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FAST FLUX
TEST FACILITY
PROJECT REPORT

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2DB USER'S MANUAL

W. W. Little, Jr.

R. W. Hardie

July 1968

AEC RESEARCH &
DEVELOPMENT REPORT

BNWL-831

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BATTELLE MEMORIAL INSTITUTE

for the

UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

PRINTED BY/FOR THE U.S. ATOMIC ENERGY COMMISSION

54-1920-018 (11-67)

SEC-45 RICHLAND, WASH.

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BNWL-831

2DB USER'S MANUAL

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ABSTRACT

2DB is a two-dimensional (X-Y, R-Z, R- θ), multigroup diffusion code for use in fast reactor criticality and burnup analysis. The code can be used to:

- Compute k_{eff} and perform criticality searches on buckling, time absorption (α), reactor composition, and reactor dimensions by means of either a flux or an adjoint model
- Compute material burnup.

All programming is in FORTRAN-IV. Since variable dimensioning is employed, no simple restrictions on problem complexity can be stated. However, in a 65K memory, the current version is nominally restricted to 50 energy groups. Running time (for a k_{eff} calculation) on a UNIVAC 1108 is about 1 minute for a 30 x 30 mesh problem using 4 energy groups.

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2DB USER'S MANUAL

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I. INTRODUCTION

A number of significant additions and alterations have been made in the 2DB diffusion-burnup code since it was first published.^(1,2) This report gives a complete description of the code including all modifications. A description of the mathematical model is given in the body of the report; a sample problem, input instructions, and a FORTRAN-IV source deck listing are included in the appendices.

2DB is designed explicitly for use in fast reactor analysis. Eigenvalues are computed by standard source-iteration techniques. Group rebalancing and successive over-relaxation with line inversion are used to accelerate convergence. Adjoint solutions are obtained by inverting the input data and redefining the source terms.

Variable dimensioning is used to make maximum use of the available fast memory. Since only one energy group is in the fast memory at any given time, the storage requirements are insensitive to the number of energy groups.

Criticality searches can be performed on buckling, time absorption, material concentrations, and region dimensions. Alpha and k_{eff} can be used as parametric eigenvalues. Criticality searches can be performed during burnup to compensate for fuel depletion.

The format of the input data (e.g., cross sections, flux dumps, geometry and composition specifications) is compatible with the Los Alamos one and two-dimensional transport codes DTF-IV⁽³⁾ and 2DF,⁽⁴⁾ and the Battelle-Northwest perturbation code PERT-IV.⁽⁵⁾ All four codes use the same input module. The logical flow of 2DB is patterned after the 2DF code. In fact, many subroutines of these two codes are almost identical.

II. FORMULATION OF DIFFERENCE EQUATIONS

Neutron Balance Equations

The multigroup diffusion equations can be written in the form

$$D_g \nabla^2 \phi_g - \Sigma_g^r \phi_g + S_g = 0, \quad g = 1, \dots, N \quad (2.1)$$

where

$$S_g = \frac{\chi_g}{k_{\text{eff}}} \sum_{g'=1}^N (\nu \Sigma_f)_{g'} + \sum_{g'=1}^{g-1} \Sigma(g' \rightarrow g) \phi_{g'} \quad (2.2)$$

and:

N = number of energy groups,

g = energy group index,

ϕ_g = flux in group g ,

S_g = source in group g ,

D_g = diffusion constant for group g ($= 1/3 \Sigma_g^{\text{tr}}$),

$(\nu \Sigma_f)_g$ = fission source cross section for group g ,

$\Sigma(g' \rightarrow g)$ = group transfer cross section from g' to g ,

Σ_g^r = removal cross section for group g

$$[\Sigma_g^a + \sum_{g'=g+1}^N \Sigma(g \rightarrow g')],$$

χ_g = fission source fraction in group g ,

k_{eff} = effective multiplication constant.

The only major choice in setting up the difference equations is the placing of the mesh point relative to the mesh boundaries (i.e., on the mesh

boundary or in the interior of the mesh). We have chosen to place the mesh point in the center of the homogeneous mesh interval (see Figure 2.1). This choice leads to a more clean-cut calculation and interpretation of all reaction rates.

The spatial difference equations are obtained by integrating Equations (2.1) and (2.2) over the volume associated with each mesh point. For the (i,j) mesh point shown in Figure 2.1, the radial integration would be from $(R_i - \frac{\delta R_i}{2})$ to $(R_i + \frac{\delta R_i}{2})$, and the axial integration would be from $(Z_j - \frac{\delta Z_j}{2})$ to $(Z_j + \frac{\delta Z_j}{2})$.

The leakage terms are obtained by first transforming the volume integral over the Laplacian to a surface integral using Green's theorem,

$$\int D \nabla^2 \phi dV = \int D \vec{\nabla} \phi \cdot d\vec{A}. \quad (2.3)$$

The flux gradients at the mesh boundary are obtained by interpolating the two contiguous flux values. Thus, volume integration of Equation (2.1) for mesh point o (see Figure 2.1) leads to the expression

$$\sum_{k=1}^4 \left\{ \frac{\bar{D}_k A_k}{\ell_k} (\phi_k - \phi_o) \right\} - \Sigma_o^r \phi_o V_o + S_o V_o = 0, \quad (2.4)$$

where, for simplicity, the group indices have been omitted, and:

- Σ_o^r = removal cross section associated with mesh point o,
- S_o = source rate associated with mesh point o,
- V_o = volume associated with mesh point o,
- ϕ_k = flux associated with mesh point k,

ℓ_k = distance between mesh point k and mesh point o,

A_k = area of boundary between mesh point k and mesh point o,

$\bar{D}_k$ = effective diffusion constant between mesh point k and mesh point o

$$\left(= \frac{D_o D_k (\delta R_o + \delta R_k)}{D_o \delta R_k + D_k \delta R_o} \right) . \quad (2.5)$$

Finally, Equation (2.4) can be recast into a form more convenient for performing flux iterations. That is,

$$\phi_o = \frac{S_o V_o + \sum_{k=1}^4 C_k \phi_k}{C_5} , \quad (2.6)$$

where

$$C_k = \frac{\bar{D}_k A_k}{\ell_k} \quad k=1, \dots, 4 \quad (2.7)$$

and

$$C_5 = \sum_o^r V_o + \sum_{k=1}^4 C_k . \quad (2.8)$$

Fig. 2.1. Mesh Description

Discussion of Boundary Conditions

Three boundary conditions are available in 2DB: $\vec{\nabla}\phi = 0$, $\phi = 0$, and periodic. These are described below using a slight modification to the nomenclature developed in the foregoing sections.

Zero Flux Gradient

Consider the left hand boundary of the one-dimensional reactor shown in Fig. 2.2. Let us now imagine that a pseudo mesh interval, interval 0, has been added on the left hand side of the boundary with the same composition and thickness of interval 1. Clearly, then, if $\vec{\nabla}\phi = 0$ at the boundary, $\phi_0 \equiv \phi_1$. Therefore, since $(\phi_0 - \phi_1)$ vanishes, the coefficient of $\phi_0 - \phi_1$, C_1 (see Eq. (2.4)), is immaterial--hence C_1 can be set equal to zero. The calculation is performed assuming that ϕ_0 does not exist and $C_1 = 0$.

Zero Flux

Again, imagine that a pseudo mesh interval with the same composition as interval IM has been added to the right hand side of the right boundary. Now, since $\phi_{IM} \neq 0$ and $\phi_{IM+1} = 0$, the coefficient of $(\phi_{IM} - \phi_{IM+1})$ in Eq. (2.4) cannot be disregarded. In fact, from Eq. (2.7), it is clear that

$$C_K = \frac{D_K A_K}{.5 \delta R_{IM} + .71 \lambda_{tr}}$$

where λ_{tr} is assumed to equal $1/\Sigma_{tr}$.

Note, as in the $\vec{\nabla}\phi = 0$ case, that there is no contribution of the pseudo flux in Eq. (2.6). For a zero flux gradient, $C_K = 0$; whereas for a zero flux, $\phi_K = 0$.

Periodic Flux

Periodic boundary conditions are available for the top and bottom boundaries. In this option,

$$\phi_0 \equiv \phi_{IM}$$

$$\phi_1 \equiv \phi_{IM+1}$$

and

$$C_K(1 \rightarrow IM) \equiv \frac{\bar{D}_K A_K}{.5(\delta R_1 + \delta R_{IM})}$$

It should be stressed that the pseudo mesh intervals discussed above are not in any way a part of the code. They are mentioned here only for heuristic purposes.

Fig. 2.2. Schematic Diagram of 1-D Reactor

III. SOLUTION OF DIFFERENCE EQUATIONS

The eigenvalue and flux profiles are computed by standard source-iteration techniques, i.e., by using an initial fission source distribution, the flux profiles in each group are sequentially computed beginning in the top (highest energy) group. After the new fluxes in all groups have been calculated, a new fission source distribution is computed from the new flux profiles. The multiplication ratio, λ , is then obtained by simply taking the ratio of the new fission source rate to the old (previous iteration) fission source rate. The above sequence of events is called an outer iteration.

Before each new outer iteration, the fission spectrum is multiplied by $1/\lambda$, so that λ approaches unity as the iteration proceeds. The effective multiplication constant is simply the product of the successive λ 's. Convergence is assumed when $|1-\lambda| < \epsilon$, where ϵ is an input parameter.

Fission source over-relaxation is employed in 2DB to accelerate convergence. The procedure is as follows: After the new fission source rate profile, F_1^{v+1} , is calculated, a second "new" value, F_2^{v+1} , is computed by magnifying the difference between the new fission source rate and the old fission source rate. Thus,

$$F_2^{v+1} = F^v + \beta^*(F_1^{v+1} - F^v) , \quad (3.1)$$

where β^* is the fission source over-relaxation factor. F_2^{v+1} is then normalized to give the same total source as F_1^{v+1} .

The group-fluxes are computed using successive line over-relaxation (SLOR). That is, the fluxes on each vertical (or horizontal) line are simultaneously

computed (by the familiar Crout reduction technique) and then over-relaxed using the algorithm

$$\phi^{v+1} = \phi^v + \beta(\phi^{v+1} - \phi^v) , \quad (3.2)$$

where β is the over-relaxation factor. In R-0 problems or problems involving periodic boundary conditions, direct inversion is performed on vertical lines beginning at the left boundary and proceeding by column to the right boundary. In all other situations, direct inversion is used along the dimension with the most mesh points. One mesh sweep is defined as one inner iteration.

The flux over-relaxation factor, β , is an input parameter. The code automatically reduces $\beta-1$ by a factor of 1.1 when the neutron balance is within a factor of 10 of the fission source error criterion. The fission source over-relaxation factor, β' , is computed internally from the ad hoc expression

$$\beta' = 1.0 + .6(\beta-1) . \quad (3.3)$$

As in the original version of 2DB, the flux in each group is normalized (by balancing the total source and loss rate) immediately before each group-flux calculation. Thus, a one-region problem with zero-gradient boundary conditions would be solved exactly in one outer iteration.

Parenthetically, it should be mentioned that an alternating direction SLOR scheme (using line inversion for rows and then columns in alternation) has been tried, but is not included in the current version of 2DB since no gain in convergence rate was realized.

IV. SEARCH OPTIONS

The 2DB code computes implicit eigenvalue searches on time absorption, material composition, zone thickness, and material buckling. In contrast to a k_{eff} calculation, the fission spectrum is not multiplied by $1/\lambda$ after each outer iteration. Instead, after a converged λ has been obtained ($|\lambda^{v+1} - \lambda^v| < \epsilon$) by a sequence of outer iterations, the desired parameter is perturbed to make λ approach unity. That is, first a converged λ is calculated for the initial system. The system is then altered by the amount specified in the input (the eigenvalue modifier) and a second converged λ is calculated. Subsequent parameter changes are determined using either linear or parabolic interpolation procedures. The iteration is continued until $|1-\lambda| < \epsilon$.

Time Absorption (α calculation)

For simplicity, let us consider the one-group, time dependent diffusion equation

$$\frac{1}{v} \frac{\partial \phi(\vec{r}, t)}{\partial t} = D \nabla^2 \phi(\vec{r}, t) - \Sigma_a \phi(\vec{r}, t) + v \Sigma_f \phi(\vec{r}, t) . \quad (4.1)$$

If we now assume that

$$\phi(\vec{r}, t) = \phi(\vec{r}) e^{\alpha t} . \quad (4.2)$$

we can obviously rewrite Equation (4.1) in the form

$$D \nabla^2 \phi(\vec{r}) - \left(\Sigma_a + \frac{\alpha}{v} \right) \phi(\vec{r}) + v \Sigma_f \phi(\vec{r}) = 0 . \quad (4.3)$$

In a time absorption calculation, the parameter α , as defined and used in Equations (4.2) and (4.3), is computed as the eigenvalue. Note that

α/v is effectively an absorption cross section--hence the name "time absorption."

Material Concentration (C calculation)

2DB can perform an extremely flexible and comprehensive criticality search on material composition. Any number of materials can simultaneously be added, depleted, or interchanged in any number of zones.

The format for specifying concentration searches can best be described by a simple example. Let us suppose that a zone mixture, say Mix 10, is to be composed of Materials 2 and 4. Let us further assume that Material 2, with an initial density of 0.02, shall be varied to obtain criticality, and Material 4 shall have a fixed density of 0.04 (atoms/barn-cm).

The I0, I1, and I2 vectors would then be set up as shown in the following tabulation.

<u>Mix Number (I0)</u>	<u>Material Number (I1)</u>	<u>Density (I2)</u>
10	0	0
10	2	0.02
10	10	0
10	4	0.04

The first row (10,0,0) instructs the code to clear a storage area for Mix 10. The second row (10,2,0.02) causes Material 2 to be added to Mix 10 with a density of 0.02. The third row (10,10,0) causes the current contents of Mix 10 to be multiplied by the eigenvalue. Finally, the last row (10,4,0.04) instructs the code to add Material 4 to Mix 10 with a density of 0.04.

All of the foregoing can be summarized by the expression

$$\Sigma_{10} = 0.02 \sigma_2 \text{ EV} + 0.04 \sigma_4 \quad (4.4)$$

where:

Σ_{10} = macroscopic cross section for Mix 10,

σ_2 = microscopic cross section for Material 2,

σ_4 = microscopic cross section for Material 4,

EV = eigenvalue.

Zone Dimensions (δ calculation)

2DB searches on reactor dimensions by varying the dimensions of each axial and radial mesh interval. Each mesh width, δr^i , is computed from the expression

$$\delta r^i = \delta r_0^i [1 + (\text{mesh modifier})^i \text{ EV}] \quad , \quad (4.5)$$

where δr_0^i is the initial mesh spacing and EV is the eigenvalue. Different mesh modifiers can be specified for each axial and radial mesh interval.

Buckling (B^2 calculation)

In a buckling search, the quantity $D_i B^2$, where D_i is the zone dependent diffusion constant for group i , is added to the i th group absorption cross section. The in-group scattering cross section, σ_{gg}^i , is reduced by the same amount so that the calculated total cross section remains equal to the input total cross section. The buckling is then computed as the eigenvalue.

V. BURNUP MODEL

The basic burnup equation for each zone has the form

$$\frac{dN^i}{dt} = -\lambda^i N^i - \bar{\sigma}_a^i \bar{\phi} N^i + \lambda^k N^k + \sum_j \bar{\sigma}_c^j \bar{\phi} N^j + \sum_m \bar{\sigma}_f^m \bar{\phi} N^m \quad (5.1)$$

where:

N^i = density of nuclide i ,

λ^i = decay constant for nuclide i ,

$\bar{\sigma}_a^i$ = spectrum averaged absorption cross section for nuclide i ,

$\bar{\sigma}_f^i$ = spectrum averaged fission cross section for nuclide i ,

$\bar{\sigma}_c^i$ = spectrum averaged capture cross section for nuclide i ,

$\bar{\phi}$ = total flux.

The last two sum terms in Equation (5.1) allow provision for two capture and seven fission sources. The latter option, for example, could be used to compute the fission product buildup.

Each input time step is arbitrarily subdivided into 10 smaller time steps. Equation (5.1) is then solved as a march-out problem using the subdivided time intervals. If we rewrite Equation (5.1) in the form

$$\frac{d\vec{N}}{dt} = \vec{F}(\vec{N}, t) \quad , \quad (5.2)$$

the particular march-out algorithm used can be written as

$$\vec{N}_{J+1} = \vec{N}_J + \frac{\delta t}{2} (\vec{f}_J + \vec{f}_{J+1}) \quad (5.3)$$

where J is the index on time and δt is the fine-step time interval.

Observe that Equation (5.3) is implicit in the sense that $\vec{N}_{J+1}$ must be known in order to compute $\vec{f}_{J+1}$. One must therefore iterate on $\vec{N}$ at each time point. This procedure leads to the algorithm

$$\vec{N}_{J+1}^{v+1} = \vec{N}_J + \frac{\delta t}{2} (\vec{f}_J + \vec{f}_{J+1}^v) \quad , \quad (5.4)$$

where v is the iteration index.

Remarks on Burnup Equations

The zone averaged flux and cross sections appearing in Equation (5.1) are computed before each input time step. The total reactor power (from the burnable isotopes) and flux profile (relative zone fluxes) are held constant during the fine-step march-out described by Equation (5.4).

It should be clear from the mathematical model presented that relatively short time steps should be employed if rapid variations in isotopic concentration or flux profiles are anticipated. Such conditions, however, are rarely encountered in fast reactor design calculations.

VI. REMARKS ON CODE OPERATION

1. Since the input data is inverted for adjoint calculations, all group indices in the output of adjoint cases are inverted. Furthermore, the balance tables in adjoint calculations do not have a direct physical interpretation.

2. The material inventory tables are inapplicable for a mixture specification more complex than a mix in a mix (e.g., a mix in a mix in a mix).

3. An isotope cannot be mentioned more than once in the same mix in burnup calculations. If mentioned more than once in other calculations, the printed inventory will be incorrect.

4. Although the new eigenvalue and material densities are computed and printed after the last time step, the zone averaged cross sections and reaction rates are not. These can be easily obtained, however, by simply taking 1 extra burnup step of miniscule length. Similarly, the zone averaged cross sections and reaction rates can be obtained in non-burnup runs by simply calling for 1 (dummy) burnup step of miniscule length.

5. A flux dump is given only when:

- 1) A dump is called for, and
- 2) The burnup time is zero.

Thus, if a dump is called for in a burnup calculation, only one dump (the initial flux) is given.

6. Tight mesh spacing in the dimension perpendicular to line inversion can cause excessive running time. Thus, if tight mesh spacing is used, it should be along the dimension containing the most mesh intervals. For the same reason, the "dummy" dimension in one-dimensional problems should contain large mesh intervals.

VII. REPRESENTATIVE RUNNING TIMES ON A UNIVAC 1108

2DB running times for problems involving typical fast reactor compositions are shown in Table 7.1. All problems are run using an initial flat flux and a k_{eff} convergence criterion of 10^{-5} .

Table 7.1
Representative Running Times for k_{eff} Calculations

<u>Case</u>	<u>Geometry</u>	<u>No. of Groups</u>	<u>Mesh Size</u>	<u>Approx. Time (minutes)</u>
1	R-Z	2	20 x 20	0.2
2	R- θ	4	20 x 30	0.7
3	X-Y	5	40 x 40	2.3
4	R-Z	20	20 x 20	3.0
5	R-Z	20	33 x 29	6.1
6	R-Z	26	24 x 18	4.1

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APPENDIX A

SIMPLIFIED LOGICAL FLOW DIAGRAM

APPENDIX A

SIMPLIFIED LOGICAL FLOW DIAGRAM

A brief description of the function of each subroutine is given below; the calling sequences of all principal subroutines are shown in Figure A.1.

AVERAG	Calculates zone averaged fluxes and cross sections.
CALC	Program management.
CLEAR	Clears storage area for dimensioned variables.
CNNP	Performs convergence tests; estimates new eigenvalue.
ERR02	Prints and evaluates anomalous conditions.
FISCAL	Computes group sums; normalizes flux and fission rate.
GRAM	Calculates and prints reactor inventory.
IFLUXN	Normalizes group fluxes before each group-flux calculation.
INCL	Tabulation of all elements in COMMON storage.
INIT	Calculates miscellaneous parameters (e.g., cross section mixes, adjoint reversals, geometric parameters).
INNER	Performs inner iteration by column.
INNER1	Calculates coefficients for use during inner iterations.
INNER2	Performs iteration by row.
INNERP	Performs inner iteration for problems with periodic boundary conditions.
INP	Reads and prints input data; sets core storage requirements.
INPB	Reads and prints input data for burnup.
MAPR	Prints core map.
MARCH	Computes variation in reactor composition for a specified time step.

OUTER	Controls program during outer iterations.
PRT	Prints two-dimensional vectors.
REAG2	Generalized input routine for floating point variables.
REAI2	Generalized input routine for integer variables.
S860	Reads input cross sections from cards.
S862	Reads input flux dumps from cards.
S8830	Monitor print.
S8847	Computes and prints total neutron balance.
S8850	Final print.

Fig. A.1. 2DB Calling Sequence

APPENDIX B

INPUT INSTRUCTIONS

APPENDIX B

INPUT INSTRUCTIONS

The following pages describe the input data for 2DB. Most input is read in via generalized input subroutines. The format for data read in through the generalized input subroutines must adhere to the following form: All cards must contain six data fields of 12 columns each. The last nine columns of each field contain the data associated with the particular field; columns 2-3 contain an integer, N, from 0 to 99. The first column of each field must contain:

- 0 - no effect (N=0),
- 1 - repeat associated entry N times,
- 2 - do N linear interpolations between associated data entry and succeeding data entry,
- 3 - terminate reading of this array with previous data entry.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 1</u> (To run a series of cases, repeat from this card)			
ID (11)	1-66	11A6	Identification card.
MAXT	67-72	I6	Maximum running time (minutes). If zero, not used.
<u>CARD 2</u>			
A02	1-6	I6	Problem type: = 0, regular calculation, = 1, adjoint calculation.
I04	7-12	I6	Eigenvalue type: = 1, k_{eff} , = 2, time absorption (α),

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
			= 3, concentration (C), = 4, zone thickness (δ), = 5, buckling (B^2).
S02	13-18	I6	Parametric eigenvalue type: = 0, none, = 1, k_{eff} , = 2, α .
IGM	19-24	I6	Number of energy groups ($1 \leq N \leq 50$).
NXCM	25-30	I6	Number of downscattering terms.
MCR	31-36	I6	Number of materials (cross sections) from cards.
MTP	37-42	I6	Number of materials from tape.
M07	43-48	I6	Initial flux guess: = 0, none, = 1, $X(R)*X(Z)$ from cards, = 2, $X(R,Z,E)$ from cards, = 3, $X(R,Z,E)$ from tape.
D05	49-54	I6	Maximum number of outer iterations. Representative value ≈ 50 .
G07	55-60	I6	Maximum number of inner iterations per group. Representative value ≈ 10 .
S04	61-66	I6	Maximum number of inner iterations per group while $ 1-\lambda > 10\epsilon$. Representative value ≈ 6 .
NPUN	67-72	I6	Flux dump option: = 0, no punch, = 1, punch flux dump, = 2, punch flux and I2 card, = 3, write flux on tape, = 4, write flux on tape and punch I2.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 3</u>			
IGE	1-6	I6	Geometry specification: = 0, X-Y, = 1, R-Z, = 2, R- θ .
IM	7-12	I6	Number of radial intervals (≥ 3).
JM	13-18	I6	Number of axial intervals (≥ 3).
IZM	19-24	I6	Number of material zones.
MT	25-30	I6	Total number of materials, including mixes.
M01	31-36	I6	Number of mixture specifications.
B01	37-42	I6	Left boundary condition: = 0, vacuum, = 1, reflective.
B02	43-48	I6	Right boundary condition.
B03	49-54	I6	Top boundary condition: = 0, vacuum, = 1, reflective, = 2, periodic.
B04	55-60	I6	Bottom boundary condition.
IZ	61-66	I6	Number of radial zones (δ option only).
JZ	67-72	I6	Number of axial zones (δ option only).
<u>CARD 4</u>			
EV	1-12	E12	Initial eigenvalue guess. (Used only in search calculations.)
EVM	13-24	E12	Initial eigenvalue modifier. This value should <u>decrease</u> reactivity--i.e., EV + EVM should produce a lower reactivity than EV. Since EVM is completely problem dependent,

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
			no representative values can be given. However, this parameter is rather important, so some thought should be given to estimating a reasonable value. (Used only in search calculations.)
S03	25-36	E12	Parametric eigenvalue (see third word on Card 2).
BUCK	37-48	E12	Buckling (cm^{-2}). Caution--search (and burnup) calculations that include a buckling term cannot be performed using input cross sections (mixes) directly in zones. Furthermore, a given input mix cannot be used directly in two or more zones in k_{eff} or search problems that have a buckling term. These problems can be avoided by mixing with a density of 1.0. If searching on buckling, BUCK should be zero.
LAL	49-60	E12	Lower limit on $ \lambda-1 $, where $\lambda-1$ is, in essence, the predicted change in the current reactivity. After LAL is reached, the eigenvalue slope is no longer altered. LAL is used only in search calculations. Recommended value $\approx .005$.
LAH	61-72	E12	Upper limit on $ \lambda-1 $. If $ \lambda-1 $ is greater than LAH, LAH rather than $ \lambda-1 $ is used in predicting the new eigenvalue. LAH is used only in search calculations. Recommended value $\approx .5$.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 5</u>			
EPS	1-12	E12	Convergence criterion on the total fission source rate. The maximum error in k_{eff} is actually about $3 \times \text{EPS}$.
EPSA	13-24	E12	Parametric eigenvalue convergence criterion. The eigenvalue is recalculated when $ \lambda^{v+1} - \lambda^v $ is less than EPSA. EPSA is only used in search calculations. Recommended value $\approx 10 \times \text{EPS}$.
G06	25-36	E12	Flux convergence test (if zero, no test). That is, $\text{Max}(\phi^{v+1} - \phi^v / \phi^v)$.
POD	37-48	E12	Parameter oscillation damper. Ratio of the computed eigenvalue change to the predicted eigenvalue change. POD can be used to accelerate convergence or damp out oscillations. (Used only in search calculations.)
ORF	49-60	E12	Over-relaxation factor. If instabilities arise, reduce ORF. Recommended value ≈ 1.6 .
S01	61-72	E12	If X is negative, the total power is normalized to $ X $ Mwt using the conversion factor of 215 Mev/fission. If positive, $X = \text{total source} / k_{\text{eff}}$.
<u>CARD 6</u>			
HOLN(MCR)	1-6	A6	Identification card for first isotope. Name.
ATW(MCR)	7-12	E6	Atomic weight of first isotope (a.m.u.).

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
ALAM(MCR)	13-18	E6	Decay constant for first isotope (days^{-1}). This value is only used in burnup calculations.
AA(9)	19-72	9A6	Miscellaneous additional identification.

CARD 7

C(ITL,IGM, MCR)	1-12	E12	Cross section data for first group of first isotope. σ_f (barns).
C(ITL,IGM, MCR)	13-24	E12	σ_a .
C(ITL,IGM, MCR)	25-36	E12	$\nu\sigma_f$.
C(ITL,IGM, MCR)	37-48	E12	σ_{tr} .
C(ITL,IGM, MCR)	49-60	E12	$\sigma(g \rightarrow g)$
C(ITL,IGM, MCR)	61-72	E12	$\sigma(g-1 \rightarrow g)$.

CARD 8

C(ITL,IGM, MCR)	1-12	E12	$\sigma(g-2 \rightarrow g)$.
C(ITL,IGM, MCR)	13-24	E12	$\sigma(g-3 \rightarrow g)$.

...

Repeat above sequence for all groups and all isotopes. Data for each new energy group must begin on a new card. The code checks the input data to insure that

$$\sigma_{tr} = \sigma_a + \sum_{g'} \sigma(g \rightarrow g').$$

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 9</u> (Optional, required if M07=1)			
RF(IM)	1-12	E12(GI*)	Initial flux guess for first radial interval.
RF(IM)	13-24	E12(GI)	Initial flux guess for second radial interval.
...			This flux profile is used for all energy groups.
<u>CARD 9'</u> (Optional, required if M07=1)			
ZF(JM)	1-12	E12(GI)	Initial flux guess for first axial interval.
ZF(JM)	13-24	E12(GI)	Initial flux guess for second axial interval.
...			This flux profile is used for all energy groups.
<u>CARD 9''</u> (Optional, required if M07=2)			
NO(IMJM)	1-12	E12	Initial flux guess for first mesh point in first group.
NO(IMJM)	13-24	E12	Initial flux guess for second mesh point in first group. Continue for all mesh points and all energy groups.
...			
<u>CARD 10</u>			
RO(IM+1)	1-12	E12(GI)	Radial position of first mesh boundary (0.0).
RO(IM+1)	13-24	E12(GI)	Radial position of second mesh boundary (cm).
...			
<u>CARD 11</u>			
ZO(JM+1)	1-12	E12(GI)	Axial position of first mesh boundary (0.0).

* Generalized input format.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
Z0(JM+1)	13-24	E12(GI)	Axial position of second mesh boundary.
...			Dimensions should be in cm for R-Z and X-Y calculations, and in fractions of a circle for R- θ calculations (e.g., 0.5 for 180 ⁰).

CARD 12

MO(IMJM)	1-12	I12(GI)	Zone number for first mesh interval.
MO(IMJM)	13-24	I12(GI)	Zone number for second mesh interval. Mesh intervals are sequence numbered beginning at the lower left and then proceeding through each row in order.
...			

CARD 13

M2(IZM)	1-12	I12(GI)	Material number for first zone.
M2(IZM)	13-24	I12(GI)	Material number for second zone.
...			

CARD 14

K7(IGM)	1-12	E12(GI)	Fission fraction (spectrum) in first energy group.
K7(IGM)	13-24	E12(GI)	Fission fraction in second energy group.
...			

CARD 15

V7(IGM)	1-12	E12(GI)	Neutron velocity for first energy group (cm/sec).
V7(IGM)	13-24	E12(GI)	Neutron velocity for second energy group.
...			

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 16</u> (Optional, required if M01>0)			
I0(M01)	1-12	I12(GI)	Material number of Mix 1.
...			
I0(M01)	N-N+12	I12(GI)	Material number of Mix 2.
...			
<u>CARD 17</u> (Optional, required if M01>0)			
I1(M01)	1-12	I12(GI)	0 (to clear storage area for Mix 1).
I1(M01)	13-24	I12(GI)	Number of first material in Mix 1.
I1(M01)	25-36	I12(GI)	Number of second material in Mix 1.
...			
I1(M01)	N-N+12	I12(GI)	0 (to clear storage area for Mix 2).
I1(M01)	N+13		
	-N+24	I12(GI)	Number of first material in Mix 2.
...			
<u>CARD 18</u> (Optional, required if M01>0)			
I2(M01)	1-12	E12(GI)	0
I2(M01)	13-24	E12(GI)	Concentration of first material in Mix 1 (atoms/barn-cm).
I2(M01)	25-36	E12(GI)	Concentration of second material in Mix 1.
...			
<u>CARD 19</u> (Optional, required if I04=4)			
R2(IM)	1-12	I12(GI)	Dimensional search zone number for first radial interval.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
R2(IM)	13-24	I12(GI)	Dimensional search zone number for second radial interval.

...

CARD 20 (Optional, required if I04=4)

R3(IZ)	1-12	E12(GI)	Dimensional modifier for first (dimensional search) radial zone.
R3(IZ)	13-24	E12(GI)	Dimensional modifier for second radial zone.

...

CARD 21 (Optional, required if I04=4)

Z2(JM)	1-12	I12(GI)	Dimensional search zone number for first axial interval.
Z2(JM)	13-24	I12(GI)	Dimensional search zone number for second axial interval.

...

CARD 22 (Optional, required if I04=4)

Z3(JZ)	1-12	E12(GI)	Dimensional modifier for first axial zone.
Z3(JZ)	13-24	E12(GI)	Dimensional modifier for second axial zone.

...

CARD 23 (Burnup Control Card)

NCON	1-6	I6	Burnup control: = 0, end of problem, read input data for next case, = N, read burnup parameters for N isotopes and take time step of DELT, < 0, take time step of DELT.
------	-----	----	--

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
NPRT	7-12	I6	Print control: = 0, partial print, = 1, full print.
DELT	13-24	E12	Length of time step (days).
<u>CARD 24</u> (Optional, required if NCON > 0)			
MATN(NCON)	1-6	I6	This card contains all burnup parameters for the first burnable isotope. Material sequence number of first burnable isotope.
NBR(NCON)	7-12	I6	Control for breeding ratio calculation: = 0, no effect, = 1, fertile isotope, = 2, fissile isotope.
LD(NCON)	13-18	I6	= 0, no decay source, = N, decay source from burnable isotope N.
LCN(NCON,2)	19-24	I6	= 0, no capture source, = N, capture source from burnable isotope N. See Eq. (5.1).
LCN(NCON,2)	25-30	I6	= 0, no capture source, = N, capture source from burnable isotope N.
LFN(NCON,7)	31-36	I6	= 0, no fission source, = N, fission source from burnable isotope N. See Eq. (5.1).
LFN(NCON,7)	37-48	I6	= 0, no fission source, = N, fission source from burnable isotope N.

• • •
(Repeat CARD 24 for all burnable isotopes. Repeat from CARD 23 for additional time steps.)

2 D B

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
												IDENTIFICATION CARD																								MAX MAX RUNNING TIME (MIN)																																											
A02 EIGENVALUE TYPE - 0. REGULAR CALCULATION - 1. ADJOINT CALCULATION		I04 EIGENVALUE TYPE - 1. k_{eff} - 2. ABSORP- TION IN - 3. CONCENTR- RATION (C) - 4. ZONE THICKNESS (M) - 5. BUCKLING (B ²)		S02 PARAMETRIC EIGENVALUE TYPE - 0. NONE - 1. k_{eff} - 2. α		I0M NUMBER OF ENERGY GROUPS		NXCM NUMBER OF DOWN- SCATTERING TERMS		MCR NUMBER OF MATERIALS FROM CARDS		MTP NUMBER OF MATERIALS FROM TAPE		M07 FLUX GUESS - 0. NONE - 1. X(RP)(Z) FROM CARDS - 2. X(R, Z, E) FROM CARDS - 3. X(R, Z, E) FROM TAPE		D05 OUTER ITERATION MAX		INNER ITERATION MAX PER GROUP		S04 INNER ITERATION MAX PER GROUP FOR H-ADJIDE		NPUN FLUX DUMP OPTION - 0. NONE - 1. PUNCH FLUX DUMP AND 12 CARD - 2. PUNCH FLUX DUMP AND 12 CARD - 3. WRITE FLUX TAPE - 4. WRITE FLUX TAPE AND PUNCH 12 CARD																																																									
I0E GEOMETRY: - 0. X-Y - 1. R-Z - 2. R- θ		I0M NUMBER OF RADIAL INTERVALS		I0M NUMBER OF AXIAL INTERVALS		I0M NUMBER OF MATERIAL ZONES		MT TOTAL NUMBER OF MATERIALS INCLUDING MIXES		M01 NUMBER OF MIXTURE SPECIFI- CATIONS		B01 LEFT BOUNDARY CONDITION - 0. VACUUM - 1. REFLECTIVE		B02 RIGHT BOUNDARY CONDITION		B03 TOP BOUNDARY CONDITION - 0. VACUUM - 1. REFLECTIVE - 2. PERIODIC		B04 BOTTOM BOUNDARY CONDITION		I0Z NUMBER OF RADIAL ZONES (ADDITION ONLY)		I0Z NUMBER OF AXIAL ZONES (ADDITION ONLY)																																																									
EV FIRST EIGENVALUE GUESS				EVM EIGENVALUE MODIFIER				S03 PARAMETRIC EIGENVALUE				BUCK BUCKLING (CM ⁻²)				LAL LAMBDA LOWER				LAH LAMBDA UPPER																																																											
EPS EIGENVALUE CONVERGENCE CRITERION				EPSA PARAMETRIC EIGENVALUE CONVERGENCE CRITERION				G06 FLUX CONVERGENCE (%) (IF ZERO, NO TEST)				POD PARAMETER OSCILLATION DAMPEN				ORF OVER-RELAXATION FACTOR				SDI - NEGATIVE, POWER (MW) - POSITIVE, NEUTRON SOURCE RATE																																																											

1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80	
HOLNUMCR) NAME OF 1ST ISOTOPE											ATWIMCR) ATOMIC WT. OF 1ST ISOTOPE											ALANIMCR) DECAY CONSTANT OF 1ST ISOTOPE (DAYS ⁻¹)											AIR) MISCELLANEOUS INFORMATION FOR 1ST ISOTOPE (HAB)																																																																																																																														
CROSS SECTION DATA FOR 1ST ISOTOPE (BER, S)																																																																															CITL, LGM, MCR)																																																																																
• • • (REPEAT ABOVE TWO CARDS FOR EACH ISOTOPE)																																																																																																																																																															
FLUX GUESS IN FIRST RADIAL INTERVAL											FLUX GUESS IN SECOND RADIAL INTERVAL											• • •																																	RF(1M)																																																																																																								
FLUX GUESS IN FIRST AXIAL INTERVAL											FLUX GUESS IN SECOND AXIAL INTERVAL											• • •																																	ZF(1M)																																																																																																								
FLUX GUESS IN 1ST MESH INTERVAL FOR GROUP 1											FLUX GUESS IN 2ND MESH INTERVAL FOR GROUP 1											• • •																																	HOL(1M)																																																																																																								
• • • (REPEAT ABOVE CARD FOR ALL GROUPS)																																																																															HOL(1M)																																																																																
1ST RADIAL POINT (G, D)											2ND RADIAL POINT											• • •																																	RQ(1M+1)																																																																																																								
1ST AXIAL POINT (G, D)											2ND AXIAL POINT											• • •																																	ZQ(1M+1)																																																																																																								
ZONE NUMBER FOR 1ST MESH INTERVAL											ZONE NUMBER FOR 2ND MESH INTERVAL											• • •																																	M0(1M)																																																																																																								
MATERIAL NUMBER FOR 1ST ZONE											MATERIAL NUMBER FOR 2ND ZONE											• • •																																	M2(1ZM)																																																																																																								
FISSION SPECTRUM IN 1ST GROUP											FISSION SPECTRUM IN 2ND GROUP											• • •																																	K7(1GM)																																																																																																								
NEUTRON VELOCITY IN 1ST GROUP											NEUTRON VELOCITY IN 2ND GROUP											• • •																																	V7(1GM)																																																																																																								
MATERIAL NUMBER OF MIX 1											• • •											MATERIAL NUMBER OF MIX 2											• • •																																	10(MQ1)																																																																																													
0											1ST MATERIAL IN MIX 1											2ND MATERIAL IN MIX 1											• • •																																	11(MQ1)																																																																																													
0											DENSITY OF 1ST MATERIAL IN MIX 1											DENSITY OF 2ND MATERIAL IN MIX 1											• • •																																	12(MQ1)																																																																																													

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80																																																																																																																																																																															
ZONE NUMBER FOR 1ST RADIAL INTERVAL																ZONE NUMBER FOR 2ND RADIAL INTERVAL																• • •																																R211M1																																																																																																															
MODIFIER FOR 1ST RADIAL ZONE																MODIFIER FOR 2ND RADIAL ZONE																• • •																																R311Z1																																																																																																															
ZONE NUMBER FOR 1ST AXIAL INTERVAL																ZONE NUMBER FOR 2ND AXIAL INTERVAL																• • •																																ZZUM1																																																																																																															
MODIFIER FOR 1ST AXIAL ZONE																MODIFIER FOR 2ND AXIAL ZONE																• • •																																ZZUJ1																																																																																																															
NCOM • Q, END OF PROBLEM • N, TAKE TIME STEP OF DELT. AND READ BURNUP DATA FOR N ISOTOPE. <0, TAKE TIME STEP OF DELT.																NPRT • Q, PARTIAL PRINT • I, FULL PRINT																DELT LENGTH OF TIME STEP (DAYS)																																																																																																																																															
MATNCOM1 MATERIAL SEQUENCE NUMBER FOR 1ST BURNABLE ISOTOPE																NBRNCOM1 • Q, NO EFFECT • I, FERTILE ISOTOPE • 2, FISSIONABLE ISOTOPE																LDNCOM1 • Q, NO DECAY SOURCE • N, DECAY SOURCE FROM BURNABLE ISOTOPE N																LCNCOM1 Z1 • Q, NO CAPTURE SOURCE • N, CAPTURE SOURCE FROM BURNABLE ISOTOPE N																• • •																LFNCOM1 Z1 • Q, NO FISSION PRODUCT SOURCE • N, FISSION PRODUCT SOURCE FROM BURNABLE ISOTOPE N																• • •																																																																															
• • • (REPEAT ABOVE CARD FOR ALL BURNABLE ISOTOPIES)																																																																																																																																																																															
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80																																																																																																																																																																															

APPENDIX C

STORAGE REQUIREMENTS

APPENDIX C

STORAGE REQUIREMENTS

The variable dimensioned arrays require N storage locations where

$$N = \text{MAX}(N_1, N_2)$$

$$\begin{aligned} N_1 = & 5 + 10 \times \text{IM} \times \text{JM} \\ & + 7 \times \text{IM} \\ & + 5 \times \text{JM} \\ & + 4 \times \text{MOI} \\ & + 3 \times (\text{IGM} + \text{IZM}) \\ & + \text{ML} \times (15 + 4 \times \text{IZM}) \\ & + \text{MT} \times \text{ITL} \\ & + 2 \times \text{MAX}(\text{IM}, \text{JM}) \\ & + \text{IZ} + \text{JZ} + \text{IM} + \text{JM} \quad (\text{if } \delta \text{ calculation}) \end{aligned}$$

$$N_2 = \text{MT} \times \text{ITL} \times (\text{IGM} + 1) + 3 \times \text{ML}$$

and:

IM = number of radial intervals

JM = number of axial intervals

IGM = number of energy groups

IZM = number of material zones

MOI = number of mixture specifications

ML = number of materials from cards or tape

ITL = length of cross section table (NXCM+5)

MT = total number of materials, including mixes

IZ = number of radial zone modifiers

JZ = number of axial zone modifiers.

For virtually all practical problems, $N_1 > N_2$ and thus $N = N_1$.

APPENDIX D

SAMPLE PROBLEM

The following pages show the input data and computer output for a 2-group, 2-region, 2-step burnup problem in R-Z geometry.

2 D B SAMPLE CASE											
0	1	2	1	10	0	0	100	20	10	2	
1	20	20	2	12	1	0	0	1	0	0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.5	0.5	
.00001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	
U238	238.05	0.0	2 GROUPS								
	.100100+00	.232887-00	.281437-00								
	.000000	.532188-00	.000000								
PU239	239.05	0.0	2 GROUPS								
	.172436+01	.184872+01	.511503+01								
	.228419+01	.324006+01	.649503+01								
PU240	240.05	0.0	2 GROUPS								
	.697066-00	.973045-00	.210364+01								
	.205185-01	.158456+01	.577565-01								
PU241	241.067	80-8	2 GROUPS								
	.173712+01	.189157+01	.528272+01								
	.250848+01	.287570+01	.744300+01								
FIS PR	1.00	0.0	2 GROUPS								
	.000000	.180334-00	.000000								
	.000000	.450420-00	.000000								
C	12.011	0.0	2 GROUPS								
	.000000	.833620-05	.000000								
	.000000	.456935-10	.000000								
NA	22.990	0.0	2 GROUPS								
	.000000	.713006-03	.000000								
	.000000	.423424-02	.000000								
FE	55.847	0.0	2 GROUPS								
	.000000	.591775-02	.000000								
	.000000	.215431-01	.000000								
U238	238.05	0.0	2 GROUPS								
	.372181-01	.189516-00	.105378+00								
	.000000	.404503-00	.000000								
FE	55.847	0.0	2 GROUPS								
	.000000	.670574-02	.000000								
	.000000	.170269-01	.000000								
212	0.02	6	42.0	72.03							
212	0.02	6	38.0	68.03							
113	11	7	2113	11	7		2113	11	7	2	
113	11	7	2113	11	7		2113	11	7	2	
113	11	7	2113	11	7		2113	11	7	2	
113	11	7	2113	11	7		2113	11	7	2	
113	11	7	2170	2170			23				
113	11	7	123								
	.987	.0133									
	7.63085+8	1.16360+83									
1 9	111	4	123								
	0	1		2		3		4		5	
	6	7		8		0		9		2	
	103										
	0	.0080	.0016	.0001		.0		.0		.0	
	.0200	.0060	.0130	0		.0400				.0	
	.00623										
6	0	50.0									
1	1	0	0	0	0	0	0	0	0	0	
2	2	0	6	0	0	0	0	0	0	0	
3	1	0	0	0	0	0	0	0	0	0	
4	2	0	0	0	0	0	0	0	0	0	
5	0	0	0	1	2	3	4	6	0	0	
9	1	0	0	0	0	0	0	0	0	0	
-1	0	50.0									
0											

* * * * 2 D B * * * *

2 D B SAMPLE CASE

2

A02	0/1=REGULAR CALCULATION/ADJOINT CALCULATION	0
I04	EIGENVALUE TYPE (1/2/3/4/5=KEFF/ALPHA/CONCENTRATION/DELTA/BUCKLING)	1
S02	PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA)	0
IGP	NUMBER OF GROUPS	2
NXCM	NUMBER OF DOWNSCATTERING TERMS	1
MCK	NUMBER OF MATERIALS FROM CARDS	10
MTF	NUMBER OF MATERIALS FROM TAPE	0
M07	FLUX GUESS (0/1/2/3=NONE/X(R)*X(Z)/X(R,Z,E)/X(R,Z,E) FROM TAPE)	0
D05	OUTER ITERATION MAX	100
G07	INNER ITERATION MAX PER GROUP	20
S04	I1 MAX PER GROUP FOR 1 - LAMBDA GREATER THAN 10*EPS	10
NP01	FLUX DUMP (0/1/2/3/4=NONE/CARDS/CARDS+I2/TAPE/TAPE+I2)	0
IGL	GEOMETRY (0/1/2=X-Y/R-Z/R-THETA)	1
IM	NUMBER OF RADIAL INTERVALS	20
JM	NUMBER OF AXIAL INTERVALS	20
I2M	NUMBER OF MATERIAL ZONES	2
MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	12
M01	NUMBER OF MIXTURE SPECIFICATIONS	13
B01	LEFT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	1
B02	RIGHT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	0
B03	TOP BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	0
B04	BOTTOM BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	1
I2	RADIAL ZONES (DELTA-OPTION ONLY)	0
J2	AXIAL ZONES (DELTA-OPTION ONLY)	0
EV	FIRST EIGENVALUE GUESS	0.0000
EVM	EIGENVALUE MODIFIER	0.0000
S03	PARAMETRIC EIGENVALUE	0.0000
BUCK	BUCKLING (CM-2)	0.0000
LAL	LAMBDA LOWER	1.0000-03
LAH	LAMBDA UPPER	5.0000-01
EPS	EIGENVALUE CONVERGENCE CRITERIA	1.0000-05
EPSA	PARAMETER CONVERGENCE CRITERIA	1.0000-03
G06	INNER ITERATION TEST (IF ZERO, NO TEST)	0.0000
POD	PARAMETER OSCILLATION DAMPER	1.0000+00
ORF	OVER-RELAXATION FACTOR	1.4000+00
S01	NEGATIVE/POSITIVE=POWER (MW)/NEUTRON SOURCE RATE	-1.0000+02

LAST 4652

D-2

BNWL-831

2 D B SAMPLE CASE

THE FOLLOWING NUCLIDES ARE FROM CARDS

1	U238	2 GROUPS	CORE
2	PU239	2 GROUPS	CORE
3	PU240	2 GROUPS	CORE
4	PU241	2 GROUPS	CORE
5	FIS PR	2 GROUPS	CORE
6	C	2 GROUPS	CORE
7	NA	2 GROUPS	CORE
8	FE	2 GROUPS	CORE
9	U238	2 GROUPS	REFLECTOR
10	FE	2 GROUPS	REFLECTOR

- .00000	.32308+01	.64615+01	.96923+01	.12923+02	.16154+02	.19385+02	.22615+02	.25846+02	.29077+02
.32308+02	.35538+02	.38769+02	.42000+02	.46286+02	.50571+02	.54857+02	.59143+02	.63429+02	.67714+02
.72000+02									
21									
- .00000	.29231+01	.58462+01	.87692+01	.11692+02	.14615+02	.17538+02	.20462+02	.23385+02	.26308+02
.29231+02	.32154+02	.35077+02	.38000+02	.42286+02	.46571+02	.50857+02	.55143+02	.59429+02	.63714+02
.60000+02									

[illegible]

2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2

MATERIAL NUMBERS BY ZONE
M2 2
11 12

FISSION SPECTRUM
K7 2
.98700-00 .13000-01

NEUTRON VELOCITY
V7 2
.76309+09 .11636+09

MIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER FOR MIX/MATERIAL DENSITY)

10	13									
11		11	11	11	11	11	11	11	12	
12		12	12							
11	13									
0		1	2	3	4	5	6	7	8	0
9		2	10							
12	13									
.00000	.80000-02	.16000-02	.10000-03	.00000	.00000	.20000-01	.60000-02	.13000-01	.00000	
.40000-01	.00000	.62000-02								

D-5

BNWL-831

2 D B SAMPLE CASE

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1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2

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A
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RADIAL

T I M E = .000 D A Y S

MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	11	0
2	11	1
3	11	2
4	11	3
5	11	4
6	11	5
7	11	6
8	11	7
9	11	8
10	12	0
11	12	9
12	12	2
13	12	10

CROSS-SECTION EDIT

GROUP 1 CROSS-SECTIONS

MAT 1	.100+00	.233-00	.281-00	.634+01	.601+01	.000
MAT 2	.172+01	.185+01	.512+01	.669+01	.477+01	.000
MAT 3	.697-00	.973-00	.210+01	.654+01	.549+01	.000
MAT 4	.174+01	.189+01	.528+01	.745+01	.543+01	.000
MAT 5	.000	.180-00	.000	.107+02	.104+02	.000
MAT 6	.000	.834-05	.000	.264+01	.245+01	.000
MAT 7	.000	.713-03	.000	.309+01	.300+01	.000
MAT 8	.000	.592-02	.000	.256+01	.252+01	.000
MAT 9	.372-01	.190-00	.105+00	.695+01	.665+01	.000
MAT 10	.000	.671-02	.000	.265+01	.260+01	.000
MAT 11	.363-02	.500-02	.106-01	.167-00	.156-00	.000
MAT 12	.149-02	.762-02	.422-02	.294-00	.282-00	.000

GROUP 2 CROSS-SECTIONS

MAT 1	.000	.532-00	.000	.132+02	.126+02	.976-01
MAT 2	.228+01	.324+01	.650+01	.139+02	.107+02	.790-01
MAT 3	.205-01	.158+01	.578-01	.139+02	.124+02	.749-01
MAT 4	.251+01	.288+01	.744+01	.119+02	.901+01	.126-00
MAT 5	.000	.450-00	.000	.142+02	.138+02	.121+00
MAT 6	.000	.457-10	.000	.449+01	.449+01	.188-00
MAT 7	.000	.423-02	.000	.498+01	.498+01	.890-01
MAT 8	.000	.215-01	.000	.482+01	.480+01	.342-01
MAT 9	.000	.405-00	.000	.122+02	.118+02	.112+00
MAT 10	.000	.120-01	.000	.450+01	.449+01	.450-01
MAT 11	.366-02	.991-02	.104-01	.311-00	.301-00	.566-02
MAT 12	.000	.163-01	.000	.516-00	.500-00	.477-02

TIME (MINUTES)	OUTER ITERATIONS	INT. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.04	0	0	.00000000	.00000000	.00000000
.06	1	20	.00000000	.61088087-00	.61088087-00
.08	2	20	.00000000	.90818238-00	.14866767+01
.10	3	20	.00000000	.96537480-00	.10629746+01
.12	4	20	.00000000	.97870443-00	.10138077+01
.14	5	20	.00000000	.98406757-00	.10054798+01
.16	6	20	.00000000	.98584873-00	.10018100+01
.18	7	18	.00000000	.98642320-00	.10005827+01
.20	8	14	.00000000	.98660496-00	.10001842+01
.21	9	9	.00000000	.98666241-00	.10000582+01
.22	10	4	.00000000	.98668050-00	.10000183+01
.23	11	2	.00000000	.98668909-00	.10000087+01

FINAL NEUTRON BALANCE TABLE

GROUP	FISSION SOURCE	IN-SCATTER	OUT-SCATTER	ABSORPTION	L. L.	R. L.	T. L.	B. L.	TOTAL LEAKAGE
1	8.410+18	2.749+11	3.845+18	4.204+18	0.000	2.507+17	1.104+17	0.000	3.611+17
2	1.108+17	3.845+18	2.443+13	3.858+18	0.000	6.780+16	2.993+16	0.000	9.774+16
3	8.521+18	3.845+18	3.845+18	8.062+18	0.000	3.185+17	1.403+17	0.000	4.588+17

	RADII	AVG RADII	AXII	AVG AXII
1	-0.0000	1.6154	-0.0000	1.4615
2	3.2308	4.8462	2.9231	4.3846
3	6.4615	8.0769	5.8462	7.3077
4	9.6923	11.3077	8.7692	10.2308
5	12.9231	14.5385	11.6923	13.1538
6	16.1538	17.7692	14.6154	16.0769
7	19.3846	21.0000	17.5385	19.0000
8	22.6154	24.2308	20.4615	21.9231
9	25.8462	27.4615	23.3846	24.8462
10	29.0769	30.6923	26.3077	27.7692
11	32.3077	33.9231	29.2308	30.6923
12	35.5385	37.1538	32.1538	33.6154
13	38.7692	40.3846	35.0769	36.5385
14	42.0000	44.1429	38.0000	40.1429
15	46.2857	48.4286	42.2857	44.4286
16	50.5714	52.7143	46.5714	48.7143
17	54.8571	57.0000	50.8571	53.0000
18	59.1429	61.2857	55.1429	57.2857
19	63.4286	65.5714	59.4286	61.5714
20	67.7143	69.8571	63.7143	65.8571
21	72.0000	3.2308	68.0000	2.9231

FLUX FOR GROUP 1

	1	2	3	4	5	
1	.4069163+16	.4034900+16	.3966767+16	.3865641+16	.3732818+16	.1461538+01
2	.4040915+16	.4006885+16	.3939217+16	.3838780+16	.3706864+16	.4384615+01
3	.3984624+16	.3951059+16	.3884317+16	.3785254+16	.3655145+16	.7307692+01
4	.3900705+16	.3867833+16	.3802471+16	.3705458+16	.3578041+16	.1023077+02
5	.3789773+16	.3757818+16	.3694281+16	.3599977+16	.3476120+16	.1315385+02
6	.3652645+16	.3621824+16	.3560545+16	.3469592+16	.3350135+16	.1607692+02
7	.3490335+16	.3460859+16	.3402254+16	.3315269+16	.3201023+16	.1900000+02
8	.3304050+16	.3276119+16	.3220587+16	.3138163+16	.3029902+16	.2192308+02
9	.3095184+16	.3068989+16	.3016910+16	.2939607+16	.2838067+16	.2484615+02
10	.2865312+16	.2841033+16	.2792763+16	.2721111+16	.2626984+16	.2776923+02
11	.2616188+16	.2593993+16	.2549865+16	.2484356+16	.2398290+16	.3069231+02
12	.2349746+16	.2329788+16	.2290106+16	.2231194+16	.2153782+16	.3361538+02
13	.2068096+16	.2050512+16	.2015551+16	.1963643+16	.1895425+16	.3653846+02
14	.1539297+16	.1526191+16	.1500131+16	.1461433+16	.1410566+16	.4014286+02
15	.1026636+16	.1017875+16	.1000455+16	.9745842+15	.9405681+15	.4442857+02
16	.0810289+15	.6752049+15	.6636243+15	.6464242+15	.6238075+15	.4871429+02
17	.4462819+15	.4424586+15	.4348569+15	.4235678+15	.4087265+15	.5300000+02
18	.2842037+15	.2817662+15	.2769206+15	.2697263+15	.2602722+15	.5728571+02
19	.1684115+15	.1669664+15	.1640942+15	.1598311+15	.1542316+15	.6157143+02
20	.8004918+14	.7936224+14	.7799711+14	.7597140+14	.7331174+14	.6585714+02
	6	7	8	9	10	
1	.3570009+16	.3379307+16	.3163166+16	.2924368+16	.2665990+16	.1461538+01
2	.3545166+16	.3355768+16	.3141107+16	.2903947+16	.2647346+16	.4384615+01
3	.3495663+16	.3308861+16	.3097148+16	.2863251+16	.2610190+16	.7307692+01
4	.3421861+16	.3238930+16	.3031608+16	.2802572+16	.2554784+16	.1023077+02
5	.3324303+16	.3146486+16	.2944965+16	.2722347+16	.2481520+16	.1315385+02
6	.3203712+16	.3032213+16	.2837856+16	.2623161+16	.2390923+16	.1607692+02
7	.3060985+16	.2896961+16	.2711074+16	.2505741+16	.2283646+16	.1900000+02
8	.2897195+16	.2741749+16	.2565576+16	.2370967+16	.2160476+16	.2192308+02
9	.2713588+16	.2567764+16	.2402476+16	.2219869+16	.2022343+16	.2484615+02
10	.2511578+16	.2376359+16	.2223055+16	.2053640+16	.1870329+16	.2776923+02
11	.2292745+16	.2169049+16	.2028757+16	.1873644+16	.1705695+16	.3069231+02
12	.2058831+16	.1947513+16	.1821195+16	.1681424+16	.1529911+16	.3361538+02
13	.1811732+16	.1713577+16	.1602132+16	.1478701+16	.1344679+16	.3653846+02
14	.1548137+16	.1274879+16	.1191621+16	.1099251+16	.9986202+15	.4014286+02
15	.8988042+15	.8497683+15	.7939970+15	.7320607+15	.6645248+15	.4442857+02
16	.5960381+15	.5634354+15	.5263677+15	.4852464+15	.4405277+15	.4871429+02
17	.3905109+15	.3691404+15	.3448759+15	.3180237+15	.2889482+15	.5300000+02
18	.2486766+15	.2350881+15	.2196877+15	.2026938+15	.1843721+15	.5728571+02
19	.1473691+15	.1393366+15	.1302491+15	.1202465+15	.1094995+15	.6157143+02
20	.7005408+14	.6624438+14	.6193963+14	.5720948+14	.5213834+14	.6585714+02
	11	12	13	14	15	
1	.2391367+16	.2104060+16	.1807818+16	.1304137+16	.8472327+15	.1461538+01
2	.2374619+16	.2089304+16	.1795124+16	.1294967+16	.8412638+15	.4384615+01
3	.2341239+16	.2059890+16	.1769821+16	.1276086+16	.8293632+15	.7307692+01
4	.2291457+16	.2016818+16	.1732074+16	.1249410+16	.8116045+15	.1023077+02

5	.4225618+16	.1957985+16	.1682131+16	.1213311+16	.7880951+15	.1315385+02
6	.2144179+16	.1886173+16	.1620313+16	.1168609+16	.7589729+15	.1607692+02
7	.2047712+16	.1801071+16	.1547615+16	.1115567+16	.7244002+15	.1900000+02
8	.1936899+16	.1703243+16	.1462688+16	.1054471+16	.6845536+15	.2192308+02
9	.1812543+16	.1593346+16	.1367832+16	.9856003+15	.6396087+15	.2484615+02
10	.1675584+16	.1472131+16	.1262975+16	.9091567+15	.5897171+15	.2776923+02
11	.1527135+16	.1340479+16	.1148657+16	.8291013+15	.5349802+15	.3069231+02
12	.1368547+16	.1199492+16	.1025452+16	.7327225+15	.4754536+15	.3361538+02
13	.1201522+16	.1050744+16	.8942024+15	.6294213+15	.4113417+15	.3653846+02
14	.0903588+15	.7743540+15	.6482323+15	.4785253+15	.3283442+15	.4014286+02
15	.5918987+15	.5146070+15	.4331807+15	.3359434+15	.2411961+15	.4442857+02
16	.3927362+15	.3425505+15	.2910301+15	.2317765+15	.1718706+15	.4871429+02
17	.2580994+15	.2260687+15	.1936756+15	.1568836+15	.1190220+15	.5300000+02
18	.1650515+15	.1451464+15	.1251755+15	.1025849+15	.7908984+14	.5728571+02
19	.9821575+14	.8664627+14	.7508507+14	.6202090+14	.4833889+14	.6157143+02
20	.4682750+14	.4139006+14	.3597844+14	.2985685+14	.2341908+14	.6585714+02
	16	17	18	19	20	
1	.5489778+15	.3520153+15	.2194873+15	.1272705+15	.5911147+14	.1461538+01
2	.5451038+15	.3495289+15	.2179369+15	.1263719+15	.5869440+14	.4384615+01
3	.5373801+15	.3445723+15	.2148467+15	.1245814+15	.5786347+14	.7307692+01
4	.5258542+15	.3371774+15	.2102382+15	.1219123+15	.5662521+14	.1023077+02
5	.5105969+15	.3273922+15	.2041440+15	.1183852+15	.5498975+14	.1315385+02
6	.4916999+15	.3152814+15	.1966092+15	.1140287+15	.5297130+14	.1607692+02
7	.4692751+15	.3009269+15	.1876925+15	.1088812+15	.5058888+14	.1900000+02
8	.4434530+15	.2844311+15	.1774703+15	.1029926+15	.4786746+14	.2192308+02
9	.4143841+15	.2659231+15	.1660415+15	.9642813+14	.4483940+14	.2484615+02
10	.3822466+15	.2455719+15	.1535368+15	.8927268+14	.4154631+14	.2776923+02
11	.3472749+15	.2236109+15	.1401316+15	.8163624+14	.3804086+14	.3069231+02
12	.3098328+15	.2003798+15	.1260621+15	.7365888+14	.3438790+14	.3361538+02
13	.2705857+15	.1763849+15	.1116397+15	.6551224+14	.3066387+14	.3653846+02
14	.2215570+15	.1467522+15	.9389603+14	.5550051+14	.2608807+14	.4014286+02
15	.1680544+15	.1138388+15	.7398577+14	.4419255+14	.2089989+14	.4442857+02
16	.1230986+15	.8520266+14	.5626668+14	.3398198+14	.1617624+14	.4871429+02
17	.8712147+14	.6142307+14	.4115224+14	.2511104+14	.1202779+14	.5300000+02
18	.5884193+14	.4209321+14	.2853756+14	.1756547+14	.8458362+13	.5728571+02
19	.3637364+14	.2629415+14	.1798306+14	.1114155+14	.5386764+13	.6157143+02
20	.1774135+14	.1290656+14	.8874632+13	.5520743+13	.2675962+13	.6585714+02

FLUX FOR GROUP 2

1	2	3	4	5
1 .1905568+16	.1889423+16	.1857291+16	.1809561+16	.1746807+16
2 .1892239+16	.1876205+16	.1844294+16	.1796892+16	.1734571+16
3 .1865667+16	.1849854+16	.1818383+16	.1771636+16	.1710176+16
4 .1826022+16	.1810539+16	.1779725+16	.1733956+16	.1673781+16
5 .1773555+16	.1758508+16	.1728565+16	.1684089+16	.1625615+16
6 .1706592+16	.1694086+16	.1665221+16	.1622347+16	.1565980+16
7 .1631524+16	.1617661+16	.1590077+16	.1549105+16	.1495239+16
8 .1542800+16	.1529678+16	.1503571+16	.1464792+16	.1413808+16
9 .1442908+16	.1430623+16	.1406181+16	.1369875+16	.1322141+16
10 .1332353+16	.1320996+16	.1298403+16	.1264641+16	.1220713+16
11 .1211634+16	.1201294+16	.1180725+16	.1150170+16	.1109990+16
12 .1081201+16	.1071966+16	.1053592+16	.1026296+16	.9903984+15
13 .9414124+15	.9333636+15	.9173516+15	.8935633+15	.8622757+15
14 .8858081+15	.8799383+15	.8682612+15	.8509121+15	.8280905+15
15 .4499177+15	.4460603+15	.4383870+15	.4269858+15	.4119863+15
16 .2946414+15	.2921110+15	.2870780+15	.2796000+15	.2697625+15
17 .1909742+15	.1893320+15	.1860660+15	.1812145+15	.1748341+15
18 .1200954+15	.1190619+15	.1170071+15	.1139556+15	.1099444+15
19 .8934911+14	.8875221+14	.8756571+14	.8580431+14	.8349019+14
20 .2963801+14	.2938293+14	.2887600+14	.2812364+14	.2713557+14
1 .1869780+16	.1579387+16	.1476675+16	.1362802+16	.1239006+16
2 .1658074+16	.1568305+16	.1466303+16	.1353218+16	.1230281+16
3 .1634738+16	.1546212+16	.1445624+16	.1334114+16	.1212886+16
4 .1599921+16	.1513249+16	.1414770+16	.1305600+16	.1186929+16
5 .1553844+16	.1469625+16	.1373937+16	.1267864+16	.1152570+16
6 .1496796+16	.1415613+16	.1323377+16	.1221136+16	.1110017+16
7 .1429124+16	.1351543+16	.1263399+16	.1165700+16	.1059523+16
8 .1351229+16	.1277794+16	.1194361+16	.1101881+16	.1001383+16
9 .1263548+16	.1194785+16	.1116654+16	.1030045+16	.9359247+15
10 .1166539+16	.1102955+16	.1030696+16	.9505814+15	.8635028+15
11 .1060657+16	.1002743+16	.9369097+15	.8638925+15	.7844916+15
12 .9463164+15	.8945540+15	.8356908+15	.7703672+15	.6992716+15
13 .8238482+15	.7787137+15	.7273660+15	.6703426+15	.6082045+15
14 .6000549+15	.5671139+15	.5296144+15	.4879216+15	.4423839+15
15 .3935563+15	.3718954+15	.3472306+15	.3198000+15	.2898451+15
16 .2576767+15	.2434772+15	.2273194+15	.2093786+15	.1898524+15
17 .1669996+15	.1578035+15	.1473560+15	.1357877+15	.1232558+15
18 .1050230+15	.9925353+14	.9271205+14	.8549075+14	.7770288+14
19 .8065325+14	.5733153+14	.5357211+14	.4943269+14	.4498394+14
20 .2592500+14	.2450879+14	.2290793+14	.2114816+14	.1926086+14
1 .1106565+16	.9667500+15	.8207621+15	.5789679+15	.3701431+15
2 .1098763+16	.9599254+15	.8149627+15	.5748729+15	.3675217+15
3 .1083206+16	.9463174+15	.8033980+15	.5667068+15	.3622939+15
4 .1059990+16	.9260073+15	.7861359+15	.5545163+15	.3544892+15
				.1461538+01
				.4384615+01
				.7307692+01
				.1023077+02
				.1315385+02
				.1607692+02
				.1900000+02
				.2192308+02
				.2484615+02
				.2776923+02
				.3069231+02
				.3361538+02
				.3653846+02
				.4014286+02
				.4442857+02
				.4871429+02
				.5300000+02
				.5728571+02
				.6157143+02
				.6585714+02
				.1461538+01
				.4384615+01
				.7307692+01
				.1023077+02
				.1315385+02
				.1607692+02
				.1900000+02
				.2192308+02
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				.2776923+02
				.3069231+02
				.3361538+02
				.3653846+02
				.4014286+02
				.4442857+02
				.4871429+02
				.5300000+02
				.5728571+02
				.6157143+02
				.6585714+02
				.1461538+01
				.4384615+01
				.7307692+01
				.1023077+02

5	.1029255+16	.8991143+15	.7632753+15	.5383694+15	.3441506+15	.1315385+02
6	.9911824+15	.8657930+15	.7349434+15	.5183526+15	.3313325+15	.1607692+02
7	.9459930+15	.8262288+15	.7012906+15	.4945660+15	.3160985+15	.1900000+02
8	.8939412+15	.7806323+15	.6624837+15	.4671154+15	.2985170+15	.2192308+02
9	.8353100+15	.7292330+15	.6186954+15	.4360976+15	.2786552+15	.2484615+02
10	.7704065+15	.6722735+15	.5700907+15	.4015721+15	.2565725+15	.2776923+02
11	.6995612+15	.6100090+15	.5168104+15	.3634966+15	.2323147+15	.3069231+02
12	.6231314+15	.5427253+15	.4589646+15	.3215660+15	.2059279+15	.3361538+02
13	.5415109+15	.4708042+15	.3966979+15	.2747681+15	.1775620+15	.3653846+02
14	.4932565+15	.3405071+15	.2832551+15	.2073095+15	.1410213+15	.4014286+02
15	.2575943+15	.2232660+15	.1871791+15	.1443362+15	.1029791+15	.4442857+02
16	.1689748+15	.1470579+15	.1245936+15	.9883984+14	.7295741+14	.4871429+02
17	.1099575+15	.9615495+14	.8221165+14	.6640696+14	.5020501+14	.5300000+02
18	.0948996+14	.6103114+14	.5255111+14	.4297188+14	.3303494+14	.5728571+02
19	.4031256+14	.3552377+14	.3074105+14	.2534205+14	.1969889+14	.6157143+02
20	.1728395+14	.1526222+14	.1324639+14	.1097054+14	.8581436+13	.6585714+02
	16	17	18	19	20	
1	.2368710+15	.1502699+15	.9251919+14	.5223892+14	.2174141+14	.1461538+01
2	.2351917+15	.1492042+15	.9186331+14	.5186890+14	.2158754+14	.4384615+01
3	.2318430+15	.1470794+15	.9055587+14	.5113149+14	.2128095+14	.7307692+01
4	.2268441+15	.1439084+15	.8860559+14	.5003200+14	.2082397+14	.1023077+02
5	.2202235+15	.1397109+15	.8602584+14	.4857869+14	.2022025+14	.1315385+02
6	.2120182+15	.1345133+15	.8283500+14	.4678307+14	.1947488+14	.1607692+02
7	.2022733+15	.1283491+15	.7905735+14	.4466056+14	.1859475+14	.1900000+02
8	.1910417+15	.1212610+15	.7472454+14	.4223146+14	.1758892+14	.2192308+02
9	.1783856+15	.1133032+15	.6987813+14	.3952244+14	.1646925+14	.2484615+02
10	.1643811+15	.1045484+15	.6457361+14	.3656854+14	.1525107+14	.2776923+02
11	.1491332+15	.9509864+14	.5888615+14	.3341546+14	.1395394+14	.3069231+02
12	.1328106+15	.8510436+14	.5291774+14	.3012176+14	.1260211+14	.3361538+02
13	.1157224+15	.7479017+14	.4680307+14	.2675940+14	.1122428+14	.3653846+02
14	.9442986+14	.6207238+14	.3928806+14	.2263030+14	.9532303+13	.4014286+02
15	.7131991+14	.4799504+14	.3087466+14	.1797464+14	.7616895+13	.4442857+02
16	.5200570+14	.3578983+14	.2340462+14	.1377843+14	.5876143+13	.4871429+02
17	.3660556+14	.2567503+14	.1703891+14	.1013492+14	.4348493+13	.5300000+02
18	.2449332+14	.1743650+14	.1171067+14	.7026007+13	.3030299+13	.5728571+02
19	.1477377+14	.1062823+14	.7200478+13	.4348049+13	.1883051+13	.6157143+02
20	.0478590+13	.4689624+13	.3193954+13	.1936704+13	.8414951+12	.6585714+02

TOTAL FLUX

	1	2	3	4	5	
1	.5974732+16	.5924323+16	.5824059+16	.5675202+16	.5479626+16	.1461538+01
2	.5933154+16	.5883090+16	.5783511+16	.5635672+16	.5441434+16	.4384615+01
3	.5850291+16	.5800913+16	.5702700+16	.5556891+16	.5365321+16	.7307692+01
4	.5726727+16	.5678372+16	.5582197+16	.5439413+16	.5251822+16	.1023077+02
5	.5563328+16	.5516326+16	.5422846+16	.5284066+16	.5101735+16	.1315385+02
6	.5361236+16	.5315910+16	.5225766+16	.5091939+16	.4916115+16	.1607692+02
7	.5121859+16	.5078520+16	.4992331+16	.4864375+16	.4696262+16	.1900000+02
8	.4846850+16	.4805798+16	.4724158+16	.4602955+16	.4443711+16	.2192308+02
9	.4538091+16	.4499611+16	.4423090+16	.4309482+16	.4160208+16	.2484615+02
10	.4197664+16	.4162029+16	.4091165+16	.3985952+16	.3847697+16	.2776923+02
11	.3827822+16	.3795287+16	.3730590+16	.3634526+16	.3508279+16	.3069231+02
12	.3430947+16	.3401753+16	.3343698+16	.3257489+16	.3144181+16	.3361538+02
13	.3009508+16	.2983876+16	.2932903+16	.2857206+16	.2757701+16	.3653846+02
14	.2225105+16	.2206129+16	.2168392+16	.2112345+16	.2038657+16	.4014286+02
15	.1476553+16	.1463935+16	.1438842+16	.1401570+16	.1352554+16	.4442857+02
16	.9756704+15	.9673160+15	.9507023+15	.9260242+15	.8935700+15	.4871429+02
17	.6372561+15	.6317904+15	.6209230+15	.6047824+15	.5835606+15	.5300000+02
18	.4042991+15	.4008281+15	.3939277+15	.3836819+15	.3702166+15	.5728571+02
19	.2377606+15	.2357187+15	.2316599+15	.2256354+15	.2177218+15	.6157143+02
20	.1096872+15	.1087452+15	.1068731+15	.1040950+15	.1004473+15	.6585714+02
	6	7	8	9	10	
1	.5239789+16	.4958694+16	.4639841+16	.4287170+16	.3904996+16	.1461538+01
2	.5203240+16	.4924073+16	.4607409+16	.4257165+16	.3877627+16	.4384615+01
3	.5130401+16	.4855073+16	.4542772+16	.4197361+16	.3823076+16	.7307692+01
4	.5021782+16	.4752179+16	.4446378+16	.4108172+16	.3741713+16	.1023077+02
5	.4878148+16	.4616111+16	.4318902+16	.3990212+16	.3634090+16	.1315385+02
6	.4700508+16	.4447826+16	.4161232+16	.3844297+16	.3500940+16	.1607692+02
7	.4490109+16	.4248504+16	.3974474+16	.3671441+16	.3343169+16	.1900000+02
8	.4248424+16	.4019544+16	.3759936+16	.3472848+16	.3161859+16	.2192308+02
9	.3977135+16	.3762550+16	.3519130+16	.3249914+16	.2958268+16	.2484615+02
10	.3678117+16	.3479314+16	.3253751+16	.3004221+16	.2733832+16	.2776923+02
11	.3353402+16	.3171793+16	.2965667+16	.2737536+16	.2490187+16	.3069231+02
12	.3065148+16	.2842067+16	.2656886+16	.2451791+16	.2229182+16	.3361538+02
13	.2635580+16	.2492291+16	.2329498+16	.2149044+16	.1952884+16	.3653846+02
14	.1948192+16	.1841993+16	.1721236+16	.1587172+16	.1441004+16	.4014286+02
15	.1292360+16	.1221664+16	.1141228+16	.1051861+16	.9543700+15	.4442857+02
16	.8537148+15	.8069126+15	.7536871+15	.6946250+15	.6303800+15	.4871429+02
17	.5575106+15	.5269439+15	.4922318+15	.4538114+15	.4122039+15	.5300000+02
18	.3536996+15	.3343417+15	.3123998+15	.2881846+15	.2620750+15	.5728571+02
19	.2060224+15	.1966682+15	.1838212+15	.1696792+15	.1544834+15	.6157143+02
20	.9597908+14	.9075317+14	.8484756+14	.7855764+14	.7139920+14	.6585714+02
	11	12	13	14	15	

1	.3497933+16	.3070810+16	.2628580+16	.1883105+16	.1217376+16	.1461538+01
2	.3473382+16	.3049229+16	.2610087+16	.1869640+16	.1208785+16	.4384615+01
3	.3424445+16	.3006208+16	.2573219+16	.1843393+16	.1191657+16	.7307692+01
4	.3351447+16	.2942026+16	.2518210+16	.1803926+16	.1166094+16	.1023077+02
5	.3254873+16	.2857097+16	.2445406+16	.1751680+16	.1132246+16	.1315385+02
6	.3135362+16	.2751966+16	.2355257+16	.1686962+16	.1090305+16	.1607692+02
7	.2993705+16	.2627299+16	.2248306+16	.1610133+16	.1040499+16	.1900000+02
8	.2830840+16	.2483875+16	.2125171+16	.1521587+16	.9830706+15	.2192308+02
9	.2647853+16	.2322579+16	.1986527+16	.1421698+16	.9182639+15	.2484615+02
10	.2445991+16	.2144405+16	.1833065+16	.1310729+16	.8462896+15	.2776923+02
11	.2226696+16	.1950488+16	.1665467+16	.1188598+16	.7672948+15	.3069231+02
12	.1991679+16	.1742217+16	.1484417+16	.1054289+16	.6813815+15	.3361538+02
13	.1743033+16	.1521548+16	.1290900+16	.9041894+15	.5889037+15	.3653846+02
14	.1283615+16	.1114861+16	.9314782+15	.6858348+15	.4693654+15	.4014286+02
15	.8494930+15	.7378730+15	.6203598+15	.4802796+15	.3441752+15	.4442857+02
16	.7617110+15	.4896084+15	.4156236+15	.3306163+15	.2448280+15	.4871429+02
17	.3660569+15	.3222239+15	.2758872+15	.2232905+15	.1692270+15	.5300000+02
18	.2345415+15	.2061775+15	.1777266+15	.1455567+15	.1121248+15	.5728571+02
19	.1385283+15	.1221700+15	.1058261+15	.8736295+14	.6803778+14	.6157143+02
20	.6411145+14	.5665828+14	.4922484+14	.4082738+14	.3200051+14	.6585714+02
	16	17	18	19	20	
1	.7858487+15	.5022852+15	.3120065+15	.1795094+15	.8085288+14	.1461538+01
2	.7802955+15	.4987331+15	.3098002+15	.1782408+15	.8028195+14	.4384615+01
3	.7692231+15	.4916516+15	.3054026+15	.1757129+15	.7914442+14	.7307692+01
4	.7526983+15	.4810858+15	.2988438+15	.1719443+15	.7744919+14	.1023077+02
5	.7308203+15	.4671032+15	.2901699+15	.1669638+15	.7521000+14	.1315385+02
6	.7037181+15	.4497947+15	.2794442+15	.1608118+15	.7244618+14	.1607692+02
7	.6715484+15	.4292760+15	.2667499+15	.1535417+15	.6918363+14	.1900000+02
8	.6344948+15	.4056920+15	.2521948+15	.1452240+15	.6545638+14	.2192308+02
9	.5927696+15	.3792263+15	.2359196+15	.1359506+15	.6130865+14	.2484615+02
10	.5466278+15	.3501203+15	.2181104+15	.1258412+15	.5679739+14	.2776923+02
11	.4964081+15	.3187095+15	.1990178+15	.1150517+15	.5199481+14	.3069231+02
12	.4420433+15	.2854841+15	.1789799+15	.1037806+15	.4699002+14	.3361538+02
13	.3863082+15	.2511751+15	.1584428+15	.9227164+14	.4188815+14	.3653846+02
14	.3159869+15	.2088246+15	.1331841+15	.7813081+14	.3562037+14	.4014286+02
15	.2393743+15	.1618339+15	.1048604+15	.6216719+14	.2851678+14	.4442857+02
16	.1751043+15	.1209925+15	.7967130+14	.4776041+14	.2205238+14	.4871429+02
17	.1237270+15	.8709810+14	.5819115+14	.3524596+14	.1637628+14	.5300000+02
18	.8333526+14	.5952971+14	.4024823+14	.2459148+14	.1148866+14	.5728571+02
19	.5114741+14	.3692238+14	.2518354+14	.1548960+14	.7269815+13	.6157143+02
20	.2421994+14	.1759618+14	.1206859+14	.7457447+13	.3517457+13	.6585714+02

POWER DENSITY (MWT/LITER)

	1	2	3	4	5	
1	.7480928-00	.7423760-00	.7298118-00	.7111583-00	.6866504-00	.1461538+01
2	.7434826-00	.7372090-00	.7247307-00	.7062048-00	.6818646-00	.4384615+01
3	.7330990-00	.7269114-00	.7146042-00	.6963326-00	.6723267-00	.7307692+01
4	.7176150-00	.7115555-00	.6995037-00	.6816113-00	.6581039-00	.1023077+02
5	.6971391-00	.6912493-00	.6795352-00	.6621445-00	.6392963-00	.1315385+02
6	.6718146-00	.6661347-00	.6548387-00	.6380686-00	.6160359-00	.1607692+02
7	.6418170-00	.6363867-00	.6255863-00	.6095519-00	.5884856-00	.1900000+02
8	.6073553-00	.6022110-00	.5919807-00	.5767926-00	.5568375-00	.2192308+02
9	.5686634-00	.5638415-00	.5542526-00	.5400163-00	.5213107-00	.2484615+02
10	.5260027-00	.5215373-00	.5126573-00	.4994731-00	.4821483-00	.2776923+02
11	.4796552-00	.4755783-00	.4674712-00	.4554335-00	.4396136-00	.3069231+02
12	.4299193-00	.4262610-00	.4189862-00	.4081837-00	.3939852-00	.3361538+02
13	.3771038-00	.3738919-00	.3675047-00	.3580195-00	.3455509-00	.3653846+02
14	.7392919-01	.7825714-01	.7692089-01	.7493663-01	.7232835-01	.4014286+02
15	.5264189-01	.5219268-01	.5129947-01	.4997290-01	.4822868-01	.4442857+02
16	.5492052-01	.5462189-01	.5402808-01	.5314612-01	.5198643-01	.4871429+02
17	.2288360-01	.2268756-01	.2229778-01	.2171891-01	.2095791-01	.5300000+02
18	.1487286-01	.1444788-01	.1419941-01	.1383052-01	.1334575-01	.5728571+02
19	.8635490-02	.8561391-02	.8414115-02	.8195518-02	.7908399-02	.6157143+02
20	.4104611-02	.4069388-02	.3999389-02	.3895519-02	.3759141-02	.6585714+02
	6	7	8	9	10	
1	.0565960-00	.6213713-00	.5814149-00	.5372205-00	.4893285-00	.1461538+01
2	.0520160-00	.6170329-00	.5773508-00	.5334605-00	.4858989-00	.4384615+01
3	.0428883-00	.6083864-00	.5692510-00	.5259665-00	.4790631-00	.7307692+01
4	.0292772-00	.5954926-00	.5571719-00	.5147901-00	.4688675-00	.1023077+02
5	.0112782-00	.5784418-00	.5411977-00	.5000084-00	.4553813-00	.1315385+02
6	.5890178-00	.5573536-00	.5214399-00	.4817237-00	.4386961-00	.1607692+02
7	.5626522-00	.5323762-00	.4980368-00	.4600628-00	.4189257-00	.1900000+02
8	.5323659-00	.5036845-00	.4711526-00	.4351767-00	.3962055-00	.2192308+02
9	.4983697-00	.4714797-00	.4409763-00	.4072402-00	.3706930-00	.2484615+02
10	.4608982-00	.4359861-00	.4077204-00	.3764515-00	.3425682-00	.2776923+02
11	.4202060-00	.3974486-00	.3716189-00	.3430316-00	.3120358-00	.3069231+02
12	.3765632-00	.3561278-00	.3329230-00	.3072227-00	.2793275-00	.3361538+02
13	.3302485-00	.3122934-00	.2918945-00	.2692822-00	.2447018-00	.3653846+02
14	.0912724-01	.6537083-01	.6110172-01	.5636531-01	.5120537-01	.4014286+02
15	.4608719-01	.4357282-01	.4071308-01	.3753723-01	.3407425-01	.4442857+02
16	.5056252-01	.2839078-01	.2699009-01	.2488155-01	.2258855-01	.4871429+02
17	.2002388-01	.1892809-01	.1768390-01	.1630702-01	.1481614-01	.5300000+02
18	.1275117-01	.1205441-01	.1126473-01	.1039335-01	.9453884-02	.5728571+02
19	.7566516-02	.7144642-02	.6678667-02	.6165773-02	.5614708-02	.6157143+02
20	.5592101-02	.5396755-02	.5176024-02	.4933480-02	.4673452-02	.6585714+02
	11	12	13	14	15	
1	.4385169-00	.3847909-00	.3293705-00	.6687109-01	.4344280-01	.1461538+01
2	.4352406-00	.3820867-00	.3270532-00	.6640088-01	.4313674-01	.4384615+01

3	.4291083-00	.3766958-00	.3224334-00	.6546349-01	.4252653-01	.7307692+01
4	.4199610-00	.3686533-00	.3155405-00	.6406488-01	.4161593-01	.1023077+02
5	.4078594-00	.3580111-00	.3064178-00	.6221386-01	.4041045-01	.1315385+02
6	.3928835-00	.3448373-00	.2951217-00	.5992174-01	.3891718-01	.1607692+02
7	.3751325-00	.3292155-00	.2817200-00	.5720195-01	.3714443-01	.1900000+02
8	.3547238-00	.3112432-00	.2662906-00	.5406919-01	.3510125-01	.2192308+02
9	.3317934-00	.2910312-00	.2489174-00	.5053776-01	.3279665-01	.2484615+02
10	.3064977-00	.2687041-00	.2296875-00	.4661803-01	.3023840-01	.2776923+02
11	.2790170-00	.2444040-00	.2086860-00	.4230799-01	.2743171-01	.3069231+02
12	.2495656-00	.2183048-00	.1859985-00	.3757116-01	.2437941-01	.3361538+02
13	.2184057-00	.1906514-00	.1617484-00	.3227428-01	.2109201-01	.3653846+02
14	.4565414-01	.3970587-01	.3323837-01	.2453692-01	.1683621-01	.4014286+02
15	.3035027-01	.2638705-01	.2221182-01	.1722588-01	.1236760-01	.4442857+02
16	.2013799-01	.1756466-01	.1492289-01	.1188460-01	.8812856-02	.4871429+02
17	.1323433-01	.1159194-01	.9930932-02	.8044381-02	.6102987-02	.5300000+02
18	.8463201-02	.7442544-02	.6418511-02	.5260153-02	.4055420-02	.5728571+02
19	.5036122-02	.4442884-02	.3850071-02	.3160191-02	.2478631-02	.6157143+02
20	.2401132-02	.2122629-02	.1844835-02	.1530943-02	.1200839-02	.6585714+02
	16	17	18	19	20	
1	.2814945-01	.1804998-01	.1125446-01	.6525936-02	.3031007-02	.1461538+01
2	.2795081-01	.1792249-01	.1117496-01	.6479862-02	.3009621-02	.4384615+01
3	.2755476-01	.1766833-01	.1101651-01	.6388051-02	.2967014-02	.7307692+01
4	.2696376-01	.1728915-01	.1078020-01	.6251189-02	.2903521-02	.1023077+02
5	.2618143-01	.1678740-01	.1046771-01	.6070331-02	.2819661-02	.1315385+02
6	.2521246-01	.1616641-01	.1008135-01	.5846949-02	.2716163-02	.1607692+02
7	.2406260-01	.1543036-01	.9624143-02	.5583004-02	.2594002-02	.1900000+02
8	.2273855-01	.1458452-01	.9099987-02	.5281060-02	.2454458-02	.2192308+02
9	.2124801-01	.1363550-01	.8513963-02	.4944460-02	.2299190-02	.2484615+02
10	.1960012-01	.1259197-01	.7872772-02	.4577556-02	.2130334-02	.2776923+02
11	.1780691-01	.1146590-01	.7185407-02	.4185989-02	.1950588-02	.3069231+02
12	.1588702-01	.1027470-01	.6463976-02	.3776942-02	.1763278-02	.3361538+02
13	.1387459-01	.9044334-02	.5724450-02	.3359213-02	.1572324-02	.3653846+02
14	.1136058-01	.7524882-02	.4814624-02	.2845851-02	.1337695-02	.4014286+02
15	.8617177-02	.5837213-02	.3793703-02	.2266022-02	.1071665-02	.4442857+02
16	.6312020-02	.4368862-02	.2885137-02	.1742464-02	.8294548-03	.4871429+02
17	.4467251-02	.3149536-02	.2110127-02	.1287597-02	.6167381-03	.5300000+02
18	.3017186-02	.2158376-02	.1463295-02	.9006892-03	.4337120-03	.5728571+02
19	.1865099-02	.1348262-02	.9221015-03	.5712956-03	.2762124-03	.6157143+02
20	.9097074-03	.6617982-03	.4550567-03	.2830823-03	.1372130-03	.6585714+02

FISSION SOURCE RATE

1	2	3	4	5	
1 .0313339+14	.6260073+14	.6154128+14	.5996838+14	.5790185+14	.1461538+01
2 .0269407+14	.6216505+14	.6111283+14	.5955069+14	.5749831+14	.4384615+01
3 .0181851+14	.6129074+14	.6025896+14	.5871826+14	.5669406+14	.7307692+01
4 .0051289+14	.6000193+14	.5898568+14	.5747696+14	.5549479+14	.1023077+02
5 .5678637+14	.5828971+14	.5730195+14	.5583552+14	.5390893+14	.1315385+02
6 .5665104+14	.5617203+14	.5521956+14	.5380547+14	.5194764+14	.1607692+02
7 .5412177+14	.5366381+14	.5275308+14	.5140102+14	.4962467+14	.1900000+02
8 .5121607+14	.5078227+14	.4991961+14	.4863890+14	.4695624+14	.2192308+02
9 .4795384+14	.4754722+14	.4673863+14	.4553817+14	.4396085+14	.2484615+02
10 .4435712+14	.4398056+14	.4323174+14	.4211997+14	.4065906+14	.2776923+02
11 .4044978+14	.4010598+14	.3942230+14	.3840719+14	.3707314+14	.3069231+02
12 .3625707+14	.3594855+14	.3533505+14	.3442405+14	.3322668+14	.3361538+02
13 .3180517+14	.3153428+14	.3099559+14	.3019563+14	.2914406+14	.3653846+02
14 .5488269+13	.6433024+13	.6323177+13	.6160062+13	.5945651+13	.4014286+02
15 .4327355+13	.4290429+13	.4217003+13	.4107953+13	.3964571+13	.4442857+02
16 .2870594+13	.2846045+13	.2797231+13	.2724731+13	.2629399+13	.4871429+02
17 .1881115+13	.1864999+13	.1832957+13	.1785373+13	.1722815+13	.5300000+02
18 .1197942+13	.1187067+13	.1167243+13	.1136918+13	.1097068+13	.5728571+02
19 .7098683+12	.7037770+12	.6916703+12	.6737008+12	.6500984+12	.6157143+02
20 .5374137+12	.3345182+12	.3287640+12	.3202254+12	.3090146+12	.6585714+02
6	7	8	9	10	
1 .5536767+14	.5239750+14	.4902859+14	.4530235+14	.4126449+14	.1461538+01
2 .5498149+14	.5203176+14	.4868590+14	.4498530+14	.4097529+14	.4384615+01
3 .5421183+14	.5130268+14	.4800290+14	.4435338+14	.4039886+14	.7307692+01
4 .5306412+14	.5021546+14	.4698437+14	.4341095+14	.3953912+14	.1023077+02
5 .5154644+14	.4877772+14	.4563740+14	.4216452+14	.3840191+14	.1315385+02
6 .4966946+14	.4699958+14	.4397142+14	.4062273+14	.3699496+14	.1607692+02
7 .4744637+14	.4489352+14	.4199809+14	.3879628+14	.3532788+14	.1900000+02
8 .4489275+14	.4247434+14	.3973129+14	.3669793+14	.3341212+14	.2192308+02
9 .4202641+14	.3975901+14	.3718698+14	.3434243+14	.3126095+14	.2484615+02
10 .3866717+14	.3676851+14	.3438312+14	.3174654+14	.2888962+14	.2776923+02
11 .3543658+14	.3351755+14	.3133950+14	.2892896+14	.2631542+14	.3069231+02
12 .3175748+14	.3003419+14	.2807738+14	.2591017+14	.2355795+14	.3361538+02
13 .2785351+14	.2633927+14	.2461894+14	.2271199+14	.2063912+14	.3653846+02
14 .2682507+13	.5373716+13	.5022779+13	.4633428+13	.4209261+13	.4014286+02
15 .5788532+13	.3581842+13	.3346760+13	.3085693+13	.2801023+13	.4442857+02
16 .2512348+13	.2374925+13	.2218681+13	.2045351+13	.1856858+13	.4871429+02
17 .1646034+13	.1555956+13	.1453679+13	.1340495+13	.1217939+13	.5300000+02
18 .1048191+13	.9909148+12	.9260008+12	.8543701+12	.7771424+12	.5728571+02
19 .0211722+12	.5873147+12	.5490099+12	.5068482+12	.4615487+12	.6157143+02
20 .2952833+12	.2792251+12	.2610802+12	.2411423+12	.2197670+12	.6585714+02
11	12	13	14	15	
1 .5696381+14	.3245143+14	.2777974+14	.5497041+13	.3571152+13	.1461538+01
2 .5670439+14	.3222337+14	.2758430+14	.5458386+13	.3545993+13	.4384615+01
3 .5618727+14	.3176875+14	.2719468+14	.5381331+13	.3495831+13	.7307692+01
4 .5541590+14	.3109051+14	.2661334+14	.5266361+13	.3420976+13	.1023077+02

5	.3439541+14	.3019305+14	.2584396+14	.5114199+13	.3321882+13	.1315385+02
6	.3313256+14	.2908211+14	.2489128+14	.4925779+13	.3199130+13	.1607692+02
7	.3163572+14	.2776474+14	.2376104+14	.4702203+13	.3053403+13	.1900000+02
8	.2991479+14	.2624918+14	.2245980+14	.4444678+13	.2885446+13	.2192308+02
9	.2798129+14	.2454480+14	.2099468+14	.4154381+13	.2696000+13	.2484615+02
10	.2564841+14	.2266213+14	.1937301+14	.3832166+13	.2485703+13	.2776923+02
11	.2353141+14	.2061317+14	.1760201+14	.3477865+13	.2254982+13	.3069231+02
12	.2104842+14	.1841265+14	.1568694+14	.3086481+13	.2004073+13	.3361538+02
13	.1842164+14	.1608129+14	.1364425+14	.2653059+13	.1733836+13	.3653846+02
14	.3752930+13	.3263962+13	.2732310+13	.2017021+13	.1383995+13	.4014286+02
15	.2494898+13	.2169107+13	.1825889+13	.1416027+13	.1016659+13	.4442857+02
16	.1655413+13	.1443876+13	.1226713+13	.9769551+12	.7244472+12	.4871429+02
17	.1087908+13	.9528973+12	.8163569+12	.6612758+12	.5016865+12	.5300000+02
18	.0957045+12	.6118028+12	.5276237+12	.4324026+12	.3333694+12	.5728571+02
19	.4139868+12	.3652204+12	.3164891+12	.2614226+12	.2037519+12	.6157143+02
20	.1973814+12	.1744874+12	.1516517+12	.1258487+12	.9871304+11	.6585714+02
	16	17	18	19	20	
1	.2313984+13	.1483772+13	.9251563+12	.5364549+12	.2491592+12	.1461538+01
2	.2297655+13	.1473291+13	.9186212+12	.5326675+12	.2474012+12	.4384615+01
3	.2265099+13	.1452399+13	.9055958+12	.5251203+12	.2438988+12	.7307692+01
4	.2216516+13	.1421228+13	.8861705+12	.5138697+12	.2386794+12	.1023077+02
5	.2152205+13	.1379983+13	.8604831+12	.4990026+12	.2317858+12	.1315385+02
6	.2072553+13	.1328935+13	.8287229+12	.4806398+12	.2232779+12	.1607692+02
7	.1978031+13	.1268430+13	.7911385+12	.4589425+12	.2132358+12	.1900000+02
8	.1869188+13	.1198899+13	.7480510+12	.4341217+12	.2017648+12	.2192308+02
9	.1746660+13	.1120886+13	.6998777+12	.4064519+12	.1890013+12	.2484615+02
10	.1611199+13	.1035104+13	.6471696+12	.3762912+12	.1751207+12	.2776923+02
11	.1463790+13	.9425366+12	.5906657+12	.3441030+12	.1603449+12	.3069231+02
12	.1305969+13	.8446156+12	.5313616+12	.3104778+12	.1449474+12	.3361538+02
13	.1140539+13	.7434755+12	.4705699+12	.2761391+12	.1292503+12	.3653846+02
14	.9338794+12	.6185713+12	.3957790+12	.2339389+12	.1099630+12	.4014286+02
15	.7083618+12	.4798390+12	.3118557+12	.1862750+12	.8809446+11	.4442857+02
16	.5188698+12	.3591354+12	.2371683+12	.1432366+12	.6818395+11	.4871429+02
17	.3672233+12	.2589027+12	.1734598+12	.1058449+12	.5069793+11	.5300000+02
18	.2480230+12	.1774259+12	.1202880+12	.7403980+11	.3565256+11	.5728571+02
19	.1533175+12	.1108317+12	.7579997+11	.4696251+11	.2270556+11	.6157143+02
20	.7478100+11	.5440202+11	.3740721+11	.2327032+11	.1127929+11	.6585714+02

2 L B SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 210.59 LITERS	ZONE 2 896.86 LITERS
1 U238	238.050	6.659+02	0.000
2 PU239	239.050	1.337+02	0.000
3 PU240	240.050	8.393+00	0.000
4 PU241	241.060	0.000	0.000
5 FIS PR	1.000	0.000	0.000
6 C	12.011	8.399+01	0.000
7 NA	22.990	4.823+01	0.000
8 FE	55.847	2.538+02	0.000
9 U238	238.050	0.000	1.418+04
10 FE	55.847	0.000	5.156+02

BURNUP DATA

BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	LAMBDA (DAYS-1)	NBR	* * * * *	SOURCE ISOTOPE FOR CAPTURE	* * * * *
					DECAY		FISSION
1	1	U238	.000	1	0	0 0	0 0 0 0 0 0
2	2	PU239	.000	2	0	1 6	0 0 0 0 0 0
3	3	PU240	.000	1	0	2 0	0 0 0 0 0 0
4	4	PU241	.780-07	2	0	3 0	0 0 0 0 0 0
5	5	FIS PR	.000	0	0	0 0	1 2 3 4 6 0 0
6	9	U238	.000	1	0	0 0	0 0 0 0 0 0

D-24

RNWL-831

Z O T I E 1 FLUX = 3.3289+15 VOLUME = 2.1059+02 LITERS

PORTABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	8.000-03	5.938+17	1.837+18	6.844-02	3.276-01
2	2	PU239	1.600-03	2.133+18	2.567+18	1.901+00	2.289+00
3	3	PU240	1.000-04	3.387+18	8.177+16	4.831-01	1.166+00
4	4	PU241	0.000	0.000	0.000	1.981+00	2.203+00
5	5	FIS PR	0.000	0.000	0.000	0.000	2.658-01
6	9	U238	0.000	0.000	0.000	2.545-02	2.575-01

		Z O N E 2	FLUX = 3.7838+14		VOLUME = 8.9686+02 LITERS		
BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	0.000	0.000	0.000	6.994-02	3.231-01
2	2	PU239	0.000	0.000	0.000	1.893+00	2.268+00
3	3	PU240	0.000	0.000	0.000	4.932-01	1.157+00
4	4	PU241	0.000	0.000	0.000	1.970+00	2.188+00
5	5	FIS PR	0.000	0.000	0.000	0.000	2.617-01
6	9	U238	4.000-02	3.530+17	3.452+18	2.600-02	2.543-01

BREEDING RATIO = 1.7918

T I M E = 50.000 D A Y S

MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY	
1	11	0	.00000000
2	11	1	.79622954-02
3	11	2	.15773843-02
4	11	3	.10713267-03
5	11	4	.10051069-05
6	11	5	.52081054-04
7	11	6	.20000000-01
8	11	7	.59999999-02
9	11	8	.13000000-01
10	12	0	.00000000
11	12	9	.39983329-01
12	12	2	.14939144-04
13	12	10	.61999999-02

TIME (MINUTES)	OUTER ITERATIONS	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.30	0	0	.00000000	.98668909-00	.00000000
.33	1	26	.00000000	.98081362-00	.98081361-00
.35	2	22	.00000000	.98037536-00	.99955316-00
.36	3	7	.00000000	.98030929-00	.99993258-00
.37	4	3	.00000000	.98028586-00	.99997609-00
.38	5	2	.00000000	.98027837-00	.99999233-00

2 D B SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 210.59 LITERS	ZONE 2 896.86 LITERS
1 U238	238.050	6.627+02	0.000
2 PU239	239.050	1.318+02	5.318+00
3 PU240	240.050	8.992+00	0.000
4 PU241	241.060	8.471+02	0.000
5 FIS PK	1.000	1.821+02	0.000
6 C	12.011	8.399+01	0.000
7 NA	22.990	4.823+01	0.000
8 FL	55.847	2.538+02	0.000
9 U238	238.050	0.000	1.417+04
10 FL	55.847	0.000	5.156+02

		Z O N E 1	FLUX = 3.3479+15		VOLUME = 2.1059+02 LITERS		
BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	7.962-03	3.837+17	1.840+18	6.835-02	3.278-01
2	2	PU239	1.577-03	2.115+18	2.547+18	1.902+00	2.290+00
3	3	PU240	1.071-04	3.644+16	8.815+16	4.825-01	1.167+00
4	4	PU241	1.005-06	1.404+15	1.562+15	1.982+00	2.204+00
5	5	FIS PR	5.208-05	0.000	9.767+15	0.000	2.660-01
6	9	U238	0.000	0.000	0.000	2.541-02	2.577-01

Z O N E 2 FLUX = 3.9247+14 VOLUME = 8.9686+02 LITERS

BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	0.000	0.000	0.000	7.000-02	3.229-01
2	2	PU239	1.494-05	9.699+15	1.162+16	1.893+00	2.267+00
3	3	PU240	0.000	0.000	0.000	4.936-01	1.157+00
4	4	PU241	0.000	0.000	0.000	1.969+00	2.187+00
5	5	FIS PR	0.000	0.000	0.000	0.000	2.615-01
6	9	U238	3.098-02	3.570+17	3.486+18	2.603-02	2.542-01

BREEDING RATIO = 1.8114

T I M E = 100.000 D A Y S

MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	11	0
2	11	1
3	11	2
4	11	3
5	11	4
6	11	5
7	11	6
8	11	7
9	11	8
10	12	0
11	12	9
12	12	2
13	12	10

.00000000
.79245276-02
.15552556-02
.11407688-03
.20546357-05
.10367878-03
.20000000-01
.59999999-02
.13000000-01
.00000000
.39966496-01
.29965160-04
.61999999-02

TIME (MINUTES)	OUTER ITERATIONS	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.39	0	0	.00000000	.98027837-00	.00000000
.41	1	26	.00000000	.97454549-00	.97454548-00
.44	2	24	.00000000	.97406803-00	.99951005-00
.45	3	8	.00000000	.97399943-00	.99992955-00
.46	4	3	.00000000	.97397433-00	.99997424-00
.47	5	2	.00000000	.9739561-00	.99999122-00

2 C U SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 210.59 LITERS	ZONE 2 896.86 LITERS
1 U238	238.050	6.596+02	0.000
2 PU239	239.050	1.300+02	1.067+01
3 PU240	240.050	9.575+00	0.000
4 PU241	241.060	1.732+01	0.000
5 FIS PK	1.000	3.625+02	0.000
6 C	12.011	8.399+01	0.000
7 HA	22.990	4.823+01	0.000
8 FE	55.847	2.538+02	0.000
9 U238	238.050	0.000	1.417+04
10 FE	55.847	0.000	5.156+02

APPENDIX E

FORTRAN-IV SOURCE DECK LISTING

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[illegible]

-ITC FOR CALC, CALC	2DB 0033
C	2DB 0034
C * * * * * DESCRIPTION OF SUBROUTINES * * * * *	2DB 0035
C	2DB 0036
C CALC MAIN PROGRAM--SETS UP TAPE UNITS AND CALLS INP, INIT,	2DB 0037
C FISCAL, S8830, ERRO2, OUTER, CNNP, S8850, GRAM,	2DB 0038
C INPB, AVERAG, AND MARCH.	2DB 0039
C	2DB 0040
C INP SUBROUTINE TO CONTROL THE READING AND PRINTING OF ALL	2DB 0041
C INPUT DATA, COMPUTE VARIABLE DIMENSION POINTERS AND	2DB 0042
C PROGRAM CONSTANTS. INP IS CALLED BY CALC AND CALLS	2DB 0043
C S860, S862, REAG2, REAI2, MAPR, AND ERRO2.	2DB 0044
C	2DB 0045
C ERRO2 ERRO2 IS USED TO PRINT AN ERROR MESSAGE. IT IS CALLED	2DB 0046
C BY CALC, INP, REAI2, REAG2, INIT, AND CNNP.	2DB 0047
C	2DB 0048
C S860 SUBROUTINE TO READ CROSS SECTIONS FROM CARDS, PERFORM	2DB 0049
C ADJOINT REVERSALS IF REQUIRED, AND WRITE CROSS SECTION	2DB 0050
C TAPE. S860 IS CALLED BY INP.	2DB 0051
C	2DB 0052
C S862 S862 READS INPUT FLUXES AND PREPARES A FLUX TAPE. IT IS	2DB 0053
C CALLED BY INP AND CALLS REAG2.	2DB 0054
C	2DB 0055
C REAG2 SUBROUTINE TO READ FLOATING POINT DATA. REAG2 IS CALLED	2DB 0056
C BY INP AND S862 AND CALLS ERRO2.	2DB 0057
C	2DB 0059
C REAI2 SUBROUTINE TO READ INTEGER DATA. REAI2 IS CALLED BY INP	2DB 0060
C AND CALLS ERRO2.	2DB 0061
C	2DB 0062
C MAPR SUBROUTINE TO PRODUCE A PICTURE BY ZONE AND	2DB 0063
C MATERIAL. MAPR IS CALLED BY INP.	2DB 0064
C	2DB 0065
C INIT INIT PERFORMS ADJOINT REVERSALS(S806), MIXES CROSS	2DB 0066
C SECTIONS(S807), MODIFIES GEOMETRY(S810), AND CALCULATES	2DB 0067
C AREAS AND VOLUMES(S811), AND FISSION NEUTRONS(S821).	2DB 0068
C INIT IS CALLED BY CALC AND CALLS CLEAR AND ERRO2.	2DB 0069
C	2DB 0070
C CLEAR CLEAR SETS AN ARRAY OF A SPECIFIED LENGTH TO A GIVEN	2DB 0071
C CONSTANT. THE SUBROUTINE IS CALLED BY INIT AND GRAM.	2DB 0072
C	2DB 0073
C FISCAL CALCULATES FISSION SUMS(S822) AND PERFORMS	2DB 0074
C NORMALIZATION(S823). FISCAL IS CALLED BY CALC.	2DB 0075
C	2DB 0076
C S8830 S8830 IS THE MONITOR PRINT SUBROUTINE--PRINTS TIME,	2DB 0077
C EIGENVALUE, LAMBDA, ETC. AFTER EACH OUTER ITERATION.	2DB 0078
C IT IS CALLED BY CALC AND S8850.	2DB 0079
C	2DB 0080
C OUTER PERFORMS A COMPLETE OUTER ITERATION. CALLS INNER1,	2DB 0081
C INNER, AND INNERP. OUTER IS CALLED BY CALC.	2DB 0082
C	2DB 0083
C INNER CALCULATES THE FLUX IN SPECIFIED GROUP. IT IS CALLED	2DB 0084
C BY OUTER AND CALLS IFLUXN.	2DB 0085
C	2DB 0086
C INNER1 CALCULATES COEFFICIENTS FOR THE FLUX EQUATION. INNER1	2DB 0087
C IS CALLED BY OUTER.	2DB 0088
C	2DB 0089
C INNER2 CALCULATES THE FLUX IN SPECIFIED GROUP. IT IS CALLED	2DB 0090
C BY OUTER AND CALLS IFLUXN.	2DB 0091
C	2DB 0092

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C	INNERP	CALCULATES THE FLUX IN SPECIFIED GROUP FOR PERIODIC B. C.	2DB 0093
C		IT IS CALLED BY OUTER AND CALLS IFLUXN.	2DB 0094
C			2DB 0095
C	IFLUXN	SUBROUTINE TO NORMALIZE THE FLUXES BEFORE EACH	2DB 0096
C		GROUP FLUX CALCULATION. IT IS CALLED BY INNER, INNER2,	2DB 0097
C		AND INNERP.	2DB 0098
C			2DB 0099
C	CNNP	PERFORMS CONVERGENCE TESTS(S851) AND COMPUTES A NEW	2DB 0100
C		EIGENVALUE FOR SEARCH OPTIONS(S852). CNNP IS CALLED	2DB 0101
C		BY CALC AND CALLS ERRO2 AND CLEAR.	2DB 0102
C			2DB 0103
C	S8850	FINAL PRINT SUBROUTINE--PRINTS THE MONITOR LINE,	2DB 0104
C		GROUP FLUXES, TOTAL FLUX, POWER DENSITY, AND FISSION	2DB 0105
C		SOURCE RATE. IT IS CALLED BY CALC AND CALLS PRT, S8830,	2DB 0106
C		AND S8847.	2DB 0107
C			2DB 0108
C	S8847	SUBROUTINE TO COMPUTE AND PRINT GROUP TOTALS. S8847 IS	2DB 0109
C		CALLED BY S8850.	2DB 0110
C			2DB 0111
C	PRT	SUBROUTINE TO PRINT ANY IM*JM ARRAY. IT IS CALLED BY	2DB 0112
C		S8850.	2DB 0113
C			2DB 0114
C	GRAM	CALCULATES AND PRINTS THE MASS OF EACH MATERIAL IN EACH	2DB 0115
C		ZONE AND THE ZONE VOLUME. IT IS CALLED BY CALC AND	2DB 0116
C		CALLS CLEAR.	2DB 0117
C			2DB 0118
C	INPB	SUBROUTINE TO READ AND PRINT THE INPUT BURNUP DATA. IT	2DB 0119
C		IS CALLED BY CALC.	2DB 0120
C			2DB 0121
C	AVERAG	AVERAG CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS	2DB 0122
C		SECTIONS, ABSORPTION CROSS SECTIONS, AND BREEDING RATIO.	2DB 0123
C		THE SUBROUTINE IS CALLED BY CALC.	2DB 0124
C			2DB 0125
C	MARCH	SUBROUTINE TO CALCULATE THE TIME DEPENDENT ISOTOPIC	2DB 0126
C		CONCENTRATIONS. MARCH IS CALLED BY CALC.	2DB 0127
C			2DB 0128
C	* * * * *	INTERNAL VARIABLES * * * * *	2DB 0129
C			2DB 0130
C	NINP	INPUT TAPE	2DB 0131
C	NOUT	OUTPUT TAPE	2DB 0132
C	NCR1	CROSS SECTION TAPE	2DB 0133
C	NFLUX1	FLUX TAPE	2DB 0134
C	NSCRAT	SCRATCH TAPE	2DB 0135
C	ALA	LAMBDA	2DB 0136
C	B07	USED FOR INTERNAL COMPUTATION IN FISCAL AND INIT	2DB 0137
C	CNT	CONVERGENCE TRIGGER FOR LAMBDA	2DB 0138
C	CVT	CONVERGENCE TRIGGER	2DB 0139
C	DAY	BURNUP TIME IN DAYS	2DB 0140
C	DELT	LENGTH OF TIME STEP (DAYS)	2DB 0141
C	E0(IGP)	FISSION RATE	2DB 0142
C	E1(IGP)	FISSION SOURCE	2DB 0143
C	E2(IGP)	IN-SCATTER	2DB 0144
C	E3(IGP)	OUT-SCATTER	2DB 0145
C	E4(IGP)	ABSORPTIONS	2DB 0146
C	E5(IGP)	LEFT LEAKAGE	2DB 0147
C	E6(IGP)	RIGHT LEAKAGE	2DB 0148
C	E7(IGP)	TOP LEAKAGE	2DB 0149
C	E8(IGP)	BOTTOM LEAKAGE	2DB 0150
C	E9(IGP)	TOTAL LEAKAGE	2DB 0151

C	E01	TEMPORARY	2DB 0152
C	E02	TEMPORARY	2DB 0153
C	E03	TEMPORARY	2DB 0154
C	EQ	TEMPORARY FOR S852 (CNNP)	2DB 0155
C	EVP	PREVIOUS EIGENVALUE	2DB 0156
C	EVPP	EIGENVALUE FOR TWO ITERATIONS BACK	2DB 0157
C	FEF	ENERGY RELEASED PER FISSION (=215 MEV)	2DB 0158
C	GBAR	GROUP INDICATOR FOR TAPE MOTION IN S824 (OUTER)	2DB 0159
C	GLH	MAXIMUM TIME IN SECONDS	2DB 0160
C	IGEP	IGE + 1	2DB 0161
C	IGP	IGM + 1	2DB 0162
C	IGV	GROUP INDICATOR FOR INNER AND OUTER	2DB 0163
C	IHS	POSITION OF SIGMA SELF SCATTER	2DB 0164
C	IHT	POSITION OF SIGMA TRANSPORT	2DB 0165
C	II	INNER ITERATION COUNT FOR A SINGLE GROUP	2DB 0166
C	IMJM	IM*JM	2DB 0167
C	IP	IM + 1	2DB 0168
C	ITEMP	TEMPORARY	2DB 0169
C	ITEMP1	TEMPORARY	2DB 0170
C	ITEMP2	TEMPORARY	2DB 0171
C	ITL	CROSS SECTION TABLE LENGTH	2DB 0172
C	IZP	IZM + 1	2DB 0173
C	JP	JM + 1	2DB 0174
C	K07	TEMPORARY STORAGE FOR G07	2DB 0175
C	KPAGE	PAGE COUNTER FOR MONITOR PRINT	2DB 0176
C	LAP	LAMBDA FOR PREVIOUS EIGENVALUE	2DB 0177
C	LAPP	LAMBDA FOR TWO ITERATIONS BACK	2DB 0178
C	LAR	LAMBDA FOR PREVIOUS ITERATION	2DB 0179
C	LC	LOOP COUNT (TOTAL II IN A SINGLE OUTER ITERATION)	2DB 0180
C	ML	MCR + MTP	2DB 0181
C	NCON	NEG/ZERO/POS=TAKE TIME STEP OF DELT/END OF PROBLEM/	2DB 0182
C		TAKE TIME STEP OF DELT AND READ BURNUP DATA	2DB 0183
C	NGOTO	TEMPORARY	2DB 0184
C	NPRT	0/1=PARTIAL PRINT/FULL PRINT	2DB 0185
C	ORFP	ORF FOR 1 - LAMBDA LESS THAN 10*EPS	2DB 0186
C	P02	OUTER ITERATION COUNT	2DB 0187
C	PEAR	TEMPORARY	2DB 0188
C	SBAR	TEMPORARY	2DB 0189
C	SK7	SUM OF K7 OVER ALL GROUPS	2DB 0190
C	T06	0/1=NOT DELTA/DELTA CALCULATION	2DB 0191
C	T7	ALPHA/VELOCITY	2DB 0192
C	T11	PREVIOUS FISSION TOTAL	2DB 0193
C	TEMP	TEMPORARY	2DB 0194
C	TEMP1	TEMPORARY	2DB 0195
C	TEMP2	TEMPORARY	2DB 0196
C	TEMP3	TEMPORARY	2DB 0197
C	TEMP4	TEMPORARY	2DB 0198
C	TI	TIME	2DB 0199
C	TSD	(MW-SEC)/(FISSIONS)	2DB 0200
C	V11	TOTAL SOURCE FOR THE GROUP	2DB 0201
C			2DB 0202
C	* * * * * INPUT VARIABLES (CARDS 1-5) * * * * *		
C			2DB 0203
C			2DB 0204
C	ID(11)	IDENTIFICATION CARD	2DB 0205
C	MAXT	MAXIMUM TIME IN MINUTES	2DB 0206
C	A02	0/1=FLUX CALCULATION/ADJOINT CALCULATION	2DB 0207
C	I04	EIGENVALUE TYPE (1/2/3/4/5=KEFF/ALPHA/CONCENTRATION/	2DB 0208
C		DELTA/BUCKLING)	2DB 0209
C	S02	PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA)	2DB 0210

C	IGM	NUMBER OF GROUPS	2DB 0211
C	NXCM	NUMBER OF DOWNSCATTERING TERMS	2DB 0212
C	MCR	NUMBER OF MATERIALS FROM CARDS	2DB 0213
C	MTP	NUMBER OF MATERIALS FROM TAPE	2DB 0214
C	M07	FLUX GUESS 0/1/2/3=NONE/X(R)*X(Z)/X(R,Z,E)/X(R,Z,E)	2DB 0215
C		FROM TAPE	2DB 0216
C	D05	OUTER ITERATION MAX	2DB 0217
C	G07	INNER ITERATION MAX PER GROUP	2DB 0218
C	S04	II MAX PER GROUP FOR 1 - LAMBDA GREATER THAN 10*EPS	2DB 0219
C	NPUN	FLUX DUMP 0/1/2/3/4=NONE/CARDS/CARDS+I2/TAPE/	2DB 0220
C		TAPE+I2	2DB 0221
C	IGE	GEOMETRY (0/1/2=X-Y/R-Z/R-THETA)	2DB 0222
C	IM	NUMBER OF RADIAL INTERVALS	2DB 0223
C	JM	NUMBER OF AXIAL INTERVALS	2DB 0224
C	I2M	NUMBER OF MATERIAL ZONES	2DB 0225
C	MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	2DB 0226
C	M01	NUMBER OF MIXTURE SPECIFICATIONS	2DB 0227
C	B01	LEFT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0228
C	B02	RIGHT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0229
C	B03	TOP BOUNDARY CONDITION (0/1/2=VAC/REFL/PERIODIC)	2DB 0230
C	B04	BOTTOM BOUNDARY CONDITION (0/1/2=VAC/REFL/PERIODIC)	2DB 0231
C	I2	RADIAL ZONES (DELTA-OPTION ONLY)	2DB 0232
C	J2	AXIAL ZONES (DELTA-OPTION ONLY)	2DB 0233
C	EV	FIRST EIGENVALUE GUESS	2DB 0234
C	EVM	EIGENVALUE MODIFIER	2DB 0235
C	S03	PARAMETRIC EIGENVALUE	2DB 0236
C	BUCK	BUCKLING	2DB 0237
C	LAL	LAMBDA LOWER	2DB 0238
C	LAH	LAMBDA UPPER	2DB 0239
C	EPS	EIGENVALUE CONVERGENCE CRITERIA	2DB 0240
C	EPSA	POINTWISE CONVERGENCE CRITERIA	2DB 0241
C	G06	INNER ITERATION TEST (IF ZERO, NO TEST)	2DB 0242
C	POD	PARAMETER OSCILLATION DAMPER	2DB 0243
C	ORF	OVER-RELAXATION FACTOR	2DB 0244
C	S01	NEG/POS=POWER (MWT)/NEUTRON SOURCE RATE	2DB 0245
C			2DB 0246
C	* * * * *	SUBSCRIPTED VARIABLES * * * * *	2DB 0247
C			2DB 0248
C	ATW(ML)	MATERIAL ATOMIC WEIGHT	2DB 0249
C	HOLN(ML)	MATERIAL NAME	2DB 0250
C	ALAN(ML)	DECAY CONSTANT (DAYS-1)	2DB 0251
C	CO(ITL,MT)	CROSS SECTION ARRAY FOR CURRENT GROUP	2DB 0252
C	N0(IM,JM)	TOTAL FLUX (OLD)	2DB 0253
C	N2(IM,JM)	TOTAL FLUX (NEW)	2DB 0254
C	A0(IP)	RADIAL AREA ELEMENT	2DB 0255
C	A1(IM)	AXIAL AREA ELEMENT	2DB 0256
C	F0(IM,JM)	FISSIONS (OLD)	2DB 0257
C	F2(IM,JM)	FISSIONS (NEW)	2DB 0258
C	I0(M01)	MIX NUMBER	2DB 0259
C	I1(M01)	MATERIAL NUMBER FOR MIX	2DB 0260
C	I2(M01)	MATERIAL DENSITY	2DB 0261
C	I3(M01)	MATERIAL DENSITIES FOR GRAM CALCULATION	2DB 0262
C	K6(IGM)	FISSION SPECTRUM (EFFECTIVE)	2DB 0263
C	K7(IGM)	FISSION SPECTRUM (INPUT)	2DB 0264
C	M0(IM,JM)	ZONE NUMBERS	2DB 0265
C	M2(I2M)	MATERIAL NUMBERS BY ZONE	2DB 0266
C	R0(IP)	INITIAL RADII	2DB 0267
C	R1(IP)	CURRENT RADII	2DB 0268
C	R2(IM)	RADIAL ZONE NUMBERS (DELTA CALCULATION ONLY)	2DB 0269

C	R3(IZ)	RADIAL ZONE MODIFIERS (DELTA CALCULATION ONLY)	2DB 0270
C	R4(IM)	AVERAGE RADII	2DB 0271
C	R5(IM)	DELTA-R	2DB 0272
C	S2(IM,JM)	FIXED SOURCE	2DB 0273
C	V0(IM,JM)	VOLUME ELEMENTS	2DB 0274
C	V7(IGM)	NEUTRON VELOCITIES	2DB 0275
C	Z0(JP)	INITIAL AXII	2DB 0276
C	Z1(JP)	CURRENT AXII	2DB 0277
C	Z2(JM)	AXIAL ZONE NUMBERS (DELTA CALCULATION ONLY)	2DB 0278
C	Z3(JZ)	AXIAL ZONE MODIFIERS (DELTA CALCULATION ONLY)	2DB 0279
C	Z4(JM)	AVERAGE AXII	2DB 0280
C	Z5(JM)	DELTA-Z	2DB 0281
C	CXS(IM,JM,3)	CONSTANTS INVOLVING CROSS SECTIONS FOR FLUX CALC.	2DB 0282
C	VOL(IZM)	ZONE VOLUME (LITERS)	2DB 0283
C	MASS(ML,IZM)	MATERIAL INVENTORY IN EACH ZONE	2DB 0284
C	MATN(ML)	MATERIAL NUMBER FOR BURNABLE ISOTOPES	2DB 0285
C	NBR(ML)	0/1/2=NO EFFECT/FERTILE/FISSILE ISOTOPE	2DB 0286
C	LD(ML)	SOURCE ISOTOPE FOR DECAY	2DB 0287
C	LCN(ML,2)	SOURCE ISOTOPES FOR CAPTURE	2DB 0288
C	LFN(ML,7)	SOURCE ISOTOPES FOR FISSION	2DB 0289
C	PHIB(IZM)	ZONE AVERAGED FLUX	2DB 0290
C	AXS(ML,IZM)	SPECTRUM AVERAGED ABSORPTION CROSS SECTION	2DB 0291
C	FXS(ML,IZM)	SPECTRUM AVERAGED FISSION CROSS SECTION	2DB 0292
C	MASSP(ML,IZM)	MATERIAL INVENTORY IN EACH ZONE (PREVIOUS)	2DB 0293
C	CXR(JM)	CONSTANTS FOR RIGHT BOUNDARY	2DB 0294
C	CXT(IM)	CONSTANTS FOR TOP BOUNDARY	2DB 0295
C	HA(IM OR JM)	TEMP STORAGE FOR LINE INVERSION	2DB 0296
C	PA(IM OR JM)	TEMP STORAGE FOR LINE INVERSION	2DB 0297
C			2DB 0298
	INCLUDE ABC		2DB 0299
	COMMON A(25000)		2DB 0300
	DIMENSION JLPTAB(21)		2DB 0301
	CALL SETDR(3,525000,52000,JLPTAB)		2DB 0302
	CALL SETDR(4,577000,52000,JLPTAB(8))		2DB 0303
	CALL SETDR(8,629000,500000,JLPTAB(15))		2DB 0304
1	CONTINUE		2DB 0305
	REWIND 3		2DB 0306
	REWIND 4		2DB 0307
	REWIND 8		2DB 0308
	CALL ETIME		2DB 0309
	CALL INP		2DB 0310
102	CALL INIT(A(LK6), A(LK7), A(LI0), A(LI1), A(LI2), A(LM0), A(LM2),		2DB 0311
1	A(LN0), A(LR0), A(LR1), A(LR2), A(LR3), A(LR4), A(LR5),		2DB 0312
2	A(LZ0), A(LZ1), A(LZ2), A(LZ3), A(LZ4), A(LZ5), A(LA0),		2DB 0313
3	A(LA1), A(LF0), A(LC0), A(LV0), ITL, IM, A(LV7),		2DB 0314
4	JM, MT)		2DB 0315
	CALL FISCAL (A(LN0),A(LF0),A(LV0),A(LC0),A(LK6),		2DB 0316
2	A(LM0),A(LM2),ITL,MT)		2DB 0317
C	CALL MONITOR PRINT		2DB 0318
101	CALL S8830		2DB 0319
	GO TO (100, 106, 106, 107), NGOTO		2DB 0320
106	CALL ERRO2(6H*MONPR,106,1)		2DB 0321
C	PERFORM AN OUTER ITERATION		2DB 0322
107	CALL OUTER(A(LA0), A(LA1), A(LC0), A(LF0), A(LK6),		2DB 0323
1	A(LM0), A(LM2), A(LN0), A(LN2),		2DB 0324
2	A(LS2), A(LV0), A(LV7), A(LZ5),		2DB 0325
3	A(LF2), ITL, MT, A(LCXS), IM, JM, A(LR5), A(LR4),		2DB 0326
4	A(LZ4), A(LCXR), A(LCXT), A(LHA), A(LPA))		2DB 0327
C	PERFORM FISSION CALCULATION		2DB 0328

	CALL FISCAL (A(LN0),A(LF0),A(LV0),A(LC0),A(LK6),	2DB 0329
	2 A(LM0),A(LM2),ITL,MT)	2DB 0330
C	PERFORM CONVERGENCE AND NEW PARAMETER CALCULATIONS	2DB 0331
	CALL CNNP (A(LF2),A(LK6))	2DB 0332
	GO TO (100,101,102),NGOTO	2DB 0333
C	100/101/102=FINAL PRINT/MONITOR PRINT/SEARCH CALCULATION	2DB 0334
100	CALL S8850(A(LF2),A(LN2),A(LR1),A(LZ1),A(LR4),A(LZ4),	2DB 0335
	1 IM,JM,A(LN2),A(LC0),A(LN0),A(LM0),A(LM2),A(LF0),ITL,MT)	2DB 0336
	CALL GRAM(A(LMASS),A(LVOL),A(LATW),A(LHOLN),IM,JM,	2DB 0337
	1 A(LM0),A(LM2),A(LV0),A(LI0),A(LI1),A(LI2),ML,	2DB 0338
	2 A(LI3))	2DB 0339
	CALL INPB(A(LMATN),A(LNBR),A(LLD),A(LLCN),A(LLFN),A(LALAM),	2DB 0340
	1 A(LHOLN),ML,A(LI2))	2DB 0341
	IF(NCON) 170,1,170	2DB 0342
170	CALL AVERAG(A(LPHIB),A(LAXS),A(LFXS),A(LMATN),A(LMASS),A(LATW),	2DB 0343
	1 A(LVOL),A(LC0),A(LN2),A(LM0),A(LV0),A(LHOLN),ML,ITL,	2DB 0344
	2 A(LNBR))	2DB 0345
	CALL MARCH(A(LPHIB),A(LMATN),A(LFXS),A(LAXS),A(LVOL),A(LMASS),	2DB 0346
	1 A(LMASSP),A(LALAM),A(LLD),A(LLCN),A(LLFN),ML,	2DB 0347
	2 A(LI0),A(LI1),A(LI2),A(LM2))	2DB 0348
	GO TO 102	2DB 0349
	END	2DB 0350

```

-ITC FOR INP,INP                                2DB 0351
  SUBROUTINE INP                                2DB 0352
  INCLUDE ABC                                    2DB 0353
  COMMON A(25000)                                2DB 0354
C  THIS SUBROUTINE CONTROLS THE READING OF ALL INPUT DATA  2DB 0355
  NCR1 = 3                                        2DB 0356
  NSCRAT = 4                                    2DB 0357
  NINP = 5                                       2DB 0358
  NOUT = 6                                       2DB 0359
  NFLUX1 = 8                                    2DB 0360
  WRITE (NOUT,5)                                2DB 0361
  FORMAT (1H1)                                  2DB 0362
  WRITE(NOUT, 10)                                2DB 0363
  FORMAT(42X,35H * * * * 2 D B * * * * /// )    2DB 0364
  READ(NINP,20) (ID(I),I=1,11), MAXT            2DB 0365
  FORMAT(11A6,I6)                                2DB 0366
  WRITE(NOUT,30) (ID(I),I=1,11), MAXT           2DB 0367
  FORMAT(10X,1H ,11A6,I6/)                      2DB 0368
  READ(NINP,40)  A02, I04, S02, IGM, NXCM, MCR, MTP, M07, D05,  2DB 0369
  1 G07, S04, NPUN, IGE, IM, JM, IZM, MT, M01, R01, R02, R03, R04, 2DB 0370
  2 IZ, JZ                                       2DB 0371
  FORMAT(12I6)                                  2DB 0372
  WRITE(NOUT,60)  A02, I04, S02, IGM, NXCM, MCR  2DB 0373
  FORMAT(                                          2DB 0374
  192H  A02          0/1=REGULAR CALCULATION/ADJOINT CALCULATION 2DB 0375
  2              I9/                                         2DB 0376
  392H  I04          EIGENVALUE TYPE (1/2/3/4/5=KEFF/ALPHA/CONCENTRATION 2DB 0377
  4N/DELTA/BUCKLING) I9/                                     2DB 0378
  592H  S02          PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA) 2DB 0379
  6              I9/                                         2DB 0380
  792H  IGM          NUMBER OF GROUPS                    2DB 0381
  8              I9/                                         2DB 0382
  992H  NXCM         NUMBER OF DOWNSCATTERING TERMS      2DB 0383
  1              I9/                                         2DB 0384
  292H  MCR          NUMBER OF MATERIALS FROM CARDS      2DB 0385
  3              I9)                                         2DB 0386
  WRITE(NOUT,70)  MTP, M07, D05, G07, S04, NPUN  2DB 0387
  FORMAT(                                          2DB 0388
  192H  MTP          NUMBER OF MATERIALS FROM TAPE      2DB 0389
  2              I9/                                         2DB 0390
  392H  M07          FLUX GUESS (0/1/2/3=NONE/X(R)*X(Z)/X(R,Z,E)/X(R,Z,E) 2DB 0391
  4) FROM TAPE) I9/                                     2DB 0392
  592H  D05          OUTER ITERATION MAX                2DB 0393
  6              I9/                                         2DB 0394
  792H  G07          INNER ITERATION MAX PER GROUP      2DB 0395
  8              I9/                                         2DB 0396
  992H  S04          11 MAX PER GROUP FOR 1 - LAMBDA GREATER THAN 10*EPS 2DB 0397
  1              I9/                                         2DB 0398
  292H  NPUN         FLUX DUMP (0/1/2/3/4=NONE/CARDS/CARDS+I2/TAPE/TAPE+ 2DB 0399
  3I2) I9/)                                         2DB 0400
  WRITE(NOUT,80)  IGE, IM, JM, IZM, MT, M01      2DB 0401
  FORMAT(                                          2DB 0402
  192H  IGE          GEOMETRY (0/1/2=X-Y/R-Z/R-THETA)    2DB 0403
  2              I9/                                         2DB 0404
  392H  IM           NUMBER OF RADIAL INTERVALS          2DB 0405
  4              I9/                                         2DB 0406
  592H  JM           NUMBER OF AXIAL INTERVALS           2DB 0407
  6              I9/                                         2DB 0408
  792H  IZM          NUMBER OF MATERIAL ZONES            2DB 0409

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	8		I9/	2DB	0410
	992H	MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	2DB	0411
	1		I9/	2DB	0412
	292H	M01	NUMBER OF MIXTURE SPECIFICATIONS	2DB	0413
	3		I9)	2DB	0414
		WRITE(NOUT,90)	B01, B02, B03, B04, IZ, JZ	2DB	0415
90		FORMAT(		2DB	0416
	192H	B01	LEFT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB	0417
	2		I9/	2DB	0418
	392H	B02	RIGHT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB	0419
	4		I9/	2DB	0420
	592H	B03	TOP BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE	2DB	0421
	6/PERIODIC)		I9/	2DB	0422
	792H	B04	BOTTOM BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE	2DB	0423
	8/PERIODIC)		I9/	2DB	0424
	992H	IZ	RADIAL ZONES (DELTA-OPTION ONLY)	2DB	0425
	1		I9/	2DB	0426
	292H	JZ	AXIAL ZONES (DELTA-OPTION ONLY)	2DB	0427
	3		I9/)	2DB	0428
		READ(NINP,100)	EV, EVM, S03, BUCK, LAL, LAH, EPS, FPSA, G06,	2DB	0429
	1		POD, ORF, S01	2DB	0430
100		FORMAT(6E12.6)		2DB	0431
		WRITE(NOUT,110)	EV, EVM, S03, BUCK, LAL, LAH	2DB	0432
110		FORMAT(		2DB	0433
	191H	EV	FIRST EIGENVALUE GUESS	2DB	0434
	2		1PE10.4/	2DB	0435
	391H	EVM	EIGENVALUE MODIFIER	2DB	0436
	2		1PE10.4/	2DB	0437
	591H	S03	PARAMETRIC EIGENVALUE	2DB	0438
	2		1PE10.4/	2DB	0439
	791H	BUCK	BUCKLING (CM-2)	2DB	0440
	2		1PE10.4/	2DB	0441
	991H	LAL	LAMBDA LOWER	2DB	0442
	2		1PE10.4/	2DB	0443
	291H	LAH	LAMBDA UPPER	2DB	0444
	2		1PE10.4/)	2DB	0445
		WRITE(NOUT,120)	EPS, EPSA, G06, POD, CRF, S01	2DB	0446
120		FORMAT(		2DB	0447
	191H	EPS	EIGENVALUE CONVERGENCE CRITERIA	2DB	0448
	2		1PE10.4/	2DB	0449
	391H	EPSA	PARAMETER CONVERGENCE CRITERIA	2DB	0450
	2		1PE10.4/	2DB	0451
	591H	G06	INNER ITERATION TEST (IF ZERO, NO TEST)	2DB	0452
	2		1PE10.4/	2DB	0453
	791H	POD	PARAMETER OSCILLATION DAMPER	2DB	0454
	2		1PE10.4/	2DB	0455
	991H	ORF	OVER-RELAXATION FACTOR	2DB	0456
	2		1PE10.4/.	2DB	0457
	291H	S01	NEGATIVE/POSITIVE=POWER (MW)/NEUTRON SOURCE RATE	2DB	0458
	2		1PE10.4/)	2DB	0459
		IF(IZ + JZ)	230, 210, 230	2DB	0460
210		IF(I04 - 4)	230, 220, 230	2DB	0461
220		CALL ERRO2 (6H***I04,220,1)		2DB	0462
230		CONTINUE		2DB	0463
		IF(S02)	240, 260, 240	2DB	0464
240		IF(S03)	260, 250, 260	2DB	0465
250		CALL ERRO2 (6H***S03,250,1)		2DB	0466
260		CONTINUE		2DB	0467
		FEF =215.0		2DB	0468

TSD = FEF*1.602*10.**(-19)	2DB 0469
GLH = MAXT*60	2DB 0470
KPAGE = 100	2DB 0471
IHS = 5	2DB 0472
ITL = NXCM + 5	2DB 0473
IHT = 4	2DB 0474
IZP = IZM + 1	2DB 0475
IP = IM + 1	2DB 0476
JP = JM + 1	2DB 0477
ML = MCR + MTP	2DB 0478
IGP = IGM + 1	2DB 0479
IGEP = IGE + 1	2DB 0480
IMJM = IM*JM	2DB 0481
EQ = .0	2DB 0482
LAP = .0	2DB 0483
LAPP = .0	2DB 0484
LAR = 0.0	2DB 0485
DAY = 0.0	2DB 0486
ALA = .0	2DB 0487
LC = 0	2DB 0488
PO2 = 0	2DB 0489
CVT = 0	2DB 0490
CNT = 0	2DB 0491
NCON = 0	2DB 0492
NPRT = 1	2DB 0493
TO6 = 0	2DB 0494
IF(I04-4) 310, 300, 310	2DB 0495
300 TO6 = 1	2DB 0496
310 CONTINUE	2DB 0497
IF(M07 - 3) 312, 311, 311	2DB 0498
311 REWIND 14	2DB 0499
312 IF(NPUN - 3) 314, 313, 313	2DB 0500
313 REWIND 16	2DB 0501
314 K07 = G07	2DB 0502
G07 = S04	2DB 0503
ORFP = .9*(ORF - 1.0) + 1.0	2DB 0504
C COMPUTE DIMENSION POINTERS	2DB 0505
LATW = 1	2DB 0506
LHOLN = LATW + ML	2DB 0507
LALAM = LHOLN + ML	2DB 0508
LCO = LALAM + ML	2DB 0509
LN0 = LCO + ITL*MT	2DB 0510
LN2 = LN0 + IMJM	2DB 0511
LA0 = LN2 + IMJM	2DB 0512
LA1 = LA0 + IP	2DB 0513
LF0 = LA1 + IM	2DB 0514
LF2 = LF0 + IMJM	2DB 0515
LI0 = LF2 + IMJM	2DB 0516
LI1 = LI0 + M01	2DB 0517
LI2 = LI1 + M01	2DB 0518
LI3 = LI2 + M01	2DB 0519
LK6 = LI3 + M01	2DB 0520
LK7 = LK6 + IGM	2DB 0521
LM0 = LK7 + IGM	2DB 0522
LM2 = LM0 + IMJM	2DB 0523
LR0 = LM2 + IZM	2DB 0524
LR1 = LR0 + IP	2DB 0525
LR2 = LR1 + IP	2DB 0526
LR3 = LR2 + TO6*IM	2DB 0527

LR4 = LR3 + T06*IZ	2DB 0528
LR5 = LR4 + IM	2DB 0529
LS2 = LR5 + IM	2DB 0530
LV0 = LS2 + IMJM	2DB 0531
LV7 = LV0 + IMJM	2DB 0532
LZ0 = LV7 + IGM	2DB 0533
LZ1 = LZ0 + JP	2DB 0534
LZ2 = LZ1 + JP	2DB 0535
LZ3 = LZ2 + JM*T06	2DB 0536
LZ4 = LZ3 + JZ*T06	2DB 0537
LZ5 = LZ4 + JM	2DB 0538
LCXS = LZ5 + JM	2DB 0539
LVOL = LCXS + IMJM*3	2DB 0540
LMASS = LVOL + IZM	2DB 0541
LMATN = LMASS + ML*IZM	2DB 0542
LNBR = LMATN + ML	2DB 0543
LLD = LNBR + ML	2DB 0544
LLCN = LLD + ML	2DB 0545
LLFN = LLCN + ML*2	2DB 0546
LPHIB = LLFN + ML*7	2DB 0547
LAXS = LPHIB + IZM	2DB 0548
LFXS = LAXS + ML*IZM	2DB 0549
LMASSP = LFXS + ML*IZM	2DB 0550
LCXR = LMASSP + ML*IZM	2DB 0551
LCXT = LCXR + JM	2DB 0552
LHA = LCXT + IM	2DB 0553
LPA = LHA + MAX0(IM,JM)	2DB 0554
LAST = LPA + MAX0(IM,JM)	2DB 0555
ITEMP = 1 + 3*ML + IGP*ITL*MT	2DB 0556
IF(LAST - ITEMP) 316,318,318	2DB 0557
316 LAST = ITEMP	2DB 0558
318 WRITE(NOUT,320) LAST	2DB 0559
320 FORMAT(5H LAST,I6)	2DB 0560
C READ CROSS SECTIONS AND WRITE CROSS SECTION TAPE	2DB 0561
CALL S860(A(LN0),A(LC0),ITL,IGM,MT,A(LATW),A(LHOLN),A(LALAM))	2DB 0562
DO 325 I=LC0, LAST	2DB 0563
325 A(I) = .0	2DB 0564
C READ FLUXES AND WRITE FLUX TAPE	2DB 0565
CALL S862(A(LN0), A(LR0), A(LZ0))	2DB 0566
WRITE(NOUT,330)	2DB 0567
330 FORMAT(51H0MESH BOUNDARIES (R0/Z0=RADIAL POINTS/AXIAL POINTS))	2DB 0568
C READ RADIAL INTERVALS	2DB 0569
CALL REAG2(6H R0,A(LR0),IP)	2DB 0570
C READ AXIAL INTERVALS	2DB 0571
CALL REAG2(6H Z0,A(LZ0),JP)	2DB 0572
C READ ZONE NUMBERS	2DB 0573
WRITE(NOUT,340)	2DB 0574
340 FORMAT(30H0ZONE NUMBERS BY MESH INTERVAL)	2DB 0575
CALL REA12(6H M0,A(LM0),IMJM)	2DB 0576
C READ MATERIAL NUMBERS	2DB 0577
WRITE(NOUT,350)	2DB 0578
350 FORMAT(25H0MATERIAL NUMBERS BY ZONE)	2DB 0579
CALL REA12(6H M2,A(LM2),IZM)	2DB 0580
C READ FISSION FRACTIONS	2DB 0581
WRITE(NOUT,360)	2DB 0582
360 FORMAT(17H0FISSION SPECTRUM)	2DB 0583
CALL REAG2(6H K7,A(LK7),IGM)	2DB 0584
C READ VELOCITIES	2DB 0585
WRITE(NOUT,370)	2DB 0586

370	FORMAT(17H0NEUTRON VELOCITY)	2DB 0587
	CALL REAG2(6H V7,A(LV7),IGM)	2DB 0588
	IF(M01) 400, 400, 380	2DB 0589
380	WRITE(NOUT,390)	2DB 0590
390	FORMAT(82H0MIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER	2DB 0591
	1 FOR MIX/MATERIAL DENSITY))	2DB 0592
	CALL REA12(6H I0,A(LI0),M01)	2DB 0593
	CALL REA12(6H I1,A(LI1),M01)	2DB 0594
	CALL REAG2(6H I2,A(LI2),M01)	2DB 0595
400	CONTINUE	2DB 0596
C	CHECK FOR DELTA CALCULATION	2DB 0597
	IF(I04 - 4) 440, 410, 440	2DB 0598
410	WRITE(NOUT,420)	2DB 0599
420	FORMAT(85H0DELTA OPTION DATA (R2/Z2/R3/Z3=RADIAL/AXIAL ZONE NOS.	2DB 0600
	1/RADIAL/AXIAL ZONE MODIFIERS))	2DB 0601
	CALL REA12(6H R2,A(LR2),IM)	2DB 0602
	CALL REAG2(6H R3,A(LR3),IZ)	2DB 0603
	CALL REA12(6H Z2,A(LZ2),JM)	2DB 0604
	CALL REAG2(6H Z3,A(LZ3),JZ)	2DB 0605
440	CONTINUE	2DB 0606
C	END OF INPUT DATA	2DB 0607
	CALL MAPR(A(LM0),A(LM2),IM,JM,A(LC0))	2DB 0608
	IF(LAST-25000) 470, 470, 450	2DB 0609
450	WRITE(NOUT,460)	2DB 0610
460	FORMAT(26H PROGRAM CAPACITY EXCEEDED)	2DB 0611
	STOP	2DB 0612
470	RETURN	2DB 0613
	END	2DB 0614

E-13

BNWL-831

```
-IT FOR ERRO2,ERRO2
  SUBROUTINE ERRO2( HOL,JSUBR,I)
  COMMON  NINP ,NOUT ,NCR1 ,NFLUX1,NSCRAT
  WRITE (NOUT,1)      HOL,JSUBR
1  FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)
  GO TO (3,4),I
3  STOP
4  RETURN
  END
```

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2DB 0615
2DB 0616
2DB 0617
2DB 0618
2DB 0619
2DB 0620
2DB 0621
2DB 0622
2DB 0623
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-ITC FOR S860,S860
SUBROUTINE S860 (C,CO,JTL,JGM,JMT,ATW,HOLN,ALAM)
INCLUDE ABC
DIMENSION C(JTL,JGM,JMT), CO(JTL,JMT), ATW(1), HOLN(1), ALAM(1)
DIMENSION AA(9)
C THIS SUBROUTINE READS CROSS SECTIONS FROM CARDS, PERFORMS
C ADJOINT REVERSALS IF REQUIRED, AND WRITES CROSS SECTION TAPE
WRITE(NOUT,5) (ID(I), I=1,11)
5 FORMAT(1H1,11A6,///)
IF(MCR) 160, 160, 10
10 WRITE (NOUT, 20 )
20 FORMAT (38H THE FOLLOWING NUCLIDES ARE FROM CARDS/)
DO 50 I=1,MCR
READ(NINP, 30) HOLN(I), ATW(I), ALAM(I), (AA(J), J=1,9)
ALAM(I) = ALAM(I)/(24.*3600.)
30 FORMAT(A6, 2E6.2, 9A6)
WRITE(NOUT, 40) I, HOLN(I), (AA(J), J=1,9)
40 FORMAT(I3, 6X, A6, 6X, 9A6)
DO 50 IIG=1,IGM
50 READ(NINP, 60) (C(L,IIG,I),L=1,ITL)
60 FORMAT(6E12.5)
C CHECK ON CROSS SECTION CONSISTENCY AND ORDER
ITEMP = 0
DO 140 J=1,MCR
DO 140 I=1,IGM
G = C(2,I,J) + C(5,I,J)
DO 110 K = 1, NXCM
KK = I + K
M = 5 + K
IF(KK - IGM) 100, 100, 110
100 G = G + C(M,KK,J)
110 CONTINUE
IF(ABS((G - C(4,I,J))/C(4,I,J)) - .01) 135, 120, 120
120 ITEMP = 1
130 FORMAT(1H /,16H CHECK MATERIAL I2,5X, 7H GROUP I2)
135 IF(ABS((G - C(4,I,J))/C(4,I,J)) - .0001) 140, 138, 138
138 WRITE(NOUT,130) J, I
140 CONTINUE
IF (ITEMP) 160,160,150
150 CALL EXIT
160 CONTINUE
C 160 CALL RECS2
C A02=0/1=FLUX CALCULATION/ADJOINT CALCULATION
IF(A02) 170, 280, 170
170 DO 190 IIG=1,IGM
IGBAR=IGM-IIG+1
DO 180 M=1,MT
DO 180 L = 1,IHS
TEMP=C(L,IIG,M)
C(L,IIG,M)=C(L,IGBAR,M)
180 C(L,IGBAR,M)=TEMP
IF (IGBAR - IIG -1) 200, 200, 190
190 CONTINUE
200 CONTINUE
KK = ITL - IHS
IF (KK) 280, 280, 210
210 CONTINUE
40 240 M = 1,MT
DO 240 IIG = 1,IGM

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2DB 0680
2DB 0681
2DB 0682

IGBAR = IGM - IIG + 1	2DB 0683
DO 240 L = 1, KK	2DB 0684
IF (L - IIG) 220, 240, 240	2DB 0685
220 I = L + IHS	2DB 0686
ITEMP = IGBAR + L	2DB 0687
IF (IIG - ITEMP) 230, 230, 240	2DB 0688
230 TEMP = C(I, IIG, M)	2DB 0689
C(I, IIG, M) = C(I, ITEMP, M)	2DB 0690
C(I, ITEMP, M) = TEMP	2DB 0691
240 CONTINUE	2DB 0692
C WRITE CROSS SECTION TAPE	2DB 0693
280 DO 300 IIG=1, IGM	2DB 0694
DO 290 M=1, MT	2DB 0695
DO 290 L=1, ITL	2DB 0696
290 CO(L, M)=C(L, IIG, M)	2DB 0697
300 WRITE (NCRI) ((CO(L, M), L=1, ITL), M=1, MT)	2DB 0698
REWIND NCRI	2DB 0699
RETURN	2DB 0700
END	2DB 0701

-ITC	FOR S862,S862	2DB 0702
	SUBROUTINE S862(N0,RF,ZF)	2DB 0703
	INCLUDE ABC	2DB 0704
	DIMENSION N0(1), RF(1), ZF(1)	2DB 0705
C	THIS SUBROUTINE READS THE INPUT FLUXES AND PREPARES A FLUX TAPE	2DB 0706
	WRITE(NOUT,5)	2DB 0707
5	FORMAT(1H1)	2DB 0708
C	M07=0/1/2/3=NO FLUX INPUT/X(R)*X(Z)/X(R,Z,E)/TAPE	2DB 0709
	KK = M07 + 1	2DB 0710
	DO 1000 IIG = 1, IGM	2DB 0711
	GO TO (50, 60, 70, 120), KK	2DB 0712
50	DO 59 I=1, IM	2DB 0713
	DO 59 J = 1, JM	2DB 0714
	ITEMP = (J - 1)*IM + I	2DB 0715
59	N0(ITEMP) = 1.0	2DB 0716
	GO TO 200	2DB 0717
60	IF(IIG - 1) 62, 62, 64	2DB 0718
62	WRITE(NOUT,63)	2DB 0719
63	FORMAT(55HOFUX GUESS (RF/ZF=TOTAL RADIAL FLUX/TOTAL AXIAL FLUX))	2DB 0720
	CALL REAG2(6H RF,RF,IM)	2DB 0721
	CALL REAG2(6H ZF,ZF,JM)	2DB 0722
64	DO 69 I = 1, IM	2DB 0723
	DO 69 J = 1, JM	2DB 0724
	ITEMP = (J - 1)*IM + I	2DB 0725
69	N0(ITEMP) = RF(I)*ZF(J)	2DB 0726
	GO TO 200	2DB 0727
70	READ(NINP,100) (N0(I), I=1, IMJM)	2DB 0728
100	FORMA0(6E12.6)	2DB 0729
	GO TO 200	2DB 0730
120	READ(14) (N0(I), I=1, IMJM)	2DB 0731
200	WRITE(NFLUX1) (N0(I), I=1, IMJM)	2DB 0732
1000	CONTINUE	2DB 0733
	IF(M07 - 3) 1020,1010,1020	2DB 0734
1010	REWIND 14	2DB 0735
1020	REWIND NFLUX1	2DB 0736
	RETURN	2DB 0737
	END	2DB 0738

-IT	FOR REAG2,REAG2	2DB 0739
	SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)	2DB 0740
	DIMENSION ARRAY(1),V(12),K(12),IN(12)	2DB 0741
	COMMON NINP ,NOUT ,NCR1 ,NFLUX1,NSCRAT	2DB 0742
	JFLAG=0	2DB 0743
	J=1	2DB 0744
10	IF(JFLAG)20,40,20	2DB 0745
20	DO 30 JJ=1,6	2DB 0746
	K(JJ)=K(JJ+6)	2DB 0747
	IN(JJ)=IN(JJ+6)	2DB 0748
30	V(JJ)=V(JJ+6)	2DB 0749
	JFLAG=0	2DB 0750
	GO TO 60	2DB 0751
40	9EAD (NINP,50) (K(I),IN(I),V(I),I=1,6)	2DB 0752
50	FORMAT(6(I1,I2,E9.4))	2DB 0753
60	DO 140 I=1,6	2DB 0754
	L=K(I)+1	2DB 0755
	GO TO (70,80,100,150),L	2DB 0756
C	NO MODIFICATION	2DB 0757
70	ARRAY(J)=V(I)	2DB 0758
	J=J+1	2DB 0759
	GO TO 140	2DB 0760
C	REPEAT	2DB 0761
80	L=IN(I)	2DB 0762
	DO 90 M=1,L	2DB 0763
	ARRAY(J)=V(I)	2DB 0764
	J=J+1	2DB 0765
90	CONTINUE	2DB 0766
	GO TO 140	2DB 0767
C	INTERPOLATE	2DB 0768
100	IF(I-6) 120,110,110	2DB 0769
110	READ (NINP,50) (K(JJ),IN(JJ),V(JJ),JJ=7,12)	2DB 0770
	JFLAG=1	2DB 0771
120	L=IN(I)+1	2DB 0772
	DEL=(V(I+1)-V(I))/FLOAT (L)	2DB 0773
	DO 130 M=1,L	2DB 0774
	ARRAY(J)=V(I)+DEL*FLOAT (M-1)	2DB 0775
	J=J+1	2DB 0776
130	CONTINUE	2DB 0777
140	CONTINUE	2DB 0778
	GO TO 10	2DB 0779
C	TERMINATE	2DB 0780
150	J=J-1	2DB 0781
	WRITE (NOUT,160) HOLL,J , (ARRAY(I),I=1,J)	2DB 0782
	IF(J -NCOUNT)170,180,170	2DB 0783
160	FORMAT(6X,A6,I6/(10E12.5))	2DB 0784
170	CALL ERRO2(6H**REAG,170,1)	2DB 0785
180	RETURN	2DB 0786
	END	2DB 0787

-IT	FOR REAI2,REAI2	2DB 0788
	SUBROUTINE REAI2(HOLL,IARRAY,NCOUNT)	2DB 0789
	DIMENSION IARRAY(1),IV(6),K(6),IN(6)	2DB 0790
	COMMON NINP ,NOUT ,NCR1 ,NFLUX1,NSCRAT	2DB 0791
	J=1	2DB 0792
10	READ(NINP,20) (K(I),IN(I),IV(I),I=1,6)	2DB 0793
20	FORMAT(6(I1,I2,I9))	2DB 0794
	DO 70 I=1,6	2DB 0795
	L=K(I)+1	2DB 0796
	GO TO (30,40,60,80),L	2DB 0797
C	NO MODIFICATION	2DB 0798
30	IARRAY(J)=IV(I)	2DB 0799
	J=J+1	2DB 0800
	GO TO 70	2DB 0801
C	REPEAT	2DB 0802
40	3=IN(I)	2DB 0803
	DO 50 M=1,L	2DB 0804
	IARRAY(J)=IV(I)	2DB 0805
	J=J+1	2DB 0806
50	CONTINUE	2DB 0807
	GO TO 70	2DB 0808
C	INTERPOLATE	2DB 0809
60	CALL ERRO2(6H REAI,60,1)	2DB 0810
70	CONTINUE	2DB 0811
	GO TO 10	2DB 0812
C	TERMINATE	2DB 0813
80	J=J-1	2DB 0814
	WRITE (NOUT,90) HOLL,J , (IARRAY(I),I=1,J)	2DB 0815
	IF (J -NCOUNT)100,110,100	2DB 0816
90	FORMAT(6X,A6,I6/(10I12))	2DB 0817
100	CALL ERRO2(6H**REAI,100,1)	2DB 0818
110	RETURN	2DB 0819
	END	2DB 0820

-ITC FOR MAPR,MAPR	2DB 0821
SUBROUTINE MAPR (M0,M2, JIM,JJM, K)	2DB 0822
INCLUDE ABC	2DB 0823
DIMENSION M0(JIM,JJM), M2(1), K(1)	2DB 0824
C PRODUCE A PICTURE PRINT BY ZONE AND MATERIAL	2DB 0825
WRITE(NOUT,10) (ID(I), I=1,11)	2DB 0826
10 FORMAT(1H1,11A6///)	2DB 0827
20 DO 30 JJ=1,JM	2DB 0828
J=JM-JJ+1	2DB 0829
30 WRITE (NOUT,40) (M0(I,J),I=1,IM)	2DB 0830
40 FORMAT(5H ,55I2)	2DB 0831
WRITE(NOUT,50)	2DB 0832
50 FORMAT(2H A/2H X/2H I/2H A/2H L//8H RADIAL)	2DB 0833
WRITE (NOUT,10) (ID(I), I = 1, 11)	2DB 0834
DO 70 JJ=1,JM	2DB 0835
J=JM-JJ+1	2DB 0836
DO 60 L=1,IM	2DB 0837
N=M0(L,J)	2DB 0838
60 K(L)=IABS (M2(N))	2DB 0839
70 WRITE (NOUT,40) (K(L),L=1,IM)	2DB 0840
WRITE(NOUT,50)	2DB 0841
RETURN	2DB 0842
END	2DB 0843

```

-ITC FOR INIT,INIT
  SUBROUTINE INIT (K6, K7, IO, I1, I2, M0, M2, N0, R0, R1, R2,
1      R3, R4, R5, Z0, Z1, Z2, Z3, Z4, Z5, A0, A1,
2      F0, C0, V0, JTL, JIM, V7, JJM, JMT)
  INCLUDE ABC
  DIMENSION K6(1), K7(1), IO(1), I1(1), I2(1), R0(1), R1(1),
1      R2(1), R3(1), R4(1), R5(1), Z0(1), Z1(1), Z2(1),
2      Z3(1), Z4(1), Z5(1), A0(1), A1(1), C0(JTL, JMT),
3      V0(JIM, JJM), M0(1), M2(1), N0(1), F0(1), V7(1)
  IF (P02) 20, 10, 20
10  WRITE(NOUT,15) DAY
15  FORMAT(1H1,30X,11H T I M E =F8.3=8H D A Y S///)
20  CONTINUE
C   ADJOINT REVERSALS
  IF(A02) 25, 45, 25
25  IF(P02) 45, 30, 45
30  IF(NCON) 45, 35, 45
35  IIG=1
  IGBAR=IGM
40  TEMP=K7(IIG)
  K7(IIG)=K7(IGBAR)
  K7(IGBAR)=TEMP
  TEMP=V7(IIG)
  V7(IIG)=V7(IGBAR)
  V7(IGBAR)=TEMP
  IIG=IIG+1
  IGBAR=IGBAR-1
  IF(IIG-IGBAR) 40, 45, 45
45  CONTINUE
C
C   MIX CROSS-SECTIONS
  B07=1
  IF(P02) 50, 55, 50
50  IF(I04-3) 185, 85, 185
55  IF(M01) 70, 70, 60
60  WRITE(NOUT, 65 ) (J, IO(J), I1(J), I2(J), J = 1, M01)
65  FORMAT(1H0,3X, 16H MIXTURE NUMBER ,18H MIX COMMAND
124H MATERIAL ATOMIC DENSITY//((I4,1X,I8,8X,I8,8X,E20.6))
70  IF(NPRT) 85, 85, 75
75  WRITE (NOUT,80 )
80  FORMAT(/19H1CROSS-SECTION EDIT)
85  REWIND NCR1
  DO 180 IIG=1,IGM
  READ (NCR1) ((C0(I,J),I=1,ITL),J=1,MT)
  IF(M01) 90, 145, 90
90  DO 140 M=1,M01
  IF(I0(M)-MT) 100, 100, 95
95  CALL ERRO2(6H**INIT,95,1)
100  IF(I1(M)-MT) 105, 105, 95
105  N=IO(M)
  L=I1(M)
  E01=I2(M)
  IF(L) 125, 125, 110
110  IF(E01) 125, 115, 125
115  IF (N-L) 125, 120, 125
120  E01 = EV
  L = 0
125  DO 140 I=1,ITL
  IF (L) 130, 135, 130

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130	CO(I,N)=CO(I,N)+CO(I,L)*E01	2DB 0903
	GO TO 140	2DB 0904
135	CO(I,N)=CO(I,N)*E01	2DB 0905
140	CONTINUE	2DB 0906
145	IF(P02) 175, 150, 175	2DB 0907
150	IF(NPRT) 175, 175, 155	2DB 0908
155	WRITE (NOUT,160) IIG	2DB 0909
160	FORMAT(7H GROUP 13,15H CROSS-SECTIONS)	2DB 0910
	DO 165 N=1,MT	2DB 0911
165	WRITE (NOUT,170) N,(CO(I,N),I=1,ITL)	2DB 0912
170	FORMAT(4H MAT,13,(10E11.3))	2DB 0913
175	WRITE (NSCRAT) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 0914
180	CONTINUE	2DB 0915
	REWIND NCR1	2DB 0916
	REWIND NSCRAT	2DB 0917
C	SWITCH TAPE DESIGNATIONS	2DB 0918
	ITEMP=NSCRAT	2DB 0919
	NSCRAT=NCR1	2DB 0920
	NCR1=ITEMP	2DB 0921
185	IF(I04-5) 190, 205, 190	2DB 0922
190	IF(BUCK) 200, 245, 200	2DB 0923
200	TEMP = BUCK	2DB 0924
	GO TO 220	2DB 0925
205	IF(P02) 210, 210, 215	2DB 0926
210	BUCK = 0.	2DB 0927
215	TEMP = EV - BUCK	2DB 0928
	BUCK = EV	2DB 0929
220	DO 240 IIG=1,IGM	2DB 0930
	READ(NCR1) ((CO(I,J), I=1,ITL),J=1,MT)	2DB 0931
	DO 235 MTZ = 1,MT	2DB 0932
	DO 230 KZ=1,IZM	2DB 0933
	IF(M2(KZ) - MTZ) 230, 225, 230	2DB 0934
225	TEMP1 = TEMP/(3.*CV(4,MTZ))	2DB 0935
	CO(2,MTZ) = CO(2,MTZ) + TEMP1	2DB 0936
	CO(5,MTZ) = CO(5,MTZ) - TEMP1	2DB 0937
	GO TO 235	2DB 0938
230	CONTINUE	2DB 0939
235	CONTINUE	2DB 0940
	WRITE(NSCRAT) ((CO(I,J), I=1,ITL),J=1,MT)	2DB 0941
240	CONTINUE	2DB 0942
	REWIND NCR1	2DB 0943
	REWIND NSCRAT	2DB 0944
C	SWITCH TAPE DESIGNATIONS	2DB 0945
	ITEMP = NSCRAT	2DB 0946
	NSCRAT = NCR1	2DB 0947
	NCR1 = ITEMp	2DB 0948
245	CONTINUE	2DB 0949
C		2DB 0950
C	MODIFY GEOMETRY	2DB 0951
	IF(P02)270, 250, 270	2DB 0952
250	IF(NCON) 375, 255, 375	2DB 0953
255	DO 260 I=1,IP	2DB 0954
260	R1(I)=R0(I)	2DB 0955
	DO 265 J=1,JP	2DB 0956
265	Z1(J)=Z0(J)	2DB 0957
270	IF(I04-4) 305, 275, 305	2DB 0958
275	DO 280 I=1,IM	2DB 0959
	K=R2(I)	2DB 0960
280	R1(I+1)=R1(I)+(R0(I+1)-R0(I))*(1.0+ EV*R3(K))	2DB 0961

	DO 285 J=1,JM	2DB 0962
	K=Z2(J)	2DB 0963
285	Z1(J+1)=Z1(J)+(Z0(J+1)-Z0(J))*(1.0+ EV*Z3(K))	2DB 0964
	IF(IGE-2) 305, 290, 305	2DB 0965
290	IF(ABS (Z1(JP)-1.0)-1.0E-04) 305, 305, 300	2DB 0966
300	CALL ERRO2(6H**INIT,300,1)	2DB 0967
305	CONTINUE	2DB 0968
C		2DB 0969
C	AREAS AND VOLUMES	2DB 0970
	PI2=6.28318	2DB 0971
	IF(P02) 310, 315, 310	2DB 0972
310	IF(I04 - 4) 375, 315, 375	2DB 0973
315	CONTINUE	2DB 0974
	DO 345 I=1,IM	2DB 0975
	R4(I)=(R1(I+1)+R1(I))*0.5	2DB 0976
	R5(I)=R1(I+1)-R1(I)	2DB 0977
	IF(R5(I)) 320, 320, 325	2DB 0978
320	CALL ERRO2 (6H*R5(I),320,1)	2DB 0979
325	CONTINUE	2DB 0980
	GO TO (330,335,340),IGEP	2DB 0981
330	A0(I)=1.0	2DB 0982
	A0(IP)=1.0	2DB 0983
	A1(I)=R5(I)	2DB 0984
	GO TO 345	2DB 0985
335	A0(I)=PI2*R1(I)	2DB 0986
	A0(IP)=PI2*R1(IP)	2DB 0987
	A1(I)=PI2*R5(I)*R4(I)	2DB 0988
	GO TO 345	2DB 0989
340	A0(I)=PI2*R1(I)	2DB 0990
	A0(IP)=PI2*R1(IP)	2DB 0991
	A1(I)=R5(I)	2DB 0992
345	CONTINUE	2DB 0993
	DO 370 J=1,JM	2DB 0994
	Z4(J)=(Z1(J+1)+Z1(J))*0.5	2DB 0995
	Z5(J)=Z1(J+1)-Z1(J)	2DB 0996
	IF(Z5(J)) 350, 350, 355	2DB 0997
350	CALL ERRO2 (6H*Z5(J),350,1)	2DB 0998
355	CONTINUE	2DB 0999
	DO 370 I=1,IM	2DB 1000
	GO TO (360, 365, 365),IGEP	2DB 1001
360	V0(I,J)=R5(I)*Z5(J)	2DB 1002
	GO TO 370	2DB 1003
365	V0(I,J)=PI2*R5(I)*Z5(J)*R4(I)	2DB 1004
370	CONTINUE	2DB 1005
375	CONTINUE	2DB 1006
C		2DB 1007
C	MATERIAL ADDRESSES	2DB 1008
380	IF(P02) 405, 385, 405	2DB 1009
385	SK7=0.	2DB 1010
	DO 400 IIG=1,IGM	2DB 1011
	IF(S02-1) 395, 390, 395	2DB 1012
390	K6(IIG)=K7(IIG)/S03	2DB 1013
	GO TO 400	2DB 1014
395	K6(IIG)=K7(IIG)	2DB 1015
400	SK7=SK7+K7(IIG)	2DB 1016
405	CONTINUE	2DB 1017
C		2DB 1018
C	FISSION NEUTRONS	2DB 1019
	T11=E1(IGP)	2DB 1020

410	CALL CLEAR(0.0,F0,IMJM)	2DB 1021
	DO 425 IIG=1,IGM	2DB 1022
	E0(IIG) = .0	2DB 1023
	READ (NFLUX1) (NO(I),I=1,IMJM)	2DB 1024
	READ (NCR1) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 1025
	DO 425 J = 1, JM	2DB 1026
	DO 425 K = 1, IM	2DB 1027
	I = K + (J-1)*IM	2DB 1028
	ITEMP=M0(I)	2DB 1029
	ITEMP=M2(ITEMP)	2DB 1030
	E0(IIG) = E0(IIG) + VO(K,J)*NO(I)*CO(I,ITEMP)	2DB 1031
	IF(A02) 415, 420, 415	2DB 1032
415	F0(I)=F0(I)+K7(IIG)*NO(I)	2DB 1033
	GO TO 425	2DB 1034
420	F0(I)=F0(I)+CO(IHT-1,ITEMP)*NO(I)	2DB 1035
425	CONTINUE	2DB 1036
	REWIND NFLUX1	2DB 1037
	REWIND NCR1	2DB 1038
	RETURN	2DB 1039
	END	2DB 1040

```
-IT FOR CLEAR,CLEAR
  SUBROUTINE CLEAR (X,Y,N)
    DIMENSION Y(1)
    DO 1 I=1,N
1   Y(I)=X
    RETURN
  END
```

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2DB 1041
2DB 1042
2DB 1043
2DB 1044
2DB 1045
2DB 1046
2DB 1047
-
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-ITC FOR FISCAL,FISCAL	2DB 1048
SUBROUTINE FISCAL (NO, FO, VO, CO, K6, MO, M2, JTL,JMT)	2DB 1049
INCLUDE ABC	2DB 1050
DIMENSION NO(1), FO(1), VO(1), CO(JTL,JMT),K6(1), MO(1), M2(1)	2DB 1051
LAR = ALA	2DB 1052
C FISSION SUMS	2DB 1053
IF(B07) 90,90,10	2DB 1054
10 IF(A02) 20, 40, 20	2DB 1055
20 DO 30 IIG=1,IGM	2DB 1056
READ (NCR1) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 1057
E1(IIG)=0.	2DB 1058
DO 30 I=1,IMJM	2DB 1059
ITEMP=MO(I)	2DB 1060
ITEMP=M2(ITEMP)	2DB 1061
30 E1(IIG)=E1(IIG)+CO(IHT-1,ITEMP)*FO(I)*VO(I)	2DB 1062
REWIND NCR1	2DB 1063
GO TO 70	2DB 1064
40 E01=0.	2DB 1065
DO 50 I=1,IMJM	2DB 1066
50 E01=E01+VO(I)*FO(I)	2DB 1067
DO 60 IIG=1,IGM	2DB 1068
60 E1(IIG)=K6(IIG)*E01	2DB 1069
70 E1(IGP)=0.	2DB 1070
E0(IGP)=0.	2DB 1071
DO 80 IIG=1,IGM	2DB 1072
E0(IGP)=E0(IGP)+E0(IIG)	2DB 1073
80 E1(IGP)=E1(IGP)+E1(IIG)	2DB 1074
IF(B07) 140, 90, 140	2DB 1075
90 ALA = E1(IGP)/T11	2DB 1076
TEMP=1.0/ALA	2DB 1077
IF(I04-1) 140, 100, 140	2DB 1078
100 DO 110 IIG=1,IGM	2DB 1079
E1(IIG)=E1(IIG)*TEMP	2DB 1080
110 K6(IIG)=K6(IIG)*TEMP	2DB 1081
E1(IGP)=E1(IGP)*TEMP	2DB 1082
IF(A02) 120, 140, 120	2DB 1083
120 DO 130 I=1,IMJM	2DB 1084
130 FO(I)=FO(I)*TEMP	2DB 1085
140 CONTINUE	2DB 1086
C	2DB 1087
C NORMALIZATION	2DB 1088
B07=0	2DB 1089
150 IF(S01) 160, 230, 170	2DB 1090
160 E01 8 ABS(S01)/(E0(IGP)*TSD)	2DB 1091
GO TO 180	2DB 1092
170 E01=S01/E1(IGP)	2DB 1093
180 DO 190 IIG=1,IGP	2DB 1094
190 E1(IIG)=E01*E1(IIG)	2DB 1095
DO 200 I=1,IMJM	2DB 1096
200 FO(I)=E01*FO(I)	2DB 1097
230 RETURN	2DB 1098
END	2DB 1099

-ITC FOR S8830,S8830		2DB 1100
SUBROUTINE S8830		2DB 1101
INCLUDE ABC		2DB 1102
C MP 830 MONITOR PRINT		2DB 1103
CALL ETIMEF(TI)		2DB 1104
TI = TI/60.		2DB 1105
-PAGE = KPAGE + 1		2DB 1106
IF(KPAGE - 40) 220, 160, 160		2DB 1107
160 KPAGE = 0		2DB 1108
210 WRITE(NOUT, 213)		2DB 1109
213 FORMAT(105H1 TIME OUTE- IN. IT. EIGENVAL		2DB 1110
1UE EIGENVALUE LAMBDA)		2DB 1111
WRITE(NOUT, 215)		2DB 1112
215 FORMAO(105H (MINUTES) ITERATIONS PER LOOP SLOPE		2DB 1113
1 /)		2DB 1114
220 WRITE(NOUT, 225) TI, P02, LC, EQ, EV, ALA		2DB 1115
225 FORMAT(4X, F6.2, 10X, I4, 11X, 14, 6X, E15.8, E15.8, E15.8)		2DB 1116
230 P02=P02+1		2DB 1117
LC=0		2DB 1118
IF(P02-D05)430,430,330		2DB 1119
330 NGOTO = 1		2DB 1120
GO TO 630		2DB 1121
430 NGOTO = 4		2DB 1122
630 RETURN		2DB 1123
END		2DB 1124

```

-ITC FOR OUTER, OUTER
SUBROUTINE OUTER( A0, A1, C0, F0, K6, M0, M2, N0, N2,
1      S2, V0, V7, Z5, F2, JTL, JMT, CXS,
2      JIM, JJM, R5, R4, Z4, CXR, CXT, HA, PA)
DIMENSION AC(1), A1(1), F0(1), K6(1), M0(1), M2(1),
1      N0(1), N2(1), S2(1),
2      V0(1), V7(1), Z5(1), F2(1), C0(JTL, JMT), HA(1), PA(1),
3      CXS(JIM, JJM, 3), R5(1), R4(1), Z4(1), CXR(1), CXT(1)
INTEGER GBAR, PBAR, SBAR
INCLUDE ABC
IGV=1
C SOURCE CALCULATION
10 CONTINUE
9EAD(NCR1) ((C0(I,M), I=1, ITL), M=1, MT)
DO 20 I=1, IMJM
20 S2(I)=0.
IF(A02) 60, 40, 60
40 DO 50 I=1, IMJM
50 S2(I)=S2(I)+K6(IGV)*F0(I)
GO TO 80
60 DO 70 I=1, IMJM
ITEMP1=M0(I)
ITEMP1=M2(ITEMP1)
70 S2(I)=S2(I)+C0(HT-1, ITEMP1)*F0(I)
80 GEAR=IGV+IHS-ITL
IF(G21R-1) 90, 100, 100
90 GEAR=1
100 PBAR = IHS + IGV - 1
IF(PBAR - ITL) 115, 115, 110
110 PBAR = ITL
115 IF(GBAR - IGV) 120, 140, 140
120 READ (NSCRAT) (N2(I), I=1, IMJM)
40 130 I=1, IMJM
ITEMP1=M0(I)
ITEMP1=M2(ITEMP1)
ITEMP=ITEMP1
TEMP=+U(PBAR, ITEMP)
130 S2(I)=S2(I)+N2(I)*TEMP
GO TO 150
140 READ (NFLUX1) (N2(I), I=1, IMJM)
150 GBAR=GBAR+1
-PBAR=PBAR-1
IF(GBAR - IGV) 120, 140, 160
160 +F(IGV - IGM) 180, 170, 180
170 REWIND NCR1
180 V11=0.
DO 190 I=1, IMJM
190 S2(I)=S2(I)*V0(I)
V11=V11+S2(I)
E2(IGV) = V11 - E1(IGV)
C SOURCE-ALPHA
200 IF(I04 - 2) 210, 240, 210
210 IF(I50 - 2) 230, 220, 230
220 T7 = 0.03/V7(IGV)
GO TO 250
230 T7 = 0.0
GO TO 270
240 T7 = EV/V7(IGV)
250 DO 260 K = 1, IZM

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ITEMP1 = M2(K)
260 CO(IHS, ITEMP1) = CO(IHS, ITEMP1) - T7
270 CONTINUE
C GROUP FLUX CALCULATION
280 II=0
    +F(V1 ) 290, 370, 290
290 CALL INNER1(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, IM, JM,
1     ITL, CXR, CXT)
    IF (+03 - 1) 310, 310, 300
300 CALL INNERP(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT,
1     HA, PA)
    GO TO 350
310 IF (IGE - 2) 320, 330, 320
320 +F (IM - JM) 330, 330, 340
330 CALL INNER(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT,
1     HA, PA)
    GO TO 350
340 CALL INNER2(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT,
1     HA, PA)
350 DO 360 K = 1, IMJM
    ITEMP1 = M2(K)
360 CO(IHS, ITEMP1) = CO(IHS, ITEMP1) + T7
    GO TO 390
370 DO 380 I=1, IMJM
    N2(I)=0.
380 NO(I)=0.
390 CONTINUE
    WRITE (NSCRAT) (N2(I), I=1, IMJM)
    SBAR=ITL-IHS
    IF(SBAR) 440, 440, 420
420 DO 430 IS=1, SBAR
430 BACKSPACE NSCRAT
440 CONTINUE
    IF(V11) 450, 500, 450
450 IF(A0 ) 460, 480, 460
460 EO(IGV)=0.0
    DO 470 I=1, IMJM
    ITEMP1=M0(I)
    ITEMP =M2(ITEMP1)
    EO(IGV)=EO(IGV) + CO(1, ITEMP1)*N2(I)*V0(I)
470 F2(I)=F2(I)+K6(IGV)*N2(I)
    GO TO 500
480 EO(IGV)=0.0
    DO 490 I=1, IMJM
    ITEMP1=M0(I)
    ITEMP=M2(ITEMP1)
    EO(IGV)=EO(IGV) + CO(1, ITEMP1)*N2(I)*V0(I)
490 F2(I)=F2(I)+CO(IHT-1, ITEMP1)*N2(I)
500 CONTINUE
    IGV=IGV+1
    IF(IGV-IGM) 10, 10, 510
510 I11 = E1(IGP)
C SWITCH TAPE DESIGNATIONS
    REWIND NCR1
    REWIND NSCRAT
    REWIND NFLUX1
    ITEMP = NSCRAT
    NSCRAT = NFLUX1
    NFLUX1 = ITEMP

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C		2DB 1243
C	OVER-RELAX FISSION SOURCE	2DB 1244
	ORFF = 1.0 + .6*(ORF - 1.0)	2DB 1245
	E02 = .0	2DB 1246
	IF(A0) 520,580,520	2DB 1247
520	E1(IGP) = .0	2DB 1248
C	FOR ADJOINT CALCULATION, S2(I) STORES ORFED F2(I)	2DB 1249
	DO 522 I=1,IMJM	2DB 1250
522	S2(I) = F0(I) + ORFF*(F2(I) - F0(I))	2DB 1251
	DO 540 IIG = 1,IGM	2DB 1252
	READ(-CR1) ((C0(I,J), I=1,ITL), J=1,MT)	2DB 1253
	E1(IIG) = .0	2DB 1254
	DO 530 I=1,IMJM	2DB 1255
	ITEMP = MU(I)	2DB 1256
	ITEMP = M2(ITEMP)	2DB 1257
	+1(I+G) = E1(IIG) + C0(IHT-1,ITEMP)*F2(I)*V0(I)	2DB 1258
530	E02 = E02 + C0(IHT-1,ITEMP)*S2(I)*V0(I)	2DB 1259
540	E1(IGP) = E1(IGP) + E1(IIG)	2DB 1260
	TEMP1 = E1(IGP)/E02	2DB 1261
	DO 550 I=1,IMJM	2DB 1262
550	F0(I) = TEMP1*S2(I)	2DB 1263
	REWIND NCR1	2DB 1264
	GO TO 620	2DB 1265
580	E01 = 0.0	2DB 1266
	DO 590 I=1,IMJM	2DB 1267
	E01 = E01 + V0(I)*F2(I)	2DB 1268
	F2(I) = F0(I) + ORFF*(F2(I) - F0(I))	2DB 1269
590	E02 = E02 + V0(I)*F2(I)	2DB 1270
	TEMP1 = E01/E02	2DB 1271
	DO 600 I=1,IMJM	2DB 1272
600	F0(I) = TEMP1*F2(I)	2DB 1273
	DO 610 IIG = 1,IGM	2DB 1274
610	E1(IIG) = K6(IIG)*E01	2DB 1275
620	E1(IGP) = 0.0	2DB 1276
	E0(IGP) = 0.0	2DB 1277
	DO 640 IIG = 1,IGM	2DB 1278
	E0(IGP) = E0(IGP) + E0(IIG)	2DB 1279
640	E1(IGP) = E1(IGP) + E1(IIG)	2DB 1280
	9RETURN	2DB 1281
	END	2DB 1282

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-ITC FOR INNER1,INNER1                                2DB 1283
  SUBROUTINE INNER1(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, 2DB 1284
  2 JIM,JJM,JTL,CXR,CXT)                                2DB 1285
    DIMENSION M0(1), M2(1),CXS(JIM,JJM,3),V0(1), C0(JTL,1), 2DB 1286
    1 A0(1), Z5(1), R5(1), R4(1), Z4(1), A1(1),CXR(1), CXT(1)2DB 1287
    INCLUDE ABC                                          2DB 1288
  C THIS SUBROUTINE CALCULATES COEFFICIENTS FOR THE FLUX EQUATION 2DB 1289
    PI2 = 6.28318                                        2DB 1290
    DO 45 KJ = 1, JM                                    2DB 1291
    DO 45 KI = 1, IM                                    2DB 1292
    GO TO (10,10, 5), IGEP                              2DB 1293
  5 TEMP = PI2*(Z4(KJ) - Z4(KJ-1))*R4(KI)                2DB 1294
    GO TO 15                                              2DB 1295
  10 TEMP = Z4(KJ) - Z4(KJ-1)                            2DB 1296
  15 I = KI + (KJ-1)*IM                                  2DB 1297
    ITEMP = M0(I)                                        2DB 1298
    ITEMP = M2(ITEMP)                                    2DB 1299
    CXS(KI,KJ,3) = V0(I)*(C0(IHT,ITEMP) - C0(IHS,ITEMP)) 2DB 1300
    IF(I - 1) 45,45,18                                  2DB 1301
  18 ITEMP1 = M0(I-1)                                    2DB 1302
    ITEMP1 = M2(ITEMP1)                                  2DB 1303
    IF (ITEMP - ITEMP1) 25,20,25                         2DB 1304
  20 CXS(KI,KJ,1)=A0(KI )*Z5(KJ)/(3.*C0(IHT,ITEMP)*(R4(KI)-R4(KI-1))) 2DB 1305
    GO TO 30                                              2DB 1306
  25 CXS(KI,KJ,1) = A0(KI)*Z5(KJ)*(R5(KI-1)+R5(KI))/((R4(KI)-R4(KI-1))*2DB 1307
  1 (3.*(R5(KI-1)*C0(IHT,ITEMP1) + R5(KI)*C0(IHT,ITEMP))) 2DB 1308
  30 IF(I - IM) 45,45,32                                  2DB 1309
  32 ITEMP3 = M0(I - IM)                                  2DB 1310
    ITEMP3 = M2(ITEMP3)                                  2DB 1311
    IF (ITEMP - ITEMP3) 40,35,40                         2DB 1312
  35 CXS(-I,KJ,2) = A1(KI)/(3.*C0(IHT,ITEMP)*TEMP)      2DB 1313
    GO TO 45                                              2DB 1314
  40 CXS(KI,KJ,2) = A1(KI)*(Z5(KJ-1) + Z5(KJ))/(ITEMP* 2DB 1315
  1 (3.*(Z5(KJ-1)*C0(IHT,ITEMP3) + Z5(KJ)*C0(IHT,ITEMP)))) 2DB 1316
  45 CONTINUE                                            2DB 1317
    DO 200 KJ = 1, JM                                    2DB 1318
    DO 200 KI = 1, IM                                    2DB 1319
    GO TO (55,55,50), IGEP                              2DB 1320
  50 TEMP = .5*PI2*Z5(KJ)*R4(KI)                        2DB 1321
    GO TO 60                                              2DB 1322
  55 TEMP = .5*Z5(KJ)                                    2DB 1323
  60 I = KI + (KJ-1)*IM                                  2DB 1324
    ITEMP = M0(I)                                        2DB 1325
    ITEMP = M2(ITEMP)                                    2DB 1326
    TEMP1 = CXS(KI+1,KJ,1)                              2DB 1327
    TEMP2 = CXS(KI,KJ+1,2)                              2DB 1328
    IF(KJ - 1) 65,65,100                                2DB 1329
  65 IF(B04 - 1) 90,95,70                                2DB 1330
  70 GO TO ( 80, 80, 75), IGEP                          2DB 1331
  75 TEMP3 = PI2*R4(KI)*.5*(Z5(KJ) + Z5(JM))            2DB 1332
    GO TO 85                                              2DB 1333
  80 TEMP3 = .5*(Z5(KJ) + Z5(JM))                      2DB 1334
  85 ITEMP3 = I + IM*(JM - 1)                            2DB 1335
    ITEMP3 = M0(ITEMP3)                                  2DB 1336
    ITEMP3 = M2(ITEMP3)                                  2DB 1337
    CXS(KI,KJ,2) = A1(KI)*(Z5(JM) + Z5(KJ))/(ITEMP3* 2DB 1338
  1 (3.*(Z5(JM)*C0(IHT,ITEMP3) + Z5(KJ)*C0(IHT,ITEMP)))) 2DB 1339
    GO TO 125                                             2DB 1340
  90 CXS(KI,KJ,2) = A1(KI)/(3.*C0(IHT,ITEMP)*(TEMP +.71/ 2DB 1341

```


1	CO(IHT,ITEMP)))	2DB 1342
	GO TO 125	2DB 1343
95	CXS(KI,KJ,2) = .0	2DB 1344
	GO TO 125	2DB 1345
100	IF (KJ - JM) 125,105,105	2DB 1346
105	IF (B03 - 1) 115,120,110	2DB 1347
110	TEMP = CXS(KI,1,2)	2DB 1348
	CXT(KI) = TEMP2	2DB 1349
	GO TO 125	2DB 1350
115	TEMP2 = A1(KI)/(3.*CO(IHT,ITEMP)*(TEMP +.71/	2DB 1351
	1 CO(IHT,ITEMP)))	2DB 1352
	CXT(KI) = TEMP2	2DB 1353
	GO TO 125	2DB 1354
120	TEMP2 = .0	2DB 1355
	CXT(KI) = TEMP2	2DB 1356
125	IF (KI - 1) 130,130,145	2DB 1357
130	IF(B01) 135,135,140	2DB 1358
135	CXS(KI,KJ,1) = A0(KI)*Z5(KJ)/(3.*CO(IHT,ITEMP)*	2DB 1359
	1 (.5*R5(KI) + .71/CO(IHT,ITEMP)))	2DB 1360
	GO TO 165	2DB 1361
140	CXS(KI,KJ,1) = .0	2DB 1362
	GO TO 165	2DB 1363
145	IF (KI - IM) 165,150,150	2DB 1364
150	IF(B02) 155,155,160	2DB 1365
155	TEMP1 = A0(KI+1)*Z5(KJ)/(3.*CO(IHT,ITEMP)*	2DB 1366
	1 (.5*R5(KI) + .71/CO(IHT,ITEMP)))	2DB 1367
	CXR(KJ) = TEMP1	2DB 1368
	GO TO 165	2DB 1369
160	TEMP1 = .0	2DB 1370
	CXR(KJ) = TEMP1	2DB 1371
165	CXS(KI,KJ,3) = CXS(KI,KJ,3) + CXS(KI,KJ,1) + CXS(KI,KJ,2)	2DB 1372
	1 + TEMP1 + TEMP2	2DB 1373
200	CONTINUE	2DB 1374
	RETURN	2DB 1375
	END	2DB 1376

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-ITC FOR INNER,INNER                                2DB 1377
SUBROUTINE INNER(N0, N2, CXS, S2, M0, M2, V0, C0, JIM, JJM, JTL, 2DB 1378
1      CXR, CXT, HA, PA)                                2DB 1379
  INCLUDE ABC                                          2DB 1380
  DIMENSION N0(1), N2(1), CXS(JIM, JJM, 3), S2(1), M0(1), M2(1), 2DB 1381
1      V0(1), C0(JTL, 1), CXR(1), CXT(1), HA(1), PA(1) 2DB 1382
  CALL IFLUXN (N2, C0, V0, CXS, M0, M2, JTL, IM, JM, CXR, CXT) 2DB 1383
2  DO 4 I=1, IMJM                                     2DB 1384
4  N0(I) = N2(I)                                       2DB 1385
C  BEGIN FLUX CALCULATION                             2DB 1386
  IKB = IM - 1                                         2DB 1387
  JKB = JM - 1                                         2DB 1388
C  FLUX CALCULATION USING SOR WITH LINE INVERSION      2DB 1389
C                                                     2DB 1390
C  CALCULATION OF LEFT BOUNDARY FLUX                  2DB 1391
  KI = 1                                              2DB 1392
  KJ = 1                                              2DB 1393
  I = KI + (KJ - 1)*IM                               2DB 1394
  HA(KJ) = CXS(KI, KJ+1, 2)/CXS(KI, KJ, 3)           2DB 1395
  PA(KJ) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1))/CXS(KI, KJ, 3) 2DB 1396
  DO 5 KJ = 2, JKB                                    2DB 1397
  I = KI + (KJ - 1)*IM                               2DB 1398
  HA(KJ) = CXS(KI, KJ+1, 2)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1399
5  PA(KJ) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1) + CXS(KI, KJ, 2)*PA(KJ-1))/2DB 1400
1  (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1))          2DB 1401
  KJ = JM                                             2DB 1402
  I = KI + (KJ - 1)*IM                               2DB 1403
  N2(I) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1) + CXS(KI, KJ, 2)*PA(KJ-1))/2DB 1404
1  (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1))          2DB 1405
  DO 10 KJJ = 2, JIM                                 2DB 1406
  KJ = JM - KJJ + 1                                  2DB 1407
  I = KI + (KJ - 1)*IM                               2DB 1408
10 N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)                 2DB 1409
  DO 15 KJ = 1, JM                                    2DB 1410
  I = KI + (KJ - 1)*IM                               2DB 1411
15 N2(I) = N0(I) + ORF*(N2(I) - N0(I))               2DB 1412
C  PRINCIPAL FLUX LOOP                               2DB 1413
  DO 40 KI = 2, IKB                                   2DB 1414
  KJ = 1                                              2DB 1415
  I = KI + (KJ - 1)*IM                               2DB 1416
  HA(KJ) = CXS(KI, KJ+1, 2)/CXS(KI, KJ, 3)           2DB 1417
  PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1))/ 2DB 1418
1  CXS(KI, KJ, 3)                                     2DB 1419
  DO 25 KJ = 2, JKB                                    2DB 1420
  I = KI + (KJ - 1)*IM                               2DB 1421
  HA(KJ) = CXS(KI, KJ+1, 2)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1422
25 PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1) + 2DB 1423
1  CXS(KI, KJ, 2)*PA(KJ-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1424
  KJ = JM                                             2DB 1425
  I = KI + (KJ - 1)*IM                               2DB 1426
  N2(I) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1) + 2DB 1427
1  CXS(KI, KJ, 2)*PA(KJ-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1428
  DO 30 KJJ = 2, JIM                                 2DB 1429
  KJ = JM - KJJ + 1                                  2DB 1430
  I = KI + (KJ - 1)*IM                               2DB 1431
30 N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)                 2DB 1432
  DO 35 KJ = 1, JM                                    2DB 1433
  I = KI + (KJ - 1)*IM                               2DB 1434
35 N2(I) = N0(I) + ORF*(N2(I) - N0(I))               2DB 1435

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40	CONTINUE	2DB 1436
C	CALCULATION OF RIGHT BOUNDARY FLUX	2DB 1437
	KI = IM	2DB 1438
	KJ = 1	2DB 1439
	I = KI + (KJ - 1)*IM	2DB 1440
	HA(KJ) = CXS(KI,KJ+1,2)/CXS(KI,KJ,3)	2DB 1441
	PA(KJ) = (S2(I) + CXS(KI,KJ,1)*N2(I-1))/CXS(KI,KJ,3)	2DB 1442
	DO 45 KJ = 2, JKB	2DB 1443
	I = KI + (KJ - 1)*IM	2DB 1444
	HA(KJ) = CXS(KI,KJ+1,2)/(CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))	2DB 1445
45	PA(KJ) = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*PA(KJ-1))/	2DB 1446
	1 (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))	2DB 1447
	KJ = JM	2DB 1448
	I = KI + (KJ - 1)*IM	2DB 1449
	N2(I) = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*PA(KJ-1))/	2DB 1450
	1 (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))	2DB 1451
	DO 50 KJJ = 2, JM	2DB 1452
	KJ = JM - KJJ + 1	2DB 1453
	I = KI + (KJ - 1)*IM	2DB 1454
50	N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)	2DB 1455
	DO 55 KJ = 1, JM	2DB 1456
	I = KI + (KJ - 1)*IM	2DB 1457
55	N2(I) = NO(I) + ORF*(N2(I) - NO(I))	2DB 1458
	E01 = .0	2DB 1459
	DO 90 I=1, IMJM	2DB 1460
	ITEMP1 = M0(I)	2DB 1461
	ITEMP = M2(ITEMP1)	2DB 1462
	E01 = E01 + ABS(N2(I) - NO(I))*V0(I)*C0(IHT-1,ITEMP)	2DB 1463
90	CONTINUE	2DB 1464
C		2DB 1465
C	INNER ITERATION CONTROL	2DB 1466
133	LC = LC + 1	2DB 1467
	II = II + 1	2DB 1468
	IF (II - G07) 533, 1033, 1033	2DB 1469
533	IF (FLOAT(IGM)*E01 - EPS*E1(IGP)) 633, 633, 2	2DB 1470
633	IF (G06) 733, 1033, 733	2DB 1471
733	TEMP1 = .0	2DB 1472
	DO 933 I=1, IMJM	2DB 1473
	TEMP2 = ABS (1.0 - NO(I)/N2(I))	2DB 1474
	IF (TEMP1 - TEMP2) 833, 933, 933	2DB 1475
833	TEMP1 = TEMP2	2DB 1476
933	CONTINUE	2DB 1477
	IF (TEMP1 - G06) 1033, 1033, 2	2DB 1478
1033	CONTINUE	2DB 1479
	RETURN	2DB 1481
	END	2DB 1482

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-ITC FOR INNER2,INNER2                                2DB 1483
  SUBROUTINE INNER2(N0, N2, CXS, S2, M0, M2, V0, C0, JIM, JJM, JTL, 2DB 1484
    1 CXR, CXT, HA, PA)                                2DB 1485
    1 INCLUDE ABC                                      2DB 1486
    DIMENSION N0(1), N2(1), CXS(JIM, JJM, 3), S2(1), M0(1), M2(1), 2DB 1487
    1 V0(1), C0(JTL, 1), CXR(1), CXT(1), HA(1), PA(1) 2DB 1488
    CALL IFLUXN(N2, C0, V0, CXS, M0, M2, ITL, IM, JM, CXR, CXT) 2DB 1489
    2 DO 4 I=1, IMJM                                  2DB 1490
    4 N0(I) = N2(I)                                    2DB 1491
    C BEGIN FLUX CALCULATION                          2DB 1492
    IKB = IM - 1                                       2DB 1493
    JKB = JM - 1                                       2DB 1494
    C FLUX CALCULATION USING SOR WITH LINE INVERSION 2DB 1495
    C                                                  2DB 1496
    C CALCULATION OF BOTTOM BOUNDARY FLUX             2DB 1497
    KI = 1                                             2DB 1498
    KJ = 1                                             2DB 1499
    I = KI + (KJ - 1)*IM                             2DB 1500
    HA(KI) = CXS(KI+1, KJ, 1)/CXS(KI, KJ, 3)         2DB 1501
    PA(KI) = (S2(I) + CXS(KI, KJ+1, 2)*N2(I+IM))/CXS(KI, KJ, 3) 2DB 1502
    DO 5 KI = 2, IKB                                  2DB 1503
    I = KI + (KJ - 1)*IM                             2DB 1504
    HA(KI) = CXS(KI+1, KJ, 1)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1505
    5 PA(KI) = (S2(I) + CXS(KI, KJ+1, 2)*N2(I+IM) + CXS(KI, KJ, 1)*PA(KI-1))/ 2DB 1506
    1 (CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1))      2DB 1507
    KI = IM                                           2DB 1508
    I = KI + (KJ - 1)*IM                             2DB 1509
    N2(I) = (S2(I) + CXS(KI, KJ+1, 2)*N2(I+IM) + CXS(KI, KJ, 1)*PA(KI-1))/ 2DB 1510
    1 (CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1))      2DB 1511
    DO 10 KII = 2, IM                                2DB 1512
    KI = IM - KII + 1                                 2DB 1513
    I = KI + (KJ - 1)*IM                             2DB 1514
    10 N2(I) = PA(KI) + HA(KI) * N2(I+1)              2DB 1515
    DO 15 KI = 1, IM                                  2DB 1516
    I = KI + (KJ - 1)*IM                             2DB 1517
    15 N2(I) = N0(I) + ORF*(N2(I) - N0(I))            2DB 1518
    C PRINCIPAL FLUX LOOP                             2DB 1519
    DO 40 KJ = 2, JKB                                 2DB 1520
    KI = 1                                             2DB 1521
    I = KI + (KJ - 1)*IM                             2DB 1522
    HA(KI) = CXS(KI+1, KJ, 1)/CXS(KI, KJ, 3)         2DB 1523
    PA(KI) = (S2(I) + CXS(KI, KJ, 2)*N2(I-IM) + CXS(KI, KJ+1, 2)*N2(I+IM))/ 2DB 1524
    1 CXS(KI, KJ, 3)                                   2DB 1525
    DO 25 KI = 2, IKB                                  2DB 1526
    I = KI + (KJ - 1)*IM                             2DB 1527
    HA(KI) = CXS(KI+1, KJ, 1)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1528
    25 PA(KI) = (S2(I) + CXS(KI, KJ, 2)*N2(I-IM) + CXS(KI, KJ+1, 2)*N2(I+IM) + 2DB 1529
    1 CXS(KI, KJ, 1)*PA(KI-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1530
    KI = IM                                           2DB 1531
    I = KI + (KJ - 1)*IM                             2DB 1532
    N2(I) = (S2(I) + CXS(KI, KJ, 2)*N2(I-IM) + CXS(KI, KJ+1, 2)*N2(I+IM) + 2DB 1533
    1 CXS(KI, KJ, 1)*PA(KI-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1534
    DO 30 KII = 2, IM                                  2DB 1535
    KI = IM - KII + 1                                 2DB 1536
    I = -1 + (KJ - 1)*IM                             2DB 1537
    30 N2(I) = PA(KI) + HA(KI) * N2(I+1)              2DB 1538
    DO 35 KI = 1, IM                                  2DB 1539
    I = KI + (KJ - 1)*IM                             2DB 1540
    35 N2(I) = N0(I) + ORF*(N2(I) - N0(I))            2DB 1541

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40  CONTINUE                                2DB 1542
C    CALCULATION OF TOP BOUNDARY FLUX      2DB 1543
      KJ = JM                                2DB 1544
      KI = 1                                2DB 1545
      I = KI + (KJ - 1)*IM                  2DB 1546
      HA(KI) = CXS(KI+1,KJ,1)/CXS(KI,KJ,3)  2DB 1547
      PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM))/CXS(KI,KJ,3) 2DB 1548
      DO 45 KI = 2,IKB                      2DB 1549
        I = KI + (KJ - 1)*IM                2DB 1550
        HA(KI) = CXS(KI+1,KJ,1)/(CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1)) 2DB 1551
45   PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM) + CXS(KI,KJ,1)*PA(KI-1))/ 2DB 1552
      1 (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1)) 2DB 1553
      KI = IM                                2DB 1554
      I = KI + (KJ - 1)*IM                  2DB 1555
      N2(I) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM) + CXS(KI,KJ,1)*PA(KI-1))/ 2DB 1556
      1 (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1)) 2DB 1557
      DO 50 KII = 2,IM                      2DB 1558
        KI = IM - KII + 1                   2DB 1559
        I = KI + (KJ - 1)*IM                2DB 1560
50   N2(I) = PA(KI) + HA(KI) * N2(I+1)      2DB 1561
      DO 55 KI = 1,IM                      2DB 1562
        I = KI + (KJ - 1)*IM                2DB 1563
55   N2(I) = NO(I) + ORF*(N2(I) - NO(I))    2DB 1564
      E01 = .0                              2DB 1565
      DO 90 I=1, IMJM                      2DB 1566
        ITEMP1 = MO(I)                     2DB 1567
        ITEMP = M2(ITEMP1)                 2DB 1568
        E01 = E01 + ABS(N2(I) - NO(I))*VO(I)*CO(IHT-1,ITEMP) 2DB 1569
90   CONTINUE                                2DB 1570
C                                            2DB 1571
C    INNER ITERATION CONTROL              2DB 1572
133  LC = LC + 1                            2DB 1573
      II = II + 1                          2DB 1574
      IF (II - G07) 533, 1033, 1033        2DB 1575
533  IF (FLOAT(IGM)*E01 - EPS*E1(IGP)) 633,633,2 2DB 1576
633  IF(G06) 733, 1033, 733               2DB 1577
733  TEMP1 = .0                             2DB 1578
      DO 933 I=1,IMJM                     2DB 1579
        TEMP2=ABS (1.0-NO(I)/N2(I))        2DB 1580
        IF(TEMP1-TEMP2)833,933,933         2DB 1581
833  TEMP1=TEMP2                           2DB 1582
933  CONTINUE                              2DB 1583
      IF (TEMP1 - G06) 1033, 1033, 2      2DB 1584
1033 CONTINUE                              2DB 1585
      RETURN                                2DB 1587
      END                                  2DB 1588

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-ITC FOR INNERP,INNERP                                2DB 1589
  SUBROUTINE INNERP(N0, N2, CXS, S2, M0, M2, V0, C0, JIM, JJM, JTL, 2DB 1590
1    CXR, CXT, HA, PA)                                2DB 1591
    INCLUDE ABC                                        2DB 1592
    DIMENSION N0(1), N2(1), CXS(JIM, JJM, 3), S2(1), M0(1), M2(1), 2DB 1593
1    V0(1), C0(JTL, 1), CXR(1), CXT(1), HA(1), PA(1) 2DB 1594
C    THIS SUBROUTINE CALCULATES THE FLUX FOR PERIODIC B. C. 2DB 1595
    CALL IFLUXN (N2, C0, V0, CXS, M0, M2, ITL, IM, JM, CXR, CXT) 2DB 1596
2    DO 4 I=1, IMJM                                    2DB 1597
4    N0(I) = N2(I)                                     2DB 1598
C    BEGIN FLUX CALCULATION                             2DB 1599
    IKB = IM - 1                                       2DB 1600
    JKB = JM - 1                                       2DB 1601
C    FLUX CALCULATION USING SOR WITH LINE INVERSION     2DB 1602
C                                                        2DB 1603
C    CALCULATION OF LEFT BOUNDARY FLUX                  2DB 1604
    KI = 1                                             2DB 1605
    KJ = 1                                             2DB 1606
    I = KI + (KJ - 1)*IM                             2DB 1607
    N2(I) = CXS(KI, 1, 2)/CXS(KI, KJ, 3)              2DB 1608
    HA(KJ) = CXS(KI, KJ+1, 2)/CXS(KI, KJ, 3)           2DB 1609
    TEMP1 = N2(I)                                     2DB 1610
    TEMP = HA(1)                                       2DB 1611
    PA(KJ) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1))/CXS(KI, KJ, 3) 2DB 1612
    TEMP2 = PA(KJ)                                    2DB 1613
    DO 5 KJ = 2, JKB                                  2DB 1614
    I = KI + (KJ - 1)*IM                             2DB 1615
    HA(KJ) = CXS(KI, KJ+1, 2)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1616
    N2(I) = CXS(KI, KJ, 2) * N2(I-IM)/                2DB 1617
1    (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1))        2DB 1618
    TEMP1 = TEMP1 + TEMP*N2(I)                        2DB 1619
    PA(KJ) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1) + CXS(KI, KJ, 2)*PA(KJ-1))/2DB 1620
1    (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1))        2DB 1621
    TEMP2 = TEMP2 + TEMP*PA(KJ)                       2DB 1622
5    TEMP = TEMP*HA(KJ)                               2DB 1623
    KJ = JM                                           2DB 1624
    I = KI + (KJ - 1)*IM                             2DB 1625
    TEMP1 = (TEMP1 + TEMP)*CXS(KI, 1, 2) + CXS(KI, KJ, 2)*N2(I-IM) 2DB 1626
    N2(I) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1) + CXS(KI, KJ, 2)*PA(KJ-1) 2DB 1627
1    + CXS(KI, 1, 2)*TEMP2 )/                          2DB 1628
1    (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1) - TEMP1) 2DB 1629
    DO 10 KJJ = 2, JM                                2DB 1630
    KJ = JM - KJJ + 1                                2DB 1631
    I = KI + (KJ - 1)*IM                             2DB 1632
    KII = (JM-1)*IM + KI                             2DB 1633
10    N2(I) = PA(KJ) + HA(KJ) * N2(I+IM) + N2(I) * N2(KII) 2DB 1634
    DO 15 KJ = 1, JM                                  2DB 1635
    I = KI + (KJ - 1)*IM                             2DB 1636
15    N2(I) = N0(I) + ORF*(N2(I) - N0(I))             2DB 1637
C    PRINCIPAL FLUX LOOP                               2DB 1638
    DO 40 KI = 2, IKB                                 2DB 1639
    KJ = 1                                             2DB 1640
    I = KI + (KJ - 1)*IM                             2DB 1641
    HA(KJ) = CXS(KI, KJ+1, 2)/CXS(KI, KJ, 3)          2DB 1642
    N2(I) = CXS(KI, 1, 2)/CXS(KI, KJ, 3)              2DB 1643
    TEMP1 = N2(I)                                     2DB 1644
    TEMP = HA(1)                                       2DB 1645
    PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1))/2DB 1646
1    CXS(KI, KJ, 3)                                    2DB 1647

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TEMP2 = PA(KJ)                                2DB 1648
DO 25 KJ = 2, JKB                              2DB 1649
I = KI + (KJ - 1)*IM                          2DB 1650
HA(KJ) = CXS(KI, KJ+1, 2) / (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1651
N2(I) = CXS(KI, KJ, 2) * N2(I-IM) /           2DB 1652
1 (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1653
TEMP1 = TEMP1 + TEMP*N2(I)                    2DB 1654
PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1) + 2DB 1655
1 CXS(KI, KJ, 2)*PA(KJ-1)) / (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1656
TEMP2 = TEMP2 + TEMP*PA(KJ)                  2DB 1657
25 TEMP = TEMP*HA(KJ)                        2DB 1658
KJ = JM                                       2DB 1659
I = KI + (KJ - 1)*IM                        2DB 1660
TEMP1 = (TEMP1 + TEMP)*CXS(KI, 1, 2) + CXS(KI, KJ, 2)*N2(I-IM) 2DB 1661
N2(I) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1) + 2DB 1662
1 CXS(KI, 1, 2)*TEMP2 + 2DB 1663
1 CXS(KI, KJ, 2)*PA(KJ-1)) / (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1) - 2DB 1664
2 TEMP1) 2DB 1665
DO 30 KJJ = 2, JM                            2DB 1666
KJ = JM - KJJ + 1                          2DB 1667
I = KI + (KJ - 1)*IM                      2DB 1668
KII = (JM-1)*IM + KI                     2DB 1669
30 N2(I) = PA(KJ) + HA(KJ) * N2(I+IM) + N2(I) * N2(KII) 2DB 1670
DO 35 KJ = 1, JM                            2DB 1671
I = KI + (KJ - 1)*IM                      2DB 1672
35 N2(I) = N0(I) + ORF*(N2(I) - N0(I))      2DB 1673
40 CONTINUE                                2DB 1674
C CALCULATION OF RIGHT BOUNDARY FLUX        2DB 1675
KI = IM                                    2DB 1676
KJ = 1                                     2DB 1677
I = KI + (KJ - 1)*IM                      2DB 1678
HA(KJ) = CXS(KI, KJ+1, 2) / CXS(KI, KJ, 3) 2DB 1679
N2(I) = CXS(KI, 1, 2) / CXS(KI, KJ, 3)     2DB 1680
TEMP1 = N2(I)                             2DB 1681
TEMP = HA(1)                              2DB 1682
PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1)) / CXS(KI, KJ, 3) 2DB 1683
TEMP2 = PA(KJ)                             2DB 1684
DO 45 KJ = 2, JKB                          2DB 1685
I = KI + (KJ - 1)*IM                      2DB 1686
HA(KJ) = CXS(KI, KJ+1, 2) / (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1687
N2(I) = CXS(KI, KJ, 2) * N2(I-IM) /         2DB 1688
1 (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1689
TEMP1 = TEMP1 + TEMP*N2(I)                  2DB 1690
PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI, KJ, 2)*PA(KJ-1)) / 2DB 1691
1 (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1692
TEMP2 = TEMP2 + TEMP*PA(KJ)                2DB 1693
45 TEMP = TEMP*HA(KJ)                      2DB 1694
KJ = JM                                    2DB 1695
I = KI + (KJ - 1)*IM                      2DB 1696
TEMP1 = (TEMP1 + TEMP)*CXS(KI, 1, 2) + CXS(KI, KJ, 2)*N2(I-IM) 2DB 1697
N2(I) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI, KJ, 2)*PA(KJ-1) 2DB 1698
1 + CXS(KI, 1, 2)*TEMP2) / 2DB 1699
1 (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1) - TEMP1) 2DB 1700
DO 50 KJJ = 2, JM                            2DB 1701
KJ = JM - KJJ + 1                          2DB 1702
I = KI + (KJ - 1)*IM                      2DB 1703
KII = (JM-1)*IM + KI                     2DB 1704
50 N2(I) = PA(KJ) + HA(KJ) * N2(I+IM) + N2(I) * N2(KII) 2DB 1705
DO 55 KJ = 1, JM                            2DB 1706

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	I = KI + (KJ - 1)*IM	2DB 1707
55	N2(I) = NO(I) + ORF*(N2(I) - NO(I))	2DB 1708
C	CALCULATION OF ERROR CRITERION	2DB 1709
	E01 = .0	2DB 1710
	DO 90 I=1, IMJM	2DB 1711
	ITEMP1 = M0(I)	2DB 1712
	ITEMP = M2(ITEMP1)	2DB 1713
	E01 = E01 + ABS(N2(I) - NO(I))*VO(I)*CO(IHT-1,ITEMP)	2DB 1714
90	CONTINUE	2DB 1715
C		2DB 1716
C	INNER ITERATION CONTROL	2DB 1717
133	LC = LC + 1	2DB 1718
	II = II + 1	2DB 1719
	IF (II - G07) 533, 1033, 1033	2DB 1720
533	IF (FLOAT(IGM)*E01 - EPS*E1(IGP)) 633,633,2	2DB 1721
633	IF(G06) 733, 1033, 733	2DB 1722
733	TEMP1 = .0	2DB 1723
	DO 933 I=1,IMJM	2DB 1724
	TEMP2=ABS (1.0-NO(I)/N2(I))	2DB 1725
	IF(TEMP1-TEMP2)833,933,933	2DB 1726
833	TEMP1=TEMP2	2DB 1727
933	CONTINUE	2DB 1728
	IF (TEMP1 - G06) 1033, 1033, 2	2DB 1729
1033	CONTINUE	2DB 1730
	RETURN	2DB 1732
	END	2DB 1733


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-ITC FOR IFLUXN,IFLUXN                                2DB 1734
  SUBROUTINE IFLUXN (N2, C0, V0, CXS, M0, M2, JTL,JIM,JJM, CXR, CXT) 2DB 1735
  INCLUDE ABC                                           2DB 1736
  DIMENSION N2(1), C0(JTL,1), V0(1),CXS(JIM,JJM,3),M0(1), M2(1), 2DB 1737
  1      CXR(1), CXT(1)                                2DB 1738
C   THIS SUBROUTINE NORMALIZES FLUXES BEFORE EACH INNER ITERATION 2DB 1739
C   ABSORPTION AND OUT-SCATTER                          2DB 1740
  E3(IGV) = 0.0                                         2DB 1741
  E4(IGV) = 0.0                                         2DB 1742
  DO 10 I=1, IMJM                                       2DB 1743
    TEMP = V0(I)*N2(I)                                  2DB 1744
    ITEMP = M0(I)                                       2DB 1745
    ITEMP = M2(ITEMP)                                   2DB 1746
    E3(IGV) = E3(IGV) + (C0(4,ITEMP) - C0(5,ITEMP))*TEMP 2DB 1747
  10  E4(IGV) = E4(IGV) + C0(2,ITEMP)*TEMP              2DB 1748
    E3(IGV) = E3(IGV) - E4(IGV)                        2DB 1749
C   LEFT LEAKAGE                                         2DB 1750
  IF(R01) 20, 20, 40                                   2DB 1751
  20  E5(IGV) = 0.0                                       2DB 1752
    DO 30 KJ = 1, JM                                     2DB 1753
      I = (KJ - 1)*IM + 1                               2DB 1754
  30  E5(IGV) = E5(IGV) + CXS(1,KJ,1)*N2(I)             2DB 1755
    GO TO 50                                             2DB 1756
  40  E5(IGV) = .0                                       2DB 1757
C   RIGHT LEAKAGE                                       2DB 1758
  IF(R02) 60, 60, 80                                   2DB 1759
  50  E6(IGV) = 0.0                                       2DB 1760
    DO 70 KJ = 1, JM                                     2DB 1761
      I = KJ*IM                                           2DB 1762
  70  E6(IGV) = E6(IGV) + CXR(KJ)*N2(I)                 2DB 1763
    GO TO 90                                             2DB 1764
  80  E6(IGV) = 0.0                                       2DB 1765
C   TOP LEAKAGE                                         2DB 1766
  IF(R03-1) 120, 140, 100                             2DB 1767
  90  E7(IGV) = .0                                       2DB 1768
    DO 110 KI = 1, IM                                   2DB 1769
      I = IMJM - IM + KI                                  2DB 1770
  110 E7(IGV) = E7(IGV) + CXS(KI,1,2)*(N2(I) - N2(KI)) 2DB 1771
    E8(IGV) = - E7(IGV)                                 2DB 1772
    GO TO 190                                           2DB 1773
  120 E7(IGV) = 0.0                                       2DB 1774
    DO 130 KI = 1, IM                                   2DB 1775
      I = IMJM - IM + KI                                  2DB 1776
  130 E7(IGV) = E7(IGV) + CXT(KI)*N2(I)                 2DB 1777
    GO TO 150                                           2DB 1778
  140 E7(IGV) = 0.0                                       2DB 1779
C   BOTTOM LEAKAGE                                      2DB 1780
  IF(R04) 160, 160, 180                                2DB 1781
  150 E8(IGV) = 0.0                                       2DB 1782
    DO 170 KI = 1, IM                                   2DB 1783
  170 E8(IGV) = E8(IGV) + CXS(KI,1,2)*N2(KI)           2DB 1784
    GO TO 190                                           2DB 1785
  180 E8(IGV) = 0.0                                       2DB 1786
  190 F9(IGV) = E5(IGV) + E6(IGV) + E7(IGV) + E8(IGV) 2DB 1787
    TEMP = (E1(IGV) + E2(IGV))/(E3(IGV) + E4(IGV) + E9(IGV)) 2DB 1788
    DO 200 I = 1, IMJM                                  2DB 1789
  200 N2(I) = TEMP*N2(I)                                  2DB 1790
    E3(IGV) = TEMP*E3(IGV)                             2DB 1791
    E4(IGV) = TEMP*E4(IGV)                             2DB 1792

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E5(IGV) = TEMP*E5(IGV)
E6(IGV) = TEMP*E6(IGV)
E7(IGV) = TEMP*E7(IGV)
E8(IGV) = TEMP*E8(IGV)
E9(IGV) = TEMP*E9(IGV)
RETURN
END

2DB 1793
2DB 1794
2DB 1795
2DB 1796
2DB 1797
2DB 1798
2DB 1799
-

-ITC FOR CNNP,CNNP	2DB 1800
SUBROUTINE CNNP (F2,K6)	2DB 1801
DIMENSION F2(1), K6(1)	2DB 1802
INCLUDE ABC	2DB 1803
C CONVERGENCE TESTS	2DB 1804
IF(MAXT) 25, 25, 10	2DB 1805
10 CALL ETIMEF(TEMP)	2DB 1806
IF(TEMP - GLH) 25, 15, 15	2DB 1807
15 NGOTO = 1	2DB 1808
WRITE(NOUT,20)	2DB 1809
20 FORMAT(53H1 * * RUNNING TIME EXCEEDED--FORCED CONVERGENCE * *//)	2DB 1810
GO TO 135	2DB 1811
25 CONTINUE	2DB 1812
30 E01=1.0-ALA	2DB 1813
IF(ABS (E01)-10.0*EPS) 40, 40, 45	2DB 1814
40 G07=K07	2DB 1815
6RF = ORFP	2DB 1816
45 CONTINUE	2DB 1817
E02=ABS(E01)	2DB 1818
50 IF(E1(IGP)) 55, 130, 55	2DB 1819
55 IF (E02 - EPS) 60, 60, 70	2DB 1820
60 CVT=1	2DB 1821
70 CALL CLEAR (0.0, F2, IMJM)	2DB 1822
GO TO 105	2DB 1823
80 EV=EV+POD*EQ*E01	2DB 1824
GO TO 170	2DB 1825
C FINAL PRINT	2DB 1826
90 NGOTO=1	2DB 1827
IF (I04 - 1) 95, 95, 80	2DB 1828
95 EV=0.0	2DB 1829
DO 100 I=1,IGM	2DB 1830
100 EV=EV+K6(I)	2DB 1831
EV=SK7/EV	2DB 1832
GO TO 135	2DB 1833
105 IF(CVT-1) 110, 90, 110	2DB 1834
110 IF(I04-1) 115, 120, 140	2DB 1835
C MONITOR PRINT	2DB 1836
115 NGOTO=2	2DB 1837
GO TO 135	2DB 1838
120 EV=0.	2DB 1839
DO 125 I=1,IGM	2DB 1840
125 EV=EV+K6(I)	2DB 1841
EV=SK7/EV	2DB 1842
GO TO 115	2DB 1843
130 CALL ERRO2(6H**CNNP,130,1)	2DB 1844
135 RETURN	2DB 1845
140 CONTINUE	2DB 1846
C	2DB 1847
C CALCULATE NEW PARAMETERS FOR SEARCH CALCULATIONS	2DB 1848
145 E03=ABS (ALA-LAR)	2DB 1849
IF (LAPP) 270, 150, 270	2DB 1850
150 IF (LAP) 230, 155, 230	2DB 1851
155 IF (EQ) 200, 160, 200	2DB 1852
160 IF (E03-EPSA) 175, 175, 165	2DB 1853
C MONITOR PRINT.	2DB 1854
165 NGOTO=2	2DB 1855
RETURN	2DB 1856
C FINAL PRINT EXIT.	2DB 1857
170 NGOTO=1	2DB 1858

175	RETURN	2DB 1859
	LAP=ALA	2DB 1860
	EVP=EV	2DB 1861
	IF (E01) 185,185,180	2DB 1862
180	EV=EV-EVM	2DB 1863
	GO TO 190	2DB 1864
185	EV=EV+EVM	2DB 1865
190	IF (I04-2) 195, 165, 195	2DB 1866
C	MIX X-SECS.	2DB 1867
195	NGOTO=3	2DB 1868
	RETURN	2DB 1869
200	IF (CVT) 170, 205,170	2DB 1870
205	EV=EV+POD*EQ*E01	2DB 1871
210	IF ((LAPP-1.0)/(LAP-1.0)) 215, 190, 190	2DB 1872
215	TEMP1=AMIN1(EVP,EVPP)	2DB 1873
	IF (EV-TEMP1) 220, 225, 225	2DB 1874
220	EV=(EVPP+EVP)/2.	2DB 1875
	GO TO 190	2DB 1876
225	TEMP1=AMAX1(EVP,EVPP)	2DB 1877
	IF (EV-TEMP1) 190, 220, 220	2DB 1878
230	IF (503-EP5A) 235, 235, 165	2DB 1879
235	EQ=(EVP-EV)/(LAP-ALA)	2DB 1880
240	IF (CNT) 260, 245, 260	2DB 1881
245	IF (E02-LAL) 265, 265, 250	2DB 1882
250	IF (E02-LAH) 260, 260, 255	2DB 1883
255	E01=SIGN (LAH,E01)	2DB 1884
260	LAPP=LAP	2DB 1885
	LAP=ALA	2DB 1886
	EVPP=EVP	2DB 1887
	EVP=EV	2DB 1888
	+0 TO 205	2DB 1889
265	CNT=1	2DB 1890
	LAP=0.0	2DB 1891
	LAPP=0.0	2DB 1892
	GO TO 205	2DB 1893
270	IF (E03-EP5A) 275, 275, 165	2DB 1894
C	CALCULATE QUADRATIC COEFFICIENTS.	2DB 1895
275	TEMP1=+VP-EV	2DB 1896
	TEMP2=EVPP-EV	2DB 1897
	TEMP3=EVPP-EVP	2DB 1898
	TEMP4=TEMP1*(EVP+EV)	2DB 1899
	TEMP5=-TEMP2*(EV+EVPP)	2DB 1900
	TEMP6=TEMP3*(EVPP+EVP)	2DB 1901
	DENOM=TEMP3*TEMP2*TEMP1	2DB 1902
	EQA=((LAPP-1.0)*TEMP1*EVP*EV-(LAP-1.0)*TEMP2	2DB 1903
	1*EV*EVPP+(ALA-1.0)*TEMP3*EVPP*EVP)/DENOM	2DB 1904
	EQB=-(LAPP*TEMP4+LAP*TEMP5+ALA*TEMP6)/DENOM	2DB 1905
	EQC=(LAPP*TEMP1-LAP*TEMP2+ALA*TEMP3)/DENOM	2DB 1906
	DISCR=EQB*EQB-4.0*EQA*EQC	2DB 1907
	IF (DISCR) 235, 280, 280	2DB 1908
280	IF (E02-LAL) 265, 265, 285	2DB 1909
285	TEMP1=EQC+EQC	2DB 1910
	TEMP=SQRT (DISCR)	2DB 1911
	EQ=1.0/(EQB+EV*TEMP1)	2DB 1912
	LAPP=LAP	2DB 1913
	LAP=ALA	2DB 1914
	EVPP=EVP	2DB 1915
	EVP=EV	2DB 1916
	EV1=(TEMP-EQB)/TEMP1	2DB 1917

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EV2=- (TEMP+EQB)/TEMP1
EVA=ABS (EV-EV1)
EVB=ABS (EV-EV2)
IF (EVA-EVB) 290, 290, 295
290 EV=EV1
GO TO 210
295 EV=EV2
GO TO 210
END
```

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2DB 1918
2DB 1919
2DB 1920
2DB 1921
2DB 1922
2DB 1923
2DB 1924
2DB 1925
2DB 1926
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-ITC FOR S8850,S8850                                2DB 1927
  SUBROUTINE S8850(F2,N2,R1,Z1,R4,Z4,JIM,JJM,FN2,      2DB 1928
    1      CO,N0,M0,M2,F0,JTL,JMT)                    2DB 1929
    INCLUDE ABC                                        2DB 1930
    DIMENSION F2(JIM,JJM), N2(JIM,JJM), R1(1), Z1(1), R4(1), Z4(1), 2DB 1931
    1      FLUX(6), FN2(1), CO(JTL,JMT), NO(JIM,JJM), MO(JIM,JJM), 2DB 1932
    2      M2(1), FO(JIM,JJM)                          2DB 1933
C FP S850 FINAL PRINT                                2DB 1934
  ICARD = 1                                           2DB 1935
  CALL S8830                                           2DB 1936
  IF(NPRT) 280, 280, 10                               2DB 1937
10  CALL S8847                                         2DB 1938
    I=IP                                              2DB 1939
    IF(IP-JP) 30, 30, 20                             2DB 1940
20  J=JP                                              2DB 1941
30  WRITE (NOUT, 40 ) (I,R1(I),R4(I),Z1(I),Z4(I),I=1,J) 2DB 1942
40  FORMAT(      84H1      RADII      AVG RADII      2DB 1943
    1      AXII      AVG AXII/(I4,4F20.4))            2DB 1944
  J=J+1                                              2DB 1945
  IF(IP-JP) 50, 90, 70                               2DB 1946
50  WRITE (NOUT, 60 ) (I,Z1(I),Z4(I),I=J,JP)         2DB 1947
60  FORMAT(I4,40X,2F20.4)                            2DB 1948
    GO TO 90                                          2DB 1949
70  WRITE (NOUT, 80 ) (I,R1(I),R4(I),I=J,IP)         2DB 1950
80  FORMAT(I4,2F20.4)                                2DB 1951
90  CONTINUE                                          2DB 1952
    DO 100 I=1, IM                                    2DB 1953
    DO 100 J=1, JM                                    2DB 1954
    NO(I,J) = 0.0                                     2DB 1955
100  F2(I,J) = 0.0                                     2DB 1956
    DO 20 IIG=1, IGM                                  2DB 1957
    WRITE (NOUT,110) IIG                              2DB 1958
110  FORM+T(1H1, 20X,14HFLUX FOR GROUP,I3)           2DB 1959
    READ (NFLUX1)((N2(I,J),I=1,IM),J=1,JM)          2DB 1960
    READ(NCR1)((CO(I,J), II = 1, ITL), J = 1, MT)    2DB 1961
    DO 120 I=1, IM                                    2DB 1962
    DO 120 J=1, JM                                    2DB 1963
    NO(I,J) = NO(I,J) + N2(I,J)                      2DB 1964
    ITEMP = MU(I,J)                                   2DB 1965
    ITEMP = M2(ITEMP)                                  2DB 1966
120  F2(I,J) = F2(I,J) + CO(I,ITEMP)*N2(I,J)*1000.*TSD 2DB 1967
    IF(NPUN) 210, 210, 130                            2DB 1968
C PUNCH FLUXES                                       2DB 1969
130  IF(DAY) 210, 140, 210                            2DB 1970
140  GO TO ( 150, 150, 200, 200 ), NPUN              2DB 1971
150  DO 180 I=1,IMJM,6                                2DB 1972
    DO 160 J=1,6                                       2DB 1973
160  FLUX(J) = 0.                                     2DB 1974
    II = MIN0(I+5,IMJM)                               2DB 1975
    JI = 1                                             2DB 1976
    DO 170 J=I,II                                       2DB 1977
    FLUX(JI) = FN2(J)                                  2DB 1978
170  JI = JI + 1                                       2DB 1979
    PUNCH 190 , (FLUX(J),J=1,6), ICARD                2DB 1980
180  ICARD = ICARD + 1                                 2DB 1981
190  FORMAT(1P6E12.6,4HFLUX,I4)                      2DB 1982
    GO TO 210                                          2DB 1983
200  WRITE(16) ((N2(I,J), I=1,IM), J=1,JM)          2DB 1984
210  CALL PRT(IM,JM,N2,Z4,NOUT)                      2DB 1985

```

220	CONTINUE	2DB 1986
	WRITE(NOUT, 230)	2DB 1987
230	FORMAT(1H1//, 19X, 11H TOTAL FLUX//)	2DB 1988
	CALL PRT(IM,JM,N0,Z4,NOUT)	2DB 1989
	WRITE(NOUT, 240)	2DB 1990
240	FORMAT(1H1//, 19X, 26HPOWER DENSITY (MWT/LITER))	2DB 1991
	CALL PRT(IM,JM,F2,Z4,NOUT)	2DB 1992
	WRITE (NOUT, 250)	2DB 1993
250	FORMAT(1H1,20X,19HFISSION SOURCE RATE)	2DB 1994
	CALL PRT(IM,JM,F0,Z4,NOUT)	2DB 1995
	IF(NPUN - 3) 270, 260, 260	2DB 1996
C	PUT AN END OF FILE AND REWIND 16	2DB 1997
260	3ALL NTRAN(16,9,11)	2DB 1998
270	REWIND NCR1	2DB 1999
	REWIND NFLUX1	2DB 2000
280	RETURN	2DB 2001
	END	2DB 2002

```

-ITC FOR S8847,S8847
SUBROUTINE S8847
INCLUDE ABC
E2(IGP) = .0
E3(IGP) = .0
E4(IGP) = .0
E5(IGP) = .0
E6(IGP) = .0
E7(IGP) = .0
E8(IGP) = .0
E9(IGP) = .0
DO 10 I = 1,IGM
E2(IGP) = E2(IGP) + E2(I)
E3(IGP) = E3(IGP) + E3(I)
E4(IGP) = E4(IGP) + E4(I)
E5(IGP) = E5(IGP) + E5(I)
E6(IGP) = E6(IGP) + E6(I)
E7(IGP) = E7(IGP) + E7(I)
E8(IGP) = E8(IGP) + E8(I)
10 E9(IGP) = E9(IGP) + E9(I)
WRITE(NOUT,20)
20 FORMAT (1H1, 28H FINAL NEUTRON BALANCE TABLE///
159H GROUP FISSION SOURCE IN-SCATTER OUT-SCATTER ABSORPTION,1X,
265H L. L. R. L. T. L. B. L. TOTAL LEAKA
3GE//)
DO 30 I = 1,IGM
25 FORMAT (I6, 1P9E13.3)
30 WRITE(NOUT,25) I,E1(I),E2(I),E3(I),E4(I),E5(I),E6(I),E7(I),
1 E8(I),E9(I)
WRITE(NOUT,35)
35 FORMAT (1H )
I = IGM + 1
WRITE(NOUT,25) I,E1(I),E2(I),E3(I),E4(I),E5(I),E6(I),E7(I),
1 E8(I),E9(I)
RETURN
END

```

2DB 2003
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-IT FOR PRT,PRT	2DB 2039
SUBROUTINE PRT (JIM,JJM, N2, Z4, NOUT)	2DB 2040
DIMENSION N2(JIM,JJM), Z4(1)	2DB 2041
REAL N2	2DB 2042
IM = JIM	2DB 2043
JM = JJM	2DB 2044
DO 50 I=1,IM,5	2DB 2045
I1=I	2DB 2046
I2=I+4	2DB 2047
IF(I2-IM) 20, 20, 10	2DB 2048
10 I2=IM	2DB 2049
20 WRITE (NOUT,30) (JJ,JJ=I1,I2)	2DB 2050
30 FORMAT(5I20)	2DB 2051
DO 50 JJ=1,JM	2DB 2052
J=JJ	2DB 2053
40 FORMAT(I5,E15.7,5E20.7)	2DB 2054
50 WRITE(NOUT,40) J,(N2(K,J),K=I1,I2),Z4(J)	2DB 2055
RETURN	2DB 2056
END	2DB 2057

-

```

-ITC  FOR GRAM,GRAM                                2DB 2058
      SUBROUTINE GRAM(MASS, VOL, ATW, HOLN,JIM,JJM, M0, M2, V0, 2DB 2059
1      IO, I1, I2,JML, I3)                          2DB 2060
      INCLUDE ABC                                    2DB 2061
      DIMENSION MASS(JML,1), VOL(1), ATW(1), HOLN(1), M0(JIM,JJM), 2DB 2062
1      M2(1), V0(JIM,JJM), IO(1), I1(1), I2(1), I3(1) 2DB 2063
C      THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS 2DB 2064
      WRITE(NOUT,10) (ID(I), I=1,11)                2DB 2065
10     FORMAT(1H1,11A6///)                          2DB 2066
      WRITE(NOUT, 20)                                2DB 2067
20     FORMAT(45H MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE / ) 2DB 2068
      CALL CLEAR(0.0,VOL,IZM)                        2DB 2069
      ITEMP = ML*IZM                                  2DB 2070
      CALL CLEAR(0.0,MASS,ITEMP)                    2DB 2071
      DO 30 J = 1, JM                                2DB 2072
      DO 30 I = 1, IM                                2DB 2073
      K = M0(I,J)                                     2DB 2074
30     VOL(K) = VOL(K) + V0(I, J)*.001              2DB 2076
      DO 39 M=1,M01                                   2DB 2077
      I3(M) = I2(M)                                   2DB 2078
      IF(I0(M) - I1(M)) 39,35,39                     2DB 2079
35     IF(I2(M)) 39,36,39                             2DB 2080
36     DO 38 MM=1,M                                   2DB 2081
      IF(I0(M) - I0(MM)) 38,37,38                   2DB 2082
37     I3(MM) = I2(MM)*EV                            2DB 2083
38     CONTINUE                                       2DB 2084
39     CONTINUE                                       2DB 2085
      DO 190 N = 1, IZM                              2DB 2086
      NN = M2(N)                                       2DB 2087
      DO 190 M = 1,M01                                2DB 2088
      IF(I0(M) - NN) 190, 40, 190                    2DB 2089
40     L = I1(M)                                       2DB 2090
      IF(L - ML) 170, 170, 50                        2DB 2091
50     NNAA = L                                       2DB 2092
      IF(L - I0(M)) 130,190, 130                     2DB 2093
130    DO 160 MAA = 1, M01                            2DB 2094
      IF(I0(MAA) - NNAA) 160, 140, 160               2DB 2095
140    L = I1(MAA)                                    2DB 2096
      IF(L) 160, 160, 150                            2DB 2097
150    E01 = I3(MAA)*I3(M)                            2DB 2098
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/+.6023) + MASS(L,N) 2DB 2099
160    CONTINUE                                       2DB 2100
      GO TO 190                                       2DB 2101
170    IF(L) 190, 190, 180                            2DB 2102
180    E01 = I3(M)                                    2DB 2103
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/+.6023) + MASS(L,N) 2DB 2104
190    CONTINUE                                       2DB 2105
      DATA ZONE/6H ZONE /                          2DB 2106
      DO 260 L = 1, IZM, 5                            2DB 2107
      LL = L + 4                                       2DB 2108
      IF(LL - IZM) 210, 210, 200                     2DB 2109
200    LL = IZM                                       2DB 2110
210    WRITE(NOUT,220) ((ZONE, K), K=L, LL)           2DB 2111
220    FORMAT(/26H MATERIAL ATOMIC WT. ,3X, 5(A6,I2,12X)) 2DB 2112
      WRITE(NOUT,230) (VOL(K), K = L, LL)            2DB 2113
230    FORMAT(25X, 5(F8.2, 7H LITERS, 5X))          2DB 2114
      DO 240 K = 1, ML                               2DB 2115
240    WRITE(NOUT,250) K, HOLN(K), ATW(K), (MASS(K, I), I = L, LL) 2DB 2116
250    FORMAT( 13,1X, A6, F13.3, 1X, 1PE13.3, 1P4E20.3) 2DB 2117

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260 IF(LL - IZM) 260, 270, 270
270 CONTINUE
RETURN
END

2DB 2118
2DB 2119
2DB 2120
2DB 2121
-

-1TC	FOR INPB,INPB	2DB	2122
	SUBROUTINE INPB(MATN,NBR,LD,LCN,LFN,ALAM,HOLN,JML,I2)	2DB	2123
	INCLUDE ABC	2DB	2124
	DIMENSION MATN(1), NBR(1), LD(1),LCN(JML,1),LFN(JML,1), ALAM(1),	2DB	2125
	1 HOLN(1), I2(1)	2DB	2126
C	THIS SUBROUTINE READS AND PRINTS THE BURNUP DATA	2DB	2127
	READ(NINP,10) ITEMP, NPRT, DELT	2DB	2128
10	FORMAT(2I6, E12.0)	2DB	2129
	DAY = DAY + DELT	2DB	2130
	CVT = 0	2DB	2131
	CNT = 0	2DB	2132
	P02 = 0	2DB	2133
	ALA = 0.0	2DB	2134
	LAP = 0.0	2DB	2135
	LAPP = 0.0	2DB	2136
	LAR = 0.0	2DB	2137
	KPAGE = 100	2DB	2138
	IF(ITEMP) 190, 15, 20	2DB	2139
15	NCON = ITEMP	2DB	2140
	KK = NPUN + 1	2DB	2141
	GO TO (190, 190, 17, 190, 17), KK	2DB	2142
17	PUNCH 18, (I2(I), I=1,M01)	2DB	2143
18	FORMAT(6(3X,E9.4))	2DB	2144
	GO TO 190	2DB	2145
20	NCON = ITEMP	2DB	2146
	DO 40 N = 1, NCON	2DB	2147
30	FORMAT(12I6)	2DB	2148
40	READ(NINP,30) MATN(N),NBR(N),LD(N),(LCN(N,K),K=1,2),(LFN(N,K),	2DB	2149
	1 K=1,7)	2DB	2150
	WRITE(NOUT,60)	2DB	2151
60	FORMAT(12H1BURNUP DATA///)	2DB	2152
	WRITE(NOUT,70)	2DB	2153
70	FORMAT(130H BURNABLE MATERIAL NAME LAMBDA	2DB	2154
	1 NBR * * * * * SOURCE ISOTOPE FOR * * * *	2DB	2155
	2 * * /	2DB	2156
	3 130H ISOTOPE NO. (DAYS-1)	2DB	2157
	4 DECAY CAPTURE FISSION	2DB	2158
	5ION /9H NO.)	2DB	2159
	DO 90 N=1, NCON	2DB	2160
80	FORMAT(3X, I3, 12X, I3, 10X, A6, 8X, E8.3, I9,15X, I3, 13X, 2I3,	2DB	2161
	1 10X, 7I3)	2DB	2162
	ITEMP = MATN(N)	2DB	2163
	ALAM(ITEMP) = 24.*3600.*ALAM(ITEMP)	2DB	2164
	WRITE(NOUT,80) N, MATN(N), HOLN(ITEMP), ALAM(ITEMP), NBR(N),	2DB	2165
	1LD(N), (LCN(N,K),K=1,2), (LFN(N,K),K=1,7)	2DB	2166
90	ALAM(ITEMP) = ALAM(ITEMP)/(3600.*24.)	2DB	2167
190	RETURN	2DB	2168
	END	2DB	2169

```

-ITC FOR AVERAG, AVERAG                                2DB 2170
  SUBROUTINE AVERAG(PHIB, AXS, FXS, MATN, MASS, ATW, VOL, CO, N2, MO, VO, 2DB 2171
    1      HOLN, JML, JTL, NBR)                          2DB 2172
    DIMENSION PHIB(1), AXS(JML,1), FXS(JML,1), MATN(1), MASS(JML,1), 2DB 2173
    1      ATW(1), VOL(1), CO(JTL,1), N2(1), MO(1), VO(1), HOLN(1) 2DB 2174
    2      , NBR(1)                                       2DB 2175
    INCLUDE ABC                                           2DB 2176
  C THIS SUBROUTINE CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS 2DB 2177
  C SECTIONS, AND ABSORPTION CROSS SECTIONS.            2DB 2178
    RL = 0.0                                              2DB 2179
    RC = 0.0                                              2DB 2180
    DO 10 KZ=1, IZM                                      2DB 2181
      PHIB(KZ) = 0.0                                     2DB 2182
      DO 10 KN=1, NCON                                   2DB 2183
        AXS(KN, KZ) = 0.0                               2DB 2184
        FXS(KN, KZ) = 0.0                               2DB 2185
        LN = MATN(KN)                                   2DB 2186
      100 MASS(LN, KZ) = (MASS(LN, KZ) * .6023) / (ATW(LN) * VOL(KZ)) 2DB 2187
      DO 100 IIG=1, IGM                                  2DB 2188
        READ(NCRI) ((CO(I, J), I=1, ITL), J=1, MT)      2DB 2189
        READ(NFLUX1) (N2(I), I=1, IMJM)                 2DB 2190
        DO 100 I=1, IMJM                                 2DB 2191
          KZ = MO(I)                                     2DB 2192
          PHIB(KZ) = PHIB(KZ) + N2(I) * VO(I)            2DB 2193
          DO 100 KN=1, NCON                               2DB 2194
            LN = MATN(KN)                                 2DB 2195
            AXS(KN, KZ) = AXS(KN, KZ) + CO(2, LN) * N2(I) * VO(I) 2DB 2196
            1000 FXS(KN, KZ) = FXS(KN, KZ) + CO(1, LN) * N2(I) * VO(I) 2DB 2197
          DO 200 KZ=1, IZM                                 2DB 2198
            TEMP3 = PHIB(KZ)                             2DB 2199
            PHIB(KZ) = PHIB(KZ) / (VOL(KZ) * 1000.)      2DB 2200
            WRITE(NOUT, 110) KZ, PHIB(KZ), VOL(KZ)       2DB 2201
          1100 FORMAT(1H1, 30X, 9H Z O N E , I3, 7X, 7H FLUX = , 1PE10.4, 7X, 9H VOLUME = , 2DB 2202
          1 1PE10.4, 7H LITERS/)                          2DB 2203
          WRITE(NOUT, 120)                                2DB 2204
          1200 FORMAT(115H BURNABLE MATERIAL NAME ATOM 2DB 2205
          1 FISSION ABSORPTION SIGMA SIGMA / 2DB 2206
          2 115H ISOTOPE NO. DENSITY 2DB 2207
          3 RATE RATE FISSION ABSORPTION/ 2DB 2208
          4 7H NO./) 2DB 2209
          DO 200 KN=1, NCON                                2DB 2210
            LN = MATN(KN)                                 2DB 2211
            TEMP1 = AXS(KN, KZ) * MASS(LN, KZ)           2DB 2212
            TEMP2 = FXS(KN, KZ) * MASS(LN, KZ)           2DB 2213
            AXS(KN, KZ) = AXS(KN, KZ) / TEMP3            2DB 2214
            FXS(KN, KZ) = FXS(KN, KZ) / TEMP3            2DB 2215
          1300 FORMAT(4X, I3, 11X, I3, 10X, A6, 2X, 1P5E15.3) 2DB 2216
          WRITE(NOUT, 130) KN, LN, HOLN(LN), MASS(LN, KZ), TEMP2, TEMP1, 2DB 2217
          1 FXS(KN, KZ), AXS(KN, KZ)                     2DB 2218
          ITEMP = NBR(KN)                                 2DB 2219
          IF (ITEMP - 1) 200, 140, 160                  2DB 2220
          140 RC = RC + TEMP1 - TEMP2                     2DB 2221
          GO TO 200                                       2DB 2222
          160 RL = RL + TEMP1                             2DB 2223
          200 CONTINUE                                   2DB 2224
          TEMP = RC / RL                                  2DB 2225
          WRITE(NOUT, 350) TEMP                          2DB 2226
          3500 FORMAT(1H /// 18H BREEDING RATIO = F7.4) 2DB 2227
          REWIND NCRI                                    2DB 2228

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REWIND NFLUX1
RETURN
END

2DB 2229
2DB 2230
2DB 2231

```

-ITC FOR MARCH,MARCH                                2DB 2232
  SUBROUTINE MARCH(PHIB,MATN,FXS,AXS,VOL,MASS,MASSP,ALAM,LD,LCN, 2DB 2233
    1      LFN,JML,I0,I1,I2,M2)                        2DB 2234
    DIMENSION PHIB(1),MATN(1),FXS(JML,1),AXS(JML,1),VOL(1), 2DB 2235
    1      MASS(JML,1),MASSP(JML,1),ALAM(1),LD(1),LCN(JML,1), 2DB 2236
    2      LFN(JML,1),I0(1),I1(1),I2(1),M2(1)          2DB 2237
    INCLUDE ABC                                         2DB 2238
  C THIS SUBROUTINE COMPUTES THE TIME DEPENDENT ISOTOPIC CONCENTRATION 2DB 2239
    TEMP = DELT * 24. * 3600. / 10.                    2DB 2240
    TEMP1 = .0                                          2DB 2241
    DO 5 KZ = 1,IZM                                    2DB 2242
    PHIB(KZ) = PHIB(KZ) * 10.**(-24)                    2DB 2243
    DO 5 KN = 1,NCON                                    2DB 2244
    LN = MATN(KN)                                       2DB 2245
    5 TEMP1 = TEMP1 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ) 2DB 2246
    DO 200 KT = 1,10                                   2DB 2247
    TEMP3 = .0                                          2DB 2248
    DO 20 KZ = 1,IZM                                    2DB 2249
    DO 20 KN = 1,NCON                                    2DB 2250
    LN = MATN(KN)                                       2DB 2251
    20 MASSP(LN,KZ) = MASS(LN,KZ)                      2DB 2252
    DO 100 KZ = 1,IZM                                    2DB 2253
    DO 50 KKK = 1,5                                     2DB 2254
    DO 50 KN = 1,NCON                                    2DB 2255
    LN = MATN(KN)                                       2DB 2256
    TEMP2 = -(MASS(LN,KZ)+MASSP(LN,KZ))*(ALAM(LN)+AXS(KN,KZ)*PHIB(KZ)) 2DB 2257
    IF (LD(KN)) 30,30,28                               2DB 2258
    28 KK = LD(KN)                                       2DB 2259
    KK = MATN(KK)                                       2DB 2260
    TEMP2 = TEMP2 + ALAM(KK)*(MASS(KK,KZ) + MASSP(KK,KZ)) 2DB 2261
    30 DO 32 K = 1,2                                     2DB 2262
    KK = LCN(KN,K)                                     2DB 2263
    KL = MATN(KK)                                       2DB 2264
    IF (KK) 32,32,31                                   2DB 2265
    31 TEMP2 = TEMP2 + (AXS(KK,KZ) - FXS(KK,KZ))*PHIB(KZ)* 2DB 2266
    1 (MASS(KL,KZ) + MASSP(KL,KZ))                    2DB 2267
    32 CONTINUE                                         2DB 2268
    DO 36 K = 1,7                                       2DB 2269
    KK = LFN(KN,K)                                     2DB 2270
    KL = MATN(KK)                                       2DB 2271
    IF (KK) 36,36,34                                   2DB 2272
    34 TEMP2 = TEMP2 + FXS(KK,KZ)*PHIB(KZ)*(MASS(KL,KZ)+MASSP(KL,KZ)) 2DB 2273
    36 CONTINUE                                         2DB 2274
    50 MASS(LN,KZ) = MASSP(LN,KZ) + .5*TEMP*TEMP2      2DB 2275
    DO 100 KN = 1,NCON                                    2DB 2276
    LN = MATN(KN)                                       2DB 2277
    100 TEMP3 = TEMP3 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ) 2DB 2278
    IF(TEMP3) 200,200,110                              2DB 2279
    DO 120 KZ = 1,IZM                                    2DB 2280
    120 PHIB(KZ) = PHIB(KZ) * TEMP1/TEMP3              2DB 2281
    200 CONTINUE                                         2DB 2282
    DO 500 KZ = 1,IZM                                    2DB 2283
    500 PHIB(KZ) = PHIB(KZ)*10.**(-24)                  2DB 2284
    DO 540 KZ=1,IZM                                     2DB 2285
    DO 540 M=1,M01                                       2DB 2286
    IF(I0(M) - M2(KZ)) 540,520,540                    2DB 2287
    520 DO 530 KN=1,NCON                                  2DB 2288
    LN = MATN(KN)                                       2DB 2289
    IF(LN - I1(M)) 530,525,530                          2DB 2290

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```
525 I2(M) = MASS(LN,KZ)
530 CONTINUE
540 CONTINUE
    RETURN
    END
```

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2DB 2291
2DB 2292
2DB 2293
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2DB 2295
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