during a small time interval dt is $q dt$, and the present worth factor at time t is e^{-gt} . If the total present worth

of the incomes received is denoted by I_p , then

$$I_p = \int_{t_1}^{t_2} q e^{-gt} dt . \quad (15)$$

Integration of Eq. (15) yields

$$I_p = \frac{q}{g} (e^{-gt_1} - e^{-gt_2}) , \quad (16)$$

which may also be written in the form

$$I_p = q(t_2 - t_1) \left[\frac{e^{-gt_1} - e^{-gt_2}}{gt_2 - gt_1} \right] . \quad (17)$$

Since the quantity $q(t_2 - t_1)$ represents the total income received, the expression in brackets may be considered as the uniform present-worth factor for the total income received during the period in question.

The total discounted electrical production is obtained in a similar manner. If Z_n kWh are produced uniformly during a time interval n , which starts at t_1 and ends at t_2 , then the total discounted electricity in this time interval is given by

$$Z_n \left[\frac{e^{-gt_1} - e^{-gt_2}}{gt_2 - gt_1} \right] . \quad (18)$$

This is analogous to the expression $P_{n,vs} Z_n$ that appeared in Eq. (1).

3.2 Conversion of Eq. (5) to Continuous Discounting

The expression $(k_f - 1) V_o$ in Eq. (5) relates to property taxes and property insurance paid on the value of the core. From Eq. (8) it can be seen that

$$(k_f - 1) V_o = (1 - k_m)(k_b + k_v f_c) V_o \sum P_{n,vs} . \quad (19)$$

The amount paid annually for property taxes and insurance is given by

$$A_p = (k_b + k_v f_c) V_o . \quad (20)$$

Then Eq. (19) may be rewritten

$$(k_f - 1) V_o = (1 - k_m) A_p \sum P_{n,vs} . \quad (21)$$

The summation is over the total number of years in which property taxes and insurance are paid.

In REFCO, the value of the core V_o is not assumed to be constant, but changes as each new batch of fuel enters the reactor. The value of the core at the start of the i th cycle will be denoted by V_i . In each cycle, V_i is based on the purchase price of the batches that are in the reactor. There is no reduction in V_i during the cycle as the fuel is gradually depleted. If some reduction in value is desired for tax purposes, this must be done by means of the adjustment factor f_c . If the amount paid for property taxes and insurance during the i th cycle is denoted by A_i , and the startup and shutdown time points of the i th cycle are t_1 and t_2 respectively, then the continuous discounting expression corresponding to Eq. (21) is

$$(k_f - 1) V_o = (1 - k_m) \sum_i A_i \left[\frac{e^{-gt_1} - e^{-gt_2}}{gt_2 - gt_1} \right]_i . \quad (22)$$

Again referring to Eq. (5), the term

$$\sum P_{n,vs} J'_n ,$$

when converted to continuous discounting, yields

$$\sum_r (e^{-gt})_r J'_r , \text{ or } \sum_r P_r J'_r , \quad (23)$$

in which the summation is taken over all the discrete fuel cycle events for which cash is paid or received. This does not include payments for taxes or insurance, but only includes items such as U_3O_8 purchase, conversion, enrichment, fabrication, reprocessing, and U and Pu credits.

In a similar manner, the tax-deductible fuel expense term in Eq. (5),

$$- k_m \sum P_{n,vs} F_n ,$$

yields a summation of the form

$$- k_m \sum_i F_i \left[\frac{e^{-gt_1} - e^{-gt_2}}{gt_2 - gt_1} \right]_i, \quad (24)$$

in which the summation is over the total number of operating cycles, and t_1 and t_2 are the startup and shutdown times of the i th cycle.

Likewise, the expression in the denominator of Eq. (5) for the total discounted energy production yields a summation of the form

$$\sum_i Z_i \left[\frac{e^{-gt_1} - e^{-gt_2}}{gt_2 - gt_1} \right]_i, \quad (25)$$

in which, as above, the summation is over the total number of operating cycles.

For convenience, the uniform continuous discount factor will be denoted by ϕ . That is,

$$\phi_i = \left[\frac{e^{-gt_1} - e^{-gt_2}}{gt_2 - gt_1} \right]_i. \quad (26)$$

Then, making use of the conversions indicated, Eq. (5) finally becomes

$$U_F = \frac{(1 - k_m) \sum_i \phi_i A_i + \sum_r P_r J'_r - k_m \sum_i \phi_i F_i}{10^{-9} (1 - k_e) \sum_i \phi_i Z_i}. \quad (27)$$

This equation can be applied over the entire lifetime of the reactor, giving the overall levelized fuel cycle cost U_F . Alternatively, it can be applied to a single batch of fuel, or to as many batches as desired. In the latter case, it will yield the levelized fuel cycle cost over the number of batches considered. Provision is made in REFCO to calculate both the individual levelized batch cost and the cumulative levelized cost through each batch.

4. DIRECT EXPENSES AND CARRYING CHARGES

REFCO produces a cost breakdown in which the following items are shown:

1. U_3O_8 purchase and conversion to UF_6 .
2. Enrichment of UF_6 .
3. Fuel fabrication.
4. Spent fuel shipping, reprocessing, and reconversion.
5. Credit for recovered plutonium.
6. Credit for recovered slightly enriched uranium.
7. Carrying charges (interest, taxes, property insurance, return on investment).

The first six items are direct expenses or credits, and do not include any interest or taxes, except for sales taxes paid at the time of the purchase. Item 3, for example, is simply the total amount spent for fuel fabrication divided by the total energy produced. The last item, carrying charges on fuel working capital, is obtained by difference, making the sum of all seven items equal to the levelized fuel cycle cost, which was calculated from Eq. (27).

The code shows this breakdown for each batch and for the cumulative cost through each batch.

5. RESULTS OF EXAMPLE PROBLEMS

To illustrate the use of the PCW76 and REFCO codes, fuel cycle costs were calculated for a hypothetical 1000-MW(e) light water reactor operating at various capacity factors from 0.83 to 0.42. The reactor mass balance quantities (charges and discharges) were assumed to be unaffected by capacity factor; that is, capacity factor changes were accomplished by stretching the operating time per cycle. Enrichment and burnup varied from about 3.19% and 30,200 MWd per metric ton in early cycles to 2.53% and 20,500 MWd per metric ton for equilibrium cycles. Refueling batch size was one-third of the core.

Example sets of computer input and output are shown in Appendixes E and F for REFCO and POW76 respectively.

For the first series of REFCO runs, summarized in Tables 1, 2, and 3, capital structure was assumed to be 48% equity at an after-tax earning rate of 10% per year and 52% debt at an annual interest rate of 4.23%. This gave an average cost of money of 7.00%. Federal and state income tax rates were 50% and 3%. Property tax was 3.2% per year on 65% of core price. Property insurance rate was 0.25% per year. Costs used were:

	<u>\$/kg</u>
U ₃ O ₈ and conversion to UF ₆	23.10
Separative duty	32.00
Fabrication	72.40
Shipping, reprocessing, and reconversion	42.00

For simplicity, these costs were assumed to remain constant over the life of the reactor, although this will undoubtedly not be true in practice. Credit for fissile Pu was assumed to be \$6.50 per gram. Losses in conversion, fabrication, and reprocessing were assumed to be 1% each. Lead times ahead of reactor startup were assumed to be as follows:

UF ₆ procurement	2.0 years
Toll enrichment	1.5 years
Fabrication	0.6 year

Lag times after discharge were assumed to be:

Reprocessing	0.8 year
Pu recovery	1.0 year
²³⁵ U recovery	1.2 years

These lead and lag times refer to the times at which money changes hands, not necessarily when the service is performed.

Table 1. Fuel Cycle Costs Obtained Using REFCO^a

Capacity Factor	Cumulative Levelized Costs (mills/kWhr)			
	Through Batch 5	Through Batch 10	Through Batch 15	Through Batch 20
0.83	2.05	2.05	2.07	2.09
0.75	2.09	2.08	2.10	2.12
0.67	2.13	2.13	2.15	2.16
0.58	2.19	2.19	2.21	2.22
0.50	2.26	2.27	2.28	2.29
0.42	2.36	2.38	2.39	2.40

^aWeighted average cost of money was 7.00% per year, composed of 52% debt at 4.23% and 48% equity at 10.0%.

Table 2. Fuel Cycle Component Costs Obtained Using REFCO^a

Capacity Factor	Direct Costs				Credits		Carrying Charges	Total Cost (mills/kWhr)
	UF ₆	Sep. Duty	Fabr.	Repr.	Pu	²³⁵ U		
0.83	0.64	0.58	0.34	0.19	0.18	0.21	0.69	2.05
0.75	0.64	0.58	0.34	0.19	0.18	0.21	0.73	2.08
0.67	0.64	0.58	0.34	0.19	0.18	0.21	0.77	2.13
0.58	0.64	0.58	0.34	0.19	0.18	0.21	0.83	2.19
0.50	0.64	0.58	0.34	0.19	0.18	0.21	0.91	2.27
0.42	0.64	0.58	0.34	0.19	0.18	0.21	1.02	2.38

^aCosts are cumulatively levelized through batch 10 and are given in mills/kWhr. Weighted average cost of money = 7.00% per year.

Table 3. Cost Breakdowns for Fuel Batches 1 Through 10^a

Batch Number	Direct Costs				Credits		Carrying Charges	Total Cost (mills/kWhr)
	UF ₆	Sep. Duty	Fabr.	Repr.	Pu	²³⁵ U		
1	1.01	0.83	0.67	0.38	0.26	0.59	0.78	2.82
2	0.65	0.53	0.43	0.24	0.21	0.25	0.61	1.99
3	0.47	0.39	0.31	0.18	0.17	0.11	0.53	1.60
4	0.67	0.63	0.33	0.19	0.18	0.23	0.76	2.18
5	0.63	0.59	0.31	0.17	0.17	0.19	0.72	2.06
6	0.62	0.58	0.31	0.17	0.17	0.18	0.71	2.03
7	0.63	0.59	0.31	0.17	0.17	0.20	0.72	2.06
8	0.62	0.59	0.31	0.17	0.17	0.20	0.71	2.03
9	0.63	0.59	0.32	0.18	0.18	0.20	0.70	2.04
10	0.64	0.59	0.33	0.19	0.18	0.21	0.70	2.05

^aData for this problem were the same as in Tables 1 and 2. Costs are in mills/kWhr. Capacity factor is 0.83. Cost of money, 7.00% per year.

Table 1 shows cumulative levelized costs through the first 5, 10, 15, and 20 batches. Table 2 shows the breakdown of fuel cycle cost into direct costs and carrying charges. Costs shown are the cumulative levelized costs for the first ten batches. The direct costs are not affected by the capacity factor. The carrying charges on fuel working capital increase as the capacity factor diminishes. The magnitude of the carrying charges is determined by the assumed economic parameters (cost of money, taxes, etc.) and the assumed lead and lag times.

The annual fixed charge rate on nondepreciable capital for this example was 14.43%. This can be calculated from the equations given on p. 23 of ORNL-4116. As indicated there, the fixed charge rate is given by

$$L_N = \frac{k_p + k_b}{1 - k_r} + \frac{i_{vs}}{1 - k_e}.$$

With zero revenue tax, $k_r = 0$, and $1 - k_e = (1 - k_t)(1 - k_s)$. The property insurance rate k_b is 0.0025, and the property tax rate on the core, k_p , is $(0.032)(0.65) = 0.0208$. The federal and state income tax rates, k_t and k_s , are 0.50 and 0.03. The value of i_{vs} is given by Eq. (4):

$$\begin{aligned} i_{vs} &= (1 - b)i_s + (1 - k_m)bi_b \\ &= (0.48)(0.10) + (0.485)(0.52)(0.0423) \\ &= 0.05867. \end{aligned}$$

Using this in the expression for L_N gives

$$L_N = 0.14426.$$

With a 1000-MW(e) reactor, a capacity factor of 0.83, and carrying charges of 0.69 mill/kWhr, the annual carrying charges are \$5.0 million. The average value of the fuel working capital is then equal to $5.0/0.1443$, or \$35 million. This same result is obtained at any other constant capacity factor.

Table 3 shows the cost breakdown for each individual batch through the first ten batches, using the same data as in Tables 1 and 2. Only the 0.83 capacity factor case is shown.

The next series of REFCO runs, summarized in Table 4, shows the effect of raising the cost of money from 7.00% to 10.00% per year. The 10% cost of money was composed of 50% debt at 7.5% and 50% equity at 12.5%. Using the same tax and insurance rates as before, this gave a fixed charge rate on nondepreciable capital of 18.97% per year. The carrying charges in Table 4 are accordingly higher than those in Table 2. As expected, the carrying charges in the two tables are in approximately the same ratio as the fixed charge rates.

The third series of REFCO runs, summarized in Table 5, shows the effect of declining prices for fuel fabrication and reprocessing, using a cost of money of 7.00% per year. For purposes of illustration, fabrication prices were assumed to decline from an initial value of \$72.40 per kg to \$40 per kg over a period of 35 years. Reprocessing (including shipping, and reconversion) was assumed to decline from \$42 per kg to \$17 per kg over the same period. It was assumed that these prices were expressed in terms of "real" or "constant" dollars, since price escalation was not being considered in this example. Thus the assumed price reductions represent reductions in real costs due to such factors as economies of scale in a growing industry or improvements in the technology of fuel processes.^{3,4}

The prices of UF_6 , separative duty, and plutonium credit were assumed to be constant at the values used previously. Table 5 may be compared with Table 3; it can be seen that the reduction of fuel cycle cost for batch 10 was about 0.13 mill/kWhr.

Since the first year of fabrication in this example was year 5, and the first year of reprocessing was year 7, prices for the first batch already show some decline below those in the previous example. Thus the fuel cycle cost for the first batch is based on a fabrication price of \$66.50 per kg and a reprocessing price of \$33 per kg.

Table 4. Fuel Cycle Component Costs with 10% Average
Cost of Money^a

Capacity Factor	Direct Costs	Carrying Charges	Total Cost
0.83	1.36	0.92	2.28
0.75	1.36	0.97	2.33
0.67	1.36	1.03	2.39
0.58	1.36	1.11	2.47
0.50	1.36	1.21	2.57
0.42	1.36	1.35	2.71

^aThe only difference between Tables 2 and 4 is that in Table 2 the cost of money was 7.00% per year. Costs are cumulatively levelized through batch 10 and are given in mills/kWhr. Direct costs are identical with those in Table 2.

Escalation was considered in the fourth series of runs, summarized in Table 6. Cost of money was 7.00% per year. Using the option whereby an escalation rate can be inserted as LL(7), a constant escalation of 3% per year was applied to all prices and credits. The prices before escalation were the same as those used in the preceding series of runs, in which fabrication and reprocessing were allowed to decline. The price multiplier for 35 years of escalation at 3% is $(1.03)^{35}$, or 2.81. This outweighs the assumed decline in both fabrication and reprocessing; thus, for fabrication, the price in year 36 was $(40)(2.81)$ or \$112 per kg. Similarly, the reprocessing price in year 36 was $(17)(2.81)$ or \$48 per kg. These prices are in terms of "as spent" or "current" dollars, taking into account both reductions in real cost due to economies of scale and improved technology, and increases due to the effect of inflation.

The overall 30-year levelized fuel cycle cost has little significance in this case because of the changing value of the dollar. The fuel cycle costs of individual batches, however, are significant, and may be used to study the trend of fuel cycle cost, considering the effects of both price increases due to escalation and price reductions due to decreases in real costs.

As in the previous example, the first batch already shows the effects of several years of escalation since escalation was assumed to start with the second year, while the reactor did not start up until the fifth year.

Finally, test calculations were made using REFCO and POW76 on the original problem to verify that the two codes yield approximately the same levelized cost. To get a fair comparison, the same basis for calculating tax-deductible fuel expense was used in each. REFCO normally makes this calculation on a batch basis but has the option of making the calculation on an overall basis, as in POW76. Using this option, the codes gave results less than 0.01 mill/kWhr apart. The levelized costs were:

REFCO	2.095 mills/kWhr
POW76	2.086 mills/kWhr

Table 5. Cost Breakdowns for Fuel Batches 1 Through 10
with Declining Prices^a

Batch Number	Direct Costs				Credits		Carrying Charges	Total Cost (mills/kWhr)
	UF ₆	Sep. Duty	Fabr.	Repr.	Pu	²³⁵ U		
1	1.01	0.83	0.62	0.30	0.26	0.59	0.78	2.68
2	0.65	0.53	0.40	0.18	0.21	0.25	0.61	1.90
3	0.47	0.39	0.29	0.13	0.17	0.11	0.54	1.53
4	0.67	0.63	0.30	0.13	0.18	0.23	0.76	2.09
5	0.63	0.59	0.28	0.12	0.17	0.19	0.72	1.98
6	0.62	0.58	0.27	0.12	0.17	0.18	0.71	1.93
7	0.63	0.59	0.26	0.12	0.17	0.20	0.71	1.95
8	0.62	0.59	0.26	0.11	0.17	0.20	0.71	1.92
9	0.63	0.59	0.26	0.12	0.18	0.20	0.70	1.92
10	0.64	0.59	0.27	0.12	0.18	0.21	0.70	1.92

^aPrices of fabrication and reprocessing were allowed to decline; all others remained constant. Costs are in mills/kWhr. Capacity factor is 0.83. Cost of money, 7.00% per year.

Table 6. Cost Breakdowns for Fuel Batches 1 Through 10 with
Price Escalation of 3% per Year^a

Batch Number	Direct Costs				Credits		Carrying Charges	Total Cost (mills/kWhr)
	UF ₆	Sep. Duty	Fabr.	Repr.	Pu	²³⁵ U		
1	1.10	0.91	0.76	0.46	0.32	0.73	0.87	3.04
2	0.71	0.58	0.48	0.30	0.26	0.32	0.67	2.17
3	0.52	0.42	0.35	0.22	0.21	0.14	0.59	1.75
4	0.76	0.71	0.39	0.24	0.24	0.29	0.87	2.43
5	0.71	0.69	0.37	0.23	0.24	0.26	0.84	2.35
6	0.72	0.69	0.38	0.24	0.24	0.25	0.85	2.38
7	0.75	0.73	0.40	0.25	0.25	0.28	0.88	2.49
8	0.77	0.74	0.40	0.25	0.25	0.29	0.90	2.53
9	0.80	0.77	0.43	0.27	0.27	0.31	0.92	2.62
10	0.84	0.79	0.46	0.29	0.28	0.33	0.94	2.71

^aPrices were the same as in the preceding example (Table 5) except that escalation of 3% per year was applied. Costs are in mills/kWhr based on "as spent" dollars. Capacity factor is 0.83. Cost of money, 7.00% per year.

The length of a time period used in POW76 was one month. The difference in the results can be attributed to the assignment of all expenditures in POW76 to the end of the month.

Execution time on an IBM 360 Model 91 computer was about 0.8 sec per problem for REFCO and 1.2 sec per problem for POW76.

6. APPENDIXES

APPENDIX A: INPUT DATA AND OPTIONS FOR REFCO

All of the input data for REFCO are read in subroutine INPUT, and are prepared as follows:

Card 1 . - This card contains the control signals LL(K), the problem name DES(I), and (optional) the capacity factor multiplier CAFAC. Format is 1012, 13A4, F8.0. The quantities read are (LL(K), K = 1,10), (DES(I), I = 1,13), CAFAC.

If CAFAC is not entered, it is set equal to 1.0, and the capacity factor in each period is determined by other input data such as the time points at the beginning and end of each period and the energy production of each batch of fuel in each period (see cards 7 and 9). If CAFAC has a value smaller than 1.0, it is used as a divisor to stretch the length of the operating periods. Thus, if CAFAC is 0.5, the length of each operating period is doubled. The lengths of the operating periods before dividing by CAFAC are specified by the time points given on cards 7. Shutdown time between operating periods is not affected by CAFAC. Thus shutdown time (in years) is given by D(26).

The signals LL(K) are defined as follows:

LL(1) = number of batches comprising initial core for tax and insurance purposes.

If LL(2) = 0, deductible expense is collected by batches and prorated to each operating period on the basis of the energy produced by that batch in that period. If LL(2) = 1, deductible expense is collected over the entire reactor history and prorated to each period on the basis of the energy produced in that period, as in POW76.

If LL(3) = 0, input energies are in 10^9 kWhr and costs are in mills/kWnr. If LL(3) = 1, input energies are in 10^{14} Btu and costs are in cents/million Btu.

If $LL(4) = 0$, a normal set of input data cards (card 1 through card 9) is provided.

If $LL(4) = 1$, only the first card is provided. All data are the same as in the preceding problem except that $LL(1)$ through $LL(10)$, the problem name, and CAFAC may be different.

If $LL(5) = 1$, the program punches a set of data cards that can be used as input to the program POW76. If $LL(5) = 0$, this is omitted.

If $LL(6) = 0$, subroutine OUT2 is called, and the program prints cost breakdown tables, both batchwise and cumulative batchwise. If $LL(6)$ is greater than 0, these tables are omitted.

If $LL(7)$ is greater than zero, a price escalation factor of $LL(7)$ percent per year is applied to all prices. This option can also be used when the input consists of only one card ($LL(4) = 1$). In this case, the escalation factor is applied to the prices used in the preceding problem.

Card 2. - This card contains NEMAX, NTMAX, NPMAX, NYMAX, NPRICE, NYOOST, and NYSTRT. These are read in Format 14I5 and are defined as follows:

NEMAX = total number of batches

NTMAX = total number of time points listed on cards 7

NPMAX = total number of operating periods (cycles)

NYMAX = not used

NPRICE = number of years for which prices are specified (cards 4)

NYOOST = year in which price data start (for example, 1970)

NYSTRT = year in which reactor starts up (for example, 1974)

Card 3. - This card gives the lead times and lag times for the various operations in the fuel cycle. The quantities to be read are (TLEAD(M),

$M = 1,6$), and the format is $6E10.0$. The first three are the lead times, referred to start of reactor operation, for UF_6 procurement, enrichment, and fresh fuel fabrication. These are entered as positive quantities. The last three are lag times, referred to time of discharge of fuel from the reactor, for reprocessing, sale of recovered Pu, and credit for recovered ^{235}U . These are entered as negative quantities. All times are in years.

Cards 4. - The number of these cards to be read is given by NPRICE. They contain the unit prices of the fuel cycle operations. Quantities read on each card are $(PRICE(NY,M), M = 1,7)$. The format is $7E10.0$. In the present state of development of the code, only the first five prices on each card are used. These are the prices of UF_6 , separative duty, fuel fabrication, shipping-reprocessing-reconversion, and fissile Pu credit, and are given in \$/kg. Provision is made for up to 70 cards, representing 70 years of price data. If fewer than 70 cards are read, the prices for the remaining years up to 70 are made the same as those for the last year entered.

Cards 5. - These five cards contain the constants $D(N), N = 1,35$. The format is $7E10.0$. These constants give the values of various economic parameters, tax rates, etc. The full list is as follows:

- $D(1)$ through $D(3)$ = not used
- $D(4)$ = fraction of capital in bonds (debt fraction)
- $D(5)$ = annual interest rate on debt
- $D(6)$ = annual after-tax earning rate on equity
- $D(7)$ = federal income tax rate
- $D(8)$ = design capacity of reactor, kW(e) (not used unless $LL(5) = 1$)
- $D(9)$ = through $D(14)$ = not used
- $D(15)$ = state income tax rate
- $D(16)$ = state gross revenues tax rate
- $D(17)$ = property tax rate

D(18) = not used

D(19) = property insurance rate

D(20) and (21) = not used

D(22) = fraction of core value for tax assessment

D(23) = not used

D(24) = ^{235}U assay of natural uranium (0.00711)

D(25) = ^{235}U assay of tails (~ 0.002)

D(26) = length of shutdown time between cycles, years (~ 0.167)

D(27) through (31) = not used

D(32) = multiplier for UF_6 procurement to account for losses
(~ 1.02)

D(33) = multiplier for separative duty and fabrication to account
for losses (~ 1.01)

D(34) = multiplier for Pu credit to account for reprocessing losses
(~ 0.99)

D(35) = multiplier for ^{235}U credit to account for reprocessing losses
(~ 0.99)

Cards 6. -- The number of these cards to be read is NPMAX. Each card contains the quantities NP, NTMA(NP), NTMB(NP), NAA(NP), and NBB(NP) for period NP. Format is 1814. NTMA(NP) and NTMB(NP) are the index numbers of the time points at the beginning and end of operating period NP. NAA(NP) and NBB(NP) are the batch numbers of the earliest and latest batches that are in the reactor during period NP.

Cards 7. -- These cards give the time in years at the start and end of each operating period. The quantities to be read are (TIME2(NT), NT = 1, NTMAX). If the number of periods is 23, then there will be 46 time points (NTMAX = 46). There are 7 points per card in format 7E10.0. For 46 points, 7 cards would be required. The first time point, representing initial startup, is entered as 0.00.

Cards 8. - These cards contain the reactor mass balance data. The number of cards is NBMAX, one card for each batch. Format is 3I3, 1X, 5E10.0. The quantities to be read are:

NB = batch number,
 NTA(NB) = time point at which batch enters reactor,
 NTB(NB) = time point at which batch leaves reactor,
 CHU(NB) = total U charged, kg,
 CH235(NB) = ^{235}U charged, kg,
 DSU(NB) = total U discharged, kg,
 DS235(NB) = ^{235}U discharged, kg,
 DSPU(NB) = total Pu discharged, kg,
 DSFPU(NB) = fissile Pu discharged, kg.

Cards 9. - These cards give the energy delivered by each batch in each period. The number of cards is NBMAX, one for each batch. Format is 3I3, 1X, 6E10.0. The quantities to be read are:

NB = batch number,
 NPA(NB) = earliest period in which batch NB delivers energy,
 NPB(NB) = last period in which batch NB delivers energy.

The next entries on each card are BKWH(NB,M), M = NPA(NB), NPB(NB). These are the energies delivered by the batch in each operating period from NPA(NB) to NPB(NB). Energies may be in 10^9 kWhr (if LL(3) = 0) or in 10^{14} Btu (LL(3) = 1).

This completes the input data.

APPENDIX B: INPUT DATA AND OPTIONS FOR POW76

In POW76, as in REFCO, all of the input data are read in subroutine INPUT. Data are prepared as follows:

Card 1. - This card contains the control signals LL1 through LL10 and the problem name DES(I), I = 1,13. Format is 10I2, 13A4. The control signals are as follows:

LL1 and LL2 are not used.

If LL3 = 0, subroutine TRY is called, and the total present worth of the cash fuel cycle expenses less credits (excluding taxes and property insurance) is printed for 40 interest rates, which start at D(32) and increase by D(33).

If LL4 = 0, subroutine OUTPUT is called, and a complete payout tabulation is calculated and printed in a manner similar to that used in FOWERCO.

LL5 is normally 0. If LL5 is 1, the input data consist of only one card. This cannot be done on the first problem of a run; the first problem must have a full set of data.

LL6 is normally 0. If LL6 is 1, the input data consist of card 1 and cards 2 (see below). As indicated above, the first problem must have a full set of data.

LL7 through LL10 are not used.

Cards 2. - These five cards contain the constants D(N), N = 1,35. Format is 7E10.0. The constants are defined as follows:

D(1) = not used

D(2) = number of periods in project life

D(3) = not used

D(4) = fraction of investment in bonds (debt fraction)

D(5) = annual interest rate on debt

D(6) = annual after-tax rate of return on equity

D(7) = federal income tax rate

D(8) = design capacity of plant, MW(e)

D(9) and D(10) = not used

D(11) = value of initial core for tax and insurance purposes

D(12) = number of periods per year

D(13) and D(14) = not used

D(15) = state income tax rate

D(16) = gross revenues tax rate

D(17) = property tax rate

D(18) = not used

D(19) = property insurance rate, fraction of initial value per year

D(20) and D(21) = not used

D(22) = fraction of core value for tax assessment

D(23) through D(29) = not used

D(30) = period in which reactor starts up (this is when property tax and insurance on core starts)

D(31) = not used

D(32) = first trial value of interest rate (used only if LL3 = 0)

D(33) = increment added to trial value of interest rate (used only if LL3 = 0)

D(34) and D(35) = not used

Cards 3. - These cards contain the plant capacity factor for each period and the fuel cycle expenditures and credits for each period, in millions of dollars. One card is entered for each period. Format is 7E10.0. The data entered are:

PFW(K) = plant capacity factor for period K

CURA(K) = cash expenditure for UF_6 and enrichment in period K

CFAB(K) = cash expenditure for fabrication in period K

CREP(K) = cash expenditure for reprocessing in period K

CPLU(K) = cash credit for recovered Pu, ^{235}U , or other material,
in period K

This completes the input data.

APPENDIX C: FORTRAN LISTING OF REFCO

**FTN,Y,E,G,L,P.
PROGRAM REFCO

C*****A NUCLEAR FUEL CYCLE COST CODE USING THE DISCOUNTED CASH FLOW
C METHOD WITH CONTINUOUS DISCOUNTING.

COMMON BLVCST(70),BLV2(70),EXPDIR(70,6)
COMMON NTA(70),NTB(70),CHN(70),CH235(70),DSU(70),DS235(70),
1 DSPU(70),DSFPU(70),TIME(70),PWF(70),NPA(70),NPB(70),DEDUC(70),
2 TOTKWH(70),BCOST(70),NAA(70),NBB(70),BKWH(70,70),BTOKWH(70)
COMMON BBUY(70),PWBEXP(70),BCUC(70)
COMMON LL(10),DES(13),D(35),TLEAD(10),PRICE(70,10)
COMMON G,XF,XT,PWEXPS,TXRE,TXRM,PWEXPA,CCRE
COMMON NBMAX,NTMAX,NPMAX,NYMAX,NPRICE,NYCOST,NYSTRT
COMMON PFW(500),CURA(500),CFAB(500),CREP(500),CPLU(500),KMAX
COMMON TOTUF6,TOTSDY,TOTFAB,TOTRPR,TOTUCR,TOTPUC

C***** DEFINITIONS *****

C BCOST(NB) = TOTAL COSTS ACCUMULATED FOR BATCH NB
C BDUC(NP) = DEDUCTIBLES FOR BATCH NB IN PERIOD NP
C BKWH(NB,NP) = KWH DELIVERED BY BATCH NB DURING PERIOD NP
C BLVCST(NB) = LEVELIZED FUEL CYCLE COST FOR BATCH NB
C BLV2(NB) = CUMULATIVE LEVELIZED FUEL CYCLE COST THROUGH BATCH NB
C BTOKWH(NB) = TOTAL KWH DELIVERED BY BATCH NB
C CARDIR(NB) = CARRYING CHARGE FOR BATCH NB, MILLS/KWH
C CFAB(K) = EXPENDITURE FOR FABRICATION IN PERIOD K
C CHU(NB) = TOTAL U CHARGED FOR BATCH NB
C CH235(NB) = U235 CHARGED FOR BATCH NB
C CPLU(K) = CREDIT FOR U235 AND PU IN PERIOD K
C CREP(K) = EXPENDITURE FOR REPROCESSING IN PERIOD K
C CUMCAR(NB) = CARRYING CHARGE, CUMULATIVE THRU BATCH NB
C CUMDIR(NB,K) = CUMUL DIRECT EXPENSE BATCH NB PROCESS K, \$
C CUMKWH(NB) = CUMULATIVE ENERGY THROUGH BATCH NB
C CURA(K) = EXPENDITURE FOR UF6 AND SEP DUTY IN PERIOD K
C D(1-35) = INPUT CONSTANTS
C DEDUC(NP) = DEDUCTIBLE FUEL EXPENSE FOR PERIOD NP
C DES(1-13) = PROBLEM NAME
C DIRCST(NB,K) = DIRECT COST BATCH NB, PROCESS K, MILLS/KWH
C DIRCUM(NB,K) = CUMUL DIRECT ENERGY COST THRU BATCH NB, PROC K
C DSFPU(NB) = FISSILE PU DISCHARGED FOR BATCH NB
C DSPU(NB) = PU DISCHARGED FOR BATCH NB
C DSU(NB) = TOTAL U DISCHARGED FOR BATCH NB
C DS235(NB) = U235 DISCHARGED FOR BATCH NB
C EXPDIR(NB,K) = DIRECT EXPENSE FOR BATCH NB AND PROCESS K, \$
C LL(1-10) = INPUT SIGNALS FOR CONTROL PURPOSES
C NAA(NP) = EARLIEST BATCH DELIVERING HEAT DURING PERIOD NP
C NBB(NP) = LATEST BATCH DELIVERING HEAT DURING PERIOD NP
C NPA(NB) = EARLIEST PERIOD IN WHICH BATCH NB DELIVERS HEAT
C NPB(NB) = LAST PERIOD IN WHICH BATCH NB DELIVERS HEAT
C NTA(NB) = TIME POINT AT WHICH BATCH NB ENTERS REACTOR
C NTB(NB) = TIME POINT AT WHICH BATCH NB LEAVES REACTOR
C NTMA(NP) = TIME POINT AT BEGINNING OF PERIOD NP
C NTMB(NP) = TIME POINT AT END OF PERIOD NP
C PFW(K) = CAPACITY FACTOR IN PERIOD K
C PRICE(M) = PRICE, \$/KG, FOR FUEL CYCLE ITEM M

C	PWF(NP)	= PRESENT WORTH FACTOR FOR PERIOD NP
C	TIME(N)	= TIME OF A REACTOR EVENT, YEARS FROM REACTOR STARTUP
C	TIME2(NT)	= TIME POINTS SUPPLIED AS INPUT DATA.
C	TLEAD(M)	= LEAD TIME, YEARS, FOR FUEL CYCLE ITEM M
C	TOTKWH(NP)	= TOTAL KWH DELIVERED DURING PERIOD NP
C	ALLKWH	= TOTAL ENERGY GENERATED OVER LIFE OF REACTOR
C	BBOT	= DENOMINATOR FOR BATCH LEVEL ENERGY COST
C	BBOT2	= CUMULATIVE VALUE OF BBOT
C	BBUY	= TAXABLE VALUE FOR BATCH NB
C	BF238	= RATIO OF FEED TO PRODUCT IN ENRICHMENT PLANT
C	BLVCST	= BATCH LEVELIZED ENERGY COST
C	BLV2	= CUMULATIVE LEVELIZED FUEL CYCLE COST
C	BND	= FRACTION OF INVESTMENT IN BONDS
C	BOT	= DENOMINATOR OF FUEL CYCLE COST EXPRESSION
C	BPRPTA	= PROPERTY TAXES AND INSURANCE FOR BATCH NB
C	BPWPTY	= PW OF PROPERTY TAXES AND INSURANCE FOR BATCH NB
C	BTOP	= NUMERATOR FOR BATCH LEVEL ENERGY COST
C	BTOP2	= CUMULATIVE VALUE OF BTOP
C	CAFAC	= CAPACITY FACTOR, USED AS PARAMETER.
C	ELAPS	= ELAPSED TIME PER PERIOD, CALCULATED FROM CAFAC.
C	EXPEND	= CASH EXPENDITURE, MILLIONS OF \$
C	G	= NATURAL LOG OF 1 + RRV
C	GTA	= PRODUCT OF G AND INITIAL TIME POINT
C	GTAX	= EXP(-GTA)
C	GTB	= PRODUCT OF G AND FINAL TIME POINT
C	NB	= BATCH NUMBER
C	NBCA	= SAME AS NAA(NP)
C	NBCB	= SAME AS NBB(NP)
C	NBMAX	= TOTAL NUMBER OF BATCHES
C	NP	= PERIOD NUMBER
C	NPANB	= SAME AS NPA(NB)
C	NPBNB	= SAME AS NPB(NB)
C	NPMAX	= TOTAL NUMBER OF PERIODS
C	NPRICE	= NUMBER OF YEARS FOR WHICH PRICES ARE ENTERED
C	NTMAX	= TOTAL NUMBER OF TIME POINTS
C	NYCOST	= YEAR IN WHICH PRICE DATA BEGIN
C	NYMAX	= NOT USED
C	NYSTRT	= YEAR IN WHICH REACTOR STARTS UP
C	PCOST	= FUEL CYCLE COST, MILLS/KWH OR CENTS/MILLION BTU
C	PRPTA	= ANNUAL PROPERTY TAXES AND INSURANCE ON CORE
C	PWDDUC	= PW DEDUCTIBLES FOR BATCH NB
C	PWBELE	= PW ENERGY DELIVERED BY BATCH NB
C	PWBTCH	= DISCOUNTED BATCH COST, \$10 ⁻⁶
C	PWDDUC	= TOTAL PRESENT WORTH OF DEDUCTIBLE FUEL EXPENSE
C	PWELEC	= TOTAL PRESENT-WORTHED ELECTRICITY PRODUCED
C	PWEXPA	= SUM OF PWEXPS THROUGH PREVIOUS BATCH
C	PWEXPS	= TOTAL PRESENT WORTH OF CASH FUEL EXPENSES
C	PWPTY	= TOTAL PRESENT WORTH OF PROPERTY TAXES AND INSURANCE
C	QT38	= QUANTITY OF UF ₆ PURCHASED PER BATCH, KG
C	RRB	= BOND INTEREST RATE PER YEAR
C	RRE	= ANNUAL EARNING RATE ON EQUITY AFTER TAXES
C	RRV	= MODIFIED INTEREST RATE
C	SALE	= CASH SALE OF PU, MILLIONS OF \$
C	SEDY	= SEPARATIVE DUTY, KG PER KG U
C	TBCOST	= TOTAL DIRECT EXPENDITURES FOR BATCH NB
C	TDCOST	= TOTAL DIRECT ENERGY COST, MILLS/KWH

C	TINRST	= INTEREST AND TAXES IN COST BREAKDOWN
C	TMLFA9	= DIRECT ENERGY COST FOR FUEL FABRICATION
C	TMLPUC	= DIRECT ENERGY CREDIT FOR RECOVERED PU
C	TMLRPR	= DIRECT ENERGY COST FOR REPROCESSING
C	TMLSDY	= DIRECT ENERGY COST FOR SEPARATIVE DUTY
C	TMLUCR	= DIRECT ENERGY CREDIT FOR RECOVERED U235
C	TMLUF6	= DIRECT ENERGY COST FOR UF6
C	TOP	= NUMERATOR OF FUEL CYCLE COST EXPRESSION
C	TOTFAB	= TOTAL SPENT FOR FABRICATION, \$10**6
C	TOTPUC	= TOTAL CREDIT FOR RECOVERED PU, \$10**6
C	TOTRPR	= TOTAL SPENT FOR REPROCESSING, \$10**6
C	TOTSDY	= TOTAL SPENT FOR SEPARATIVE DUTY, \$10**6
C	TOTUCR	= TOTAL CREDIT FOR RECOVERED U235, \$10**6
C	TOTUF6	= TOTAL SPENT FOR UF6, \$10**6
C	TXR	= FEDERAL INCOME TAX RATE
C	TXRE	= TAX CONSTANT K SUB E
C	TXRM	= TAX CONSTANT K SUB M
C	VALUE	= VALUE OF RETURNED URANIUM, \$/KG
C	XF	= U235 ASSAY OF NATURAL U308 = 0.00711
C	XP	= U235 ASSAY OF FRESH FUEL
C	XT	= U235 ASSAY OF DIFFUSION PLANT TAILS

C*** NAA(NP) IS THE EARLIEST BATCH IN THE REACTOR DURING PERIOD NP
 C*** NBB(NP) IS THE LATEST BATCH IN THE REACTOR DURING PERIOD NP
 C LL(1) = NUMBER OF BATCHES COMPRISING INITIAL CORE FOR
 C TAX AND INSURANCE PURPOSES.

C*** OPTIONS *****

C**** IF LL(2)=1, DEDUCTIBLE FUEL EXPENSE IS PRORATED BY KWH AS IN
 C POWERCO. IF LL(2)=0, DEDUCTIBLE EXPENSE IS COLLECTED BY BATCHES
 C AND PRORATED TO EACH PERIOD ON THE BASIS OF THE ELECTRICITY
 C PRODUCED BY THAT BATCH IN THAT PERIOD.
 C LL(3)=0, COSTS IN MILLS/KWH, INPUT ENERGIES IN 10**9 KWH.
 C LL(3)=1, COSTS IN CENTS/MILLION BTU, ENERGIES IN 10**14 BTU.
 C LL(4)=0, NORMAL INPUT DATA SET
 C LL(4)=1, PROBLEM DATA CONSISTS OF ONE CARD ONLY. CAPACITY FACTOR
 C AND OTHER DATA ON CARD 1 MAY BE CHANGED FROM VALUES USED IN
 C PREVIOUS PROBLEM. ALL OTHER DATA REMAIN UNCHANGED.
 C LL(5)=1, SUBROUTINE POWINP IS CALLED TO PREPARE INPUT DATA
 C CARDS FOR PROGRAM POW76 WHICH CAN BE RUN SUBSEQUENTLY.
 C LL(5)=0, POWINP IS NOT CALLED.
 C IF LL(6)=0, SUBROUTINE OUT2 IS CALLED AND BATCHWISE COST
 C BREAKDOWNS ARE PRINTED.
 C IF LL(7) IS GREATER THAN 0 PRICES ARE ESCALATED AT THE RATE
 C OF LL(7) PERCENT PER YEAR.

C*** THE UNIFORM PRESENT WORTH FUNCTION IS AS FOLLOWS.

$$PWFCN(GTA,GTB)=(EXP(-GTA)-EXP(-GTB))/(GTB-GTA)$$

```
1 CALL INPCT
  KMAX=1
  PWDDUC=0.
  PWELEC=0.
```

```

CORE=0.
TBCOST=0.
ALLKWH=0.
TOTUF6=0.
TOTSDY=0.
TOTFAB=0.
TOTRPR=0.
TOTUCR=0.
TOTPUC=0.
DO 2 K=1,500
  PFW(K)=0.
  CURA(K)=0.
  CFAB(K)=0.
  CREP(K)=0.
2 CPLU(K)=0.

C*** COLLECT COSTS FOR EACH BATCH IN TURN. TOTAL PRESENT WORTH OF
C EXPENSES, PWEXPS, IS ACCUMULATED DURING THIS PROCESS.

  DO 45 NB=1,NBPAX
    BCOST(NB)=0.
    CALL COSTS(NB)
45 CALL SALES(NB)

  DO 46 NB=1,NBPAX
46 TBCOST=TBCOST+BCOST(NB)

C*** DO FOR EACH PERIOD NP. COLLECT TOTKWH(NP), THE TOTAL KWH
C DELIVERED DURING PERIOD NP. ALSO COLLECT DEDUC(NP), THE TAX-
C DEDUCTIBLE FUEL EXPENSE FOR PERIOD NP.

  IF(ILL(2).EQ.1)GO TO 82
  DO 80 NP=1,NPPAX
    DEDUC(NP)=0.
    TOTKWH(NP)=0.
    NBCA=NAA(NP)
    NBCE=NEB(NP)
    DO 64 NB=NBCE,NBCA
63 TOTKWH(NP)=TOTKWH(NP)+BKWH(NB,NP)
64 DEDUC(NP)=DEDUC(NP)+BCOST(NB)*BKWH(NB,NP)/BTOKWH(NB)
    PWDDUC=PWDDUC+CEDUC(NP)*PWF(NP)
    PWELEC=PWELEC+TOTKWH(NP)*PWF(NP)
    ALLKWH=ALLKWH+TOTKWH(NP)
80 CONTINUE
    GO TO 91

82 DO 86 NP=1,NFPAX
    DEDUC(NP)=0.
    TOTKWH(NP)=0.
    NBCA=NAA(NP)
    NBCE=NEB(NP)
    DO 83 NB=NBCE,NBCA
83 TOTKWH(NP)=TOTKWH(NP)+BKWH(NB,NP)
    ALLKWH=ALLKWH+TOTKWH(NP)
83 PWELEC=PWELEC+TOTKWH(NP)*PWF(NP)
    DO 87 NP=1,NFPAX
    DEDUC(NP)=TOTKWH(NP)*TBCOST/ALLKWH

```

87 PWDDUC = PWCOUC + CEDUC(NP) * PWF(NP)

C*** PRPTA IS THE ANNUAL AMOUNT SPENT FOR PROPERTY TAXES AND INSURANCE.
C PRESENT WORTH IS PWPTY.

91 PWPTY = 0.
D92 = (D(17) * D(22) + D(19))
DO 92 NB = 1, NBMAX
GTA = G * TIME(NTA(NB))
GTB = G * TIME(NTB(NB))
PW92 = D92 * DBUY(NB) * (TIME(NTB(NB)) - TIME(NTA(NB))) * PWFCN(GTA, GTB)
92 PWPTY = PWPTY + PW92

C*** CALCULATE FUEL CYCLE COST, PCOST.

TOP = (1. - TXRM) * PWPTY - TXRM * PWDDUC + PWEXPS
BOT = (1. - TXRE) * PWELEC
PCOST = TOP / BOT

C*** PRINT OUTPUT.

PRINT 500, (DES(I), I = 1, 13)
IF (LL(3).EQ.0) PRINT 507, PCOST
IF (LL(3).EQ.1) PRINT 508, PCOST
PRINT 505
PRINT 520
PRINT 504
PRINT 503, TOP, BOT, PCOST, PWELEC, PWPTY, PWDDUC, PWEXPS, TXRE, TXRM, G
PRINT 505
IF (LL(3).EQ.0) PRINT 506
IF (LL(3).EQ.1) PRINT 516
DO 93 NP = 1, NPMAX
93 PRINT 502, NP, TCTKWH(NP), DEDUC(NP), PWF(NP)

C** CALCULATION OF BATCH LEVELIZED ENERGY COSTS.

PRINT 517
PRINT 518
BTOP2 = 0.
BBOT2 = 0.
DO 98 NB = 1, NBMAX
PWBELE = 0.
PWBDUC = 0.

C** DO FOR THE PERIODS DURING WHICH THIS BATCH IS IN THE REACTOR.

NPANB = NPA(NB)
NPBNB = NPB(NB)
DO 96 NP = NPANE, NPBNB
PWBELE = PWBELE + BKWH(NB, NP) * PWF(NP)
BDUC(NP) = BKWH(NB, NP) * BCOST(NB) / BTOKWH(NB)
96 PWBDUC = PWBDUC + BDUC(NP) * PWF(NP)
GTA = G * TIME(NTA(NB))
GTB = G * TIME(NTB(NB))
BPRPTA = D92 * DBUY(NB)
BPWPTY = BPRPTA * (TIME(NTB(NB)) - TIME(NTA(NB))) * PWFCN(GTA, GTB)
BTOP = (1. - TXRM) * BPWPTY - TXRM * PWBDUC + PWBEXP(NB)
BBOT = (1. - TXRE) * PWBELE
BLVCST(NB) = BTCP / BBOT
BTOP2 = BTOP2 + BTCP

```

      BBOT2=BBCT2+BBCT
      BLV2(NB)=BTOP2/BBOT2
508 PRINT 519,NB,BTOKWH(NB),PWBELE,BLVCST(NE),BLV2(NB),BTOP2,BBOT2

```

```

      TMLUF6=TOTUF6/ALLKWH
      TMLSDY=TOTSDY/ALLKWH
      TMLFAB=TOTFAB/ALLKWH
      TMLRPR=TCTRPR/ALLKWH
      TMLUCR=TCTUCR/ALLKWH
      TMLPUC=TOTPLC/ALLKWH
      TDCOST=TMLUF6+TMLSDY+TMLFAB+TMLRPR-TMLUCR-TMLPUC
      TINRST=PCCST-TDCOST

```

```

500 FORMAT('1',5X,'RESULTS',5X,13A4,///)
502 FORMAT(' ',15,6X,F14.5,3X,5F14.5)
503 FORMAT(' ',10F12.5)
504 FORMAT(' ',TOP,BOT,PCOST,PWELEC',
      1 ' PWPTY PWDDUC PWEXPS TXRE',
      2 ' TXRM G',/)
505 FORMAT(' ',///)
506 FORMAT(' PERIOD 10**9 KWH DEDUC $10**6',
      1 ' PW FACTOR',/)
507 FORMAT(' LEVELIZED FUEL CYCLE COST, MILLS/KWH',F14.5,///)
508 FORMAT(' LEVELIZED FUEL CYCLE COST, CENTS/MILLION BTU',F14.5,///)
516 FORMAT(' PERIOD 10**14 BTU DEDUC $10**6',
      1 ' PW FACTOR',/)
517 FORMAT('1 LEVELIZED ENERGY COST FOR EACH BATCH',///)
518 FORMAT(' BATCH ENERGY PW ENERGY LEVEL COST',
      1,' CUM LVL CCST',/)
519 FORMAT(' ',18,6X,6F14.5)
520 FORMAT(' OTHER CALCULATED QUANTITIES',/)

```

```

      IF(LL(5).EQ.1)CALL POWINP
      IF(LL(6).EQ.0)CALL OUT2
      GO TO 1
      END REFCO

```


SUBROUTINE INPUT

```

COMMON BLVCST(70),BLV2(70),EXFDIR(70,6)
COMMON NTA(70),NTB(70),CHU(70),CH235(70),DSU(70),DS235(70),
1 DSPU(70),CSFPU(70),TIME(70),PWF(70),NPA(70),NPB(70),DEDUC(70),
2 TOTKWH(70),BCOST(70),NAA(70),NBB(70),BKWH(70,70),BTOKWH(70)
COMMON BBUY(70),PBEXP(70),BCUC(70)
COMMON LL(10),CES(13),D(35),TLEAD(10),PRICE(70,10)
COMMON G,XF,XT,PWEXPS,TXRE,TXRM,PWEXPA,CCRE
COMMON NBMAX,NTMAX,NPMAX,NYMAX,NPRICE,NYCOST,NYSTRT
COMMON PFW(500),CURA(500),CFAB(500),CREP(500),CPLU(500),KMAX
COMMON TCTUF6,TOTSDY,TOTFAB,TOTRPR,TOTUCR,TOTPUC
DIMENSION NTMA(70),NTMB(70)
DIMENSION TIME2(70)

```

C*** THE UNIFORM PRESENT WORTH FUNCTION IS AS FOLLOWS.
 $PWFCN(GTA,GTB)=(EXP(-GTA)-EXP(-GTB))/(GTB-GTA)$

C**** ALL INPUT DATA FOR THE ENTIRE PROGRAM IS READ IN THIS SUBROUTINE.

```

1 READ 400,(LL(K),K=1,10),(DES(I),I=1,13),CAFAC
IF(LL(4).EQ.1)GO TO 19
READ 409,NBMAX,NTMAX,NPMAX,NYMAX,NPRICE,NYCOST,NYSTRT
READ 401,(TLEAD(M),M=1,7)
DO 5 NY=1,NPRICE
5 READ 401,(PRICE(NY,M),M=1,7)
DO 6 NY=NPRICE,70
DO 6 M=1,7
6 PRICE(NY,M)=PRICE(NPRICE,M)
READ 401,(D(N),N=1,35)
DO 10 NP=1,NBMAX
10 READ 402,NP,NTMA(NP),NTMB(NP),NAA(NP),NBB(NP)
12 READ 401,(TIME2(NT),NT=1,NTMAX)
DO 14 N=1,NBMAX
14 READ 406,NB,NTA(NB),NTB(NB),CHU(NB),CH235(NB),DSU(NB),
1 DS235(NB),DSPU(NB),CSFPU(NB)
DO 18 N=1,NBMAX
18 READ 406,NB,NPA(NB),NPB(NB),(BKWH(NB,M),M=NPA(NB),NPB(NB))

```

C**** THIS COMPLETES THE READING OF INPUT DATA.

```
19 IF(LL(7).EQ.0)GO TO 21
```

C*** PRICE ESCALATOR OPTION *****

```

ESCAL2=1.00+0.01*LL(7)
DO 20 NY=2,70
DO 20 M=1,6
20 PRICE(NY,M)=PRICE(NY-1,M)*ESCAL2

21 BND=D(4)
RRB=D(5)
RRE=D(6)
TXR=D(7)
XF=D(24)

```

```

      XT=D(25)
      TXRM=TXR+C(15)-TXR*D(15)
      TXRE=(1.-TXR)*(D(15)+D(16)-D(15)*D(16))+TXR
      RRV=BND<RRB*(1.-TXRM)+(1.-BND)*RRE
      G=ALOG(1.+RRV)
      DO 24 NB=1,NBMAX
        BTCKMH(NB)=0.
        NPANB=NPANB(NB)
        NPBNB=NPBNB(NB)
        DO 23 NP=NPANB,NPBNB
23      BTCKMH(NB)=BTCKMH(NB)+BKMH(NB,NP)
24      CONTINUE

26      TIME(1)=0.0
      DO 28 NT=2,NTMAX,2
        ELAPS=(TIME2(NT)-TIME2(NT-1))/CAFAC
        TIME(NT)=TIME(NT-1)+ELAPS
28      TIME(NT+1)=TIME(NT)+D(26)
      DO 35 NP=1,NPMAX
        GTA=G*TIME(NTNA(NP))
        GTB=G*TIME(NTNB(NP))
35      PWF(NP)=PWFCN(GTA,GTB)

      PRINT 500,(DES(I),I=1,13)
      PRINT 509
      PRINT 510,(LL(K),K=1,10)
      PRINT 502
      PRINT 520
      PRINT 505
      DO 58 NB=1,NBMAX
58      PRINT 501,NB,NTA(NB),NTB(NB),CHU(NB),CH235(NB),DSU(NB),
1      DS235(NB),DSPU(NB),DSFPU(NB)
      PRINT 500,(DES(I),I=1,13)
      PRINT 519
      PRINT 517
      DO 55 NY=1,NPRICE
        NY55=NYCOST+NY-1
55      PRINT 518,NY55,(PRICE(NY,M),M=1,5)
      PRINT 500,(DES(I),I=1,13)
      IF(LL(3).EQ.0)PRINT 506
      IF(LL(3).EQ.1)PRINT 516
      DO 59 NB=1,NBMAX
59      PRINT 504,NB,APA(NB),NPB(NB),TIME(NTA(NB)),TIME(NTB(NB)),
1      (BKMH(NB,M),M=NPANB,NPB(NB))
      PRINT 502
      PRINT 507
      PRINT 503,(D(N),N=1,35)
      PRINT 502
      PRINT 508
      PRINT 503,(PWF(N),N=1,NPMAX)

400      FORMAT(10I2,13A4,F8.0)
401      FORMAT(7E10.0)
402      FORMAT(18I4)
406      FORMAT(3I3,1X,6E10.0)
407      FORMAT(13,7X,6E10.0)
409      FORMAT(14I5)

```

```

500 FORMAT('1',5X,'INPUT DATA',5X,13A4,///)
501 FORMAT(' ',16,2I10,5X,7F13.1)
502 FORMAT(' ',///)
503 FORMAT(' ',10F12.5)
504 FORMAT(' ',16,2I10,5X,7F13.5)
505 FORMAT('    BATCH      NTA IN   NTB OUT      CHARGE U   ',
1  ' CHARGE U235   DISCH U     DISCH U235   ',
2  ' DISCH PL     DISCH FPU',/)
506 FORMAT('    BATCH      NPD IN   NPD OUT      TIME IN',
1  ' TIME CUT      ENERGY DELIVERED PER PERIOD, 10**9 KWH',/)
507 FORMAT(' INPUT CONSTANTS D(N),N=1,35 ',/)
508 FORMAT(' PRESENT WORTH FACTORS FOR EACH PERIOD',/)
509 FORMAT(' INPLT SIGNALS, LL(K),K=1,10',/)
510 FORMAT(' ',10I6)
516 FORMAT('    BATCH      NPD IN   NPD OUT      TIME IN',
1  ' TIME CUT      ENERGY DELIVERED PER PERIOD, 10**14 BTU',/)
517 FORMAT(' ', ' YEAR',8X,'UF6',6X,'SEP DUTY',6X,'FABR',7X,
1  'REPRCC',4X,'PU CREDIT',/)
518 FORMAT(' ',18,7F12.2)
519 FORMAT(' PRICE DATA ENTERED BY YEARS',/)
520 FORMAT(' TIME POINTS ')

```

```

RETURN
END

```

SUBROUTINE COSTS(NB)

```

COMMON BLVCST(70),BLV2(70),EXPDIR(70,6)
COMMON NTA(70),NTB(70),CHU(70),CH235(70),DSU(70),DS235(70),
1  DSPU(70),DSFPU(70),TIME(70),PWF(70),NPA(70),NPB(70),DEDUC(70),
2  TOTKWH(70),BCOST(70),NAA(70),NBB(70),BSWH(70,70),BTOKWH(70)
COMMON BBUY(70),PWBEXP(70),BDUC(70)
COMMON LL(10),CES(13),D(35),TLEAD(10),PRICE(70,10)
COMMON G,XF,XT,PWEXPS,TXRE,TXRM,PWEXPA,CORE
COMMON NBMAX,NTMAX,NPMAX,NYMAX,NPRICE,NYCCST,NYSTRT
COMMON PFN(500),CURA(500),CFAB(500),CREP(500),CPLU(500),KMAX
COMMON TOTUF6,TOTSDY,TOTFAB,TOTRPR,TOTUCR,TOTPUC

C*** NPA(NB) IS THE PERIOD IN WHICH BATCH NB IS CHARGED.
C*** NPB(NB) IS THE PERIOD IN WHICH BATCH NB IS DISCHARGED.
C*** NTA(NB) IS THE TIME POINT AT WHICH BATCH NB IS CHARGED.
C*** NTB(NB) IS THE TIME POINT AT WHICH BATCH NB IS DISCHARGED.

C*** M=1 PURCHASE U308 AND CONVERT TO UF6.
C      M=2 ENRICH UF6.
C      M=3 FABRICATE FUEL ASSEMBLIES.
C      M=4 REPROCESS SPENT FUEL.

C*****V(X) IS THE VALUE FUNCTION FOR SEPARATIVE DUTY.
      V(X)=(1.-2.*X)*ALOG(1./X -1.)

      IF(MOD(NB,4).EQ.1)PRINT 506
      PRINT 500,NB,TIME(NTA(NB)),TIME(NTB(NB))
      PRINT 501
      BBUY(NB)=0.
      PWEXPA=PWEXPS

C*** UF6 COST
      IF(CHU(NB).EQ.0.)RETURN
      XP=CH235(NB)/CHU(NB)
      BF238=(XP-XT)/(XF-XT)
      QT38=CHU(NB)*BF238*D(32)
      TM38=(TIME(NTA(NB))-TLEAD(1))
      NY=NYSTRT-NYCCST+TM38+1
      EXPEND=1.0E-06*QT38*PRICE(NY,1)
      BBUY(NB)=BBUY(NB)+EXPEND
      EXPDIR(NB,1)=EXPEND
      BCOST(NB)=GCOST(NB)+EXPEND
      IF(NB.LE.LL(1))CORE=CORE+EXPEND
      GTA=G*TM38
      GTAX=EXP(-GTA)
      EX38=EXPEND*GTAX
      PWEXPS=PWEXPS+EX38
      TOTUF6=TOTUF6+EXPEND
      K=12.*(TM38+TLEAD(1))+1.01
      CURA(K)=CURA(K)+EXPEND
      IF(K.GT.KMAX)KMAX=K
      PRINT 502,TM38,EXPEND,GTAX,EX38,PWEXPS

C*** SEPARATIVE DUTY COST IS NEXT

```

```

SEDY=V(XP)-BF238*V(XF)+(BF238-1.1)*V(XT)
QT38=SEDY*CHU(NB)*D(33)
TM38=(TIME(NTA(NB))-TLEAD(2))
NY=NYSTRT-NYCCST+TM38+1
EXPEND=1.0E-06*QT38*PRICE(NY,2)
BBUY(NB)=BBUY(NB)+EXPEND
EXPDIR(NB,2)=EXPEND
BCOST(NB)=BCOST(NB)+EXPEND
IF(NB.LE.LL(1))CORE=CORE+EXPEND
GTA=G*TM38
GTAX=EXP(-GTA)
EX38=EXPEND*GTAX
PWEXPS=PWEXPS+EX38
TOTS DY=TOTS DY+EXPEND
K=12.*(TM38+TLEAD(1))+1.01
CURA(K)=CURA(K)+EXPEND
IF(K.GT.KMAX)KMAX=K
PRINT 503, TM38, EXPEND, GTAX, EX38, SEDY, PWEXPS

```

```

C*** FABRICATION CCST IS NEXT.
QT38=CHU(NB)*C(33)
TM38=(TIME(NTA(NB))-TLEAD(1))
NY=NYSTRT-NYCCST+TM38+1
EXPEND=1.0E-06*QT38*PRICE(NY,3)
BBUY(NB)=BBUY(NB)+EXPEND
EXPDIR(NB,3)=EXPEND
BCOST(NB)=BCOST(NB)+EXPEND
IF(NB.LE.LL(1))CORE=CORE+EXPEND
GTA=G*TM38
GTAX=EXP(-GTA)
EX38=EXPEND*GTAX
PWEXPS=PWEXPS+EX38
TOTFAB=TOTFAB+EXPEND
K=12.*(TM38+TLEAD(1))+1.01
CFAB(K)=CFAB(K)+EXPEND
IF(K.GT.KMAX)KMAX=K
PRINT 504, TM38, EXPEND, GTAX, EX38, PWEXPS

```

```

C*** REPROCESSING CCST IS NEXT.
QT38=DSU(NB)+DSPU(NB)
TM38=(TIME(NTB(NB))-TLEAD(4))
NY=NYSTRT-NYCCST+TM38+1
EXPEND=1.0E-06*QT38*PRICE(NY,4)
BCOST(NB)=BCOST(NB)+EXPEND
EXPDIR(NB,4)=EXPEND
GTA=G*TM38
GTAX=EXP(-GTA)
EX38=EXPEND*GTAX
PWEXPS=PWEXPS+EX38
TOTRPR=TCTRPR+EXPEND
K=12.*(TM38+TLEAD(1))+1.01
CREP(K)=CREP(K)+EXPEND
IF(K.GT.KMAX)KMAX=K
PRINT 505, TM38, EXPEND, GTAX, EX38, PWEXPS

```

```

500 FORMAT('0  CCSTS FOR BATCH NUMBER',I3,10X,'TIME IN',F12.5,
1 10X,'TIME CUT',F12.5,10X,'YEARS FROM STARTUP')

```

```
501 FORMAT('0',20X,'TIME',10X,'AMOUNT',8X,'PW FACTOR',6X,'PW AMOUNT',  
1      6X,'SEP DUTY',8X,'VALUE',7X,'CUMUL PW EXP',//)  
502 FORMAT(' UF6 CCST ',4F15.5,30X,F15.5)  
503 FORMAT(' SEP DUTY ',5F15.5,15X,F15.5)  
504 FORMAT(' FAB CCST ',4F15.5,30X,F15.5)  
505 FORMAT(' REPPCESS ',4F15.5,30X,F15.5)  
506 FORMAT('1 CALCULATED BATCH COSTS, MILLICNS OF $',//)  
      RETURN  
      END
```

SUBROUTINE SALES(NB)

```

COMMON BLVCST(70),BLV2(70),EXPDIR(70,6)
COMMON NTA(70),NTB(70),CHU(70),CH235(70),DSU(70),DS235(70),
1  DSPU(70),DSFPU(70),TIME(70),PMF(70),NPA(70),NPB(70),DEDUC(70),
2  TOTKWH(70),BCGST(70),NAA(70),NBB(70),BKWH(70,70),BTOKWH(70)
COMMON BBUY(70),PWBEXP(70),BDUC(70)
COMMON LL(10),CES(10),D(35),TLEAD(10),PRICE(70,10)
COMMON G,XF,XT,PWEXPS,TXRE,TXRM,PWEXPA,CCRE
COMMON ABMAX,NTMAX,NPMAX,NYMAX,NPRICE,NYCCST,NYSTRT
COMMON PFH(500),CURA(500),CFAB(500),CREP(500),CPLU(500),KMAX
COMMON TCTUF6,TOTSDY,TOTFAB,TOTRPR,TCTUCR,TOTPUC

```

C****V(X) IS THE VALUE FUNCTION FOR SEPARATIVE DUTY.
 $V(X) = (1 - 2 \cdot X) \cdot \text{ALOG}(1/X - 1)$

C M=5 SALE OF RECOVERED PU.
 C M=6 SALE OF RECOVERED U.

C*** SALE OF FISSILE PU IS NEXT.
 QT38=DSFPU(NB)*D(34)
 TM38=(TIME(NTB(NB))-TLEAD(5))
 NY=NYSTRT-NYCCST+TM38+1
 SALE =1.0E-06*QT38*PRICE(NY,5)
 BCGST(NB)=BCGST(NB)-SALE
 EXPDIR(NB,5)=SALE
 GTA=G*TM38
 GTAX=EXP(-GTA)
 EX39=SALE*GTAX
 PWEXPS=PWEXPS-EX39
 TOTPUC=TOTPUC+SALE
 K=12.*(TM38+TLEAD(1))+1.01
 CPLU(K)=CPLU(K)+SALE
 IF(K.GT.KMAX)KMAX=K
 PRINT 506, TM38, SALE, GTAX, EX39, PWEXPS

C*** SALE OF U235 IS NEXT.
 IF(DSU(NB).EQ.0)RETURN
 XP=DS235(NB)/DSU(NB)
 IF(XP.LE.XT)RETURN
 BF238=(XP-XT)/(XF-XT)
 SEDY=V(XP)-BF238*V(XF)+(BF238-1.0)*V(XT)
 TM38=(TIME(NTB(NB))-TLEAD(6))
 NY=NYSTRT-NYCCST+TM38+1
 VALUE=BF238*PRICE(NY,1)+SEDY*PRICE(NY,2)
 SALE=1.0E-06*DSU(NB)*D(35)*VALUE
 BCGST(NB)=BCGST(NB)-SALE
 EXPDIR(NB,6)=SALE
 GTA=G*TM38
 GTAX=EXP(-GTA)
 EX39=SALE*GTAX
 PWEXPS=PWEXPS-EX39
 TOTUCR=TCTUCR+SALE
 K=12.*(TM38+TLEAD(1))+1.01
 CPLU(K)=CPLU(K)+SALE

```
IF (X.GT.KPAX)KPAX=X
PRINT 507,TM38,SALE ,GTAX,EX39,VALUE,PWEXPS
PWBTC=PWEXPS-PWEXPA
PWBEXP(NB)=PWBTC
PRINT 508,BCCST(NC),PWBTC,PWEXPS

506 FORMAT(' SALE FIPU ',4F15.5,30X,F15.5)
507 FORMAT(' CREDIT ',4F15.5,15X,2F15.5)
508 FORMAT(' TOTAL COST',15X,F15.5,15X,F15.5,30X,F15.5,/)

RETURN
END
```


SUBROUTINE POWINP

```

COMMON BLVCS(70),BLV2(70),EXPDIR(70,6)
COMMON NTA(70),NTB(70),CHU(70),CH235(70),DSJ(70),DS235(70),
1 DSPU(70),DSFPU(70),TIME(70),PWF(70),NPA(70),NPB(70),DEDC(70),
2 TOTKWH(70),BCOST(70),NAA(70),NBB(70),BKWH(70,70),BTOKWH(70)
COMMON BBUY(70),PWBEXP(70),BDUC(70)
COMMON LL(10),CES(13),DI(35),TLEAD(10),PRICE(70,10)
COMMON G,XF,XT,PWEXPS,TXRE,TXRM,PWEXPA,CCRE
COMMON ABMAX,NTMAX,NPMAX,NYMAX,NPRICE,NYCCST,NYSTRT
COMMON PFW(500),CURA(500),CFAB(500),CREP(500),CPLU(500),KMAX
COMMON TOTUF6,TOTSDY,TOTFAB,TOTRPR,TOTUCR,TOTPUC

C*****TMAAA=TIME AT BEGINNING OF PERIOD NP, YEARS FROM STARTUP
C*****TMBBB=TIME AT END OF PERIOD NP, YEARS FROM STARTUP
PRINT 400
1 DM6=D(8)*1000.*365.*24.*1.0E-09
2 DO 40 NP=1,NPPAX
  TMAAA=TIME(NTA(NP*2))
  TMBBB=TIME(NTB(NP))
  PFWNP=TOTKWH(NP)/(DM6*(TMBBB-TMAAA))
  KA=12.0*(TMAAA+TLEAD(1))+2.01
  KB=12.0*(TMBBB+TLEAD(1))+2.01
  XKA=KA
  XKB=KB-1
  TK1=12.0*(TMAAA+TLEAD(1))
  TK2=12.0*(TMBBB+TLEAD(1))
  PFW(KA)=PFWNP*(XKA-TK1)
  PFW(KB)=PFWNP*(TK2-XKB)
  IF(PFW(KA).LT.C.)PFW(KA)=0.
  IF(PFW(KB).LT.C.)PFW(KB)=0.
  KA2=KA+1
  KB2=KB-1
  DO 30 K=KA2,KB2
30 PFW(K)=PFWNP
40 CONTINUE

DO 65 K=1,KMAX
PUNCH 401,PFW(K),CURA(K),CFAB(K),CREP(K),CPLU(K)
65 PRINT 402,K,PFW(K),CURA(K),CFAB(K),CREP(K),CPLU(K)

400 FORMAT('1 RESULTS OF SUBROUTINE POWINP',///)
401 FORMAT(7F10.6)
402 FORMAT(' ',16,6F15.6)

RETURN
END

```

SUBROUTINE CWT2

```

COMMON BLVCST(70),BLV2(70),EXPDIR(70,6)
COMMON NTA(70),NTB(70),CHU(70),CH235(70),DSU(70),DS235(70),
1  DSPU(70),DSFPU(70),TIME(70),PWF(70),NPA(70),NPB(70),DEDOC(70),
2  TOTKWH(70),BCOST(70),NAA(70),NBB(70),BKWH(70,70),BTOKWH(70)
COMMON BBUY(70),PBEXP(70),BDUC(70)
COMMON LL(10),DES(13),DI(35),TLEAD(10),PRICE(70,10)
COMMON G,XF,XT,PWEZF5,TXRE,TXRM,PWEXPA,CCE
COMMON NBMAX,NTHAX,NPMAX,NYMAX,NPRICE,NVCCST,NVSTRT
COMMON PFW(500),CURA(500),CFAB(500),CREP(500),CPLU(500),KMAX
COMMON TOTIF6,TOTSDY,TOTFAB,TOTRPR,TOTUCR,TOTPUC

DIMENSION CUPKWH(70),CARDIR(70),CUMCAR(70),CUMDIR(70,6),
1  DIRCST(70,6),DIRCUM(70,6)

SS22=0.
SS31=0.
SS32=0.
SS33=0.
SS34=0.
SS35=0.
SS36=0.

DO 20 NB=1,NBPAX
  CUMKWH(NB)=0.
  DO 18 K=1,6
18  CUMDIR(NB,K)=0.
20  CONTINUE

DO 32 NB=1,NBPAX
  SS22=SS22+BTOKWH(NB)
  SS31=SS31+EXPCIR(NB,1)
  SS32=SS32+EXPCIR(NB,2)
  SS33=SS33+EXPCIR(NB,3)
  SS34=SS34+EXPCIR(NB,4)
  SS35=SS35+EXPCIR(NB,5)
  SS36=SS36+EXPCIR(NB,6)
  CUMKWH(NB)=SS22
  CUMDIR(NB,1)=SS31
  CUMDIR(NB,2)=SS32
  CUMDIR(NB,3)=SS33
  CUMDIR(NB,4)=SS34
  CUMDIR(NB,5)=SS35
  CUMDIR(NB,6)=SS36
  DO 31 K=1,6
    DIRCST(NB,K)=EXPDIR(NB,K)/BTOKWH(NB)
31  DIRCUM(NB,K)=CUMDIR(NB,K)/CUMKWH(NB)
    CARDIR(NB)=BLVCST(NB)-DIRCST(NB,1)-DIRCST(NB,2)-DIRCST(NB,3)
1    -DIRCST(NB,4)+DIRCST(NB,5)+DIRCST(NB,6)
    CUMCAR(NB)=BLV2(NB)-DIRCUM(NB,1)-DIRCUM(NB,2)-DIRCUM(NB,3)
1    -DIRCUM(NB,4)+DIRCUM(NB,5)+DIRCUM(NB,6)
32  CONTINUE

PRINT 501,(DES(I),I=1,13)
PRINT 502

```

```

      DO 103 NB=1,NEMAX
103 PRINT 503,NB,(DIRCST(NB,K),K=1,6),CARDIR(NB),BLVCST(NB)
      PRINT 504,(DES(I),I=1,13)
      PRINT 502
      DO 106 NB=1,NEMAX
106 PRINT 503,NB,(CIRCUM(NB,K),K=1,6),CUMCAR(NB),BLV2(NB)

501 FORMAT('1  CCST BREAKDOWN BY BATCHES      ',5X,13A4,///)
502 FORMAT('  BATCH              UF6      SEP DUTY      FABR      ',
1 '      REPRCC      PU CRED      U CREDIT      CARRY CHG ',
2 '      TOTAL      :,,')
503 FORMAT(' ',I4,4X,8F13.5)
504 FORMAT('1  CUMULATIVE BATCHWISE COST BREAKDOWN',5X,13A4,///)

      RETURN
      END

```

APPENDIX D: FORTRAN LISTING OF POW76

**FTN,Y,E,G,L.

PROGRAM PCW76

C THIS IS AN ABBREVIATED VERSION OF POWERCO-75 DESIGNED TO OBTAIN
C THE FUEL CYCLE COST ONLY. MUCH OF THE OUTPUT HAS BEEN ELIMINATED.
C ONLY THE PROPORTIONAL BOND/EQUITY REPAYMENT CASE IS PERMITTED.
C PROPERTY TAXES AND INSURANCE ON THE CORE ARE CALCULATED ON
C THE INPUT VALUE OF THE CORE WHICH IS D(11).
C WITH RESPECT TO POWERCO-50, THE FOLLOWING CHANGES HAVE BEEN MADE.
C 4. ALL FUEL EXPENDITURES PRIOR TO STARTUP ARE INPUTTED.
C 5. INITIAL CORE IS USED ONLY FOR TAXES AND INSURANCE.

COMMON TXR,BND,RRB,RRE,PLT,WC,CORE,NY,TXRE,TXRM,DMW
COMMON PWV(500),PFW(500),U(500),EFU(500),EP(500),
1 XTU(500),CURA(500),CFAB(500),CREP(500),CPLU(500),B(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRNP

C ANNUAL QUANTITIES, FOR YEAR N

C	CFAB(N)	= FABRICATION EXPENDITURE	, \$MM
C	CPLU(N)	= RECOVERED U-PU CREDIT	, \$MM
C	CREP(N)	= REPROCESSING EXPENDITURE	, \$MM
C	CURA(N)	= URANIUM EXPENDITURE	, \$MM
C	EFU(N)	= FUEL EXPENDITURES	, \$MM
C	EGP(N)	= TCTAL EXPENSES G PRIME	
C	EP(N)	= PFCRATED FUEL EXPENSE	, \$MM
C	PFW(N)	= LCAD FACTOR (PLANT FACTOR)	
C	PWV(N)	= PRESENT WORTH FACTOR AT I SUB V	
C	U(N)	= KWHR OF ELECTRICITY PRODUCED	
C	T SUB J,N	IS XTU(N)	
C	BND	= FRACTION OF INVESTMENT IN BCNDS	
C	BGT	= DENOMINATOR OF POWER COST	
C	CORE	= CCST OF INITIAL CORE, \$MM	
C	D(7)	= K SUB T = FEDERAL INCOME TAX RATE	
C	D(14)	= CCNSTANT ANNUAL EXPENSE, \$/YR	
C	D(15)	= K SUB S = STATE INCCME TAX RATE	
C	D(16)	= K SUB R = STATE GROSS REVENUE TAX RATE	
C	D(17)	= K SUB V = LOCAL PROPERTY TAX RATE	
C	D(18)	= K SUB A = INTERIM REPLACEMENT FACTOR	
C	D(19)	= K SUB B = PROPERTY INSURANCE FACTOR	
C	D(22)	= F SUB C = FRAC OF CORE VALUE FOR TAX PURPOSES	
C	D(23)	= K SUB P = PROPERTY TAX RATE ON NONFUEL WORK CAP	
C	D(27)	= NCT USED	
C	D(28)	= NCT USED	
C	D(29)	= STARTING PERIOD FOR PLANT DEPRECIATION	
C	D(30)	= STARTING PERIOD FOR PROPERTY TAXES, PROPERTY	
C		INSURANCE, INTERIM REPLACEMENTS, AND REACTOR STARTUP	
C	DES	= PROBLEM IDENTIFICATION	
C	NY	= PROJECT LIFE	, YEARS
C	P	= POWER COST	, MILLS/KWHR(E)
C	RRB	= INTEREST RATE ON BCNDS	
C	RRE	= RATE OF RETURN ON EQUITY	
C	RRV	= I SUB VS = MODIF WEIGHTED AVG INTEREST RATE	

C	TOP	=	NUMERATOR OF POWER COST	
C	TXR	=	FEDERAL INCOME TAX RATE	
C	TXRE	=	K SUB E = $KT + (1-KT)KW$	
C	TXRM	=	K SUB M = $KT + (1-KT)KS$	
C	VOU	=	VARIABLE OPERATING COST D(10)	
C	WC	=	NONFUEL WORKING CAPITAL	, \$MM
C	WEX	=	SLP OF LEAD FACTORS	
C	WRX	=	SLP OF ANNUAL FUEL EXPENSES	
C	YRS	=	PROJECT LIFE	, YEARS

```

1 CALL INPUT
  CALL DATACHK
2 CALL FACTORS
3 PLT=0.
  WC=0.
6 CALL EXPENSES
10 CALL COSTEQ
11 IF(ILL3.EQ.0)CALL TRY
12 IF(ILL4.EQ.0)CALL OUTPUT

```

```

GO TO 1
END POW76

```

SUBROUTINE INFLT

```

COMMON TXR,BNC,RRB,RRE,PLT,WC,CORE,NY,TXRE,TXRM,DMW
COMMON PFW(500),PU(500),U(500),EFU(500),EP(500),
1 XTU(500),CURA(500),CFAB(500),CREP(500),CPLU(500),D(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRNP

```

```

1 READ(50,401)LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,
  LL9,LL10,(DES(I),I=1,13)

```

```

  IF(LL5.EQ.1)GO TO 150

```

```

5 READ(50,402)(D(N),N=1,35)

```

```

  IF(LL6.EQ.1)GO TO 150

```

```

  NY=D(2)

```

```

10 DO 12 K=1,NY

```

```

  READ 402,PFW(K),CURA(K),CFAB(K),CREP(K),CPLU(K)

```

```

  IF(PFW(K).LT.0.)PFW(K)=0.

```

```

12 CONTINUE

```

```

150 BND=D(4)

```

```

  RRB=D(5)

```

```

  RRE=D(6)

```

```

  TXR=D(7)

```

```

  DMW=D(8)

```

```

  CORE=D(11)

```

```

401 FORMAT(10I2,13A4)

```

```

402 FORMAT(7E10.0)

```

```

900 RETURN

```

```

  END

```

SUBROUTINE DATACHK

```

COMMON TXR,BNC,RRB,RRE,PLT,WC,CORE,NY,TXRE,TXRM,DMW
COMMON PHV(500),PFW(500),U(500),EFU(500),EP(500),
1 XTU(500),CURA(500),CFAB(500),CREP(500),CPLU(500),D(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRNP

WRITE(51,511)(DES(I),I=1,13)
PRINT 624
PRINT 625
PRINT 626,(D(N),N=1,35)
PRINT 627
PRINT 628,LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10
WRITE(51,537)
WRITE(51,538)
WRITE(51,539)
DO 102 N=1,NY
102 WRITE(51,540)N,PFW(N),CURA(N),CFAB(N),CREP(N),CPLU(N)
511 FORMAT(15H1 INPUT DATA      ,I3A4)
537 FORMAT(48H1 INPUT DATA      EXPENSES IN $MM PER PERIOD
538 FORMAT(1H0,2HPD,6X,4HCAPY,7X,4HFUEL,7X,4HFAER,7X,
1 4HREPR,8X,4HUPU)
539 FORMAT(1H ,7X,6HFACTOR,5X,5HPURCH,7X,4HCGST,7X,
1 4HCOST,7X,4HCRED,/)
540 FORMAT(1H ,I3,5F11.5)
624 FORMAT('C',///)
625 FORMAT('O  D(N),N=1,35',/)
626 FORMAT(' ',10F11.5)
627 FORMAT('O  CONTROL CARD SIGNALS, LL1-LL10')
628 FORMAT('O ',10I6)
RETURN
END

```


SUBROUTINE FACTORS

```

COMMON TXR,BRC,RRB,RRE,PLT,WC,CORE,NY, TXRE, TXRH,GMW
COMMON PhV(500),PFW(500),U(500),EFU(500),EP(500),
1 XTU(500),CJFA(500),CFAB(500),CREP(500),CPLU(500),D(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRNP
DIMENSION PhW(500)

TXRH=TXR+C(15)-TXR*D(15)
TXRE=(1.-TXR)*(D(15)+D(16)-D(15)*D(16))+TXR
3 RRV=BND*RRB*(1.-TXRH)+(1.-BND)*RRE
RRW=BND*RRB+(1.-BND)*RRE
10 PhV(1)=1./(1.+RRV)
PhW(1)=1./(1.+RRW)
DO 11 N=2,NY
PhW(N)=PhW(1)*PhW(N-1)
11 PhV(N)=PhV(1)*PhV(N-1)

DR5=1.-D(15)
DT6=1.-TXR
TXRD=DR5*(D(15)+D(17)+D(22))
BKMA=0.
BKMV=0.
SUMLA=0.
SUMLV=0.
DO 20 N=1,NY
BKMA=BKMA+PhW(N)
BKMV=BKMV+PhV(N)
SUMLA=SUMLA+PhW(N)*PFW(N)
20 SUMLV=SUMLV+PhV(N)*PFW(N)
RP=SUMLA*BKMV/(BKMA*SUMLV)
TXRH=1.-PhV(NY)+DT6*TXRD*BKMV
TT8=(1.-TXRE)*BKMV
FCRN=TXRH/TT8
FCRNP=FCRN*RP
PRINT 500
PRINT 501,FCRN
PRINT 502,FCRNP
500 FORMAT('O FIXED CHARGE RATES ON NONDEPRECIABLE CAPITAL')
501 FORMAT(' ',5X,'USING CONSTANT CAPACITY FACTOR',F10.5)
502 FORMAT(' ',5X,'USING VARIABLE CAPACITY FACTOR',F10.5)

RETURN
END

```

SUBROUTINE EXPENSES

```

COMMON TXR,BND,RRB,RRE,FLT,WC,CORE,NY,TXRE,TXRM,DMW
COMMON PMV(500),PFM(500),U(500),EFU(500),EP(500),
1 XTU(500),CURA(500),CFAB(500),CREP(500),CPLU(500),D(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRN2

```

```

DM67=DMW*1000.*24.*365./D(12)
PRPTA=D(17)*C(22)*CORE
PRPTY=D(15)*CCRE
ND30=D(30)+.01
90 DO 91 N=1,NY
91 XTU(N)=0.
92 DO 93 N=C30,NY
93 XTU(N)=PRFTA+PRPTY

5 WEX=0.
WRX=0.
DO 6 M=1,NY
EFU(M)=CURA(M)+CFAB(M)+CREP(M)-CPLU(M)
U(M)=PFM(M)*CP67
WRX=WRX+EFU(M)
6 WEX=WEX+PFM(M)
TE7=WRX/WEX
DO 7 M=1,NY
7 EP(M)=TE7*PFM(M)
RETURN
END

```

SUBROUTINE COSTEQ

```

COMMON TXR, BHC, RRB, RRE, PLT, MC, CORE, NY, TXRE, TXRM, DMW
COMMON PWV(500), PFW(500), U(500), EFU(500), EP(500),
1 XTU(500), CURA(500), CFAB(500), CREP(500), CPLU(500), D(13), DES(13)
COMMON LL1, LL2, LL3, LL4, LL5, LL6, LL7, LL8, LL9, LL10, P
COMMON FCRN, FCRNP
DIMENSION PWFC(500), PWFN(500)

```

C T SUB J, A IS XTU(N)

```

      BOT=0.
10 DO 12 N=1, NY
12 BOT=BOT+PWV(N)*U(N)
      TOP=0.
      DO 21 N=1, NY
      TOP=TOP+PWV(N)*(EFU(N)-TXRM*EP(N))
21 TOP=TOP+(1.-TXRM)*PWV(N)*XTU(N)
15 P=TOP/(BOT*(1.-TXRE))+1.0E+C9
      PRINT 501, P
      PWFC(1)=1./(1.+FCRN)
      PWFN(1)=1./(1.+FCRNP)
      DO 45 N=2, NY
      PWFC(N)=PWFC(1)*PWFC(N-1)
45 PWFN(N)=PWFN(1)*PWFN(N-1)
      TOP2=0.
      BOT2=0.
      TOP3=0.
      BOT3=0.
      DO 50 N=1, NY
      TOP2=TOP2+PWFC(N)*EFU(N)
      BOT2=BOT2+PWFC(N)*U(N)
      TOP3=TOP3+PWFN(N)*EFU(N)
50 BOT3=BOT3+PWFN(N)*U(N)
      P2=TOP2/BOT2 *1.0E09
      P3=TOP3/BOT3 *1.0E09
      PRINT 502, P2
      PRINT 503, P3
501 FORMAT(1H1, 'FLEL CYCLE COST, MILLS/KWH', F20.6, '/')
502 FORMAT(1H, 'SAFE USING FCRN', F20.6)
503 FORMAT(1H, 'SAFE USING FCRNP', F20.6)
      RETURN
      END

```

```

SUBROUTINE TRY
COMMON TXR,BNC,RRB,RRE,PLT,WC,CORE,NY,TXRE,TXRM,OMW
COMMON PMV(500),PFM(500),U(500),EFU(500),EF(500),
1 XTU(500),CURA(500),CFAB(500),CREP(500),CPLU(500),D(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRNP
DIMENSION PWT(500),CTTT(500)
DO 7 N=1,NY
7 CTTT(N)=CURA(N)+CFAB(N)+CREP(N)-CPLU(N)
PRINT 500,P
DO 30 K=1,40
RRT=D(32)+D(23)*(K-1)
PWT(1)=1./(1.+RRT)
DO 9 N=2,NY
9 PWT(N)=PWT(1)*PWT(N-1)
TOP=0.
BOT=C.
DO 12 N=1,NY
TOP=TOP+PWT(N)*CTTT(N)
12 BOT=BOT+PWT(N)*U(N)
BOT=BOT*1.0E-09
PTA=TOP/BOT
30 PRINT 501,K,RRT,TOP,BOT,PTA,P
500 FORMAT('1',T2C,'TRIAL VALUES OF INTEREST RATE',10X,'COST=',
1 F10.5,2X,'BILLS/KWH',///)
501 FORMAT(' ',I4,6F12.5)
RETURN
END

```

SUBROUTINE OUTPUT

```

COMMON TXR,BNC,RRB,RRE,PLT,WC,CORE,NY,TXRE,TXRM,DMW
COMMON PWV(500),PFW(500),U(500),EFU(500),EP(500),
1 XTU(500),CURA(500),CFAB(500),CREP(500),CPLU(500),D(35),DES(13)
COMMON LL1,LL2,LL3,LL4,LL5,LL6,LL7,LL8,LL9,LL10,P
COMMON FCRN,FCRNP
DIMENSION PWA(500),CAPTL(500)

PRINT 404,(DES(I),I=1,13)
PRINT 406
RRA=BND*RRB+(1.-BND)*RRE
PWA(1)=1./(1.+RRA)
DO 10 N=2,NY
10 PWA(N)=PWA(1)*PWA(N-1)
TPW=0.0
TLSC=D(17)*C(22)*CORE
P9=P*1.0E-09
PGNB=D(19)*CCRE
CAPTL(1)=0.0
DO 20 N=1,NY
EARN=CAPTL(N)*RRA
SALES=U(N)*P9
BINT=BND*CAPTL(N)*RRB
TLSB=D(16)*SALES
TLSQ=TLSB+XTU(N)+EP(N)+BINT
TLSA=D(15)*(SALES-TLSQ)
TEA=TXR*(SALES-TLSQ-TLSA)
TEQ=EFU(N)+TLSA+TLSB+XTU(N)+TEA
TGG=SALES-TEQ
TPW=TPW+(TLSB+TLSA+TEA+XTU(N)+EARN)*PWA(N)
CAPTL(N+1)=CAPTL(N)-(TGG-EARN)
20 PRINT 405,N,CAPTL(N),SALES,EFU(N),EARN,D(18),EP(N),TLSB,
1 TLSA,TEA,TEQ,CAPTL(N+1)

404 FORMAT('1 RESULTS SUBROUTINE OUTPUT',4X,13A4,///)
405 FORMAT(' ',14,11F11.5)
406 FORMAT(' ',8X,'CAPITAL',4X,'INCCME',5X,'FUEL EXP',3X,'INTEREST',
1 3X,'PROPERTY',3X,'DEDUCTBL',3X,'REVN TAX',3X,'S INC TX',3X,
2 'F INC TX',2X,'CASH EXP',3X,'CAPITAL',/)
END

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APPENDIX E: EXAMPLE OUTPUT, REFCO

INPUT DATA REFCO PCB P703 CECLINING PRICES 0.83 CAPY

INPUT SIGNALS, LL(K),K=1,10

3 0 0 0 0 0 0 0 0 0

BATCH	TIME POINTS		CHARGE U	CHARGE U235	DISCH U	DISCH U235	DISCH PU	DISCH FPU
	NTA IN	NTB OUT						
1	1	2	29415.0	716.9	28870.0	345.5	164.5	131.1
2	1	4	29415.0	716.9	28532.0	275.3	217.9	161.4
3	1	6	29415.0	716.9	28309.0	217.4	255.5	178.7
4	3	8	29414.0	938.6	28264.0	295.3	257.8	184.8
5	5	10	29414.0	938.5	28223.0	280.5	263.3	186.9
6	7	12	29414.0	938.5	28208.0	275.2	265.2	187.6
7	9	14	29414.0	938.5	28229.0	282.9	262.7	186.7
8	11	16	29414.0	937.7	28240.0	285.8	261.0	185.8
9	13	18	29414.0	918.3	28271.0	285.2	257.2	183.6
10	15	20	29414.0	899.3	28308.0	286.7	252.7	181.2
11	17	22	29414.0	881.0	28337.0	285.8	249.0	179.0
12	19	24	29415.0	863.3	28369.0	286.3	244.8	176.6
13	21	26	29416.0	846.2	28400.0	286.6	240.8	174.4
14	23	28	29416.0	829.5	28432.0	288.2	236.2	171.9
15	25	30	29415.0	813.5	28491.0	288.6	230.0	167.4
16	27	32	29416.0	798.0	28489.0	288.6	228.4	167.4
17	29	34	29416.0	783.0	28515.0	288.4	224.5	165.1
18	31	36	29416.0	768.5	28539.0	287.9	221.0	163.0
19	33	38	29416.0	754.5	28539.0	287.9	221.0	163.0
20	35	40	29416.0	743.8	28539.0	287.9	221.0	163.0
21	37	40	29416.0	743.8	28856.0	428.0	144.7	121.5
22	39	40	29416.0	743.8	29179.0	568.9	97.0	81.0

INPUT DATA REFUCO PCB P7U3 DECLINING PRICES 0.83 CAPY

PRICE DATA ENTERED BY YEARS

YEAR	UF6	SEP DUTY	FABR	REPROC	PU CREDIT
1965	23.10	32.00	72.40	42.00	6500.00
1966	23.10	32.00	71.40	41.00	6500.00
1967	23.10	32.00	70.00	40.00	6500.00
1968	23.10	32.00	68.00	38.00	6500.00
1969	23.10	32.00	66.50	36.00	6500.00
1970	23.10	32.00	65.40	34.00	6500.00
1971	23.10	32.00	64.00	33.00	6500.00
1972	23.10	32.00	63.00	32.00	6500.00
1973	23.10	32.00	61.00	31.00	6500.00
1974	23.10	32.00	60.00	30.00	6500.00
1975	23.10	32.00	59.40	29.50	6500.00
1976	23.10	32.00	58.50	29.00	6500.00
1977	23.10	32.00	57.80	28.50	6500.00
1978	23.10	32.00	57.00	28.00	6500.00
1979	23.10	32.00	56.20	27.20	6500.00
1980	23.10	32.00	55.40	26.50	6500.00
1981	23.10	32.00	54.60	26.00	6500.00
1982	23.10	32.00	53.80	25.20	6500.00
1983	23.10	32.00	53.00	24.50	6500.00
1984	23.10	32.00	52.10	24.00	6500.00
1985	23.10	32.00	51.20	23.50	6500.00
1986	23.10	32.00	50.20	23.00	6500.00
1987	23.10	32.00	49.20	22.50	6500.00
1988	23.10	32.00	48.60	22.00	6500.00
1989	23.10	32.00	48.00	21.50	6500.00
1990	23.10	32.00	47.40	21.00	6500.00
1991	23.10	32.00	47.00	20.50	6500.00
1992	23.10	32.00	46.20	20.00	6500.00
1993	23.10	32.00	45.50	19.50	6500.00
1994	23.10	32.00	45.00	19.30	6500.00
1995	23.10	32.00	44.40	19.00	6500.00
1996	23.10	32.00	43.50	18.50	6500.00
1997	23.10	32.00	42.40	18.00	6500.00
1998	23.10	32.00	41.20	17.60	6500.00
1999	23.10	32.00	40.20	17.20	6500.00
2000	23.10	32.00	40.00	17.00	6500.00
2001	23.10	32.00	39.80	16.80	6500.00
2002	23.10	32.00	39.50	16.50	6500.00
2003	23.10	32.00	39.20	16.20	6500.00
2004	23.10	32.00	39.00	16.00	6500.00

INPUT DATA

REFCO PCB P7U3 DECLINING PRICES 0.83 CAPY

BATCH	NPD IN	NPD CUT	TIME IN	TIME OUT	ENERGY DELIVERED PER PERIOD, 10**9 KWH		
1	1	1	0.0	1.02400	3.30000		
2	1	2	0.0	1.82300	3.00000	1.90000	
3	1	3	0.0	2.73400	2.67000	1.75000	2.11700
4	2	4	1.19100	3.75700	1.88600	2.30000	2.55000
5	3	5	1.99000	4.70000	2.10000	2.50000	2.27600
6	4	6	2.90100	5.65900	2.44900	2.26600	2.32300
7	5	7	3.92400	6.61000	2.25600	2.31300	2.30000
8	6	8	4.86700	7.54400	2.30200	2.28900	2.35000
9	7	9	5.82600	8.42400	2.27900	2.34000	2.09200
10	8	10	6.77700	9.29500	2.32900	2.08200	2.06600
11	9	11	7.71100	10.15000	2.07200	2.05600	2.01900
12	10	12	8.59100	10.97300	2.04500	2.00900	1.92600
13	11	13	9.46200	11.77200	1.99900	1.91600	1.84600
14	12	14	10.31700	12.55500	1.90500	1.84500	1.79900
15	13	15	11.14000	13.32200	1.84500	1.79900	1.75200
16	14	16	11.93900	14.06500	1.79800	1.75200	1.68200
17	15	17	12.72200	14.79200	1.75200	1.68200	1.63600
18	16	18	13.48900	15.49900	1.68200	1.63500	1.57700
19	17	19	14.23200	16.19798	1.63500	1.57700	1.55300
20	18	20	14.95900	16.90097	1.57600	1.55300	1.56500
21	19	20	15.66600	16.90097	1.55400	1.56500	
22	20	20	16.36497	16.90097	1.56500		

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INPUT CONSTANTS D(N), N=1,35

100.00000	30.00000	2.00000	0.52000	0.04230	0.10000	0.50000	1000.00000	10.00000	1.00000
29.48000	1.00000	0.0	1.00000	0.03000	0.0	0.03200	0.00350	0.00250	0.0
0.0	0.65000	0.03000	0.00711	0.00240	0.16700	0.0	0.0	1.00000	1.00000
0.98000	1.02000	1.01000	0.99000	0.99000					

PRESENT WORTH FACTORS FOR EACH PERIOD

0.97137	0.91772	0.87408	0.82722	0.78212	0.74085	0.70159	0.66488	0.63137	0.60063
0.57179	0.54508	0.52043	0.49750	0.47600	0.45594	0.43723	0.41972	0.40323	0.38743

CALCULATED BATCH COSTS, MILLIONS OF \$

COSTS FOR BATCH NUMBER 1		TIME IN	O.O	TIME OUT	1.02400	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	-2.00000	3.23316	1.12078	3.62365			3.62365
SEP DUTY	-1.50000	2.65229	1.08928	2.88908	2.78986		6.51273
FAB COST	-0.60000	1.97565	1.03480	2.04440			8.55714
REPROCESS	1.82400	0.95814	0.90124	0.86351			9.42065
SALE FIPU	2.02400	0.84363	0.89102	0.75169			8.66896
U CREDIT	2.22400	1.89582	0.88092	1.67006		66.33101	6.99889
TOTAL COST		6.07979		6.99889			6.99889

COSTS FOR BATCH NUMBER 2		TIME IN	O.O	TIME OUT	1.82300	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	-2.00000	3.23316	1.12078	3.62365			10.62254
SEP DUTY	-1.50000	2.65229	1.08928	2.88908	2.78986		13.51163
FAB COST	-0.60000	1.97565	1.03480	2.04440			15.55603
REPROCESS	2.62300	0.92160	0.86110	0.79359			16.34961
SALE FIPU	2.82300	1.03861	0.85134	0.88421			15.46540
U CREDIT	3.02300	1.26700	0.84169	1.06642		44.77637	14.39898
TOTAL COST		6.47710		7.40009			14.39898

COSTS FOR BATCH NUMBER 3		TIME IN	O.O	TIME OUT	2.73400	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	-2.00000	3.23316	1.12078	3.62365			18.02263
SEP DUTY	-1.50000	2.65229	1.08928	2.88908	2.78986		20.91171
FAB COST	-0.60000	1.97565	1.03480	2.04440			22.95612
REPROCESS	3.53400	0.88550	0.81752	0.72392			23.68002
SALE FIPU	3.73400	1.14993	0.80825	0.92944			22.75058
U CREDIT	3.93400	0.77485	0.79909	0.61917		27.64758	22.13139
TOTAL COST		6.82182		7.73241			22.13139

COSTS FOR BATCH NUMBER 4		TIME IN	1.19100	TIME OUT	3.75700	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	-0.80900	4.34224	1.04720	4.54720			20.67859
SEP DUTY	-0.30900	4.07495	1.01777	4.14738	4.28645		30.82596
FAB COST	0.59100	1.94291	0.96687	1.87854			32.70448
REPROCESS	4.55700	0.85565	0.77121	0.65989			33.36436
SALE FIPU	4.75700	1.18919	0.76246	0.90671			32.45754
U CREDIT	4.95700	1.45288	0.75382	1.09521		51.92329	31.36243
TOTAL COST		8.57368		9.23103			31.36243

CALCULATED BATCH COSTS, MILLIONS OF \$

COSTS FOR BATCH NUMBER 5		TIME IN	1.99000	TIME OUT	4.70000	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	-0.01000	4.34174	1.00057	4.34421			35.70663
SEP DUTY	0.49000	4.07431	0.97245	3.96207	4.28578		39.66870
FAB COST	1.39000	1.90132	0.92381	1.75646			41.42516
REPROCESS	5.50000	0.84035	0.73084	0.61416			42.03431
SALE FIPU	5.70000	1.20270	0.72256	0.86902			41.17029
U CREDIT	5.90000	1.31995	0.71436	0.94292		47.24098	40.22736
TOTAL COST		8.63507		8.86493			40.22736

COSTS FOR BATCH NUMBER 6		TIME IN	2.90100	TIME OUT	5.65900	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	0.90100	4.34174	0.94993	4.12435			44.35170
SEP DUTY	1.40100	4.07431	0.92323	3.76155	4.28578		48.11324
FAB COST	2.30100	1.87161	0.87706	1.64151			49.75475
REPROCESS	6.45900	0.82572	0.69196	0.57136			50.32610
SALE FIPU	6.65900	1.20720	0.68411	0.82586			49.50023
U CREDIT	6.85900	1.27293	0.67636	0.86095		45.58235	48.63927
TOTAL COST		8.63325		8.41191			48.63927

COSTS FOR BATCH NUMBER 7		TIME IN	3.92400	TIME OUT	6.61000	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	1.92400	4.34174	0.89611	3.89069			52.52995
SEP DUTY	2.42400	4.07431	0.87093	3.54844	4.28578		56.07838
FAB COST	3.32400	1.81219	0.82737	1.49935			57.57773
REPROCESS	7.41000	0.81201	0.65544	0.53223			58.10994
SALE FIPU	7.61000	1.20141	0.64801	0.77853			57.33141
U CREDIT	7.81000	1.34138	0.64066	0.85937		47.99770	56.47203
TOTAL COST		8.49747		7.83276			56.47203

COSTS FOR BATCH NUMBER 8		TIME IN	4.86700	TIME OUT	7.54400	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	2.06700	4.33773	0.84921	3.68364			60.15567
SEP DUTY	3.36700	4.06507	0.82534	3.35838	4.28026		63.51404
FAB COST	4.26700	1.78249	0.78406	1.39758			64.91161
REPROCESS	8.34400	0.79863	0.62145	0.49594			64.40753
SALE FIPU	8.54400	1.19562	0.61441	0.73460			64.67293
U CREDIT	8.74400	1.36719	0.60744	0.83048		48.90225	63.84244
TOTAL COST		8.42450		7.37041			63.84244

CALCULATED BATCH COSTS, MILLIONS OF \$

COSTS FOR BATCH NUMBER 9		TIME IN	5.82600	TIME OUT	8.42400	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	3.82600	4.24068	0.80403	3.40962			67.25206
SEP DUTY	4.32600	3.94188	0.78143	3.08030	4.14647		70.33235
FAB COST	5.22600	1.76466	0.74235	1.30995			71.64233
REPROCESS	9.22400	0.77597	0.59104	0.45863			72.10095
SALE FIPU	9.42400	1.18147	0.58434	0.69038			71.41057
U CREDIT	9.62400	1.36040	0.57772	0.78592		48.60596	70.62463
TOTAL COST		8.18132		6.78220			70.62463

COSTS FOR BATCH NUMBER 10		TIME IN	6.77700	TIME OUT	9.29500	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	4.77700	4.14564	0.76160	3.15730			73.78192
SEP DUTY	5.27700	3.81776	0.74019	2.82588	4.01591		76.60779
FAB COST	6.17700	1.73792	0.70317	1.22206			77.82982
REPROCESS	10.09500	0.75686	0.56241	0.42566			78.25542
SALE FIPU	10.29500	1.16602	0.55603	0.64835			77.60713
U CREDIT	10.49500	1.37241	0.54973	0.75445		48.97095	76.85263
TOTAL COST		7.91975		6.21804			76.85268

COSTS FOR BATCH NUMBER 11		TIME IN	7.71100	TIME OUT	10.15000	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	5.71100	4.05409	0.72210	2.92747			79.78014
SEP DUTY	6.21100	3.69863	0.70181	2.59573	3.89059		82.37585
FAB COST	7.11100	1.71713	0.66671	1.14482			83.52068
REPROCESS	10.95000	0.75753	0.53565	0.40577			83.92644
SALE FIPU	11.15000	1.15186	0.52958	0.61001			82.31642
U CREDIT	11.35000	1.36297	0.52358	0.71362		48.58466	82.60280
TOTAL COST		7.71254		5.75012			82.60289

COSTS FOR BATCH NUMBER 12		TIME IN	8.59100	TIME OUT	10.97300	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP
UF6 COST	6.59100	3.96553	0.68677	2.72340			85.32619
SEP DUTY	7.09100	3.58376	0.66747	2.39205	3.76964		87.71823
FAB COST	7.99100	1.71719	0.63408	1.08884			88.80707
REPROCESS	11.77300	0.74396	0.51110	0.38024			89.18730
SALE FIPU	11.97300	1.13642	0.50531	0.57424			88.61305
U CREDIT	12.17300	1.36612	0.49958	0.68248		48.64191	87.93056
TOTAL COST		7.50789		5.32776			87.93056

CALCULATED BATCH COSTS, MILLIONS OF \$

COSTS FOR BATCH NUMBER 13			TIME IN	9.46200	TIME OUT	11.77200	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	7.46200	3.87998	0.65350	2.53556			90.46611	
SEP DUTY	7.96200	3.47319	0.63513	2.20594	3.65321		92.67204	
FAB COST	8.86200	1.69348	0.60337	1.02179			93.69382	
REPROCESS	12.57200	0.72175	0.48834	0.35246			94.04626	
SALE FIPU	12.77200	1.12226	0.48281	0.54183			93.50443	
U CREDIT	12.97200	1.36750	0.47733	0.65275		48.63776	92.85167	
TOTAL COST		7.27863		4.92111			92.85167	

COSTS FOR BATCH NUMBER 14			TIME IN	10.31700	TIME OUT	12.55500	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	8.31700	3.79644	0.62241	2.36293			95.21460	
SEP DUTY	8.81700	3.36567	0.60492	2.03595	3.54012		97.25055	
FAB COST	9.71700	1.66971	0.57466	0.95952			98.21005	
REPROCESS	13.35500	0.70237	0.46702	0.32802			98.53807	
SALE FIPU	13.55500	1.10618	0.46173	0.51075			98.02731	
U CREDIT	13.75500	1.38063	0.45649	0.63025		49.04970	97.39706	
TOTAL COST		7.04737		4.54939			97.39706	

COSTS FOR BATCH NUMBER 15			TIME IN	11.14000	TIME OUT	13.32200	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	9.14000	3.71641	0.59388	2.20710			99.60416	
SEP DUTY	9.64000	3.26311	0.57719	1.88343	3.43236		101.48758	
FAB COST	10.54000	1.64588	0.54832	0.90247			102.39005	
REPROCESS	14.12200	0.68930	0.44704	0.30815			102.69818	
SALE FIPU	14.32200	1.07722	0.44197	0.47610			102.22208	
U CREDIT	14.52200	1.38170	0.43696	0.60375		48.98590	101.61832	
TOTAL COST		6.85579		4.22125			101.61832	

COSTS FOR BATCH NUMBER 16			TIME IN	11.93900	TIME OUT	14.06500	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	9.93900	3.63885	0.56743	2.06481			103.68312	
SEP DUTY	10.43900	3.16398	0.55149	1.74490	3.32797		105.42801	
FAB COST	11.33900	1.62217	0.52391	0.84986			106.27786	
REPROCESS	14.86500	0.68922	0.42850	0.29533			106.57318	
SALE FIPU	15.06500	1.07722	0.42364	0.45635			106.11682	
U CREDIT	15.26500	1.38179	0.41884	0.57875		48.99242	105.53807	
TOTAL COST		6.65522		3.91075			105.53807	

CALCULATED BATCH COSTS, MILLIONS OF \$

COSTS FOR BATCH NUMBER 17			TIME IN	12.72200	TIME OUT	14.79200	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	10.72200	3.56382	0.54266	1.93395			107.47202	
SEP DUTY	11.22200	3.06848	0.52741	1.61835	3.22752		109.09036	
FAB COST	12.12200	1.59840	0.50103	0.80085			109.89120	
REPROCESS	15.59200	0.67538	0.41110	0.27765			110.16885	
SALE FIPU	15.79200	1.06242	0.40644	0.43181			109.73703	
U CREDIT	15.99200	1.37884	0.40183	0.55407		48.84341	109.18295	
TOTAL COST		6.46482		3.64488			109.18295	

COSTS FOR BATCH NUMBER 18			TIME IN	13.48900	TIME OUT	15.49900	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	11.48900	3.49128	0.51944	1.81352			110.99648	
SEP DUTY	11.98900	2.97651	0.50485	1.50268	3.13078		112.49915	
FAB COST	12.88900	1.59840	0.47960	0.76659			113.26573	
REPROCESS	16.29900	0.66148	0.39486	0.26119			113.52692	
SALE FIPU	16.49855	1.04890	0.39039	0.40948			113.11743	
U CREDIT	16.69895	1.37326	0.38596	0.53002		48.60481	112.58740	
TOTAL COST		6.30551		3.40445			112.58740	

COSTS FOR BATCH NUMBER 19			TIME IN	14.23200	TIME OUT	16.19798	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	12.23200	3.42124	0.49790	1.70344			114.29083	
SEP DUTY	12.73200	2.88805	0.48391	1.39755	3.03773		115.68837	
FAB COST	13.63200	1.57464	0.45971	0.72387			116.41223	
REPROCESS	16.99797	0.66148	0.37944	0.25099			116.66321	
SALE FIPU	17.19798	1.04890	0.37513	0.39348			116.26971	
U CREDIT	17.39758	1.37326	0.37088	0.50932		48.60481	115.76039	
TOTAL COST		6.12324		3.17299			115.76039	

COSTS FOR BATCH NUMBER 20			TIME IN	14.95900	TIME OUT	16.90097	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	12.95900	3.36771	0.47769	1.60871			117.36909	
SEP DUTY	13.45900	2.82067	0.46426	1.30953	2.96687		118.67862	
FAB COST	14.35900	1.54790	0.44104	0.68269			119.36130	
REPROCESS	17.70056	0.64710	0.36453	0.23589			119.59718	
SALE FIPU	17.90057	1.04890	0.36040	0.37802			119.21915	
U CREDIT	18.10097	1.37326	0.35631	0.48931		48.60481	118.72983	
TOTAL COST		5.96122		2.96944			118.72983	

CALCULATED BATCH COSTS, MILLIONS OF \$

COSTS FOR BATCH NUMBER 21			TIME IN	15.66600	TIME OUT	16.90097	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	13.66600	3.36771	0.45881	1.54516			120.27498	
SEP DUTY	14.16600	2.82067	0.44592	1.25780	2.96687		121.53276	
FAB COST	15.06600	1.52116	0.42362	0.64439			122.17714	
REPROCESS	17.70096	0.65252	0.36452	0.23786			122.41499	
SALE FIPU	17.90097	0.78185	0.36040	0.28178			122.13321	
U CREDIT	18.10097	2.70968	0.35631	0.96549		94.85219	121.16771	
TOTAL COST		4.87052		2.43788			121.16771	

COSTS FOR BATCH NUMBER 22			TIME IN	16.36497	TIME OUT	16.90097	YEARS FROM STARTUP	
	TIME	AMOUNT	PW FACTOR	PW AMOUNT	SEP DUTY	VALUE	CUMUL PW EXP	
UF6 COST	14.36497	3.36771	0.44089	1.48479			122.65250	
SEP DUTY	14.86497	2.82067	0.42850	1.20866	2.96687		123.86115	
FAB COST	15.76497	1.52116	0.40707	0.61922			124.48035	
REPROCESS	17.70096	0.65871	0.36453	0.24012			124.72046	
SALE FIPU	17.90097	0.52123	0.36040	0.18785			124.53261	
U CREDIT	18.10097	4.15394	0.35631	1.48010		143.79887	123.05251	
TOTAL COST		3.69308		1.88480			123.05251	

RESULTS REFCO PROB P7U3 DECLINING PRICES 0.83 CAPY

LEVELIZED FUEL CYCLE COST, MILLS/KWH 1.97860

OTHER CALCULATED QUANTITIES

TOP	BOT	FCOST	PWELEC	PWPTY	PWDDUC	PWFXPS	TXRE	TXRM	G
74.90639	37.85828	1.97860	78.05830	6.54846	99.65465	123.05251	0.51500	0.51500	0.05701

PERIOD	10**9 KWH	DEDUC \$10**6	PW FACTOR
1	8.97000	12.83168	0.97137
2	5.53600	6.73830	0.91772
3	6.51700	7.77394	0.87408
4	7.49900	9.38934	0.82722
5	6.79800	8.42871	0.78212
6	6.93800	8.50489	0.74085
7	6.86800	8.40181	0.70159
8	7.01900	8.55272	0.66488
9	6.24600	7.69580	0.63137
10	6.16700	7.67333	0.60063
11	6.02700	7.58111	0.57179
12	5.74700	7.25823	0.54508
13	5.53600	7.01962	0.52045
14	5.39600	6.85756	0.49750
15	5.25600	6.68855	0.47600
16	5.04600	6.45139	0.45594
17	4.90600	6.29369	0.43723
18	4.73000	6.05981	0.41972
19	4.66000	6.39460	0.40323
20	4.69500	8.12442	0.38743

LEVELIZED ENERGY COST FOR EACH BATCH

BATCH	ENERGY	PW ENERGY	LEVEL COST	CUM LVL COST		
1	3.30000	3.20552	2.60235	2.60235	4.04581	1.55468
2	4.90000	4.65778	1.94026	2.21016	8.42890	3.81370
3	6.53700	6.05000	1.60375	1.94647	13.13470	6.74795
4	6.73600	5.85060	1.99366	1.96044	18.79179	9.58549
5	6.87600	5.68371	1.97720	1.96418	24.24214	12.34209
6	7.03800	5.51911	1.93397	1.95880	29.41891	15.01886
7	6.86900	5.09168	1.95145	1.95776	34.23795	17.48831
8	6.94100	4.87383	1.92085	1.95337	38.77846	19.85111
9	6.71100	4.47556	1.91971	1.95005	42.94547	22.02275
10	6.47700	4.10391	1.91845	1.94743	46.76393	24.01314
11	6.14700	3.69753	1.96170	1.94842	50.28185	25.80643
12	5.98000	3.42683	1.95844	1.94903	53.53679	27.46843
13	5.76100	3.14813	1.96558	1.94992	56.53853	28.99527
14	5.54900	2.89361	1.97324	1.95100	59.30777	30.39867
15	5.35600	2.68918	1.96866	1.95173	61.87540	31.70291
16	5.23200	2.49535	1.96786	1.95232	64.25697	32.91315
17	5.07000	2.31614	1.96900	1.95287	66.46881	34.03647
18	4.85400	2.14365	1.98360	1.95378	68.53110	35.07613
19	4.76500	2.00297	1.97751	1.95442	70.45213	36.04756
20	4.69400	1.89401	1.95863	1.95453	72.25131	36.96616
21	3.11900	1.23294	2.48984	1.96305	73.74017	37.56413
22	1.56500	0.60633	3.96512	1.97860	74.90619	37.85820

COST BREAKDOWN BY BATCHES

REFLO PROB P7U3 DECLINING PRICES 0.83 CAPY

BATCH	UF6	SEP DUTY	FABR	REPRCC	PU CRED	U CREDIT	CARRY CHG	TOTAL
1	0.97975	0.20372	0.59868	0.29034	0.25564	0.57449	0.75998	2.60235
2	0.65983	0.54128	0.40319	0.18808	0.21196	0.25857	0.61840	1.94026
3	0.49459	0.40574	0.30223	0.13546	0.17591	0.11853	0.56018	1.60375
4	0.64463	0.60495	0.28844	0.12703	0.17654	0.21569	0.72084	1.99366
5	0.63143	0.59254	0.27652	0.12221	0.17491	0.19196	0.72137	1.97720
6	0.61690	0.57890	0.26593	0.11732	0.17153	0.18087	0.70730	1.93397
7	0.63208	0.59315	0.26382	0.11821	0.17490	0.19528	0.71438	1.95145
8	0.62494	0.58624	0.25681	0.11497	0.17225	0.19697	0.70712	1.92085
9	0.63190	0.58738	0.26295	0.11563	0.17605	0.20271	0.70062	1.91971
10	0.64006	0.58943	0.26832	0.11685	0.18002	0.21189	0.69570	1.91845
11	0.65952	0.60170	0.27934	0.12324	0.18730	0.22173	0.70701	1.96170
12	0.66313	0.59929	0.28715	0.12441	0.19004	0.22845	0.70293	1.95844
13	0.67349	0.60288	0.29396	0.12528	0.19480	0.23737	0.70254	1.96598
14	0.68417	0.60654	0.30090	0.12658	0.19935	0.24881	0.70321	1.97324
15	0.68873	0.60473	0.30502	0.12774	0.19963	0.25606	0.69813	1.96866
16	0.69550	0.60474	0.31005	0.13173	0.20589	0.26410	0.69584	1.96786
17	0.70292	0.60522	0.31527	0.13321	0.20955	0.27196	0.69389	1.96900
18	0.71338	0.60820	0.32660	0.13516	0.21432	0.28060	0.69518	1.98360
19	0.71799	0.60610	0.33046	0.13882	0.22013	0.28820	0.69246	1.97751
20	0.71745	0.60091	0.32976	0.13786	0.22346	0.29256	0.68866	1.95863
21	1.07974	0.50435	0.48771	0.20921	0.25067	0.86877	0.92828	2.48984
22	2.15189	1.80235	0.97199	0.42090	0.33306	2.65428	1.60533	3.96512

CUMULATIVE BATCHWISE CCST BREAKDOWN

REFCO PROB P7U3 DECLINING PRICES C.83 CAPY

BATCH	UF6	SEF DUTY	FABR	REPRCC	PU CRED	U CREDIT	CARRY CHG	TOTAL
1	0.97975	0.80372	0.59868	0.29034	0.25564	0.57449	0.75998	2.60235
2	0.78858	0.64690	0.48187	0.22924	0.22954	0.38571	0.67884	2.21016
3	0.65817	0.53992	0.40218	0.18764	0.20575	0.26720	0.63150	1.94647
4	0.65392	0.56022	0.36650	0.16862	0.19659	0.25104	0.65869	1.96044
5	0.64847	0.56814	0.34469	0.15737	0.19133	0.23671	0.67358	1.96418
6	0.64219	0.57028	0.32901	0.14940	0.18739	0.22560	0.68091	1.95880
7	0.64055	0.57400	0.31842	0.14433	0.18536	0.22067	0.68650	1.95776
8	0.63835	0.57572	0.30972	0.14019	0.18351	0.21733	0.69023	1.95337
9	0.63757	0.57712	0.30411	0.13724	0.18262	0.21558	0.69220	1.95005
10	0.63783	0.57840	0.30039	0.13513	0.18235	0.21519	0.69322	1.94743
11	0.63978	0.58049	0.29851	0.13406	0.18280	0.21578	0.69417	1.94842
12	0.64165	0.58200	0.29759	0.13328	0.18338	0.21680	0.69468	1.94903
13	0.64394	0.58350	0.29733	0.13271	0.18420	0.21827	0.69492	1.94992
14	0.64654	0.58499	0.29756	0.13231	0.18518	0.22025	0.69502	1.95100
15	0.64903	0.58615	0.29801	0.13204	0.18603	0.22237	0.69489	1.95173
16	0.65155	0.58716	0.29866	0.13293	0.18711	0.22463	0.69466	1.95232
17	0.65412	0.58806	0.29949	0.13209	0.18823	0.22699	0.69434	1.95287
18	0.65684	0.58899	0.30073	0.13223	0.18943	0.22946	0.69388	1.95378
19	0.65946	0.58972	0.30201	0.13251	0.19075	0.23198	0.69344	1.95442
20	0.66181	0.59018	0.30313	0.13273	0.19207	0.23443	0.69318	1.95453
21	0.67277	0.59841	0.30797	0.13473	0.19361	0.25106	0.69383	1.96305
22	0.69197	0.61404	0.31659	0.13845	0.19542	0.28225	0.69522	1.97860

APPENDIX F: EXAMPLE OUTPUT, POW76

INPUT DATA POW76 TEST AGAINST REFCO 243 PERIODS

D(IN), N=1.35

100.00000	243.00000	2.00000	0.52000	0.00346	0.00797	0.50000	1000.00000	10.00000	1.00000
24.10912	12.00000	0.0	1.00000	0.03000	0.0	0.00267	0.00029	0.00021	0.0
0.0	0.65000	0.03000	0.0	0.0	0.0	0.0	0.0	25.00000	25.00000
0.0	0.0	0.0	0.0	0.0	0.0				

CONTROL CARD SIGNALS, LL1-LL10

0 0 1 0 0 0 0 0 0 0

EXPENSES IN \$PM PER PERIOD					
INPUT DATA					
PO	CAPY FACTOR	FUEL PURCH	FABR COST	REPR COST	U-PU CRED
1	0.0	9.69949	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	7.93687	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	4.34224	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	6.45281	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	4.07495	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	4.34174	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0
26	0.99997	0.0	0.0	0.0	0.0
27	0.99997	0.0	0.0	0.0	0.0
28	0.99997	0.0	0.0	0.0	0.0
29	0.99997	0.0	0.0	0.0	0.0
30	0.99997	0.0	0.0	0.0	0.0
31	0.99997	4.07431	0.0	0.0	0.0
32	0.99997	0.0	0.0	0.0	0.0
33	0.99997	0.0	2.15087	0.0	0.0
34	0.99997	0.0	0.0	0.0	0.0
35	0.99997	0.0	0.0	0.0	0.0
36	0.99997	4.34174	0.0	0.0	0.0
37	0.99997	0.0	0.0	0.0	0.0
38	0.28757	0.0	0.0	0.0	0.0
39	0.0	0.0	0.0	0.0	0.0
40	0.70798	0.0	0.0	0.0	0.0
41	0.99994	0.0	0.0	0.0	0.0
42	0.99994	4.07431	2.15087	0.0	0.0
43	0.99994	0.0	0.0	0.0	0.0
44	0.99994	0.0	0.0	0.0	0.0
45	0.99994	0.0	0.0	0.0	0.0
46	0.99994	0.0	0.0	0.0	0.0
47	0.87593	0.0	0.0	1.21945	0.0
48	0.0	0.0	0.0	0.0	0.0
49	0.12002	4.34174	0.0	0.0	0.0
50	0.99993	0.0	0.0	0.0	0.84363
51	0.99993	0.0	0.0	0.0	0.0
52	0.99993	0.0	0.0	0.0	1.09382
53	0.99993	0.0	0.0	0.0	0.0
54	0.99993	0.0	2.15087	0.0	0.0
55	0.99993	4.07431	0.0	0.0	0.0
56	0.99993	0.0	0.0	0.0	0.0
57	0.99993	0.0	0.0	1.20959	0.0

124	1.00002	0.0	0.0	0.0	0.0	0.0	0.0
125	1.00002	3.79643	0.0	0.0	0.0	0.0	0.0
126	1.00002	0.0	0.0	1.19704	0.0	0.0	0.0
127	0.08798	0.0	0.0	0.0	0.0	0.0	0.0
128	0.0	0.0	0.0	0.0	0.0	1.19562	0.0
129	0.90801	0.0	0.0	0.0	0.0	0.0	0.0
130	0.99999	0.0	0.0	0.0	0.0	1.36719	0.0
131	0.99999	3.36547	0.0	0.0	0.0	0.0	0.0
132	0.99999	0.0	2.15101	0.0	0.0	0.0	0.0
133	0.99999	0.0	0.0	0.0	0.0	0.0	0.0
134	0.99999	0.0	0.0	0.0	0.0	0.0	0.0
135	0.99999	3.71641	0.0	0.0	0.0	0.0	0.0
136	0.99999	0.0	0.0	1.19818	0.0	0.0	0.0
137	0.53997	0.0	0.0	0.0	0.0	0.0	0.0
138	0.0	0.0	0.0	0.0	0.0	0.0	0.0
139	0.45403	0.0	0.0	0.0	0.0	1.18146	0.0
140	1.00002	0.0	0.0	0.0	0.0	0.0	0.0
141	1.00002	3.26311	0.0	0.0	0.0	1.36040	0.0
142	1.00002	0.0	2.15101	0.0	0.0	0.0	0.0
143	1.00002	0.0	0.0	0.0	0.0	0.0	0.0
144	1.00002	0.0	0.0	0.0	0.0	0.0	0.0
145	1.00002	3.63885	0.0	0.0	0.0	0.0	0.0
146	1.00002	0.0	0.0	0.0	0.0	0.0	0.0
147	0.79999	0.0	0.0	1.19955	0.0	0.0	0.0
148	0.0	0.0	0.0	0.0	0.0	0.0	0.0
149	0.19604	0.0	0.0	0.0	0.0	1.16602	0.0
150	1.00008	0.0	0.0	0.0	0.0	0.0	0.0
151	1.00008	3.16358	0.0	0.0	0.0	1.37240	0.0
152	1.00008	0.0	2.15094	0.0	0.0	0.0	0.0
153	1.00008	0.0	0.0	0.0	0.0	0.0	0.0
154	1.00008	3.56382	0.0	0.0	0.0	0.0	0.0
155	1.00008	0.0	0.0	0.0	0.0	0.0	0.0
156	1.00008	0.0	0.0	0.0	0.0	0.0	0.0
157	0.67602	0.0	0.0	1.20061	0.0	0.0	0.0
158	0.0	0.0	0.0	0.0	0.0	0.0	0.0
159	0.32002	0.0	0.0	0.0	0.0	1.15186	0.0
160	0.99994	3.06848	0.0	0.0	0.0	0.0	0.0
161	0.99994	0.0	0.0	0.0	0.0	0.0	0.0
162	0.99994	0.0	2.15101	0.0	0.0	1.36297	0.0
163	0.99994	3.49128	0.0	0.0	0.0	0.0	0.0
164	0.99994	0.0	0.0	0.0	0.0	0.0	0.0
165	0.99994	0.0	0.0	0.0	0.0	0.0	0.0
166	0.99994	0.0	0.0	0.0	0.0	0.0	0.0
167	0.26395	0.0	0.0	1.20178	0.0	0.0	0.0
168	0.0	0.0	0.0	0.0	0.0	0.0	0.0
169	0.73202	2.97651	0.0	0.0	0.0	1.13642	0.0
170	0.99997	0.0	0.0	0.0	0.0	0.0	0.0
171	0.99997	0.0	0.0	0.0	0.0	0.0	0.0
172	0.99997	3.42124	2.15101	0.0	0.0	1.36612	0.0
173	0.99997	0.0	0.0	0.0	0.0	0.0	0.0
174	0.99997	0.0	0.0	0.0	0.0	0.0	0.0
175	0.99997	0.0	0.0	0.0	0.0	0.0	0.0
176	0.65994	0.0	0.0	1.20291	0.0	0.0	0.0
177	0.0	0.0	0.0	0.0	0.0	0.0	0.0
178	0.53604	2.88805	0.0	0.0	0.0	0.0	0.0
179	1.00000	0.0	0.0	0.0	0.0	1.12226	0.0
180	1.00000	0.0	2.15101	0.0	0.0	0.0	0.0
181	1.00000	3.36771	0.0	0.0	0.0	1.36750	0.0
182	1.00000	0.0	0.0	0.0	0.0	0.0	0.0
183	1.00000	0.0	0.0	0.0	0.0	0.0	0.0
184	1.00000	0.0	0.0	0.0	0.0	0.0	0.0
185	0.86397	0.0	0.0	0.0	0.0	0.0	0.0
186	0.0	0.0	0.0	0.0	0.0	0.0	0.0
187	0.13204	2.82067	0.0	1.20406	0.0	0.0	0.0
188	1.00005	0.0	0.0	0.0	0.0	0.0	1.10617
189	1.00005	0.0	2.15101	0.0	0.0	0.0	0.0

190	1.00005	3.36771	0.0	0.0	0.0
191	1.00005	0.0	0.0	0.0	1.38063
192	1.00005	0.0	0.0	0.0	0.0
193	1.00005	0.0	0.0	0.0	0.0
194	0.77984	0.0	0.0	0.0	0.0
195	0.0	0.0	0.0	1.20628	0.0
196	0.21608	2.82067	0.0	0.0	0.0
197	1.00008	0.0	0.0	0.0	1.07722
198	1.00008	3.36771	2.15101	0.0	0.0
199	1.00008	0.0	0.0	0.0	0.0
200	1.00008	0.0	0.0	0.0	1.38170
201	1.00009	0.0	0.0	0.0	0.0
202	1.00008	0.0	0.0	0.0	0.0
203	0.50395	0.0	0.0	0.0	0.0
204	0.0	2.82067	0.0	1.10613	0.0
205	0.49215	0.0	0.0	0.0	0.0
206	0.99992	0.0	2.15101	0.0	1.07722
207	0.99992	0.0	0.0	0.0	0.0
208	0.99992	0.0	0.0	0.0	0.0
209	0.99992	0.0	0.0	0.0	1.38179
210	0.99992	0.0	0.0	0.0	0.0
211	0.98783	0.0	0.0	0.0	0.0
212	0.0	0.0	0.0	0.0	0.0
213	0.0	0.0	0.0	1.20706	0.0
214	1.00814	0.0	0.0	0.0	0.0
215	0.99996	0.0	2.15101	0.0	1.06242
216	0.99996	0.0	0.0	0.0	0.0
217	0.99996	0.0	0.0	0.0	1.37864
218	0.99996	0.0	0.0	0.0	0.0
219	0.99996	0.0	0.0	0.0	0.0
220	0.37578	0.0	0.0	0.0	0.0
221	0.0	0.0	0.0	1.20792	0.0
222	0.62026	0.0	0.0	0.0	0.0
223	0.99993	0.0	0.0	0.0	1.04890
224	0.99993	0.0	0.0	0.0	0.0
225	0.99993	0.0	0.0	0.0	0.0
226	0.99993	0.0	0.0	0.0	1.37926
227	0.99993	0.0	0.0	0.0	0.0
228	0.81159	0.0	0.0	0.0	0.0
229	0.0	0.0	0.0	1.20792	0.0
230	0.0	0.0	0.0	0.0	0.0
231	0.0	0.0	0.0	0.0	0.0
232	0.0	0.0	0.0	0.0	1.04890
233	0.0	0.0	0.0	0.0	0.0
234	0.0	0.0	0.0	0.0	1.37926
235	0.0	0.0	0.0	0.0	0.0
236	0.0	0.0	0.0	0.0	0.0
237	0.0	0.0	0.0	0.0	0.0
238	0.0	0.0	0.0	3.62376	0.0
239	0.0	0.0	0.0	0.0	0.0
240	0.0	0.0	0.0	0.0	3.14671
241	0.0	0.0	0.0	0.0	0.0
242	0.0	0.0	0.0	0.0	0.0
243	0.0	0.0	0.0	0.0	4.11978

FIXED CHARGE RATES ON NONDEPRECIABLE CAPITAL
 USING CONSTANT CAPACITY FACTOR 0.01163
 USING VARIABLE CAPACITY FACTOR 0.01152

FUEL CYCLE COST, MILLS/KWH 2.086168

SAME USING FCRN 2.191711
SAME USING FCRNP 2.183407

	CAPITAL	INCOME	EXP	INTEREST	PROPERTY	DEDUCTBL	REVN TAX	S INC TX	F INC TX	CASH EXP	CAPITAL
1	0.0	0.0	9.69948	0.0	0.0	0.0	0.0	0.0	0.0	9.69948	9.69948
2	9.69948	0.0	0.0	0.05457	0.0	0.0	0.0	-0.00052	-0.00846	-0.00898	9.74507
3	9.74507	0.0	0.0	0.05483	0.0	0.0	0.0	-0.00053	-0.00850	-0.00903	9.79087
4	9.79087	0.0	0.0	0.05508	0.0	0.0	0.0	-0.00053	-0.00854	-0.00907	9.83688
5	9.83688	0.0	0.0	0.05534	0.0	0.0	0.0	-0.00053	-0.00858	-0.00911	9.88311
6	9.88311	0.0	0.0	0.05560	0.0	0.0	0.0	-0.00053	-0.00862	-0.00915	9.92956
7	9.92956	0.0	7.95687	0.05586	0.0	0.0	0.0	-0.00054	-0.00866	7.94767	17.93709
8	17.93309	0.0	0.0	0.10089	0.0	0.0	0.0	-0.00097	-0.01564	-0.01661	18.01736
9	18.01736	0.0	0.0	0.10137	0.0	0.0	0.0	-0.00097	-0.01572	-0.01669	18.10204
10	18.10204	0.0	0.0	0.10184	0.0	0.0	0.0	-0.00098	-0.01579	-0.01677	18.18710
11	18.18710	0.0	0.0	0.10232	0.0	0.0	0.0	-0.00098	-0.01586	-0.01684	18.27257
12	18.27257	0.0	0.0	0.10280	0.0	0.0	0.0	-0.00099	-0.01594	-0.01692	18.35844
13	18.35844	0.0	0.0	0.10328	0.0	0.0	0.0	-0.00099	-0.01601	-0.01700	18.44472
14	18.44472	0.0	0.0	0.10377	0.0	0.0	0.0	-0.00100	-0.01609	-0.01708	18.53140
15	18.53140	0.0	4.34224	0.10426	0.0	0.0	0.0	-0.00100	-0.01616	4.32507	22.96072
16	22.96072	0.0	0.0	0.12918	0.0	0.0	0.0	-0.00124	-0.02003	-0.02127	23.06863
17	23.06863	0.0	6.45281	0.12978	0.0	0.0	0.0	-0.00124	-0.02012	6.43145	29.62985
18	29.62985	0.0	0.0	0.16670	0.0	0.0	0.0	-0.00160	-0.02584	-0.02744	29.76910
19	29.76910	0.0	0.0	0.16748	0.0	0.0	0.0	-0.00161	-0.02597	-0.02757	29.90901
20	29.90901	0.0	0.0	0.16827	0.0	0.0	0.0	-0.00161	-0.02609	-0.02770	30.04958
21	30.04958	0.0	4.07495	0.16906	0.0	0.0	0.0	-0.00162	-0.02621	4.04712	34.26575
22	34.26575	0.0	0.0	0.19278	0.0	0.0	0.0	-0.00185	-0.02989	-0.03174	34.42679
23	34.42679	0.0	0.0	0.19368	0.0	0.0	0.0	-0.00186	-0.03003	-0.03189	34.58858
24	34.58858	0.0	4.34174	0.19459	0.0	0.0	0.0	-0.00187	-0.03017	4.30970	39.09286
25	39.09286	0.0	0.0	0.21994	0.04681	0.0	0.0	-0.00351	-0.05680	-0.01350	39.29929
26	39.29929	1.52286	0.0	0.22110	0.04681	1.07165	0.0	0.01001	0.16186	0.21868	38.21620
27	38.21620	1.52286	0.0	0.21500	0.04681	1.07165	0.0	0.01007	0.16280	0.21968	37.12802
28	37.12802	1.52286	0.0	0.20888	0.04681	1.07165	0.0	0.01013	0.16375	0.22069	36.03473
29	36.03473	1.52286	0.0	0.20273	0.04681	1.07165	0.0	0.01019	0.16470	0.22170	34.93629
30	34.93629	1.52286	0.0	0.19655	0.04681	1.07165	0.0	0.01025	0.16566	0.22272	33.83270
31	33.83270	1.52286	4.07431	0.19034	0.04681	1.07165	0.0	0.01031	0.16662	0.22374	32.72923
32	32.72923	1.52286	0.0	0.20703	0.04681	1.07165	0.0	0.01035	0.16758	0.22476	31.62576
33	31.62576	1.52286	2.15087	0.20087	0.04681	1.07165	0.0	0.01041	0.16854	0.22578	30.52229
34	30.52229	1.52286	0.0	0.20678	0.04681	1.07165	0.0	0.01045	0.16950	0.22680	29.41882
35	29.41882	1.52286	0.0	0.20062	0.04681	1.07165	0.0	0.01051	0.17046	0.22782	28.31535
36	28.31535	1.52286	4.34174	0.19443	0.04681	1.07165	0.0	0.01057	0.17142	0.22884	27.21188
37	27.21188	1.52286	0.0	0.21264	0.04681	1.07165	0.0	0.01063	0.17238	0.22986	26.10841
38	26.10841	0.43855	0.0	0.20650	0.04681	0.30861	0.0	0.00051	0.00830	0.05563	36.52878
39	36.52878	0.0	0.0	0.20551	0.04681	0.0	0.0	-0.00338	-0.05457	-0.01113	36.72316
40	36.72316	1.07819	0.0	0.20660	0.04681	0.75873	0.0	0.00620	0.10020	0.15321	36.07478
41	36.07478	1.52281	0.0	0.20256	0.04681	1.07162	0.0	0.01019	0.16472	0.22172	34.97623
42	34.97623	1.52281	6.22518	0.19638	0.04681	1.07162	0.0	0.01025	0.16568	0.22274	33.87276
43	33.87276	1.52281	0.0	0.22519	0.04681	1.07162	0.0	0.00997	0.16121	0.21870	32.76929
44	32.76929	1.52281	0.0	0.21912	0.04681	1.07162	0.0	0.01003	0.16216	0.21900	31.66582
45	31.66582	1.52281	0.0	0.21302	0.04681	1.07162	0.0	0.01009	0.16310	0.22000	30.56235
46	30.56235	1.52281	0.0	0.20689	0.04681	1.07162	0.0	0.01015	0.16405	0.22101	29.45888
47	29.45888	1.33395	1.21945	0.20073	0.04681	0.93871	0.0	0.00853	0.13787	1.41265	35.95808
48	35.95808	0.0	0.0	0.20230	0.04681	0.0	0.0	-0.00334	-0.05407	-0.01060	36.14978
49	36.14978	0.18278	4.34174	0.20338	0.04681	0.12862	0.0	-0.00173	-0.02797	4.35885	40.52922
50	40.52922	1.52280	-0.84363	0.22802	0.04681	1.07161	0.0	0.00994	0.16077	-0.62610	38.60834
51	38.60834	1.52280	0.0	0.21721	0.04681	1.07161	0.0	0.01005	0.16245	0.21931	37.50487
52	37.50487	1.52280	-1.89582	0.21110	0.04681	1.07161	0.0	0.01011	0.16340	-1.67551	34.53484
53	34.53484	1.52280	2.15087	0.19429	0.04681	1.07161	0.0	0.01027	0.16600	2.37395	35.58026
54	35.58026	1.52280	0.0	0.20017	0.04681	1.07161	0.0	0.01021	0.16509	0.22212	34.47975
55	34.47975	1.52280	4.07431	0.19398	0.04681	1.07161	0.0	0.01027	0.16605	4.29745	37.44838
56	37.44838	1.52280	0.0	0.21068	0.04681	1.07161	0.0	0.01011	0.16346	0.22039	36.35664
57	36.35664	1.52280	1.20959	0.20454	0.04681	1.07161	0.0	0.01017	0.16441	1.43099	36.46936

124	29.90388	1.52253	0.0	0.16824	0.04681	1.07170	0.0	0.01052	0.17006	0.22739	28.77658
125	28.77658	1.52253	3.79443	0.16190	0.04681	1.07170	0.0	0.01058	0.17104	4.02487	31.44041
126	31.44041	1.52253	1.19704	0.17688	0.04681	1.07170	0.0	0.01044	0.16872	1.42701	31.51736
127	31.51736	0.13399	0.0	0.17732	0.04681	0.09429	0.0	-0.00191	-0.03094	0.01396	31.57465
128	31.57465	0.0	-1.19562	0.17764	0.04681	0.0	0.0	-0.00311	-0.05024	-1.20216	30.55013
129	30.55013	1.38282	0.0	0.17187	0.04681	0.97310	0.0	0.00324	0.14934	0.20541	29.54459
130	29.54459	1.52289	-1.36719	0.16622	0.04681	1.07167	0.0	0.01054	0.17037	-1.13947	27.04243
131	27.04843	1.52289	3.36567	0.15217	0.04681	1.07167	0.0	0.01067	0.17255	3.59570	29.27341
132	29.27341	1.52289	2.15101	0.16469	0.04681	1.07167	0.0	0.01055	0.17061	2.37898	30.29417
133	30.29417	1.52289	0.0	0.17043	0.04681	1.07167	0.0	0.01050	0.16971	0.22703	29.16873
134	29.16873	1.52289	0.0	0.16410	0.04681	1.07167	0.0	0.01056	0.17070	0.22867	28.03801
135	28.03801	1.52289	3.71641	0.15774	0.04681	1.07167	0.0	0.01062	0.17168	3.94552	30.61838
136	30.61838	1.52289	1.19818	0.17226	0.04691	1.07167	0.0	0.01048	0.16943	1.42491	30.69264
137	30.69264	0.82233	0.0	0.17268	0.04681	0.57868	0.0	0.00425	0.06870	0.11976	30.16273
138	30.16273	0.0	0.0	0.16969	0.04681	0.0	0.0	-0.00303	-0.04901	-0.00523	30.32719
139	30.32719	0.69449	-1.18146	0.17062	0.04681	0.48872	0.0	0.00313	0.05064	-1.08087	28.72244
140	28.72244	1.52253	0.0	0.16159	0.04681	1.07170	0.0	0.01058	0.17109	0.22849	27.58958
141	27.58958	1.52253	1.90271	0.15522	0.04681	1.07170	0.0	0.01064	0.17208	2.13225	28.35411
142	28.35411	1.52253	2.15101	0.15952	0.04681	1.07170	0.0	0.01060	0.17141	2.37984	29.37053
143	29.37053	1.52253	0.0	0.16524	0.04681	1.07170	0.0	0.01055	0.17053	0.22789	28.24072
144	28.24072	1.52253	0.0	0.15888	0.04681	1.07170	0.0	0.01061	0.17151	0.22893	27.10561
145	27.10561	1.52253	3.63885	0.15250	0.04681	1.07170	0.0	0.01067	0.17250	3.84884	29.60403
146	29.60400	1.52253	0.0	0.16655	0.04681	1.07170	0.0	0.01054	0.17032	0.22767	28.47530
147	28.47530	1.21830	1.19955	0.16020	0.04681	0.85733	0.0	0.00789	0.12753	1.38178	28.79877
148	28.79877	0.0	0.0	0.16202	0.04681	0.0	0.0	-0.00296	-0.04782	-0.00397	28.95702
149	28.95702	0.29856	-1.16602	0.16291	0.04681	0.21010	0.0	-0.00031	-0.00506	-1.12458	27.69679
150	27.69679	1.52302	0.0	0.15582	0.04681	1.07176	0.0	0.01064	0.17200	0.22945	26.55904
151	26.55904	1.52302	1.79158	0.14942	0.04681	1.07176	0.0	0.01070	0.17299	2.02208	27.20750
152	27.20750	1.52302	2.15094	0.15307	0.04681	1.07176	0.0	0.01067	0.17243	2.38034	28.21838
153	28.21838	1.52302	0.0	0.15876	0.04681	1.07176	0.0	0.01061	0.17154	0.22897	27.08308
154	27.08308	1.52302	3.56382	0.15237	0.04681	1.07176	0.0	0.01067	0.17253	3.79383	29.50626
155	29.50626	1.52302	0.0	0.16600	0.04681	1.07176	0.0	0.01054	0.17042	0.22777	28.37701
156	28.37701	1.52302	0.0	0.15965	0.04681	1.07176	0.0	0.01060	0.17141	0.22882	27.24246
157	27.24246	1.02950	1.20061	0.15327	0.04681	0.72447	0.0	0.00628	0.10148	1.35517	27.72139
158	27.72139	0.0	0.0	0.15596	0.04681	0.0	0.0	-0.00290	-0.04688	-0.00297	27.87437
159	27.87437	0.48736	-1.15186	0.15682	0.04681	0.34296	0.0	0.00142	0.02302	-1.08061	26.46323
160	26.46323	1.52281	3.06848	0.14888	0.04681	1.07162	0.0	0.01070	0.17305	3.29904	28.38832
161	28.38832	1.52281	0.0	0.15971	0.04681	1.07162	0.0	0.01060	0.17137	0.22878	27.25400
162	27.25400	1.52281	0.78804	0.15333	0.04681	1.07162	0.0	0.01066	0.17236	1.01787	26.90237
163	26.90237	1.52281	3.49124	0.15135	0.04681	1.07162	0.0	0.01068	0.17266	3.72143	29.25233
164	29.25233	1.52281	0.0	0.16457	0.04681	1.07162	0.0	0.01055	0.17061	0.22798	28.12207
165	28.12207	1.52281	0.0	0.15821	0.04681	1.07162	0.0	0.01061	0.17160	0.22903	26.98650
166	26.98650	1.52281	0.0	0.15183	0.04681	1.07162	0.0	0.01068	0.17259	0.23002	25.84558
167	25.84558	0.40157	1.20178	0.14541	0.04681	0.28287	0.0	0.00077	0.01252	1.26188	26.85089
168	26.85089	0.0	0.0	0.15106	0.04681	0.0	0.0	-0.00285	-0.04612	-0.00216	26.99979
169	26.99979	1.11479	1.84009	0.15190	0.04681	0.78449	0.0	0.00705	0.11394	2.00789	28.04478
170	28.04478	1.52286	0.0	0.15778	0.04681	1.07165	0.0	0.01062	0.17167	0.22910	26.90880
171	26.90880	1.52286	2.15101	0.15139	0.04681	1.07165	0.0	0.01068	0.17266	2.38116	27.91849
172	27.91849	1.52286	2.05512	0.15707	0.04681	1.07165	0.0	0.01063	0.17178	2.28434	28.83704
173	28.83704	1.52286	0.0	0.16224	0.04681	1.07165	0.0	0.01058	0.17098	0.22837	27.70477
174	27.70477	1.52286	0.0	0.15587	0.04681	1.07165	0.0	0.01064	0.17197	0.22942	26.56720
175	26.56720	1.52286	0.0	0.14947	0.04681	1.07165	0.0	0.01070	0.17296	0.23047	25.42427
176	25.42427	1.00502	1.20291	0.14304	0.04681	0.70724	0.0	0.00616	0.09954	1.35542	25.91771
177	25.91771	0.0	0.0	0.14581	0.04681	0.0	0.0	-0.00280	-0.04531	-0.00130	26.06221
178	26.06221	0.51176	2.88805	0.14663	0.04681	0.36013	0.0	0.00174	0.02811	2.96470	28.66176
179	28.66176	1.52250	-1.12226	0.16125	0.04681	1.07168	0.0	0.01059	0.17114	-0.89372	26.40637
180	26.40637	1.52250	2.15101	0.14856	0.04681	1.07168	0.0	0.01071	0.17311	2.38164	27.41367
181	27.41367	1.52250	2.00022	0.15423	0.04681	1.07168	0.0	0.01065	0.17223	2.22991	28.27490
182	28.27490	1.52250	0.0	0.15907	0.04681	1.07168	0.0	0.01061	0.17148	0.22890	27.13997
183	27.13997	1.52250	0.0	0.15269	0.04681	1.07168	0.0	0.01067	0.17247	0.22995	25.99969
184	25.99969	1.52250	0.0	0.14627	0.04681	1.07168	0.0	0.01073	0.17346	0.23100	24.85406
185	24.85406	1.31574	0.0	0.13983	0.04681	0.92590	0.0	0.00895	0.14469	0.20045	23.87860
186	23.87860	0.0	1.20406	0.13434	0.04681	0.0	0.0	-0.00269	-0.04353	1.20465	25.21759
187	25.21759	0.20108	2.82067	0.14187	0.04681	0.14150	0.0	-0.00098	-0.01580	2.85070	28.00908
188	28.00908	1.52257	-1.10617	0.15758	0.04681	1.07173	0.0	0.01062	0.17172	-0.87702	25.76666
189	25.76666	1.52257	2.15101	0.14496	0.04681	1.07173	0.0	0.01074	0.17368	2.38224	26.77089

190	26.77089	1.52257	3.36771	0.15061	0.04681	1.07173	0.0	0.01069	0.17280	3.59801	28.99654
191	26.99654	1.52257	-1.38063	0.16313	0.04681	1.07173	0.0	0.01057	0.17086	-1.15239	26.48430
192	26.48430	1.52257	0.0	0.14900	0.04681	1.07173	0.0	0.01070	0.17305	0.23057	25.34088
193	25.34088	1.52257	0.0	0.14257	0.04681	1.07173	0.0	0.01077	0.17405	0.23163	24.19209
194	24.19209	1.18768	0.0	0.13610	0.04681	0.83578	0.0	0.00785	0.12687	0.18153	23.32204
195	23.32204	0.0	1.20626	0.13121	0.04681	0.0	0.0	-0.00266	-0.04305	1.20738	24.66063
196	24.66063	0.32907	2.82067	0.13874	0.04681	0.23157	0.0	0.00019	0.00307	2.87075	27.34103
197	27.34103	1.52302	-1.07722	0.15382	0.04681	1.07176	0.0	0.01066	0.17231	-0.84744	25.12439
198	25.12439	1.52302	5.51873	0.14135	0.04681	1.07176	0.0	0.01078	0.17424	5.75056	29.49327
199	29.49327	1.52302	0.0	0.16593	0.04681	1.07176	0.0	0.01054	0.17043	0.22779	28.36395
200	28.36395	1.52302	-1.38170	0.15957	0.04681	1.07176	0.0	0.01060	0.17142	-1.15287	25.84763
201	25.84763	1.52302	0.0	0.14542	0.04681	1.07176	0.0	0.01074	0.17361	0.23116	24.70117
202	24.70117	1.52302	0.0	0.13897	0.04681	1.07176	0.0	0.01080	0.17461	0.23222	23.54933
203	23.54933	0.76746	0.0	0.13249	0.04681	0.54007	0.0	0.00415	0.06704	0.11800	23.03235
204	23.03235	0.0	4.02680	0.12958	0.04681	0.0	0.0	-0.00265	-0.04279	4.02817	27.19009
205	27.19009	0.74949	0.0	0.15297	0.04681	0.52742	0.0	0.00379	0.06128	0.11189	26.70546
206	26.70546	1.52277	1.07379	0.15024	0.04681	1.07159	0.0	0.01069	0.17283	1.30412	26.63705
207	26.63705	1.52277	0.0	0.14986	0.04681	1.07159	0.0	0.01069	0.17289	0.23039	25.49452
208	25.49452	1.52277	0.0	0.14343	0.04681	1.07159	0.0	0.01076	0.17388	0.23145	24.34663
209	24.34663	1.52277	-1.38179	0.13657	0.04681	1.07159	0.0	0.01082	0.17489	-1.14927	21.81155
210	21.81155	1.52277	0.0	0.12271	0.04681	1.07159	0.0	0.01095	0.17710	0.23486	20.64635
211	20.64635	1.50437	0.0	0.11616	0.04681	1.05864	0.0	0.01085	0.17547	0.23313	19.49126
212	19.49126	0.0	0.0	0.10966	0.04681	0.0	0.0	-0.00246	-0.03970	0.00465	19.60556
213	19.60556	0.0	1.20706	0.11030	0.04681	0.0	0.0	-0.00246	-0.03980	1.21160	20.92746
214	20.92746	1.53529	0.0	0.11774	0.04681	1.08040	0.0	0.01111	0.17967	0.23759	19.74748
215	19.74748	1.52284	1.08859	0.11110	0.04681	1.07163	0.0	0.01107	0.17891	1.32538	19.66112
216	19.66112	1.52284	0.0	0.11061	0.04681	1.07163	0.0	0.01107	0.17898	0.23687	18.48575
217	18.48575	1.52284	-1.37884	0.10400	0.04681	1.07163	0.0	0.01113	0.18001	-1.14088	15.92603
218	15.92603	1.52284	0.0	0.08960	0.04681	1.07163	0.0	0.01127	0.18224	0.24032	14.73311
219	14.73311	1.52284	0.0	0.08289	0.04681	1.07163	0.0	0.01134	0.18328	0.24143	13.53459
220	13.53459	0.57227	0.0	0.07615	0.04681	0.40271	0.0	0.00295	0.04773	0.09749	13.13596
221	13.13596	0.0	1.20792	0.07390	0.04681	0.0	0.0	-0.00211	-0.03416	1.21846	14.42831
222	14.42831	0.94459	0.0	0.08117	0.04681	0.66472	0.0	0.00621	0.10045	0.15348	13.71837
223	13.71837	1.52280	-1.04890	0.07718	0.04681	1.07160	0.0	0.01139	0.18416	-0.80654	11.46622
224	11.46622	1.52280	0.0	0.06451	0.04681	1.07160	0.0	0.01151	0.18612	0.24445	10.25238
225	10.25238	1.52280	0.0	0.05768	0.04681	1.07160	0.0	0.01158	0.18718	0.24557	9.03283
226	9.03283	1.52280	-1.37326	0.05082	0.04681	1.07160	0.0	0.01164	0.18825	-1.12656	6.43430
227	6.43430	1.52280	0.0	0.03620	0.04681	1.07160	0.0	0.01178	0.19051	0.24911	5.19681
228	5.19681	1.23557	0.0	0.02924	0.04681	0.86976	0.0	0.00930	0.15037	0.20649	4.19657
229	4.19657	0.0	1.20792	0.02361	0.04681	0.0	0.0	-0.00163	-0.02636	1.22674	5.44691
230	5.44691	0.0	0.0	0.03064	0.04681	0.0	0.0	-0.00170	-0.02745	0.01766	5.49521
231	5.49521	0.0	0.0	0.03092	0.04681	0.0	0.0	-0.00170	-0.02750	0.01761	5.54374
232	5.54374	0.0	-1.04890	0.03119	0.04681	0.0	0.0	-0.00170	-0.02754	-1.03133	4.54360
233	4.54360	0.0	0.0	0.02556	0.04681	0.0	0.0	-0.00165	-0.02667	0.01850	4.58766
234	4.58766	0.0	-1.37326	0.02581	0.04681	0.0	0.0	-0.00165	-0.02671	-1.35480	3.25867
235	3.25867	0.0	0.0	0.01833	0.04681	0.0	0.0	-0.00158	-0.02555	0.01969	3.29668
236	3.29668	0.0	0.0	0.01855	0.04681	0.0	0.0	-0.00158	-0.02558	0.01965	3.33488
237	3.33488	0.0	0.0	0.01876	0.04681	0.0	0.0	-0.00158	-0.02561	0.01962	3.37326
238	3.37326	0.0	3.62376	0.01898	0.04681	0.0	0.0	-0.00159	-0.02565	3.64334	7.03557
239	7.03557	0.0	0.0	0.03958	0.04681	0.0	0.0	-0.00178	-0.02884	0.01619	7.09134
240	7.09134	0.0	-3.14671	0.03990	0.04681	0.0	0.0	-0.00179	-0.02889	-3.13057	4.00066
241	4.00066	0.0	0.0	0.02251	0.04681	0.0	0.0	-0.00162	-0.02619	0.01900	4.04217
242	4.04217	0.0	0.0	0.02274	0.04681	0.0	0.0	-0.00162	-0.02623	0.01896	4.08387
243	4.08387	0.0	-4.11978	0.02298	0.04681	0.0	0.0	-0.00162	-0.02627	-4.10085	0.00599

7. NOTATION

- A_p = Annual amount paid for property taxes and insurance, \$.
 b = Fraction of investment in bonds (debt).
 f_c = Fraction of core value for tax assessment.
 F_n = tax-deductible fuel expense in period n , \$.
 g = Equivalent annual continuous interest rate.
 i_a = Average cost of money = $bi_b + (1 - b)i_e$.
 i_b = Annual interest rate on debt.
 i_e = Annual after-tax earning rate on equity.
 I_p = Total present worth of incomes from t_1 to t_2 , \$.
 i_v = Modified interest rate = $(1 - k_t)bi_b + (1 - b)i_e$.
 i_{vs} = Modified interest rate = $(1 - k_m)bi_b + (1 - b)i_e$.
 J_n = Cash expenditure in period n , \$.
 J'_n = Cash expenditures in period n , including preoperational periods.
 k_b = Property insurance rate.
 $k_c = (1 - k_s)(k_v f_c + k_b)$.
 $k_e = 1 - (1 - k_t)(1 - k_w)$.
 $k_f = 1 - (1 - k_t)k_c \sum P_{n,vs}$.
 $k_m = 1 - (1 - k_t)(1 - k_s)$.
 k_r = Gross revenues tax rate.
 k_s = State income tax rate.
 k_t = Federal income tax rate.
 k_v = Property tax rate.
 $k_w = 1 - (1 - k_r)(1 - k_s)$.
 L_n = Annual fixed charge rate on nondepreciable capital.
 ϕ_i = Uniform continuous discount factor for period i .

$P_{n,vs}$ = Discrete discount factor for period n at interest rate i_{vs} .

P_t = Continuous discount factor at time t .

q = Rate of income from t_1 to t_2 , \$/year.

t = Time, years after reactor startup.

t_1 = Initial point of continuous time interval.

t_2 = Final point of continuous time interval.

U_F = Levelized fuel cycle cost, mills/kWhr.

V_0 = Price paid for initial core, \$.

Z_n = Electricity produced in period n , kWhr.

8. REFERENCES

1. R. Salmon, A Procedure and a Computer Code (POWERCO) for Calculating the Cost of Electricity Produced by Nuclear Power Stations, ORNL-3944 (June 1966).
2. R. Salmon, A Revision of Computer Code POWERCO (Cost of Electricity Produced by Nuclear Power Stations) to Include Breakdowns of Power Cost and Fixed Charge Rates, ORNL-4116 (August 1969).
3. Current Status and Future Technical and Economic Potential of Light Water Reactors, USAEC Report WASH-1082 (March 1968).
4. Reactor Fuel Cycle Costs for Nuclear Power Evaluation, USAEC Report WASH-1099 (in press).