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**PREMOR: A Point Reactor Exposure Model
Computer Code for Survey Analysis of
Power Plant Performance**

D. R. Vondy

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D. R. Vondy

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NOTE

In earlier publications this report
may have been erroneously identified
as ORNL-6229.

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ABSTRACT

The PREMOR computer code was written to exploit a simple, two-group point nuclear reactor power plant model for survey analysis. Up to thirteen actinides, fourteen fission products, and one lumped absorber nuclide densities are followed over a reactor history. Successive feed batches are accounted for with provision for from one to twenty batches resident. The effect on exposure of each of the batches to the same neutron flux is determined.

The requirements for a critical system and desired power level are satisfied by a direct iteration procedure that adjusts the actinide feed composition as necessary. Elaborate edits report such results as the neutron absorption distribution, nuclide concentrations, fuel cost and ore requirements, and such integral information as the simple fuel conversion ratio and doubling time, fuel consumption rate, effective neutron production per absorption and reactivity importance of the nuclides, at selected points in the history. Only the essential amount of calculation is done to produce adequate results for parameter studies at a low cost of computation. Iteration may be done to an optimum fuel cost, or succeeding problems solved to vary the neutron loss fraction. Locally a load module is available for application which was generated from the Fortran source program. The code has been used extensively for analysis of the graphite moderated, gas cooled reactor concept. This report documents the equations programmed and discusses application.

Computer Code PREMOR Abstract

1. Program Identification: PREMOR, a point, two-group reactor exposure model computer code.
2. Function: Survey analysis of reactor performance in a power plant with emphasis on quick solutions, and de-emphasis of the neutronics, eigenvalue problem.
3. Method of solution: Nested loops are used to follow the reactor history with delayed recycle and direct iteration to required feed conditions to satisfy the critical state.
4. Related Material: (Two group microscopic cross sections, and correlation data, must be supplied.)
5. Restrictions: No severe ones.
6. Computer: IBM 360 series.
7. Running Time: Reactor histories are done in seconds of IBM 360/91 computer time.
8. Programming Languages: FORTRAN.
9. Operating System: IBM OS-360 under HASP with FORTRAN IV, H level compiler version 21.8.
10. Machine Requirements: 68,000 short word memory needed for the compile step, no auxiliary data input/output.
11. Author: D. R. Vondy, ORNL, Box X, Oak Ridge, Tennessee.
12. Reference: D. R. Vondy, "PREMOR: A Point Reactor Exposure Model Computer Code for Survey Analysis of Power Plant Performance," DOE Report, ORNL-6229 (1979), this report.
13. Material Available: Source Deck.

INTRODUCTION

The need to apply a simple reactor model arose in the local effort on assessment of nuclear reactor power plant performance. Attention can be paid to many aspects with a simple model which lie outside our capability for analysis with the major neutronics codes which consider one or more space coordinates and exposure. A simple model is especially useful for parameter studies considering the much higher computation cost when an elaborate model is treated. Typically the 24 nuclide densities of a point model become 360 in one dimension, 3,600 in two, and 36,000 in three dimensions, or more, and calculation cost is proportionally higher, or even more, to account for spacial variation.

The original effort was directed at satisfying relatively simple requirements in a specific application, specifically the behavior in a neutronics and fissile mass balance sense of successive batches of feed material. The author was also interested in testing certain methods of calculation including the iterative procedure for establishing the feed composition to satisfy the reactivity requirement, due to applicability in our more sophisticated codes. An average generation rate, difference method for solution of the chain equations was suspect from the first application, so a parallel explicit solution was added, and then this was adopted as the default procedure.

Given useful results, the need for more flexibility and additional auxiliary information seems to never end. Thus the capability to calculate the fast-to-thermal flux ratio, nuclide importance, costs, and enrichment unit cost, and the provisions for flexible recycle were added. A major extension was the capability to consider more than one successive feed batch resident. This latter was added in a way to produce reasonable results adequate for survey analysis but at a low cost of computation.

The author has relied on a background of experience and years of access to published material on the subject. Much of the calculational procedure resembles that in the TONG computer code¹ written at ORNL over a decade ago, and similarly rather ancient experience with economic

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analysis.² The efforts of others have been drawn upon, but acknowledgment of any major influences is not simple to do.

The effort expended in producing this formal documentation has been found to be justified. Careful examination of the actual equations programmed and the procedures showed both errors and inconsistencies which were removed. During this process of formalization, input data checking and error tests were added which have proven quite valuable in application by the author.

It would be possible to make major extensions to this code. For example, the number of nuclides considered could be increased, the number of energy groups increased, and the data library (at least cross sections) supplied externally; these would not be simple changes, but the code presents a basic structure and logic which would allow such extensions to the simple model. Also it should be relatively simple to make changes to the program to treat special situations not covered by the models implemented.

At the time this is written, a scheme is just being incorporated to account for cross section changes with exposure to allow treating the plutonium isotopes realistically, so the description of the formulation and final procedure to be adopted may be incomplete.

The Model

Shown in Fig. 1 is a diagram of the physical models. Successive batches of fuel are treated for exposure to the neutron flux calculated for the conditions at a reference point in time. The feed is adjusted to satisfy the reactivity requirements at the reference point in an iteration loop. Without subzones,^a the reference selected is half the core residence time. Given the fast-to-thermal flux ratio needed to satisfy a neutron balance, and the flux level required for the desired power level, the feed material is exposed to the reference point in time. After a converged solution is obtained from the iterative process, the actinide nuclide concentrations are treated for exposure from the reference point to the full residence time. The initial loading is specified and make-up feed material may have the same composition as the initial loading, or may be different. Previously discharged

^aBy subzone is meant multiple batches resident.

Fig. 1. The Point Reactor Model

material is recycled, with delay if desired, and the feed composition can be only recycle material or make-up feed added, or the make-up composition may depend on the breeding performance of the previous cycle, on option. A shut down period may be considered for the last batch exposed.

When subzones are considered, the initial loading may be uniform or the nuclide concentrations subzone dependent. The volume of the

reactor is considered to be divided into a specified number of equal subvolumes. These subzones are refueled in sequential order (repeating), and at any reference point in time, the loaded material in each of the different subzones will have been exposed over the time associated with its residence in the reactor. The adjustments made to the initial loading are usually uniform over the subzones; subzone nuclide concentrations are adjusted proportionally. Exposure of the first subzone is for a period of the reference residence time divided by the number of subzones, this subzone is discharged, and then it is refueled with the feed composition adjusted to satisfy reactivity requirements at the reference point for the second exposure period. The calculation continues with the exposed material in each subzone further exposed for the length of time between fuelings. When the number of exposure periods cumulates to the number of subzones, the material discharged will have been exposed for the reference core residence time, and this state continues over the reactor history.

It should be noted that the simple batch model (without subzones) assumes that control rods are not needed. With one subzone, satisfying reactivity requirements at the end of exposure allows for control losses, while satisfying it midway between refuelings does not.

It was found necessary to use the subzone (multibatch) option to treat the continuously fueled reactor realistically due to the non-linearity of fuel density over a long exposure. By option, the critical condition is satisfied at the end of exposure (allows control loss for fixed fuel) or at the mid point (approximates continuous fueling).

The Nuclide Chains

The actinide and fission product nuclide chains are shown below with reference nuclide order numbers:

Note that two lumped fission products are treated (L_1, L_2), a slowly saturating one which adds to the rate of generation of the nonsaturating one by neutron capture. The key intermediate nuclides in the actinide chains are included to account for loss in the production of fuel from the fertile nuclides. The nuclides I^{135} and Pm^{149} , which effect no significant neutron absorption losses, are treated to allow the application to special situations (short exposure) to account for hold-up. The cross section data absorption, capture, fission and ν , allow proper accounting of total loss rate and lower capture rate in producing the product.

Note that such refinements as following (n, 2n) reactions, treating the recycle of higher actinides, and estimating decay heating and processing hazards are not included in the treatment.

Solution of the Chain Equations

The actinide chains are treated with an explicit chain solution as the default option for treating subzones. For the first nuclide in a chain, the concentration after some exposure time T has a value

$$N_n(T) = N_n(0)e^{-a_n T}.$$

where $a_n = s_n + 10^{-24} \sum_m \phi_m \sigma_{a,n,m}$, s_n is the decay constant (sec^{-1}), ϕ_m is the flux in group m (fixed), and $\sigma_{a,n,m}$ is the absorption cross section for nuclide n in group m (fixed).

For nuclides down the chain, the equation

$$\frac{dN_n(t)}{dt} = -a_n N_n(t) + b_{m \rightarrow n} N_m(t)$$

is solved explicitly with $b_{m \rightarrow n}$ being the specific generation rate coefficient, decay or capture, with provision for two routes of generation of U^{234} and Pu^{240} . The equations are cast in such a way as to account for the end-period equilibrium concentration of a nuclide having a large specific loss coefficient (Np^{239} and Pa^{233}).

The average generation rate solution procedure is used as the default for batch calculations (no subzones). The equation solved is

$$N_n(l) = e^{-a_n \Delta} N_n(l-1) + \frac{g_n(l)}{a_n} (1 - e^{-a_n \Delta}),$$

where the generation rate g_n calculated from the precursor nuclide concentrations,

$$g_n(l) = b_{m \rightarrow n} [\alpha N_m(l-1) + (1 - \alpha) N_m(l)],$$

and α may be specified to override the default value of 0.45.

To treat an exposure period T , the above equations are solved L times over short intervals Δ such that $\Delta L = T$. A reasonable treatment for the whole period of exposure is $L = 100$, 50 steps to the midexposure point, and then 50 steps to end exposure, but more steps may be necessary for high accuracy than this default.

When the average generation rate method is used, a linear average of the power level is taken over the steps. When the explicit solution is used, the exposure period is treated in two steps and a weighted average between the three points (initial, half and full exposure) is made on the power level. Since the fuel nuclide concentrations vary considerably over the exposure period, especially when there is conversion from one mixture to another (e.g., U^{235} feed, Pu generation) and the exposure time is long, then the treatment of flux normalization to an average power level in the average generation rate scheme may cause it to produce more representative results than the default explicit solution scheme.

The actinide exposure calculations are done in IBM double precision.

The method of solution of the fission product chains involves the use of an estimate of the average actinide concentrations from available data for the period from the start to the reference point, to establish

fission yield rates, except reference point values are used for yield of I^{135} and Xe^{135} . Then explicit solution of the coupling chain equations are used for Nd^{143} and Pm^{147} and for the lumped fission products L_1 and L_2 . Equilibrium loss rates are obtained for I^{135} , Xe^{135} , Pm^{148} , Pm^{148m} , Pm^{149} and Sm^{149} .

A caution is in order regarding the selection of reliable data for the fission products. Key nuclides have been extracted from the set to account for specific aspects. The explicit treatment of the primary Pm, Sm chain admits coarse study of the effect of fission product recycle (and Sm^{149} poisoning). The data which is required must be tailored to the scheme adopted with care to establish the properties of lumped fission products (yield and cross sections) which adequately represent the nuclides not treated explicitly. The objective is accurate representation of the loss of neutrons through absorption by the fission products collectively in the model. Clearly data should be tested by application with the model and results compared with those from a more reliable treatment. The lumped fission products in this representation are not the same as for other representations. Either their yield fractions or cross sections or both must be larger than when more nuclides are treated explicitly or smaller than when fewer are treated explicitly.

The Criticality Search

The desired multiplication ratio to be satisfied is

$$k_e = \frac{B(1 - f_l)}{A},$$

where k_e is the multiplication factor, unity unless specified,

B is the neutron generation rate,

A is the neutron absorption rate,

f_l is the specified fraction uncounted for losses of the total.

Thus either a value of $k > 1$ or $f_2 > 0$, or both may be used to take into account neutron losses not accounted for in the point model. These include leakage, absorption by other nuclides not accounted for, control losses as for trim or oscillation stabilization, and possibly a normalization to effect agreement with results from the use of more sophisticated methods. It should be noted that an automated procedure in the code causes a series of cases to be treated with f_2 varied over a range of values as a parameter study. It is usual in even a large, reflected thermal reactor without blankets for the leakage from the core to be as high as 0.04 fraction of total losses.

The components of the above equation are calculated for the reference conditions using microscopic production and absorption cross sections as

$$B = \phi \sum_n C_n [\omega_{f,n,2} + X \omega_{f,n,1}], \text{ and}$$

$$A = \phi \sum_n C_n [\sigma_{a,n,2} + X \sigma_{a,n,1}],$$

where ϕ is the reference thermal flux,

C_n is the concentration of nuclide n , and

X is the fast-to-thermal flux ratio.

Given the macroscopic downscatter cross section $\Sigma_{1 \rightarrow 2}$, the flux ratio is calculated as

$$X = \frac{\sum_n C_n \sigma_{a,n,2}}{\Sigma_{1 \rightarrow 2}};$$

if $\Sigma_{1 \rightarrow 2}$ is not provided, the flux ratio specified will be used even if zero.

The normalization is such as to produce the desired power level estimated by one of the methods on the average. At some point in time the power level is

$$P = \phi \sum_n C_n E_n [\sigma_{f,n,2} + X \sigma_{f,n,1}]$$

where P is the thermal power level, and

E_n is the energy produced per fission for nuclide n in the data set.

Note that E_n values should be degraded from ideal to allow for unrecoverable energy. Also, it may be desirable to include the $(n, 2n)$ reaction cross section in σ_a and in σ_f and weight in an associated value of ν of 2 in the data to take into account the gain from the $(n, 2n)$ reaction. Then the effective value of E_n must be less to be consistent. (It may well be as attractive to simply decrease the value of f_g or k_e , to account for the $(n, 2n)$, well within the accuracy of the model.)

The feed composition is adjusted to satisfy the desired multiplication. Several options are available. The procedure in use is rather involved and is yet under modification at the time this is written, experimentation continuing. Basic aspects are discussed here.

The reactivity importance of a nuclide, for which the feed concentration is to be altered, may be available from a forward, adjoint flux weighting, or simply the net neutron balance contribution:

$$I_n = \phi C_n \left[\frac{\nu}{k_e} \sigma_{f,n,2} - \sigma_{a,n,2} + X \left(\frac{\nu}{k} \sigma_{f,n,1} - \sigma_{a,n,1} \right) \right]$$

Given relative weights by select nuclides h_n , and a reference change in concentration or eigenvalue of the problem λ , a neutron accounting is given by

$$\frac{B}{k_e A} (1 - f_l) - 1 = \lambda \sum_n h_n I_n, \text{ or}$$

$$\lambda = \frac{\left[\frac{B(1 - f_l)}{k_e A} - 1 \right]}{\sum_n h_n I_n}.$$

Note that the values of B and A are determined for the nuclide concentrations at the reference point while the concentrations used to determine the importance values are feed values. This is the direct criticality search approach.

The value of λ is used directly to adjust the feed mixture, for iteration i (see constraints below):

$$C_{n,i} = C_{n,i-1} + \lambda_i X_n.$$

where X_n is selected from the options on choice of nuclide(s) and the make up or recycle streams, and the iterative process continues. There are nonlinear contributions from simultaneous calculation of the flux ratio, the power level, exposure to the reference point, and difference between actual importance and that estimated. After three iterations in the early history, or after the first iteration the next period after the start of recycle, a linear interpolation scheme with acceleration is used. Given successive estimates, the new estimate is

$$\lambda_i^* = (k_e - k_{i-1}) D_{i-1}$$

where the derivative is estimated as:

$$D_i = \frac{\lambda_i}{k_i - k_{i-1}} = \frac{dN}{dk},$$

where N refers to the concentration of a reference nuclide in the search group, but significance of both the numerator and the denominator is required. To stabilize the effects of nonlinearities, dampening is done in the form

$$D_i = \max(0.95 D_{i-1}, \min(1.25 D_{i-1}, D_i^*)) ,$$

where D_i^* refers to the newly calculated value, but this equation must be altered when the derivative is negative.

At iterations where $I - 1$ is divisible by ten, if three successive iterate values of k_i are monotonic, D_i is multiplied by 1.5, provided the difference between the current estimate of k and the desired value exceeds five times the most recent iterate change in k . If the three successive iterate values of k are not monotonic, then prior to continuing iterations, D_i is multiplied by 0.75.

Each iteration evenly divisible by 5, an attempt at acceleration is made by applying a quadratic fit of the form

$$k = \frac{C_1 N}{N + C_2} ,$$

and the new value of λ estimated from the data for three successive iterations. This procedure is used only if the values of $(\Delta k / \Delta N)$ are monotonic and display the expected sign; significance is required in the calculated coefficients. Default is use of the linear change applying the estimate of the derivative, except each iteration evenly divisible by 10, default is to use of importance data.

Acceleration is done when the value of λ is estimated from the nuclide importance data in the form

$$\lambda_i^{**} = \lambda_i^* + \alpha(\lambda_i^* - \lambda_{i-1})$$

where λ_i^{**} is the accelerated value and λ_i^* the calculated value. A default value of 0.05 is used for α , rather small.

In addition, a constraint is applied on the concentration changes, for one reason to avoid negative values and for another to avoid moving the solution over a dip into the swampy, nonthermal region. Letting i be the iteration, J the number of subzones, and l the cycle count, the search eigenvalue is restrained to

$$i \leq 10, A = 2.5$$

$$10 < i \leq 25, A = 1.25$$

$$i > 25, A = .3125$$

$$B = \max(1./J, .25)$$

$$C = \begin{cases} A, & l = 1, \text{ or} \\ A/B, & l > 1, \end{cases}$$

$$\lambda_i = \left\{ \max .01, \min \left[\frac{.2}{B}, 5J|k_e - k_i|, \frac{A}{Ci} \right] \right\}.$$

Clearly if conditions are far from critical, these constraints may prevent effecting a critical system, and either the conditions must be changed or the coding (supply nuclide concentrations more representative).

After the second period beyond the start of recycle, this procedure is changed provided the source of makeup material has not changed this iteration. The cumulative change in the search eigenvalue for exposure period j is determined as

$$Z_j = \begin{cases} 1 + \sum_i \lambda_i & \text{if material is added, or} \\ \prod_i (1 + \lambda_i) & \text{if existing material is adjusted} \end{cases}$$

and $\lambda_1 = Z_j - 1$ is used for the first iteration of the next exposure period. Furthermore, the last estimate of $\Delta\lambda/\Delta k$ is saved and used in the early iterative history.

Not only are the flux ratio and flux level saved for use the first iteration of a successive exposure period, but this data is also saved for use the first iteration of the first exposure period for succeeding histories (as during optimization), and initial concentrations are modified for succeeding histories (which also affects succeeding cases).

Iteration limits adopted are as follows where the reference value is for exposure periods > 2 :

Periods	>2 ,	21, +5 for Pu, +5 for subzones,
Period	2,	three-halves the reference,
Period	1,	twice the reference

The allowed number of iterations is increased by three each successive pass when convergence is not satisfied to a maximum twice the reference value.

Requiring significance is mentioned above. With hexadecimal roundoff on the local IBM machines, significance is 6+ decimal digits. Significance required in these calculations has been tested over reasonable conditions and has been set in the range of 2×10^{-5} to 2×10^{-4} depending on the situation and experience from testing. Convergence of the iterative procedure is judged adequate if

$$|k_i - k_d| < 2 \times 10^{-4},$$

where k_d is the desired value (often unity), and if

$$|F_1 - 1| < 10^{-4},$$

where F_1 is the multiplier used this iteration on the flux level to effect a desired power level at the reference condition, and F_1 is given by

$$F_i = \frac{P_d}{P_{i-1}},$$

where P_{i-1} refers to the power level the previous iteration and P_d is the desired power level. Note that not only may the flux level be changing each iteration but also the fast to thermal flux ratio.

Recovery from a failure of any of the procedures to produce a significant result any iteration is provided by use of one of the other procedures. Thus if use of worths fails, an attempt is made to use the derivative of search eigenvalue with respect to k , or the reverse. Total failure causes termination, and failure to converge the first exposure step causes termination. As the limiting number of iterations is approached, key results are edited which can be identified in the program, and failure to converge when the limiting number of iterations is reached is reported in a special edit. Three successive iterations which fail to adjust the feed, or the value of the multiplication factor differing from the desired value by more than 0.01 are fatal errors. Any tendency to cause the search nuclide concentrations to become negative is dampened for a few iterations, and any negative nuclide density is a fatal error.

Reduction in computation time was found for many problems by repeating the exposure calculation after adjusting the flux level to effect the desired power level. This is repeated for at most 4 sweeps, or only 2 if the last change is less than 5 percent, or until the last change is less than 0.5 percent, with a restriction of 50 percent change each sweep, and driving the flux in the direction of change by 10 percent. The flux ratio is also adjusted each sweep, but the change is limited to 10 percent. The inner iteration is discontinued after five cycles.

Special action is taken in certain situations. When subzones are treated, concentrations of the nuclides to be adjusted are changed in all subzones the first exposure period (initial feed), but after that only the concentrations in that zone refueled are adjusted. Make up feed may be specified, or it may simply be assumed to have the same relative densities (of the search nuclides) as the initial fuel.

After recycle starts (it may be delayed), there may be inadequate fuel available (conversion ratio less than unity), requiring external feed or supplemental recycle material, or only a fraction of the available recycle fuel is required (breeding ratio greater than unity). Flexibility in selection of recycle and make up material and of specific nuclides is provided.

Generally the primary fertile material Th^{232} , U^{238} or a combination is reinitialized at the start of the iteration procedure each exposure period. Note that if the total heavy metal is fixed, the concentration(s) of the primary fertile material will change. Recycle content is not used, as continued exposure would severely deplete this material.

A special case is made of highly enriched uranium. If the U^{235} concentration exceeds 0.1 times that of the Th^{232} or if the U^{238} concentration is less than 0.1 times that of the U^{235} , the U^{238} concentration is adjusted in proportion to its search feed composition. For a uranium search, U^{233} , U^{234} , U^{235} and U^{236} concentrations are altered by a common factor. To hold the heavy metal constant, adjustments are made such that the sum of the atom densities is fixed as added from the search feed composition, generally causing decrease in U^{238} or Th^{232} concentration with increase in fuel concentration. Note the special treatment of U^{239} discussed above and the possible conflict in defaults and options. The user should study calculations carefully to make sure the results are acceptable considering both physical reality and the desired application of the model.

The user is cautioned about the general difficulty faced in satisfying critical conditions. Reasonable results may often be effected by simple procedures. Still there are many situations where simple rules do not lead to either mathematical solutions or conditions which can have physical reality. A mixture of nuclides presents the most serious challenge, as when plutonium is to be recycled. The general dependence of the multiplication factor on the search eigenvalue (reference nuclide concentration) is illustrated on the next page, the troublesome range magnified.

One usually tries to operate on the left of the crest. But the peak value of k may be less than desired. The condition to the far right is typical of a very fast neutron spectrum and often involves nuclide densities that exceed physical reality. Hopefully the reader recognizes that there are difficulties not easily surmounted by a calculational procedure; generally there is inadequate information available to take the specific action desired by the analyst to solve the difficulty, especially considering the large number of possibilities. Note furthermore that a mixture of nuclides may have a net neutron worth of zero, or nearly zero. It is assumed in this program that simple fuel searches treat situations for which the search composition has a positive reactivity worth: adding fuel increases the multiplication factor even after accounting for increase in the fast to thermal flux ratio and exposure effects.

It may be of interest that the usual search problem is often difficult to solve. Not only do the nonlinearities impact calculation, but also the low precision of IBM single precision. The actual cause of slow convergence was often very difficult to identify. Such a large number of input options and logic decisions are incorporated that revealing testing is difficult and improvement slow. And then the wide variety of conditions to be treated could but be casually sampled.

In retrospect it is the opinion of the author that the calculations should have been done in IBM double precision (long word) to remove

lack of significance as a contamination and source of confusion. It appears that when a program is written in IBM single precision, results generally contain such contamination from lack of significance that sound programming decisions can not be made on the basis of application testing, and that the developer may not be able to provide adequate assurance of reliability in application to qualify the program for serious use.

The Effect of Exposure on Cross Sections

A simple scheme was desired to take into account the effect of exposure on reaction rates. The formulation which was adopted considers a contribution from the density of the nuclide involved and a linear contribution from the total absorption cross section. As implemented, a single value of the cross section in each group each exposure step between fuelings is used for exposure for each nuclide, an effective value. They are recalculated for the reference conditions, e.g. the end of exposure step when subzones are treated. When subzones are treated and exposure of individual batches is followed, the correlation is applied each interval of exposure time by subzone; thus the cross sections do vary with exposure for each batch. Also with subzones, the local fast to thermal flux ratio in the batch is calculated and used when the correlation is applied in a way which allows the thermal flux to be subzone dependent, unless the default procedure is overridden.

The correlation applied to the microscopic cross sections for nuclide n in group g yields a relative absorption cross section,

$$R_{n,g,x} = \frac{\sigma_{a,g,n,x}}{\sigma_{a,g,n,o}} = \frac{1}{\left[1 + \alpha_{g,n} \Sigma_{a,g,y}\right] \left[1 + C_{n,x} \beta_{g,n}\right]},$$

where x refers to the conditions under study,

$\Sigma_{a,g,y}$ is the macroscopic absorption cross section calculated from nuclide concentrations and unadjusted microscopic cross sections,

$\sigma_{a,g,n,o}$ is the unadjusted microscopic cross section for nuclide n , group g ,

$C_{n,x}$ is the nuclide concentration under consideration, and

$\alpha_{g,n}$ and $\beta_{g,n}$ are the correlating parameters.

Given values of the relative absorption cross section, the adjusted cross sections are

$$\sigma_{a,g,n,x} = R_{n,g,x} \sigma_{a,g,n,o}$$

$$\sigma_{c,g,n,x} = R_{n,g,x} \sigma_{c,g,n,o}$$

$$\sigma_{f,g,n,x} = R_{n,g,x} \sigma_{f,g,n,o}$$

and the v_g value is not changed.

Care must be taken in applying such a correlation. Not only must the range of application be adequately covered, but also the reference condition for which the unadjusted cross sections are selected must be consistent with the application. Note that typical values are $\alpha_{g,n} = 1$, $\beta_{g,n} = 0.5$. The effect of increasing either $\alpha_{g,n}$ or $\beta_{g,n}$ is reducing $R_{n,x}$ in the usual range of application. Values of $\beta_{g,n} = 0$ are not used.

The procedure of calculation implemented is the calculation of adjusted cross sections for the nuclide concentrations at the start of an exposure step, calculation of the concentrations at the reference point after exposure, and then recalculation of the effect of exposure using the average of the nuclide concentrations at start and end (or weighted start, mid-exposure and end when applicable, and when available for recalculation of the cross sections). Thus effective cross sections for the exposure period are estimated by a simple scheme without iteration on the problem or accounting for the changes over the exposure period. The calculation is most realistic when the reactor is partially refueled and the subzone scheme is used to follow individual batches; this breaks the total residence time into shorter steps and effective cross sections are reevaluated for each of these steps. It may be necessary to consider the actual approximation used when the correlating parameters are generated. The use of the macroscopic absorption cross section in the correlation presents some difficulty in generating the correlating parameters; not only must this be considered but also the likelihood that a set of parameters can only apply over a very specific range for application which may indeed be quite limited. Note also

that correlation on both the macroscopic cross section and the nuclide concentration need not be used, rather only one of these when appropriate.

Regarding the Subzone Treatment

With the default procedure, the following conditions are set:

- 1) The flux level is established as necessary to effect the desired power level over the exposure interval (estimated for an average condition), and
- 2) The multiplication factor is satisfied for the end of exposure conditions, or at the midpoint on option.

The effective fast and thermal flux levels are estimated in each subzone for the average conditions and for the conditions at the end of each exposure step. If the cross section correlation is applied, two passes are made through the exposure calculation, with cross sections recalculated each pass in each subzone, and then they are recalculated for the end of exposure condition. One value of the override option on floating the flux level causes a single reference condition to be used, that at the end of exposure, and only one set of flux values are used, but the flux level is set as necessary to effect the desired power level over the interval; the fast to thermal flux level is fixed at end of exposure conditions. With another value of the override option, fast-to-thermal flux ratios are determined for both the exposure period and the end of the exposure period. Treating the zone dependence and exposure dependence of the flux levels adds nonlinearities to the problem which can be expected to decrease the rate of convergence of the iterative process. Also, extra calculation is not done to accelerate the procedure in the early iterative history; rather, use is made of information readily available and the procedures used to drive the results toward a proper solution.

Subzone Flux Level

Individual batches of fuel are treated as subzones. If the size of a batch is large, then the larger the thermal macroscopic cross section the lower the thermal flux level in the batch. The default procedure attempts to account for the effect of variation in the

macroscopic cross section as follows. Given the thermal absorption cross section in subzone i of $\Sigma_{a,i}$, the core average is approximated as

$$\bar{\Sigma}_a = \frac{1}{I} \sum_i \Sigma_{a,i} .$$

The two group flux values are related through the fast flux removal cross section Σ_r , fixed, and fixed fast group flux,

$$\phi_1 \Sigma_r = \bar{\phi}_2 \bar{\Sigma}_a ;$$

$$\frac{\phi_1}{\bar{\phi}_2} = \frac{\bar{\Sigma}_a}{\Sigma_r} .$$

With full isolation given the fast flux level,

$$\phi_1 \Sigma_r = \bar{\phi}_2 \bar{\Sigma}_a = \phi_{2,i} \Sigma_{a,i} ;$$

$$\phi_{2,i} = \phi_1 \frac{\Sigma_r}{\Sigma_{a,i}} .$$

Since only the thermal flux and the flux ratio values are carried, the thermal flux would be given as

$$\phi_{2,i} = \bar{\phi}_2 \left(\frac{\bar{\Sigma}_a}{\Sigma_r} \right) \left(\frac{\Sigma_r}{\Sigma_{a,i}} \right) .$$

However, only half the indicated change is used, and used only if the default option is not overridden,

$$\phi_{2,i} = \bar{\phi}_2 \left[1 + \frac{1}{2} \left(\frac{\bar{\Sigma}_a}{\Sigma_r} \right) \left(\frac{\Sigma_r}{\Sigma_{a,i}} \right) \right] ,$$

and the fast flux is obtained as

$$\phi_{1,i} = \phi_{2,i} \left(\frac{\Sigma_r}{\Sigma_{a,i}} \right) .$$

Remarks About Special Fuel Management Options

Typically in a calculation done to treat multiple fuel batches (subzones), the search nuclide concentrations in all the batches are initially adjusted proportionally to initial values. The first subzone is then discharged and refueled, and then initial concentrations in this reloaded subzone (the feed) determined which satisfy the reactivity requirements for the second exposure period. The calculation continues over the history. Thus for three subzones, successive exposure periods may be pictured as follows:

<u>Period</u>	<u>State</u>	<u>Remarks</u>
1		adjust concentrations in all subzones
2		first subzone refueled
3		second subzone refueled
4		third subzone refueled
5		first subzone refueled

Note that the discharged material may be selectively recycled with delay, and separate makeup feed may be specified.

On option, the nuclide densities in only the first subzone may be adjusted at the start of the history.

The following schemes for special treatment are yet under development.

A "once-thru single subzone" option is available which complicates matters. When this option is exercised, the last subzone is treated in a special way while the others have the usual treatment. A separate and special feed stream is used for this last subzone, and the material discharged is not used for recycle. The option specifies the number of exposure periods the material is resident in this last subzone. To make the residence times the same, the value should be one less than the number of subzones because the other subzones reside one less than the number of subzones exposure periods.

Consider the example shown on the previous page with the addition of another subzone, total four subzones. Under the "once-thru single subzone" option with a residence of two exposure periods, the early history may be pictured as:

Note that the last subzone is discharged and then refueled every other exposure period. Refueling is based on the initial nuclide densities in this last subzone.

This option has limited utility for representing a blanket. Such modeling must be done under the constraints of no provision to disadvantage the microscopic cross sections and the subzones are assumed to have equal volumes, a space point equally subdivided. There is provision

to specify a fast to thermal flux ratio, a relative flux level and a relative importance to make such treatment realistic given such information. The approximation is coarse at best.

This option may also be used to adjust the feed composition to the last "once-thru" zone instead of the other feed zone, and this other feed zone would have fixed feed. This model is useful for study of recycle of fertile particles to a core, and other complexities.

Under all options, the subzones are assumed to have equal volumes and mass balances are weighted equally. A degree of freedom is allowed because the nuclide concentrations may be varied to approximate special situations. However, solutions which represent realistic situations regarding the satisfaction of a critical reactor considering the modeling and simple weighting of neutron reaction rates, may or may not be obtained.

Auxiliary Results

Nuclide reactivity importance is considered for fission source neutrons only in the first group and ignoring transport and scattering contributions, giving

$$I_n = \frac{\partial k}{k \partial C_n} = - \frac{\sum_m \phi_m [\phi_1^* \nu \sigma_{f,n,m} - \phi_m^* \sigma_{a,n,m}]}{\phi_1^* \sum_n C_n \sum_m \phi_m \nu \sigma_{f,n,m}}$$

where ϕ_m^* is the adjoint flux in group m . The relative importance of equal concentrations of two nuclides is given by the ratio I_1/I_2 . Total worth (or the estimate of the effect of a 100 percent increase in the concentration) of a nuclide is given by $C_n I_n$.

Conversion (breeding) ratio at a reference state is calculated by the simple formula

$$CR = \frac{H - B}{A}$$

where H is the rate of capture by the fertile nuclides (Th^{232} , U^{238} , U^{234} , Pu^{240}), B is the absorption rate in the intermediate nuclides (Pa^{233} , Np^{239}), and A is the absorption rate in the fissile nuclides (U^{233} , U^{235} , Pu^{239} , Pu^{241}).

An effective conversion ratio is also calculated from fissile mass balances as

$$\text{CR} = 1 + \frac{F_2 - F_1}{E \frac{dF}{dE}},$$

where F_2 is the amount of fissile discharge,

F_1 is the amount of fissile feed,

E is the thermal energy produced over the period of interest,

and

dF/dE is the rate of fissile consumption per unit energy production.

Fissile inventory doubling time is calculated in the simple sense lacking data on out-of-core requirements. Actually the reciprocal of the doubling time is reported, a continuous function,

$$\frac{1}{T_d} = \frac{P}{I} \left(\frac{\mu}{\eta_e} \right) (\text{CR} - 1) \frac{dF}{dE}$$

where P is the power level, I is the fissile loading, μ is the plant load factor, and η_e is the energy conversion efficiency. Note that the conversion ratio may be the instantaneous value from reaction rates or that obtained from mass balances. The simple reciprocal doubling time is obtained from mass balances to produce information about each exposure period and to show an effective value for the reactor history. However, the fissile inventory used is the average of that associated with the current fissile feed and the amount in the reactor at the reference point in time.

Reference values of the rate of fissile consumption per unit energy generation are printed for each of the nuclides, an effective value is weighted over the fissile nuclides at each reference point, and the average taken over the reactor history for the history summary.

Summary results are reported for the reactor history. The simple approximation for a delay in recycle of one year real time for the batch feed calculation (no subzones) is made by extending the length of time the batch data applies one year, and these results are reported. This alters the history, because now fewer cycles are required for the plant life.

Fuel Cost

The costs associated with producing electrical energy between successive fuelings are allocated to that energy. The direct costs associated with the purchase and sale of fuel are calculated directly from unit values, for example

$$X_f(n) = \left(\frac{1}{.6022} \right) A(n)N(n)V_c W(n)$$

where $X_f(n)$ is the cost of nuclide n in the feed,

$A(n)$ is the atomic weight,

$N(n)$ is the nuclide feed concentration (atoms/bn-cn),

V_c is the core volume (cc), and

$W(n)$ is the unit value.

Given unit costs for fabrication of the feed and processing cost for the discharge, the direct cost is given by the difference between the feed cost,

$$C_f = \frac{L_z}{qPT} \left[\sum_n X_f(n) + G_f Q_f \right] \left(\frac{1}{1-f} \right),$$

and the value of the recovered material

$$C_p = \frac{L_z}{qPT} \left[(1-g) \sum_n X_p(n) - G_p Q_p \right],$$

allocated to the amount of energy, and

$$C_d = C_f - C_p,$$

where subscripts f, p and d refer to feed, discharged product, and direct cost respectively, and

G_f is the unit cost of fabrication which may be higher for recycle feed,
 G_p is the unit cost of processing,
 f is the fabrication loss fraction,
 g is the processing loss fraction,
 Q_f is the amount of fabricated feed material,
 Q_p is the amount of discharge material processed,
 P is the reactor power level, thermal,
 q is the energy conversion, thermal to electrical,
 T is the core residence time, and
 L_z is the number of subzones.

Indirect costs are calculated by the simple interest charge method. Given a plant load factor of ℓ , lead time of t_a , lag time of t_b , the indirect cost referenced to the midpoint of the exposure period, half exposure time of $t_x = T/2\ell L_z$, is

$$C_t = C_f \left[1 + i (t_x - t_a) \right] - C_p \left[1 - i (t_x + t_b) \right],$$

where i is the interest charge rate (fraction) and C_t is the total cost. Note that positive indirect contributions are associated with feed, fabrication and discharge (recovery), but a negative contribution from deferred processing.

Although the default value of the plant load factor is used as a constant, there is a user option to apply a declining value. Given initial and final load factors ℓ_o and ℓ_f , the variation is assumed to depend on the square of the relative history time,

$$\ell(t) = \ell_o - (\ell_o - \ell_f)(t/T)^2,$$

where t is a midcycle reference and T is the real length of the history. The average load factor is approximated as a simple integral,

$$\bar{l} = \frac{1}{T} \int_0^T l(t) dt = \frac{1}{3}(2l_o + l_f) ,$$

and this value is used to predict the real length of the history when the number of exposure periods is given.

Discrete values of the load factor are selected for each exposure period based on a running account of the real time and an estimate of the real time for the midcycle point of the current exposure period. The last period may well exceed the desired exposure time due to discretization into explicit exposure periods. Thus the load factor is varied, decreased with time, in an approximate manner to simulate real plant operation. The actual values employed should be studied.

The fuel cost for the reactor history is calculated by the discount method in a levelizing sense. Discounting to a reference point yields an effective cost C by the present value formulation for M periods of

$$C = \frac{\sum_{m=1}^M c_{t,m} (1+j)^{(1-m)2t_x}}{\sum_{m=1}^M (1+j)^{(1-m)2t_x}} ,$$

where j is the discount factor (fraction) and the index m on exposure has been incorporated. (Actually the individual cost components are levelized by the discount method, the same equation as for the total, and reported.) The result is independent of the reference point selected for discounting — present and future value come out the same since both the numerator and denominator are discounted.

Units have been ignored above. They must be consistent. Thus to use a fabrication unit cost in \$/kgm, the amount of material fabricated is in Kgm. For unit nuclide costs in \$/gm, amounts are in grams. Fuel costs are reported in mil/Kw_e-hr which equals \$/Mw_e-hr.

For the subzone, multi-batch treatment, effective residence intervals are determined for charging indirect costs at a simple interest rate, and reference points in the history are estimated for the multi-fueling history. The calculation has significance only if the number of exposure periods is sufficient to effect a true quasi-continuous fueling, discharge condition. Let T_n be the mid-exposure reference time for exposure step n , and the exposure time each step at the applicable load factor be Δ . The following equations are applied to determine the effective displacement from the reference loading or disloading point in the history, T_i , and the reference point for discounting, T_r , given J subzones and N total exposure steps.

Recovery (reprocessing, fuel sale):

$$T_i = \begin{cases} \frac{n\Delta}{2}, & n < J; \\ \frac{J\Delta}{2}, & J \leq n < N; \\ \left(\frac{J+1}{4}\right)\Delta, & n = N. \end{cases}$$

$$T_r = \begin{cases} T_n + \frac{\Delta}{2} - T_i, & n < N; \\ T_n + \frac{\Delta}{2} - Z, & n = N. \end{cases}$$

In the above equation,

$$Z = \frac{\Delta}{2J^2} \sum_{j=1}^J j^2.$$

Purchase (fabrication, fueling cost):

$$T_i = \begin{cases} \left(\frac{J+1}{4}\right)\Delta, & n = 1; \\ \frac{J\Delta}{2}, & 1 < n \leq N-J+1; \\ (N-n+1) \frac{\Delta}{2}, & n > N-J+1. \end{cases}$$

$$T_r = \begin{cases} T_n - \frac{\Delta}{2} + Z, & n = 1; \\ T_n - \frac{\Delta}{2} + T_i, & n > 1. \end{cases}$$

It is noted that straight discounting could be done and it would be more straightforward. The above carries through the strategy of using one simple interest rate while discounting at another. There is no simple resolution of the differences between this and discounting at an effective discount factor because a unique equivalent value is not available. The indirect charges so determined may be realistic of a fabricated fuel rental situation.

Note that the whole reactor is fueled, J batches, at $n = 1$, and J batches are discharged at $n = N$, compared with one batch at other times. The differences among these batches are not accounted for in the cost model in this code. If such differences were taken into account, the applicable equations would be somewhat different than shown here.

When the calculation approximates a reactor which is continuously fueled, there is additional indirect cost compared to the batch fueling calculation. For the one subzone calculation, the model in effect applies a costing scheme by following a fuel element through its history of fabrication, exposure and energy generation, and reprocessing and sale. However, the reactor would have to be loaded initially which is assumed to add direct fabrication cost and indirect fabrication and fuel cost. (Effects at the end of the history are ignored.) When a summary of the calculation is requested, an estimate of the extra charges for continuous fueling are reported. This calculation approximates the effect of the initial purchase of fabricated fuel at the start of the history by discounting.

Since the neutronics calculation of the multi-fueling history and the fuel cost calculation are done independently, certain inconsistencies may result. These include differences in the recycle delay, and in the fabrication and processing losses between the two calculations. Consistency is desirable but often cannot be effected precisely. The plant load factor is involved, and there is no provision to admit consistency when this factor is decreased with time.

Enrichment Unit Value

On option, the optimum tails enrichment of U^{235} in U^{238} is determined for the specified feed and separative work unit values³ (otherwise the reference data is used). The equation solved by simple iteration for no value of the tails, is

$$\frac{O}{S} = (2X_o - 1) \left[\ln \left(\frac{X_o}{1 - X_o} \right) - \ln \left(\frac{X_t}{1 - X_t} \right) \right] + \frac{1}{X_t} \left(\frac{X_o - X_t}{1 - X_t} \right) (1 - 2X_t),$$

where S is the separative work cost,

O is the ore cost,

X_o is the ore enrichment, and

X_t is the tails enrichment.

Given the optimum tails enrichment, the unit value of uranium enriched to a value of X_p is given by

$$W_x = \left(\frac{0.001}{X_p} \right) \left[O \left(\frac{X_p - X_t}{X_o - X_t} \right) + S \left\{ (2X_p - 1) \ln \left(\frac{X_p}{1 - X_p} \right) + \left(\frac{X_p - X_o}{X_o - X_t} \right) (2X_t - 1) \ln \left(\frac{X_t}{1 - X_t} \right) - \left(\frac{X_p - X_t}{X_o - X_t} \right) (2X_o - 1) \ln \left(\frac{X_o}{1 - X_o} \right) \right\} + R \right].$$

Note the inclusion of a charge R for chemical processing. Of special interest is the value of fully enriched material. W_p is

determined for $X_p = 0.25$, and the reference nuclide values are proportioned to this recalculated value, and the multiplier applied to nuclide worths other than Th^{232} , U^{238} , and the lumped absorber is

$$\frac{W_x = .95, \text{ new}}{W_x = .95, \text{ old}}$$

Also, the amount of ore required to supply a given amount of fissile material requires a reference factor,

$$F_o = \frac{0.001}{X_p} \left(\frac{X_p - X_t}{X_o - X_t} \right) (1.1793),$$

where F_o is the Mgm ore per Kgm fissile U^{235} .

A special calculational problem is presented by the addition of make-up to recycle feed when the enrichment is adjusted to satisfy a critical condition. The technique used is to keep a record of the amounts of U^{235} and U^{238} recycled, and determine make-up quantity and enrichment from the data for the actual feed.

Given A_5 amount of U^{235} and A_8 amount of U^{238} in the mixture, B_5 and B_8 respective amounts in the recycle stream, the make-up amount of U^{235} is $A_5 - B_5$, and the enrichment is

$$\frac{\text{U}^{235}}{\text{U}^{235} + \text{U}^{238}} \Bigg|_{\text{makeup}} = \frac{A_5 - B_5}{A_5 - B_5 + A_8 - B_8}$$

However, for cost accounting, a charge is made directly for the total feed and its enrichments at each refueling.

There is the likelihood that situations will arise where the accounting is inaccurate. Note that the amount of make up fuel may be negative, so the reported results should be carefully examined for reliability.

Fuel Cost Optimization

On option, the exposure time of feed batches is adjusted to seek a minimum fuel cost. After an initial history has been followed, the exposure time is increased by one year and the history recalculated. Then a third history is followed with the exposure time again increased by one year (unless it needs to be reduced or interpolation is indicated).

Given three points, a quadratic fit is made to predict an optimum,

$$X(t) = a + bt + ct^2$$

$$\frac{dX(t)}{dt} = 0 = b + 2ct_0 ,$$

$$t_0 = -\frac{b}{2c} \quad \text{if } c > 0 ,$$

where X is the fuel cost and t is the exposure time, t_0 being the apparent optimum.

Even retaining the data for the lowest values of the fuel cost during an iterative process, a quadratic fit to three points was found to be quite inadequate in many situations. Given four or more data sets, a least squares quadratic fit is used to predict the optimum. This has generally produced good results. However, the predicted value of the fuel cost at the apparent optimum exposure time may be significantly different from what is calculated using that value. Also the nonlinearities associated with discrete step and the history time varying, the load factor changing, etc., it has been found that only if continued addition of points concentrates them near (closer and closer to) the minimum will the global minimum be found. Thus in the extreme, concentrating points near a local minima emphasizes it with the procedure and the global minima will not be found. Thus some caution is in order in application: start near the true minimum fuel cost condition. The difficulty is most extreme when very few cycles are required to span the history, and the total history time is varied as the exposure time is changed to account for the history with discrete exposure steps.

The least squares fit to a quadratic involves determining the coefficients a , b and c for the above quadratic fit. Given calculated values of the cost Y_n , given t_n we desire

$$\min \sum_n (X_n - Y_n)^2,$$

$$\frac{\partial}{\partial z} \sum_n (Y_n - X_n)^2 = 0, \text{ where } z = a, b \text{ and } c;$$

$$\sum_n Y_n = aN + b \sum_n t_n + c \sum_n t_n^2,$$

$$\sum_n Y_n t_n = a \sum_n t_n + b \sum_n t_n^2 + c \sum_n t_n^3,$$

$$\sum_n Y_n t_n^2 = a \sum_n t_n^2 + b \sum_n t_n^3 + c \sum_n t_n^4,$$

where the index n is over the number of sets of data N . This leads to three equations in the unknown parameters a , b and c which are determined directly, the optimum exposure time is estimated, and the associated fuel cost predicted. A small improvement in application testing was found by correlating cost with reciprocal time.

Criteria are used to reject an apparent solution, to disregard the application of the procedure (use simple extrapolation), and to estimate that the history calculated is near to the optimum.

Users Flow Chart

Shown in Fig. 2 is a chart of the flow of a calculation. An inner iteration procedure is used to effect the desired critical state. This involves adjusting the feed composition, performing exposure for the period of interest and measuring the multiplication factor at the reference time along with adjusting the fast to thermal flux ratio and the flux level to effect the desired power level on the average. After the iterative problem is solved, exposure to end of residence time is done, and key

Fig. 2. PREMOR Point Model Code Users Flow Chart.

results are printed on selected cycles. The fuel cost for that cycle (exposure period) is determined, and then the nuclide concentrations are adjusted to account for delayed recycle and start of the next exposure period. At the completion of the calculation, key results are edited to summarize the performance.

There is provision for repeating the history to adjust the fraction losses over a set range, or to seek the economic optimum fuel cost.

Program Information

The main program consists primarily of comment cards which describe the input data requirements. A BLOCK DATA subprogram contains the nuclear and economics data required. Since special data must be supplied for each specific situation, it is recommended that these two routines be regularly compiled at run time and the program assembled for execution. A table of the routines follows with the calling routine given and the primary function of each described briefly:

Routine	Called by	Primary role
MAIN	---	Drives calculations through multiple histories, recovers data, processes input
BLOCK DATA	---	Supplies reference data, comments input requirements
RATE	MAIN	Drives the iteration procedure through successive exposures
OPTI	PREX	Adjusts the exposure time
LSQF	OPTI	Applies a least squares fit to a quadratic
FEED	RATE	Adjusts the search nuclide feed
EXPO	RATE	Treats exposure
EDIT	RATE	Edits key results
COST	RATE	Calculates fuel costs
WRTH	COST	Applies the diffusion plant equations
RCYC	RATE	Accounts for feed material with recycle
WRUP	RATE	Generates supplemental results for the history
SIGC	EXPO	Correlates cross sections, adjusts subzone flux level

The programming is basically Fortran II with a few extensions including mixed mode arithmetic. Only standard IBM library routines are used. The source deck has about 2,400 cards, <10 percent comments. As used, the program with system routines requires 25,000 short word, computer memory (but 270K bytes are recommended locally for a compile step).

Locally the ICLOCK(o) function is used to obtain a reference count on processor time in 10^2 sec.

Results

A few results from application testing are presented. Shown in Table 1 are the results obtained in a survey assessment of a partially refueled graphite moderated reactor showing the effect of exposure time and fraction of the reactor refueled. Shown in Fig. 3 is the dependence of the conversion (breeding) ratio of this partially refueled reactor on the core residence time through operating histories with U^{235} fuel feed and delayed recycle.

The edit from a computer run is shown in Appendix A, which documents the Job Control Instructions, the user input data instructions, the data used for the sample problems, and the sample problems with input data and results are hopefully self explanatory.

Table 1. Point Model Results for Fully Enriched U^{235} Feed
To a Partially Refueled Reactor, Recycle Delayed One Cycle
(1,200 Mw_e Plant at 0.75 Load Factor, 5 W_{th}/CC)

Residence Time (Yrs at full power)	Fraction Core Refueled	Exposure (Mw _{th} -D/ Kgm/HM)	U ²³⁵ Feed (Kgm/D)	Fissile Loading end-of-cycle (Kgm)	Conversion Ratio	Ore Consumption (Kgm/Mw _e Yr)	Fuel Cost (Mil/Kw _e Hr)	
							Cycle	30 Year
<u>C/HM 250, 0.05 fraction core neutron leakage</u>								
3	1/3	71.1	1.1540	1,425	.646	91.5	5.20	5.059
2	1/4	48.2	.9428	1,329	.715	73.5	5.50	5.480
3	1/4	71.2	1.0898	1,425	.666	86.3	5.01	4.911
4	1/4	93.7	1.2121	1,515	.625	97.1	5.01	4.774
5	1/4	114.9	1.3248	1,612	.591	106.2	5.18	4.800
3	1/6	71.5	1.0185	1,411	.688	80.6	4.84	4.758
3	1/8	71.6	.9812	1,404	.699	77.7	4.74	4.680
4	1/8	94.0	1.0854	1,491	.666	86.5	4.65	4.461
4	1/12	94.3	1.0376	1,475	.681	82.7	4.51	4.353
<u>C/HM 400, 0.075 fraction core neutron leakage</u>								
3	1/3	101.3	1.5353	1,098	.496	130.0	5.95	5.771
3	1/4	103.2	1.4622	1,097	.520	124.8	5.73	5.570
3	1/6	102.2	1.3768	1,083	.548	117.5	5.49	5.350
3	1/8	102.6	1.3295	1,075	.563	113.5	5.37	5.232
4	1/8	132.8	1.4254	1,159	.534	121.6	5.36	5.036
3	1/12	102.9	1.2785	1,067	.580	109.1	5.23	5.106

Fig. 3. Fuel Conversion Ratio Through Reactor History

References

1. D. R. Vondy and T. B. Fowler, "Computer Code TONG for Zero-Dimensional Reactor Depletion Calculations," USAEC Report ORNL-TM-1533 (1967).
2. M. W. Rosenthal, et. al., "A Comparative Evaluation of Advanced Converters," USAEC Report, ORNL-3686 (1965).
3. W. H. McVey, et. al., "Calculating U-235 Outputs and Charges," USAEC Report, Division of Operating Analysis and Forecasting, TID-8539 (1963).

APPENDIX A: EXCERPTS FROM A COMPUTER RUN SHOWING INPUT DATA REQUIREMENTS AND TEST PROBLEM INPUT AND OUTPUT

```

//DRVN      JOB (*****), 'BLDG 6025 DAVE WOODY',
// COND=(5,L)
// *CLASS CPU91=240S, IO=605, REGION=C270A, LINES=100, CARDS=1
// EXEC FORTHCLG,
// PARM,PORT='MODECK,MOLIST,IO,SOURCE,XREF,NAP',
// REGION.CO=270*
//PORT.SYSIN DD *
C DATA BLOCK FOR PRINAST
C
C BLOCK DATA
C
C THE FOLLOWING DOCUMENTING COMMENT CARDS MAY BE REMOVED BY THE
C REGULAR USER AFTER A LISTING IS AVAILABLE FOR REFERENCE
C
C THE FOURTEENTH NUCLIDE IS INACTIVE - SUM OF ALL INACTIVE NUCLIDES
C SUCH AS MODERATOR, COOLANT, STRUCTURAL, ETC.
C
C INPUT DATA FOR EACH CASE
C -----
C FIRST CARD, TITLE (10A4)
C SECOND CARD CONTROL INSTRUCTIONS (2*13)
C NI CONTROL OPTIONS (3)
C (1) GENERAL CONTROL ON PROBLEM TYPE
C 0- TERMINATES COMPUTER RUN
C 1- USE DENSITIES SUPPLIED FOR REFERENCE CONDITIONS
C THE CALCULATION INVOLVES NO ITERATION
C 2- ACTINIDE EXPOSURE TO REFERENCE POINT AND END
C 3- 2.2 SEK COST OPTIMUM EXPOSURE TIME, BY ITERATION
C OVER SUCCESSIVE HISTORIES, THIS IS THE MAXIMUM
C NUMBER OF ITERATIONS (LOTS OF CALCULATION AND
C TO FIX LIFE, NI(5) MUST BE NEGATIVE
C NORMALLY MUST BE 2 (OR MORE)
C (2) INPUT OPTION ON NUCLIDE DENSITIES
C IF .GP.G, DO NOT SUPPLY INITIAL ZONE DENSITIES
C 1- USE DISCHARGE ACTINIDES FROM PREVIOUS CASE
C (TH, U-239 RESTORED, PA, NP DECAYED TO FUEL)
C 2- USE INITIAL CONCENTRATIONS FROM PREVIOUS CASE
C (AS ADJUSTED FOR ITS INITIAL CONDITIONS)
C (3) FEED NUCLIDE DENSITY ADJUSTMENT OPTION
C 0- CALCULATE MULTIPLICATION, IF SAFE IF NECESSARY
C (GENERALLY THIS HAS A NEGATIVE COST BENEFIT)
C 1- U-233, U-238, U-235, U-236 DENSITIES ADJUSTED
C (ALSO U-239 IF 238 LT .1*232 AND 235 GT .1*233)
C 2- TH, U-238
C ONLY TH-232 IF 239 .LT. .1*232
C 3- PU
C 4- TH, U-239 - J -- FIX TOTAL ACTINIDES
C 5- TH, U-238 - PU -- FIX TOTAL ACTINIDES
C (4) OPTION TO CALCULATE FUEL COST
C -1 DO NOT CALCULATE
C 0, 1- USE FIXED UNIT VALUES
C (USES DATA FOR U-235 COST AND ORE, .95 ENRICHED)
C 2- CALCULATE ENRICHMENT WORTH (U-238 INVOLVED)
C 3- SAME AS 2 EXCEPT FIRST DETERMINE OPTIMUM TAILS
C UNIT VALUES PROPORTIONED TO U-235 REFERENCE
C AND USED IN SUBSEQUENT CASES
C (EVALUATION DONE ONLY THE FIRST TIME NEEDED)
C 4- SAME AS 3 BUT UNIT VALUES OF ACTINIDES ARE NOT
C PROPORTIONED BUT RETAINED (NOT U-235)
C (5) NUMBER OF EXPOSURE PERIODS (TOTAL FUELINGS)
C MUST BE 2 OR MORE IF NI(9) EXCEEDS 0 (FOR SURPLUSES)
C IF NEGATIVE, REAL TIME IN YEARS FOR HISTORY

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C	(6)	OPTION ON FEED ADJUSTMENT	DATA 593
C		0- ADJUSTS THE FEED MIXTURE PRESENTED	DATA 590
C		(DEFAULTED TO 1 IF MAKE-UP MIXTURE IS INPUT)	DATA 600
C		1- ADJUSTS MAKEUP FEED (NOT RECYCLED)	DATA 513
C		2- ADJUSTS RECYCLE FEED	DATA 523
C		3- ADJUSTS RECYCLE OR MAKEUP FEED BASED ON BREEDING	DATA 630
C		MAKE NEGATIVE TO ADJUST ONLY THE CONCENTRATIONS IN	DATA 640
C		THE FIRST ZONE FOR THE FIRST EXPOSURE PERIOD	DATA 553
C		(THE ZONE TO BE REFUELED AFTER THE FIRST EXPOSURE),	DATA 553
C		OTHERWISE ADJUSTMENTS ARE MADE IN ALL SUBZONES	DATA 676
C	(7)	RECYCLE ACTINIDE SELECTION	DATA 680
C		0- ALL	DATA 593
C		1- URANIUM, NOT Pu	DATA 703
C		2- Pu, NOT URANIUM	DATA 710
C		OPTION MAY CHANGE SEARCH OPTION (FOR RECYCLED)	DATA 720
C	(8)	OPTION TO PRODUCE AUXILIARY RESULTS AT END OF CASE	DATA 733
C		(HIGHER LEVEL OF EDIT IF MADE 2)	DATA 743
C	(9)	NUMBER OF SUBZONES OR RESIDENT BATCHES (.LE.20)	DATA 750
C		PRESENTLY 3 ARE BEING USED FOR CONTINUOUS FUELING	DATA 760
C		WHILE FOR BATCH FUELING THIS IS THE RECIPROCAL	DATA 763
C		OF THE FRACTION OF THE REACTOR REFUELED EACH TIME -	DATA 765
C		NOTE THAT 1 MAY BE USED FOR BATCH TREATMENT AND	DATA 768
C		EFFECT END EXPOSURE CRITICAL STATE (ALLOWS CONTROL)	DATA 770
C		(THE PERFORMANCE AND ECONOMICS ARE SENSITIVE TO THE	DATA 793
C		INITIAL DISTRIBUTIONS OF FUEL ENRICHMENTS OVER THE	DATA 793
C		SUBZONES - INCREASE ENRICHMENT WITH RESIDENCE TIME	DATA 800
C		SO THAT THE PISSELE DISCHARGE IS LOW FOR LOW	DATA 810
C		EXPOSURE, WITHIN POWER DENSITY PEAKING LIMITS)	DATA 823
C		MAKE NEGATIVE IF SUBZONE DENSITIES ARE TO BE INPUT	DATA 833
C		(AND DO NOT SUPPLY ZONE DENSITIES)	DATA 843
C	(10)	ONCE-THRU SINGLE SUBZONE OPTION, SPECIFIES THE NUMBER OF	DATA 850
C		RESIDENCE EXPOSURE PERIODS - THIS IS THE SPECIAL	DATA 860
C		OPTION TO TREAT N-1 BATCHES NORMALLY BUT THE	DATA 862
C		WITH ONE DIFFERENTLY WITH THIS MANY PERIODS	DATA 863
C		RESIDENCE BEFORE REFUELING	DATA 866
C		MAKE NEGATIVE TO ADJUST FEED IN THIS SUBZONE (THE LAST)	DATA 876
C	***** OPTION ABOVE NOT IMPLEMENTED IN THIS VERSION *****		
C	(11)	DELAY CYCLES FOR RECYCLE .LE.6, IF NI(5).GT.1 OR LT.3 (3)	DATA 893
C		IF .LT.3, NO RECYCLE -- SUBZONE CASES ONLY	DATA 893
C	(12)	EXPOSURE OPTIONS WHEN THERE ARE SUBZONES	DATA 933
C		0- REFERENCE POINT END STEP (ALLOWS CONTROL LOSS)	DATA 910
C		POWER LEVEL ESTIMATED FOR AVERAGE CONDITIONS	DATA 920
C		1- REFERENCE POINT MID STEP, ALLOWS NO CONTROL LOSS,	DATA 933
C		BASICALLY A CONTINUOUS FUELING MODEL	DATA 932
C		2- SAME AS 0 EXCEPT FOR POWER LEVEL ESTIMATE	DATA 940
C		(LESS CALCULATION, LESS ACCURATE)	DATA 950
C	(13)	OPTION ON MAKE-UP NUCLIDE DENSITIES	DATA 953
C		0- USE MAKE UP FEED COMPOSITION FROM PREVIOUS CASE	DATA 973
C		(THIS IS NOT DISCHARGE MATERIAL)	DATA 980
C		0- USE INITIAL VALUES (IN HIGHEST SUBZONE NUMBER	DATA 990
C		IF NI(9).GT.0 AND NI(6).NE.0)	DATA 1003
C		1- INPUT VALUES AT END OF CASE DATA, 3 CARDS (DO	DATA 1013
C		NOT APPLY TO ADJUSTMENT OF INITIAL DENSITIES)	DATA 1023
C		2- INPUT VALUES AT END OF CASE DATA, 3 CARDS	DATA 1030
C		SPECIFIES ONLY THOSE TO BE ADJUSTED	DATA 1043
C		(FIRST 13 NUCLIDES MAY BE INCLUDED HERE)	DATA 1053
C		NORMALLY EXCLUDE PRIMARY FERTILE MATERIAL	DATA 1060
C		OVERRIDES SEARCH OPTIONS FOR REFUELING	DATA 1070
C	(14)	PLANT LOAD FACTOR OPTION	DATA 1093
C		0- FIXED VALUE OVER LIFE	DATA 1093
C		1- APPLIES EXPONENTIAL FUNCTION OVER LIFE	DATA 1100
C	(15)	LONG TIME SHUTDOWN AT END OF CASE	DATA 1110
C		NUMBER OF MONTHS, 12/YR, SINGLE STEP	DATA 1123
C	(16)	OPTION TO CORRELATE ABSORPTION CROSS SECTIONS	DATA 1133
C	(17)	OPTION ON FLUX WITH SUBZONES	DATA 1140
C		0- FLAT THERMAL FLUX, ACCOUNT FOR FLUX RATIO CHANGE	DATA 1150
C		1- USE A SINGLE SET OF FLUX VALUES EACH EXPOSURE STEP	DATA 1163
C		2- ONLY ACCOUNT FOR FLUX RATIO CHANGE OVER EXPOSURE	DATA 1173
C	(18)	OPTIONS ON THE SEARCH PROCEDURE	DATA 1180
C		1- OVERRIDE USE OF IMPORTANCE DATA	DATA 1182
C		2- OVERRIDE USE OF DERIVATIVES	DATA 1188

C	(19)	DEBUG EDIT LEVEL (1)	DATA1193
C		1- MODEST LEVEL OF EDIT DURING ITERATION	DATA1200
C		2- HIGH LEVEL OF EDIT DURING ITERATION	DATA1210
C	(20)	OPTION TO SKIP EDITS THIS MANY CONTINUOUS CYCLES	DATA1223
C		DEFAULTED TO NI(5)/5 IF 0 AND NI(5) .GT. 5	DATA1233
C		OR NI(5)/2 WHEN OPTIMIZATION IS DONE AND THEN	DATA1240
C		HALVED FOR THE LAST PASS NORMALLY IF INPUT 0	DATA1250
C		(MAKE NEGATIVE FOR AN EDIT EACH CYCLE)	DATA1263
C	(21)	100% SEARCH EIGENVALUE ACCELERATION FACTOR (5)	DATA1273
C	(22)	100% GENERATION RATE WEIGHTING (40)	DATA1293
C	(23)	STEPS FOR EXPOSURE CALCULATION	DATA1290
C		DEFAULT ASSIGNMENTS RECOMMENDED	DATA1300
C		(USES AN EXPLICIT CHAIN SOLUTION IF 2)	DATA1313
C	(24)	OPTION TO ALLOW ADDITIONAL DATA TO BE INPUT	DATA1323
C		1- ONE MORE CARD OF SUPPLEMENTAL PARAMETERS	DATA1333
C		2- ALSO AN ADDITIONAL CARD OF NUCLIDE DENSITIES	DATA1340
C	THIRD CARD DATA (1226.3)		DATA1350
C			DATA1360
C	VC	CORE VOLUME, CC (1)	DATA1370
C	TE	UPPER LIMIT ON EXPOSURE TIME WHEN OPTIMIZATION IS DONE	DATA1383
C	ELF	PLANT LOAD FACTOR (OVERRIDES DATA BLOCK DATA)	DATA1393
C		START OF LIFE IF POSITIVE	DATA1400
C		END OF LIFE IF NEGATIVE	DATA1410
C	QB	TOTAL FRACTION LOSS OF RECYCLE MATERIAL	DATA1423
C		(ZEROS FISSION PRODUCTS, HOLDS TR-232, J-238 AT ORIGINAL)	DATA1433
C		1.-QB FRACTION PRODUCT RECYCLED	DATA1440
C		AND THEN ADJUSTMENTS ARE MADE ACCORDING TO INSTRUCTIONS	DATA1450
C		TO SATISFY CRITICALITY REQUIREMENT	DATA1463
C	TC	CORE RESIDENCE TIME, YR (2)	DATA1473
C	IR	MACRO SCATTERING GROUP 1 TO 2, OVERRIDES FLUX RATIO (0)	DATA1480
C	INT	FAST TO THERMAL FLUX RATIO (0)	DATA1490
C	FLX	THERMAL FLUX, W/CM ² -SEC, FIXED IF POW = 0 (5.E+12)	DATA1503
C	FWPH	THERMAL EFFICIENCY (1.)	DATA1513
C	POW	POWER LEVEL, NORMALLY W ELECTRICAL, PER CC IF VC IS 0 (0)	DATA1520
C	PL	FRACTION OTHER NEUTRON LOSS (0)	DATA1530
C		IF .LT.0, DOES SERIES OF 5 CASES WITH LOSS FRACTION	DATA1543
C		X, 0,.....-3X, WHERE X=PL (5 CASES)	DATA1553
C		EXCEPT VALUE USED IF OPTIMIZATION IS DONE	DATA1560
C	EX	DESIRED MULTIPLICATION (1.)	DATA1570
C			DATA1583
C	EXTRA DATA CARD (1226.3) IF NI(20) .GT. 0		DATA1593
C			DATA1600
C	CP	END OF LIFE PLANT LOAD FACTOR	DATA1610
C	PC	RESERVED	DATA1623
C	PS	RESERVED	DATA1633
C	DLT	FLUX RATIO IN THE LAST SUBZONE, NI(10).NE.0	DATA1640
C	DTT	RELATIVE FLUX LEVEL IN THE LAST SUBZONE NI(10).NE.0	DATA1650
C	PRX	REACTIVITY DISADVANTAGE IN THE LAST SUBZONE NI(10).NE.0	DATA1663
C	PRX	REACTIVITY DISADVANTAGE IN THE LAST SUBZONE NI(10).NE.0	DATA1673
C		(OTHERS RESERVED)	DATA1683
C	FOURTH THRU SIXTH CARDS NUCLIDE DENSITIES, ATOMS/BAFW-CM (5212.1)		DATA1690
C		TR, PA, J-233, U, T-235, U, T-238, SP, PU-239, PU, PU, PU, AM, C	DATA1700
C	FIFTH CARD PLUS -- SUB-ZONE DENSITIES IF NI(9) .LT. 0		DATA1713
C		THE FIRST SUBZONE WILL BE DISCHARGED AND REPLED FIRST	DATA1723
C		(SUBZONE DENSITIES ARE SAVED AND MAY BE USED FOR A SUBSEQUENT	DATA1733
C		CASE IF IT HAS THE SAME NUMBER OR LESS SUBZONES, DATA USED	DATA1740
C		IN ORDER FROM THE FIRST -- OTHERWISE ZONE DENSITIES ARE	DATA1750
C		RECOVERED AND DISTRIBUTED UNIFORMLY IF NI(9) .GT. 0)	DATA1763
C			DATA1773
C			DATA1780
C			DATA1790
C	COMMON/DATA/CSCF(4, 24), CSCF(4, 24), CCYC(24), TLD(14, 10), ATW(24),		DATA1803
C	* DL(19), TL(18), ZPF(24), NI(24), VC, VS, QP, QP, TC, X8, XRT, FLX, FWPH, POW,		DATA1813
C	* PL, EK, CP, PC, PS, DLT, DTT, PRX, DNDK, BN1, BN2, BN3, BN4, BN5, XL, YJ, AY1,		DATA1823
C	* AN2, AN3, AN4, AN5, AN6, AN7, AN8, AN9, AN1, C12, C13, ZZZ, C20, C5R, C8R, Z1		DATA1830
C	COMMON/CONP/ASI1(24), ASI1(24), ASI12(24), ASI12(24), CKCF(4, 24),		DATA1840
C	* CKCF(4, 24), XPP(24), XTF(24)		DATA1853
C	COMMON/DXTX/CND(24), CND(24), CND(24), CND(24), GPS(24), GPS(24),		DATA1863
C	* TRN(24), TRN(24), TRN(24), TRN(24), TRN(24), TRN(24), TRN(24), TRN(24)		DATA1873
C	COMMON/COSD/W(14), PLP, TLED, TLA1, TMT, PARC, CKCF, PRCC, WPC, WPC, WPC,		DATA1883
C	* PLO, PLO, DISF, CX(4, 5), CY(4, 5), T, TC, TTT, RELI, JPPTR, NT, VTT		DATA1893
C	COMMON/WANE/TNA12		DATA1903
C	COMMON/WR1/ 31, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15		DATA1910
C			DATA1920

REAL*8 TDATE(24) DATA1930

C DATA NAME /6HFN-232,6HFA-233,6H U-233,6H U-234,6H U-235,6H U-236, DATA1940

* 6H 7-238,6HFP-239,6HPU-239,6HPU-240,6HPU-241,6HPU-242,6HAY-243, DATA1950

* 6H PIX20,6H I-135,6HKE-135,6HPS-147,6HPR-148,6HPR148H,6HPR-149, DATA1970

* 6HSH-149,6HSD-143,6H PP1,6H PP2 / DATA1980

DATA AIN/ 232.1, 233.1, 233.1, 234.1, 235.1, 236.1, 238.1, 239.1, DATA1990

* 239.1, 240.1, 241.1, 242.1, 243.1, 12., 135., 135., 147., 148., DATA2000

* 148., 149., 149., 143., 117., 117./ DATA2010

C ENERGY PER FISSION (TOTAL RECOVERABLE), WATT-SEC/FISS DATA2020

DATA EFF/3.12E-11,3.13E-11,3.13E-11,3.15E-11,3.17E-11,3.18E-11, DATA2030

* 3.24E-11,3.20E-11,3.27E-11,3.29E-11,3.30E-11,3.31E-11,3.32E-11, DATA2040

* 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0/ DATA2050

C DECAY COEFFICIENTS, SEC-1 DATA2060

DATA DYC/0.2.93E-7,0.0,0.0,0.3.41E-6,0.0,1.68E-9,0.0,0.2.97E-5, DATA2070

* 2.09E-5,8.29E-9,1.49E-6,1.98E-7,3.63E-6,0.0,0.0,0.0/ DATA2080

C THIS DOCUMENTING TITLE CAUSES A NON-FATAL DIAGNOSTIC ON LOCAL I/O DATA2090

DATA DL/ DATA2100

*72H PEBBLE BED REACTOR DATA, C/RN 250, SIG(1,2) .0017688 DATA2110

* LATE '77/ DATA2120

C FAST CROSS SECTIONS, SIGA, SIGC, SIGF, MU -TWO NUCLIDES PER LINE DATA2130

DATA CSCF/ 2.425, 2.414, .0108, 2.3418, 20.57, 20.42, .149, 2.715, DATA2140

* 30.23, 5.36, 24.87, 2.505, 33.12, 32.88, .24, 2.687, DATA2150

* 19.51, 7.439, 12.07, 2.4457, 15.32, 16.23, .09, 2.6716, DATA2160

* 6.275, 6.23, .0407, 2.715, 25.72, 25.45, .26, 2.687, DATA2170

* 22.12, 9.246, 12.869, 2.893, 3.404, 9.024, .39, 3.041, DATA2180

* 35.21, 6.242, 28.97, 2.935, 54.30, 54.07, .23, 3.0602, DATA2190

* 16.22, 16.05, .17, 3.3031, 9.14E-5, 9.14E-5, 0.0, DATA2200

* 0.0,0.0, 11.75, 11.75,0.0, DATA2210

* 114., 114., 0.0, 2.76E+3, 2.75E+3,0.0, DATA2220

* 1.66E+3, 1.66E+3,0.0,0.0,0.0,0.0, DATA2222

* 49.9, 49.9, 0.0, 3.916, 3.916, 0.0, DATA2224

* 3.982, 3.982, 0.0, .436, .436, 0.0/ DATA2225

C THERMAL CROSS SECTIONS, SIGA, SIGC, SIGF, MU -TWO NUCLIDES PER LINE DATA2230

DATA CSCF/ 2.981, 2.981, 0.0, 53.86, 58.86, 0.0, DATA2240

* 266.9, 24.77, 242.1, 2.503, 35.16, 35.16, 0.0, DATA2260

* 256.4, 40.47, 215.9, 2.430, 2.648, 2.648, 0.0, DATA2270

* 1.182, 1.182, 0.0, 22.90, 22.90,0.0, DATA2280

* 600., .226., .374., 2.873, 608., 597.81, .19, 2.87, DATA2300

* 750., .149., 551., 2.932, 14.16, 14.16, 0.0, DATA2310

* 126.9, 126.9, 0.0, 2.0E-3, 2.0E-3, 0.0, DATA2312

* 0.0,0.0, 1.08E+6, 1.08E+6, 0.0, DATA2314

* 100.,100.,0.0, 630., 636., 0.0, DATA2315

* 1.14E+4, 1.14E+4, 0.0,0.0,0.0,0.0, DATA2318

* 3.44E+4, 3.44E+4, 0.0,131.1,131.1,0.0, DATA2319

* 6.1, 6.1, 0.0, .471, .471, 0.0/ DATA2320

C TWO-GROUP ABSORPTION CORRELATION DATA (PAKED HERE) DATA2322

DATA ASIG1/.5,1.,1.,1.,1.,1.,.5,1.,1.,.8,.6,.8,1.0,1.0,1.0,1.0, DATA2330

* 1.0,1.0,1.0,1.0,1.0,1.0,1.0/ DATA2340

DATA BSIG1/.9,.5,.4,.5,.7,.6,.6,.6,.5,.5,.5,.5,0.9,.9,.9,.9, DATA2350

* .9,.9,.9,.9,.9,.9/ DATA2360

DATA ASIG2/.5,1.,1.,1.,1.,1.,.5,1.,.9,.3,.8,.6,.8,.8,.8,.8,.8, DATA237

* .8,.8,.8,.8,.8,.8/ DATA2380

DATA BSIG2/.5,.3,.3,.3,.3,.5,.4,.2,.2,.2,.2,.2,0.8,.8,.8,.8, DATA2390

* .4,.4,.4,.4,.4,.4/ DATA2400

C FIRST 14 NUCLIDES FISSION YIELD TO EACH OF 10 PRODUCT NUCLIDES DATA2410

DATA YLD/ .0539,.054,.0563,.055,.0617,.059,.0578,.063,.0639,.053, DATA2420

* .063,0.0,0.0,.0021,.002,.0022,.0022,.0024,.0022,.0022,.002,.0027, DATA2430

* .0025,.0025,0.0,0.0,.0382,.035,.0193,.025,.0236,.03,.028,.026,.021, DATA2440

* .021,.022,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0, DATA2450

* 0.0,0.0,0.0,.0095,.012,.0077,.016,.0113,.017,.021,.012,.013,.012, DATA2460

* .012,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0, DATA2470

* .060,.055,.048,.046,.046,.050,.056,0.0,0.0,1.06,1.03,1.02,1.06, DATA2480

* 1.08,1.1,1.14,1.14,1.2,1.2,1.2,0.0,0.3,1.3,3.1,3.2,3.3,3.3, DATA2490

* 3.5,3.6,3.8,3.8,3.8,0.0,0.0/ DATA2500

C UNIT NUCLIDE VALUES DATA2510

DATA W/.029,56.25,56.25,-7.5,45., -15.,0.30,.30,.0.30,.0.0,0.0,0.01/

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C                                     DATA2533
C FUEL COST PARAMETERS                                     DATA2540
C PLP INITIAL PLANT LOAD FACTOR                             DATA2550
C TLED LEAD TIME FOR FUEL PURCHASE (YRS)                   DATA2560
C TLAG LAG TIME FOR RECOVERED FUEL SALE (YRS)              DATA2570
C TINT INTEREST RATE FOR INDIRECT COST CHARGES (FRACTION) DATA2580
C FABC FABRICATION COST WITH SHIPPING ($/KGM)             DATA2590
C EXCP REFABRICATION COST WITH SHIPPING ($/KGM)           DATA2600
C PRCC REPROCESSING COST WITH SHIPPING, WASTE DISPOSAL ($/KGM) DATA2610
C WPRC TOTAL THROUGHWAY (WASTED) COST ($/KGM)
C WPC RESERVED
C WPR RESERVED
C PLQ FABRICATION LOSS (FRACTION)                           DATA2620
C PLQ REPROCESSING LOSS (FRACTION)                           DATA2630
C DISP DISCOUNT FACTOR FOR MULTI-CYCLE WEIGHING (FRACTION) DATA2640
C RELI RELATIVE INVENTORY FOR COSTING (FRACTION .GE.1)     DATA2650
C QDPT FINAL PLANT LOAD FACTOR, IF CORRELATED (FRACTION)   DATA2660
C DATA PLP,TLED,TLAG,TINT,FABC,EXCP,PRCC,WPRC,WPC,WPR,
* PLQ,PLQ,DISP,RELI,QDPT/
* .75,0.50,1.00,0.100,298.,517.,672.,185.,0.0,.005,.010,.07,1.,0.5/
C                                     DATA2690
C ECONOMIC PARAMETERS ASSOCIATED WITH ORE                   DATA2700
C E1 FEED COST ($/KGM)                                       DATA2710
C E2 SEPARATIVE WORK, EQUIVALENT ($/KGM)                   DATA2720
C E3 PRODUCT TREATMENT ($/KGM)                             DATA2730
C E4 FEED ENRICHMENT (FRACTION)                             DATA2740
C E5 TAILS ENRICHMENT, IF NEEDED (FRACTION)                 DATA2750
C E6 RESERVED                                                DATA2760
C E7 ORE FOR .95 ENRICHED U-235 (KGM U308/KGM U235)        DATA2770
C E8-E13 RESERVED                                           DATA2780
C IE OPTION ON SEPARATION TREATMENT                         DATA2790
C 0- DETERMINE OPTIMUM TAILS                               DATA2800
C 1- USE SPECIFIED TAILS ENRICHMENT                         DATA2810
C DATA E1,E2,E3,E4,E5,E6,E7,E8,E9,E10,E11,E12,E13,IE,JE /120., 30.,
* 3.5, .007115, .002, 0.,.2307, 0.0,0.0,0.0,0.0 /
C                                     DATA2830
C                                     DATA2840
END
/* *** PORTMAN DECKS PRECEED THIS CARD
//LKED.PREPOR DD UNIT=3330,VOLUME=SER=2X1111,DISP=64R,
// DSWANE=X.DRV16456.PREPOR.COD1973
//LKED.SYSIN DD *
INCLUDE PREPOR
/*
//GO.FT06P001 DD SYSOUT=(J,,1101)
//GO.FT05P001 DD *
TH EXPOSURE, NO FUEL .5 YR
2 -1
.5 5.81 2.9+13
5. -4
.34
TH EXPOSURE, NO FUEL 1. YR
1 -1
1. 3.0 4. +13
5. -4
.34
TH EXPOSURE, NO FUEL 1. YR IN TWO STEPS (RECYCLE)
1 2 -1 2
.5 3.0 4. +13
TH EXPOSURE, NO FUEL 1. YR IN FOUR STEPS WITH 2 SUBZONPS (RECYCLE)
1 2 -1 4
2 3.0 4. +13
TH EXPOSURE, SAME AS PREVIOUS CASE WITH DELAYED RECYCLE
1 2 -1 4
2 1 3.0 4. +13
CHECKOUT CASE, U-233, FLUX RATIO SET, LOW POWER , 2
2 0 1 1 3
2.5 -4 1.5 -5 2.5 2.+12 .4 1.25

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.04
 CHECKOUT CASE, U-233, FLUX RATIO SET, LOW POWER, CALCULATE KEFF
 2 2 0 1 5
 1. +9 2.5 2. +12 .4 1.25 +9
 U-235 FEED, 4 SUBZONES, 4 YR RESIDENCE, DELAYED RECYCLE
 2 0 1 1-30 1 1-04 1 12
 .6 +9 4. 1.75-3 5. 2. +12 .4 1.2 +9 .05
 2.5 -4 1.5 -5
 1.184 -6 .05
 2.5 -4 1.75-5
 1.316 -6 .05
 2.5 -4 2. -5
 1.447 -6 .05
 2.5 -4 2.25-5
 1.579 -6 .05
 U-235 FEED, 3 SUBZONE, CONTINUOUS FUELING THROWAWAY, 4 YR
 2 2 1 1-12 1 1 3 -1 1 2
 .3 +9 4. 1.75-3 5. 2. +12 .4 .6 +9 .05
 U-233 FEED WITH 4 SUBZONES
 2 0 1 1-15 1 2 4 1 1
 .6 +9 2. 1.75-3 5. 2. +12 .4 1.2 +9 .025
 1.827-4 0.5 -5

.0474
 CASE TO CHECK CERTAIN OPTIONS
 2 0 1 2 5
 1. 5. 2. +12 .4 2.5
 1. -8 1. -5
 5. -5
 .04
 U-235, U-238 FEED, FIX TOTAL HEAVY METAL
 2 0 4 4-10 1 2
 .5 1.6 -3 5. 2. +12 .4 2.5 .04
 1. -4 1. -5
 .05
 U-235, U-238 FEED, FIX TOTAL HEAVY METAL
 2 2 4 4-10 1 2 1
 .5 1.6 -3 5. 2. +12 .4 2.5 .04
 PLUTONIUM, URANIUM SYSTEM WITH DELAYED RECYCLE
 2 0 5 1 5 1 1 10 1 2
 .5 1.6 -3 5. 2. +12 .4 2.5 .03
 1. -4 .125 -4 .05 -4 .025 -4 .01 -4
 .04
 1. -4 .05 -4 .02 -4 .01 -4 .004 -4
 PLUTONIUM, URANIUM SYSTEM WITH DELAYED RECYCLE
 2 2 5 1 5 1 -1 10 1
 .5 1.6 -3 5. 2. +12 .4 2.5 .03

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PCINT REACTOR EXPOSURE MODEL CALCULATION (2- GROUP) CODE PRENOP, ORNL VERSION I, 3/78

BASE DATA FOR NUCLIDES

PEBBLE BED REACTOR DATA, C/HW 250, SIG(1,2) .0017684

LATE '77

	NUCLIDE	A	DECAY	W/FISS	PAST SIG-A	ALPHA	ETA	THERMAL SIG-A	ALPHA	ETA	S/GM
1	TH-232	232.1	0.0	3.12000E-11	2.42500	223.51854	0.01043	2.98100	0.0	0.0	3.0290
2	PA-233	233.1	2.93000E-07	3.13000E-11	20.56999	137.04697	0.01967	58.85999	0.0	0.0	56.2500
3	U-233	233.1	0.0	3.13000E-11	30.23000	0.21552	2.06084	266.89990	0.10240	2.27042	56.2500
4	U-234	234.1	0.0	3.15000E-11	33.12000	136.99998	0.01947	35.15999	0.0	0.0	-7.5000
5	U-235	235.1	0.0	3.17000E-11	19.50999	0.61632	1.51305	256.39990	0.18745	2.04617	45.0000
6	U-236	236.1	0.0	3.18000E-11	16.31999	190.33333	0.01473	2.64800	0.0	0.0	-15.0000
7	U-238	238.1	0.0	3.24000E-11	6.27500	153.16951	0.01761	1.18200	0.0	0.0	0.0
8	NP-239	239.1	3.41000E-06	3.20000E-11	25.71999	97.88460	0.02716	22.89999	0.0	0.0	30.0000
9	PN-239	239.1	0.0	3.27000E-11	22.12000	0.71847	1.68135	600.00000	0.60000	1.79084	30.0000
10	PU-240	240.1	0.0	3.29000E-11	9.40400	23.74736	0.12288	698.00000	3672.68311	0.00078	0.0
11	PU-241	241.1	1.68000E-09	3.30000E-11	35.20999	0.21546	2.41485	750.00000	0.36116	2.15404	30.0000
12	PU-242	242.1	0.0	3.31000E-11	54.29999	235.08696	0.01296	14.16000	0.0	0.0	0.0
13	AM-243	243.1	0.0	3.32000E-11	16.21999	94.41171	0.03462	126.89999	0.0	0.0	0.0
14	FIXED	12.0	0.0	0.0	0.00009	0.0	0.0	3.00750	0.0	0.0	0.0010
FISSION PRODUCTS								FRACTION YIELD FROM U-233			PN-239
15	I-135	135.0	2.87000E-05	0.0	0.0	0.0	0.0	0.0	0.05630	0.06170	0.0639
16	Xs-135	135.0	2.09000E-05	0.0	11.75030	0.0	0.0	1080000.00000	0.00220	0.00240	0.0027
17	Te-147	147.0	8.29000E-09	0.0	114.00000	0.0	0.0	100.00000	0.01930	0.02360	0.0210
18	PN-148	148.0	1.49000E-06	0.0	2760.00030	0.0	0.0	636.07000	0.0	0.0	0.0
19	PM-148	148.0	1.98000E-07	0.0	1660.00030	0.0	0.0	11400.00000	0.0	0.0	0.0
20	PN-149	149.0	3.63000E-06	0.0	0.0	0.0	0.0	0.0	0.00770	0.01130	0.0130
21	SM-149	149.0	0.0	0.0	49.89999	0.0	0.0	34400.00000	0.0	0.0	0.0
22	MD-143	143.0	0.0	0.0	3.91600	0.0	0.0	131.09999	0.05900	0.06000	0.0460
23	FP1	117.0	0.0	0.0	3.98200	0.0	0.0	6.10000	1.02000	1.08000	1.2000
24	FP2	117.0	0.0	0.0	0.43600	0.0	0.0	0.47100	3.10000	3.30000	1.8000

COST DATA, -- LEAD TIME, LAG TIME, INTEREST, FABRICATION, RECYCLE FAB, PROCESSING, THROWAWAY

EXTRA (2), PAB LOSS, PROC LOSS, DISCOUNT P. CTOR

0.50000	1.00000	0.10000	238.00000	517.00100	572.00000	185.00000	0.0	0.0	0.00500	0.01000	0.07000
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RELATIVE INVENTORY	1.0000	START AND END LOAD FACTORS	0.7500	0.5000
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ENRICHMENT DATA	120.00000	80.00000	3.50000	0.00711	0.00200	0.0	0.23070
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TH EXPOSURE, NO PDEL .5 YR

[illegible]

DISCHARGE CONCENTRATIONS

0.956E-04	9.274E-07	3.134E-06	1.007E-07	4.328E-09	4.926E-11	0.0	0.0	0.0	0.0	0.0	0.0
0.0	4.000E-02	7.548E-11	4.310E-11	4.526E-09	2.969E-11	6.312E-11	5.505E-11	1.983E-10	1.660E-08	2.898E-07	8.869E-07

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 1
(INITIAL CONCENTRATIONS USED) PISSILE FEED (KG/H) 0.0

FLUX, LOSSES, SIGA2, FLUX RATIO (2),	SUM IMPORTANCE*N,	MULTIPLICATION,	RECIPROCAL DOUBLING TIME (YR-1),	CONVERSION RATIO (2)
4.0000E 13 2.121E 11 1.6119E-03	3.00000	3.00000	-0.00000	0.00731
CYCLE, IT, K, PISS FEED, EXIT, POWER,	CR, YRS, COST	1	0.0073	0.0
			1.1431E-06	0.0
				0.3333
				0.0

	CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (PULL POWER YEARS)	2	0.750
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

DISCHARGE CONCENTRATIONS

DISCHARGE CONCENTRATIONS	1.897E-07	1.096E-08	2.437E-10	0.0	0.0	0.0
9.968E-04	6.768E-07	4.630E-06				
0.0	9.000E-02	1.165E-10	5.422E-11	1.199E-08	6.082E-11	1.167E-10
				1.279E-10	3.359E-10	4.232E-08
						7.576E-07
						2.317E-06

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) (INITIAL CONCENTRATIONS USED) PISSIBLE FEED (KGM)	0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS
	1.1431E-06

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWE-YR
TH-232	5.0000E-04	1.9271E-01	0.798082	0.795113	0.002521	0.005904	0.007398	-3.7100E 03	0.0	123.31602
PA-233	6.8651E-07	2.6374E-04	0.012882	0.012834	0.000048	0.000130	0.010069	-3.8948E 03	0.78263	105.19505
U-233	2.9513E-06	1.7424E-03	0.164248	0.018772	0.145471	0.364182	2.217272	2.3367E 05	0.0	0.44034
U-234	6.4364E-08	2.5021E-05	0.001347	0.001340	0.000007	0.000019	0.014382	-4.9010E 04	0.0	72.71283
U-235	1.9381E-09	7.5662E-07	0.000095	0.000019	0.000076	0.000185	1.947086	1.7410E 05	0.0	0.48516
U-236	2.0927E-11	8.2046E-09	0.000000	0.000000	0.000000	0.000000	0.013977	-2.0876E 04	0.0	74.31691
FIXED	0.0000E-02	7.9708E-01	0.014158	0.014158	0.0	0.0	0.0	-5.7495E-01	0.0	0.0
I-135	7.4629E-11	1.6730E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.00833	0.0
XE-135	3.4719E-11	7.7833E-09	0.005836	0.005836	0.0	0.0	0.0	-2.4828E 08	0.0	0.0
SM-137	5.3276E-09	1.3005E-06	0.000366	0.000366	0.0	0.0	0.0	-1.6668E 05	0.00017	0.0
PA-148	2.7034E-11	6.6440E-09	0.000038	0.000038	0.0	0.000038	0.0	-3.6350E 06	0.00016	0.0
PA148A	5.1887E-11	1.2752E-08	0.000132	0.000132	0.0	0.0	0.0	-4.7129E 06	0.00004	0.0
PA-149	9.3135E-11	2.3044E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.00132	0.0
SM-149	2.4463E-10	6.0529E-08	0.001315	0.001315	0.0	0.0	0.0	-7.9705E 06	0.0	0.0
ND-143	1.7422E-08	4.1370E-06	0.000387	0.000387	0.0	0.0	0.0	-3.5072E 04	0.0	0.0
PP1	3.0509E-07	5.9335E-05	0.000858	0.000858	0.0	0.0	0.0	-6.4213E 03	0.0	0.0
PP2	9.3108E-07	1.8090E-04	0.000258	0.000258	0.0	0.0	0.0	-6.5783E 02	0.0	0.0
OTHER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUM	9.9147E-01	1.000002	0.0	0.148123	0.370420	2.217116	PISSLE	0.43273		

PLUX, LOSSES, SIGL2, PLUX RATIO (2), SUM IMPORTANCE*W, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)										
Q.00002	13	2.5702E	11	2.4530E-03	3.00000	-1.23288	0.37042	0.0	4.77035	4.77035
CYCLE IT. K. MISS PERD. EXIT. POWER- CR. YRS. COST	2	1	0.3704	1.1431E-06	2.0584E-06	0.0	4.7703	1.0000	0.0	0.0

[illegible]

ORE ID-235	PEDI INITIAL.	FEDD,	DISCHARGE,	NET (NGM)		
				0.0	1.745531E-10	7.385975E-07 -7.384230E-07

CASE END NORMAL.	TH EXPOSURE, NO FUEL 1. YR IN TWO STEPS (RECYCLE)	, PROCESSOR (SEC)	0.07

TH EXPOSURE, SAME AS PREVIOUS CASE WITH DELAYED RECYCLE

THIS CALCULATION TREATS SUBZONES, NUMBER
IN RAPIDONE, SAME AS PREVIOUS, UNDER 2

[illegible]

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 2				
4.98E-04	6.195E-07	9.325E-07	2.037E-08	3.045E-10
1.596E-12	0.0	0.0	0.0	0.0
4.000E-02				

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
(INITIAL CONCENTRATIONS USED) FISSION FEED (KGH)

0.250 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 1
0.0

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGH/MWE-YR
TH-232	4.9838E-04	1.9209E-01	0.963906	0.960804	0.003045	0.007131	0.007398	-1.0259E 04	0.0	123.31607
PA-233	6.1955E-07	2.3982E-04	0.014087	0.014034	0.000052	0.000142	0.010069	-9.7637E 04	0.85481	105.19429
U-233	9.3251E-07	3.6095E-04	0.062882	0.007187	0.055694	0.139427	2.217272	8.1217E 05	0.0	0.44034
U-234	2.0371E-08	7.9192E-06	0.000517	0.000514	0.000003	0.000007	0.014382	-1.3708E 05	0.0	72.71283
U-235	3.0447E-10	1.1887E-07	0.000018	0.000004	0.000014	0.000035	1.947087	6.2614E 05	0.0	0.48516
U-236	1.5958E-12	6.2566E-10	0.010000	0.000000	0.000000	0.000000	0.013977	-6.2886E 04	0.0	74.31693
FIXED	4.0000E-02	7.9709E-01	0.017155	0.017155	0.0	0.0	0.0	-1.0283E 00	0.0	0.0
I-135	2.4416E-11	5.4734E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.00330	0.0
XE-135	1.1359E-11	2.5464E-09	0.002313	0.002313	0.0	0.0	0.0	-3.6507E 08	0.00112	0.0
PR-147	8.6300E-10	2.1066E-07	0.000072	0.000072	0.0	0.0	0.0	-4.7330E 05	0.00003	0.0
PR-148	4.3791E-12	1.0762E-09	0.000007	0.000007	0.0	0.0	0.0	-1.0856E 07	0.00003	0.0
PR-149	8.4051E-12	2.0657E-09	0.000026	0.000026	0.0	0.0	0.0	-1.0253E 07	0.00001	0.0
PR-149	1.4226E-11	3.5198E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.00024	0.0
SM-149	3.7366E-11	9.2453E-09	0.000243	0.000243	0.0	0.0	0.0	-1.1819E 07	0.0	0.0
ND-143	2.6672E-09	6.3336E-07	0.000072	0.000072	0.0	0.0	0.0	-5.9407E 04	0.0	0.0
PP1	4.5371E-08	8.8150E-06	0.000154	0.000154	0.0	0.0	0.0	-1.7413E 04	0.0	0.0
PP2	1.3775E-07	2.6763E-05	0.000046	0.000046	0.0	0.0	0.0	-1.8401E 03	0.0	0.0
CYNER			0.0							
SUM		9.8981E-01	1.061491		0.058808	0.146743	2.217195	FISSION		0.41721

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
4.0000E 13 2.1211E 11 1.6119E-03 3.00000 3.00000 -4.46619 0.00731 19.97006 280.63965 15.05923
CYCLE, IT, K, FISSION FEED, EXIT, POWER, CR, YRS, COST 1 1 0.0077 0.0 3.0044E-07 2.0602E-02280.6396 0.1667 0.0
CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 4 0.875

DISCHARGE CONCENTRATIONS

9.952E-04	1.296E-06	9.302E-06	3.713E-07	2.152E-08	4.753E-10	0.0	0.0	0.0	0.0	0.0
0.0	8.000E-02	2.341E-10	1.089E-10	1.979E-08	1.004E-10	1.928E-10	2.758E-10	7.244E-10	6.753E-06	1.198E-06 3.660E-06

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
(INITIAL CONCENTRATIONS USED) FISSION FEED (KGH)

0.250 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 1
8.1169E-07

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGH/MWE-YR
TH-232	4.9758E-04	1.9178E-01	0.752459	0.750037	0.002377	0.005467	0.007398	-2.5501E 03	0.0	123.31609
PA-233	6.4815E-07	2.5089E-04	0.011523	0.011480	0.000043	0.000116	0.010069	-2.8482E 04	0.70004	105.19501
U-233	4.6512E-06	1.8004E-03	0.245240	0.028029	0.217204	0.543764	2.217272	1.3242E 05	0.0	0.44034
U-234	1.8563E-07	7.2164E-05	0.003682	0.003662	0.000020	0.000053	0.014382	-3.3430E 04	0.0	72.71284
U-235	1.0758E-08	4.1999E-06	0.000500	0.000100	0.000400	0.000973	1.947086	9.5091E 04	0.0	0.48516
U-236	2.3763E-10	9.3167E-08	0.000002	0.000002	0.000000	0.000000	0.013977	-1.3473E 04	0.0	74.31689
FIXED	4.0000E-02	7.9708E-01	0.013413	0.013413	0.0	0.0	0.0	-4.9062E-01	0.0	0.0

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWE-YR
TH-232	4.9838E-04	1.9209E-01	0.963906	0.960804	0.003045	0.007131	0.007398	-1.02958 04	0.0	123.31607
PA-233	6.1955E-07	2.3982E-04	0.014087	0.014034	0.000052	0.000142	0.010069	9.7637E 04	0.85581	105.19499
U-233	9.3251E-07	3.6095E-04	0.062882	0.007187	0.055694	0.139427	2.217272	3.217E 05	0.0	0.44034
U-234	2.0371E-08	7.9192E-06	0.000517	0.000514	0.000003	0.000007	0.014382	-1.3708E 05	0.0	72.71283
U-235	3.0447E-10	1.1887E-07	0.000018	0.000004	0.000014	0.000035	1.947087	6.2614E 05	0.0	0.44516
U-236	1.5958E-12	6.2566E-10	0.000000	0.000000	0.000000	0.000000	0.013977	-6.2886E 04	0.0	74.31693
FIXED	4.0000E-02	7.9708E-01	0.017155	0.017155	0.0	0.0	0.0	-1.0283E 00	0.0	0.0
I-135	2.4416E-11	5.4734E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.00330	0.0
XF-135	1.1359E-11	2.5464E-09	0.002313	0.002313	0.0	0.0	0.0	-3.6507E 08	0.00112	0.0

PN-147	6.6300E-10	2.1066E-07	0.000072	0.000072	0.0	0.0	0.0	0.0	-4.7330E 05	0.00003	0.0
PN-148	4.3791E-12	1.0762E-09	0.000007	0.000007	0.0	0.0	0.0	0.0	-1.0854E 07	0.00003	0.0
PN148H	8.4051E-12	2.0657E-09	0.000026	0.000026	0.0	0.0	0.0	0.0	-1.0253E 07	0.00001	0.0
PN-149	1.4226E-11	3.5158E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00024	0.0
SN-149	3.7366E-11	9.2453E-09	0.000243	0.000243	0.0	0.0	0.0	0.0	-1.1819E 07	0.0	0.0
ND-143	2.6672E-09	6.3336E-07	0.000072	0.000072	0.0	0.0	0.0	0.0	-5.9407E 04	0.0	0.0
FP1	4.5371E-08	8.8150E-06	0.000154	0.000154	0.0	0.0	0.0	0.0	-1.7413E 04	0.0	0.0
FP2	1.3775E-07	2.6763E-05	0.000046	0.000046	0.0	0.0	0.0	0.0	-1.8401E 03	0.0	0.0
CTHER			0.0								
SUN	9.8981E-01	1.061491		0.058808	0.146743	2.217195	FISSILE			0.41721	

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUN IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 4.0000E 13 2.1211E 11 1.6119E-03 3.00000 3.00000 -4.46619 0.00731 19.97006 280.63965 15.05923
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 1 1 0.0073 0.0 3.0044E-07 2.0602E-02280.6396 0.1667 0.0
 CCNTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 4 0.875

DISCHARGE CONCENTRATIONS

9.952E-04	1.296E-06	7.080E-06	2.345E-07	1.042E-08	1.718E-10	0.0	0.0	0.0	0.0	0.0	0.0
0.0	8.000E-02	1.787E-10	8.311E-11	1.379E-08	6.998E-11	1.343E-10	1.987E-10	5.220E-10	4.663E-08	8.247E-07	2.518E-06

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.250 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 1
 (INITIAL CONCENTRATIONS USED) FISSILE FEED (KGM) 5.7134E-07

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
TH-232	4.9758E-04	1.9178E-01	0.809863	0.807257	0.002558	0.005991	0.007398	-3.2407E 03	0.0	123.31609
PA-233	6.4815E-07	2.5089E-04	0.012402	0.012356	0.000086	0.000125	0.010069	-3.5325E 04	0.75345	105.19504
U-233	3.5400E-06	1.3703E-03	0.200891	0.022960	0.177925	0.445431	2.217273	1.8260E 05	0.0	0.44034
U-234	1.1723E-07	4.5573E-05	0.002503	0.002489	0.000013	0.000036	0.014382	-4.2615E 04	0.0	72.71284
U-235	5.2091E-09	2.0336E-06	0.000260	0.000252	0.000208	0.000507	1.947086	1.3333E 05	0.0	0.48516
U-236	8.5919E-11	3.3686E-08	0.000001	0.000001	0.000000	0.000000	0.013977	-1.7567E 04	0.0	74.31694
FIXED	4.0000E-02	7.9708E-01	0.014436	0.014436	0.0	0.0	0.0	-5.7498E-01	0.0	0.0
I-135	8.9326E-11	2.0025E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.01017	0.0
IF-135	4.1557E-11	9.3161E-09	0.007123	0.007123	0.0	0.0	0.0	-2.5853E 08	0.00345	0.0
PN-147	6.8959E-09	1.6833E-06	0.000484	0.000484	0.0	0.0	0.0	-1.4399E 05	0.00023	0.0
PN-148	3.4992E-11	8.5998E-09	0.000050	0.000050	0.0	0.0	0.0	-3.0589E 06	0.00021	0.0
PN148H	6.7161E-11	1.6506E-08	0.000175	0.000175	0.0	0.0	0.0	-4.4769E 06	0.00005	0.0
PN-149	9.9361E-11	2.4585E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.00147	0.0
SN-149	2.6099E-10	6.4575E-08	0.001431	0.001431	0.0	0.0	0.0	-8.2867E 06	0.0	0.0
ND-143	2.3315E-08	5.5365E-06	0.000529	0.000529	0.0	0.0	0.0	-3.5505E 04	0.0	0.0
FP1	4.1235E-07	8.0115E-05	0.001181	0.001181	0.0	0.0	0.0	-5.6535E 03	0.0	0.0
FP2	1.2588E-06	2.4456E-04	0.000355	0.000355	0.0	0.0	0.0	-5.7189E 02	0.0	0.0
CTHER			0.0							
SUN	9.9086E-01	1.051676		0.186152	0.452090	2.216923	FISSILE		0.43403	

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUN IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 4.0000E 13 2.5205E 11 2.3624E-03 3.00000 3.00000 -1.03445 0.33784 1.87706 4.73446 3.96390
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 4 1 0.3378 5.7134E-07 1.6232E-06 1.0659E 00 4.7355 1.1667 0.0

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 4.81774E-04 4.79288E-04 2.48640E-06
 SUMMED FISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 8.71786E-07 0.0 3.06632E-06 2.19451E-06
 FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 0.42712 5.82037 2.08971

ORE (U-235 FED) INITIAL, FEED, DISCHARGE, NET (KGM) 0.0 1.007211E-10 7.073997E-07 -7.072490E-07

CASE END NORMAL, TH EXPOSURE, SAME AS PREVIOUS CASE WITH DELAYED RECYCLE , PROCESSOR (SRC) 3.11

4-15

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	ORCAT	KGM/MWE-YR
TH-232	2.4629E-04	9.4924E-02	0.468237	0.466813	0.001398	0.003274	3.006992	-1.8932E-03	0.0	326.21143
PA-233	3.9036E-07	1.5110E-04	0.009050	0.009030	0.000031	0.000083	0.009174	-2.3077E-04	0.45844	299.66479
U-233	6.1959E-06	2.3983E-03	0.446083	0.049743	3.396326	0.992166	2.224136	0.7652E-04	0.0	1.09740
U-234	4.1254E-07	1.6037E-04	0.010233	0.010178	0.003052	0.000140	0.013667	-2.4522E-04	0.0	191.28448
U-235	3.4766E-04	1.3573E-05	0.002230	0.030432	3.001798	0.004374	1.960959	6.1186E-04	0.0	1.20415
U-236	1.1762E-09	4.5881E-07	0.000011	0.000011	0.000000	0.000000	0.013835	-9.0120E-03	0.0	187.69884
FIXED	4.0000E-02	7.9708E-01	0.018739	3.018739	0.0	0.0	0.0	-4.7208E-01	0.0	0.0

[illegible]

PUL	CYCLE	ECONOMICS	----	POWER,	VOLUME,	TIME,	LOAD	FACTOR,	INTEREST,	FEED	(KGM),	DISCHARGE,	WGT-D/KGM
1-24995E	00	1.00000E	00	2.00000E	00	7.50000E-01	1.00300E-01	9.93288E-05	9.54457E-05	2.29657E-01			

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/WH-HR	BI, MICROCYCLE	REAL YRS
FABRICATION	1.312857	0.0	1.312857	0.240588	1.553445			1.333333
PROCESSING	0.0	-0.899569	2.899569	-0.676566	2.223002			
PUT	6.564579	6.637768	-0.073189	2.752112	2.679123			
SUM	7.877436	3.730199	4.139236	2.316434	6.455670	2.499905	-06	2.499905

CYCLE, IT, K, PISS PERD, EXIT, POWER, CR, YRS, COST	1	10	1.0000	2.4937E-06	2.6117E-06	1.2500E 00	1.0431	1.3333	6.4557
CONTINUING WITH RECYCLE- CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS)	2	3.000							

[illegible]

	ADJUSTED INITIAL CONCENTRATIONS	(SEARCH RICHNESS)	VALUE			
2.50E-04	9.0	6.53E-06	7.50E-07	1.11E-07	7.80E-09	0.0
0.0	4.00E-02	0.0	0.0	0.0	0.0	0.0
						0.42948
						0.98575

DISCHARGE: ACTINIDE CONCENTRATIONS, STEPS 100
2.429E-04 3.734E-07 6.286E-06 1.259E-06 2.96
0.0 9.000E-02

TYPE	IT	E	PLSS	PROD.	EXIT	MOSES	CB	VBS	COST	1	10	1-0000	2-49377-06	2-61172-06	1-2500E	00	1-0431	1-3333	6-4557	
SUM			7.0577430		3.7750155		47.135230		6.5104534		0.4935070		ENERGY (MWH/IN)	0.4935070	2.4935070	0.00	2.4935070	0.00	2.4935070	0.00

SEARCH IT	1	1.00000E-00	1.33333E-00	3.98E-03	3.98E-03	2.50000E-00	5.26478E-13	3.250781E-00	0.0
SEARCH IT	1	1.00000E-00	1.33333E-00	3.98E-03	3.98E-03	2.50000E-00	5.081850E-01	3.282896E-00	0.0
TRACE	2	0 0 0 1 0	-7.830E-03	-2.810E-03	0.0	0.0	5.933E-03	4.955E-03	1.070E-01
SEARCH IT	2	9.921702E-01	-7.89785E-03	0.0	0.0	2.50000E-00	5.036537E-13	3.109311E-00	1.004459E-00
SEARCH IT	2	9.921702E-01	-7.89785E-03	0.0	0.0	2.50000E-00	5.064447E-03	3.126137E-00	1.002289E-00
TRACE	3	0 0 0 1 0	-3.138E-03	-2.779E-03	3.202E-00	0.0	5.917E-03	4.937E-03	5.031E-01
SEARCH IT	3	9.990563E-01	-3.138440E-03	3.202076E-00	3.202076E-00	2.50000E-00	5.062639E-13	3.118711E-00	1.002014E-00
TRACE	4	0 0 0 1 0	-1.902E-03	-2.760E-03	3.624E-00	0.0	5.899E-03	4.905E-03	5.015E-01
SEARCH IT	4	9.871478E-01	-1.929686E-03	3.624331E-00	3.624331E-00	2.50000E-00	5.73863E-13	3.121596E-00	1.001148E-00
TRACE	5	0 0 0 1 0	-7.795E-04	-2.756E-03	3.443E-00	0.0	4.901E-03	4.904E-03	5.005E-01
SEARCH IT	5	9.863783E-01	-7.795442E-04	3.443114E-00	3.443114E-00	2.50000E-00	5.079945E-13	3.123708E-00	1.000497E-00
TRACE	6	0 0 0 1 0	-7.266E-04	-2.756E-03	3.271E-00	0.0	4.904E-03	4.905E-03	5.005E-01
SEARCH IT	6	9.866675E-01	-7.205678E-04	3.270958E-00	3.270958E-00	2.50000E-00	5.082250E-13	3.133662E-00	1.0006220E-00
TRACE	7	0 0 0 1 0	-7.283E-05	-2.756E-03	3.213E-00	0.0	4.903E-03	4.903E-03	5.005E-01
SEARCH IT	7	9.856797E-01	-7.23002E-05	3.227172E-00	3.227172E-00	2.50000E-00	5.084639E-13	3.125092E-00	9.99960E-01
TRACE	8	0 0 0 1 0	-7.104E-05	-2.756E-03	3.213E-00	0.0	4.905E-03	4.905E-03	5.005E-01
SEARCH IT	8	9.837493E-01	-7.104385E-05	3.212717E-00	3.212717E-00	2.50000E-00	5.084473E-13	1.125138E-00	9.999779E-01

[illegible]

DISCHARGE: ACTINIDE CONCENTRATIONS, STEPS 100
2.429E-04 3.734E-07 6.286E-06 1.259E-06 2.96
0.0 9.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
FISSILE LOADING (KGM) 2.5011E-03 FISSILE FEED

2.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 8
2.5744E-06 MAX POWER DENSITY 3.1251E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWP-YR
TR-232	2.4640E-04	9.4968E-02	0.454270	0.452889	0.001356	0.003176	0.006992	-1.8372E 03	0.0	326.21118
PA-233	3.7882E-07	1.4663E-04	0.008517	0.008488	0.000029	0.000078	0.009174	-2.2404E 04	0.44505	288.66455
U-233	6.2570E-06	2.4220E-03	0.436849	0.487114	0.388123	0.971630	2.2.3175	8.4903E 04	0.0	1.09740
U-234	1.0247E-06	3.9833E-04	0.024641	0.024516	0.000125	0.000337	0.013667	-2.3795E 04	0.0	191.28465
U-235	2.0267E-07	7.9124E-05	0.012609	0.002441	0.010167	0.024726	1.960959	5.9240E 04	0.0	1.20415
U-236	2.1665E-08	8.4942E-04	0.000192	0.000191	0.000001	0.000003	0.013835	-8.7409E 03	0.0	187.69891
FIXED	4.0000E-02	7.9708E-01	0.018172	0.018172	0.0	0.0	0.0	-4.5860E-01	0.0	0.0
I-135	1.9605E-10	4.3951E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02256	0.0
XE-135	7.7117E-11	1.7288E-08	0.016979	0.016979	0.0	0.0	0.0	-2.2250E 08	0.00646	0.0
PM-147	4.0778E-08	9.9541E-06	0.003201	0.003201	0.0	0.0	0.0	-7.8704E 04	0.00136	0.0
PM-148	2.2586E-10	5.5508E-08	0.000347	0.000347	0.0	0.0	0.0	-1.5377E 06	0.00135	0.0
PM-148M	3.7948E-10	9.3264E-08	0.001203	0.001203	0.0	0.0	0.0	-3.1944E 04	0.00030	0.0
PM-149	3.2061E-10	7.9326E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.00467	0.0
SM-149	6.6298E-10	1.6404E-07	0.004666	0.004666	0.0	0.0	0.0	-7.1121E 06	0.0	0.0
NE-143	1.6666E-07	3.9574E-05	0.004787	0.004787	0.0	0.0	0.0	-2.9004E 04	0.0	0.0
FP1	3.1769E-06	6.1722E-04	0.010398	0.010398	0.0	0.0	0.0	-3.2862E 03	0.0	0.0
FP2	9.9085E-06	1.9057E-03	0.003121	0.003121	0.0	0.0	0.0	-3.1925E 02	0.0	0.0
CTHER			0.0							
SUM		9.9767E-01	0.999952		0.399801	0.999949	2.216792	FISSILE		1.09631

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
5.0842E 13 2.4940E 11 2.7554E-03 2.50000 2.50000 -0.00589 1.00000 0.01741 1.04332 1.04323

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, MWT-D/KGM
1.25005E 00 1.00000E 00 2.00000E 00 7.50000E-01 1.00000E-01 9.97060E-05 9.58165E-05 2.28807E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS	3.999999
REPLICATION	1.317734	0.0	1.317734	0.241583	1.559317		
PROCESSING	0.0	-2.910595	2.910595	-0.679139	2.231456		
FUEL	6.647483	6.733267	-0.085784	2.789793	2.704009		
SUM	7.965217	3.822672	4.142545	2.352237	6.494781	ENERGY (MWE-YR), SUM	2.50011E-06 5.00001E-06

CYCLE, IT, R, FISS FEED, EXIT, POWER, CR, YRS, COST 2 8 1.0000 2.5744E-06 2.6931E-06 1.2501E 00 1.0433 4.0000 6.4948
CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 3 5.000

TRACE	1	0	2	1	0	1	0	-1.425E-02	-2.756E-03	3.213E 00	0.0	5.064E-20	4.905E-03	5.005E-01	1.063E 00
SEARCH IT	1	9.857493E-01	-1.425070E-02	3.212717E 00	2.500000E 00	5.084225E 13	3.202373E 00	0.0							
SEARCH IT	1	9.857493E-01	-1.425070E-02	3.212717E 00	2.500000E 00	4.961383E 13	3.126877E 00	1.000487E 00							
TRACE	2	0	0	0	1	0	0	-3.024E-03	-2.735E-03	3.213E 00	0.0	5.020E-03	5.029E-03	5.107E-01	1.055E 00
SEARCH IT	2	9.827682E-01	-3.024270E-03	3.212717E 00	2.500000E 00	4.958406E 13	3.118062E 00	1.001647E 00							
TRACE	3	0	0	1	0	1	0	-3.092E-03	-2.735E-03	3.713E 00	0.0	5.001E-03	5.005E-03	5.107E-01	1.055E 00
SEARCH IT	3	9.797299E-01	-3.091554E-03	3.713322E 00	2.500000E 00	4.969135E 13	3.119141E 00	1.000833E 00							
TRACE	4	0	0	1	0	1	0	4.516E-04	-2.735E-03	3.528E 00	0.0	4.997E-03	4.996E-03	5.107E-01	1.055E 00
SEARCH IT	4	9.801718E-01	4.516481E-04	3.527655E 00	2.500000E 00	4.979394E 13	3.126357E 00	9.998720E-01							
TRACE	5	0	0	0	1	0	0	1.527E-04	-2.714E-03	3.528E 00	0.0	5.010E-03	5.010E-03	5.078E-01	1.049E 00
SEARCH IT	5	9.803213E-01	1.526543E-04	3.527655E 00	2.500000E 00	4.977015E 13	3.125205E 00	9.999025E-01							
TRACE	6	0	0	1	0	1	0	1.150E-04	-2.714E-03	3.528E 00	0.0	5.008E-03	5.008E-03	5.078E-01	1.049E 00
SEARCH IT	6	9.804335E-01	1.150147E-04	3.527655E 00	2.500000E 00	4.976566E 13	3.125219E 00	9.999674E-01							

ADJUSTED INITIAL CONCENTRATIONS (SEARCH SIGNVALUE 0.98575 0.98043)
 2.500E-04 0.0 6.529E-06 1.23E-06 2.503E-07 4.22E-08 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
 2.430E-04 3.65E-07 6.287E-06 1.582E-06 4.33E-07 1.02E-07 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.000E-02 1.99E-10 7.96E-11 5.91E-08 3.21E-10 5.47E-10 3.68E-10 7.79E-10 3.03E-07 6.38E-06 1.98E-05

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 2.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 4
 FISSION LOADING (KGM) 2.5681E-03 FISSION PERIOD 2.6408E-06 MAX POWER DENSITY 3.125E 00

NUCLIDE	DENSITY	GRANS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWR-YR
TH-232	2.468E-04	9.497E-02	0.44367E	0.44367E	0.001329	0.003111	0.006992	-1.8001E 03	0.0	326.21193
PA-233	3.710E-07	1.4362E-04	0.008170	0.008170	0.000028	0.000075	0.009174	-2.1547E 04	0.0	288.66455
U-233	6.2561E-06	2.4216E-03	0.427769	0.047701	0.380035	0.931433	2.224176	8.3081E 04	0.0	1.09740
U-234	1.4203E-06	5.5214E-04	0.033450	0.033280	0.000170	0.000457	0.013667	-2.3314E 04	0.0	191.28467
U-235	3.7530E-07	1.4652E-04	0.022866	0.004426	0.018438	0.048840	1.960959	5.7950E 04	0.0	1.20415
U-236	6.938E-08	2.7203E-05	0.000602	0.000599	0.000003	0.000008	0.013835	-8.5613E 01	0.0	167.69684
FIXED	4.000E-02	7.970E-01	0.017797	0.017797	0.0	0.0	0.0	-4.8967E-01	0.0	0.0
X-135	1.964E-10	4.4037E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02262	0.0
Y-135	7.847E-11	1.7532E-08	0.016921	0.016921	0.0	0.0	0.0	-2.1819E 08	0.00658	0.0
PA-147	4.120E-08	1.0037E-05	0.003167	0.003167	0.0	0.0	0.0	-7.7107E 04	0.00137	0.0
PA-148	2.243E-10	5.5132E-08	0.000338	0.000338	0.0	0.0	0.0	-1.5062E 06	0.00134	0.0
PH-180	3.817E-10	9.3823E-08	0.001185	0.001185	0.0	0.0	0.0	-3.1317E 04	0.00030	0.0
PH-149	3.2081E-10	7.9378E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.00467	0.0
SR-149	6.777E-10	1.6770E-07	0.004672	0.004672	0.0	0.0	0.0	-6.9745E 06	0.0	0.0
WD-143	1.671E-07	3.9682E-05	0.004701	0.004701	0.0	0.0	0.0	-2.8440E 04	0.0	0.0
FP1	3.181E-06	6.1820E-04	0.010199	0.010199	0.0	0.0	0.0	-3.2200E 03	0.0	0.0
FP2	9.821E-06	1.9083E-03	0.003061	0.003061	0.0	0.0	0.0	-3.1274E 02	0.0	0.0
OTHER										
SUM	8.9794E-01	0.999924			0.400023	0.999925	2.210820	FISSION		1.09820

PIUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 4.9763E 13 2.492E 11 2.815E-03 2.5000 2.5000 -0.00663 1.0000 0.01597 1.0406 1.04027

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, PRED(KGM), DISCHARGE, MWT-D/KGM
 1.2500E 00 1.0000E 00 2.0000E 00 7.5000E-01 1.0000E-01 9.9750E-05 9.6079E-05 2.2819E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR RL, MIDCYCLE REAL YRS
FABRICATION	1.32124	0.0	1.32124	0.242229	1.563469	6.466665
PROCESSING	0.0	-2.918492	2.918492	-0.680982	2.237511	
FUEL	6.707645	6.793670	-0.086024	2.814918	2.728891	
SUM	8.028899	3.875177	4.153722	2.376164	6.529886	

SUM 2.40017E-04 7.40018E-06

CYCLE THROUGHAWAY COST ESTIMATE, DIRECT, TOTAL 8.81235 10.11684

COST LEVELIZED OVER 3 FUEL CYCLES AT DISCOUNT FACTOR 0.0700, REAL YEARS 0.000

FABRICATION	1.317281	0.0	1.317281	0.292645	1.609925
PROCESSING	0.0	-2.909552	2.909552	-0.605723	2.303828
FUEL	6.639896	6.721567	-0.081671	2.872195	2.790724

SUM 7.957177 3.812016 4.145162 2.559316 6.704477, ENERGY (MWE-YR), SUM 7.50018E-06

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

FABRICATION	1.317281	0.0	1.317281	0.222891	1.540172
PROCESSING	0.0	-2.909552	2.909552	-0.343404	2.566148
FUEL	2.113009	2.264556	-0.151546	1.462733	1.311187

SUM 3.330290 -0.644996 4.075286 1.342220 5.417506, ENERGY (MWE-YR), SUM 7.50018E-06

COST ESTIMATE WITH DISCOUNTING ONLY AT TWICE THE RATE 6.81766

THROWAWAY COST ESTIMATE, DIRECT, TOTAL, AND WITH ONLY DISCOUNTING 6.75816 10.35177 10.00294

CYCLE, IT, K, PISS FEED, EXIT, POWER, CR, YRS, COST 3 6 1.0000 2.6404E-06 2.7521E-06 1.2501E 00 1.0407 1.6667 6.5299

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 2.35065E-04 2.80775E-04 8.28970E-06
 SUMMED PISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 7.70856E-06 0.0 8.05691E-06 3.48351E-07
 PISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.09601 1.04237 0.01657

ORE (U-235 FEED) INITIAL, FEED, DISCHARGE, NET (KGM) 0.0 4.613999E-01 1.858728E-06 4.413980E-01

CASE END NORMAL, CHECKOUT CASE, U-233, FLUX RATIO SET, LOW POWER, PROCESSOR (SEC) 0.64

CHECKOUT CASE, U-233, FLUX RATIO SET, LOW POWER, CALCULATE KEFF

CONTROL OPTIONS	2	2	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 1.000E 09 0.0	0.0	0.0	0.0	2.000E 00 0.0	2.500E 00 2.000E 12	4.000E-01	1.250E 09 0.0	1.000E 00											
INITIAL CONCENTRATIONS	2.5000E-04	0.0	6.4423E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	4.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100

2.426E-04	3.846E-07	6.248E-06	7.609E-07	1.135E-07	7.914E-09	0.0	0.0	0.0	0.0	0.0
0.0	4.000E-02									

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 2.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 3
 (INITIAL CONCENTRATIONS USED) PISSILE FEED (KGM) 2.4937E 03

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
TR-232	2.4629E-04	9.4924E 07	0.468224	0.466801	0.001398	0.003274	0.006992	-1.8932E 03	0.0	326.21143
PA-233	3.9036E-07	1.5110E 05	0.009050	0.009019	0.000031	0.000083	0.009174	-2.3077E 04	0.45844	288.66479
U-233	6.1958E-06	2.3983E 06	0.446070	0.049742	0.396315	3.992139	2.224175	8.7653E 04	0.0	1.09740
U-234	4.1255E-07	1.6038E 05	0.010230	0.010178	0.000052	0.000140	0.013667	-2.4522E 04	0.0	191.28456
U-235	3.4768E-08	1.3573E 04	0.002230	0.000432	0.001799	0.004374	1.960959	6.1186E 04	0.0	1.20415
U-236	1.1703E-09	4.5884E 02	0.000011	0.000011	0.000000	0.000000	0.013835	-9.0120E 03	0.0	187.69844
FIXED	4.0000E-02	7.9708E 08	0.018739	0.018739	0.0	0.0	0.0	-4.7208E-01	0.0	0.0
I-135	1.9562E-10	4.3854E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02250	0.0
XE-135	7.5230E-11	1.6863E 01	0.017081	0.017081	0.0	0.0	0.0	-2.2899E 08	0.00630	0.0

PH-147 4.0265E-08 9.8330E 03 0.003250 0.003260 0.0 0.0 -9.1118E 04 0.00134 0.0
 PH-148 2.2868E-10 5.6202E 01 0.000362 0.000362 0.0 0.0 -1.5854E 06 0.00137 0.0
 PH-149 3.7720E-10 9.2704E 01 0.001233 0.001233 0.0 0.0 -3.2894E 04 0.00030 0.0
 PH-149 3.2196E-10 7.9660E 01 0.0 0.0 0.0 0.0 0.0 0.00468 0.0
 SH-149 6.4543E-10 1.5970E 02 0.004684 0.004684 0.0 0.0 -7.3192E 06 0.0 0.0
 NC-143 1.6605E-07 3.9430E 04 0.004918 0.004918 0.0 0.0 -2.9854E 04 0.0 0.0
 PP1 3.1724E-06 6.1636E 05 0.010707 0.010707 0.0 0.0 -3.3861E 03 0.0 0.0
 PP2 9.7986E-06 1.9038E 06 0.003215 0.003215 0.0 0.0 -3.2900E 02 0.0 0.0
 OTHER 0.0
 SUM 8.9729E 08 1.000015 0.399594 1.000009 2.22866 PISSELE 1.09183

FLUX, LOSSES, SIG2, PLOT RATIO (2), SUM IMPORTANCE*, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 5.2448E 13 2.4949E 11 2.6719E-03 2.50000 2.50000 -0.00483 0.99999 0.01789 1.04314 1.04378

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, HWT-D/KGM
 1.24998E 09 1.00000E 09 2.00000E 00 7.50000E-01 1.00000E-01 9.93288E 04 9.54457E 04 2.29662E 01

FABRICATION 1.312828 0.0 1.312828 0.240584 1.553512
 PROCESSING 0.0 -2.899506 2.899506 -0.676551 2.222955
 FUEL 6.564434 6.637621 -0.073187 2.752251 2.679064
 SUM 7.877262 3.738115 4.139147 2.316383 6.455530, ENERGY (KWE-YR), SUM 2.49996E 03 2.49996E 03

CYCLE, IT. K. PISSELE, EXIT. POWER, CR. YRS. COST 1 3 1.0000 2.4937E 03 2.6117E 03 1.2500E 09 1.0431 1.3333 6.4555
 CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (PULL POWER YEARS) 2 3.000

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100
 2.429E-04 3.700E-07 6.319E-06 1.267E-06 2.980E-07 4.320E-08 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 2.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 3
 (INITIAL CONCENTRATIONS USED) PISSELE FEED (KGM) 2.6117E 03

NUCLIDE DENSITY GRAMS ABSORPTION CAPTURE FISSION PRODUCTION ETA IMPORTANCE DECAY KGM/MWE-YR
 TR-232 2.4643E-04 9.4981E 07 0.452288 0.450913 0.001350 0.003162 0.006992 -1.8225E 03 0.0 326.21118
 PA-233 3.7536E-07 1.4529E 05 0.008401 0.008373 0.000028 0.000077 0.009174 -2.2238E 04 0.0 288.66455
 U-233 6.3139E-06 2.4440E 06 0.438441 0.048936 0.389892 0.976059 2.224176 8.3977E 04 0.0 1.09740
 U-234 1.0349E-06 4.0232E 05 0.074776 0.024650 0.000126 0.000339 0.013667 -2.3603E 04 0.0 191.28462
 U-235 2.0411E-07 7.9865E 04 0.012670 0.002452 0.010216 0.024845 1.960959 5.8551E 04 0.0 1.20415
 U-236 2.1806E-08 8.5493E 03 0.000192 0.000191 0.000001 0.000003 0.013835 -8.6632E 03 0.0 187.69697
 FIXED 0.0000E-02 7.9709E 08 0.018090 0.018090 0.0 0.0 -8.5570E-01 0.0 0.0
 I-135 1.9597E-10 4.3931E 01 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 XE-135 7.7614E-11 1.7399E 01 0.017012 0.017012 0.0 0.0 -2.2115E 08 0.0 0.0
 PH-147 4.0973E-08 1.0002E 04 0.003201 0.003201 0.0 0.0 -7.8058E 04 0.0 0.0
 PH-148 2.2523E-10 5.5354E 01 0.000344 0.000344 0.0 0.0 -1.5241E 06 0.0 0.0
 PH-149 3.8057E-10 9.3532E 01 0.001201 0.001201 0.0 0.0 -3.1728E 06 0.0 0.0
 SH-149 3.2027E-10 7.9242E 01 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 NC-143 6.6850E-10 1.6543E 02 0.004685 0.004685 0.0 0.0 -7.0691E 06 0.0 0.0
 PP1 1.6721E-07 3.9706E 04 0.004781 0.004781 0.0 0.0 -2.8821E 04 0.0 0.0
 PP2 3.1846E-06 6.1873E 05 0.010376 0.010376 0.0 0.0 -3.2604E 03 0.0 0.0
 OTHER 9.8310E-06 1.9101E 06 0.003114 0.003114 0.0 0.0 -3.1667E 02 0.0 0.0
 SUM 8.9729E 08 0.999973 0.401614 1.004483 2.216789 PISSELE 1.09605

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 1.0000E 11 2.4417E 11 2.7722E-03 2.50000 2.50000 -0.00307 1.00451 0.01361 1.01410 1.01466

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGM), DISCHARGE, NWT-D/KGM
 1.25000E 09 1.00000E 09 2.00000E 00 7.50000E-01 1.00000E-01 9.97477E 04 9.58576E 04 2.28709E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MIL/KW-HR FL, MIDCYCLE REAL YRS	1.999999
FABRICATION	1.318307	0.0	1.318307	0.241688	1.559995		
PROCESSING	0.0	-2.911892	2.911892	-0.679441	2.232450		
FUEL	6.744845	6.763760	-0.021914	2.814208	2.792294		
SUM	8.060152	3.851868	4.208284	2.376454	6.584739	ENERGY (MWE-YR), SUM	2.50006E 03 5.00002E 01

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 2 3 1.0045 2.6117E 03 2.7057E 03 1.2500E 09 1.0343 4.0000 6.5847
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 3 3 1.0076 2.7057E 03 2.771E 03 1.2500E 09 1.0256 6.6167 6.6425
 CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 5 9.000

DISCHARGE CONCENTRATIONS
 2.433E-04 3.486E-07 6.362E-06 2.001E-06 6.919E-07 2.631E-07 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 4.000E-02 1.975E-10 9.178E-11 6.074E-08 3.175E-10 5.569E-10 3.654E-10 8.120E-10 3.068E-07 6.356E-06 1.990E-05

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 2.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 3
 (INITIAL CONCENTRATIONS USED) FISSILE FEED (KGM) 2.8272E 03

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
TH-232	2.4665E-04	9.5063E 07	0.428847	0.427543	0.001280	0.002998	0.006992	-1.7198E 03	0.0	326.21143
PA-233	3.5329E-07	1.3675E 05	0.007491	0.007465	0.000025	0.000069	0.009174	-2.1017E 04	0.42063	288.66455
U-233	6.3758E-06	2.4679E 06	0.419804	0.046813	0.372979	0.933719	2.224175	7.8673E 04	0.0	1.09740
U-234	1.9264E-06	7.4887E 05	0.043689	0.043466	0.000222	0.000597	0.013667	-2.2268E 04	0.0	191.28450
U-235	6.3867E-07	2.4934E 05	0.037473	0.007253	0.030216	0.073482	1.960958	5.4753E 04	0.0	1.20415
U-236	2.2049E-07	8.6444E 04	0.001842	0.001832	0.000010	0.000025	0.013835	-8.1595E 03	0.0	187.69897
FIXED	4.0000E-02	7.9708E 08	0.017138	0.017138	0.0	0.0	0.0	-4.3110E-01	0.0	0.0
I-135	1.9676E-10	4.4108E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02295	0.0
XE-135	8.1493E-11	1.8269E 01	0.016922	0.016922	0.0	0.0	0.0	-2.0971E 08	0.00692	0.0
PM-147	4.2238E-08	1.0311E 04	0.003126	0.003126	0.0	0.0	0.0	-7.3621E 04	0.00142	0.0
PM-148	2.2083E-10	5.4273E 01	0.000320	0.000320	0.0	0.0	0.0	-1.4358E 06	0.00134	0.0
PM-148R	3.9728E-10	9.5181E 01	0.001158	0.001158	0.0	0.0	0.0	-3.0029E 06	0.00031	0.0
PM-149	3.2069E-10	7.9346E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00473	0.0
SM-149	7.1265E-10	1.7633E 02	0.004730	0.004730	0.0	0.0	0.0	-6.7032E 06	0.0	0.0
MC-143	1.6900E-07	4.0131E 04	0.004578	0.004578	0.0	0.0	0.0	-2.7318E 04	0.0	0.0
FP1	3.2073E-06	6.2313E 05	0.009900	0.009900	0.0	0.0	0.0	-3.0778E 03	0.0	0.0
FP2	9.8945E-06	1.9224E 06	0.002970	0.002970	0.0	0.0	0.0	-2.9876E 02	0.0	0.0
OTHER			0.0							
SUM		8.9843E 08	0.999986		0.404732	1.010890	2.202606	FISSILE		1.10131

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 4.7312E 13 2.4609E 11 2.9375E-03 2.50000 2.50000 -0.00091 1.01091 0.00491 1.01330 1.01365

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGM), DISCHARGE, NWT-D/KGM
 1.25002E 09 1.00000E 09 2.00000E 00 7.50000E-01 1.00000E-01 1.00458E 05 9.65435E 04 2.27098E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	
FABRICATION	1.327654	0.0	1.327654	0.243402	1.571055	
PROCESSING	0.0	-2.932762	2.932762	-0.684311	2.248451	
FUEL	7.011959	6.934876	0.076982	2.903638	2.950620	
SUM	8.339513	4.002114	4.337399	2.462729	6.800127	WILL/KW-HR EL, MIDCYCLE REAL YRS 11.999997

CYCLE THRONAWAY COST ESTIMATE, DIRECT, TOTAL 9.14689 10.48741

	COST	RETURN	DIRECT	INDIRECT	TOTAL	
FABRICATION	1.321301	0.0	1.321301	0.292530	1.613832	
PROCESSING	0.0	-2.918567	2.918567	-0.609060	2.309506	
FUEL	6.829015	6.817802	0.011172	2.909432	2.520605	
SUM	8.150316	3.899276	4.251040	2.592902	6.843943	ENERGY (MWE-YR), SUM 1.25002E 04

	COST	RETURN	DIRECT	INDIRECT	TOTAL	
FABRICATION	1.321301	0.0	1.321301	0.222608	1.543909	
PROCESSING	0.0	-2.918567	2.918567	-0.346094	2.572473	
FUEL	1.312887	1.386974	-0.074087	1.381000	1.306912	
SUM	2.634139	1.531592	4.165781	1.257513	5.423294	ENERGY (MWE-YR), SUM 1.25002E 04

COST ESTIMATE WITH DISCOUNTING ONLY AT TWICE THE RATE 6.75110
 THRONAWAY COST ESTIMATE, DIRECT, TOTAL, AND WITH ONLY DISCOUNTING 8.95379 10.54955 10.19241

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 5 3 1.0109 2.8272E 03 2.8639E 03 1.2500E 09 1.0133 12.0100 4.8001

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 4.81775E 05 4.68389E 05 1.33863E 04
 SUMMED FISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 1.34143E 04 0.0 1.37845E 04 3.70188E 02
 FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.09790 1.02697 0.01021

ONE (U-235 FEED) INITIAL, FEED, DISCHARGE, NET (KGM) 0.0 9.227998E-01 3.180076E 03 -3.179153E 03

CASE END NORMAL, CHECKOUT CASE, U-233, FLUX RATIO SET, LOW POWER, CALCULATE KEFF , PROCESSOR (SEC) 0.47

U-235 FEED, 4 SUBZONES, 4 YR RESIDENCE, DELAYED RECYCLE
 THIS CALCULATION TREATS SUBZONES, NUMBER 4

CONTROL OPTIONS	2	0	1	-30	1	0	1	-4	0	1	0	0	0	12	0	0	0	0	0	0	0
DATA 6.000E 08 0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000E 00	1.750E-03	5.000E 00	2.000E 12	4.000E-01	1.200E 09	5.000E-02	1.000E 00							
SUBZONE 1	2.5000E-04	0.0	0.0	0.0	0.0	0.0	1.5000E-05	0.0	0.0	1.1840E-06	0.0	0.0	0.0								
0.0	0.0	0.0	5.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
SUBZONE 2	2.5000E-04	0.0	0.0	0.0	0.0	0.0	1.7500E-05	0.0	0.0	1.3160E-06	0.0	0.0	0.0								
0.0	0.0	0.0	5.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
SUBZONE 3	2.5000E-04	0.0	0.0	0.0	0.0	0.0	2.0000E-05	0.0	0.0	1.4470E-06	0.0	0.0	0.0								
0.0	0.0	0.0	5.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
SUBZONE 4	2.5000E-04	0.0	0.0	0.0	0.0	0.0	2.2500E-05	0.0	0.0	1.5790E-06	0.0	0.0	0.0								
0.0	0.0	0.0	5.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
INITIAL CONCENTRATIONS	2.5000E-04	0.0	0.0	0.0	0.0	0.0	0.0	1.8750E-05	0.0	0.0	1.3815E-06	0.0	0.0								
0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0								

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE) 1.00000 0.52619)
 2.500E-04 0.0 0.0 9.866E-06 0.0 7.269E-07 0.0 0.0 0.0 0.0
 0.0 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 2
 2.457E-04 4.480E-07 2.661E-05 1.998E-07 3.344E-06 7.113E-07 6.056E-07 1.581E-10 8.590E-09 1.854E-09 9.617E-10 1.410E-10
 8.056E-12 5.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.000 NORMALLY ELECTRICAL POWER BASIS, IRRADIATIONS 13
 PISSELE LOADING (KGM) 2.3110E 06 PISSELE FEED 2.3110E 03 MAX POWER DENSITY 5.6205E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
TH-232	2.4565E-04	5.680E 07	0.367700	0.366715	0.000968	0.002266	0.006163	-1.4161E 03	0.0	370.04199
PA-233	4.5424E-07	1.0550E 05	0.008900	0.008900	0.000025	0.000067	0.007534	-1.8034E 04	0.0	351.46338
U-233	2.7352E-06	6.3525E 05	0.130100	0.019274	0.160420	0.402583	2.235325	8.7727E 04	0.0	1.09189
U-234	1.8885E-07	4.4049E 04	0.003645	0.003629	0.000017	0.000044	0.01187	-1.8225E 04	0.0	214.52527
U-235	4.9951E-06	1.1701E 06	0.298595	0.055074	0.243489	0.592024	1.982697	6.4881E 04	0.0	1.19070
U-236	8.6963E-07	2.0457E 05	0.005650	0.005621	0.000029	0.000076	0.013500	-6.3456E 03	0.0	192.36191
U-238	7.0336E-07	1.6733E 05	0.001786	0.001775	0.000010	0.000028	0.015921	-2.4610E 03	0.0	164.06577
U-239	1.9579E-10	4.6641E 01	0.000003	0.000003	0.000000	0.000000	0.018093	-1.3281E 04	0.0	145.27924
PA-239	1.1060E-08	2.6189E 03	0.001152	0.000551	0.000901	0.002591	1.784106	1.1732E 05	0.0	1.54206
PA-240	2.2968E-09	5.4945E 02	0.000337	0.000337	0.000000	0.000000	0.003635	-1.2953E 05	0.0	749.51611
PA-241	1.0121E-09	2.4312E 02	0.000163	0.000163	0.000125	0.000167	2.174113	2.1389E 05	0.0	1.29006
PA-242	1.5224E-10	3.6724E 01	0.000003	0.000003	0.000000	0.000000	0.011303	-2.2119E 04	0.0	259.26416
AM-243	9.1364E-12	5.2129E 00	0.000000	0.000000	0.000000	0.000000	0.006405	-2.8735E 04	0.0	494.37671
FISSION	5.0000E-02	5.9781E 08	0.022206	0.022206	0.0	0.0	0.0	-3.9620E-01	0.0	0.0
U-235	3.0609E-10	4.1171E 01	0.0	0.0	0.0	0.0	0.0	0.02426	0.0	0.0
U-238	9.392E-11	1.2158E 01	0.020051	0.020051	0.0	0.0	0.0	-1.9594E 08	0.00522	0.0
PA-147	7.2150E-08	1.0567E 04	0.004482	0.004482	0.0	0.0	0.0	-5.9725E 04	0.00165	0.0
PA-149	4.6176E-10	6.4090E 01	0.000525	0.000525	0.0	0.0	0.0	-1.1221E 06	0.00190	0.0
PA-148	6.1751E-10	9.1057E 01	0.001820	0.001820	0.0	0.0	0.0	-2.6718E 06	0.00074	0.0
PA-149	6.9957E-10	1.0386E 02	0.0	0.0	0.0	0.0	0.0	0.00701	0.0	0.0
PA-149	9.9480E-10	1.4758E 02	0.007047	0.007047	0.0	0.0	0.0	-6.2591E 06	0.0	0.0
PA-143	2.5090E-07	3.6317E 04	0.007227	0.007227	0.0	0.0	0.0	-2.5214E 04	0.0	0.0
FP1	5.2458E-06	6.1152E 05	0.014192	0.014192	0.0	0.0	0.0	-2.5592E 03	0.0	0.0
FP2	1.6326E-05	1.9032E 06	0.004176	0.004176	0.0	0.0	0.0	-2.4449E 02	0.0	0.0
OTHER		0.050000								
SUM	6.5951E 08	1.000066			0.406384	1.000048	2.076889	PISSELE		1.14969

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 7.4386E 13 3.6218E 11 3.1081E-03 1.95252 1.77605 0.12441 1.03000 -0.13635 0.71204 0.75690

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, MWT-D/KGM
 1.19996E 09 6.00000E 08 1.00000E 00 7.50000E-01 1.00000E-01 6.05883E 04 1.45510E 04 1.80722E 01

FABRICATION	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS	0.666667
	1.668349	0.0	1.668349	0.417086	2.085435		
PROCESSING	0.0	-0.920928	0.920928	-0.153488	0.767440		
FUEL	10.101731	1.883463	8.218268	2.839334	11.057602		
SUM	11.770081	0.962535	10.807586	3.102931	13.910477	ENERGY (MWE-YR), SUM	1.19996E 03 1.19996E 03

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 1 11 1.0000 2.3110E 03 4.2618E 07 1.2000E 09 0.711 0.6667 11.9105
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 2 14 1.0000 8.1591E 02 3.9954E 07 1.2000E 09 0.7044 2.0000 4.5941
 CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 3 2.500

ADJUSTED INITIAL CONCENTRATIONS (SEARCH RIGNVALUE 1.20568 0.60384)
 2.500E-04 0.0 3.109E-06 1.898E-07 1.099E-05 7.113E-07 1.107E-06 0.0 8.748E-07 1.854E-09 8.617E-10 1.410E-10
 9.056E-12 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEP3 2
 2.375E-04 4.145E-07 4.688E-06 8.060E-07 1.503E-06 1.488E-06 6.381E-07 1.759E-07 1.287E-08 4.388E-09 3.666E-09 2.108E-09
 4.813E-10 5.060E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 12
 FISSILE LOADING (KGM) 2.3653E 06 FISSILE PROD R.2482E 02 MAX POWER DENSITY 6.2392E 00

NITRIDE	DENSITY	GRANS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAT	KGM/MWP-YR
TH-232	2.4053E-04	5.5624E 07	0.341630	0.340693	0.003920	0.002153	0.006304	-1.3591E 03	0.0	161.81816
PA-233	4.2828E-07	9.9467E 04	0.007870	0.007847	0.003023	0.000041	0.007796	-1.7202E 04	0.34185	319.68066
U-233	4.5526E-06	1.0573E 06	0.277741	0.029910	0.247821	0.620380	2.233662	7.9217E 04	0.0	1.09270
U-234	6.5246E-07	1.4985E 05	0.011735	0.033005	0.000054	0.000147	0.012440	-1.7807E 04	0.0	210.16461
U-235	3.4035E-06	7.9733E 05	0.118209	0.034928	0.11061	0.372166	1.979506	5.8584E 04	0.0	1.19265
U-236	1.6214E-06	3.8140E 05	0.010176	0.010124	0.000052	0.000138	0.013561	-6.1444E 04	0.0	191.88696
U-238	9.6782E-07	2.0587E 05	0.002121	0.002108	0.000013	0.000034	0.016004	-2.3841E 03	0.0	163.21097
NP-239	2.7338E-10	5.6539E 01	0.000003	0.000003	0.000000	0.000000	0.018427	-1.2722E 04	0.00222	142.64359
NP-239	1.7399E-08	4.1450E 01	0.002104	0.000798	0.003130	0.003753	1.783745	1.0216E 05	0.0	156.65405
NP-240	5.1597E-09	1.2341E 03	0.00069	0.000695	0.000001	0.000003	0.003795	-1.2216E 05	0.0	156.65405
NP-241	2.6628E-09	8.8138E 02	0.000564	0.000146	0.000419	0.001227	2.175174	1.9381E 05	0.00002	1.28943
NP-242	1.7041E-09	4.1107E 02	0.000337	0.000337	0.000000	0.000000	0.011382	-2.1392E 04	0.0	257.46045
NP-243	2.9782E-10	7.2147E 01	0.000009	0.000009	0.000000	0.000000	0.006702	-2.7240E 04	0.0	472.48515
FIXED	5.0000E-02	5.9781E 08	0.020466	0.020466	0.0	0.0	0.0	-3.7831E-01	0.0	0.0
I-135	2.9927E-10	4.0254E 01	0.0	0.0	0.0	0.0	0.0	3.0	0.02354	0.0
XE-135	7.4893E-11	1.2709E 01	0.019235	0.0	0.0	0.0	0.0	-1.8466E 08	0.00541	0.0
PM-147	9.5311E-08	1.3960E 04	0.005643	0.005643	0.0	0.0	0.0	-5.7450E 04	0.00217	0.0
PM-148	5.9154E-10	8.7228E 01	0.000649	0.000649	0.0	0.0	0.0	-1.0857E 06	0.00242	0.0
PM-149	8.2782E-10	1.2208E 02	0.002265	0.002265	0.0	0.0	0.0	-2.5367E 06	0.00045	0.0
PM-149	7.1083E-10	1.0553E 02	0.0	0.0	0.0	0.0	0.0	0.0	0.00707	0.0
SM-149	1.0992E-09	1.6319E 02	0.007147	0.007147	0.0	0.0	0.0	-5.8991E 06	0.0	0.0
ND-143	4.7830E-07	6.8147E 04	0.012482	0.012482	0.0	0.0	0.0	-2.3801E 04	0.0	0.0
FP1	1.1813E-05	1.3771E 06	0.030231	0.030231	0.0	0.0	0.0	-2.4525E 03	0.0	0.0
FP2	3.7816E-05	4.4081E 06	0.009194	0.009194	0.0	0.0	0.0	-2.3486E 02	0.0	0.0
OTHER			0.050000							
SUM		6.6200E 08	1.000003		0.403669	1.000062	2.125560	FISSILE		1.12976

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*W, MULTIPLICATION, RECIPROCAL DOWLING TIME (YR-1), CONVERSION RATIO (2)
 6.8786E 11 1.449E 11 3.2867E-03 1.97852 1.87809 0.10749 0.99999 -0.28106 0.70049 0.74156
 PUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGM), DISCHARGE, MWT-D/KGM
 1.19999E 09 6.00000E 08 1.00000E 00 7.50000E-01 1.00000E-01 1.54712E 04 1.41477E 04 5.30775E 01

FABRICATION	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR PL, MIDCYCLE REAL YRS	3.333331
PROCESSING	0.764798	0.0	0.764798	0.242184	1.006982		
FUEL	0.0	-0.895458	0.895458	-0.268637	0.626821		
	3.713849	1.825961	1.887881	1.723838	3.611721		
SUM	4.478646	0.910508	3.548134	1.697385	5.245523	ENERGY (MWE-YR), SUM	1.19989E 03 1.59982E 01

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 3 12 1.0000 8.2482E 02 3.8530E 02 1.1999E 09 0.7005 3.3333 5.2155
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 4 10 1.0000 8.0936E 02 3.7088E 02 1.1959E 09 0.7000 4.6667 5.1100
 CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 23 22.500

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUES 0.59342 0.59434)
 2.500E-04 0.0 6.091E-06 2.278E-06 8.701E-06 4.066E-06 2.388E-06 0.0 4.169E-08 1.494E-08 1.324E-08 1.849E-08
 1.193E-08 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
 9.627E-04 1.540E-06 2.383E-05 9.153E-06 1.334E-05 1.757E-05 8.501E-06 2.154E-09 1.997E-07 6.743E-08 5.572E-09 7.414E-08
 5.160E-08 2.000E-01 1.195E-09 4.370E-10 3.970E-07 2.264E-09 3.569E-09 2.667E-09 4.991E-09 2.199E-06 5.317E-05 1.705E-04

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YPS) 1.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 6
 FISSILE LOADING (KGM) 2.6715E 06 FISSILE FEED 8.6650E 02 MAX POWER DENSITY 5.9741E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWE-YR
TH-232	2.4068E-04	5.5658E 07	0.305752	0.304867	0.090869	0.002034	0.006652	-1.2534E 03	0.0	342.84839
PA-233	3.8501E-07	8.9417E 04	0.006144	0.006124	0.000019	0.000052	0.008474	-1.5654E 04	0.30833	312.50171
U-233	5.9588E-06	1.3838E 06	0.305623	0.033468	0.272146	0.681280	2.229153	6.3807E 04	0.0	1.09493
U-234	2.2883E-06	5.3373E 05	0.037741	0.037557	0.000184	0.000493	0.013065	-1.6177E 04	0.0	200.10632
U-235	3.3351E-06	7.8121E 05	0.153714	0.029120	0.124577	0.302933	1.970761	4.5473E 04	0.0	1.19805
U-236	4.3926E-06	1.0333E 06	0.025748	0.025616	0.000132	0.000353	0.013706	-5.7739E 03	0.0	189.46893
U-238	2.1252E-06	5.0416E 05	0.004844	0.004814	0.000029	0.000078	0.016200	-2.2388E 03	0.0	161.23906
NP-239	5.3861E-10	1.2831E 02	0.000007	0.000006	0.000000	0.000000	0.019247	-1.1829E 04	0.00502	136.56381
PO-239	4.9915E-08	1.1891E 04	0.004991	0.001895	0.003096	0.008898	1.782743	7.9978E 04	0.0	1.5/ 334
PN-240	1.6857E-08	4.0326E 03	0.001869	0.001866	0.000093	0.000008	0.004242	-1.0841E 05	0.0	677.73462
PN-241	1.3929E-08	3.3460E 03	0.001776	0.000457	0.001319	0.003869	2.178104	1.5236E 05	0.00306	1.28771
PU-242	1.8536E-08	4.4711E 03	0.000377	0.000375	0.000001	0.000004	0.011569	-2.0051E 04	0.0	253.30052
U-233	1.2899E-08	3.1243E 03	0.000323	0.000322	0.000001	0.000002	0.007504	-2.4455E 04	0.0	421.98877
FIXED	5.0000E-02	5.9781E 08	0.016960	0.016960	0.0	0.0	0.0	-3.3351E-01	0.0	0.0
I-135	2.9869E-10	4.0176E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02341	0.0
XE-135	1.0925E-10	1.4695E 01	0.018210	0.018210	0.0	0.0	0.0	-1.6361E 08	0.00624	0.0
PN-147	9.9255E-08	1.4537E 04	0.005313	0.005313	0.0	0.0	0.0	-5.3240E 04	0.00225	0.0
PN-148	5.6590E-10	8.3448E 01	0.000577	0.000577	0.0	0.0	0.0	-1.0186E 06	0.00230	0.0
PN-149	8.9217E-10	1.3156E 02	0.002065	0.002065	0.0	0.0	0.0	-2.2816E 06	0.00048	0.0
PN-149	6.6680E-10	9.8990E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00662	0.0
SN-149	1.2477E-09	1.8522E 02	0.006645	0.006645	0.0	0.0	0.0	-5.2277E 06	0.0	0.0
ND-143	5.4963E-07	7.9309E 04	0.011840	0.011840	0.0	0.0	0.0	-2.1168E 04	0.0	0.0
FP1	1.3292E-05	1.5495E 06	0.030199	0.030199	0.0	0.0	0.0	-2.2546E 03	0.0	0.0
FP2	4.2616E-05	4.9679E 06	0.009306	0.009306	0.0	0.0	0.0	-2.1703E 02	0.0	0.0
OTHER			0.050000							
SUM		6.6443E 08	1.000021		0.402375	1.000004	2.138965	FISSILE		1.12802

PLUX, LOSSES, SIGA2, PLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 5.6465E 13 3.6586E 11 3.7888E-03 2.27017 2.16502 0.06078 0.99999 -0.25211 0.70326 0.73579

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FRED(KGM), DISCHARGE, MWT-D/KGM
 1.19999E 09 6.00000E 08 1.00000E 00 7.50000E-01 1.00000E-01 1.59126E 04 5.94011E 04 6.88126E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS
FABRICATION	0.786552	0.0	0.786552	0.091764	0.878315	29.999771
PROCESSING	0.0	-3.759380	3.759380	-1.127813	2.631567	
FUEL	3.705001	9.472545	-5.767544	3.274008	-2.493536	
SUM	4.491552	5.713164	-1.221612	2.237959	1.016346	ENERGY (MWE-YR), SUM 1.19999E 03 2.75995E 04

CYCLE THROWAWAY COST ESTIMATE, DIRECT, TOTAL 4.75029 6.07774

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 23 6 1.0000 8.6650E 02 2.2698E 03 1.2000E 04 0.7033 29.9998 1.0163

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 3.78193E 05 3.57513E 05 2.06903E 04
SUMMED FISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 2.06630E 04 1.18030E 04 1.15861E 04 -9.07686E 03
FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOWTLING TIME (YRS-1) 1.12666 0.70810 -0.09311

SUBZONE FLUX RATIOS 2.35534 2.52983 1.96692 2.12602

SUBZONE FLUX LEVELS 5.5426E 13 5.2321E 13 6.0507E 13 5.8283E 13

AFTER SHUTDOWN DENSITIES (TIME, YR 1.00000) 9.627E-04 1.495E-10 2.537E-05 9.153E-06 1.334E-05 1.757E-05 8.501E-06
0.0 2.018E-07 6.743E-08 5.284E-08 7.414E-08 5.160E-08 2.000E-01 0.0 0.0 0.0 0.0
0.0 7.658E-09 2.199E-09 5.317E-05 1.705E-04

ORE (U-235 FED) INITIAL, FEED, DISCHARGE, NET (KGM) 5.13151E 02 2.72781E 03 2.67292E 03 5.48867E 01

MAKE-UP FISSILE ASSOCIATED WITH ORE AND ORE 1.18030E 04 2.72296E 03

FUEL COST ANALYSIS

COST LEVELIZED OVER 23 FUEL CYCLES AT DISCOUNT FACTOR 0.0700 , REAL YEARS 30.666 ENERGY (MWE-YR) 2.75995E 04

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	0.800894	0.0	0.800894	0.185174	0.986068	
PROCESSING	0.0	-1.025655	1.025655	-0.299866	0.725789	
FUEL	3.951650	2.201978	1.749672	1.833465	3.583137	
SUM	4.752543	1.176323	3.576221	1.718772	5.294992	

TOTAL WITH QUARTERLY ENERGY ACCOUNTING 5.25586

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

FABRICATION	0.800894	0.0	0.800894	0.128876	0.929770
PROCESSING	0.0	-1.025655	1.025655	-0.158518	0.667137
FUEL	2.216237	0.494581	1.721656	1.229032	2.950687
SUM	3.017131	-0.531074	3.548204	1.199389	4.747594

COST ONLY DISCOUNTING WITH QUARTERLY ENERGY ACCOUNTING 4.71251, AND AT TWICE THE RATE 6.04534

THROWAWAY COST ESTIMATE, DIRECT, TOTAL 5.03490 6.28751 TOTAL ANNUAL AND QUARTERLY ONLY DISCOUNTING, 5.97965 5.93546

THE CHANGE AND TOTAL COST FOR FIFTY PERCENT INCREASE IN UNIT COSTS

FABRICATION	0.493033	5.788025
PROCESSING	0.362894	5.657886
FUEL	1.791568	7.086560

DISTRIBUTION OF THE COSTS AFTER THE INCREASE BY FIFTY PERCENT

MILL/KW-HR ELECTRIC

	COST	RETURN	DIRECT	INDIRECT	TOTAL
FARRICATION	1.201341	0.0	1.201341	0.27760	1.479100
PROCESSING	0.0	-1.534482	1.534482	-0.449799	1.084682
FUEL	5.927474	3.302966	2.624503	2.750196	5.174704
	-----	-----	-----	-----	-----
SW	7.128815	1.764484	5.364330	2.578157	7.942488

ADDITIONAL CONTINUOUS FUELING CHARGES - FARRICATION DIRECT, INDIRECT, FUEL INDIRECT, TOTAL.

ONE CYCLE	0.07254	0.11444	0.34646	0.53344
HISTORY	3.01813	0.02961	0.03662	0.13336

COST DEPENDENCE ON INDIRECT CHARGES

INTEREST RATE	0.0500	0.0750	0.1000	0.1250	0.1500
TOTAL FUEL COST	4.43561	4.84510	5.29499	5.72468	6.15430

SUMMARY OF REACTOR HISTORY, ENERGY (MWE-YR) 2.759952 04

PERIOD	TIME (YR)	LOAD FACTOR	FISSION MAKEUP AND PEED	AND DISCHARGE	CONVERSION	POWER	COST
1	0.66667	0.75000	2.31102E 03	4.06183E 02	0.71204	1.19996E 09	13.91048
2	2.00000	0.75000	8.35909E 02	3.95909E 02	0.70837	1.19997E 09	4.59432
3	3.33333	0.75000	4.18642E 02	8.24825E 02	0.70049	1.19989E 09	5.24552
4	4.66666	0.75000	4.09816E 02	8.09359E 02	0.69937	1.19995E 09	5.31004
5	6.00000	0.75000	3.98510E 02	7.83812E 02	0.70366	1.19996E 09	5.10510
6	7.33333	0.75000	4.37248E 02	8.08130E 02	0.70989	1.19996E 09	5.21895
7	8.66666	0.75000	4.12163E 02	8.10331E 02	0.71169	1.19996E 09	5.20617
8	9.99999	0.75000	4.11782E 02	8.13416E 02	0.71272	1.20002E 09	5.22588
9	11.33332	0.75000	4.12174E 02	8.17438E 02	0.71250	1.20004E 09	5.21946
10	12.66666	0.75000	4.17639E 02	8.23760E 02	0.71285	1.20002E 09	5.24770
11	13.99999	0.75000	4.10661E 02	8.26869E 02	0.71300	1.19994E 09	5.23190
12	15.33332	0.75000	4.12310E 02	8.30123E 02	0.71203	1.20001E 09	5.22001
13	16.66664	0.75000	4.11795E 02	8.35189E 02	0.71123	1.19998E 09	5.23504
14	17.99995	0.75000	4.11378E 02	8.39752E 02	0.71051	1.19996E 09	5.24841
15	19.33327	0.75000	4.09313E 02	8.42599E 02	0.70989	1.20002E 09	5.25693
16	20.66658	0.75000	4.09210E 02	8.45047E 02	0.70930	1.19994E 09	5.24687
17	21.99989	0.75000	4.10242E 02	8.48842E 02	0.70829	1.20002E 09	5.24623
18	23.33321	0.75000	4.10419E 02	8.52840E 02	0.70737	1.19999E 09	5.26147
19	24.66652	0.75000	4.10316E 02	8.55917E 02	0.70647	1.19997E 09	5.27055
20	25.99983	0.75000	4.09850E 02	8.57854E 02	0.70570	1.20001E 09	5.27554
21	27.33315	0.75000	4.09997E 02	8.60274E 02	0.70507	1.19994E 09	4.97328
22	28.66646	0.75000	4.11422E 02	8.63194E 02	0.70410	1.20000E 09	4.67613
23	29.99977	0.75000	4.12038E 02	8.66498E 02	0.70326	1.19999E 09	1.01635
OVERALL	30.66643	0.75000	1.14030E 04	2.36630E 04	0.70810	1.19998E 09	6.16464

COST ESTIMATE DISCOUNTING ENERGY ON THE BASIS OF ONE-QUARTER YEARS
COST ESTIMATE DISCOUNTING ENERGY FROM MID-CYCLE EXPOSURE POINTS (NOT A BETTER ESTIMATE)

1 DIRECT ACCOUNTING OF THE TIME OCCURRENCE OF COSTS YIELDS A FUEL COST OF (SEE SUMMARY ABOVE) 5.29499

CASE END NORMAL, 0-235 PEED, 4 SUBZONES, 4 YR RESIDENCE, DELAYED RECYCLE PROCESSOR (SPC) 10.11

U-235 FEED, 3 SUBZONE, CONTINUOUS FUELING THROWAWAY, 4 YR
THIS CALCULATION TREATS SUBZONES, NUMBER 3

CONTROL OPTIONS 2 2 1 1-12 1 0 1 3 0 -1 1 0 0 0 0 2 0 0 0 0 0 0
DATA 3.000E 08 0.0 0.0 0.0 4.000E 00 1.750E-03 5.000E 00 2.000E 12 4.000E-01 6.000E 08 5.000E-02 1.000E 00
INITIAL CONCENTRATIONS 2.4999E-04 0.0 0.0 0.0 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.00000 1.03532)
2.500E-04 0.0 0.0 0.0 9.514E-06 0.0 7.167E-07 0.0 0.0 0.0 0.0 0.0
0.0 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 2
2.440E-04 4.643E-07 3.389E-06 3.051E-07 3.157E-06 8.777E-07 6.193E-07 1.742E-10 1.056E-08 2.696E-09 1.516E-09 3.456E-10
2.917E-11 5.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.333 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 10
FISSILE LOADING (KGM) 9.2048E 05 FISSILE FEED 1.1166E 03 MAX POWER DENSITY 5.5278E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWE-YR
TH-232	2.4700E-04	2.8560E 07	0.372295	0.371297	0.000980	0.002295	0.006165	-1.4266E 03	0.0	369.95923
PA-233	4.6907E-07	5.4470E 04	0.009253	0.009227	0.000026	0.000070	0.007537	-1.8169E 04	0.36208	351.34448
U-233	1.9631E-06	2.2796E 05	0.130126	0.013927	0.116195	0.290872	2.235311	8.8280E 04	0.0	1.09189
U-234	1.0803E-07	1.2599E 04	0.002100	0.002090	0.000010	0.000026	0.012189	-1.8359E 04	0.0	214.48131
U-235	5.9034E-06	6.9141E 05	0.355256	0.065529	0.294568	0.704353	1.982664	6.5277E 04	0.0	1.19072
U-236	6.5221E-07	7.6712E 04	0.004268	0.004246	0.000022	0.000058	0.013500	-6.3919E 03	0.0	192.35304
U-238	7.0231E-07	8.3304E 04	0.001791	0.001780	0.000011	0.000029	0.015922	-2.4810E 03	0.0	164.05719
NP-239	1.9759E-10	2.3535E 01	0.000003	0.000003	0.000000	0.000000	0.018096	-1.3380E 04	0.00178	145.25273
PN-239	8.8380E-09	1.0527E 03	0.001168	0.000443	0.000725	0.002084	1.784102	1.1801E 05	0.0	1.54206
PO-240	1.4276E-09	1.7075E 02	0.000211	0.000211	0.000000	0.000001	0.003636	-1.3053E 05	0.0	789.18970
PD-241	4.7809E-10	5.7423E 01	0.000080	0.000021	0.000060	0.000175	2.174124	2.1522E 05	0.00000	1.29005
PN-242	4.7945E-11	5.7826E 00	0.000001	0.000001	0.000000	0.000000	0.011303	-2.2280E 04	0.0	259.24561
AP-243	1.8956E-12	2.2956E-01	0.000000	0.000000	0.000000	0.000000	0.006408	-2.9952E 04	0.0	494.15601
FIXED	5.0000E-02	2.9890E 08	0.022354	0.022354	0.0	0.0	0.0	-3.9920E-01	0.0	0.0
I-135	3.2433E-10	2.1912E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02452	0.0
XE-135	9.1529E-11	6.1557E 00	0.020439	0.020438	0.0	0.0	0.0	-1.9744E 08	0.00504	0.0
PN-147	5.8692E-08	4.2981E 03	0.003672	0.003672	0.0	0.0	0.0	-6.0166E 04	0.00128	0.0
PE-148	3.9375E-10	2.8294E 01	0.000440	0.000440	0.0	0.0	0.0	-1.1303E 06	0.00151	0.0
PM-148M	4.9468E-10	3.6472E 01	0.001468	0.001468	0.0	0.0	0.0	-2.6940E 06	0.00026	0.0
PN-149	6.9534E-10	5.1614E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00665	0.0
SM-149	9.3255E-10	6.9221E 01	0.006650	0.006650	0.0	0.0	0.0	-6.3071E 06	0.0	0.0
ND-141	1.8736E-07	1.3347E 04	0.005348	0.005348	0.0	0.0	0.0	-2.5405E 04	0.0	0.0
FP1	3.7093E-06	2.1620E 05	0.010105	0.010105	0.0	0.0	0.0	-2.5782E 03	0.0	0.0
FP2	1.1478E-05	6.6901E 05	0.002956	0.002956	0.0	0.0	0.0	-2.4630E 02	0.0	0.0
CTHFP			0.050000							
SUM		3.2951E 08	0.999980		0.407715	0.999961	2.049778	FISSILE		1.16045

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*4, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
7.8476E 13 1.7957E 11 3.1099E-01 1.77702 1.77702 0.12445 0.99999 -0.12471 0.74505 0.75234

A-21

FUEL CYCLE ECONOMICS ----- POWER, VOLUME, TMR, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, WWT-D/KGM
 6.00018E-08 3.00000E-08 1.33333E-00 7.50000E-01 1.00000E-01 3.00000E-01 9.60000E-01 2.41002E-01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	WTL/KW-HR EL.	WIDCYCLE REAL YRS	0.886689
FABRICATION	1.249501	0.0	1.249501	0.321630	1.571132			
PROCESSING	0.0	-0.916139	0.916139	-0.171048	0.743090			
FUEL	7.324619	1.921495	5.403124	2.244736	7.649860			
SUM	8.574121	1.007357	7.566763	2.397318	9.964082	9.964082	8.00023E-02	8.00023E-02

CYCLE, IT, K, PISS FEED, EXIT, POWER, CR, YRS, COST 1 10 1.0000 1.1166E-03 2.7289E-02 6.0002E-08 0.7450 0.8889 9.9541

RECYCLE HAS NOT STARTED, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 2 2.000

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.03532 0.21641)
 2.500E-04 0.0 0.0 1.325E-05 0.0 9.589E-07 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STPPS 2
 2.383E-04 4.457E-07 4.699E-06 7.419E-07 1.563E-06 1.320E-06 6.611E-07 1.846E-10 1.301E-08 4.256E-09 3.347E-09 1.738E-09
 3.330E-10 5.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.333 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 11
 FISSILE LOADING (KGM) 9.2648E-05 WISILE FEED 5.1741E-02 MAX POWER DENSITY 6.2771E-00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	EVA	IMPORTANCE	DECAY	KGM/HWE-YR
TR-232	2.4374E-04	2.8113E-07	0.353899	0.352338	0.000944	0.002211	0.006249	-1.3867E-03	0.0	364.99780
PA-233	4.5440E-07	5.2767E-04	0.008596	0.008772	0.000024	0.000066	0.007893	-1.7591E-04	0.34480	344.23613
U-233	3.4617E-06	4.0198E-05	0.218473	0.023469	0.194997	0.488139	2.234324	8.3259E-04	0.0	1.09238
U-234	3.9352E-07	4.4727E-04	0.007207	0.007174	0.000033	0.000089	0.012341	-1.7856E-04	0.0	211.85051
U-235	4.4629E-06	5.2270E-05	0.235286	0.047291	0.297967	0.305664	1.980776	6.1248E-04	0.0	1.19188
U-236	1.1671E-06	1.3727E-05	0.007454	0.007417	0.000038	0.000101	0.013538	-6.2480E-03	0.0	191.82520
U-238	7.8533E-07	9.3152E-04	0.001954	0.001942	0.000011	0.000031	0.015972	-2.4246E-01	0.0	163.54147
NE-239	2.1232E-10	2.6124E-01	0.000003	0.000003	0.000000	0.000000	0.018296	-1.3022E-04	0.00194	143.66273
PU-239	1.2930E-08	1.5401E-03	0.001621	0.000615	0.001006	0.002492	1.783890	1.1034E-05	0.0	1.54226
PU-240	3.3383E-09	3.9930E-02	0.000467	0.000467	0.000001	0.000002	0.003731	-1.2549E-05	0.0	769.45386
PU-241	2.1341E-09	2.5632E-02	0.000340	0.000084	0.000252	0.000740	2.174751	2.0234E-05	0.00001	1.28968
PA-242	7.3334E-10	8.8446E-01	0.000016	0.000016	0.000000	0.000000	0.011351	-2.1761E-04	0.0	258.15771
AM-243	9.6118E-11	1.1640E-01	0.000003	0.000003	0.000000	0.000000	0.006584	-2.7926E-04	0.0	480.94946
FIXED	5.000E-02	2.9890E-08	0.021216	0.021216	0.0	0.0	0.0	-3.8424E-01	0.0	0.0
1-135	3.2202E-10	2.1669E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.02395	0.0
XE-135	9.3706E-11	6.3020E-00	0.019809	0.019809	0.0	0.0	0.0	-1.8974E-08	0.00507	0.0
PM-147	8.6035E-08	6.3004E-03	0.005211	0.005211	0.0	0.0	0.0	-1.8567E-04	0.00185	0.0
PM-148	5.5072E-10	4.0925E-01	0.000620	0.000620	0.0	0.0	0.0	-1.1041E-06	0.00214	0.0
PM-148A	7.3304E-10	5.4087E-01	0.002073	0.002073	0.0	0.0	0.0	-2.5994E-06	0.00038	0.0
PM-149	7.4326E-10	5.5171E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.00699	0.0
SM-149	1.0349E-09	7.6821E-01	0.006987	0.006987	0.0	0.0	0.0	-6.0615E-06	0.0	0.0
WE-143	3.6743E-07	2.6175E-04	0.009946	0.009946	0.0	0.0	0.0	-2.4441E-04	0.0	0.0
PP1	8.4297E-06	4.9134E-05	0.021136	0.021136	0.0	0.0	0.0	-2.5038E-01	0.0	0.0
PP2	2.6650E-05	1.5533E-06	0.006635	0.006635	0.0	0.0	0.0	-2.3955E-02	0.0	0.0
OTHER			0.050000							
SUM		3.3035E-08	0.999954		0.405274	0.999935	2.096685	FISSILE		1.14222

PLUX, LOSSES, SIGA2, FLUX RATIO (2). SUN IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 1.5578E 13 3.8613E 11 3.2152E-03 1.83728 1.83728 0.11448 1.00000 -0.21863 0.73642 0.74397

FUEL CYCLE ECONOMICS ----- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, NWT-D/KGM
 6.00036E 08 3.00000E 08 1.33333E 00 7.50000E-01 1.00000E-01 1.02400E 04 9.45678E 03 4.74288E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL	MIDCYCLE REAR YRS	2.666665
FABRICATION	0.422912	0.0	0.422912	0.13322	0.556133			
PROCESSING	0.0	-0.897692	0.897692	-0.249359	0.648333			
FUEL	3.378442	1.867067	1.511374	1.588466	3.099840			
SUN	3.801353	0.969375	2.831978	1.473028	4.305006	8.00047E 02	1.60007E 03	

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 2 11 1.0000 5.1741E 02 2.6044E 02 6.0004E 08 0.7364 2.6667 4.7350
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 3 8 1.0000 5.4330E 02 2.5115E 02 5.9995E 08 0.7207 4.4444 4.6461
 CYCLE HAS NOT STARTED, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 4 4.667

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 0.27726 0.23063)
 2.500E-04 0.0 0.0 1.341E-05 0.0 9.701E-07 0.0 0.0 0.0 0.0 0.0
 0.0 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 2
 2.332E-04 4.228E-07 5.147E-06 1.096E-06 1.124E-06 1.890E-06 8.505E-07 2.335E-10 1.771E-08 6.089E-09 5.152E-09 4.238E-09
 1.209E-09 5.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
 FISSILE LOADING (KGM) 9.7660E 75 FISSILE FEED 5.2347E 02 MAX POWER DENSITY 6.0891E 00

	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
W-232	2.4151E-04	2.7924E 07	0.340557	0.339613	0.000926	0.002169	0.006368	-1.3562E 03	0.0	356.15527
PA-233	4.3765E-07	5.0822E 04	0.007942	0.007918	0.000023	0.000063	0.007918	-1.7115E 04	0.33206	334.43262
U-233	3.7039E-06	4.3012E 05	0.221862	0.233963	0.197892	0.495390	2.232870	7.7857E 04	0.0	1.09310
U-234	5.0046E-07	5.8365E 04	0.009127	0.009084	0.000043	0.000115	0.012556	-1.7477E 04	0.0	208.22241
U-235	4.6462E-06	5.4417E 05	0.251635	0.046910	0.204698	0.497728	1.977979	5.6819E 04	0.0	1.19359
U-236	1.8953E-06	1.7588E 05	0.009394	0.009346	0.000048	0.000128	0.013589	-6.1565E 03	0.0	191.09715
U-238	9.2233E-07	1.0940E 05	0.002256	0.002242	0.000013	0.000036	0.016042	-2.3885E 01	0.0	162.83018
NP-239	2.5323E-10	3.0163E 01	0.000003	0.000003	0.000000	0.000000	0.018560	-1.2757E 04	0.00224	141.46957
PU-239	1.6236E-08	1.9339E 03	0.001922	0.000729	0.001193	0.003428	1.783571	1.0178E 03	0.0	1.54256
PU-240	4.4766E-09	5.3545E 02	0.000591	0.000590	0.000001	0.000002	0.003872	-1.2090E 05	0.0	741.75977
PU-241	3.1258E-09	3.7544E 02	0.000471	0.000122	0.000339	0.001025	2.174681	1.8840E 05	0.00001	1.28913
PU-242	1.5446E-09	1.8629E 02	0.000034	0.000034	0.000000	0.000000	0.011817	-2.1423E 04	0.0	256.65723
AN-243	3.1321E-10	3.7932E 01	0.000009	0.000009	0.000000	0.000000	0.006843	-2.7025E 04	0.0	462.73462
FIXED	5.0000E-02	2.9890E 08	0.020044	0.020044	0.0	0.0	0.0	-3.7075E-01	0.0	0.0
I-135	3.2192E-10	2.1650E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02392	0.0
XE-135	9.8229E-11	6.6063E 00	0.019543	0.019543	0.0	0.0	0.0	-1.8269E 08	0.00532	0.0
PM-147	9.2880E-08	6.8017E 03	0.005470	0.005470	0.0	0.0	0.0	-5.7388E 04	0.00199	0.0
PM-148	5.6504E-10	4.3135E 01	0.000642	0.000642	0.0	0.0	0.0	-1.0874E 06	0.00226	0.0
PM-148M	8.0294E-10	5.9200E 01	0.002159	0.002159	0.0	0.0	0.0	-2.5177E 06	0.00041	0.0
PM-149	7.5271E-10	5.5872E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00708	0.0
SM-149	1.1135E-09	8.2656E 01	0.007076	0.007076	0.0	0.0	0.0	-5.8366E 06	0.0	0.0
XD-143	4.5476E-07	3.2397E 04	0.011615	0.011615	0.0	0.0	0.0	-2.3566E 04	0.0	0.0
FP1	1.785E-05	6.6356E 05	0.028888	0.028888	0.0	0.0	0.0	-2.4451E 03	0.0	0.0
FP2	3.6549E-05	2.1303E 06	0.008829	0.008829	0.0	0.0	0.0	-2.3446E 02	0.0	0.0
OTHER			0.050000							
SUN	3.3103E 08		1.000067		0.405186	1.003083	2.096321	PISSILE		1.14291

PLN, LOSSES, SIGA2, FLUX RATIO (2), SUN IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 7.1137E 13 3.8617E 11 3.3730E-03 1.92741 1.92741 0.10073 0.00000 -0.23029 0.71489 0.72198

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, PRED (KGM), DISCHARGE, MWT-D/KGM
 5.99952E 08 3.00000E 08 1.33333E 00 7.50000E-01 1.00000E-01 1.02465E 04 9.30282E 03 7.12377E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	HILL/KW-HR EL	MIDCYCLE REAL YRS	6.222219
FABRICATION	0.423241	0.0	0.423241	0.134026	0.557266			
PROCESSING	0.0	-0.883209	0.883209	-0.321943	0.561266			
FUEL	3.417961	1.830370	1.587591	1.751487	3.341078			
SUN	3.841202	0.947161	2.894080	1.563669	4.457709			

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, TRS, COST 4 8 1.0000 5.2347E 02 2.6037E 02 5.5995E 08 0.7149 6.2222 4.4577
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, TRS, COST 5 6 1.0000 5.2056E 02 2.6384E 02 5.9995E 08 0.7151 8.0000 4.4246
 RECYCLE HAS NOT STARTED, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 7 8.667

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 0.22224 0.22529)
 2.500E-04 0.0 0.0 1.335E-05 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
 7.165E-04 1.302E-06 1.319E-05 2.059E-06 9.108E-06 5.104E-06 2.674E-06 7.352E-10 5.240E-08 1.604E-08 1.186E-08 6.897E-09
 1.620E-09 1.500E-01 8.776E-10 2.667E-10 2.967E-07 1.873E-09 2.562E-09 2.214E-09 3.249E-09 1.609E-06 4.271E-05 1.384E-04

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.33 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 5
 FISSILE LOADING (KGM) 9.7194E 05 FISSILE FEED 5.2119E 02 MAX POWER DENSITY 6.0694E 00

NUCLEIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWT-YR
TH-232	2.4158E-04	2.7933E 07	0.341868	0.340524	0.0	0.002171	0.006338	-1.3585E 03	0.0	358.71362
PA-233	4.3805E-07	5.0962E 04	0.007989	0.007966	0.000003	0.000003	0.007899	-1.7152E 04	0.0	335.23193
U-233	3.6999E-06	4.2965E 05	0.22331	0.024024	0.198500	0.496911	2.232993	7.8204E 04	0.0	1.09303
U-234	4.9468E-07	5.7665E 04	0.009037	0.008995	0.000042	0.000113	0.012538	-1.7504E 04	0.0	208.51830
U-235	4.6108E-06	5.4002E 05	0.250791	0.046727	0.204037	0.496119	1.978216	5.7170E 04	0.0	1.19345
U-236	1.4732E-06	1.7328E 05	0.009266	0.009219	0.000047	0.000126	0.013505	-6.1633E 03	0.0	191.15665
U-238	9.0935E-07	1.0786E 05	0.002227	0.002213	0.000013	0.000036	0.016036	-2.3912E 03	0.0	162.88811
RE-239	2.4999E-10	2.9777E 01	0.000003	0.000003	0.000000	0.000000	0.018556	-1.2777E 04	0.0	141.64851
PU-239	1.5994E-08	1.9051E 03	0.001902	0.000722	0.001180	0.003392	1.783598	1.0286E 05	0.0	1.54253
PU-240	4.4224E-09	5.2897E 02	0.000366	0.000585	0.000001	0.000002	0.003860	-1.2126E 05	0.0	744.03931
PU-241	3.0941E-09	3.7163E 02	0.000468	0.000121	0.000347	0.001019	2.175603	1.8950E 05	0.0	1.28918
PU-242	1.5154E-09	1.8277E 02	0.000033	0.000033	0.000000	0.000000	0.011412	-2.1448E 04	0.0	256.77954
AM-243	3.0231E-10	3.6611E 01	0.000009	0.000009	0.000000	0.000000	-2.7095E 04	0.0	0.0	464.22046
FIXED	5.0000E-02	2.9890E 08	0.020134	0.020134	0.0	0.0	0.006821	-1.7161E-01	0.0	0.0
I-135	3.2188E-10	2.1647E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE-135	9.7831E-11	6.5794E 00	0.019358	0.019558	0.0	0.0	0.0	-1.8324E 08	0.0	0.0
PE-147	9.2138E-08	6.7474E 03	0.005438	0.005438	0.0	0.0	0.0	-5.7477E 04	0.0	0.0
PM-149	5.8147E-10	4.2872E 01	0.000639	0.000639	0.0	0.0	0.0	-1.0887E 06	0.0	0.0
PM-149	7.9553E-10	5.8654E 01	0.002148	0.002148	0.0	0.0	0.0	-2.5241E 06	0.0	0.0
PM-149	7.5105E-10	5.5745E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SM-149	1.1055E-09	8.2062E 01	0.007059	0.007059	0.0	0.0	0.0	-5.8582E 06	0.0	0.0
RE-143	4.4947E-07	3.2019E 04	0.011532	0.011532	0.0	0.0	0.0	-2.1635E 04	0.0	0.0
FP1	1.1189E-05	6.5215E 05	0.028465	0.028465	0.0	0.0	0.0	-2.4500E 03	0.0	0.0
FP2	3.5893E-05	2.0921E 06	0.008690	0.008690	0.0	0.0	0.0	-2.3484E 02	0.0	0.0
CTR		3.3098E 08	0.999973		0.405118	0.999953	2.096819	FISSILE		1.14263

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*W, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 7.1485E 13 3.8620E 11 3.3595E-03 1.91973 1.91973 0.10187 0.99999 -0.22981 0.71669 0.72384

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, NET-D/KGM
 6.00023E 08 3.00000E 08 1.33333E 00 7.50000E-01 1.00000E-01 1.02441E 04 2.86260E 04 7.12632E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS 11.555549
FABRICATION	0.423089	0.0	0.423089	0.058762	0.481851	
PROCESSING	0.0	-2.717407	2.717407	-0.835351	1.882056	
FUEL	3.402892	6.332391	-2.929499	2.419246	0.510253	
SUM	3.825981	3.614984	0.210998	1.642656	1.853654	ENERGY (MWE-YR), SUM 8.00030E 02 5.59987E 01

CYCLE THROWAWAY COST ESTIMATE, DIRECT, TOTAL 4.07535 5.19547

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 7 5 1.0000 5.2119E 02 9.1918E 02 6.0002E 08 0.7167 11.5555 1.8417

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 8.70321E 04 8.24467E 04 4.58544E 03
 SUMMED FISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 4.26241E 03 4.26241E 03 2.49038E 01 -1.77203E 01
 FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.14509 0.72387 0.10022

ORP (7-235 FED) INITIAL, FEED, DISCHARGE, NET (KGM) 2.575945E 02 9.833364E 02 5.745298E 02 4.088066E 02

MAKE-UP FISSILE ASSOCIATED WITH ORE AND ORE 4.262406E 03 9.833364E 02

FUEL COST ANALYSIS

COST LEVELIZED OVER 7 FUEL CYCLES AT DISCOUNT FACTOR 0.0700, REAL YEARS 12.444 ENERGY (MWE-YR) 5.59987E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	0.541291	0.0	0.541291	0.164721	0.706013	
PROCESSING	0.0	-1.151844	1.151844	-0.325212	0.826632	
FUEL	3.980547	2.491064	1.489483	1.789421	3.278904	
SUM	4.521837	1.339220	3.192617	1.628930	4.811548	

TOTAL WITH QUARTERLY ENERGY ACCOUNTING 4.73494

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

	COST	RETURN	DIRECT	INDIRECT	TOTAL
FABRICATION	0.541291	0.0	0.541291	0.126366	0.667657
PROCESSING	0.0	-1.151844	1.151844	-0.178642	0.973202
FUEL	3.990547	2.491064	1.489483	1.201384	2.690866
SUM	4.521837	1.339220	3.182617	1.149107	4.331725

CCST ONLY DISCOUNTING WITH QUARTERLY ENERGY ACCOUNTING 4.26276, AND AT TWICE THE RATE 5.54170

THROWAWAY COST ESTIMATE, DIRECT, TOTAL 4.93894 5.98216 TOTAL ANNUAL AND QUARTERLY ONLY DISCOUNTING, 5.70917 5.61827

THE CHANGE AND TOTAL COST FOR FIFTY PERCENT INCREASE IN UNIT COSTS

FABRICATION	0.353006	5.164554
PROCESSING	0.413315	5.224863
FUEL	1.639452	6.451000

DISTRIBUTION OF THE COSTS AFTER THE INCREASE BY FIFTY PERCENT

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	0.811937	0.0	0.811937	0.247002	1.059018	
PROCESSING	0.0	-1.727766	1.727766	-0.487818	1.239947	
FUEL	5.970820	3.736596	2.234224	2.684132	4.918356	
SUM	6.782757	2.008830	4.773927	2.443396	7.217322	

ADDITIONAL CONTINUOUS FUELING CHARGES - FABRICATION DIRECT, INDIRECT, FUEL INDIRECT, TOTAL

ONE CYCLE	0.17850	0.10837	0.3176	0.60450
HISTORY	0.05950	0.03612	0.10588	0.20150

CCST DEPENDENCE ON INDIRECT CHARGES

INTEREST RATE	0.0500	0.0750	0.1000	0.1250	0.1500
TOTAL FUEL COST	3.99708	4.40431	4.81155	5.21878	5.62601

SUMMARY OF REACTOR HISTORY, ENERGY (MWE-YR) 5.59987E 03

PERIOD	TIME (YR)	LOAD FACTOR	FISSILE MAKEUP AND FEED	AND DISCHARGE	CONVERSION	POWER	COST
1	0.88889	0.75000	1.11658E 03	1.11658E 03	2.72894E 02	0.74505	6.00018E 08
2	2.66667	0.75000	5.17415E 02	5.17415E 02	2.60438E 02	0.73642	6.00036E 08
3	4.44444	0.75000	5.43299E 02	5.43299E 02	2.51153E 02	0.72066	5.99949E 08
4	6.22222	0.75000	5.23465E 02	5.23465E 02	2.60369E 02	0.71489	5.99952E 08
5	8.00000	0.75000	5.20561E 02	5.20561E 02	2.63836E 02	0.71506	5.99952E 08

6	9.77777	0.75000	5.19897E 02	5.19897E 02	2.62509E 02	0.71654	5.99980E 08
7	11.55555	0.75000	5.21192E 02	5.21192E 02	9.19179E 02	0.71669	6.00023E 08
OVERALL	12.44444	0.75000	4.26241E 03	4.26241E 03	2.49038E 03	0.72361	5.99987E 08

CCST ESTIMATE DISCOUNTING ENERGY ON THE BASIS OF ONE- QUARTER YEARS 5.35168

CCST ESTIMATE DISCOUNTING ENERGY FROM MID-CYCLE EXPOSURE POINTS (NOT A BETTER ESTIMATE) 5.25951

A DIRECT ACCOUNTING OF THE TIME OCCURANCE OF COSTS YIELDS A FUEL COST OF (SEE SUMMARY ABOVE) 4.81155

CASE END NORMAL, U-235 FEED, 3 SUBZONE, CONTINUOUS FUELING THROWAWAY, 4 YR PROCESSOR (SEC) 1.25

0-233 FEED WITH 4 SUBZONES
THIS CALCULATION TREATS SUBZONES, NUMBER 4

CONTROL OPTIONS 2 0 1 1 -15 1 0 2 4 0 1 0 0 1 0 0 0 0 0 0 0 0 0
DATA 6.000E 08 0.0 0.0 0.0 2.000E 00 1.750E-03 5.000E 00 2.000E 12 4.000E-01 1.200E 09 2.500E-02 1.000E 00
INITIAL CONCENTRATIONS 1.8270E-04 0.0 5.0000E-06 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 4.7400E-02 0.0 0.0 0.0 0.0

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.00000 0.88207)
1.827E-04 0.0 4.410E-06 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 4.740E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 2
1.803E-04 4.954E-07 3.501E-06 3.289E-07 2.272E-08 9.357E-10 0.0 0.0 0.0 0.0 0.0 0.0
0.0 4.740E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 12
FISSILE LOADING (KGM) 1.0243E 06 FISSILE FEED 1.0243E 03 MAX POWER DENSITY 5.0002E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
TH-232	1.8028E-04	4.1690E 07	0.410697	0.409870	0.000812	0.001901	0.004629	-1.7803E 03	0.0	492.70532
PP-233	4.9536E-07	1.1505E 05	0.016641	0.016610	0.000031	0.000084	0.005023	-2.3603E 04	0.39611	527.21069
U-233	3.5006E-06	8.1301E 05	0.441224	0.044707	0.396502	0.992518	2.249465	2.0114E 05	0.0	1.08497
U-234	3.2886E-07	7.6706E 04	0.009456	0.009423	0.000033	0.000088	0.009351	-2.2737E 04	0.0	279.56547
U-235	2.2715E-08	5.3209E 03	0.002660	0.000461	0.002199	0.005345	2.009132	1.6011E 05	0.0	1.17474
U-236	9.3572E-10	2.2012E 02	0.000007	0.000007	0.000000	0.000000	0.012642	-7.3974E 03	0.0	205.411'4
FIXED	4.7400E-02	5.6672E 08	0.042098	0.042098	0.0	0.0	0.0	-5.6123E-01	0.0	0.0
I-135	2.8811E-10	3.8753E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02257	0.0
XE-135	4.5437E-11	6.1116E 00	0.020857	0.020857	0.0	0.0	0.0	-2.8247E 08	0.00259	0.0
PM-147	3.5689E-08	5.2272E 03	0.003213	0.003213	0.0	0.0	0.0	-7.3690E 04	0.00081	0.0
PM-148	3.1320E-10	4.6184E 01	0.000445	0.000445	0.0	0.0	0.0	-1.1172E 06	0.00127	0.0
PM148M	2.5147E-10	3.7081E 01	0.001392	0.001392	0.0	0.0	0.0	-3.6738E 06	0.00014	0.0
PM-149	5.2639E-10	7.8145E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00521	0.0
SM-149	3.5615E-10	5.2873E 01	0.005215	0.005215	0.0	0.0	0.0	-9.0179E 06	0.0	0.0
NE-143	1.2657E-07	1.8034E 04	0.007259	0.007259	0.0	0.0	0.0	-3.5921E 04	0.0	0.0
FP1	2.5380E-06	2.9586E 05	0.010794	0.010794	0.0	0.0	0.0	-3.2558E 03	0.0	0.0
FP2	7.8322E-06	9.1302E 05	0.002992	0.002992	0.0	0.0	0.0	-3.0499E 02	0.0	0.0
OTHER			0.025000							
SUM		6.1065E 08	0.999951		0.399577	0.999936	2.248025	FISSILE		1.08310

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*W, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
1.5573E 14 3.6642E 11 1.7168E-03 1.00952 0.99102 0.30569 0.99998 -0.14018 0.86019 0.90711

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGM), DISCHARGE, MWT-D/KGM
1.20006E 09 6.00000E 08 5.00000E-01 7.50000E-01 1.00000E-01 4.34842E 04 1.05666E 04 1.25914E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	*ILL/KW-HR EL, MIDCYCLE REAL YRS	0.333333
FABRICATION	2.394550	0.0	2.394550	0.359181	2.753732		
PROCESSING	0.0	-1.337403	1.337403	-0.179121	1.159082		
FUEL	11.248927	2.498608	8.750319	2.020482	10.770802		
SUM	13.643477	1.161204	12.482273	2.201343	14.683616	ENERGY (MWE-YR), SUM	6.00029E 02 6.00029E 02

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 1 12 1.0000 1.0243E 03 2.3334E 02 1.2001E 09 0.8601 0.3331 14.6416
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 2 15 1.0000 3.7916E 02 2.2370E 02 1.7000E 09 0.8448 1.0006 4.7407

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 3 1.250

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.48768 0.50829)

1.827E-04 0.0 6.238E-06 3.289E-07 2.272E-08 9.357E-10 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 2

1.756E-04 4.729E-07 3.190E-06 8.099E-07 1.215E-07 1.674E-08 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 12
 FISSILE LOADING (KGM) 1.1180E 06 FISSILE FEED 3.6350E 02 MAX POWER DENSITY 6.1645E 00

NUCLEIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWP-YR
TH-232	1.7740E-04	4.1024E 07	0.380855	0.380054	0.000787	0.001842	0.004837	-1.7287E 03	0.0	471.50586
PA-233	4.7556E-07	1.1045E 05	0.014926	0.014797	0.000029	0.000079	0.005330	-2.3959E 04	0.36994	496.83691
U-233	3.7603E-06	9.7332E 05	0.434242	0.044273	0.389954	0.976131	2.247897	1.8061E 05	0.0	1.08573
U-234	7.8778E-07	1.7442E 05	0.020322	0.020249	0.000074	0.000198	0.009743	-2.2103E 04	0.0	268.32495
U-235	1.0138E-07	2.3747E 04	0.010850	0.001894	0.008955	0.021768	2.006260	1.4276E 05	0.0	1.17645
U-236	1.1616E-08	2.7325E 03	0.000090	0.000089	0.000000	0.000001	0.012782	-7.2626E 03	0.0	203.15628
FIXED	4.7400E-02	5.6672E 08	0.038387	0.038387	0.0	0.0	0.0	-5.3630E-01	0.0	0.0
I-135	2.9547E-10	3.9743E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02251	0.0
XE-135	4.9757E-11	6.6926E 00	0.020752	0.020752	0.0	0.0	0.0	-2.5934E 08	0.00276	0.0
PR-147	5.5414E-08	8.1161E 03	0.004734	0.004734	0.0	0.0	0.0	-7.1746E 04	0.00122	0.0
PR-148	4.7453E-10	6.9973E 01	0.000654	0.000654	0.0	0.0	0.0	-1.2919E 06	0.00188	0.0
PR-149	3.9946E-10	5.8905E 01	0.002031	0.002031	0.0	0.0	0.0	-3.5246E 06	0.00021	0.0
SM-149	6.2261E-10	9.2429E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00600	0.0
SM-149	4.5244E-10	6.7167E 01	0.006020	0.006020	0.0	0.0	0.0	-8.5993E 06	0.0	0.0
PC-143	2.3253E-07	3.3130E 04	0.012146	0.012146	0.0	0.0	0.0	-3.4302E 04	0.0	0.0
FP1	5.6686E-06	6.6080E 05	0.022621	0.022621	0.0	0.0	0.0	-3.1562E 03	0.0	0.0
FP2	1.7896E-05	2.0962E 06	0.006459	0.006459	0.0	0.0	0.0	-2.9648E 02	0.0	0.0
OTHER			0.025000							
SUM		6.1172E 02	0.999988		0.399798	1.000018	2.242007	FISSILE		1.08538

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUN IMPORTANCE*W, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 1.4545E 14 3.7664E 11 1.8607E-03 1.09065 1.06328 0.27951 1.00002 -0.33195 0.83036 0.86606

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGM), DISCHARGE, MWT-D/KGM
 1.20001E 09 6.00000E 08 5.00000E-01 7.46525E-01 1.00000E-01 1.09983E 04 1.03142E 04 3.73156E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS
FABRICATION	1.087259	0.0	1.087259	0.200005	1.287264	1.469415
PROCESSING	0.0	-1.305506	1.305506	-0.261709	1.043797	
FUEL	3.937126	2.293024	1.644102	1.183919	2.828021	
SUM	5.024385	0.987518	4.036867	1.122214	5.159081	6.00006E 02 1.80002E 03

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 3 12 1.0000 3.6350E 02 2.1921E 02 1.2000E 09 0.8304 1.6694 5.1591
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 4 9 1.0000 3.5735E 02 2.1705E 02 1.1999E 09 0.8229 2.3406 5.1071

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 20 9.750										
ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 0.44508 0.44381)										
1.827E-04 0.0 5.858E-06 1.961E-06 5.039E-07 3.705E-07 0.0 0.0 0.0 0.0 0.0 0.0										
0.0 1.740E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0										
DISCHARGE CONCENTRATIONS										
7.095E-04 1.750E-06 1.375E-05 8.084E-06 2.100E-06 1.635E-06 0.0 0.0 0.0 0.0 0.0 0.0										
0.0 1.896E-01 1.197E-09 2.271E-10 2.429E-07 1.948E-09 1.813E-09 2.536E-09 2.112E-09 1.060E-06 2.603E-05 8.248E-05										
REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)										
PISSELE LOADING (KGM) 1.2496E 06 PISSELE FEED 3.694E 02 MAX POWER DENSITY 5.7705E 00										
0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 1										
KGM/MWR-YR										
NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSON	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWR-YR
TR-232	1.773E-04	4.1020E 07	0.349228	0.349449	0.000765	0.001792	0.005130	-1.6533E 03	0.0	444.59497
PA-233	8.374E-07	0.1060E 05	0.012235	0.012209	0.000026	0.000071	0.005378	-2.1775E 04	0.34044	458.27979
U-233	3.938E-06	9.1465E 05	0.400288	0.041193	0.359082	0.898860	2.245534	1.5396E 05	0.0	1.08668
U-234	2.0210E-06	4.7139E 05	0.050576	0.050383	0.000194	0.000520	0.010290	-2.1166E 04	0.0	254.05597
U-235	5.2509E-07	1.2300E 05	0.049273	0.008691	0.040576	0.098640	2.001902	1.2030E 05	0.0	1.17906
U-236	4.0881E-07	9.6168E 04	0.003028	0.003011	0.000015	0.000039	0.012965	-7.0389E 03	0.0	200.29327
PIED	4.7400E-02	5.6672E 08	0.033544	0.0	0.0	0.0	0.0	-5.0274E-01	0.0	0.0
I-135	2.9914E-10	4.0237E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.02280	0.0
XE-135	5.6778E-11	7.6370E 00	0.020579	0.020579	0.0	0.0	0.0	-2.5177E 08	0.00315	0.0
PM-147	6.0725E-08	8.8940E 03	0.004802	0.004802	0.0	0.0	0.0	-6.8839E 04	0.00134	0.0
PM-148	4.8706E-10	7.1821E 01	0.000641	0.000641	0.0	0.0	0.0	-1.2505E 06	0.00193	0.0
PM-149	4.5318E-10	6.6826E 01	0.000204	0.000204	0.0	0.0	0.0	-3.3205E 06	0.00024	0.0
SM-149	6.3389E-10	9.4104E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.00611	0.0
SM-149	5.2811E-10	7.8401E 01	0.006107	0.006107	0.0	0.0	0.0	-8.0392E 06	0.0	0.0
ND-143	2.6496E-07	3.751E 04	0.012072	0.012072	0.0	0.0	0.0	-3.2126E 04	0.0	0.0
FP1	6.5081E-06	7.5866E 05	0.023671	0.023671	0.0	0.0	0.0	-3.0123E 03	0.0	0.0
FP2	2.0621E-05	2.4038E 06	0.006850	0.006850	0.0	0.0	0.0	-2.8392E 02	0.0	0.0
OTHER			0.025090							
SUM		6.1266E 08	0.999928		0.400657	0.999921	2.218031	PISSELE		1.09362
PLUX, LOSSES, SIGA2, PLUX RATIO (2), SUM IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)										
1.2635E 14 3.7651E 11 2.0824E-03 1.21925 1.18994 0.23844 0.99999 -0.21063 0.83186 0.85994										
FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, MWT-D/KGM										
1.2001E 09 6.0000E 08 5.0000E-01 5.1226E-01 1.0000E-01 1.11219E 04 4.22927E 04 4.92303E 01										
MILL/KW-HR EL, MIDCYCLE REAL YRS 14.554218										
COST RETURN DIRECT INDIRECT TOTAL										
FABRICATION 1.099418 0.0 1.099418 0.108624 1.208042										
PROCESSING 0.0 -5.352845 5.352845 -1.318991 4.033854										
FUEL 3.743531 11.093615 3.103438 -4.746645										
SUM 4.842949 5.740769 -0.897820 1.893072 0.995252, ENERGY (MWT-YR), SUM 6.00040E 02 1.20004E 04										
CYCLE THROW										

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 2.42935E 05 2.32905E 05 1.01303E 04
 SUMMED FISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 7.94674E 03 1.59695E 03 5.74584E 03 -2.20090E 03
 FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.09005 0.83175 -0.10517

SUBZONE FLUX RATIOS 1.17003 1.23403 .12055 1.14143

SUBZONE FLUX LEVELS 1.2847E 14 1.2559E 14 1.2131E 14 1.3041E 14

ORE (U-235 FEED) INITIAL, FEED, DISCHARGE, NET (MGH) 0.0 4.152504E 00 1.325565E 03 -1.321412E 03

FUEL COST ANALYSIS

COST LEVELIZED OVER 20 FUEL CYCLES AT DISCOUNT FACTOR 0.0700 , REAL YEARS 15.042 ENERGY (MWE-YR) 1.20004E 04

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	1.135029	0.0	1.135029	0.231552	1.366081	
PROCESSING	0.0	-1.509146	1.509146	-0.266347	1.242799	
FUEL	4.173005	2.867543	1.305462	1.531945	2.837407	
SUM	5.309034	1.358397	2.949636	1.496651	5.446287	

TOTAL WITH QUARTERLY ENERGY ACCOUNTING 5.36798

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

	COST	RETURN	DIRECT	INDIRECT	TOTAL
FABRICATION	1.135029	0.0	1.135029	0.173423	1.307452
PROCESSING	0.0	-1.509146	1.509146	-0.121723	1.383423
FUEL	1.948654	0.678741	1.269913	0.925413	2.195326
SUM	3.083683	-0.830405	3.914087	0.972114	4.886201

COST ONLY DISCOUNTING WITH QUARTERLY ENERGY ACCOUNTING 4.81595, AND AT TWICE THE RATE 5.90139

THROWAWAY COST ESTIMATE, DIRECT, TOTAL 5.72349 6.87811 TOTAL ANNUAL AND QUARTERLY ONLY DISCOUNTING, 6.63819 6.94276

THE CHANGE AND TOTAL COST FOR FIFTY PERCENT INCREASE IN UNIT COSTS

FABRICATION	0.683041	6.129328
PROCESSING	0.621399	6.067686
FUEL	1.418703	6.864300

DISTRIBUTION OF THE COSTS AFTER THE INCREASE BY FIFTY PERCENT

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	1.702543	0.0	1.702543	0.346579	2.049122	
PROCESSING	0.0	-2.263719	2.263719	-0.392520	1.864198	
FUEL	6.259507	4.301314	1.958193	2.297917	4.256110	
SUM	7.962050	2.037596	5.924455	2.244975	8.169430	

ADDITIONAL CONTINUOUS FUELING CHARGES - FABRICATION DIRECT, INDIRECT, FUEL INDIRECT, TOTAL
 ONE CYCLE 0.11973 0.08756 0.20567 0.41295
 HISTORY 0.02993 0.02169 0.05142 0.10324

COST DEPENDENCE ON INDIRECT CHARGES

INTEREST RATE 0.0500 0.0750 0.1000 0.1250 0.1500
 TOTAL FUEL COST 4.69796 5.07212 5.44629 5.82045 6.19461

SUMMARY OF REACTOR HISTORY, ENERGY (MWE-YR) 1.20004E 04
 PERIOD TIME (YR) LOAD FACTOR FISSION MAKEUP AND FEE AND DISCHARGE CONVERSION POWER COST
 1 0.33333 0.75000 1.02429E 03 1.02429E 03 2.33741E 02 0.86010 1.20006E 09 14.68162
 2 1.00060 0.74866 3.79162E 02 3.79162E 02 2.23705E 02 0.84476 1.19997E 09 4.74072
 3 1.66941 0.74553 1.30160E 02 1.30160E 02 2.19211E 02 0.83036 1.20001E 09 5.15908
 4 2.34060 0.74339 1.33646E 02 1.33646E 02 2.17052E 02 0.82295 1.19995E 09 5.10734
 5 3.01575 0.73923 1.32399E 02 1.32399E 02 2.34350E 02 0.82131 1.19999E 09 4.88183
 6 3.69380 0.73403 1.42917E 02 1.42917E 02 2.36180E 02 0.82503 1.19994E 09 4.97250
 7 4.37797 0.72775 1.24849E 02 1.24849E 02 2.38686E 02 0.82698 1.20004E 09 4.95027
 8 5.06854 0.72036 1.24015E 02 1.24015E 02 2.40455E 02 0.82829 1.20010E 09 4.94737
 9 5.76681 0.71181 1.22466E 02 1.22466E 02 2.43979E 02 0.82909 1.20010E 09 4.93239
 10 6.47412 0.70205 1.22199E 02 1.22199E 02 2.45299E 02 0.83003 1.20010E 09 4.94171

CASE TO CHECK CERTAIN OPTIONS

CONTROL OPTIONS 2 0 1 2 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 DATA 1.000E 00 0.0 0.0 0.0 1.000E 00 0.0 5.000E 00 2.000E 12 4.000E-01 2.500E 00 0.0 1.000E 00
 INITIAL CONCENTRATIONS 0.0 0.0 0.0 0.0 0.0 1.000E-08 1.000E-05 0.0 5.000E-05 0.0
 0.0 0.0 0.0 0.0 0.0 4.000E-02 0.0 0.0 0.0 0.0

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.00000 0.72850)
 0.0 0.0 0.0 7.285E-09 7.285E-06 0.0 5.000E-05 0.0 0.0 0.0 0.0 0.0
 0.0 4.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100
 0.0 0.0 0.0 3.744E-09 2.255E-06 9.376E-07 4.488E-05 4.462E-08 1.903E-06 5.508E-07 3.071E-07 6.977E-08
 1.546E-09 4.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 5
 FISSION LOADING (KGW) 2.2166E-03 FISSION FEE 2.8441E-06 MAX POWER DENSITY 6.2501E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGW/MWE-YR
U-234	5.1223E-09	2.0301E-06	0.000217	0.000215	0.000001	0.000003	0.016061	-4.2810E 04	0.0	162.77692
U-235	4.0524E-06	1.5821E-03	0.296397	0.065037	0.231331	0.562929	1.899238	5.1260E 04	0.0	1.24405
U-236	6.5755E-07	2.5780E-04	0.011447	0.011386	0.000061	0.000163	0.014270	-1.7311E 04	0.0	181.97908
U-238	4.7373E-05	1.8730E-02	0.318705	0.316699	0.001992	0.005469	0.016970	-6.6804E 03	0.0	153.92183
NE-239	4.7091E-08	1.8697E-05	0.001474	0.001461	0.000013	0.000034	0.023057	-3.1881E 04	0.11556	113.99992
PU-239	1.5041E-06	5.9720E-04	0.220865	0.084613	0.136244	0.391769	1.773794	7.9666E 04	0.0	1.55184
PU-240	2.7556E-07	1.0987E-04	0.042423	0.042304	0.000119	0.000360	0.008487	-1.9215E 05	0.0	340.58350
PU-241	9.3228E-08	3.7325E-05	0.017840	0.004435	0.013405	0.039313	2.203625	1.8788E 05	0.00031	1.27294
PU-242	9.7787E-09	3.9313E-06	0.000577	0.000575	0.000002	0.000007	0.012320	-5.9104E 04	0.0	237.86127
AM-243	1.0066E-09	4.0635E-07	0.030043	0.030043	0.000000	0.000001	0.013498	-4.9584E 04	0.0	234.58311
FIXED	4.0000E-02	7.9708E-01	0.020309	0.020309	0.0	0.0	0.0	-6.2092E-01	0.0	0.0
I-135	4.2467E-10	9.5202E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02395	0.0
XE-135	9.4273E-11	2.1134E-08	0.021040	0.021040	0.0	0.0	0.0	-2.5432E 08	0.00387	0.0

PR-147	4.2620E-08	1.0408E-05	0.005901	0.005901	0.0	0.0	0.0	-1.4411E 05	0.00069	0.0
PR-148	5.2407E-10	1.3003E-07	0.001579	0.001579	0.0	0.0	0.0	-1.0191E 06	0.00155	0.0
PR-149	6.2180E-10	1.5283E-07	0.002531	0.002531	0.0	0.0	0.0	-4.7161E 06	0.00024	0.0
PR-149	1.2339E-09	1.0531E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00880	0.0
SR-149	1.2293E-09	3.0417E-07	0.008802	0.008802	0.0	0.0	0.0	-9.1072E 06	0.0	0.0
ND-149	1.6299E-07	1.8705E-05	0.005075	0.005075	0.0	0.0	0.0	-3.8557E 04	0.0	0.0
FP1	3.4841E-06	6.7691E-04	0.018726	0.018726	0.0	0.0	0.0	-5.7201E 03	0.0	0.0
FP2	1.1017E-05	2.1405E-03	0.006035	0.006035	0.0	0.0	0.0	-5.7447E 02	0.0	0.0
OTHER			0.0							
SUM		8.2129E-01	0.999997		0.999997	1.857609	PISSILE			1.34939

FIUX, LOSSES, SIGA2, PLUX RATIO (2), SUM IMPORTANCE*4, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)

1.0515E 14	5.0887E 11	2.5466E-03	5.00000	5.00000	-0.14414	1.00000	-0.29794	0.68356	0.66855
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FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FUEL (KGM), DISCOUNT, MWT-D/KGM

2.50003E 00	1.00000E 00	1.00000E 00	7.50000E-01	1.00000E-01	2.27259E-05	1.99407E-05	1.00382E 02
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	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS	0.66667
FABRICATION	0.300360	0.0	0.300360	0.035042	0.335401		
PROCESSING	0.0	-0.605752	0.605752	-0.100959	0.504793		
FUEL	5.276879	2.417901	2.858974	1.019615	3.878589		
SUM	5.577238	1.812149	3.765089	0.952698	4.717787	ENERGY (MWE-YR), SUM	2.50003E-06 2.50003E-06

CYCLE, IT, K, FISS FEED, FUIT, POWER, CR, YRS, COST 1 5 1.0000 2.8441E-06 1.7766E-06 2.5000E 00 0.6916 0.6667 4.7178

11	7.19201	0.69101	1.19673E 02	3.63653E 02	2.47333E 02	0.83063	1.20005E 09	4.94462
12	7.92220	0.67861	1.18661E 02	3.63960E 02	2.49160E 02	0.83104	1.20006E 09	4.95070
13	8.66668	0.66476	1.17642E 02	3.64975E 02	2.50735E 02	0.83138	1.20005E 09	4.96308
14	9.42777	0.64932	1.16786E 02	3.65947E 02	2.52139E 02	0.83166	1.20005E 09	4.97970
15	10.20825	0.63217	1.15949E 02	3.66684E 02	2.52938E 02	0.83185	1.20010E 09	4.99931
16	11.01146	0.61312	1.15296E 02	3.67436E 02	2.54102E 02	0.83192	1.20009E 09	5.02436
17	11.84155	0.59194	1.14838E 02	3.67776E 02	2.55154E 02	0.83194	1.20006E 09	5.05643
18	12.70376	0.56835	1.14384E 02	3.68486E 02	2.55992E 02	0.83194	1.20005E 09	4.88312
19	13.60492	0.54196	1.13973E 02	3.69127E 02	2.56784E 02	0.83191	1.2000E 09	4.69826
20	14.55424	0.51226	1.13648E 02	3.69639E 02	1.13925E 03	0.83186	1.20009E 09	0.99525
OVERALL	15.04227	0.67336	3.59695E 01	7.94674E 03	5.74584E 03	0.83175	1.20004E 09	5.94647
CCST ESTIMATE DISCOUNTING ENERGY ON THE BASIS OF ONE- QUARTER YEARS								5.86097
CCST ESTIMATE DISCOUNTING ENERGY FROM MID-CYCLE EXPOSURE POINTS (NOT A BETTER ESTIMATE)								5.57679

A DIRECT ACCOUNTING OF THE TIME OCCURANCE OF COSTS YIELDS A FUEL COST OF (SEE SUMMARY ABOVE) 5.44629

CASE END NORMAL, U-233 FEED WITH 4 SUBZONES

PROCESSOR (SEC) 7.94

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 5 4.500
 SEARCH IT 19 6.867055E 00 9.266436E-03 5.000000E 00 5.000000E 00 9.959201E 12 6.300617E 00 9.986194E-01
 SEARCH IT 20 6.935720E 00 9.999998E-03 5.000000E 00 5.000000E 00 9.862509E 12 6.305654E 00 9.990085E-01
 SEARCH IT 21 6.961503E 00 3.718212E-03 3.750000E 00 5.000000E 00 9.829559E 12 6.269040E 00 9.993425E-01
 *** CONVERGENCE NOT SATISFIED ON ITERATION CYCLE 5 KEFF 0.99934

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 4.57247 6.96150)
 0.0 0.0 0.0 3.007E-07 7.071E-05 2.411E-04 5.000E-05 0.0 2.218E-06 7.985E-07 6.057E-07 3.817E-07
 2.745E-07 4.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
 0.0 0.0 0.0 2.826E-07 6.338E-05 2.365E-04 4.950E-05 4.614E-09 2.223E-06 8.013E-07 5.873E-07 3.901E-07
 2.903E-07 4.000E-02 4.025E-10 3.809E-10 1.163E-07 2.487E-10 9.188E-10 4.783E-10 7.230E-09 3.589E-07 6.726E-06 2.071E-05

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 1.000 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 21
 PISSILE LOADING (KGM) 2.7249E-02 PISSILE FEED 2.8728E-05 MAX POWER DENSITY 6.2690E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/KWR-YR
U-234	2.9148E-07	1.1331E-04	0.001182	0.001174	0.000007	0.000019	0.016061	-4.3764E 03	0.0	162.77695
U-235	6.6930E-05	2.6130E-02	0.478331	0.104957	0.373127	0.908465	1.899237	3.7406E 03	0.0	1.24405
U-236	2.3877E-04	9.3612E-02	0.406164	0.403995	0.002169	0.005796	0.014270	-1.7115E 03	0.0	181.97914
U-238	4.9748E-05	1.9669E-02	0.032702	0.032497	0.000204	0.000555	0.016970	-6.6111E 02	0.0	151.92166
U-239	4.6533E-09	1.8476E-06	0.000014	0.000014	0.000000	0.000000	0.023057	-3.2426E 03	0.03259	113.99989
U-239	2.2192E-06	8.8114E-04	0.031842	0.012198	0.019642	0.056491	1.773795	4.8010E 03	0.0	1.55184
U-240	7.9987E-07	3.1991E-04	0.012032	0.011999	0.000034	0.000102	0.008487	-2.2357E 04	0.0	140.58350
U-241	5.9565E-07	2.3848E-04	0.011138	0.002769	0.008369	0.024543	2.203624	1.4664E 04	0.00206	1.27794
U-242	3.8619E-07	1.5526E-04	0.002227	0.002219	0.000009	0.000027	5.012320	-5.9694E 03	0.0	237.85127
U-243	2.8245E-07	1.1402E-04	0.001186	0.001181	0.000005	0.000016	0.013498	-5.5019E 03	0.0	234.58315
FIXED	4.0000E-02	7.9708E-01	0.001984	0.001984	0.0	0.0	0.0	-7.0942E-02	0.0	0.0
I-135	4.2478E-10	9.5227E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02504	0.0
XE-135	4.0148E-10	9.0004E-08	0.008755	0.008755	0.0	0.0	0.0	-3.3318E 07	0.01724	0.0
PN-147	6.6769E-08	1.6299E-05	0.000903	0.000903	0.0	0.0	0.0	-1.4640E 04	0.00114	0.0
PN-148	1.4325E-10	3.5206E-08	0.000042	0.000042	0.0	0.0	0.0	-2.9939E 05	0.00044	0.0
PN-148M	5.2860E-10	1.2991E-07	0.000210	0.000210	0.0	0.0	0.0	-5.1994E 05	0.00021	0.0
PN-149	6.7107E-10	1.6604E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00500	0.0
SN-149	7.1284E-09	1.7637E-06	0.004987	0.004987	0.0	0.0	0.0	-1.0661E 06	0.0	0.0
U-143	1.8677E-07	4.4350E-05	0.000568	0.000568	0.0	0.0	0.0	-4.4412E 03	0.0	0.0
FP1	3.4654E-06	6.7329E-04	0.001820	0.001820	0.0	0.0	0.0	-5.9180E 02	0.0	0.0
FP2	1.0645E-05	2.0681E-03	0.000570	0.000570	0.0	0.0	0.0	-5.9721E 01	0.0	0.0
OTHER			0.0							
SUM		9.4112E-01	0.996659		0.401766	0.996004	1.898078	PISSILE		1.25258

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 5.8296E 12 4.6692E 11 2.1062E-02 5.00000 5.00000 -0.22342 0.97934 -0.07574 0.08500 0.08758

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FRED(KGM), DISCHARGE, MWT-D/KGM
 2.59762E 00 1.00000E 00 1.00000E 00 7.50000E-01 1.00000E-01 1.44414E-04 1.37432E-04 1.54447E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS	0.994995
FABRICATION	1.902884	0.0	1.902884	0.222001	2.124886		
PROCESSING	0.0	-4.162240	4.162240	-0.693707	3.468534		
FUEL	0.0	0.0	0.0	0.0	0.0		

SUM 1.902884 -4.162240 4.065125 -0.471705 5.593419, ENERGY (MWE-YR), SUM 2.50761E-06 1.35075E-05

() 7-12:

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
FISSILE LOADING (KGM) 1.3950E-03 FISSILE FEED

0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 10
1.6760E-06 MAX POWER DENSITY 6.2499E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWR-YR
U-235	2.7435E-06	1.0711E-03	0.307421	0.053403	0.253984	0.617392	2.008293	1.4121E 05	0.0	1.17524
U-236	2.6463E-07	1.0375E-04	0.002047	0.002037	0.000010	0.000026	0.012685	-7.3437E 03	0.0	204.71719
U-238	1.0443E-04	4.1290E-02	0.317480	0.315733	0.001734	0.004708	0.014830	-2.8648E 03	0.0	176.13676
NP-239	4.6210E-08	1.8586E-05	0.000926	0.000921	0.000005	0.000013	0.014402	-1.6983E 04	0.31494	182.50159
PU-239	7.7855E-07	3.0912E-04	0.196678	0.074372	0.122304	0.351448	1.786924	2.6488E 05	0.0	1.53940
PU-240	1.1815E-07	4.7105E-05	0.033934	0.033906	0.000027	0.000082	0.002412	-2.0964E 05	0.0	1181.92651
PU-241	3.8156E-08	1.5276E-05	0.012166	0.003180	0.003987	0.026350	2.165793	4.5433E 05	0.00013	1.29496
PU-242	3.5969E-09	1.4460E-06	0.000100	0.000100	0.000000	0.000001	0.010292	-2.6056E 04	0.0	284.73315
AM-243	8.4601E-11	3.4152E-08	0.000005	0.000005	0.000000	0.000000	0.003941	-4.3930E 04	0.0	803.52783
FIXED	5.0000E-02	9.9635E-01	0.042464	0.042464	0.0	0.0	0.0	-6.2896E-01	0.0	0.0
I-135	4.2656E-10	9.5625E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02415	0.0
XF-135	5.2367E-11	1.1740E-08	0.022962	0.022962	0.0	0.0	0.0	-3.1951E 08	0.00216	0.0
PH-147	2.9860E-08	7.2891E-06	0.002601	0.002601	0.0	0.0	0.0	-7.6095E 04	0.00044	0.0
PH-148	3.1882E-10	7.8355E-08	0.000441	0.000441	0.0	0.0	0.0	-1.3142E 06	0.00094	0.0
PH-148N	2.1463E-10	5.2748E-08	0.001139	0.001139	0.0	0.0	0.0	-4.0498E 06	0.00008	0.0
PH-149	8.6076E-10	2.1297E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00616	0.0
SP-149	4.4078E-10	1.0906E-07	0.006165	0.006165	0.0	0.0	0.0	-1.0197E 07	0.0	0.0
MC-143	8.1306E-08	1.9307E-05	0.034457	0.004457	0.0	0.0	0.0	-4.0342E 04	0.0	0.0
FP1	1.7200E-06	3.3417E-04	0.007054	0.007054	0.0	0.0	0.0	-3.4292E 03	0.0	0.0
FP2	5.3465E-06	1.0388E-03	0.001973	0.001973	0.0	0.0	0.0	-3.1722E 02	0.0	0.0
OTHER			0.040000							
SUM		1.0406E 00	1.000012		0.387050	1.000019	1.927671	FISSILE		1.29006

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*4, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
2.0577E 14 5.0683E 11 1.6079E-03 1.00496 1.00496 0.21712 1.00000 -0.45751 0.69626 0.67545

OPTIMUM ENRICHMENT, IT, TAILS, .95 PRODUCT COST, ORE (KGM/GM) 0.001855 0.0 0.210700

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, MWT-D/KGM
2.49997E 00 1.00000E 00 5.00000E-01 7.50000E-01 1.00000E-01 4.36820E-05 4.18329E-05 2.61116E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR PL, MIDCYCLE PLAT YRS
FABRICATION	1.154684	0.0	1.154684	0.096223	1.250907	0.333333
PROCESSING	0.0	-2.541639	2.541639	-0.338885	2.202754	
FUEL	5.423425	2.881401	2.542024	0.836137	3.378160	
SUM	6.578109	0.339762	6.238347	0.591874	6.831821	ENERGY (MWE-YR), SUM 1.24998E-01 1.24998E-06

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 1 10 1.0000 1.6760E-06 1.1862E-06 2.5000E 00 0.6964 0.3333 6.8113

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 15 7.250

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 0.16897 0.16921)
0.0 0.0 0.0 0.0 5.490E-06 3.033E-06 9.652E-06 0.0 2.690E-06 9.143E-07 7.479E-07 8.612E-07
6.082E-07 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
0.0 0.0 0.0 0.0 3.885E-06 3.181E-06 9.451E-05 3.663E-08 2.678E-06 9.255E-07 7.572E-07 8.002E-07
6.490E-07 5.000E-02 3.952E-10 1.217E-10 5.124E-08 3.874E-10 5.379E-10 9.792E-10 1.312E-09 1.516E-07 1.476E-06 1.098E-06

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 6
FISSILE LOADING (KGM) 3.1658E-03 FISSILE FEED 3.5107E-06 MAX POWER DENSITY 6.250E-06

NUCLEIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DPGAT	KGM/MWP-YR
U-235	4.6184E-06	1.8030E-03	0.194538	0.038199	0.356119	2.379702	1.951816	3.7891E-04	0.0	1.20990
U-236	3.1221E-06	1.2241E-03	0.020587	0.020480	0.000107	0.000787	0.013933	-6.5252E-03	0.0	146.17924
U-238	9.5508E-05	3.7762E-02	0.244262	0.242765	0.001495	0.004033	0.016509	-2.5256E-03	0.0	158.22055
NP-239	3.7012E-08	1.4696E-05	0.000879	0.000875	0.000004	0.000010	0.020655	-1.2855E-04	0.0	127.25575
PJ-239	2.6725E-06	1.0611E-03	0.279394	0.091105	0.000284	0.026242	1.780503	6.4761E-04	0.0	1.54546
PC-240	9.2026E-07	3.6691E-04	0.090157	0.090000	0.000157	0.000474	0.005260	-1.0386E-05	0.0	547.74609
PO-241	7.5253E-07	3.0129E-04	0.096435	0.022043	0.004393	0.188826	2.184590	1.2962E-05	0.0	1.28393
PJ-242	8.7086E-07	3.5011E-04	0.019736	0.019659	0.000077	0.000234	0.011867	-2.257E-04	0.0	246.93172
AM-243	6.2916E-07	2.5398E-04	0.014694	0.014654	0.000041	0.000135	0.009187	-2.423E-04	0.0	344.64140
FIXED	5.0000E-02	9.9635E-01	0.015267	0.015267	0.0	0.0	0.0	-7.2755E-01	0.0	0.0
I-135	4.2216E-10	9.4638E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02327	0.0
IE-135	1.3003E-10	2.9150E-08	0.018989	0.018988	0.0	0.0	0.0	-1.5532E-08	0.00522	0.0
PN-147	3.0506E-08	7.4465E-06	0.001741	0.001741	0.0	0.0	0.0	-5.7941E-04	0.00089	0.0
PM-148	2.3060E-10	5.6674E-08	0.000263	0.000263	0.0	0.0	0.0	-1.1461E-06	0.00066	0.0
PI-148N	3.2019E-10	7.8692E-08	0.000697	0.000697	0.0	0.0	0.0	-2.2738E-06	0.00012	0.0
PM-149	8.0619E-10	1.9947E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00552	0.0
SM-149	1.2033E-09	2.9774E-07	0.005620	0.005620	0.0	0.0	0.0	-8.9662E-06	0.0	0.0
ND-143	8.1850E-08	1.9436E-05	0.001573	0.001573	0.0	0.0	0.0	-2.0350E-04	0.0	0.0
PP1	1.8025E-06	3.5021E-04	0.004229	0.004229	0.0	0.0	0.0	-2.3989E-01	0.0	0.0
PP2	5.6568E-06	1.0991E-03	0.001303	0.001303	0.0	0.0	0.0	-2.3114E-02	0.0	0.0
CTHER			0.040000							
SUM		1.0410E 00	3.999962		0.370666	0.999943	1.911669	FISSILE		1.35267

FLUX, LOSSES, SIGA2, PLOX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
7.0404E 13 5.2070E 11 4.5216E-03 2.82601 2.82601 0.00111 0.99999 -0.26949 0.61749 0.61866

FUEL CYCLE ECONOMICS ----- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, MWT-D/KGM
2.50012E 00 1.00000E 00 5.00000E-01 7.50000E-01 1.00000E-01 4.40301E-05 4.20661E-05 2.59068E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILI/KW-HR EL, MIDCYCLE PEAL YRS	KGM/MWP-YR
FABRICATION	1.163815	0.0	1.163815	0.096988	1.260799		0.666664
PROCESSING	0.0	-2.555653	2.555653	-0.340754	2.214999		
FUEL	9.422469	6.898326	2.524143	1.704978	4.229121		
SUM	10.586295	4.342673	6.243611	1.461208	7.704820	ENERGY (MWP-YR), SUM 1.25006E-04	1.87506E-04

CYCLE THROWAWAY COST ESTIMATE, DIRECT, TOTAL 11.24985 12.07823

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 15 6 1.0000 3.5107E-06 2.8978E-04 2.5001E 00 0.6175 9.6667 7.7440

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 5.92995E-04 4.80119E-04 1.28758E-05
SUMMED FISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 4.12270E-05 1.12572E-05 1.48676E-05 -0.15910E-01
FISSILE (KGM/MWP-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.34784 0.66924 -0.24108

ORE (U-235 FEED) INITIAL, FEED, DISCHARGE, NET (KGM) 3.57889E-07 2.48277E 00 7.336949E-06 2.482769E 00

MAKE-UP FISSILE ASSOCIATED WITH ORE AND ORE 1.125716E-05 2.453109E-06

FUEL COST ANALYSIS

COST LEVELIZED OVER 15 FUEL CYCLES AT DISCOUNT FACTOR 0.0700 , REAL YEARS 10.000 ENERGY (MWE-YR) 1.87505E-05

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	1.160098	0.0	1.160098	0.139406	1.299499	
PROCESSING	0.0	-2.550376	2.550376	-0.264572	2.285904	
FUEL	8.484334	5.644393	2.839941	1.625943	4.465884	
SUM	9.644432	3.094017	6.550415	1.500772	8.051187	

TOTAL WITH QUARTERLY ENERGY ACCOUNTING 7.91043

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

	COST	RETURN	DIRECT	INDIRECT	TOTAL
FABRICATION	1.160098	0.0	1.160098	0.109015	1.269114
PROCESSING	0.0	-2.550376	2.550376	-0.140422	2.409954
FUEL	3.236991	0.459889	2.777102	0.622647	3.399750
SUM	4.397089	-2.090487	6.487576	0.591241	7.078817

COST ONLY DISCOUNTING WITH QUARTERLY ENERGY ACCOUNTING 6.95506, AND AT TWICE THE RATE 7.67257

THROWAWAY COST ESTIMATE, DIRECT, TOTAL 10.34654 11.26709 TOTAL ANNUAL AND QUARTERLY ONLY DISCOUNTING, 11.05253 10.85910

THE CHANGE AND TOTAL COST FOR FIFTY PERCENT INCREASE IN UNIT COSTS

FABRICATION	0.649749	8.700935
PROCESSING	1.142901	9.194088
FUEL	2.232942	10.284128

DISTRIBUTION OF THE COSTS AFTER THE INCREASE BY FIFTY PERCENT

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	1.740147	0.0	1.740147	0.209101	1.949247	
PROCESSING	0.0	-3.825563	3.825563	-0.396858	3.428705	
FUEL	12.726501	8.466519	4.259912	2.438914	6.698826	
SUM	14.466647	4.641026	9.825622	2.251157	12.076778	

ADDITIONAL CONTINUOUS FUELING CHARGES - FABRICATION DIRECT, INDIRECT, FUEL INDIRECT, TOTAL
HISTORY 0.07698 0.03810 0.98948 0.20456

COST DEPENDENCE ON INDIRECT CHARGES

INTEREST RATE	0.0500	0.0750	0.1000	0.1250	0.1500
TOTAL FUEL COST	7.30080	7.67599	8.05119	8.42638	8.80157

SUMMARY OF REACTOR HISTORY, ENERGY (MWE-YR) 1.875052-05									
PERIOD	TIME (YR)	LOAD FACTOR	FISSION RATE	AND PRED	AND DISCHARGE	CONVERSION	POWER	COST	
1	0.3333	0.7500	1.6759E-06	1.6759E-06	1.1817E-06	0.69626	2.49997E 00	6.83192	
2	1.0000	0.7500	1.1317E-07	2.0934E-06	1.5431E-06	0.69674	2.50011E 00	8.01598	
3	1.6666	0.7500	7.4155E-07	2.3358E-06	1.8250E-06	0.69597	2.49983E 00	8.06476	
4	2.3333	0.7500	6.8802E-07	2.5125E-06	1.9923E-06	0.69207	2.49986E 00	8.16264	
5	3.0000	0.7500	6.6724E-07	2.6595E-06	2.1293E-06	0.68672	2.49983E 00	8.28369	
6	3.6666	0.7500	6.5809E-07	2.7874E-06	2.2468E-06	0.68087	2.50017E 00	8.41545	
7	4.3333	0.7500	6.5525E-07	2.9020E-06	2.3518E-06	0.67490	2.50015E 00	8.58195	
8	5.0000	0.7500	6.5405E-07	3.0069E-06	2.4491E-06	0.66906	2.50013E 00	8.78962	
9	5.6666	0.7500	6.5478E-07	3.0972E-06	2.5297E-06	0.66352	2.50015E 00	8.91679	
10	6.3333	0.7500	6.5508E-07	3.1810E-06	2.6066E-06	0.65830	2.50012E 00	9.03868	
11	6.9999	0.7500	6.5648E-07	3.2630E-06	2.6763E-06	0.65347	2.50022E 00	9.16228	
12	7.6666	0.7500	6.5720E-07	3.3398E-06	2.7398E-06	0.64898	2.50019E 00	9.28219	
13	8.3333	0.7500	6.5852E-07	3.3985E-06	2.7976E-06	0.64483	2.50014E 00	9.40128	
14	8.9999	0.7500	6.5965E-07	3.4529E-06	2.8501E-06	0.64101	2.50014E 00	9.52061	
15	9.6666	0.7500	6.6061E-07	3.5072E-06	2.8977E-06	0.63749	2.50012E 00	9.64082	
OVERALL	9.9999	0.7500	1.1257E-05	4.3227E-05	3.4867E-05	0.66935	2.50007E 00	8.05120	
COST ESTIMATE DISCOUNTING ENERGY ON THE BASIS OF ONE-QUARTER YEARS									7.91035
COST ESTIMATE DISCOUNTING ENERGY FROM MID-CYCLE EXPOSURE POINTS (NOT A BETTER ESTIMATE)									7.78254

DETAILED REACTOR HISTORY, ENERGY (MWE-YR) 1.87497E-05									
PERIOD	TIME (YR)	LOAD FACTOR	FISSION RATE	AND PRED	AND DISCHARGE	CONVERSION	POWER	COST	
1	1.6666	0.7500	4.1891E-06	4.1891E-06	2.9654E-06	0.69626	2.49997E 00	6.83182	
2	3.3333	0.7500	2.2923E-06	5.2483E-06	3.9858E-06	0.69674	2.50011E 00	8.01598	
3	5.0000	0.7500	1.8539E-06	6.3371E-06	4.5612E-06	0.69597	2.49983E 00	8.06476	
4	6.6666	0.7500	1.7200E-06	6.2812E-06	4.9808E-06	0.69207	2.49986E 00	8.16264	
5	8.3333	0.7500	1.6641E-06	6.6489E-06	5.3233E-06	0.68672	2.49983E 00	8.28369	
6	10.0000	0.7500	1.6452E-06	6.9685E-06	5.6170E-06	0.68087	2.50017E 00	8.41545	
OVERALL	10.0000	0.7500	1.3361E-05	3.5176E-05	2.7437E-05	0.69144	2.49996E 00	8.14483	
COST ESTIMATE DISCOUNTING ENERGY ON THE BASIS OF ONE-QUARTER YEARS									8.00244
COST ESTIMATE DISCOUNTING ENERGY FROM MID-CYCLE EXPOSURE POINTS (NOT A BETTER ESTIMATE)									7.87654

PROCESSOR (SEC) 1.87

CASE END NORMAL. U-235, U-238 FEED, FIX TOTAL HEAVY METAL

U-235, U-238 FEED, FIX TOTAL HEAVY METAL
THE CROSS SECTION CORRELATION IS APPLIED

NUCLIDE ABSORPTION CORRELATING DATA- NAME, FAST ALPHA, BETA, THERMAL ALPHA, BETA

1	U-232	0.50000	0.90000	0.50000	0.50000
2	PA-233	1.00000	0.50000	1.00000	0.30000
3	U-233	1.00000	0.80000	1.00000	0.30000
4	U-234	1.00000	0.50000	1.00000	0.30000
5	U-235	1.00000	0.70000	1.00000	0.30000
6	U-236	1.50000	0.60000	1.00000	0.30000
7	U-238	0.50000	0.60000	0.50000	0.50000
8	NP-239	1.00000	0.60000	1.00000	0.40000
9	PU-239	1.00000	0.50000	0.90000	0.20000
10	PU-240	1.00000	0.50000	0.80000	0.20000
11	PU-241	0.80000	0.50000	0.80000	0.20000
12	PU-242	0.60000	0.50000	0.60000	0.20000
13	AN-243	0.80000	0.50000	0.80000	0.20000

A-45

PLIN, LOSSSES, SIGA2, FLUX RATIO (2), S/N IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 2.106E-14 5.0095E-11 1.5602E-03 0.97760 0.97760 0.22477 0.99999 -0.45705 0.69398 0.67355

FUEL CYCLE ECONOMICS ----- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, PRPD (KGM), DISCHARGE, HWT-D/KGM
 2.5001E-00 1.0000E-00 5.0000E-01 7.5000E-01 1.0000E-01 4.3681E-05 4.1833E-05 2.6113E-01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR	PI, MIDCYCLE	REAL YRS	0.33333
FABRICATION	1.15459	0.0	1.15459	0.096216	1.250815				
PROCESSING	0.0	-2.541477	-2.541477	-0.338663	2.70214				
FUEL	5.480949	2.914127	2.566822	0.845294	3.412116				
SUM	6.635549	0.372650	6.262898	0.602647	6.865545	ENERGY (MWE-YR), SUM	1.25007E-06	1.25007E-06	

CYCLE, IT, K, PISS PERD, EXIT, POWER, CR, YRS, COST 1 11 1.0000 1.6911E-06 1.1975E-06 2.5001E-00 0.6931 0.3333 6.8555

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 2 0.750

ADJUSTED INITIAL CONCENTRATIONS (SEARCH SIGNVALDE 1.00905 0.34661)
 0.0 0.0 0.0 4.113E-06 4.297E-07 1.039E-04 0.0 1.135E-06 2.592E-07 1.421E-07 3.060E-08
 1.534E-09 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDP CONCENTRATIONS, STEPS 100
 0.0 0.0 0.0 2.173E-06 7.433E-07 1.015E-04 4.335E-08 1.565E-06 4.347E-07 2.358E-07 1.160E-07
 1.311E-08 5.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
 PISSILE LOADING (KGM) 1.8153E-03 PISSILE PERD 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 15
 2.1136E-06 MAX POWER DENSITY 6.2501E-00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	MCAT	KGM/MWE-YR
P-235	2.9902E-06	1.1674E-03	0.235979	0.042509	0.193444	0.470297	1.992964	8.9264E-04	0.0	1.18445
P-236	6.1637E-07	2.4165E-04	0.004515	0.004952	0.000022	0.000060	0.013249	-7.1143E-03	0.0	195.99809
P-238	1.0272E-04	4.0615E-02	0.293293	0.291599	0.001682	0.004566	0.015567	-2.7599E-03	0.0	167.79211
U-235	4.3855E-08	1.7412E-05	0.030739	0.000734	0.000005	0.000012	0.016740	-1.5571E-04	0.29097	157.01811
P-239	1.4115E-06	5.6041E-04	0.236527	0.089612	0.146912	0.422203	1.785007	1.5590E-05	0.0	1.54121
P-240	3.5278E-07	1.4066E-04	0.067432	0.067360	0.000072	0.000216	0.003205	-1.6177E-05	0.0	893.90015
P-241	2.1858E-07	8.7513E-05	0.047274	0.012270	0.035035	0.102641	2.171175	-2.8431E-05	0.00071	1.29179
P-242	6.6757E-08	2.6838E-05	0.001720	0.001714	0.000006	0.000019	0.011027	-2.8893E-04	0.0	265.75439
A-243	5.9031E-09	2.3830E-06	0.000245	0.000245	0.000003	0.000001	0.005463	-3.5903E-04	0.0	579.57861
FIXED	5.0000E-02	9.9635E-01	0.030118	0.030118	0.0	0.0	0.0	-5.1556E-01	0.0	0.0
I-135	4.2319E-10	9.4869E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02363	0.0
XE-135	7.1047E-11	1.5927E-08	0.021694	0.021594	0.0	0.0	0.0	-2.5848E-08	0.00289	0.0
PM-147	3.0050E-08	7.3353E-06	0.022232	0.022232	0.0	0.0	0.0	-6.9925E-04	0.00048	0.0
PP-148	2.8211E-10	6.9334E-08	0.000365	0.000365	0.0	0.0	0.0	-1.2661E-06	0.00082	0.0
PP-149	2.4518E-10	6.0257E-08	0.000954	0.000954	0.0	0.0	0.0	-3.3982E-06	0.00009	0.0
PM-149	9.5067E-10	2.1048E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00601	0.0
SH-149	6.1651E-10	1.5254E-07	0.006009	0.006008	0.0	0.0	0.0	-8.2518E-06	0.0	0.0
MD-143	8.0629E-08	1.9146E-05	0.003111	0.003111	0.0	0.0	0.0	-3.9202E-04	0.0	0.0
PP1	1.7811E-06	3.4604E-04	0.005915	0.005915	0.0	0.0	0.0	-3.0580E-01	0.0	0.0
PP2	5.5752E-06	1.0932E-03	0.001716	0.001716	0.0	0.0	0.0	-2.8758E-02	0.0	0.0
CTAER			0.040000							
SUM		1.0407E-00	0.999835		3.377149	1.000014	1.914541	PISSILEP		1.33008

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*W, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 1.4560E 14 5.1395E 11 2.2818E-33 1.42615 1.42615 3.13937 0.99999 -0.37394 0.69426 0.68918

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KG), DISCHARGE, MWT-D/KGM
 2.5000E 00 1.0000E 00 5.0000E-01 7.5000E-01 1.1000E-01 4.3697E-05 4.1840E-05 2.6103E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS	1.000000
FABRICATION	1.155055	0.0	1.155055	0.096253	1.251308		
PROCESSING	0.0	-2.542031	2.542031	-0.333938	2.203094		
FUEL	6.339235	3.993603	2.345633	1.060747	3.406380		
SUM	7.494290	1.451571	6.042719	0.818063	6.860782	ENERGY (MWE-YR), SUM	1.25001E-06 2.50008E-06

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 2 15 1.0000 2.1136E-06 1.6053E-06 2.5000E 00 0.6943 1.0000 6.8508
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 3 11 1.0000 2.3520E-06 1.8374E-06 2.4999E 00 0.6918 1.6667 6.9721

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 12 5.750

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 0.39261 0.39322)
 0.0 0.0 0.0 0.0 5.137E-06 2.572E-06 9.756E-05 0.0 2.661E-06 8.839E-07 7.189E-07 7.745E-07
 4.619E-07 5.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100
 0.0 0.0 0.0 0.0 3.557E-06 2.735E-06 9.552E-05 3.737E-08 2.663E-06 9.008E-07 7.332E-07 8.072E-07
 5.131E-07 5.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 7
 FISSILE LOADING (KGM) 3.0126E-03 FISSILE FEED 3.3501E-06 MAX POWER DENSITY 6.2503E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
T-235	4.275E-06	1.6690E-03	0.191510	0.037396	0.154094	0.374760	1.956866	4.1534E 04	0.0	1.20672
U-236	2.668E-06	1.0462E-03	0.017774	0.017681	0.000092	0.000247	0.013880	-6.5789E 03	0.0	187.09666
U-238	9.653E-05	3.8169E-02	0.249072	0.247554	0.001506	0.004089	0.016418	-2.5428E 03	0.0	159.09792
NF-239	3.777E-08	1.4997E-05	0.000502	0.000498	0.000004	0.000010	0.020209	-1.3143E 04	0.24714	130.06731
PU-239	2.651E-06	1.0529E-03	0.242536	0.092286	0.150245	0.431876	1.780666	6.8448E 04	0.0	1.54531
PJ-240	9.928E-07	3.5597E-04	0.090646	0.090491	0.000154	0.000465	0.005127	-1.0441E 05	0.0	561.72998
PM-241	7.266E-07	2.9070E-04	0.086396	0.022058	0.064339	0.188664	2.183707	1.3708E 05	0.00234	1.28444
PM-242	7.91E-07	3.1807E-04	0.018091	0.018021	0.000070	0.000214	0.011834	-2.2656E 04	0.0	247.62650
AM-243	4.880E-07	1.9700E-04	0.011784	0.011753	0.000032	0.000105	0.008940	-2.4552E 04	0.0	354.19092
FISSILE	5.000E-02	9.9635E-01	0.016652	0.016652	0.0	0.0	0.0	-3.4337E-01	0.0	0.0
I-135	4.221E-10	9.4631E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02325	0.0
XE-135	1.203E-10	2.6984E-08	0.019361	0.019361	0.0	0.0	0.0	-1.6644E 08	0.00483	0.0
PM-147	3.041E-08	7.424E-06	0.001786	0.001786	0.0	0.0	0.0	-5.9224E 04	0.00048	0.0
PM-149	2.357E-10	5.7946E-08	0.000273	0.000273	0.0	0.0	0.0	-1.1592E 06	0.00067	0.0
PM-148	3.091E-10	7.5969E-08	0.000722	0.000722	0.0	0.0	0.0	-2.3949E 06	0.00012	0.0
PM-149	9.123E-10	2.0099E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00566	0.0
SN-149	1.106E-09	2.7229E-07	0.005658	0.005658	0.0	0.0	0.0	-5.3195E 06	0.0	0.0
NO-143	9.152E-08	1.9359E-05	0.001712	0.001712	0.0	0.0	0.0	-2.1673E 04	0.0	0.0
PP1	1.804E-06	3.5058E-04	0.004392	0.004392	0.0	0.0	0.0	-2.4650E 03	0.0	0.0
PP2	5.664E-06	1.1006E-03	0.001343	0.001343	0.0	0.0	0.0	-2.3948E 02	0.0	0.0
OTHER			0.040000							
SUM		1.0409E 00	1.000209		0.30535	1.000427	1.912410	FISSILE		1.35326

SLUG, LOSSES, SIGA2, FLUX RATIO (2), STM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YF-1), CONVERSION RATIO (2)
 7.7494P 13 5.2115E 11 4.1220P-03 2.57622 0.57622 0.01803 0.99999 -0.27165 0.64779 0.64857

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, MWT-D/KGM
 2.50012E 00 1.00000E 00 5.00000E-01 7.50000E-01 1.00000E-01 4.39968E-05 4.20518E-05 2.59264E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILI	M-HR FL	MIDCYCLE PPAL YRS	7.66660
FABRICATION	1.162933	0.0	1.162933	0.096910	1.259844				
PROCESSING	0.0	-2.554779	2.554779	-0.340617	2.214162				
FUEL	5.069306	6.607912	2.461394	1.63627	4.098222				
SUN	10.232240	4.053133	6.179107	1.393101	7.572207	ENERGY (MWE-YR)	SUN	1.25000E-06	1.50004P-05

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 12 7 1.0000 3.3501E-06 2.7543E-06 2.5001P 00 0.6478 7.6667 7.5722
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 13 7 1.0000 3.4144P-06 2.8118E-06 2.5001P 00 0.6417 8.3311 7.6246
 CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 14 6 1.0000 3.4727E-06 2.8639E-06 2.5001E 00 0.6199 9.0000 7.6711
 CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 15 7.250

ORIGINAL AND CORRELATED CROSS SECTIONS, SUBZONE 0

NAME	FAST ABSORPTION (2), PRODUCTION -- THERMAL ABSORPTION (2), PRODUCTION
1 TH-232	2.82500E 00 2.82378E 00 2.52787E-02 2.98100E 00 2.97406E 00 0.0
2 PA-233	2.05700E 01 2.05502E 01 4.04290E-01 5.88603E 01 5.85890E 01 0.0
3 U-233	3.02300E 01 3.02009E 01 6.22393E-01 2.66900E 02 2.65671E 02 6.03186E 02
4 U-238	3.3120E 01 3.30812E 01 6.48259E-01 3.51600E 01 3.49981E 01 0.0
5 U-235	1.95106E 01 1.94881E 01 2.94864E-01 2.56400E 02 2.48678E 02 5.08817E 02
6 U-236	1.63200E 01 1.62970E 01 2.40136E-01 2.64800E 00 2.57885E 00 0.0
7 U-239	6.27500E 00 6.28779E 00 1.10021E-01 1.19200E 00 1.16783E 00 0.0
8 U-234	2.57200E 01 2.56952E 01 6.97967E-01 2.29000E 01 2.27946E 01 0.0
9 U-239	2.21200E 01 2.20630E 01 3.70956E-01 6.00000E 02 5.54649E 02 9.93286E 02
10 U-240	9.40400E 00 9.38634E 00 1.1538E 00 6.98000E 02 6.54748E 02 5.11510E-01
11 U-241	3.52100E 01 3.51516E 01 8.48908E-01 7.50003E 02 7.05185E 02 1.51900E 03
12 U-242	5.83000E 01 5.82199E 01 7.02808E-01 1.41600E 01 1.33070E 01 0.0
13 AM-243	1.62200E 01 1.61955E 01 5.60679E-01 1.26900E 02 1.19609E 02 0.0
14 FIXED	9.18000E-05 9.13120E-05 0.0 2.00000E-03 1.99261E-03 0.0
15 I-135	0.0 0.0 0.0 0.0 0.0 0.0
16 I-135	1.17500E 01 1.17387E 01 0.0 1.08000E 06 1.07601E 06 0.0
17 PH-147	1.18000E 02 1.13890E 02 0.0 1.03000E 02 9.96305E 01 0.0
18 PH-148	2.76000E 03 2.75738E 03 0.0 6.36000E 02 6.33650E 02 0.0
19 PH-148M	1.66000E 03 1.65840E 03 0.0 1.14000E 04 1.13579E 04 0.0
20 PH-149	0.0 0.0 0.0 0.0 0.0 0.0
21 SM-149	4.99000E 01 4.98520E 01 0.0 3.44000E 04 3.42729E 04 0.0
22 ND-143	3.91500E 00 3.91223E 00 0.0 1.31103E 02 1.30616E 02 0.0
23 FPI	3.98200E 00 3.97817E 00 0.0 6.10000E 00 6.07746E 00 0.0
24 FP2	4.36000E-01 4.35580E-01 0.0 4.71003E-01 4.69260E-01 0.0

ORIGINAL AND CORRELATED CROSS SECTIONS, SUBZONE 0

NAME	FAST ABSORPTION (2), PRODUCTION -- THERMAL ABSORPTION (2), PRODUCTION
1 TH-232	2.82500E 00 2.82379E 00 2.52788E-02 2.98100E 00 2.97411E 00 0.0
2 PA-233	2.05700E 01 2.05503E 01 4.04297E-01 5.88600E 01 5.85910E 01 0.0
3 U-233	3.02300E 01 3.02011E 01 6.22398E-01 2.66900E 02 2.65680E 02 6.03207E 02

4	N-234	3.31200E	01	3.30883E	01	6.44263E-01	3.51600E	01	3.49997E	01	0.0		
5	U-235	1.95100E	01	1.94896E	01	2.94873E	01	2.56400E	02	2.49000E	02	5.09495E	02
6	U-236	1.63200E	01	1.62970E	01	2.40106E-01	2.64800E	00	2.57849E	00	0.0		
7	U-238	6.27500E	00	6.24796E	00	1.13024E-01	1.18200E	00	1.16791E	00	0.0		
8	NP-239	2.57200E	01	2.56954E	01	6.97952E-01	2.29000E	01	2.27748E	01	0.0		
9	PO-239	2.21200E	01	2.20633E	01	3.70960E	01	6.00000E	02	5.54698E	02	9.93374E	02
10	PO-240	9.40400E	00	9.38637E	00	1.15341E	03	6.98000E	02	6.54717E	02	5.11486E	-01
11	PO-241	3.52100E	01	3.51537E	01	8.48909E	01	7.50000E	02	7.05154E	02	1.51493E	01
12	PO-242	5.43000E	01	5.42198E	01	7.02807E-01	1.41600E	01	1.33055E	01	0.0		
13	AM-243	1.62200E	01	1.61953E	01	5.60674E-01	1.26900E	02	1.19568E	02	0.0		
14	FIXED	9.14000E-05	9.13126E-05	0.0	0.0	0.0	2.00000E-03	1.99266E-03	0.0	0.0	0.0		
15	I-135	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
16	XE-135	1.17500E	01	1.17388E	01	0.0	1.08000E	06	1.07597E	06	0.0		
17	PM-147	1.14000E	02	1.13891E	02	0.0	1.00000E	02	9.95462E	01	0.0		
18	PM-148	2.76000E	03	2.75736E	03	0.0	6.36000E	02	6.33617E	02	0.0		
19	PM-148H	1.66000E	03	1.65841E	03	0.0	1.14000E	04	1.13570E	04	0.0		
20	PM-149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
21	SM-149	4.99000E	01	4.98523E	01	0.0	3.44000E	04	3.42682E	04	0.0		
22	ND-143	3.91600E	00	3.91226E	00	0.0	1.31100E	02	1.30440E	02	0.0		
23	FP1	3.98200E	00	3.97819E	00	0.0	6.10000E	00	6.04787E	00	0.0		
24	FP2	4.16000E-01	4.15583E-01	0.0	0.0	0.0	4.71000E-01	4.65630E-01	0.0	0.0	0.0		

ORIGINAL AND CORRELATED CROSS SECTIONS, SUBZONE 0
NAME FAST ABSORPTION (2), PRODUCTION -- THERMAL ABSORPTION (2), PRODUCTION

1	TH-232	2.42500E	00	2.42379E	00	2.52798E-02	2.98100E	00	2.97431E	00	0.0		
2	PA-233	2.05700E	01	2.05594E	01	4.34299E-01	5.48600E	01	5.45990E	01	0.0		
3	U-233	3.02300E	01	3.02012E	01	6.22403E	01	2.66900E	02	2.65716E	02	6.03289E	02
4	N-234	3.31200E	01	3.30885E	01	6.44266E-01	3.51600E	01	3.50041E	01	0.0		
5	N-235	1.95100E	01	1.94892E	01	2.94881E	01	2.56400E	02	2.49360E	02	5.10231E	02
6	U-236	1.63200E	01	1.62970E	01	2.40105E-01	2.64800E	00	2.57849E	00	0.0		
7	U-238	6.27500E	00	6.24813E	00	1.10027E-01	1.18200E	00	1.16805E	00	0.0		
8	NP-239	2.57200E	01	2.56955E	01	6.97955E-01	2.29000E	01	2.27754E	01	0.0		
9	PO-239	2.21200E	01	2.20634E	01	3.70962E	01	6.00000E	02	5.54766E	02	9.93494E	02
10	PO-240	9.40400E	00	9.38639E	00	1.15342E	00	6.98000E	02	6.54744E	02	5.11507E	-01
11	PO-241	3.52100E	01	3.51538E	01	8.48911E	01	7.50000E	02	7.05183E	02	1.51899E	03
12	PO-242	5.43000E	01	5.42198E	01	7.02806E-01	1.41600E	01	1.33049E	01	0.0		
13	AM-243	1.62200E	01	1.61952E	01	5.60670E-01	1.26900E	02	1.19540E	02	0.0		
14	FIXED	9.14000E-05	9.13131E-05	0.0	0.0	0.0	2.00000E-03	1.99288E-03	0.0	0.0	0.0		
15	I-135	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
16	XE-135	1.17500E	01	1.17398E	01	0.0	1.08000E	06	1.07609E	06	0.0		
17	PM-147	1.14000E	02	1.13892E	02	0.0	1.00000E	02	9.95280E	01	0.0		
18	PM-148	2.76000E	03	2.75738E	03	0.0	6.36000E	02	6.33656E	02	0.0		
19	PM-148H	1.66000E	03	1.65842E	03	0.0	1.14000E	04	1.13577E	04	0.0		
20	PM-149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
21	SM-149	4.99000E	01	4.98525E	01	0.0	3.44000E	04	3.42697E	04	0.0		
22	ND-143	3.91600E	00	3.91228E	00	0.0	1.31100E	02	1.30396E	02	0.0		
23	FP1	3.98200E	00	3.97821E	00	0.0	6.10000E	00	6.03899E	00	0.0		
24	FP2	4.16000E-01	4.15585E-01	0.0	0.0	0.0	4.71000E-01	4.64522E-01	0.0	0.0	0.0		

ADJUSTED INITIAL CONCENTRATIONS (SEARCH SIGNVALUE 0.14432 0.19498)
0.0 0.0 0.0 0.0 5.445E-06 3.045E-06 9.646E-05 0.0 2.764E-06 9.286E-07 7.564E-07 5.576E-07
6.060E-07 5.00E-07 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS

0.0 0.0 0.0 0.0 3.834E-06 3.192E-06 9.445E-05 3.657E-08 2.753E-06 9.400E-07 7.654E-07 8.769E-07
 6.475E-07 5.000E-02 3.948E-10 1.177E-10 5.116E-08 3.902E-10 5.286E-10 8.820E-10 1.263E-09 1.513E-07 1.476E-06 1.098E-05

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
 FISSILE LOADING (KGM) 3.1795E-03 FISSILE FEED

0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 6
 3.5259E-06 MAX POWER DENSITY 6.2503E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWE-YR
U-235	4.5696E-06	1.7840E-03	0.195353	0.038445	0.156887	0.381566	1.953216	3.8974E 04	0.0	1.20901
U-236	3.1332E-06	1.2284E-03	0.020673	0.020565	0.000108	0.000288	0.013518	-6.5213E 03	0.0	186.58080
U-238	4.5449E-05	3.7739E-02	0.243869	0.242378	0.001479	0.004017	0.016470	-2.5200E 01	0.0	158.59669
NP-239	3.6952E-08	1.4672E-05	0.000482	0.000478	0.000004	0.000010	0.020453	-1.2939E 04	0.24198	128.51309
PD-239	2.7475E-06	1.0909E-03	0.238935	0.090957	0.147973	0.425356	1.780210	6.3917E 04	0.0	1.54574
PD-240	9.3465E-07	3.7265E-04	0.089978	0.089819	0.000159	0.000480	0.005334	-1.0032E 05	0.0	540.14063
PD-241	7.6110E-07	3.0472E-04	0.096205	0.021972	0.064233	0.186358	2.184999	1.2920E 05	0.00246	1.28369
PD-242	8.6744E-07	3.3873E-04	0.019621	0.019545	0.000076	0.000233	0.011883	-2.2435E 04	0.0	246.60284
AR-243	6.2727E-07	2.5322E-04	0.014499	0.014459	0.000041	0.000135	0.009277	-2.3732E 04	0.0	341.33496
FIXED	5.0000E-02	9.9635E-01	0.015851	0.015851	0.0	0.0	0.0	-3.3091E-01	0.0	0.0
Z-135	4.2213E-10	9.4633E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02327	0.0
XE-135	1.2578E-10	2.8197E-08	0.019160	0.019160	0.0	0.0	0.0	-1.5983E 08	0.00505	0.0
PH-147	3.0495E-08	7.4439E-06	0.001758	0.001758	0.0	0.0	0.0	-5.8322E 04	0.00049	0.0
PH-148	2.0262E-10	5.7169E-08	0.000266	0.000266	0.0	0.0	0.0	-1.1882E 06	0.00367	0.0
PH1484	3.1512E-10	7.7446E-08	0.000706	0.000706	0.0	0.0	0.0	-2.3209E 06	0.00012	0.0
PH-149	8.0833E-10	2.0000E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00563	0.0
SH-149	1.1571E-09	2.8630E-07	0.005635	0.005635	0.0	0.0	0.0	-5.1091E 06	0.0	0.0
ND-143	8.1803E-08	1.9425E-05	0.001632	0.001632	0.0	0.0	0.0	-2.0863E 04	0.0	0.0
FP1	1.8032E-06	3.5034E-04	0.004235	0.004285	0.0	0.0	0.0	-3.4178E 03	0.0	0.0
FP2	5.6590E-06	1.0995E-03	0.001315	0.001315	0.0	0.0	0.0	-2.3551E 02	0.0	0.0
CTHPR			0.040000							
SUM		1.0410E 00	1.030223		0.370960	1.000440	1.912186	FISSILE		1.35197

PLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 7.3710E 13 5.2073E 11 4.3230E-03 2.70194 2.70188 0.90976 0.99998 -0.26802 0.63636 0.63711

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (KGM), DISCHARGE, NET-D/KGM
 2.50014E 00 1.00000E 00 5.00000E-01 7.50000E-01 1.00000E-01 4.40290E-05 4.20648E-05 2.59076E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE PNL YRS	9.666459
FABRICATION	1.163777	0.0	1.163777	0.096981	1.260758		
PROCESSING	0.0	-2.555556	2.555556	-0.340741	2.214815		
FUEL	9.439109	6.909616	2.529493	1.707670	4.237364		
SUM	10.602886	4.354059	6.248827	1.464110	7.712937	ENERGY (MWE-YR), SUM	1.25007E-04 1.87505E-05

CYCLE THROWAWAY COST ESTIMATE, DIRECT, TOTAL 11.30642 12.09619

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 15 0.0000 3.5259E-06 2.9113E-06 2.5001E 00 0.6364 9.6667 7.7129

SUNNED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 5.92651E-04 5.79798E-04 1.28525E-05
 SUNNED FISSILE FEED, WAKEUP, DISCHARGE, NET PRODUCTION (KGM) 4.34743E-05 1.13043E-05 3.50813E-05 -8.39298E-06
 FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.34665 0.66762 -0.28958

ORE (U-235 FED) INITIAL, FEED, DISCHARGE, NET (MGM) 3.612911E-07 2.471552E 00 7.377986E-06 2.471544E 00
 MAKE-UP PISSEIL ASSOCIATED WITH ORE AND ORE 1.130430E-05 2.426406E-06

FUEL COST ANALYSIS

COST LEVELIZED OVER 15 FUEL CYCLES AT DISCOUNT FACTOR 0.0700 , REAL YEARS 10.000 ENERGY (MWE-YR) 1.87505E-05

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	1.160052	0.0	1.160052	0.139393	1.299445	
PROCESSING	0.0	-2.550265	2.550265	-0.264566	2.285699	
FUEL	8.054849	5.665929	2.388925	1.501204	3.890128	
SUM	9.214901	3.115659	6.099242	1.376030	7.475272	

TOTAL WITH QUARTERLY ENERGY ACCOUNTING 7.34459

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

FABRICATION	1.160052	0.0	1.160052	0.109009	1.269061
PROCESSING	0.0	-2.550265	2.550265	-0.140420	2.409845
FUEL	2.827910	0.460641	2.367269	0.509680	2.876948
SUM	3.987963	-2.089623	6.077586	0.478269	6.555855

CCST ONLY DISCOUNTING WITH QUARTERLY ENERGY ACCOUNTING 6.44124, AND AT TWICE THE RATE 7.03664

THROWAWAY COST ESTIMATE, DIRECT, TOTAL 9.91698 10.71162 TOTAL ANNUAL AND QUARTERLY ONLY DISCOUNTING, 10.51004 10.32629

THE CHANGE AND TOTAL COST FOR FIFTY PERCENT INCREASE IN UNIT COSTS

FABRICATION	0.649722	8.124994
PROCESSING	1.142849	8.618111
FUEL	1.945064	9.420336

DISTRIBUTION OF THE COSTS AFTER THE INCREASE BY FIFTY PERCENT

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR ELECTRIC
FABRICATION	1.740078	0.0	1.740078	0.209089	1.949167	
PROCESSING	0.0	-3.825397	3.825397	-0.396850	3.428548	
FUEL	12.082273	8.498886	3.583386	2.251800	5.835192	
SUM	13.822351	4.673489	9.148862	2.064045	11.212907	

ADDITIONAL CONTINUOUS FUELING CHARGES - FABRICATION DIRECT, INDIRECT, FUEL INDIRECT, TOTAL
 HISTORY 0.07697 0.03910 0.09043 0.20550

ADJUSTED INITIAL CONCENTRATIONS (SEARCH SIGNATURE) 1.00000 1.23577
 0.0 0.0 0.0 0.0 9.505E-05 0.0 1.545E-05 6.179E-06 1.089E-06 1.236E-06
 0.0 0.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100
 0.0 0.0 0.0 0.0 0.0 9.324E-05 3.109E-08 1.368E-05 6.09E-06 3.377E-06 1.281E-06
 2.012E-07 4.000E-02

REFERENCE CONDITIONS FOR THE REFERENCE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 18
 PUSILE LOADING (RCN) 7.0565E-03 PUSILE FEED 7.3701E-06 MAX POWER DENSITY 6.2505E 0.0

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HR-YR
U-238	9.4139E-05	1.7221E-02	0.204181	0.206808	0.001323	0.003592	0.017277	-2.1783E 03	0.0	151.36713
U-235	3.3409E-08	1.3265E-05	0.000326	0.000323	0.000003	0.000008	0.024773	-9.6547E 03	0.20655	106.10056
PL-239	1.4447E-05	5.7559E-03	0.406384	0.157645	0.248714	0.715650	1.7617E 04	-1.8117E 04	0.0	1.56413
PL-240	6.1523E-06	2.4530E-03	0.168346	0.167498	0.000448	0.002573	0.015282	-3.0712E 04	0.0	189.62094
PL-241	3.2486E-06	1.3006E-03	0.124514	0.029554	0.034962	0.278526	2.236902	4.3272E 04	0.00989	1.25417
PL-242	1.2569E-06	5.0525E-04	0.024254	0.024154	0.000100	0.000306	0.012625	-1.9121E 04	0.0	232.10658
AM-243	1.0165E-07	4.1117E-05	0.001034	0.001032	0.000006	0.000020	0.019086	-1.0704E 04	0.0	165.90154
FIXED	4.0000E-02	7.9708E-01	0.004280	0.004280	0.0	0.0	0.0	-1.1876E-01	0.0	0.0
I-135	4.2249E-10	9.4711E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02198	0.0
XE-135	2.9143E-10	6.5332E-08	0.011857	0.011857	0.0	0.0	0.0	-4.7046E 07	0.01104	0.0
PM-147	2.8715E-08	7.0094E-06	0.001282	0.001282	0.0	0.0	0.0	-4.3813E 04	0.00043	0.0
PM-148	1.7880E-10	4.3944E-08	0.000175	0.000175	0.0	0.0	0.0	-9.8309E 05	0.00048	0.0
PM-149	4.2818E-10	1.0523E-07	0.000430	0.000430	0.0	0.0	0.0	-1.0711E 06	0.00015	0.0
PM-149	7.7291E-10	1.9124E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00409	0.0
SM-149	3.8758E-09	9.5897E-07	0.005088	0.005088	0.0	0.0	0.0	-1.5152E 06	0.0	0.0
MD-143	7.3286E-08	1.7403E-05	0.000461	0.000461	0.0	0.0	0.0	-7.0563E 03	0.0	0.0
FP1	1.8254E-06	3.5466E-04	0.002935	0.002935	0.0	0.0	0.0	-1.6424E 04	0.0	0.0
FP2	5.8045E-06	1.1277E-03	0.000979	0.000979	0.0	0.0	0.0	-1.7123E 02	0.0	0.0
CYBER										
SUM		8.4588E-01	1.000449		0.345956	1.000673	1.872629	PISSILE		1.86423

PLUX, LOSSES, SIGA2, PLUX RATIO (2). SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 2.1042E 13 5.5157E 11 1.4545E-02 9.09085 9.09085 -0.04699 0.99994 -0.11832 0.68661 0.70443

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEEDING, DISCHARGE, MWT-D/KGM
 2.50021E 00 1.00000E 00 5.00000E-01 1.50000E-01 1.00000E-01 4.81438E-05 4.62101E-05 2.36940E 01

	CCST	RETURN	DIRECT	INDIRECT	TOTAL	WILL/KW-HR EL, CYCLES PERAL YRS	0.33333
FABRICATION	1.272505	0.0	1.272505	0.106041	1.378546		
PROCESSING	0.0	-2.807315	2.807315	-0.374109	2.433206		
Prep	20.288559	18.425613	1.862946	4.147451	6.010397		
SUM	21.561050	15.618299	5.942765	3.879184	9.821949	ENERGY (MWT-YR), SUM 1.25010E-06	1.25010E-06

CYCLF, IT, K, PISS FEED, EXIT, POWER, CH, YRS, COST 1 14 1.0000 7.3701E-06 6.7950E-06 2.5002E 00 0.6866 0.3333 0.8219

RECYCLE HAS NOT STARTED, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 2 0.750

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.23577 1.52309)
 0.0
 0.0 0.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100
 0.0
 1.771E-07 0.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 29
 FISSION LOADING (KGM) 5.7080E-03 FISSION PERIOD 6.0151E-06 MAX POWER DENSITY 6.2508E 00

WTCIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HWE-YR
W-238	8.6319E-05	3.4129E-02	7.2029E6	0.2016E3	0.0312E4	0.0038E7	0.0171E0	-2.3164E 03	0.0	152.04506
W-239	3.2571E-08	1.2932E-05	0.0003E3	0.0003E0	0.0003E0	0.0000E0	0.0242E3	-1.0424E 04	0.20139	108.20003
W-239	1.1643E-05	4.6229E-03	0.4033E9	0.1558E6	0.2475E2	0.7120E1	1.7652E5	2.3064E 04	0.0	1.56001
W-240	2.5911E-06	1.9900E-03	0.1736E4	0.1223E7	0.0073E7	0.0022E3	0.0128E3	-3.8374E 04	0.0	225.31584
W-241	2.7102E-06	1.0851E-03	0.1270E3	0.0306E6	0.0963E5	0.2827E5	2.4257E5	5.3018E 04	0.00826	1.26038
W-242	1.0463E-06	4.2064E-04	0.0215E1	0.0218E3	0.0008E0	0.0003E0	0.0125E1	-2.0360E 04	0.0	233.47006
W-243	8.9102E-08	3.5969E-05	0.0710E8	0.0010E3	0.0000E6	0.0000E0	0.0173E2	-1.2428E 04	0.0	182.69254
FIXED	4.0000E-02	7.9708E-01	0.0052E6	0.0052E6	0.0	0.0	0.0	-1.4365E-01	0.0	0.0
1-135	4.2243E-10	9.4698E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02198	0.0
1E-135	2.5270E-10	5.6651E-08	0.0132E4	0.0133E4	0.0	0.0	0.0	-5.9488E 07	0.00958	0.0
W-187	2.8600E-08	6.9814E-06	0.0013E5	0.0013E5	0.0	0.0	0.0	-4.7370E 04	0.00043	0.0
W-189	1.8894E-10	4.6435E-08	0.0001E7	0.0001E7	0.0	0.0	0.0	-1.0442E 06	0.00051	0.0
W-189	4.1171E-10	1.0118E-07	0.0004E0	0.0004E0	0.0	0.0	0.0	-1.2360E 06	0.00035	0.0
W-189	7.9583E-10	1.9443E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00517	0.0
W-189	3.0483E-09	7.5427E-07	0.0051E4	0.0051E4	0.0	0.0	0.0	-1.9124E 04	0.0	0.0
W-189	7.3278E-08	1.7401E-05	0.0005E3	0.0005E3	0.0	0.0	0.0	-8.6434E 03	0.0	0.0
W-189	1.8368E-06	3.5566E-04	0.0032E4	0.0032E4	0.0	0.0	0.0	-1.7928E 03	0.0	0.0
W-189	5.8231E-06	1.1314E-03	0.0010E3	0.0010E3	0.0	0.0	0.0	-1.8542E 02	0.0	0.0
OTHER			0.0400E0							
SUM		8.4089E-01	1.0005E6		0.3460E4	1.0007E0	1.8755E6	FISSION		1.46649

PLUX, LOSSES, SIGA2, FLUX RATIO (2), SUN IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
 2.7195E 13 5.5149E 11 1.1908E-02 7.44249 7.44249 -0.03466 0.99998 -0.14309 0.69081 0.70567

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGM), DISCHARGE, WWT-D/KGM
 2.5002E 00 1.0000E 00 5.0000E-01 7.5000E-01 1.0000E-01 4.3124E-05 4.1271E-05 2.6451E 01

	CCGT	NETWR	DIRECT	INDIRECT	TOTAL	WWT-KW-HR PL	MIDCYCLE REAL YRS	1.000000
FABRICATION	1.1398E4	0.0	1.1398E4	0.0949E6	1.2383E0			
PROCESSING	0.0	-2.5072E3	2.5072E3	-0.3443E6	2.1729E7			
FUEL	16.5692E5	18.7846E5	1.7846E6	3.3529E1	5.1366E2			
SUM	17.7091E6	12.2773E2	5.4317E7	3.1127E1	8.5444E6	ENERGY (HWE-YR), SUN	1.2501E-06	2.5002E-06

CYCLE. IT. K. FISSION PERIOD. EXIT. POWER, CR. YRS, COST 2 29 1.0000 6.0191E-06 5.4523E-06 2.5002E 00 0.6908 1.0000 8.5445

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 5 2.250

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 0.31862 0.25514)
 0.0 0.0 0.0 0.0 0.0 0.0 8.5P3E-05 0.0 1.243E-05 5.959E-06 3.647E-06 1.389E-06
 3.900E-07 4.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
 0.0 0.0 0.0 0.0 0.0 0.0 8.418E-05 3.100E-08 1.091E-05 5.623E-06 3.736E-06 1.468E-06
 5.910E-07 4.000E-02 4.065E-10 2.604E-10 5.001E-08 3.222E-10 7.342E-10 8.371E-10 3.662E-09 1.443E-07 3.580E-06 1.144E-05

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 16
 MISSILE LOADING (MGM) 6.0917E-01 MISSILE FEED 6.1936E-06 MAX POWER DENSITY 6.2495E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/MWP-YR
P-238	9.5024E-05	3.3617E-02	0.194944	0.193699	0.001236	0.003357	0.017219	-2.2579E 03	0.0	151.69653
NP-239	3.1305E-08	1.2430E-05	0.000319	0.000316	0.000007	0.000008	0.024538	-1.0072E 04	0.19184	107.12009
PN-239	1.1605E-05	4.6075E-03	0.364445	0.141063	0.223361	0.642622	1.761290	2.0892E 04	0.0	1.56193
PN-240	5.7534E-06	2.3122E-03	0.180132	0.179300	0.000832	0.002522	0.013998	-3.4200E 04	0.0	206.94762
PN-241	3.7071E-06	1.4842E-03	0.157741	0.03742	0.120002	0.351960	2.231252	4.8447E 04	0.01129	1.25732
PN-242	1.4293E-06	5.7462E-04	0.028614	0.028496	0.000118	0.003360	0.012590	-1.9824E 04	0.0	232.75069
AN-243	4.9119E-07	1.9874E-04	0.005403	0.005373	0.000030	0.000099	0.018285	-1.1463E 04	0.0	173.17064
FISSD	4.0000E-02	7.0708E-01	0.004768	0.004768	0.0	0.0	0.0	-1.1032E-01	0.0	0.0
I-135	4.2165E-10	9.4526E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02193	0.0
TE-135	2.7018E-10	0.0569E-08	0.012611	0.012611	0.0	0.0	0.0	-5.2701E 07	0.01023	0.0
PN-137	2.9760E-08	7.0205E-06	0.001299	0.001299	0.0	0.0	0.0	-4.5690E 04	0.00043	0.0
PN-189	1.8526E-10	4.5529E-08	0.000188	0.000188	0.0	0.0	0.0	-1.0192E 06	0.00050	0.0
PN-144	4.2224E-10	1.0377E-07	0.000459	0.000459	0.0	0.0	0.0	-1.1505E 06	0.00015	0.0
PN-149	7.7679E-10	1.9220E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00511	0.0
PN-149	3.3903E-09	8.4099E-07	0.005112	0.005112	0.0	0.0	0.0	-1.6959E 06	0.0	0.0
ND-143	7.4746E-08	1.7678E-05	0.000526	0.000526	0.0	0.0	0.0	-7.7891E 03	0.0	0.0
FP1	1.2292E-06	3.5539E-04	0.003089	0.003089	0.0	0.0	0.0	-1.7214E 03	0.0	0.0
FP2	5.8177E-06	1.1303E-03	0.001026	0.001026	0.0	0.0	0.0	-1.7885E 02	0.0	0.0
OTHER			0.040000							
SUM		5.4140E-01	1.000675		0.345581	1.000926	1.908652	MISSILE		1.44555

PLUX, LOSSES, SIGAD, FLUX RATIO (2), SUM IMPORTANCE*FN, MULTIPLICATION, RECIPROCAL DOPPLING TIME (1/R-1), CONVERSION RATIO (2)
 2.4119E 13 5.5186E 11 1.3134E-02 8.20895 1.20895 -0.03452 1.00001 -0.11181 0.69271 0.71369

FUEL CYCLE ECONOMICS --- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED (MGM), DISCHARGE, MWT-D/MGM
 2.49942E 00 1.00000E 00 5.00000E-01 7.50000E-01 1.00000E-01 4.31504E-05 4.1740E-05 2.61290E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/MW-HR PL, MIDCYCLE REAL YRS
REPRODUCTION	2.071445	0.0	2.071445	0.172619	2.244064	
PROCESSING	0.0	-2.537605	0.537605	-0.338147	2.199258	
FUEL	17.603149	15.834211	1.764933	3.578146	5.147079	

SUM 19.674591 13.296611 6.377904 3.412417 9.790001, ENERGY (MWT-YR), SUM 1.24991E-06 7.26010E-06

CYCLE THROWAWAY COST ESTIMATE, DIRECT, TOTAL 20.37317 21.91957

COST LEVELIZED OVER 5 FUEL CYCLES AT DISCOUNT FACTOR 0.0700, REAL YEARS 3.333

FABRICATION	1.724384	0.0	1.724384	0.182532	1.906917
PROCESSING	0.0	-2.584574	2.584574	-0.263026	2.121548
FUEL	17.905252	16.014023	1.791229	3.817510	5.608739

SUM 19.529633 13.429449 6.100187 3.737016 9.837201, ENERGY (MWE-YR), SUM 6.25013E-06

COST BY DISCOUNTING ONLY AT REFERENCE RATE 0.07000

FABRICATION	1.724384	0.0	1.724384	0.137944	1.862329
PROCESSING	0.0	-2.584574	2.584574	-0.136935	2.447639
FUEL	7.876317	6.234124	1.642193	2.014062	3.656195

SUM 9.600701 3.649550 5.951151 2.015011 7.966162, ENERGY (MWE-YR), SUM 6.25013E-06

COST ESTIMATE WITH DISCOUNTING ONLY AT TWICE THE RATE 9.97053

THROWAWAY COST ESTIMATE, DIRECT, TOTAL, AND WITH ONLY DISCOUNTING 20.24115 22.55142 22.07378

CYCLE, IT, K, PISS FEED, EXIT, POWER, CP, YRS, COST 5 16 1.0000 6.3936E-06 5.8384E-06 2.4998E 00 0.6927 3.0000 9.7304

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 1.74635E-04 1.71184E-04 3.45868E-06
 SUMMED PISSILE FEED, MAKEUP, DISCHARGE, NET PRODUCTION (KGM) 3.23382E-05 0.0 2.95264E-05 -2.81184E-06
 PISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.45781 0.69137 -0.13043

AFTER SHUTDOWN DENSITIES (TIME, YR 0.83333) 0.0 0.0 0.0 0.0 0.0 0.0 0.0 8.418E-04
 3.733E-47 1.094E-05 5.623E-06 3.575E-06 1.468E-06 9.910E-07 4.000E-02 0.0 0.0 0.0 0.0
 3.109E-51 4.459E-09 1.443E-07 3.580E-06 1.144E-05

CASE END NORMAL, PLUTONIUM, URANIUM SYSTEM WITH DELAYED RECYCLE, PROCESSOR (SEC) 7.07

PLUTONIUM, URANIUM SYSTEM WITH DELAYED RECYCLE
 THE CROSS SECTION CORRELATION IS APPLIED

CONTROL OPTIONS	2	2	5	1	5	0	0	0	0	0	1	0	-1	0	10	1	0	0	0	0	0	0	0	0
DATA	1.000E 00	0.0	0.0	0.0	0.0	5.000E-01	1.600E-03	5.000E 00	2.000E 12	4.000E-01	2.500E 00	4.000E-02	1.000E 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAKE-UP CONCENTRATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INITIAL CONCENTRATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.5447E-05	6.1789E-06	3.0895E-06	1.2358E-06	0.0	4.0000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.00000 1.00004)
 0.0 0.0 0.0 0.0 0.0 0.0 9.505E-05 0.0 1.545E-05 6.179E-06 3.090E-06 1.236E-06
 0.0 4.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100
 0.0 0.0 0.0 0.0 0.0 0.0 9.324E-05 3.309E-04 1.368E-05 6.091E-06 3.377E-06 1.282E-06
 2.012E-07 4.000E-02

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)									
FISSILE LOADING (KG)									
0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 6									
7.3705E-06 MAX POWER DENSITY 6.2501E 00									
NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IKRSTANCE	DECAY
U-238	9.4138E-05	3.7221E-02	0.2081M	0.206511	0.001323	0.003592	0.017257	-2.1783E 03	0.0
U-235	3.3408E-08	1.3265E-05	0.000326	0.000323	0.000003	0.000008	0.024773	-9.4546E 03	0.20656
PU-239	1.4450E-05	5.7562E-03	0.406402	0.157652	0.248725	0.715682	1.761018	1.8116E 04	0.0
PU-240	6.1526E-06	2.4531E-03	0.168352	0.167504	0.000848	0.003573	0.015282	-3.0711E 04	0.0
PU-241	3.2487E-06	1.3007E-03	0.124518	0.029555	0.094945	0.278534	2.236905	4.3270E 04	0.00990
PU-242	1.2548E-06	5.0527E-04	0.024256	0.024156	0.000100	0.000306	0.012625	-1.9121E 04	0.0
AM-243	1.0186E-07	4.1110E-05	0.001038	0.001032	0.000006	0.000020	0.019057	-1.0705E 04	0.0
FIXED	0.0000E-02	7.9709E-01	0.004280	0.004280	0.0	0.0	0.0	-1.1876E-01	0.0
I-135	4.2246E-10	9.4705E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02198
XE-135	2.9143E-10	6.5333E-08	0.011857	0.011857	0.0	0.0	0.0	-4.7043E 07	0.0
PH-147	2.8713E-08	7.0090E-06	0.001242	0.001242	0.0	0.0	0.0	-4.3812E 04	0.00043
PH-148	1.7879E-10	4.3340E-08	0.000175	0.000175	0.0	0.0	0.0	-9.8307E 05	0.0
PE-149	4.2816E-10	1.0723E-07	0.000430	0.000430	0.0	0.0	0.0	-1.0711E 06	0.00015
PH-149	7.7286E-10	1.7123E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00509
SM-149	3.8760E-09	9.5503E-07	0.005088	0.005088	0.0	0.0	0.0	-1.5151E 06	0.0
XD-143	7.3282E-08	1.7402E-05	0.000461	0.000461	0.0	0.0	0.0	-7.0560E 03	0.0
PP1	1.8253E-06	3.5644E-04	0.002935	0.002935	0.0	0.0	0.0	-1.6423E 03	0.0
PP2	5.8041E-06	1.1277E-3	0.000979	0.000979	0.0	0.0	0.0	-1.7122E 02	0.0
OTHER									
SUM		8.4508E-01	1.000482	0.000000	0.345970	1.000713	1.872628	FISSILE	1.46823
FUEL, LOSSES, SIG2, FLUX RATIO (2), SUM IMPORTANCE, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)									
2.1040E 13 5.5154E 11 1.4546E-02 9.09122 9.09122 -0.04698 0.99999 -0.11831 0.68662 0.70442									
FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, PERD(KGH), DISCHARGE, MWT-D/KGH									
2.50306E 00 1.0000E 00 5.0000E-01 7.5000E-01 1.0000E-01 4.8143E-05 4.6210E-05 2.3692E 01									
MILL/KW-HR ELV, MIDCYCLE REAL YRS 0.313333									
FABRICATION	1.272581	0.0	1.272581	0.106048	1.378629				
PROCESSING	0.0	-2.807484	2.807484	-0.374331	2.433152				
FUEL	20.290604	18.827551	1.863052	4.147877	6.010929				
SUM	21.563171	15.620064	5.943117	3.879593	9.822710	ENERGY (MWE-YR), SUM	1.25003E-06	1.25003E-06	
CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 1 6 1.0000 7.3705E-06 6.7954E-04 2.5001E 00 0.4866 0.3333 9.8227									
RECYCLE HAS NOT STARTED, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 2 0.750									
ADJUSTED INITIAL CONCENTRATIONS (SEARCH EIGENVALUE 1.00004 1.52313)									
0.0	0.0	0.0	0.0	0.0	0.0	8.721E-05	0.0	1.262E-05	5.046E-06
0.0	4.000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DISCHARGE ACTINIDE CONCENTRATIONS, STEPS 100									
0.0	0.0	0.0	0.0	0.0	0.0	8.544E-05	3.224E-08	1.083E-05	4.897E-06
1.771E-07	4.000E-02	0.0	0.0	0.0	0.0	9.544E-05	3.224E-08	1.083E-05	4.897E-06

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS)
MISSILE LOADING (KGN) 5.7081E-03 MISSILE FEED

0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 34
6.0192E-06 MAX POWER DENSITY 6.2503E 00

NUCLIDE	DENSITY	GRAMS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	KTA	IMPORTANCE	DECAY	KGN/HWE-YR
U-235	8.6319E-05	3.4129E-02	3.202962	0.201668	0.001284	0.003487	0.017180	-2.3164E 03	0.0	152.04504
U-238	3.2570E-04	1.2932E-05	0.000343	0.000340	0.000003	0.000008	0.024293	-1.0424E 04	0.20139	108.19983
PU-239	1.1644E-05	4.6230E-03	0.403384	0.155832	0.247531	0.712088	1.765285	2.3061E 04	0.0	1.56001
PU-240	4.9911E-06	1.9900E-03	0.173699	0.172763	0.000737	0.002233	0.012853	-3.8373E 04	0.0	125.31245
PU-241	2.7102E-06	1.0851E-03	0.127022	0.030626	0.096397	0.282723	2.225785	5.0017E 04	0.00826	1.26038
PU-242	1.0463E-06	4.2064E-04	0.021507	0.021414	0.000088	0.000270	0.012551	-2.0360E 04	0.0	233.46996
AM-243	8.9101E-08	3.5969E-05	0.001054	0.001053	0.000006	0.000014	0.017772	-1.2428E 04	0.0	182.69090
FIXED	4.0000E-02	7.9708E-01	0.005246	0.005246	0.0	0.0	0.0	-1.4365E-01	0.0	0.0
I-135	4.2241E-10	9.4695E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02198	0.0
IE-135	2.5270E-10	5.6651E-08	0.013324	0.013324	0.0	0.0	0.0	-5.9447E 07	0.00959	0.0
PR-147	2.8599E-08	6.9812E-06	0.001335	0.001335	0.0	0.0	0.0	-4.7269E 04	0.00043	0.0
PR-148	1.8893E-10	4.6433E-08	0.000197	0.000197	0.0	0.0	0.0	-1.0462E 06	0.00051	0.0
PR-149	4.1170E-10	1.0118E-07	0.000480	0.000480	0.0	0.0	0.0	-1.2360E 06	0.00015	0.0
PR-149	7.8579E-10	1.9443E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00317	0.0
SM-149	3.0485E-09	7.5429E-07	0.005174	0.005174	0.0	0.0	0.0	-1.9124E 06	0.0	0.0
MD-143	7.3275E-08	1.7400E-05	0.000573	0.000573	0.0	0.0	0.0	-8.6432E 03	0.0	0.0
PP1	1.8305E-04	3.3565E-04	0.003214	0.003214	0.0	0.0	0.0	-1.7927E 03	0.0	0.0
PP2	5.8229E-06	1.1313E-03	0.001063	0.001063	0.0	0.0	0.0	-1.8542E 02	0.0	0.0
CTHER			3.040000							
SUM		8.4089E-01	1.000578		0.346046	1.000826	1.875566	FISSILE		1.46649

FLUX, LOSSES, SIGA2, FLUX RATIO (2), SUM IMPORTANCE*N, MULTIPLICATION, RECIPROCAL DOUBLING TIME (YR-1), CONVERSION RATIO (2)
2.7199E 13 5.5147E 11 1.1908E-02 7.44261 7.44261 -0.03263 0.99998 -0.14309 0.65081 0.70566

FUEL CYCLE ECONOMICS ---- POWER, VOLUME, TIME, LOAD FACTOR, INTEREST, FEED(KGN), DISCHARGE, HWT-D/KGN
2.50012E 00 1.00000E 00 5.00000E-01 7.50000E-01 1.00000E-01 4.31249E-05 4.12718E-05 2.64506E 01

	COST	RETURN	DIRECT	INDIRECT	TOTAL	MILL/KW-HR EL, MIDCYCLE REAL YRS	1.000000
FABRICATION	1.139889	0.0	1.139889	0.094990	1.234879		
PROCESSING	0.0	-2.507393	2.507393	-0.334319	2.173074		
FUEL	16.570175	14.785493	1.784682	3.352226	5.136909		
SUM	17.710052	12.278100	5.431964	3.112897	8.544861	ENERGY (HWE-YR), LJM	1.25006E-06 2.50009E-06

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 2 34 1.0000 6.0192E-06 5.124E-06 2.5001E 00 0.6908 1.0000 8.5449

CONTINUING WITH RECYCLE, CYCLE COUNT, MIDCYCLE TIME (FULL POWER YEARS) 5 2.250

ADJUSTED INITIAL CONCENTRATIONS (SEARCH RIGENVALUE 0.31779 0.25504)
0.0 0.0 0.0 0.0 0.0 0.0 8.988E-05 0.0 1.243E-05 5.959E-06 3.647E-06 1.389E-06
3.900E-07 4.000E-02 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DISCHARGE CONCENTRATIONS
0.0 0.0 0.0 0.0 0.0 0.0 8.418E-05 3.100E-08 1.091E-03 5.623E-06 3.734E-06 1.468E-06
5.910E-07 4.000E-02 4.065E-10 2.604E-10 5.001E-08 3.222E-10 7.342E-10 8.371E-10 3.662E-09 1.443E-07 3.580E-06 1.144E-05

REFERENCE CONDITIONS FOR THE EXPOSURE PERIOD (YRS) 0.500 NORMALLY ELECTRICAL POWER BASIS, ITERATIONS 20
PISSILE LOADING (KGH) - 6.0915E-03 PISSILE PHED 6.3934E-06 MAX POWER DENSITY 6.2495E 00

NUCLIDE	DENSITY	GRASS	ABSORPTION	CAPTURE	FISSION	PRODUCTION	ETA	IMPORTANCE	DECAY	KGM/HRT-TN
U-238	8.5035E-05	3.3617E-02	0.194966	0.193701	0.001236	0.003357	0.017219	-2.2579E 03	0.0	151.69667
U-235	1.1305E-08	1.2430E-05	0.000319	0.000316	0.000003	0.000007	0.024538	-1.0072E 04	0.0	107.12024
U-233	1.1305E-05	4.6074E-03	0.364441	0.141062	0.223359	0.442616	1.763290	2.0893E 04	0.0	1.56193
U-240	5.7992E-06	3.3122E-03	0.180132	0.179300	0.000832	0.002521	0.013998	-3.4201E 04	0.0	206.95181
U-241	3.7070E-06	1.6842E-04	0.157741	0.037742	0.120002	0.351960	2.231251	4.8448E 04	0.0	1.25732
U-242	1.4293E-06	5.7461E-04	0.028613	0.028495	0.000118	0.000360	0.013590	-1.9824E 04	0.0	232.75078
AM-243	4.9118E-07	1.9828E-04	0.005403	0.005373	0.000030	0.000099	0.018289	-1.1469E 04	0.0	173.17249
PM20	4.0000E-02	7.9708E-01	0.004768	0.004768	0.0	0.0	0.0	-1.3032E-01	0.0	0.0
1-135	4.2152E-10	9.4525E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.02193	0.0
KE-135	2.7018E-10	6.0568E-08	0.012611	0.012611	0.0	0.0	0.0	5.2703E 07	0.01023	0.0
PM-147	2.8760E-08	7.0205E-06	0.001299	0.001299	0.0	0.0	0.0	-4.5690E 04	0.00043	0.0
PM-148	1.8524E-10	4.5330E-08	0.000188	0.000188	0.0	0.0	0.0	-1.0192E 06	0.00050	0.0
PM-149	4.2234E-10	1.0377E-07	0.000459	0.000459	0.0	0.0	0.0	-1.1506E 06	0.00015	0.0
PM-149	7.7679E-10	1.9220E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.00511	0.0
SH-149	3.3985E-09	8.4096E-07	0.005112	0.005112	0.0	0.0	0.0	-1.6959E 06	0.0	0.0
MD-143	7.4446E-06	1.7678E-05	0.000526	0.000526	0.0	0.0	0.0	-7.7883E 03	0.0	0.0
P21	1.8232E-06	3.5539E-04	0.003089	0.003089	0.0	0.0	0.0	-1.7214E 03	0.0	0.0
P22	5.8176E-06	1.1303E-03	0.001026	0.001026	0.0	0.0	0.0	-1.7885E 02	0.0	0.0
CTERN			0.040000							
SUM		9.4140E-01	1.000673		0.345579	1.000920	1.904652	7.2522E		1.44555

PLUX, LOSSES,	SIGA2,	FLOX	RATIO	(2),	SUN	IMPORTANCESN,	MULTIPLICATION,	RECIPROCAL	DOUBLING	TIME	(VR-1),	CONVERSION	RATIO	(2)
2.4119E-13	5.5187E-11	1.3136E-02	8.20875	-0.03832	1.00001	-0.11191	0.69275							

PUBL CYCLE ECONOMICS

[illegible]

	CYCLE THROWAWAY COST ESTIMATE, DIRECT, TOTAL	20.37268	21.91902
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

	5 PERCENT LEVELIZED OVER COST CYCLES AT DISCOUNT FACTOR	0.0700 , REAL YEARS	3.333
1	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000
16	1.0000	1.0000	1.0000
17	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000
19	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000
21	1.0000	1.0000	1.0000
22	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000
24	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000
26	1.0000	1.0000	1.0000
27	1.0000	1.0000	1.0000
28	1.0000	1.0000	1.0000
29	1.0000	1.0000	1.0000
30	1.0000	1.0000	1.0000
31	1.0000	1.0000	1.0000
32	1.0000	1.0000	1.0000
33	1.0000	1.0000	1.0000
34	1.0000	1.0000	1.0000
35	1.0000	1.0000	1.0000
36	1.0000	1.0000	1.0000
37	1.0000	1.0000	1.0000
38	1.0000	1.0000	1.0000
39	1.0000	1.0000	1.0000
40	1.0000	1.0000	1.0000
41	1.0000	1.0000	1.0000
42	1.0000	1.0000	1.0000
43	1.0000	1.0000	1.0000
44	1.0000	1.0000	1.0000
45	1.0000	1.0000	1.0000
46	1.0000	1.0000	1.0000
47	1.0000	1.0000	1.0000
48	1.0000	1.0000	1.0000
49	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000
51	1.0000	1.0000	1.0000
52	1.0000	1.0000	1.0000
53	1.0000	1.0000	1.0000
54	1.0000	1.0000	1.0000
55	1.0000	1.0000	1.0000
56	1.0000	1.0000	1.0000
57	1.0000	1.0000	1.0000
58	1.0000	1.0000	1.0000
59	1.0000	1.0000	1.0000
60	1.0000	1.0000	1.0000
61	1.0000	1.0000	1.0000
62	1.0000	1.0000	1.0000
63	1.0000	1.0000	1.0000
64	1.0000	1.0000	1.0000
65	1.0000	1.0000	1.0000
66	1.0000	1.0000	1.0000
67	1.0000	1.0000	1.0000
68	1.0000	1.0000	1.0000
69	1.0000	1.0000	1.0000
70	1.0000	1.0000	1.0000
71	1.0000	1.0000	1.0000
72	1.0000	1.0000	1.0000
73	1.0000	1.0000	1.0000
74	1.0000	1.0000	1.0000
75	1.0000	1.0000	1.0000
76	1.0000	1.0000	1.0000
77	1.0000	1.0000	1.0000
78	1.0000	1.0000	1.0000
79	1.0000	1.0000	1.0000

SON	19-528285	13-428786	6-100101	3-736908	9-837009	ENERGY (MWE-YR)	SON 6-250088-06

CCST BY DISCOUNTING ONLY AT REFERENCE RATE	0.0700
PAPRICATION	1.724393
PROCESSING	0.0
	-2.584596
	2.584596
	-0.136931
	2.447864
	1.862329
	0.137946

FOEL 7.875551 6.233028 1.642523 2.013950 3.656473

SUM 9.599935 3.648433 5.951502 2.014965 7.966467, ENERGY (MWE-YR), SUM 6.25004E-06

CCSI ESTIMATE WITH DISCOUNTING ONLY AT TWICE THE RATE 9.97079

THROWAWAY COST ESTIMATE, DIRECT, TOTAL, AND WITH ONLY DISCOUNTING 20.24040 22.55070 22.07307

CYCLE, IT, K, FISS FEED, EXIT, POWER, CR, YRS, COST 5 20 1.0000 6.3934E-06 5.8382E-06 2.4998E 00 0.4927 3.0000 9.7902

SUMMED FERTILE FEED, DISCHARGE, NET USAGE (KGM) 1.74637E-04 1.71187E-04 3.45077E-04

SUMMED FISSILE FEED, BACKUP, DISCHARGE, NET PRODUCTION (KGM) 3.23366E-05 0.0 2.95249E-05 -2.81166E-06

FISSILE (KGM/MWE-YR), CONVERSION, AND RECIPROCAL DOUBLING TIME (YRS-1) 1.45781 0.69139 -0.13043

AFTER SHUTDOWN DENSITIES (TIME, YR 0.83333) 0.0 0.0 0.0 0.0 0.0 0.0 0.0 8.418E-05

3.733E-47 1.094E-05 5.623E-06 3.575E-06 1.468E-06 5.910E-07 4.000E-02 0.0 0.0 0.0 0.0

3.109E-51 4.499E-09 1.243E-07 3.580E-06 1.144E-05

CASE END NORMAL, PLUTONIUM, URANIUM SYSTEM WITH DELAYED RECYCLE, PROCESSOR (SEC) 7.11

INCO02I STOP 0