**2DB, A TWO-DIMENSIONAL
DIFFUSION-BURNUP CODE
FOR FAST REACTOR ANALYSIS**

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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. All programming is in FORTRAN-IV. The code can be used to:

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

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 2 minutes for a 30 x 30 mesh problem using 4 energy groups.

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2DB, A TWO-DIMENSIONAL DIFFUSION-BURNUP CODE FOR FAST REACTOR ANALYSIS

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I. INTRODUCTION

This report describes the two-dimensional (X-Y, R-Z, R- θ) diffusion-burnup code, 2DB. A brief 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 point-wise over-relaxation 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 time absorption (α , where $\phi = \phi_0 e^{\alpha t}$), 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⁽¹⁾ and 2DF,⁽²⁾ and the Battelle-Northwest perturbation code PERT-IV.⁽³⁾ 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

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

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

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.

FIGURE 2.1. Mesh Description

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,

$$\int D \nabla^2 \phi dV = \int D \nabla \phi \cdot \overrightarrow{dA}. \quad (2.3)$$

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.

If the mesh boundary is not a zone boundary,

$$\bar{D}_k = D_o \quad . \quad (2.5)$$

If the mesh boundary also constitutes a zone boundary,

$$\bar{D}_k = \frac{D_o D_k (\delta R_o + \delta R_k)}{D_o \delta R_k + D_k \delta R_o} \quad . \quad (2.6)$$

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

$$\phi_o = \frac{S_o V_o + \sum_{k=1}^4 C_k \phi_k}{C_5} \quad , \quad (2.7)$$

where

$$C_k = \frac{\bar{D}_k A_k}{\ell_k} \quad k=1, \dots, 4 \quad (2.8)$$

and

$$C_5 = \Sigma_o^r V_o + \sum_{k=1}^4 C_k \quad . \quad (2.9)$$

III. SOLUTION OF DIFFERENCE EQUATIONS

The flux profiles and eigenvalue 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 eigenvalue 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.

The flux calculations in each group are performed using Equation (2.7). Thus, the flux at each mesh point is computed from the source rate at that mesh point and the fluxes of the four adjacent mesh points. The spatial fluxes are computed from left to right in each row (radial dimension), beginning with the bottom row and proceeding up in order. The most recently computed contiguous fluxes are always used (i.e., fluxes below and to the left of the mesh point being treated have already been computed in the current flux pass). One complete mesh sweep is called an inner iteration.

The acceleration schemes employed in 2DB, group rebalancing and point-wise over-relaxation, greatly accelerate convergence. Group rebalancing means that the total source and loss rate in each group are balanced before and after each group-flux calculation. Thus, a one-region problem with zero-gradient boundary conditions would be solved exactly in one outer iteration.

Point-wise over-relaxation is an extremely simple and valuable method of accelerating convergence. The procedure is as follows: After each new flux is obtained, a second "new" value

is computed by magnifying the difference between the new flux and the old flux by a factor of β , the over-relaxation factor. Thus,

$$\phi_2^{u+1} = \phi^u + \beta(\phi_1^{u+1} - \phi^u) \quad . \quad (3.1)$$

The over-relaxation factor, β , is an input parameter. The code automatically reduces $\beta-1$ by a factor of 2 when the neutron balance is within a factor of 10 of the fission source error criterion.

In passing, it should be mentioned that both block spatial rebalancing and alternating-direction mesh sweeps have been tried. Since neither scheme produced any significant improvement in convergence for test cases involving typical fast reactor compositions, they have not been incorporated in the current version of 2DB.

IV. SEARCH OPTIONS

As mentioned in the introduction, 2DB will perform criticality searches on time absorption (α), material composition, and zone dimensions. The following paragraphs outline these search calculations.

Time Absorption (α calculation)

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

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

If we now assume that

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

we can obviously rewrite Equation (4.1) in the form

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

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

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

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

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

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.

V. BURNUP MODEL

The basic burnup equation for each zone has the form

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

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

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

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. However, such conditions are rarely encountered in fast reactor design calculations.

REFERENCES

1. K. D. Lathrop. DTF-IV, a FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, 1965.
2. Unpublished Data. 2DF, A Two-Dimensional Transport Code from the Los Alamos Scientific Laboratory, Los Alamos, New Mexico.
3. R. W. Hardie and W. W. Little, Jr. PERT-IV, A Two-Dimensional Perturbation Code in FORTRAN-IV, BNWL-409, Pacific Northwest Laboratory, Richland, Washington, 1967.

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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, and 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.
ERRO2	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 and after each inner iteration.
INCL	Tabulation of all elements in COMMON storage.
INIT	Calculates miscellaneous parameters (e.g., cross section mixes, adjoint reversals, geometric parameters).
INNER	Performs inner iterations.
INNER1	Calculates coefficients for use during inner iterations.
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.

FIGURE 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.

CARD 2

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), = 3, concentration (C), = 4, zone thickness (δ).

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
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, $X(R) * X(Z)$, = 2, $X(R,Z,E)$.
D05	49-54	I6	Maximum number of outer iterations.
G07	55-60	I6	Maximum number of inner iterations per group.
S04	61-66	I6	Maximum number of inner iterations per group while $ 1-\lambda > 10\epsilon$.
NPUN	67-72	I6	Flux punch option: = 0, no punch, = 1, punch flux dump.

CARD 3

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.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
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.
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).

CARD 4

EV	1-12	E12	Initial eigenvalue guess.
EVM	13-24	E12	Initial eigenvalue modifier (this value should decrease reactivity).
S03	25-36	E12	Parametric eigenvalue (see third word on Card 2).
BUCK	37-48	E12	Buckling (cm^{-2}).
LAL	49-60	E12	Lower limit on delta lambda--used in search calculations.
LAH	61-72	E12	Upper limit on delta lambda--used in search calculations.

CARD 5

EPS	1-12	E12	Convergence criterion on the total fission source rate.
EPSA	13-24	E12	Parametric eigenvalue convergence criterion.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
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 (recommended value ≈ 1.0).
ORF	49-60	E12	Over-relaxation factor. See Equation (3.1).
S01	61-72	E12	Normalization constant: -N, power (Mwt), +N, neutron source rate.

CARD 6

HOLN(MCR)	1-6	A6	Identification card for first isotope. Name.
ATW(MCR)	7-12	E6	Atomic weight of first isotope (a.m.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	$v\sigma_f$.
C(ITL,IGM, MCR)	37-48	E12	σ_{tr} .

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
C(ITL,IGM, 49-60 MCR)		E12	$\sigma(g \rightarrow g)$.
C(ITL,IGM, 61-72 MCR)		E12	$\sigma(g-1 \rightarrow g)$.
<u>CARD 8</u>			
C(ITL,IGM, 1-12 MCR)		E12	$\sigma(g-2 \rightarrow g)$.
C(ITL,IGM, 13-24 MCR)		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>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.
...			

* Generalized input format.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<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).
ZO(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°).
...			
<u>CARD 12</u>			
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.
...			

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 13</u>			
M2(IZM)	1-12	I12(GI)	Material number for first zone.
M2(IZM)	13-24	I12(GI)	Material number for second zone.
...			
<u>CARD 14</u>			
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.
...			
<u>CARD 15</u>			
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>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>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<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.
R2(IM)	13-24	I12(GI)	Dimensional search zone number for second radial interval.
...			
<u>CARD 20</u> (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.
...			
<u>CARD 21</u> (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.
...			
<u>CARD 22</u> (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.
...			

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 23</u> (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.
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).

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
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
ID(1)												MAXT																																																																			
IDENTIFICATION CARD												MAX RUNNING TIME (MIN)																																																																			
A02 REGULAR CALCULATION - 1. ADJOINT CALCULATION				I04 EIGENVALUE TYPE + 1. K_{EFF} + 2. ABSORPTION (H) + 3. CONCENTRATION (C) + 4. ZONE THICKNESS (H)				S02 PARAMETRIC EIGENVALUE TYPE + 0. NONE + 1. K_{EFF} + 2. μ				IGM 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(R,P,K,Z) + 2. X(R, Z, E)				D05 OUTER ITERATION MAX				G07 INNER ITERATION MAX PER GROUP				S04 INNER ITERATION MAX PER GROUP FOR H-HALFIDE				NPUN PUNCH FLUXES: + 0. NO + 1. YES																																			
IGE GEOMETRY: + 0. X-Y + 1. R-Z + 2. R- θ				JM NUMBER OF RADIAL INTERVALS				JM NUMBER OF AXIAL INTERVALS				IZM NUMBER OF MATERIAL ZONES				MT TOTAL NUMBER OF MATERIALS INCLUDING MIXES				M01 NUMBER OF MIXTURE SPECIFICATIONS				B01 LEFT BOUNDARY CONDITION: + 0. VACUUM + 1. REFLECTIVE				B02 RIGHT BOUNDARY CONDITION				B03 TOP BOUNDARY CONDITION				B04 BOTTOM BOUNDARY CONDITION				IZ NUMBER OF RADIAL ZONES (OPTION ONLY)				IZ NUMBER OF AXIAL ZONES (OPTION 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 TEST (IF ZERO, NO TEST)				POD PARAMETER OSCILLATOR DAMPER				ORF OVER-RELAXATION FACTOR				S01 + NEGATIVE POWER (MW) + POSITIVE NEUTRON SOURCE RATE																																																											

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	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	
	HOLNMCR) NAME OF 1ST ISOTOPE						ATWAMCR) ATOMIC WT. OF 1ST ISOTOPE						ALAMMCR) DECAY CONSTANT OF 1ST ISOTOPE (DAYS ⁻¹)						A(9) MISCELLANEOUS INFORMATION FOR 1ST ISOTOPE (9A6)																																																														
	CROSS SECTION DATA FOR 1ST ISOTOPE (6E2-5)																																																																																CHTL1GM, MCR)
	• • • (REPEAT ABOVE TWO CARDS FOR EACH ISOTOPE)																																																																																
IF(MD1) = 1	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)																									
IF(MD1) = 2	FLUX GUESS IN 1ST MESH INTERVAL FOR GROUP 1											FLUX GUESS IN 2ND MESH INTERVAL FOR GROUP 1											• • •																																	NO(1MUM)																									
	• • • (REPEAT ABOVE CARD FOR ALL GROUPS)																																																																																NO(1MUM)
	1ST RADIAL POINT (0, 0)											2ND RADIAL POINT											• • •																																	RQ(1M-1)																									
	1ST AXIAL POINT (0, 0)											2ND AXIAL POINT											• • •																																	ZQ(1M-1)																									
	ZONE NUMBER FOR 1ST MESH INTERVAL											ZONE NUMBER FOR 2ND MESH INTERVAL											• • •																																	MO(1MUM)																									
	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)																									
OPTIONAL	MATERIAL NUMBER OF MIX 1											• • •											MATERIAL NUMBER OF MIX 2											• • •																						10(MD1)																									
	0											1ST MATERIAL IN MIX 1											2ND MATERIAL IN MIX 1											• • •																						11(MD1)																									
	0											DENSITY OF 2ND MATERIAL IN MIX 1											DENSITY OF 1ST MATERIAL IN MIX 1											• • •																						12(MD1)																									

APPENDIX C

STORAGE REQUIREMENTS

APPENDIX C

STORAGE REQUIREMENTS

The variable dimensioned arrays require N storage locations where

$$\begin{aligned} N = & 5 + 10 \times IM \times JM \\ & + 7 \times IM \\ & + 5 \times JM \\ & + 3 \times (M01 + IGM + IZM) \\ & + ML \times (15 + 4 \times IZM) \\ & + MT \times ITL \\ & + IZ + JZ + IM + JM \quad (\text{if } \delta \text{ calculation}) \end{aligned}$$

and:

IM = number of radial intervals
JM = number of axial intervals
IGM = number of energy groups
IZM = number of material zones
M01 = number of mixture specifications
ML = number of materials from cards on 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.

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 2 1 10 0 0 100 20 10 2

1 20 20 2 12 13 1 0 0 1 0 0

0.0 0.0 0.0 0.0 0.001 1.4 0.5

.00001 .001 0.0 -100.

U238 238.05 0.0 2 GROUPS CORE

.100100+00 .232887-00 .281437-00 .633569+01 .600524+01 .000000

.000000 .532188-00 .000000 .131583+02 .126261+02 .975608-01

PU239 239.05 0.0 2 GROUPS CORE

.172436+01 .184872+01 .511503+01 .669364+01 .476589+01 .000000

.228419+01 .324006+01 .649503+01 .139176+02 .106775+02 .790403-01

PU240 240.05 0.0 2 GROUPS CORE

.697066-00 .973045-00 .210364+01 .654004+01 .549212+01 .000000

.205185-01 .158456+01 .577565-01 .135455+02 .123609+02 .748743-01

PU241 241.067 80-8 2 GROUPS CORE

.173712+01 .189157+01 .528272+01 .745286+01 .543496+01 .000000

.250848+01 .287570+01 .744300+01 .118888+02 .901306+01 .126336-00

FIS PR 1.00 0.0 2 GROUPS CORE

.000000 .180334-00 .000000 .106936+02 .103924+02 .000000

.450420-00 .000000 .142171+02 .137666+02 .120810+00

C 12.011 0.0 2 GROUPS CORE

.000000 .833620-05 .000000 .263926+01 .245063+01 .000000

.000000 .456935-10 .000000 .448553+01 .448553+01 .188417-00

NA 22.990 0.0 2 GROUPS CORE

.000000 .713006-03 .000000 .309019+01 .300053+01 .000000

.000000 .423424-02 .000000 .498455+01 .498031+01 .889546-01

FE 55.847 0.0 2 GROUPS CORE

.000000 .591775-02 .000000 .255761+01 .251745+01 .000000

.000000 .215431-01 .000000 .482144+01 .479990+01 .342399-01

U238 238.05 0.0 2 GROUPS REFLECTOR

.372181-01 .189516-00 .105378+00 .694904+01 .664715+01 .000000

.000000 .404503-00 .000000 .122090+02 .118045+02 .112345+00

FE 55.847 0.0 2 GROUPS REFLECTOR

.000000 .670574-02 .000000 .265143+01 .259971+01 .000000

.000000 .120269-01 .000000 .449904+01 .448701+01 .450092-01

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

11 123

.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

.0200 .0060 .0130 0 .0400 .0

.00623

6 0 50.0

1 1 0 0 0 0 0 0 0 0

2 2 0 1 6 0 0 0 0 0

3 1 0 2 0 0 0 0 0 0

4 2 0 3 0 0 0 0 0 0

5 0 0 0 0 1 2 3 4 6 0

9 1 0 0 0 0 0 0 0 0

-1 0 50.0

0

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* * * * 2 D B * * * *

2 D B SAMPLE CASE

2

A02	0/1=REGULAR CALCULATION/ADJOINT CALCULATION	0
I04	EIGENVALUE TYPE (1/2/3/4=KEFF/ALPHA/CONCENTRATION/DELTA)	1
S02	PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA)	0
IGM	NUMBER OF GROUPS	2
NXCM	NUMBER OF DOWNSCATTERING TERMS	1
MCR	NUMBER OF MATERIALS FROM CARDS	10
MTP	NUMBER OF MATERIALS FROM TAPE	0
M07	FLUX GUESS 0/1/2=NONE/X(R)*X(Z)/X(R,Z,E)	0
O05	OUTER ITERATION MAX	100
G07	INNER ITERATION MAX PER GROUP	20
S04	II MAX PER GROUP FOR 1 - LAMBDA GREATER THAN 10*EPS	10
NPUN	PUNCH FLUXES 0/1=NO/YES	0
IGE	GEOMETRY (0/1/2=X-Y/R-Z/R-THETA)	1
IM	NUMBER OF RADIAL INTERVALS	20
JM	NUMBER OF AXIAL INTERVALS	20
IZM	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=VACUUM/REFLECTIVE)	0
B04	BOTTOM BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	1
IZ	RADIAL ZONES (DELTA-OPTION ONLY)	0
JZ	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 (MWt)/NEUTRON SOURCE RATE	-1.0000+02

LAST 4599

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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

R0	21								
- .00000	.32308+01	.64615+01	.96923+01	.12923+02	.16154+02	.19385+02	.22515+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									
Z0	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
.68000+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

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)

I0	13								
11		11	11	11	11	11	11	11	12
12		12	12						
I1	13								
0		1	2	3	4	5	6	7	8
.9		2	10						0
I2	13								
.00000	.80000-02	.16000-02	.10000-03	.00000	.00000	.20000-01	.60000-02	.13000-01	.00000
.40000-01	.00000	.62000-02							

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2 D B SAMPLE CASE

```

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

```

A
X
I
A
L

RADIAL

D-6

BNWL-640

A
X
I
A
L

D-7

BNWL-640

T I M E = .000 D A Y S

	MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	11	0	.00000000
2	11	1	.79999999-02
3	11	2	.16000000-02
4	11	3	.99999999-04
5	11	4	.00000000
6	11	5	.00000000
7	11	6	.20000000-01
8	11	7	.59999999-02
9	11	8	.13000000-01
10	12	0	.00000000
11	12	9	.39999999-01
12	12	2	.00000000
13	12	10	.61999999-02

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```

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	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.03	0	0	.00000000	.00000000	.00000000
.05	1	20	.00000000	.58832850-00	.58832850-00
.07	2	20	.00000000	.79878639-00	.13577217+01
.09	3	20	.00000000	.90076014-00	.11276608+01
.10	4	20	.00000000	.94503607-00	.10491539+01
.12	5	20	.00000000	.96529486-00	.10214370+01
.14	6	20	.00000000	.97531544-00	.10103802+01
.16	7	20	.00000000	.98054086-00	.10053577+01
.18	8	20	.00000000	.98334240-00	.10028571+01
.19	9	20	.00000000	.98486482-00	.10015482+01
.21	10	20	.00000000	.98569695-00	.10008449+01
.23	11	20	.00000000	.98615301-00	.10004627+01
.25	12	19	.00000000	.98640179-00	.10002523+01
.26	13	16	.00000000	.98653486-00	.10001349+01
.28	14	14	.00000000	.98660697-00	.10000731+01
.29	15	6	.00000000	.98662335-00	.10000166+01
.30	16	3	.00000000	.98663099-00	.10000077+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	2.062+11	3.845+18	4.204+18	0.000	2.508+17	1.104+17	0.000	3.612+17
2	1.108+17	3.845+18	2.474+13	3.858+18	0.000	6.782+16	2.994+16	0.000	9.776+16
3	8.521+18	3.845+18	3.845+18	8.062+18	0.000	3.186+17	1.404+17	0.000	4.589+17

	RADII	AVG RADII	AXII	AVG AXII
1	-.0000	1.6154	-.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	.4067981+16	.4033754+16	.3965689+16	.3864656+16	.3731946+16	.1461538+01
2	.4039799+16	.4005803+16	.3938200+16	.3837852+16	.3706044+16	.4384615+01
3	.3983619+16	.3950085+16	.3883401+16	.3784421+16	.3654412+16	.7307692+01
4	.3899844+16	.3866998+16	.3801688+16	.3704749+16	.3577423+16	.1023077+02
5	.3789077+16	.3757144+16	.3693651+16	.3599413+16	.3475635+16	.1315385+02
6	.3652125+16	.3621321+16	.3560078+16	.3469180+16	.3349790+16	.1607692+02
7	.3489990+16	.3460525+16	.3401948+16	.3315009+16	.3200818+16	.1900000+02
8	.3303868+16	.3275943+16	.3220432+16	.3138043+16	.3029827+16	.2192308+02
9	.3095143+16	.3068950+16	.3016886+16	.2939609+16	.2838103+16	.2484615+02
10	.2865385+16	.2841105+16	.2792844+16	.2721210+16	.2627109+16	.2776923+02
11	.2616345+16	.2594146+16	.2550022+16	.2484525+16	.2398476+16	.3069231+02
12	.2349952+16	.2329988+16	.2290308+16	.2231402+16	.2154002+16	.3361538+02
13	.2068319+16	.2050729+16	.2015767+16	.1963862+16	.1895650+16	.3653846+02
14	.1539498+16	.1526386+16	.1500323+16	.1461625+16	.1410760+16	.4014286+02
15	.1026799+16	.1018034+16	.1000611+16	.9747379+15	.9407206+15	.4442857+02
16	.6811565+15	.6753290+15	.6637453+15	.6465427+15	.6239238+15	.4871429+02
17	.4463770+15	.4425512+15	.4349470+15	.4236556+15	.4088121+15	.5300000+02
18	.2842706+15	.2818313+15	.2769839+15	.2697877+15	.2603318+15	.5728571+02
19	.1684540+15	.1670078+15	.1641343+15	.1598699+15	.1542692+15	.6157143+02
20	.8007003+14	.7938254+14	.7801680+14	.7599044+14	.7333010+14	.6585714+02
	6	7	8	9	10	
1	.3569262+16	.3378690+16	.3162676+16	.2923996+16	.2665721+16	.1461538+01
2	.3544466+16	.3355192+16	.3140653+16	.2903605+16	.2647103+16	.4384615+01
3	.3495042+16	.3308356+16	.3096755+16	.2862963+16	.2609993+16	.7307692+01
4	.3421344+16	.3238518+16	.3031297+16	.2802354+16	.2554647+16	.1023077+02
5	.3323907+16	.3146182+16	.2944749+16	.2722212+16	.2481453+16	.1315385+02
6	.3203444+16	.3032022+16	.2837740+16	.2623112+16	.2390929+16	.1607692+02
7	.3060842+16	.2896883+16	.2711057+16	.2505777+16	.2283724+16	.1900000+02
8	.2897169+16	.2741774+16	.2565648+16	.2371079+16	.2160618+16	.2192308+02
9	.2713662+16	.2567877+16	.2402624+16	.2220044+16	.2022537+16	.2484615+02
10	.2511730+16	.2376539+16	.2223259+16	.2053862+16	.1870561+16	.2776923+02
11	.2292951+16	.2169274+16	.2028997+16	.1873892+16	.1705946+16	.3069231+02
12	.2059063+16	.1947756+16	.1821447+16	.1681679+16	.1530163+16	.3361538+02
13	.1611964+16	.1713816+16	.1602375+16	.1478943+16	.1344916+16	.3653846+02
14	.1348333+16	.1275077+16	.1191819+16	.1099445+16	.9988075+15	.4014286+02
15	.8989559+15	.8499186+15	.7941445+15	.7322035+15	.6646608+15	.4442857+02
16	.5961524+15	.5635472+15	.5264762+15	.4853503+15	.4406257+15	.4871429+02
17	.3905943+15	.3692213+15	.3449537+15	.3180977+15	.2890175+15	.5300000+02
18	.2487343+15	.2351438+15	.2197410+15	.2027442+15	.1844192+15	.5728571+02
19	.1474053+15	.1393714+15	.1302823+15	.1202778+15	.1095287+15	.6157143+02
20	.7007176+14	.6626132+14	.6195575+14	.5722466+14	.5215245+14	.6585714+02
	11	12	13	14	15	
1	.2391185+16	.2103944+16	.1807747+16	.1304109+16	.8472346+15	.1461538+01
2	.2374458+16	.2089204+16	.1795067+16	.1294948+16	.8412709+15	.4384615+01
3	.2341116+16	.2059822+16	.1769789+16	.1276684+16	.8293800+15	.7307692+01
4	.2291384+16	.2015992+16	.1732076+16	.1249430+16	.8116343+15	.1023077+02

5	.2225604+16	.1958005+16	.1682172+16	.1213357+16	.7501400+15	.1315385+02
6	.2144227+16	.1886246+16	.1620395+16	.1168683+16	.7590336+15	.1607692+02
7	.2047819+16	.1801191+16	.1547136+16	.1115666+16	.7244758+15	.1900000+02
8	.1937058+16	.1703406+16	.1462943+16	.1054593+16	.6546421+15	.2192308+02
9	.1812745+16	.1593544+16	.1368013+16	.9857392+15	.6397067+15	.2484615+02
10	.1675816+16	.1472351+16	.1263173+16	.9093060+15	.5898205+15	.2776923+02
11	.1527380+16	.1340708+16	.1148861+16	.8252532+15	.5350844+15	.3069231+02
12	.1368790+16	.1199716+16	.1025650+16	.7328688+15	.4755537+15	.3361538+02
13	.1201747+16	.1050950+16	.8943832+15	.6295538+15	.4114331+15	.3653846+02
14	.8905350+15	.7745138+15	.6483614+15	.4786321+15	.3234213+15	.4014286+02
15	.5920254+15	.5147215+15	.4332802+15	.3360237+15	.2412564+15	.4442857+02
16	.3928269+15	.3426324+15	.2911018+15	.2318356+15	.1719163+15	.4871429+02
17	.2581633+15	.2261267+15	.1937264+15	.1569260+15	.1190554+15	.5300000+02
18	.1650948+15	.1451855+15	.1252100+15	.1026139+15	.7911296+14	.5728571+02
19	.9624255+14	.8667045+14	.7510644+14	.6203896+14	.4835337+14	.6157143+02
20	.4684045+14	.4140775+14	.3598877+14	.2986559+14	.2342611+14	.5595714+02
	16	17	18	19	20	
1	.5489922+15	.3520330+15	.2195031+15	.1272819+15	.5911758+14	.1461538+01
2	.5451212+15	.3495482+15	.2179536+15	.1263638+15	.5870069+14	.4384615+01
3	.5374030+15	.3445947+15	.2148651+15	.1245941+15	.5787014+14	.7307692+01
4	.5258847+15	.3372041+15	.2102589+15	.1219263+15	.5663241+14	.1023077+02
5	.5106360+15	.3274239+15	.2041675+15	.1184005+15	.5499757+14	.1315385+02
6	.4917481+15	.3153183+15	.1966355+15	.1140456+15	.5297974+14	.1607692+02
7	.4693319+15	.3009686+15	.1877214+15	.1088994+15	.5059790+14	.1900000+02
8	.4435171+15	.2844768+15	.1775014+15	.1030119+15	.4787694+14	.2192308+02
9	.4144534+15	.2659716+15	.1660741+15	.9644817+14	.4484916+14	.2484615+02
10	.3823187+15	.2456218+15	.1535700+15	.8929294+14	.4155614+14	.2776923+02
11	.3473469+15	.2236604+15	.1401644+15	.8165620+14	.3805051+14	.3069231+02
12	.3099020+15	.2004273+15	.1260936+15	.7367799+14	.3439712+14	.3361538+02
13	.2706494+15	.1764288+15	.1116688+15	.6552996+14	.3067242+14	.3653846+02
14	.2216119+15	.1467905+15	.9392165+14	.5551615+14	.2609562+14	.4014286+02
15	.1680986+15	.1138703+15	.7400700+14	.4420560+14	.2090621+14	.4442857+02
16	.1231328+15	.8522741+14	.5628359+14	.3399245+14	.1618133+14	.4871429+02
17	.8714686+14	.6144170+14	.4116511+14	.2511907+14	.1203170+14	.5300000+02
18	.5685973+14	.4210641+14	.2854676+14	.1757124+14	.8461182+13	.5728571+02
19	.3638487+14	.2630254+14	.1798894+14	.1114526+14	.5388576+13	.6157143+02
20	.1774683+14	.1291067+14	.8877522+13	.5522567+13	.2676854+13	.6585714+02

FLUX FOR GROUP 2

1	2	3	4	5	6
1	.1904760+16	.1888645+16	.1856562+16	.1808895+16	.1746217+16
2	.1691461+16	.1875474+16	.1843608+16	.1796266+16	.1734016+16
3	.1864985+16	.1849195+16	.1817765+16	.1771073+16	.1709679+16
4	.1825434+16	.1809970+16	.1779192+16	.1733472+16	.1673356+16
5	.1773073+16	.1758041+16	.1728128+16	.1683694+16	.1625272+16
6	.1708219+16	.1693724+16	.1664884+16	.1622046+16	.1565722+16
7	.1631259+16	.1617403+16	.1589838+16	.1548895+16	.1495065+16
8	.1542635+16	.1529517+16	.1503423+16	.1464667+16	.1413711+16
9	.1442829+16	.1430545+16	.1406112+16	.1369823+16	.1322111+16
10	.1332345+16	.1320986+16	.1298398+16	.1264648+16	.1220736+16
11	.1211678+16	.1201335+16	.1180768+16	.1150220+16	.1110051+16
12	.1081278+16	.1072038+16	.1053664+16	.1026372+16	.9904817+15
13	.9415037+15	.9334499+15	.9174363+15	.8936497+15	.8623659+15
14	.6858958+15	.6800214+15	.6683419+15	.6509925+15	.6281720+15
15	.4499923+15	.4461314+15	.4384556+15	.4270529+15	.4120528+15
16	.2947007+15	.2921677+15	.2871325+15	.2796529+15	.2698142+15
17	.1910187+15	.1893746+15	.1861070+15	.1812540+15	.1748724+15
18	.1201264+15	.1190917+15	.1170357+15	.1139831+15	.1099710+15
19	.6936820+14	.6877056+14	.6758333+14	.6582123+14	.6350646+14
20	.2964636+14	.2939097+14	.2888371+14	.2813103+14	.2714267+14
6	7	8	9	10	11
1	.1669271+16	.1578962+16	.1476332+16	.1362534+16	.1238805+16
2	.1657597+16	.1567908+16	.1465983+16	.1352970+16	.1230097+16
3	.1634312+16	.1545860+16	.1445343+16	.1333696+16	.1212731+16
4	.1599560+16	.1512955+16	.1414540+16	.1305429+16	.1186810+16
5	.1553557+16	.1469396+16	.1373764+16	.1267743+16	.1152492+16
6	.1496586+16	.1415453+16	.1323264+16	.1221066+16	.1109982+16
7	.1428990+16	.1351449+16	.1263344+16	.1165678+16	.1059530+16
8	.1351164+16	.1277761+16	.1194358+16	.1101904+16	.1001427+16
9	.1263542+16	.1194804+16	.1116695+16	.1030105+16	.9359992+15
10	.1166590+16	.1103014+16	.1030771+16	.9506690+15	.8635989+15
11	.1060730+16	.1002829+16	.9370060+15	.8639967+15	.7845997+15
12	.9464078+15	.8946533+15	.8357963+15	.7704767+15	.6993819+15
13	.8239432+15	.7788133+15	.7274688+15	.6704468+15	.6083076+15
14	.6001379+15	.5671983+15	.5296993+15	.4880057+15	.4424657+15
15	.3936224+15	.3719615+15	.3472950+15	.3198626+15	.2899050+15
16	.2577274+15	.2435266+15	.2273673+15	.2094245+15	.1898957+15
17	.1670368+15	.1578394+15	.1473904+15	.1358203+15	.1232864+15
18	.1050486+15	.9927813+14	.9273543+14	.8551280+14	.7772347+14
19	.6066887+14	.5734647+14	.5358628+14	.4944599+14	.4499632+14
20	.2593180+14	.2451527+14	.2291406+14	.2115390+14	.1926621+14
11	12	13	14	15	16
1	.1106421+16	.9666518+15	.8206982+15	.5789390+15	.3701375+15
2	.1098633+16	.9598381+15	.8149070+15	.5748492+15	.3675189+15
3	.1083100+16	.9462468+15	.8033570+15	.5666924+15	.3622963+15
4	.1059914+16	.9259631+15	.7861141+15	.5545142+15	.3544985+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

5	.1029213+16	.8990979+15	.7632754+15	.5383813+15	.3441677+15	.1315385+02
6	.9911758+15	.8658054+15	.7349661+15	.5183790+15	.3313578+15	.1607692+02
7	.9460205+15	.8262686+15	.7013349+15	.4946061+15	.3161315+15	.1900000+02
8	.8939990+15	.7806962+15	.6625467+15	.4671673+15	.2985564+15	.2192308+02
9	.8353919+15	.7293159+15	.6187728+15	.4361583+15	.2786994+15	.2484615+02
10	.7705051+15	.6723688+15	.5701773+15	.4016382+15	.2566193+15	.2776923+02
11	.6996680+15	.6101097+15	.5169005+15	.3635643+15	.2323618+15	.3069231+02
12	.6232382+15	.5428245+15	.4590525+15	.3216314+15	.2059732+15	.3361538+02
13	.5416095+15	.4708950+15	.3967777+15	.2748270+15	.1776032+15	.3653846+02
14	.3933337+15	.3405773+15	.2833160+15	.2073568+15	.1410557+15	.4014286+02
15	.2576502+15	.2233165+15	.1872232+15	.1443717+15	.1030060+15	.4442857+02
16	.1690150+15	.1470942+15	.1246253+15	.9886602+14	.7297770+14	.4871429+02
17	.1099858+15	.9618046+14	.8223412+14	.6642569+14	.5021977+14	.5300000+02
18	.6950892+14	.6104827+14	.5256626+14	.4298460+14	.3304507+14	.5728571+02
19	.4032396+14	.3553408+14	.3075019+14	.2534975+14	.1970506+14	.6157143+02
20	.1728887+14	.1526667+14	.1325033+14	.1097386+14	.8584101+13	.6585714+02
	16	17	18	19	20	
1	.2368755+15	.1502775+15	.9252654+14	.5224439+14	.2174394+14	.1461538+01
2	.2351977+15	.1492125+15	.9187105+14	.5187455+14	.2159014+14	.4384615+01
3	.2318518+15	.1470893+15	.9056443+14	.5113754+14	.2128369+14	.7307692+01
4	.2268568+15	.1439204+15	.8861529+14	.5003862+14	.2082693+14	.1023077+02
5	.2202406+15	.1397254+15	.8603685+14	.4858596+14	.2022344+14	.1315385+02
6	.2120399+15	.1345302+15	.8284735+14	.4679101+14	.1947833+14	.1607692+02
7	.2022992+15	.1283684+15	.7907093+14	.4466910+14	.1859842+14	.1900000+02
8	.1910712+15	.1212821+15	.7473910+14	.4224046+14	.1759276+14	.2192308+02
9	.1784175+15	.1133256+15	.6989328+14	.3953170+14	.1647317+14	.2484615+02
10	.1644142+15	.1045713+15	.6458891+14	.3657781+14	.1525499+14	.2776923+02
11	.1491662+15	.9512124+14	.5890118+14	.3342453+14	.1395777+14	.3069231+02
12	.1328422+15	.8512595+14	.5293208+14	.3013042+14	.1260577+14	.3361538+02
13	.1157513+15	.7480998+14	.4681627+14	.2676738+14	.1122764+14	.3653846+02
14	.9445452+14	.6208948+14	.3929953+14	.2263726+14	.9535232+13	.4014286+02
15	.7133964+14	.4800896+14	.3088410+14	.1798040+14	.7619325+13	.4442857+02
16	.5202091+14	.3580073+14	.2341210+14	.1378304+14	.5878092+13	.4871429+02
17	.3661680+14	.2568320+14	.1704457+14	.1013844+14	.4349981+13	.5300000+02
18	.2450114+14	.1744223+14	.1171469+14	.7028498+13	.3031355+13	.5726571+02
19	.1477856+14	.1063177+14	.7202955+13	.4349589+13	.1883702+13	.6157143+02
20	.6480666+13	.4691157+13	.3195029+13	.1937371+13	.8417788+12	.6585714+02

TOTAL FLUX

	1	2	3	4	5	
1	.5972741+16	.5922399+16	.5822251+16	.5673551+16	.5478163+16	.1461538+01
2	.5931280+16	.5881277+16	.5781808+16	.5634118+16	.5440060+16	.4384615+01
3	.5848604+16	.5799280+16	.5701167+16	.5555495+16	.5364091+16	.7307692+01
4	.5725278+16	.5676968+16	.5580881+16	.5438221+16	.5250779+16	.1023077+02
5	.5562150+16	.5515185+16	.5421780+16	.5283107+16	.5100906+16	.1315385+02
6	.5366344+16	.5315045+16	.5224962+16	.5091225+16	.4915513+16	.1607692+02
7	.5121249+16	.5077928+16	.4991787+16	.4863904+16	.4695883+16	.1900000+02
8	.4846502+16	.4805460+16	.4723856+16	.4602710+16	.4443538+16	.2192308+02
9	.4537972+16	.4499495+16	.4422998+16	.4309432+16	.4160214+16	.2484615+02
10	.4197730+16	.4162092+16	.4091242+16	.3986059+16	.3847345+16	.2776923+02
11	.3828022+16	.3795481+16	.3730790+16	.3634745+16	.3508527+16	.3069231+02
12	.3431230+16	.3402026+16	.3343972+16	.3257775+16	.3144484+16	.3361538+02
13	.3009822+16	.2984179+16	.2933203+16	.2857511+16	.2758016+16	.3653846+02
14	.2225394+16	.2206407+16	.2168665+16	.2112618+16	.2038932+16	.4014286+02
15	.1476791+16	.1464165+16	.1439067+16	.1401791+16	.1352773+16	.4442857+02
16	.9758572+15	.9674967+15	.9508778+15	.9261956+15	.8937381+15	.4871429+02
17	.6373957+15	.6319258+15	.6210540+15	.6049096+15	.5836845+15	.5300000+02
18	.4043970+15	.4009230+15	.3940196+15	.3837708+15	.3703027+15	.5728571+02
19	.2378222+15	.2357783+15	.2317176+15	.2256912+15	.2177756+15	.6157143+02
20	.1097164+15	.1087735+15	.1069005+15	.1041215+15	.1004728+15	.6585714+02
	6	7	8	9	10	
1	.5238533+16	.4957652+16	.4639008+16	.4286530+16	.3904527+16	.1461538+01
2	.5202063+16	.4923100+16	.4606636+16	.4256576+16	.3877201+16	.4384615+01
3	.5129354+16	.4854216+16	.4542099+16	.4196859+16	.3822723+16	.7307692+01
4	.5020905+16	.4751472+16	.4445838+16	.4107784+16	.3741457+16	.1023077+02
5	.4877465+16	.4615578+16	.4318513+16	.3989955+16	.3633946+16	.1315385+02
6	.4700030+16	.4447475+16	.4161004+16	.3844178+16	.3500912+16	.1607692+02
7	.4489832+16	.4248332+16	.3974401+16	.3671455+16	.3343254+16	.1900000+02
8	.4248333+16	.4019536+16	.3760006+16	.3472983+16	.3162046+16	.2192308+02
9	.3977204+16	.3762661+16	.3519319+16	.3250150+16	.2958537+16	.2484615+02
10	.3678311+16	.3479553+16	.3254030+16	.3004531+16	.2734160+16	.2776923+02
11	.3353681+16	.3172103+16	.2966003+16	.2737689+16	.2490546+16	.3069231+02
12	.3005471+16	.2842410+16	.2657243+16	.2452156+16	.2229545+16	.3361538+02
13	.2635907+16	.2492629+16	.2329344+16	.2149390+16	.1953224+16	.3653846+02
14	.1948471+16	.1842275+16	.1721518+16	.1587451+16	.1441273+16	.4014286+02
15	.1292578+16	.1221880+16	.1141440+16	.1052066+16	.9545658+15	.4442857+02
16	.8538797+15	.8070738+15	.7538435+15	.6947748+15	.6305214+15	.4871429+02
17	.5576310+15	.5270606+15	.4923440+15	.4539181+15	.4123039+15	.5300000+02
18	.3537829+15	.3344219+15	.3124764+15	.2882570+15	.2621426+15	.5728571+02
19	.2080742+15	.1967179+15	.1838685+15	.1697238+15	.1545250+15	.6157143+02
20	.9600355+14	.9077659+14	.8486980+14	.7837855+14	.7141866+14	.6585714+02
	11	12	13	14	15	

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1	.3497606+16	.3070595+16	.2628445+16	.1883048+16	.1217372+16	.1461538+01
2	.3473091+16	.3049043+16	.2609974+16	.1869798+16	.1208790+16	.4384615+01
3	.3424215+16	.3006071+16	.2573146+16	.1843376+16	.1191676+16	.7307692+01
4	.3351298+16	.2941955+16	.2518190+16	.1803945+16	.1166133+16	.1023077+02
5	.3254817+16	.2857102+16	.2445447+16	.1751738+16	.1132308+16	.1315385+02
6	.3135403+16	.2752051+16	.2355361+16	.1687062+16	.1090391+16	.1607692+02
7	.2993839+16	.2627460+16	.2248470+16	.1610273+16	.1040607+16	.1900000+02
8	.2631057+16	.2484103+16	.2125389+16	.1521760+16	.9831985+15	.2192308+02
9	.2448137+16	.2322859+16	.1986786+16	.1421897+16	.9184061+15	.2484615+02
10	.2446321+16	.2144720+16	.1833350+16	.1310944+16	.8464398+15	.2776923+02
11	.2227048+16	.1950817+16	.1665761+16	.1188618+16	.7674462+15	.3069231+02
12	.1992028+16	.1742540+16	.1484703+16	.1054500+16	.6815270+15	.3361538+02
13	.1743356+16	.1521845+16	.1291161+16	.9043808+15	.5390363+15	.3653846+02
14	.1283869+16	.1115091+16	.9316775+15	.6659889+15	.4694770+15	.4014286+02
15	.8496756+15	.7380380+15	.6205033+15	.4603954+15	.3442625+15	.4442857+02
16	.5018419+15	.4897266+15	.4157271+15	.3307016+15	.2448940+15	.4071429+02
17	.3681491+15	.3223071+15	.2759605+15	.2233517+15	.1692751+15	.5300000+02
18	.2346038+15	.2062338+15	.1777762+15	.1455985+15	.1121580+15	.5728571+02
19	.1385665+15	.1222045+15	.1058566+15	.6738871+14	.6805042+14	.6157143+02
20	.6412932+14	.5667442+14	.4923911+14	.4083945+14	.3201021+14	.6585714+02
	16	17	18	19	20	
1	.7858676+15	.5023104+15	.3120297+15	.1795263+15	.8086152+14	.1461538+01
2	.7803189+15	.4987608+15	.3098246+15	.1782583+15	.8029083+14	.4384615+01
3	.7692548+15	.4916640+15	.3054295+15	.1757317+15	.7915384+14	.7307692+01
4	.7527415+15	.4811245+15	.2988742+15	.1719649+15	.7745934+14	.1023077+02
5	.7306766+15	.4671493+15	.2902044+15	.1669665+15	.7522101+14	.1315385+02
6	.7037680+15	.4498485+15	.2794328+15	.1608366+15	.7245307+14	.1607692+02
7	.6716311+15	.4293369+15	.2667924+15	.1535685+15	.6919633+14	.1900000+02
8	.6345883+15	.4057589+15	.2522405+15	.1452524+15	.6546970+14	.2192308+02
9	.5928708+15	.3792972+15	.2359673+15	.1359799+15	.6132233+14	.2484615+02
10	.5467329+15	.3501930+15	.2181589+15	.1250707+15	.5681112+14	.2776923+02
11	.4965131+15	.3187816+15	.1990656+15	.1150807+15	.5200428+14	.3069231+02
12	.4427441+15	.2855532+15	.1790256+15	.1038084+15	.4700289+14	.3361538+02
13	.3664007+15	.2512388+15	.1584851+15	.9229734+14	.4190006+14	.3653846+02
14	.3160665+15	.2088800+15	.1332212+15	.7815341+14	.3563085+14	.4014286+02
15	.2394382+15	.1618792+15	.1048911+15	.6218600+14	.2852554+14	.4442857+02
16	.1751537+15	.1210281+15	.7969569+14	.4777549+14	.2205942+14	.4871429+02
17	.1237637+15	.8712490+14	.5820969+14	.3525750+14	.1638168+14	.5300000+02
18	.8336087+14	.5954865+14	.4026144+14	.2459973+14	.1149254+14	.5728571+02
19	.5116343+14	.3693431+14	.2519190+14	.1549484+14	.7272278+13	.6157143+02
20	.2422749+14	.1760183+14	.1207255+14	.7459938+13	.3518633+13	.6585714+02

POWER DENSITY (MWT/LITER)						
1	2	3	4	5		
1	.7484432-00	.7421348-00	.7295851-00	.7109513-00	.6864669-00	.1461538+01
2	.7432477-00	.7369818-00	.7245171-00	.7060099-00	.6816922-00	.4384615+01
3	.7328875-00	.7267066-00	.7144119-00	.6961576-00	.6721724-00	.7307692+01
4	.7174333-00	.7113795-00	.6993387-00	.6814618-00	.6579731-00	.1023077+02
5	.6969914-00	.6911061-00	.6794015-00	.6620242-00	.6391924-00	.1315385+02
6	.6717027-00	.6660262-00	.6547379-00	.6379791-00	.6159604-00	.1607692+02
7	.6417411-00	.6363125-00	.6255180-00	.6094929-00	.5884380-00	.1900000+02
8	.6073117-00	.6021686-00	.5919427-00	.5767618-00	.5568159-00	.2192308+02
9	.5686484-00	.5638269-00	.5542409-00	.5400100-00	.5213114-00	.2484615+02
10	.5260109-00	.5215451-00	.5126670-00	.4994864-00	.4821668-00	.2776923+02
11	.4796803-00	.4756026-00	.4674962-00	.4554609-00	.4396446-00	.3069231+02
12	.4299547-00	.4262953-00	.4190206-00	.4082194-00	.3940231-00	.3361538+02
13	.3771431-00	.3739299-00	.3675423-00	.3580577-00	.3455904-00	.3653846+02
14	.7893947-01	.7826714-01	.7693074-01	.7494648-01	.7233829-01	.4014286+02
15	.5265627-01	.5220084-01	.5130745-01	.4998077-01	.4623650-01	.4442857+02
16	.3492706-01	.3462825-01	.3403428-01	.3315220-01	.3199239-01	.4871429+02
17	.2288848-01	.2269231-01	.2230240-01	.2172341-01	.2096230-01	.5300000+02
18	.1457629-01	.1445122-01	.1420266-01	.1383367-01	.1334880-01	.5728571+02
19	.8637665-02	.8563509-02	.8416171-02	.8197510-02	.7910324-02	.6157143+02
20	.4105680-02	.4070428-02	.4000398-02	.3896495-02	.3760083-02	.6585714+02
6	7	8	9	10		
1	.6564385-00	.6212406-00	.5813104-00	.5371402-00	.4892696-00	.1461538+01
2	.6518684-00	.6169109-00	.5772538-00	.5333866-00	.4858454-00	.4384615+01
3	.6427571-00	.6082790-00	.5691667-00	.5259035-00	.4790189-00	.7307692+01
4	.6291672-00	.5954041-00	.5571041-00	.5147414-00	.4688354-00	.1023077+02
5	.6111925-00	.5783750-00	.5411489-00	.4999761-00	.4553631-00	.1315385+02
6	.5889578-00	.5573097-00	.5214112-00	.4817087-00	.4386926-00	.1607692+02
7	.5626175-00	.5323546-00	.4980277-00	.4600646-00	.4189363-00	.1900000+02
8	.5323545-00	.5036835-00	.4711613-00	.4351937-00	.3962289-00	.2192308+02
9	.4983782-00	.4714961-00	.4409999-00	.4072697-00	.3707267-00	.2484615+02
10	.4609224-00	.4360160-00	.4077554-00	.3764902-00	.3426092-00	.2776923+02
11	.4202410-00	.3974874-00	.3716610-00	.3430758-00	.3120809-00	.3069231+02
12	.3766038-00	.3561708-00	.3329678-00	.3072684-00	.2793730-00	.3361538+02
13	.3302895-00	.3123358-00	.2919377-00	.2693256-00	.2447444-00	.3653846+02
14	.6913730-01	.6538098-01	.6111185-01	.5637526-01	.5121497-01	.4014286+02
15	.4609497-01	.4358053-01	.4072065-01	.3754456-01	.3408123-01	.4442857+02
16	.3056838-01	.2889651-01	.2699565-01	.2488688-01	.2259357-01	.4871429+02
17	.2002816-01	.1893223-01	.1768789-01	.1631082-01	.1481970-01	.5300000+02
18	.1275413-01	.1205726-01	.1126747-01	.1039594-01	.9456299-02	.5728571+02
19	.7558373-02	.7146426-02	.6680369-02	.6167380-02	.5616204-02	.6157143+02
20	.3593008-02	.3397623-02	.3176850-02	.2934258-02	.2674175-02	.6585714+02
11	12	13	14	15		
1	.4382760-00	.3847640-00	.3293536-00	.6686967-01	.4344290-01	.1461538+01
2	.4352041-00	.3820633-00	.3270391-00	.6639993-01	.4313710-01	.4384615+01

3	.4290795-00	.3766786-00	.3224243-00	.6546339-01	.4252739-01	.7307692+01
4	.4199423-00	.3686444-00	.3155381-00	.6406594-01	.4161746-01	.1023077+02
5	.4076523-00	.3580117-00	.3064230-00	.6221624-01	.4041276-01	.1315385+02
6	.3928886-00	.3448479-00	.2951347-00	.5992551-01	.3892030-01	.1607692+02
7	.3751493-00	.3292357-00	.2817407-00	.5720705-01	.3714831-01	.1900000+02
8	.3547510-00	.3112717-00	.2663179-00	.5407543-01	.3510579-01	.2192308+02
9	.3318291-00	.2910664-00	.2489499-00	.5054488-01	.3280168-01	.2484615+02
10	.3065390-00	.2687436-00	.2297232-00	.4662568-01	.3024371-01	.2776923+02
11	.2790611-00	.2444453-00	.2087228-00	.4231578-01	.2743705-01	.3069231+02
12	.2496094-00	.2183453-00	.1860343-00	.3757667-01	.2438455-01	.3361538+02
13	.2184462-00	.1906885-00	.1617811-00	.3228108-01	.2109669-01	.3653846+02
14	.4566317-01	.3971406-01	.3324546-01	.2454239-01	.1684017-01	.4014286+02
15	.3035676-01	.2639292-01	.2221692-01	.1722999-01	.1237069-01	.4442857+02
16	.2014264-01	.1756866-01	.1492657-01	.1188763-01	.8815200-02	.4871429+02
17	.1323761-01	.1159490-01	.9933535-02	.8046555-02	.6104698-02	.5300000+02
18	.8465423-02	.7444548-02	.6420280-02	.5261641-02	.4056605-02	.5728571+02
19	.5037496-02	.4444124-02	.3851167-02	.3181117-02	.2479373-02	.6157143+02
20	.2401796-02	.2123229-02	.1845365-02	.1531392-02	.1201200-02	.6585714+02
	16	17	18	19	20	
1	.2615019-01	.1805088-01	.1125527-01	.6526521-02	.3031320-02	.1461538+01
2	.2795170-01	.1792348-01	.1117581-01	.6480469-02	.3009944-02	.4384615+01
3	.2755594-01	.1766948-01	.1101745-01	.6388704-02	.2967356-02	.7307692+01
4	.2696532-01	.1729052-01	.1078126-01	.6251905-02	.2903890-02	.1023077+02
5	.2618343-01	.1678903-01	.1046892-01	.6071120-02	.2820062-02	.1315385+02
6	.2521493-01	.1616830-01	.1008270-01	.5847814-02	.2716596-02	.1607692+02
7	.2406552-01	.1543250-01	.9625627-02	.5583939-02	.2594464-02	.1900000+02
8	.2274183-01	.1458686-01	.9101582-02	.5282051-02	.2454943-02	.2192308+02
9	.2125156-01	.1363799-01	.8515633-02	.4945488-02	.2299691-02	.2484615+02
10	.1960382-01	.1259453-01	.7874473-02	.4578595-02	.2130837-02	.2776923+02
11	.1781060-01	.1146844-01	.7187088-02	.4187013-02	.1951082-02	.3069231+02
12	.1589057-01	.1027713-01	.6465588-02	.3777921-02	.1763751-02	.3361538+02
13	.1387785-01	.9046586-02	.5725944-02	.3360122-02	.1572762-02	.3653846+02
14	.1136340-01	.7526850-02	.4815938-02	.2846652-02	.1338082-02	.4014286+02
15	.8619443-02	.5838825-02	.3794792-02	.2266691-02	.1071989-02	.4442857+02
16	.6313773-02	.4370131-02	.2886004-02	.1743001-02	.8297159-03	.4871429+02
17	.4468553-02	.3150492-02	.2110787-02	.1288008-02	.6169389-03	.5300000+02
18	.3018098-02	.2159053-02	.1463767-02	.9009848-03	.4338566-03	.5728571+02
19	.1665675-02	.1348692-02	.9224031-03	.5714854-03	.2763053-03	.6157143+02
20	.9099884-03	.6620092-03	.4552049-03	.2831758-03	.1372587-03	.6585714+02

FISSION SOURCE RATE						
	1	2	3	4	5	
1	.6311271+14	.6258077+14	.6152256+14	.5995134+14	.5788681+14	.1461538+01
2	.6267461+14	.6214626+14	.6109522+14	.5953467+14	.5748419+14	.4384615+01
3	.6180103+14	.6127984+14	.6024313+14	.5870391+14	.5668147+14	.7307692+01
4	.6049792+14	.5998745+14	.5897215+14	.5746475+14	.5548417+14	.1023077+02
5	.5877426+14	.5827800+14	.5729105+14	.5582577+14	.5390057+14	.1315385+02
6	.5664195+14	.5616329+14	.5521143+14	.5379831+14	.5194166+14	.1607692+02
7	.5411566+14	.5365790+14	.5274768+14	.5139641+14	.4962104+14	.1900000+02
8	.5121271+14	.5077903+14	.4991675+14	.4863666+14	.4695478+14	.2192308+02
9	.4795289+14	.4754631+14	.4673799+14	.4553799+14	.4396126+14	.2484615+02
10	.4435811+14	.4398153+14	.4323288+14	.4212143+14	.4066095+14	.2776923+02
11	.4045218+14	.4010831+14	.3942472+14	.3840981+14	.3707606+14	.3069231+02
12	.3626031+14	.3595170+14	.3533822+14	.3442734+14	.3323016+14	.3361538+02
13	.3180872+14	.3153772+14	.3099901+14	.3019910+14	.2914764+14	.3653846+02
14	.6489160+13	.6433899+13	.6324041+13	.6160926+13	.5946522+13	.4014286+02
15	.4328081+13	.4291136+13	.4217696+13	.4108637+13	.3965250+13	.4442857+02
16	.2871156+13	.2846593+13	.2797766+13	.2725255+13	.2629914+13	.4871429+02
17	.1881533+13	.1865406+13	.1833354+13	.1785759+13	.1723192+13	.5300000+02
18	.1198235+13	.1187953+13	.1167520+13	.1137188+13	.1097330+13	.5728571+02
19	.7100537+12	.7039577+12	.6918458+12	.6738710+12	.6502631+12	.6157143+02
20	.3375048+12	.3346069+12	.3288501+12	.3203088+12	.3090952+12	.6585714+02
	6	7	8	9	10	
1	.5535482+14	.5238699+14	.4902019+14	.4529598+14	.4125990+14	.1461538+01
2	.5496946+14	.5202190+14	.4867813+14	.4497946+14	.4097116+14	.4384615+01
3	.5420118+14	.5129403+14	.4799620+14	.4434846+14	.4039550+14	.7307692+01
4	.5305526+14	.5020840+14	.4697905+14	.4340723+14	.3953678+14	.1023077+02
5	.5153963+14	.4877248+14	.4563368+14	.4216218+14	.3840073+14	.1315385+02
6	.4966480+14	.4699626+14	.4396938+14	.4062183+14	.3699501+14	.1607692+02
7	.4744383+14	.4489207+14	.4199769+14	.3879679+14	.3532912+14	.1900000+02
8	.4489216+14	.4247461+14	.3973237+14	.3669969+14	.3341441+14	.2192308+02
9	.4202748+14	.3976075+14	.3718931+14	.3434524+14	.3126410+14	.2484615+02
10	.3886954+14	.3676936+14	.3438638+14	.3175011+14	.2889336+14	.2776923+02
11	.3543983+14	.3352113+14	.3134334+14	.2893297+14	.2631948+14	.3069231+02
12	.3176118+14	.3003808+14	.2808142+14	.2591428+14	.2356203+14	.3361538+02
13	.2785722+14	.2634309+14	.2462283+14	.2271588+14	.2064293+14	.3653846+02
14	.5683386+13	.5374601+13	.5023660+13	.4634292+13	.4210093+13	.4014286+02
15	.3789207+13	.3582509+13	.3347414+13	.3086326+13	.2801625+13	.4442857+02
16	.2512854+13	.2375419+13	.2219160+13	.2045810+13	.1857290+13	.4871429+02
17	.1646402+13	.1556312+13	.1454021+13	.1340820+13	.1218243+13	.5300000+02
18	.1048445+13	.9911593+12	.9262347+12	.8545913+12	.7773489+12	.5728571+02
19	.6213312+12	.5874673+12	.5491554+12	.5069854+12	.4616764+12	.6157143+02
20	.2953608+12	.2792994+12	.2611509+12	.2412088+12	.2198288+12	.6585714+02
	11	12	13	14	15	
1	.3696071+14	.3244946+14	.2777858+14	.5496978+13	.3571195+13	.1461538+01
2	.3670165+14	.3222170+14	.2758338+14	.5458363+13	.3546058+13	.4384615+01
3	.3618518+14	.3176761+14	.2719418+14	.5381376+13	.3495936+13	.7307692+01
4	.3541466+14	.3109006+14	.2661340+14	.5266499+13	.3421136+13	.1023077+02

5	.3439515+14	.3019340+14	.2584465+14	.5114445+13	.3322104+13	.1315385+02
6	.3313331+14	.2908329+14	.2489262+14	.4926137+13	.3199418+13	.1607692+02
7	.3163745+14	.2776671+14	.2376302+14	.4702668+13	.3053752+13	.1900000+02
8	.2991739+14	.2625185+14	.2246233+14	.4445236+13	.2885848+13	.2192308+02
9	.2798458+14	.2454801+14	.2049763+14	.4155009+13	.2696440+13	.2484615+02
10	.2585216+14	.2266569+14	.1937622+14	.3832834+13	.2486164+13	.2776923+02
11	.2353537+14	.2061666+14	.1760531+14	.3473541+13	.2255445+13	.3069231+02
12	.2105233+14	.1841625+14	.1569212+14	.3089130+13	.2004516+13	.3361538+02
13	.1842525+14	.1608460+14	.1364714+14	.2653645+13	.1734240+13	.3653846+02
14	.3753712+13	.3264669+13	.2722921+13	.2017492+13	.1384335+13	.4014286+02
15	.2495456+13	.2169613+13	.1826328+13	.1416360+13	.1016925+13	.4442857+02
16	.1655813+13	.1444237+13	.1227029+13	.9772147+12	.7246478+12	.4871429+02
17	.1068189+13	.9531510+12	.8165798+12	.6614618+12	.5018327+12	.5300000+02
18	.6956946+12	.6119742+12	.5277750+12	.4325298+12	.3334706+12	.5728571+02
19	.4141041+12	.3653263+12	.3165827+12	.2615016+12	.2038152+12	.6157143+02
20	.1974381+12	.1745386+12	.1516970+12	.1256870+12	.9874387+11	.6585714+02
	16	17	18	19	20	
1	.2314068+13	.1483861+13	.9252320+12	.5365084+12	.2491077+12	.1461538+01
2	.2297751+13	.1473368+13	.9187004+12	.5327227+12	.2474304+12	.4384615+01
3	.2265218+13	.1452508+13	.9056822+12	.5251792+12	.2439296+12	.7307692+01
4	.2216667+13	.1421356+13	.8862666+12	.5139337+12	.2387124+12	.1023077+02
5	.2152392+13	.1380131+13	.8605905+12	.4990725+12	.2318213+12	.1315385+02
6	.2072777+13	.1329104+13	.8288421+12	.4807158+12	.2233160+12	.1607692+02
7	.1978290+13	.1268619+13	.7912684+12	.4590240+12	.2132762+12	.1900000+02
8	.1869478+13	.1199104+13	.7481896+12	.4342076+12	.2018070+12	.2192308+02
9	.1746971+13	.1121102+13	.7000221+12	.4065406+12	.1890446+12	.2484615+02
10	.1611519+13	.1035325+13	.6473159+12	.3763805+12	.1751641+12	.2776923+02
11	.1464109+13	.9427554+12	.5908099+12	.3441906+12	.1603874+12	.3069231+02
12	.1306274+13	.8448250+12	.5314995+12	.3105615+12	.1449880+12	.3361538+02
13	.1140820+13	.7436687+12	.4706975+12	.2762166+12	.1292879+12	.3653846+02
14	.9341209+12	.6187398+12	.3958910+12	.2340072+12	.1099962+12	.4014286+02
15	.7085556+12	.4799768+12	.3119484+12	.1863319+12	.8812219+11	.4442857+02
16	.5190196+12	.3592438+12	.2372421+12	.1432822+12	.6820626+11	.4871429+02
17	.3673345+12	.2589841+12	.1735159+12	.1058799+12	.5071506+11	.5300000+02
18	.2481008+12	.1774836+12	.1203280+12	.7406487+11	.3566490+11	.5728571+02
19	.1533666+12	.1108684+12	.7582554+11	.4697859+11	.2271350+11	.6157143+02
20	.7480500+11	.5442004+11	.3741982+11	.2327828+11	.1128326+11	.6585714+02

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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	* * * * *	FISSION:
					DECAY			
1	1	U238	.000	1	0	0 0	0 0 0 0 0 0 0	0 0
2	2	PU239	.000	2	0	1 6	0 0 0 0 0 0 0	0 0
3	3	PU240	.000	1	0	2 0	0 0 0 0 0 0 0	0 0
4	4	PU241	.780-07	2	0	3 0	0 0 0 0 0 0 0	0 0
5	5	FIS PR	.000	0	0	0 0	1 2 3 4 6 0 0	0 0
6	9	U238	.000	1	0	0 0	0 0 0 0 0 0 0	0 0

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		Z O N E 1	FLUX = 3,3288+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	8.000-03	3.838+17	1.837+18	6.844-02	3.275-01
2	2	PU239	1.600-03	2.133+18	2.567+18	1.901+00	2.289+00
3	3	PU240	1.000-04	3.386+16	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 = 3.7844+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	2.185+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 = 1.7920

T I M E = 50.000 D A Y S

	MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	11	0	.00000000
2	11	1	.79622971-02
3	11	2	.15773848-02
4	11	3	.10713228-03
5	11	4	.10050562-05
6	11	5	.52079447-04
7	11	6	.20000000-01
8	11	7	.59999999-02
9	11	8	.13000000-01
10	12	0	.00000000
11	12	9	.39983326-01
12	12	2	.14941343-04
13	12	10	.61999999-02

TIME (MINUTES)	OUTER ITERATIONS	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.36	0	0	.00000000	.98663099-00	.00000000
.38	1	29	.00000000	.98080501-00	.98080499-00
.40	2	24	.00000000	.98047140-00	.99965986-00
.41	3	10	.00000000	.98039351-00	.99992055-00
.42	4	4	.00000000	.98036959-00	.99997560-00
.43	5	3	.00000000	.98035435-00	.99998444-00
.44	6	2	.00000000	.98034477-00	.99999022-00

2 D B SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC #T.	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	5.319+00
3 PU240	240.050	8.992+00	0.000
4 PU241	241.060	8.471-02	0.000
5 FIS PR	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 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

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Z O N E 1 FLUX = 3.3460+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+16	6.835-02	3.275-01
2	2	PU239	1.577-03	2.115+18	2.547+16	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 = 3.8241+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	4.937-01	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	3.998-02	3.569+17	3.485+18	2.603-02	2.542-01

BREEDING RATIO = 1.8112

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

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TIME (MINUTES)	OUTER ITERATIONS	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.45	0	0	.00000000	.98034477-00	.00000000
.47	1	25	.00000000	.97459356-00	.97459355-00
.49	2	27	.00000000	.97420231-00	.99959853-00
.51	3	14	.00000000	.97409389-00	.99988870-00
.52	4	6	.00000000	.97406195-00	.99996720-00
.53	5	3	.00000000	.97404774-00	.99998540-00
.53	6	2	.00000000	.97403887-00	.99999087-00

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	6.596+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 PR	1.000	3.625+02	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 U235	238.050	0.000	1.417+04
10 FE	55.847	0.000	5.156+02

* * * * 2 D B * * * *

APPENDIX E
FORTTRAN-IV SOURCE DECK LISTING


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-IL PDP INCL                                2DB 0001
ABC* FCOPY                                2DB 0002
COMMON  NINP, NOUT, NCR1, NFLUX1, NSCRAT, ALA, B07, 2DB 0003
1      CNT, CVT, DAY, DELT, E0(51), E1(51), E2(51), 2DB 0004
2      E3(51), E4(51), E5(51), E6(51), E7(51), E8(51), E9(51), 2DB 0005
3      E01, E02, E03, EQ, EVP, EVPP, FEF, 2DB 0006
4      GBAR, GLH, IGEP, IGP, IGV, IHS, IHT, 2DB 0007
5      II, IMJM, IP, ITEM, ITEM1, ITEM2, ITL, 2DB 0008
6      IZP, JP, K07, KPAGE, LAP, LAPP, LAR, 2DB 0009
7      LC, ML, NCON, NGOTO, NPRT, ORFP, P02, 2DB 0010
8      PBAR, SBAR, SK7, T06, T7, T11, TEMP, 2DB 0011
9      TEMP1, TEMP2, TEMP3, TEMP4, TI, TSD, V11 2DB 0012
COMMON  ID(11), MAXT, A02, I04, S02, IGM, NXCM, 2DB 0013
1      MCR, MTP, M07, D05, G07, S04, NPUN, 2DB 0014
2      IGE, IM, JM, IZM, MT, M01, B01, 2DB 0015
3      B02, B03, B04, IZ, JZ, EV, EVM, 2DB 0016
4      S03, BUCK, LAL, LAH, EPS, EPSA, G06, 2DB 0017
5      POD, ORF, S01 2DB 0018
COMMON  LATW, LHOLN, LALAM, LC0, LN0, LN2, LA0, 2DB 0019
1      LA1, LF0, LF2, LI0, LI1, LI2, LK6, 2DB 0020
2      LK7, LM0, LM2, LR0, LR1, LR2, LR3, 2DB 0021
3      LR4, LR5, LS2, LV0, LV7, LZ0, LZ1, 2DB 0022
4      LZ2, LZ3, LZ4, LZ5, LCXS, LVOL, LMASS, 2DB 0023
5      LMATN, LNBR, LLD, LLCN, LLFN, LPHIB, LAXS, 2DB 0024
6      LFXS, LMASSP, LCXR, LCXT 2DB 0025
INTEGER A02, B01, B02, B03, B04, CNT, CVT, 2DB 0026
1      D05, G07, P02, S02, S04, T06, R2, 2DB 0027
2      Z2 2DB 0028
REAL I2, K6, K7, LAH, LAL, LAP, LAPP, 2DB 0029
1      LAR, NO, N2, MASS, MASSP 2DB 0030
END 2DB 0031

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-ITC FOR	CALC,CALC	2DB 0032
C		2DB 0033
C	* * * * * DESCRIPTION OF SUBROUTINES * * * * *	2DB 0034
C		2DB 0035
C	CALC	2DB 0036
C	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	2DB 0041
C	SUBROUTINE TO CONTROL THE READING AND PRINTING OF ALL	2DB 0042
C	INPUT DATA, COMPUTE VARIABLE DIMENSION POINTERS AND	2DB 0043
C	PROGRAM CONSTANTS. INP IS CALLED BY CALC AND CALLS	2DB 0044
C	S860, S862, REAG2, REAI2, MAPR, AND ERRO2.	2DB 0045
C		2DB 0046
C	ERRO2	2DB 0047
C	ERRO2 IS USED TO PRINT AN ERROR MESSAGE. IT IS CALLED	2DB 0048
C	BY CALC, INP, REAI2, REAG2, INIT, AND CNNP.	2DB 0049
C		2DB 0050
C	S860	2DB 0051
C	SUBROUTINE TO READ CROSS SECTIONS FROM CARDS, PERFORM	2DB 0052
C	ADJOINT REVERSALS IF REQUIRED, AND WRITE CROSS SECTION	2DB 0053
C	TAPE. S860 IS CALLED BY INP.	2DB 0054
C		2DB 0055
C	S862	2DB 0056
C	S862 READS INPUT FLUXES AND PREPARES A FLUX TAPE. IT IS	2DB 0057
C	CALLED BY INP AND CALLS REAG2.	2DB 0058
C		2DB 0059
C	REAG2	2DB 0060
C	SUBROUTINE TO READ FLOATING POINT DATA. REAG2 IS CALLED	2DB 0061
C	BY INP AND S862 AND CALLS ERRO2.	2DB 0062
C		2DB 0063
C	REAI2	2DB 0064
C	SUBROUTINE TO READ INTEGER DATA. REAI2 IS CALLED BY INP	2DB 0065
C	AND CALLS ERRO2.	2DB 0066
C		2DB 0067
C	MAPR	2DB 0068
C	SUBROUTINE TO PRODUCE A PICTURE BY ZONE AND	2DB 0069
C	MATERIAL. MAPR IS CALLED BY INP.	2DB 0070
C		2DB 0071
C	INIT	2DB 0072
C	INIT PERFORMS ADJOINT REVERSALS(S806), MIXES CROSS	2DB 0073
C	SECTIONS(S807), MODIFIES GEOMETRY(S810), AND CALCULATES	2DB 0074
C	AREAS AND VOLUMES(S811), AND FISSION NEUTRONS(S821).	2DB 0075
C	INIT IS CALLED BY CALC AND CALLS CLEAR AND ERRO2.	2DB 0076
C		2DB 0077
C	CLEAR	2DB 0078
C	CLEAR SETS AN ARRAY OF A SPECIFIED LENGTH TO A GIVEN	2DB 0079
C	CONSTANT. THE SUBROUTINE IS CALLED BY INIT AND GRAM.	2DB 0080
C		2DB 0081
C	FISCAL	2DB 0082
C	CALCULATES FISSION SUMS(S822) AND PERFORMS	2DB 0083
C	NORMALIZATION(S823). FISCAL IS CALLED BY CALC.	2DB 0084
C		2DB 0085
C	S8830	2DB 0086
C	S8830 IS THE MONITOR PRINT SUBROUTINE--PRINTS TIME,	2DB 0087
C	EIGENVALUE, LAMBDA, ETC. AFTER EACH OUTER ITERATION.	2DB 0088
C	IT IS CALLED BY CALC AND S8850.	2DB 0089
C		2DB 0090
C	OUTER	2DB 0091
C	PERFORMS A COMPLETE OUTER ITERATION. CALLS INNER1 AND	2DB 0092
C	INNER. OUTER IS CALLED BY CALC.	2DB 0093
C		2DB 0094
C	INNER1	2DB 0095
C	CALCULATES COEFFICIENTS FOR THE FLUX EQUATION. INNER1	2DB 0096
C	IS CALLED BY OUTER.	2DB 0097
C		2DB 0098
C	INNER	2DB 0099
C	CALCULATES THE FLUX FOR SPECIFIED GROUP. IT IS CALLED	2DB 0100
C	BY OUTER AND CALLS IFLUXN.	2DB 0101
C		2DB 0102
C	IFLUXN	2DB 0103
C	SUBROUTINE TO NORMALIZE THE FLUXES BEFORE AND AFTER EACH	2DB 0104
C	INNER ITERATION. IT IS CALLED BY INNER.	2DB 0105
C		2DB 0106

C	CNNP	PERFORMS CONVERGENCE TESTS(S851) AND COMPUTES A NEW	2DB 0091
C		EIGENVALUE FOR SEARCH OPTIONS(S852). CNNP IS CALLED	2DB 0092
C		BY CALC AND CALLS ERRO2 AND CLEAR.	2DB 0093
C			2DB 0094
C	S8850	FINAL PRINT SUBROUTINE--PRINTS THE MONITOR LINE,	2DB 0095
C		GROUP FLUXES, TOTAL FLUX, POWER DENSITY, AND FISSION	2DB 0096
C		SOURCE RATE. IT IS CALLED BY CALC AND CALLS PRT, S8830,	2DB 0097
C		AND S8847.	2DB 0098
C			2DB 0099
C	S8847	SUBROUTINE TO COMPUTE AND PRINT GROUP TOTALS. S8847 IS	2DB 0100
C		CALLED BY S8850.	2DB 0101
C			2DB 0102
C	PRT	SUBROUTINE TO PRINT ANY IM*JM ARRAY. IT IS CALLED BY	2DB 0103
C		S8850.	2DB 0104
C			2DB 0105
C	GRAM	CALCULATES AND PRINTS THE MASS OF EACH MATERIAL IN EAFH	2DB 0106
C		ZONE AND THE ZONE VOLUME. IT IS CALLED BY CALC AND	2DB 0107
C		CALLS CLEAR.	2DB 0108
C			2DB 0109
C	INPB	SUBROUTINE TO READ AND PRINT THE INPUT BURNUP DATA. IT	2DB 0110
C		IS CALLED BY CALC.	2DB 0111
C			2DB 0112
C	AVERAG	AVERAG CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS	2DB 0113
C		SECTIONS, ABSORPTION CROSS SECTIONS, AND BREEDING RATIO.	2DB 0114
C		THE SUBROUTINE IS CALLED BY CALC.	2DB 0115
C			2DB 0116
C	MARCH	SUBROUTINE TO CALCULATE THE TIME DEPENDENT ISOTOPIC	2DB 0117
C		CONCENTRATIONS. MARCH IS CALLED BY CALC.	2DB 0118
C			2DB 0119
C		* * * * * INTERNAL VARIABLES * * * * *	2DB 0120
C			2DB 0121
C	NINP	INPUT TAPE	2DB 0122
C	NOUT	OUTPUT TAPE	2DB 0123
C	NCR1	CROSS SECTION TAPE	2DB 0124
C	NFLUX1	FLUX TAPE	2DB 0125
C	NSCRAT	SCRATCH TAPE	2DB 0126
C	ALA	LAMBDA	2DB 0127
C	B07	USED FOR INTERNAL COMPUTATION IN FISCAL AND INIT	2DB 0128
C	CNT	CONVERGENCE TRIGGER FOR LAMBDA	2DB 0129
C	CVT	CONVERGENCE TRIGGER	2DB 0130
C	DAY	BURNUP TIME IN DAYS	2DB 0131
C	DELT	LENGTH OF TIME STEP (DAYS)	2DB 0132
C	E0(IGP)	FISSION RATE	2DB 0133
C	E1(IGP)	FISSION SOURCE	2DB 0134
C	E2(IGP)	IN-SCATTER	2DB 0135
C	E3(IGP)	OUT-SCATTER	2DB 0136
C	E4(IGP)	ABSORPTIONS	2DB 0137
C	E5(IGP)	LEFT LEAKAGE	2DB 0138
C	E6(IGP)	RIGHT LEAKAGE	2DB 0139
C	E7(IGP)	TOP LEAKAGE	2DB 0140
C	E8(IGP)	BOTTOM LEAKAGE	2DB 0141
C	E9(IGP)	TOTAL LEAKAGE	2DB 0142
C	E01	TEMPORARY	2DB 0143
C	E02	TEMPORARY	2DB 0144
C	E03	TEMPORARY	2DB 0145
C	EQ	TEMPORARY FOR S852 (CNNP)	2DB 0146
C	EVP	PREVIOUS EIGENVALUE	2DB 0147
C	EVPP	EIGENVALUE FOR TWO ITERATIONS BACK	2DB 0148
C	FEF	ENERGY RELEASED PER FISSION (=215 MEV)	2DB 0149
C	GBAR	GROUP INDICATOR FOR TAPE MOTION IN S824 (OUTER)	2DB 0150
C	GLH	MAXIMUM TIME IN SECONDS	2DB 0151
C	IGEP	IGE + 1	2DB 0152

C	IGP	IGM + 1	2DB 0153
C	IGV	GROUP INDICATOR FOR INNER AND OUTER	2DB 0154
C	IHS	POSITION OF SIGMA SELF SCATTER	2DB 0155
C	IHT	POSITION OF SIGMA TRANSPORT	2DB 0156
C	II	INNER ITERATION COUNT FOR A SINGLE GROUP	2DB 0157
C	IMJM	IM*JM	2DB 0158
C	IP	IM + 1	2DB 0159
C	ITEMP	TEMPORARY	2DB 0160
C	ITEMP1	TEMPORARY	2DB 0161
C	ITEMP2	TEMPORARY	2DB 0162
C	ITL	CROSS SECTION TABLE LENGTH	2DB 0163
C	IZP	IZM + 1	2DB 0164
C	JP	JM + 1	2DB 0165
C	K07	TEMPORARY STORAGE FOR G07	2DB 0166
C	KPAGE	PAGE COUNTER FOR MONITOR PRINT	2DB 0167
C	LAP	LAMBDA FOR PREVIOUS EIGENVALUE	2DB 0168
C	LAPP	LAMBDA FOR TWO ITERATIONS BACK	2DB 0169
C	LAR	LAMBDA FOR PREVIOUS ITERATION	2DB 0170
C	LC	LOOP COUNT (TOTAL II IN A SINGLE OUTER ITERATION)	2DB 0171
C	ML	MCR + MTP	2DB 0172
C	NCON	NEG/ZERO/POS=TAKE TIME STEP OF DELT/END OF PROBLEM/	2DB 0173
C		TAKE TIME STEP OF DELT AND READ BURNUP DATA	2DB 0174
C	NGOTO	TEMPORARY	2DB 0175
C	NPRT	0/1=PARTIAL PRINT/FULL PRINT	2DB 0176
C	ORFP	ORF FOR 1 - LAMBDA LESS THAN 10*EPS	2DB 0177
C	P02	OUTER ITERATION COUNT	2DB 0178
C	PBAR	TEMPORARY	2DB 0179
C	SBAR	TEMPORARY	2DB 0180
C	SK7	SUM OF K7 OVER ALL GROUPS	2DB 0181
C	T06	0/1=NOT DELTA/DELTA CALCULATION	2DB 0182
C	T7	ALPHA/VELOCITY	2DB 0183
C	T11	PREVIOUS FISSION TOTAL	2DB 0184
C	TEMP	TEMPORARY	2DB 0185
C	TEMP1	TEMPORARY	2DB 0186
C	TEMP2	TEMPORARY	2DB 0187
C	TEMP3	TEMPORARY	2DB 0188
C	TEMP4	TEMPORARY	2DB 0189
C	TI	TIME	2DB 0190
C	TSD	(MW-SEC)/(FISSIONS)	2DB 0191
C	V11	TOTAL SOURCE FOR THE GROUP	2DB 0192
C			2DB 0193
C	*****	INPUT VARIABLES (CARDS 1-5) *****	2DB 0194
C			2DB 0195
C	ID(11)	IDENTIFICATION CARD	2DB 0196
C	MAXT	MAXIMUM TIME IN MINUTES	2DB 0197
C	A02	0/1=FLUX CALCULATION/ADJOINT CALCULATION	2DB 0198
C	I04	EIGENVALUE TYPE (1/2/3/4=KEFF/ALPHA/CONCENTRATION/	2DB 0199
C		DELTA)	2DB 0200
C	S02	PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA)	2DB 0201
C	IGM	NUMBER OF GROUPS	2DB 0202
C	NXCM	NUMBER OF DOWNSCATTERING TERMS	2DB 0203
C	MCR	NUMBER OF MATERIALS FROM CARDS	2DB 0204
C	MTP	NUMBER OF MATERIALS FROM TAPE	2DB 0205
C	M07	FLUX GUESS 0/1/2=NONE/X(R)*X(Z)/X(R,Z,E)	2DB 0206
C	D05	OUTER ITERATION MAX	2DB 0207
C	G07	INNER ITERATION MAX PER GROUP	2DB 0208
C	S04	II MAX PER GROUP FOR 1 - LAMBDA GREATER THAN 10*EPS	2DB 0209
C	NPUN	PUNCH FLUXES 0/1=N//YES	2DB 0210
C	IGE	GEOMETRY (0/1/2=X-Y/R-Z/R-THETA)	2DB 0211

C	IM	NUMBER OF RADIAL INTERVALS	2DB 0212
C	JM	NUMBER OF AXIAL INTERVALS	2DB 0213
C	IZM	NUMBER OF MATERIAL ZONES	2DB 0214
C	MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	2DB 0215
C	M01	NUMBER OF MIXTURE SPECIFICATIONS	2DB 0216
C	B01	LEFT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0217
C	B02	RIGHT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0218
C	B03	TOP BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0219
C	B04	BOTTOM BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0220
C	IZ	RADIAL ZONES (DELTA-OPTION ONLY)	2DB 0221
C	JZ	AXIAL ZONES (DELTA-OPTION ONLY)	2DB 0222
C	EV	FIRST EIGENVALUE GUESS	2DB 0223
C	EVM	EIGENVALUE MODIFIER	2DB 0224
C	S03	PARAMETRIC EIGENVALUE	2DB 0225
C	BUCK	BUCKLING	2DB 0226
C	LAL	LAMBDA LOWER	2DB 0227
C	LAH	LAMBDA UPPER	2DB 0228
C	EPS	EIGENVALUE CONVERGENCE CRITERIA	2DB 0229
C	EPSA	POINTWISE CONVERGENCE CRITERIA	2DB 0230
C	G06	INNER ITERATION TEST (IF ZERO, NO TEST)	2DB 0231
C	POD	PARAMETER OSCILLATION DAMPER	2DB 0232
C	ORF	OVER-RELAXATION FACTOR	2DB 0233
C	S01	NEG/POS=POWER (MWT)/NEUTRON SOURCE RATE	2DB 0234
C			2DB 0235
C	* * * * *	SUBSCRIPTED VARIABLES * * * * *	2DB 0236
C			2DB 0237
C	ATW(ML)	MATERIAL ATOMIC WEIGHT	2DB 0238
C	HOLN(ML)	MATERIAL NAME	2DB 0239
C	ALAM(ML)	DECAY CONSTANT (DAYS-1)	2DB 0240
C	C0(ITL,MT)	CROSS SECTION ARRAY FOR CURRENT GROUP	2DB 0241
C	N0(IM,JM)	TOTAL FLUX (OLD)	2DB 0242
C	N2(IM,JM)	TOTAL FLUX (NEW)	2DB 0243
C	A0(IP)	RADIAL AREA ELEMENT	2DB 0244
C	A1(IM)	AXIAL AREA ELEMENT	2DB 0245
C	F0(IM,JM)	FISSIONS (OLD)	2DB 0246
C	F2(IM,JM)	FISSIONS (NEW)	2DB 0247
C	I0(M01)	MIX NUMBER	2DB 0248
C	I1(M01)	MATERIAL NUMBER FOR MIX	2DB 0249
C	I2(M01)	MATERIAL DENSITY	2DB 0250
C	K6(IGM)	FISSION SPECTRUM (EFFECTIVE)	2DB 0251
C	K7(IGM)	FISSION SPECTRUM (INPUT)	2DB 0252
C	M0(IM,JM)	ZONE NUMBERS	2DB 0253
C	M2(IZM)	MATERIAL NUMBERS BY ZONE	2DB 0254
C	R0(IP)	INITIAL RADII	2DB 0255
C	R1(IP)	CURRENT RADII	2DB 0256
C	R2(IM)	RADIAL ZONE NUMBERS (DELTA CALCULATION ONLY)	2DB 0257
C	R3(IZ)	RADIAL ZONE MODIFIERS (DELTA CALCULATION ONLY)	2DB 0258
C	R4(IM)	AVERAGE RADII	2DB 0259
C	R5(IM)	DELTA-R	2DB 0260
C	S2(IM,JM)	FIXED SOURCE	2DB 0261
C	V0(IM,JM)	VOLUME ELEMENTS	2DB 0262
C	V7(IGM)	NEUTRON VELOCITIES	2DB 0263
C	Z0(JP)	INITIAL AXII	2DB 0264
C	Z1(JP)	CURRENT AXII	2DB 0265
C	Z2(JM)	AXIAL ZONE NUMBERS (DELTA CALCULATION ONLY)	2DB 0266
C	Z3(JZ)	AXIAL ZONE MODIFIERS (DELTA CALCULATION ONLY)	2DB 0267
C	Z4(JM)	AVERAGE AXII	2DB 0268
C	Z5(JM)	DELTA-Z	2DB 0269
C	CXS(IM,JM,3)	CONSTANTS INVOLVING CROSS SECTIONS FOR FLUX CALC.	2DB 0270
C	VOL(IZM)	ZONE VOLUME (LITERS)	2DB 0271
C	MASS(ML,IZM)	MATERIAL INVENTORY IN EACH ZONE	2DB 0272
C	MATN(ML)	MATERIAL NUMBER FOR BURNABLE ISOTOPES	2DB 0273

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C      NBR(ML)          0/1/2=NO EFFECT/FERTILE/FISSILE ISOTOPE          2DB 0274
C      LD(ML)           SOURCE ISOTOPE FOR DECAY                        2DB 0275
C      LCN(ML,2)        SOURCE ISOTOPES FOR CAPTURE                     2DB 0276
C      LFN(ML,7)        SOURCE ISOTOPES FOR FISSION                     2DB 0277
C      PHIB(IZM)        ZONE AVERAGED FLUX                             2DB 0278
C      AXS(ML,IZM)      SPECTRUM AVERAGED ABSORPTION CROSS SECTION     2DB 0279
C      FXS(ML,IZM)      SPECTRUM AVERAGED FISSION CROSS SECTION        2DB 0280
C      MASSP(ML,IZM)    MATERIAL INVENTORY IN EACH ZONE (PREVIOUS)     2DB 0281
C      CXR(JM)          CONSTANTS FOR RIGHT BOUNDARY                   2DB 0282
C      CXT(IM)          CONSTANTS FOR TOP BOUNDARY                       2DB 0283
C                                                                2DB 0284
C      INCLUDE ABC                                                  2DB 0285
C      COMMON A(25000)                                             2DB 0286
C      DIMENSION JLPTAB(21)                                       2DB 0287
C      CALL SETIO(9,2)                                             2DB 0288
C      CALL SETIO(10,1)                                           2DB 0289
C      CALL SETDR(3,525000,52000,JLPTAB)                          2DB 0290
C      CALL SETDR(4,577000,52000,JLPTAB(8))                      2DB 0291
C      CALL SETDR(6,629000,500000,JLPTAB(15))                    2DB 0292
1      CONTINUE                                                  2DB 0293
      REWIND 3                                                    2DB 0294
      REWIND 4                                                    2DB 0295
      REWIND 6                                                    2DB 0296
      CALL ETIME                                                  2DB 0297
      CALL INP                                                    2DB 0298
102     CALL INIT(A(LK6), A(LK7), A(LI0), A(LI1), A(LI2), A(LM0), A(LM2), 2DB 0299
1         A(LN0), A(LR0), A(LR1), A(LR2), A(LR3), A(LR4), A(LR5), 2DB 0300
2         A(LZ0), A(LZ1), A(LZ2), A(LZ3), A(LZ4), A(LZ5), A(LA0), 2DB 0301
3         A(LA1), A(LF0), A(LC0), A(LV0), ITL, IM, A(LV7), 2DB 0302
4         JM, MT) 2DB 0303
      CALL FISCAL (A(LN0),A(LF0),A(LV0),A(LC0),A(LK6), 2DB 0304
2         A(LM0),A(LM2),ITL,MT) 2DB 0305
C      CALL MONITOR PRINT 2DB 0306
101     CALL S8830 2DB 0307
      GO TO (100, 106, 106, 107), NGOTO 2DB 0308
106     CALL ERRO2(6H*MONPR,106,1) 2DB 0309
C      PERFORM AN OUTER ITERATION 2DB 0310
107     CALL OUTER( A(LA0), A(LA1), A(LC0), A(LF0), A(LK6), 2DB 0311
1         A(LM0), A(LM2), A(LN0), A(LN2), 2DB 0312
2         A(LS2), A(LV0), A(LV7), A(LZ5), 2DB 0313
3         A(LF2), ITL, MT, A(LCXS), IM, JM, A(LR5), A(LR4), 2DB 0314
4         A(LZ4), A(LCXR), A(LCXT)) 2DB 0315
C      PERFORM FISSION CALCULATION 2DB 0316
      CALL FISCAL (A(LN0),A(LF0),A(LV0),A(LC0),A(LK6), 2DB 0317
2         A(LM0),A(LM2),ITL,MT) 2DB 0318
C      PERFORM CONVERGENCE AND NEW PARAMETER CALCULATIONS 2DB 0319
      CALL CNNP (A(LF2), A(LK6)) 2DB 0320
      GO TO (100, 101, 102), NGOTO 2DB 0321
C      100/101/102=FINAL PRINT/MONITOR PRINT/SEARCH CALCULATION 2DB 0322
100     CALL S8850(A(LF2),A(LN2),A(LR1),A(LZ1),A(LR4),A(LZ4), 2DB 0323
1         IM,JM,A(LN2),A(LC0),A(LN0),A(LM0),A(LM2),A(LF0),ITL,MT) 2DB 0324
      CALL GRAM(A(LMASS), A(LVOL), A(LATW), A(LHOLN), IM, JM, 2DB 0325
1         A(LM0), A(LM2), A(LV0), A(LI0), A(LI1), A(LI2), ML) 2DB 0326
      CALL INPB(A(LMATN),A(LNBR),A(LLD),A(LLCN),A(LLFN),A(LALAM), 2DB 0327
1         A(LHOLN),ML) 2DB 0328
      IF(NCON) 170,1,170 2DB 0329
170     CALL AVERAG(A(LPHIB),A(LAXS),A(LFXS),A(LMATN),A(LMASS),A(LATW), 2DB 0330
1         A(LVOL),A(LC0),A(LN2),A(LM0),A(LV0),A(LHOLN),ML,ITL, 2DB 0331
2         A(LNBR)) 2DB 0332

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CALL MARCH(A(LPHIB),A(LMATN),A(LFXS),A(LXSS),A(LVOL),A(LMASS),	2DB 0333
1 A(LMASSP),A(LALAM),A(LLD),A(LLCN),A(LLFN),ML,	2DB 0334
2 A(LI0),A(LI1),A(LI2),A(LM2))	2DB 0335
GO TO 102	2DB 0336
END	2DB 0337

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-ITC FOR INP,INP                                2DB 0338
  SUBROUTINE INP                                2DB 0339
  INCLUDE ABC                                    2DB 0340
  COMMON A(25000)                                2DB 0341
C  THIS SUBROUTINE CONTROLS THE READING OF ALL INPUT DATA  2DB 0342
  NCR1 = 3                                        2DB 0343
  NSCRAT = 4                                    2DB 0344
  NFLUX1 = 6                                    2DB 0345
  NOUT = 9                                       2DB 0346
  NINP = 10                                     2DB 0347
  WRITE (NOUT,5)                                2DB 0348
5  FORMAT (1H1)                                  2DB 0349
  WRITE(NOUT, 10)                                2DB 0350
10  FORMAT(42X,35H * * * * 2 D B * * * * /// )  2DB 0351
  READ(NINP,20) (ID(I),I=1,11), MAXT            2DB 0352
20  FORMAT(11A6,I6)                              2DB 0353
  WRITE(NOUT,30) (ID(I),I=1,11), MAXT           2DB 0354
30  FORMAT(10X,1H ,11A6,I6/)                    2DB 0355
  READ(NINP,40) A02, I04, S02, IGM, NXCM, MCR, MTP, M07, D05,  2DB 0356
1  G07, S04, NPUN, IGE, IM, JM, IZM, MT, M01, B01, B02, B03, B04,  2DB 0357
2  IZ, JZ                                       2DB 0358
40  FORMAT(12I6)                                2DB 0359
  WRITE(NOUT,60) A02, I04, S02, IGM, NXCM, MCR  2DB 0360
60  FORMAT(
192H A02      0/1=REGULAR CALCULATION/ADJOINT CALCULATION  2DB 0362
2          I9/                                           2DB 0363
392H I04      EIGENVALUE TYPE (1/2/3/4=KEFF/ALPHA/CONCENTRATION/ 2DB 0364
4DELTA)      I9/                                           2DB 0365
592H S02      PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA) 2DB 0366
6          I9/                                           2DB 0367
792H IGM      NUMBER OF GROUPS                            2DB 0368
8          I9/                                           2DB 0369
992H NXCM     NUMBER OF DOWNSCATTERING TERMS              2DB 0370
1          I9/                                           2DB 0371
292H MCR      NUMBER OF MATERIALS FROM CARDS              2DB 0372
3          I9/                                           2DB 0373
  WRITE(NOUT,70) MTP, M07, D05, G07, S04, NPUN  2DB 0374
70  FORMAT(
192H MTP      NUMBER OF MATERIALS FROM TAPE              2DB 0375
2          I9/                                           2DB 0376
392H M07      FLUX GUESS 0/1/2=NONE/X(R)*X(Z)/X(R,Z,E)    2DB 0377
4          I9/                                           2DB 0378
592H D05      OUTER ITERATION MAX                        2DB 0379
6          I9/                                           2DB 0380
792H G07      INNER ITERATION MAX PER GROUP              2DB 0382
8          I9/                                           2DB 0383
992H S04      II MAX PER GROUP FOR 1 - LAMBDA GREATER THAN 10*EPS 2DB 0384
1          I9/                                           2DB 0385
292H NPUN     PUNCH FLUXES 0/1=NO/YES                    2DB 0386
3          I9/                                           2DB 0387
  WRITE(NOUT,80) IGE, IM, JM, IZM, MT, M01        2DB 0388
80  FORMAT(
192H IGE      GEOMETRY (0/1/2=X-Y/R-Z/R-THETA)           2DB 0390
2          I9/                                           2DB 0391
392H IM       NUMBER OF RADIAL INTERVALS                  2DB 0392
4          I9/                                           2DB 0393
592H JM       NUMBER OF AXIAL INTERVALS                   2DB 0394
6          I9/                                           2DB 0395
792H IZM      NUMBER OF MATERIAL ZONES                   2DB 0396

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      8          19/
992H   MT      TOTAL NUMBER OF MATERIALS INCLUDING MIXES      2DB 0397
      1          19/
      2          19/
992H   M01     NUMBER OF MIXTURE SPECIFICATIONS                2DB 0399
      3          19/
      4          19/
      5 WRITE(NOUT,90) B01, B02, B03, B04, IZ, JZ              2DB 0400
90     6          19/
      7 FORMAT(
      8 192H   B01     LEFT   BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE) 2DB 0401
      9 2          19/
     10 392H   B02     RIGHT  BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE) 2DB 0402
     11 4          19/
     12 592H   B03     TOP    BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE) 2DB 0403
     13 6          19/
     14 792H   B04     BOTTOM BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE) 2DB 0404
     15 8          19/
     16 992H   IZ      RADIAL ZONES (DELTA-OPTION ONLY)           2DB 0405
     17 1          19/
     18 292H   JZ      AXIAL  ZONES (DELTA-OPTION ONLY)           2DB 0406
     19 3          19/
     20 4          19/
     21 READ(NINP,100) EV, EVM, S03, BUCK, LAL, LAH, EPS, EPSA, G06, 2DB 0407
     22 1          19/
     23 2          19/
     24 3          19/
     25 4          19/
     26 5          19/
     27 6          19/
     28 7          19/
     29 8          19/
     30 9          19/
     31 10         19/
     32 11        19/
     33 12        19/
     34 13        19/
     35 14        19/
     36 15        19/
     37 16        19/
     38 17        19/
     39 18        19/
     40 19        19/
     41 20        19/
     42 21        19/
     43 22        19/
     44 23        19/
     45 24        19/
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     49 28        19/
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IHS = 5	2DB 0459
ITL = NXCM + 5	2DB 0460
IHT = 4	2DB 0461
IZP = IZM + 1	2DB 0462
IP = IM + 1	2DB 0463
JP = JM + 1	2DB 0464
ML = MCR + MTP	2DB 0465
IGP = IGM + 1	2DB 0466
IGEP = IGE + 1	2DB 0467
IMJM = IM*JM	2DB 0468
EQ = .0	2DB 0469
LAP = .0	2DB 0470
LAPP = .0	2DB 0471
DAY = 0.0	2DB 0472
CVT = 0	2DB 0473
CNT = 0	2DB 0474
NCON = 0	2DB 0475
NPRT = 1	2DB 0476
T06 = 0	2DB 0477
IF(I04-4) 310, 300, 310	2DB 0478
300 T06 = 1	2DB 0479
310 CONTINUE	2DB 0480
K07 = G07	2DB 0481
G07 = S04	2DB 0482
ORFP = .5*(ORF - 1.0) + 1.0	2DB 0483
C COMPUTE DIMENSION POINTERS	2DB 0484
LATW = 1	2DB 0485
LHOLN = LATW + ML	2DB 0486
LALAM = LHOLN + ML	2DB 0487
LCO = LALAM + ML	2DB 0488
LN0 = LCO + ITL*MT	2DB 0489
LN2 = LN0 + IMJM	2DB 0490
LA0 = LN2 + IMJM	2DB 0491
LA1 = LA0 + IP	2DB 0492
LF0 = LA1 + IM	2DB 0493
LF2 = LF0 + IMJM	2DB 0494
LI0 = LF2 + IMJM	2DB 0495
LI1 = LI0 + M01	2DB 0496
LI2 = LI1 + M01	2DB 0497
LK6 = LI2 + M01	2DB 0498
LK7 = LK6 + IGM	2DB 0499
LM0 = LK7 + IGM	2DB 0500
LM2 = LM0 + IMJM	2DB 0501
LR0 = LM2 + IZM	2DB 0502
LR1 = LR0 + IP	2DB 0503
LR2 = LR1 + IP	2DB 0504
LR3 = LR2 + T06*IM	2DB 0505
LR4 = LR3 + T06*IZ	2DB 0506
LR5 = LR4 + IM	2DB 0507
LS2 = LR5 + IM	2DB 0508
LV0 = LS2 + IMJM	2DB 0509
LV7 = LV0 + IMJM	2DB 0510
LZ0 = LV7 + IGM	2DB 0511
LZ1 = LZ0 + JP	2DB 0512
LZ2 = LZ1 + JP	2DB 0513
LZ3 = LZ2 + JM*T06	2DB 0514
LZ4 = LZ3 + JZ*T06	2DB 0515
LZ5 = LZ4 + JM	2DB 0516
LCXS = LZ5 + JM	2DB 0517

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LVOL = LCXS + IMJM*3
LMASS = LVOL + IZM
LMATN = LMASS + ML*IZM
LNBR = LMATN + ML
LLD = LNBR + ML
LLCN = LLD + ML
LLFN = LLCN + ML*2
LPHIB = LLFN + ML*7
LAXS = LPHIB + IZM
LFXS = LAXS + ML*IZM
LMASSP = LFXS + ML*IZM
LCXR = LMASSP + ML*IZM
LCXT = LCXR + JM
LAST = LCXT + IM
WRITE(NOUT,320) LAST
320 FORMAT(5H LAST,16)
C READ CROSS SECTIONS AND WRITE CROSS SECTION TAPE
CALL S860(A(LNO),A(LCO),ITL,IGM,MT,A(LATW),A(LHOLN),A(LALAM))
C READ FLUXES AND WRITE FLUX TAPE
CALL S862(A(LNO),A(LRO),A(LZO))
WRITE(NOUT,330)
330 FORMAT(51H MESH BOUNDARIES (R0/Z0=RADIAL POINTS/AXIAL POINTS))
C READ RADIAL INTERVALS
CALL REAG2(6H R0,A(LRO),IP)
C READ AXIAL INTERVALS
CALL REAG2(6H Z0,A(LZO),JP)
C READ ZONE NUMBERS
WRITE(NOUT,340)
340 FORMAT(30H ZONE NUMBERS BY MESH INTERVAL)
CALL REAI2(6H M0,A(LM0),IMJM)
C READ MATERIAL NUMBERS
WRITE(NOUT,350)
350 FORMAT(25H MATERIAL NUMBERS BY ZONE)
CALL REAI2(6H M2,A(LM2),IZM)
C READ FISSION FRACTIONS
WRITE(NOUT,360)
360 FORMAT(17H FISSION SPECTRUM)
CALL REAG2(6H K7,A(LK7),IGM)
C READ VELOCITIES
WRITE(NOUT,370)
370 FORMAT(17H NEUTRON VELOCITY)
CALL REAG2(6H V7,A(LV7),IGM)
IF(M01) 400, 400, 380
380 WRITE(NOUT,390)
390 FORMAT(82H MIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER
1 FOR MIX/MATERIAL DENSITY))
CALL REAI2(6H I0,A(LI0),M01)
CALL REAI2(6H I1,A(LI1),M01)
CALL REAG2(6H I2,A(LI2),M01)
400 CONTINUE
C CHECK FOR DELTA CALCULATION
IF(I04 - 4) 440, 410, 440
410 WRITE(NOUT,420)
420 FORMAT(85H DELTA OPTION DATA (R2/Z2/R3/Z3=RADIAL/AXIAL ZONE NOS.
1/RADIAL/AXIAL ZONE MODIFIERS))
CALL REAI2(6H R2,A(LR2),IM)
CALL REAG2(6H R3,A(LR3),IZ)
CALL REAI2(6H Z2,A(LZ2),JM)
CALL REAG2(6H Z3,A(LZ3),JZ)
440 CONTINUE
C END OF INPUT DATA
CALL MAPR(A(LM0),A(LM2),IM,JM,A(LCO))

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	IF(LAST-25000) 470, 470, 450	2DB 0580
450	WRITE(NOUT,460)	2DB 0581
460	FORMAT(26H PROGRAM CAPACITY EXCEEDED)	2DB 0582
	STOP	2DB 0583
470	RETURN	2DB 0584
	END	2DB 0585

-IT FOR	ERRO2,ERRO2	2DB 0586
	SUBROUTINE ERRO2(HOL,JSUBR,I)	2DB 0587
	COMMON NINP ,NOUT ,NCR1 ,NFLUX1,NSCRAT	2DB 0588
	WRITE (NOUT,1) HOL,JSUBR	2DB 0589
1	FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)	2DB 0590
	GO TO (3,4),I	2DB 0591
3	STOP	2DB 0592
4	RETURN	2DB 0593
	END	2DB 0594

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-ITC FOR S860,S860                                2DB 0595
  SUBROUTINE S860 (C,C0,JTL,JGM,JMT,ATW,HOLN,ALAM)  2DB 0596
    INCLUDE ABC                                    2DB 0597
    DIMENSION C(JTL,JGM,JMT), C0(JTL,JMT), ATW(1), HOLN(1), ALAM(1) 2DB 0598
    DIMENSION AA(9)                                2DB 0599
  C THIS SUBROUTINE READS CROSS SECTIONS FROM CARDS, PERFORMS 2DB 0600
  C ADJOINT REVERSALS IF REQUIRED, AND WRITES CROSS SECTION TAPE 2DB 0601
    WRITE(NOUT,5) (ID(I), I=1,11)                  2DB 0602
  5  FORMAT(1H1,11A6,///)                           2DB 0603
    IF(MCR) 160, 160, 10                            2DB 0604
  10  WRITE (NOUT, 20 )                               2DB 0605
  20  FORMAT (38H THE FOLLOWING NUCLIDES ARE FROM CARDS/) 2DB 0606
    DO 50 I=1,MCR                                    2DB 0607
    READ(NINP, 30) HOLN(I), ATW(I), ALAM(I), (AA(J), J=1,9) 2DB 0608
    ALAM(I) = ALAM(I)/(24.*3600.)                    2DB 0609
  30  FORMAT(A6, 2E6.2, 9A6)                          2DB 0610
    WRITE(NOUT, 40) I, HOLN(I), (AA(J), J=1,9)        2DB 0611
  40  FORMAT(I3, 6X, A6, 6X, 9A6)                     2DB 0612
    DO 50 IIG=1,IGM                                  2DB 0613
  50  READ(NINP, 60) (C(L,IIG,I),L=1,ITL)            2DB 0614
  60  FORMAT(6E12.5)                                  2DB 0615
  C CHECK ON CROSS SECTION CONSISTENCY AND ORDER      2DB 0616
    DO 140 J=1,MCR                                    2DB 0617
    DO 140 I=1,IGM                                    2DB 0618
    G = C(2,I,J) + C(5,I,J)                          2DB 0619
    DO 110 K = 1, NXCM                                2DB 0620
    KK = I + K                                         2DB 0621
    M = 5 + K                                         2DB 0622
    IF(KK - IGM) 100, 100, 110                       2DB 0623
  100  G = G + C(M,KK,J)                             2DB 0624
  110  CONTINUE                                       2DB 0625
    IF(ABS((G - C(4,I,J))/C(4,I,J)) - .01) 135, 120, 120 2DB 0626
  120  WRITE(NOUT,130) J, I                          2DB 0627
  130  FORMAT(1H /,16H CHECK MATERIAL 12,5X, 7H GROUP 12) 2DB 0628
    CALL EXIT                                         2DB 0629
  135  IF(ABS((G - C(4,I,J))/C(4,I,J)) - .0001) 140, 138, 138 2DB 0630
  138  WRITE(NOUT,130) J, I                          2DB 0631
  140  CONTINUE                                       2DB 0632
  160  CONTINUE                                       2DB 0633
  C 160 CALL RECS2                                    2DB 0634
  C A02=0/1=FLUX CALCULATION/ADJOINT CALCULATION    2DB 0635
    IF(A02) 170, 280, 170                            2DB 0636
  170  DO 190 IIG=1,IGM                              2DB 0637
    IGBAR=IGM-IIG+1                                   2DB 0638
    DO 180 M=1,MT                                     2DB 0639
    DO 180 L = 1,IHS                                  2DB 0640
    TEMP=C(L,IIG,M)                                   2DB 0641
    C(L,IIG,M)=C(L,IGBAR,M)                          2DB 0642
  180  C(L,IGBAR,M)=TEMP                             2DB 0643
    IF (IGBAR - IIG -1) 200, 200, 190                2DB 0644
  190  CONTINUE                                       2DB 0645
  200  CONTINUE                                       2DB 0646
    KK = ITL - IHS                                    2DB 0647
    IF (KK) 280, 280, 210                             2DB 0648
  210  CONTINUE                                       2DB 0649
    DO 240 M = 1,MT                                   2DB 0650
    DO 240 IIG = 1,IGM                                2DB 0651
    IGBAR = IGM - IIG + 1                             2DB 0652
    DO 240 L = 1,KK                                  2DB 0653

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	IF (L - IIG) 220, 240, 240	2DB 0654
220	I = L + IHS	2DB 0655
	ITEMP = IGBAR + L	2DB 0656
	IF (IIG - ITEMP) 230, 230, 240	2DB 0657
230	TEMP = C(I, IIG, M)	2DB 0658
	C(I, IIG, M) = C(I, ITEMP, M)	2DB 0659
	C(I, ITEMP, M) = TEMP	2DB 0660
240	CONTINUE	2DB 0661
C	WRITE CROSS SECTION TAPE	2DB 0662
280	DO 300 IIG=1, IGM	2DB 0663
	DO 290 M=1, MT	2DB 0664
	DO 290 L=1, ITL	2DB 0665
290	CO(L, M)=C(L, IIG, M)	2DB 0666
300	WRITE (NCR1) ((CO(L, M), L=1, ITL), M=1, MT)	2DB 0667
	REWIND NCR1	2DB 0668
	RETURN	2DB 0669
	END	2DB 0670

-ITC	FOR S862,S862	2DB 0671
	SUBROUTINE S862(N0,RF,ZF)	2DB 0672
	INCLUDE ABC	2DB 0673
	DIMENSION NO(1), RF(1), ZF(1)	2DB 0674
C	THIS SUBROUTINE READS THE INPUT FLUXES AND PREPARES A FLUX TAPE	2DB 0675
	WRITE(NOUT,5)	2DB 0676
5	FORMAT(1H1)	2DB 0677
C	M07=0/1/2=NO FLUX INPUT/X(R)*X(Z)/X(R,Z,E)	2DB 0678
	KK = M07 + 1	2DB 0679
	DO 1000 IIG = 1, IGM	2DB 0680
	GO TO (50, 60, 70), KK	2DB 0681
50	DO 59 I=1, IM	2DB 0682
	DO 59 J = 1, JM	2DB 0683
	ITEMP = (J - 1)*IM + I	2DB 0684
59	NO(ITEMP) = 1.0	2DB 0685
	GO TO 200	2DB 0686
60	IF(IIG - 1) 62, 62, 64	2DB 0687
62	WRITE(NOUT,63)	2DB 0688
63	FORMAT(55H0FLUX GUESS (RF/ZF=TOTAL RADIAL FLUX/TOTAL AXIAL FLUX))	2DB 0689
	CALL REAG2(6H RF,RF,IM)	2DB 0690
	CALL REAG2(6H ZF,ZF,JM)	2DB 0691
64	DO 69 I = 1, IM	2DB 0692
	DO 69 J = 1, JM	2DB 0693
	ITEMP = (J - 1)*IM + I	2DB 0694
69	NO(ITEMP) = RF(I)*ZF(J)	2DB 0695
	GO TO 200	2DB 0696
70	READ(NINP,100) (NO(I), I=1, IMJM)	2DB 0697
100	FORMAT(6E12.6)	2DB 0698
200	WRITE(NFLUX1) (NO(I), I=1, IMJM)	2DB 0699
1000	CONTINUE	2DB 0700
	REWIND NFLUX1	2DB 0701
	RETURN	2DB 0702
	END	2DB 0703

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-IT  FOR REAG2,REAG2                                2DB 0704
      SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)           2DB 0705
      DIMENSION ARRAY(1),V(12),K(12),IN(12)         2DB 0706
      COMMON  NINP ,NOUT ,NCR1 ,NFLUX1,NSCRAT       2DB 0707
      JFLAG=0                                       2DB 0708
      J=1                                           2DB 0709
10    IF(JFLAG)20,40,20                             2DB 0710
20    DO 30 JJ=1,6                                   2DB 0711
      K(JJ)=K(JJ+6)                                2DB 0712
      IN(JJ)=IN(JJ+6)                              2DB 0713
30    V(JJ)=V(JJ+6)                                2DB 0714
      JFLAG=0                                       2DB 0715
      GO TO 60                                     2DB 0716
40    READ (NINP,50) (K(I),IN(I),V(I),I=1,6)       2DB 0717
50    FORMAT(6(I1,I2,E9.4))                        2DB 0718
60    DO 140 I=1,6                                  2DB 0719
      L=K(I)+1                                       2DB 0720
      GO TO (70,80,100,150),L                      2DB 0721
C     NO MODIFICATION                             2DB 0722
70    ARRAY(J)=V(I)                                 2DB 0723
      J=J+1                                         2DB 0724
      GO TO 140                                     2DB 0725
C     REPEAT                                       2DB 0726
80    L=IN(I)                                       2DB 0727
      DO 90 M=1,L                                  2DB 0728
      ARRAY(J)=V(I)                                2DB 0729
      J=J+1                                         2DB 0730
90    CONTINUE                                     2DB 0731
      GO TO 140                                     2DB 0732
C     INTERPOLATE                                 2DB 0733
100   IF(I-6) 120,110,110                          2DB 0734
110   READ (NINP,50) (K(JJ),IN(JJ),V(JJ),JJ=7,12) 2DB 0735
      JFLAG=1                                       2DB 0736
120   L=IN(I)+1                                     2DB 0737
      DEL=(V(I+1)-V(I))/FLOAT (L)                 2DB 0738
      DO 130 M=1,L                                 2DB 0739
      ARRAY(J)=V(I)+DEL*FLOAT (M-1)               2DB 0740
      J=J+1                                         2DB 0741
130   CONTINUE                                     2DB 0742
140   CONTINUE                                     2DB 0743
      GO TO 10                                     2DB 0744
C     TERMINATE                                   2DB 0745
150   J=J-1                                         2DB 0746
      WRITE (NOUT,160) HOLL,J , ( ARRAY(I),I=1,J) 2DB 0747
      IF(J -NCOUNT)170,180,170                     2DB 0748
160   FORMAT(6X,A6,I6/(10E12.5))                  2DB 0749
170   CALL ERRO2( 6H**REAG,170,1)                 2DB 0750
180   RETURN                                       2DB 0751
      END                                           2DB 0752

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-IT	FOR REAI2,REAI2	2DB 0753
	SUBROUTINE REAI2(HOLL,IARRAY,NCOUNT)	2DB 0754
	DIMENSION IARRAY(1),IV(6),K(6),IN(6)	2DB 0755
	COMMON NINP ,NOUT ,NCR1 ,NFLUX1,NSCRAT	2DB 0756
	J=1	2DB 0757
10	READ(NINP,20) (K(I),IN(I),IV(I),I=1,6)	2DB 0758
20	FORMAT(6(I1,I2,I9))	2DB 0759
	DO 70 I=1,6	2DB 0760
	L=K(I)+1	2DB 0761
	GO TO (30,40,60,80),L	2DB 0762
C	NO MODIFICATION	2DB 0763
30	IARRAY(J)=IV(I)	2DB 0764
	J=J+1	2DB 0765
	GO TO 70	2DB 0766
C	REPEAT	2DB 0767
40	L=IN(I)	2DB 0768
	DO 50 M=1,L	2DB 0769
	IARRAY(J)=IV(I)	2DB 0770
	J=J+1	2DB 0771
50	CONTINUE	2DB 0772
	GO TO 70	2DB 0773
C	INTERPOLATE	2DB 0774
60	CALL ERRO2(6H REAI,60,1)	2DB 0775
70	CONTINUE	2DB 0776
	GO TO 10	2DB 0777
C	TERMINATE	2DB 0778
80	J=J-1	2DB 0779
	WRITE (NOUT,90) HOLL,J , (IARRAY(I),I=1,J)	2DB 0780
	IF(J -NCOUNT)100,110,100	2DB 0781
90	FORMAT(6X,A6,I6/(10I12))	2DB 0782
100	CALL ERRO2(6H**REAI,100,1)	2DB 0783
110	RETURN	2DB 0784
	END	2DB 0785

-ITC FOR MAPR,MAPR	2DB 0786
SUBROUTINE MAPR (M0,M2, JIM,JJM, K)	2DB 0787
INCLUDE ABC	2DB 0788
DIMENSION M0(JIM,JJM), M2(1), K(1)	2DB 0789
C PRODUCE A PICTURE PRINT BY ZONE AND MATERIAL	2DB 0790
WRITE (NOUT,6) (ID(I), I = 1, 11)	2DB 0791
6 FORMAT(1H1,11A6///)	2DB 0792
3 DO 5 JJ=1,JM	2DB 0793
J=JM-JJ+1	2DB 0794
5 WRITE (NOUT,4) (M0(I,J),I=1,IM)	2DB 0795
4 FORMAT(5H ,55I2)	2DB 0796
WRITE(NOUT,15)	2DB 0797
15 FORMAT(2H A/2H X/2H I/2H A/2H L//8H RADIAL)	2DB 0798
WRITE (NOUT,6) (ID(I), I = 1, 11)	2DB 0799
DO 10 JJ=1,JM	2DB 0800
J=JM-JJ+1	2DB 0801
DO 11 L=1,IM	2DB 0802
N=M0(L,J)	2DB 0803
11 K(L)=IABS (M2(N))	2DB 0804
10 WRITE (NOUT,4) (K(L),L=1,IM)	2DB 0805
WRITE(NOUT,15)	2DB 0806
RETURN	2DB 0807
END	2DB 0808

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-ITC FOR INIT,INIT                                2DB 0809
  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,    2DB 0810
2      F0, C0, V0, JTL,JIM, V7,JJM,JMT)            2DB 0811
  INCLUDE ABC                                       2DB 0812
  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),    2DB 0813
2      Z3(1), Z4(1), Z5(1), A0(1), A1(1), C0(JTL,JMT),    2DB 0814
3      V0(JIM,JJM), M0(1), M2(1), N0(1), F0(1), V7(1)    2DB 0815
  IF (P02) 2, 1, 2                                2DB 0816
1  WRITE(NOUT,10) DAY                               2DB 0817
10  FORMAT(1H1,30X,11H T I M E =F8.3,8H D A Y S///)    2DB 0818
2  CONTINUE                                         2DB 0819
C AR S806 ADJOINT REVERSALS                         2DB 0820
  IF(A02)106,9906,106                             2DB 0821
106 IF(P02)9906,206,9906                          2DB 0822
206 IF(NCON) 9906,2006,9906                        2DB 0823
2006 IIG=1                                           2DB 0824
  IGBAR=IGM                                          2DB 0825
306 TEMP=K7(IIG)                                    2DB 0826
  K7(IIG)=K7(IGBAR)                                2DB 0827
  K7(IGBAR)=TEMP                                    2DB 0828
  TEMP=V7(IIG)                                       2DB 0829
  V7(IIG)=V7(IGBAR)                                 2DB 0830
  V7(IGBAR)=TEMP                                    2DB 0831
  IIG=IIG+1                                          2DB 0832
  IGBAR=IGBAR-1                                     2DB 0833
  IF(IIG-IGBAR)306,9906,9906                       2DB 0834
9906 CONTINUE                                       2DB 0835
C                                                    2DB 0836
C MX S807 MIX CROSS-SECTIONS                       2DB 0837
  B07=1.0                                           0 0
  IF(P02)107,207,107                               2DB 0841
107 IF(I04-3)9907,307,9907                         2DB 0842
207 IF(M01) 2109, 2109, 209                       2DB 0843
209 WRITE(NOUT, 208) (J, IO(J), I1(J), I2(J), J = 1, M01) 2DB 0844
208 FORMAT(1H0,2X, 16H MIXTURE NUMBER ,18H MIX COMMAND 2DB 0845
124H MATERIAL ATOMIC DENSITY//(I3,1X,I8,8X,I8,8X,E20.8)) 2DB 0846
  IF(NPRT) 307,307,2109                           2DB 0847
2109 WRITE (NOUT,407)                               2DB 0848
407 FORMAT(/19H1CROSS-SECTION EDIT)               2DB 0849
307 REWIND NCR1                                     2DB 0850
  DO 2607 IIG=1,IGM                                2DB 0851
  READ (NCR1) ((C0(I,J),I=1,ITL),J=1,MT)          2DB 0852
  IF(M01)707,2207,707                              2DB 0853
707 DO 1907 M=1,M01                                2DB 0854
  IF(I0(M)-MT)7707,7707,7807                      2DB 0855
7807 CALL ERRO2(6H**S807,7807,1)                 2DB 0856
7707 IF(I1(M)-MT)1007,1007,7807                   2DB 0857
1007 N=I0(M)                                         2DB 0858
  L=I1(M)                                           2DB 0859
  E01=I2(M)                                         2DB 0860
  IF(L)1407,1407,1207                              2DB 0861
1207 IF(E01)1407,1307,1407                        2DB 0862
1307 IF (N-L) 1407,13007,1407                     2DB 0863
13007 E01 = EV                                       2DB 0864
  L = 0                                              2DB 0865
1407 DO 1907 I=1,ITL                               2DB 0866
  IF (L) 1607,1707,1607                           2DB 0867

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1607	CO(I,N)=CO(I,N)+CO(I,L)*E01	2DB 0868
	GO TO 1907	2DB 0869
1707	CO(I,N)=CO(I,N)*E01	2DB 0870
1907	CONTINUE	2DB 0871
2207	IF(P02)2407,2307,2407	2DB 0872
2307	IF(NPRT) 2407,2407,4807	2DB 0873
4807	WRITE (NOUT,2807) IIG	2DB 0874
2807	FORMAT(7H GROUP I3,15H CROSS-SECTIONS)	2DB 0875
	DO 2907 N=1,MT	2DB 0876
2907	WRITE (NOUT,3007) N,(CO(I,N),I=1,ITL)	2DB 0877
3007	FORMAT(4H MAT,I3,(10E11.3))	2DB 0878
2407	WRITE (NSCRAT) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 0879
2607	CONTINUE	2DB 0880
	REWIND NCR1	2DB 0881
	REWIND NSCRAT	2DB 0882
C	SWITCH TAPE DESIGNATIONS	2DB 0883
	ITEMP=NSCRAT	2DB 0884
	NSCRAT=NCR1	2DB 0885
	NCR1=ITEMP	2DB 0886
	IF(BUCK) 5507, 9907, 5507	2DB 0887
5507	DO 8807 IIG=1,IGM	2DB 0888
	READ(NCR1) ((CO(I,J), I=1,ITL),J=1,MT)	2DB 0889
	DO 6607 MTZ = 1, MT	2DB 0890
	DO 6607 KZ=1,IZM	2DB 0891
	IF(M2(KZ) - MTZ) 6607, 6007, 6607	2DB 0892
6007	TEMP1 = BUCK/(3.*CO(4,MTZ))	2DB 0893
	CO(2,MTZ) = CO(2,MTZ) + TEMP1	2DB 0894
	CO(5,MTZ) = CO(5,MTZ) - TEMP1	2DB 0895
6607	CONTINUE	2DB 0896
	WRITE(NSCRAT) ((CO(I,J), I=1,ITL),J=1,MT)	2DB 0897
8807	CONTINUE	2DB 0898
	REWIND NCR1	2DB 0899
	REWIND NSCRAT	2DB 0900
C	SWITCH TAPE DESIGNATIONS	2DB 0901
	ITEMP = NSCRAT	2DB 0902
	NSCRAT = NCR1	2DB 0903
	NCR1 = ITEMP	2DB 0904
9907	CONTINUE	2DB 0905
C		2DB 0906
C MG	S810 MODIFY GEOMETRY	2DB 0907
	IF(P02)210,110,210	2DB 0908
110	IF(NCON) 9911,1210,9911	2DB 0909
1210	DO 310 I=1,IP	2DB 0910
310	R1(I)=R0(I)	2DB 0911
	DO 410 J=1,JP	2DB 0912
410	Z1(J)=Z0(J)	2DB 0913
210	IF(I04-3)9910,9910,510	2DB 0914
510	DO 610 I=1,IM	2DB 0915
	K=R2(I)	2DB 0916
610	R1(I+1)=R1(I)+(R0(I+1)-R0(I))*(1.0+ EV*R3(K))	2DB 0917
	DO 810 J=1,JM	2DB 0918
	K=Z2(J)	2DB 0919
810	Z1(J+1)=Z1(J)+(Z0(J+1)-Z0(J))*(1.0+ EV*Z3(K))	2DB 0920
	IF(IGE-2)9910,910,9910	2DB 0921
910	IF(ABS (Z1(JP)-1.0)-1.0E-04)9910,9910,1010	2DB 0922
1010	CALL ERRO2(6H**S810,1010,1)	2DB 0923
9910	CONTINUE	2DB 0924
C		2DB 0925
C AV	S811 AREAS AND VOLUMES	2DB 0926
	PI2=6.28318	2DB 0927
	IF(P02)111,211,111	2DB 0928
111	IF(I04-3)9911,9911,211	2DB 0929

211	CONTINUE	2DB 0930
	DO 311 I=1,IM	2DB 0931
	R4(I)=(R1(I+1)+R1(I))*0.5	2DB 0932
	R5(I)=R1(I+1)-R1(I)	2DB 0933
	IF(R5(I)) 1911,1911,2011	2DB 0934
1911	CALL ERRO2 (6H*R5(I),1911,1)	2DB 0935
2011	CONTINUE	2DB 0936
	GO TO (411,511,611),IGEP	2DB 0937
411	A0(I)=1.0	2DB 0938
	A0(IP)=1.0	2DB 0939
	A1(I)=R5(I)	2DB 0940
	GO TO 311	2DB 0941
511	A0(I)=PI2*R1(I)	2DB 0942
	A0(IP)=PI2*R1(IP)	2DB 0943
	A1(I)=PI2*R5(I)*R4(I)	2DB 0944
	GO TO 311	2DB 0945
611	A0(I)=PI2*R1(I)	2DB 0946
	A0(IP)=PI2*R1(IP)	2DB 0947
	A1(I)=R5(I)	2DB 0948
311	CONTINUE	2DB 0949
	DO 1211 J=1,JM	2DB 0950
	Z4(J)=(Z1(J+1)+Z1(J))*0.5	2DB 0951
	Z5(J)=Z1(J+1)-Z1(J)	2DB 0952
	IF(Z5(J)) 2111,2111,2211	2DB 0953
2111	CALL ERRO2 (6H*Z5(J),2111,1)	2DB 0954
2211	CONTINUE	2DB 0955
	DO 1211 I=1,IM	2DB 0956
	GO TO (1311,1411,1411),IGEP	2DB 0957
1311	V0(I,J)=R5(I)*Z5(J)	2DB 0958
	GO TO 1211	2DB 0959
1411	V0(I,J)=PI2*R5(I)*Z5(J)*R4(I)	2DB 0960
1211	CONTINUE	2DB 0961
9911	CONTINUE	2DB 0962
C		2DB 0963
C MA	S813 MATERIAL ADDRESSES	2DB 0964
113	IF(P02)9913,213,9913	2DB 0965
213	SK7=0.	2DB 0966
	DO 313 IIG=1,IGM	2DB 0967
	IF(S02-1)513,413,513	2DB 0968
413	K6(IIG)=K7(IIG)/S03	2DB 0969
	GO TO 313	2DB 0970
513	K6(IIG)=K7(IIG)	2DB 0971
313	SK7=SK7+K7(IIG)	2DB 0972
9913	CONTINUE	2DB 0973
C		2DB 0974
C FN	S821 FISSION NEUTRONS	2DB 0975
	T11=E1(IGP)	2DB 0976
221	CALL CLEAR(0.0,F0,IMJM)	2DB 0977
	DO 921 IIG=1,IGM	2DB 0978
	E0(IIG) = .0	2DB 0979
	READ (NFLUX1) (NO(I),I=1,IMJM)	2DB 0980
	READ (NCR1) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 0981
	DO 921 J = 1, JM	2DB 0982
	DO 921 K = 1, IM	2DB 0983
	I = K + (J-1)*IM	2DB 0984
	ITEMP=M0(I)	2DB 0985
	ITEMP=M2(ITEMP)	2DB 0986
	E0(IIG) = E0(IIG) + V0(K,J)*NO(I)*CO(1,ITEMP)	2DB 0987
	IF(A02)621,521,621	2DB 0988

621	FO(I)=FO(I)+K7(IIG)*NO(I) .	2DB 0989
	GO TO 921	2DB 0990
521	FO(I)=FO(I)+CO(IHT-1,ITEMP)*NO(I)	2DB 0991
921	CONTINUE	2DB 0992
	REWIND NFLUX1	2DB 0993
	REWIND NCR1	2DB 0994
	RETURN	2DB 0995
	END	2DB 0996

-IT FOR	CLEAR,CLEAR	2DB 0997
	SUBROUTINE CLEAR (X,Y,N)	2DB 0998
	DIMENSION Y(1)	2DB 0999
	DO 1 I=1,N	2DB 1000
1	Y(I)=X	2DB 1001
	RETURN	2DB 1002
	END	2DB 1003

-ITC	FOR FISCAL,FISCAL	2DB 1004
	SUBROUTINE FISCAL (NO, FO, VO, CO, K6, MO, M2, JTL,JMT)	2DB 1005
	INCLUDE ABC	2DB 1006
	DIMENSION NO(1), FO(1), VO(1), CO(JTL,JMT),K6(1), MO(1), M2(1)	2DB 1007
	LAR = ALA	2DB 1008
C FS	S822 FISSION SUMS	2DB 1009
822	IF(A02)222,122,222	2DB 1010
222	DO 322 IIG=1,IGM	2DB 1011
	READ (NCR1) ((CO(I,J),I=1,ITL)=J=1,MT)	2DB 1012
	E1(IIG)=0.	2DB 1013
	DO 322 I=1,IMJM	2DB 1014
	ITEMP=MO(I)	2DB 1015
	ITEMP=M2(ITEMP)	2DB 1016
322	E1(IIG)=E1(IIG)+CO(IHT-1,ITEMP)*FO(I)*VO(I)	2DB 1017
	REWIND NCR1	2DB 1018
	GO TO 422	2DB 1019
122	E01=0.	2DB 1020
	DO 522 I=1,IMJM	2DB 1021
522	E01=E01+VO(I)*FO(I)	2DB 1022
	DO 622 IIG=1,IGM	2DB 1023
622	E1(IIG)=K6(IIG)*E01	2DB 1024
422	E1(IGP)=0.	2DB 1025
	E0(IGP)=0.	2DB 1026
	DO 722 IIG=1,IGM	2DB 1027
	E0(IGP)=E0(IGP)+E0(IIG)	2DB 1028
722	E1(IGP)=E1(IGP)+E1(IIG)	2DB 1029
	IF(B07) 9922,922,9922	2DB 1030
922	ALA = E1(IGP)/T11	2DB 1031
	TEMP=1.0/ALA	2DB 1032
	IF(I04-1)9922,1022,9922	2DB 1033
1022	DO 1122 IIG=1,IGM	2DB 1034
	E1(IIG)=E1(IIG)*TEMP	2DB 1035
1122	K6(IIG)=K6(IIG)*TEMP	2DB 1036
	E1(IGP)=E1(IGP)*TEMP	2DB 1037
	IF(A02)1222,9922,1222	2DB 1038
1222	DO 1322 I=1,IMJM	2DB 1039
1322	FO(I)=FO(I)*TEMP	2DB 1040
9922	CONTINUE	2DB 1041
C		2DB 1042
C NZ	S823 NORMALIZATION	2DB 1043
	B07=0.	2DB 1044
123	IF(S01) 1023,9923,223	2DB 1045
1023	E01 = ABS(S01)/(E0(IGP)*TSD)	2DB 1046
	GO TO 1123	2DB 1047
223	E01=S01/E1(IGP)	2DB 1048
1123	DO 323 IIG=1,IGP	2DB 1049
323	E1(IIG)=E01*E1(IIG)	2DB 1050
	DO 423 I=1,IMJM	2DB 1051
423	FO(I)=E01*FO(I)	2DB 1052
	DO 1523 IIG=1,IGM	2DB 1053
	READ (NFLUX1) (NO(I),I=1,IMJM)	2DB 1054
	DO 923 I=1,IMJM	2DB 1055
923	NO(I)=NO(I)*E01	2DB 1056
	WRITE (NSCRAT) (NO(I),I=1,IMJM)	2DB 1057
1523	CONTINUE	2DB 1058
	ITEMP=NSCRAT	2DB 1059
	NSCRAT=NFLUX1	2DB 1060
	NFLUX1=ITEMP	2DB 1061
	REWIND NFLUX1	2DB 1062
	REWIND NSCRAT	2DB 1063
9923	RETURN	2DB 1064
	END	2DB 1065


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-ITC FOR OUTER,OUTER                                2DB 1091
  SUBROUTINE OUTER( A0, A1, C0, F0, K6, M0, M2, N0, N2, 2DB 1092
1      S2, V0, V7, Z5, F2, JTL,JMT, CXS,             2DB 1093
2      JIM, JJM, R5, R4, Z4, CXR, CXT)                2DB 1094
  DIMENSION A0(1), A1(1), F0(1), K6(1), M0(1), M2(1), 2DB 1095
1      N0(1), N2(1), S2(1),                          2DB 1096
2      V0(1), V7(1), Z5(1), F2(1), C0(JTL,JMT),      2DB 1097
3      CXS(JIM,JJM,3), R5(1), R4(1), Z4(1), CXR(1), CXT(1) 2DB 1098
  INTEGER GBAR, PBAR, SBAR                            2DB 1099
  INCLUDE ABC                                           2DB 1100
  IGV=1                                                 2DB 1101
C ST 824 SOURCE CALCULATION                           2DB 1102
124 CONTINUE                                           2DB 1103
  READ(NCR1) ((C0(I,M),I=1,ITL),M=1,MT)              2DB 1104
  DO 624 I=1,IMJM                                     2DB 1105
    S2(I)=0.                                           2DB 1106
    724 IF(A02)1024,824,1024                          2DB 1107
    824 DO 924 I=1,IMJM                               2DB 1108
    924 S2(I)=S2(I)+K6(IGV)*F0(I)                    2DB 1109
    GO TO 1324                                         2DB 1110
  1024 DO 1224 I=1,IMJM                               2DB 1111
    ITEMP1=M0(I)                                       2DB 1112
    ITEMP1=M2(ITEMP1)                                 2DB 1113
    1224 S2(I)=S2(I)+C0(IHT-1,ITEMP1)*F0(I)          2DB 1114
    1324 GBAR=IGV+IHS-ITL                             2DB 1115
    IF(GBAR-1)1424,1524,1524                         2DB 1116
    1424 GBAR=1                                         2DB 1117
    1524 PBAR = IHS + IGV - 1                         2DB 1118
    IF (PBAR - ITL) 1724,1724,1624                   2DB 1119
    1624 PBAR = ITL                                     2DB 1120
    1724 IF(GBAR - IGV) 4224, 2624, 2624             2DB 1121
    4224 READ (NSCRAT) (N2(I),I=1,IMJM)              2DB 1122
    DO 2324 I=1,IMJM                                  2DB 1123
    ITEMP1=M0(I)                                       2DB 1124
    ITEMP1=M2(ITEMP1)                                 2DB 1125
    ITEMP=ITEMP1                                       2DB 1126
    TEMP=C0(PBAR,ITEMP)                              2DB 1127
    2324 S2(I)=S2(I)+N2(I)*TEMP                      2DB 1128
    GO TO 2724                                         2DB 1129
    2624 READ (NFLUX1) (N2(I),I=1,IMJM)              2DB 1130
    2724 GBAR=GBAR+1                                   2DB 1131
    PBAR=PBAR-1                                       2DB 1132
    IF(GBAR - IGV) 4224, 2624, 3924                 2DB 1133
    3924 IF(IGV - IGM) 3524, 3424, 3524              2DB 1134
    3424 REWIND NCR1                                  2DB 1135
    3524 V11=0.                                        2DB 1136
    DO 3624 I=1,IMJM                                  2DB 1137
    S2(I)=S2(I)*V0(I)                                2DB 1138
    3624 V11=V11+S2(I)                                2DB 1139
    E2(IGV) = V11 - E1(IGV)                          2DB 1140
C SA 825 SOURCE-ALPHA                                2DB 1141
125 IF(I04 - 2) 825, 225, 825                       2DB 1142
825 IF(S02 - 2) 725, 925, 725                       2DB 1143
925 T7 = S03/V7(IGV)                                2DB 1144
GO TO 325                                             2DB 1145
725 T7 = 0.0                                          2DB 1146
GO TO 1025                                           2DB 1147
225 T7 = EV/V7(IGV)                                  2DB 1148
325 DO 625 K = 1, IZM                               2DB 1149

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ITEMP1 = M2(K)                                2DB 1150
625 CO(IHS, ITEMP1) = CO(IHS, ITEMP1) - T7      2DB 1151
1025 CONTINUE                                  2DB 1152
C PP S831 GROUP FLUX CALCULATION                2DB 1153
131  II=0                                        2DB 1154
      IF(V11)231,431,231                        2DB 1155
231  CALL INNER1(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, IM, JM,  2DB 1156
      1 ITL, CXR, CXT)                          2DB 1157
      CALL INNER(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT) 2DB 1158
      DO 3531 K = 1, IZM                        2DB 1159
      ITEMP1 = M2(K)                            2DB 1160
3531 CO(IHS, ITEMP1) = CO(IHS, ITEMP1) + T7      2DB 1161
      GO TO 141                                  2DB 1162
431  DO 531 I=1, IMJM                          2DB 1163
      N2(I)=0.                                  2DB 1164
531  NO(I)=0.                                  2DB 1165
C GC S841                                        2DB 1166
141  CONTINUE                                  2DB 1167
941  WRITE (NSCRAT) (N2(I), I=1, IMJM)          2DB 1168
441  SBAR=ITL-IHS                              2DB 1169
      IF(SBAR) 2541,2541,541                    2DB 1170
541  DO 641 IS=1, SBAR                         2DB 1171
641  BACKSPACE NSCRAT                          2DB 1172
2541 CONTINUE                                  2DB 1173
      IF(V11)841,2441,841                       2DB 1174
841  IF(A02)1341,1641,1341                     2DB 1175
1341 EO(IGV)=0.0                               2DB 1176
      DO 1541 I=1, IMJM                         2DB 1177
      ITEMP1=M0(I)                              2DB 1178
      ITEMP1=M2(ITEMP1)                         2DB 1179
      EO(IGV)=EO(IGV) + CO(1, ITEMP1)*N2(I)*V0(I) 2DB 1180
1541 F2(I)=F2(I)+K6(IGV)*N2(I)                 2DB 1181
      GO TO 2441                                 2DB 1182
1641 EO(IGV)=0.0                               2DB 1183
      DO 1841 I=1, IMJM                         2DB 1184
      ITEMP1=M0(I)                              2DB 1185
      ITEMP1=M2(ITEMP1)                         2DB 1186
      EO(IGV)=EO(IGV) + CO(1, ITEMP1)*N2(I)*V0(I) 2DB 1187
1841 F2(I)=F2(I)+CO(IHT-1, ITEMP1)*N2(I)        2DB 1188
2441 CONTINUE                                  2DB 1189
      IGV=IGV+1                                  2DB 1190
      IF(IGV-IGM) 124,124,847                   2DB 1191
847  T11 = E1(IGP)                             2DB 1192
      DO 18347 I=1, IMJM                        2DB 1193
18347 F0(I) = F2(I)                             2DB 1194
C SWITCH TAPE DESIGNATIONS                     2DB 1195
      REWIND NCR1                                2DB 1196
      REWIND NSCRAT                             2DB 1197
      REWIND NFLUX1                             2DB 1198
      ITEMP = NSCRAT                            2DB 1199
      NSCRAT = NFLUX1                           2DB 1200
      NFLUX1 = ITEMP                            2DB 1201
      RETURN                                    2DB 1202
      END                                        2DB 1203

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-ITC FOR INNER1,INNER1                                2DB 1204
  SUBROUTINE INNER1(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, 2DB 1205
    2          JIM,JJM,JTL,CXR,CXT)                    2DB 1206
    DIMENSION M0(1), M2(1),CXS(JIM,JJM,3),V0(1), C0(JTL,1), 2DB 1207
    1          A0(1), Z5(1), R5(1), R4(1), Z4(1), A1(1),CXR(1), CXT(1)2DB 1208
    INCLUDE ABC                                         2DB 1209
  C THIS SUBROUTINE CALCULATES COEFFICIENTS FOR THE FLUX EQUATION 2DB 1210
    PI2 = 6.28318                                       2DB 1211
    DO 89 KJ = 1, JM                                    2DB 1212
    DO 89 KI = 1, IM                                    2DB 1213
    GO TO (44,44,40), IGEP                              2DB 1214
  40 TEMP = PI2*(Z4(KJ) - Z4(KJ-1))*R4(KI)              2DB 1215
    GO TO 46                                             2DB 1216
  44 TEMP = Z4(KJ) - Z4(KJ-1)                          2DB 1217
  46 I = KI + (KJ-1)*IM                                2DB 1218
    ITEMP = M0(I)                                       2DB 1219
    ITEMP = M2(ITEMP)                                  2DB 1220
    ITEMP1 = M0(I-1)                                   2DB 1221
    ITEMP1 = M2(ITEMP1)                                2DB 1222
    ITEMP3 = M0(I - IM)                                2DB 1223
    ITEMP3 = M2(ITEMP3)                                2DB 1224
    CXS(KI,KJ,3) = V0(I)*(C0(IHT,ITEMP) - C0(IHS,ITEMP)) 2DB 1225
    IF (ITEMP - ITEMP1) 52,50,52                      2DB 1226
  50 CXS(KI,KJ,1)=A0(KI )*Z5(KJ)/(3.*C0(IHT,ITEMP)*(R4(KI)-R4(KI-1))) 2DB 1227
    GO TO 69                                             2DB 1228
  52 CXS(KI,KJ,1) = A0(KI)*Z5(KJ)*(R5(KI-1)+R5(KI))/((R4(KI)-R4(KI-1))* 2DB 1229
    1 (3.*(R5(KI-1)*C0(IHT,ITEMP1) + R5(KI)*C0(IHT,ITEMP)))) 2DB 1230
    IF (ITEMP - ITEMP3) 72,70,72                      2DB 1231
  70 CXS(KI,KJ,2) = A1(KI)/(3.*C0(IHT,ITEMP)*TEMP)    2DB 1232
    GO TO 89                                             2DB 1233
  72 CXS(KI,KJ,2) = A1(KI)*(Z5(KJ-1) + Z5(KJ))/(ITEMP* 2DB 1234
    1 (3.*(Z5(KJ-1)*C0(IHT,ITEMP3) + Z5(KJ)*C0(IHT,ITEMP)))) 2DB 1235
  89 CONTINUE                                           2DB 1236
    DO 100 KJ = 1, JM                                  2DB 1237
    DO 100 KI = 1, IM                                  2DB 1238
    GO TO (24,24,20), IGEP                              2DB 1239
  20 TEMP = .5*PI2*Z5(KJ)*R4(KI)                      2DB 1240
    GO TO 26                                             2DB 1241
  24 TEMP = .5*Z5(KJ)                                   2DB 1242
  26 I = KI + (KJ-1)*IM                                2DB 1243
    ITEMP = M0(I)                                       2DB 1244
    ITEMP = M2(ITEMP)                                  2DB 1245
    TEMP1 = CXS(KI+1,KJ,1)                             2DB 1246
    TEMP2 = CXS(KI,KJ+1,2)                             2DB 1247
    IF(KJ - 1) 9, 9, 12                                2DB 1248
  9 IF(B04) 10, 10, 11                                2DB 1249
  10 CXS(KI,KJ,2) = A1(KI)/(3.*C0(IHT,ITEMP)*( TEMP  +.71/ 2DB 1250
    1 C0(IHT,ITEMP)))                                  2DB 1251
    GO TO 19                                             2DB 1252
  11 CXS(KI,KJ,2) = .0                                  2DB 1253
    GO TO 19                                             2DB 1254
  12 IF (KJ - JM) 19,15,15                             2DB 1255
  15 IF(B03) 16, 16, 17                                2DB 1256
  16 TEMP2 = A1(KI)/(3.*C0(IHT,ITEMP)*( TEMP  +.71/ 2DB 1257
    1 C0(IHT,ITEMP)))                                  2DB 1258
    CXT(KI) = TEMP2                                    2DB 1259
    GO TO 19                                             2DB 1260
  17 TEMP2 = .0                                         2DB 1261
    CXT(KI) = TEMP2                                    2DB 1262

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19	IF (KI - 1) 1,1,4	2DB 1263
1	IF(B01) 2, 2, 3	2DB 1264
2	CXS(KI,KJ,1) = A0(KI)*Z5(KJ)/(3.*CO(IHT,ITEMP)*	2DB 1265
	1 (.5*R5(KI) + .71/CO(IHT,ITEMP)))	2DB 1266
	GO TO 90	2DB 1267
3	CXS(KI,KJ,1) = .0	2DB 1268
	GO TO 90	2DB 1269
4	IF (KI - IM) 90,5,5	2DB 1270
5	IF(B02) 6, 6, 7	2DB 1271
6	TEMP1 = A0(KI+1)*Z5(KJ)/(3.*CO(IHT,ITEMP)*	2DB 1272
	1 (.5*R5(KI) + .71/CO(IHT,ITEMP)))	2DB 1273
	CXR(KJ) = TEMP1	2DB 1274
	GO TO 90	2DB 1275
7	TEMP1 = .0	2DB 1276
	CXR(KJ) = TEMP1	2DB 1277
90	CXS(KI,KJ,3) = CXS(KI,KJ,3) + CXS(KI,KJ,1) + CXS(KI,KJ,2)	2DB 1278
	1 + TEMP1 + TEMP2	2DB 1279
100	CONTINUE	2DB 1280
	RETURN	2DB 1281
	END	2DB 1282

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-ITC FOR INNER,INNER
  SUBROUTINE INNER(N0, N2, CXS, S2, M0, M2, V0, C0, JIM, JJM, JTL,
1      CXR, CXT)
    INCLUDE ABC
    DIMENSION N0(1), N2(1), CXS(JIM, JJM, 3), S2(1), M0(1), M2(1),
1      V0(1), C0(JTL, 1), CXR(1), CXT(1)
    CALL IFLUXN (N2, C0, V0, CXS, M0, M2, ITL, IM, JM, CXR, CXT)
2      DO 4 I=1, IMJM
4      N0(I) = N2(I)
C      BEGIN FLUX CALCULATION
        IKB = IM - 1
        JKB = JM - 1
C      FLUX CALCULATION FROM LOWER LEFT TO UPPER RIGHT
C
C      CALCULATION OF FLUX ALONG BOTTOM MESH LINE
5      N2(1) = (CXS(2,1,1)*N2(2) + CXS(1,2,2)*N2(IM+1) + S2(1))/
1      CXS(1,1,3)
        N2(1) = N0(1) + ORF*(N2(1) - N0(1))
        DO 10 KI = 2, IKB
            I = KI
            IRP = I + IM
            N2(I) = (CXS(KI,1,1)*N2(I-1) + CXS(KI+1,1,1)*N2(I+1)
1      + CXS(KI,2,2)*N2(IRP) + S2(I))/CXS(KI,1,3)
            N2(I) = N0(I) + ORF*(N2(I) - N0(I))
10     CONTINUE
        IRP = IM + IM
        N2(IM) = (CXS(IM,1,1)*N2(IM-1) + CXS(IM,2,2)*N2(IRP) + S2(IM))/
1      CXS(IM,1,3)
        N2(IM) = N0(IM) + ORF*(N2(IM) - N0(IM))
C      PRINCIPAL FLUX LOOP
        DO 70 KJ = 2, JKB
        DO 70 KI = 1, IM
            I = KI + (KJ - 1)*IM
            IRP = I + IM
            IRM = I - IM
            IF(KI - 1) 40, 40, 36
36     IF(KI - IM) 60, 50, 50
40     CONTINUE
C      CALCULATION OF LEFT BOUNDARY FLUX
        N2(I) = (CXS(KI+1,KJ,1)*N2(I+1) + CXS(KI,KJ,2)*N2(IRM) + S2(I)
1      + CXS(KI,KJ+1,2)*N2(IRP))/CXS(KI,KJ,3)
        GO TO 70
50     CONTINUE
C      CALCULATION OF RIGHT BOUNDARY FLUX
        N2(I) = (CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*N2(IRM) + S2(I)
1      + CXS(KI,KJ+1,2)*N2(IRP))/CXS(KI,KJ,3)
        GO TO 70
60     CONTINUE
C      CALCULATION OF INTERNAL FLUX
        N2(I) = (CXS(KI,KJ,1)*N2(I-1) + CXS(KI+1,KJ,1)*N2(I+1) + S2(I)
1      + CXS(KI,KJ,2)*N2(IRM) + CXS(KI,KJ+1,2)*N2(IRP))/CXS(KI,KJ,3)
70     N2(I) = N0(I) + ORF*(N2(I) - N0(I))
C      CALCULATION OF FLUX ALONG TOP MESH LINE
        I = IMJM - IM + 1
        N2(I) = (CXS(2,JM,1)*N2(I+1) + CXS(1,JM,2)*N2(I-IM)
1      + S2(I))/CXS(1,JM,3)
        N2(I) = N0(I) + ORF*(N2(I) - N0(I))
        DO 80 KI = 2, IKB
            I = KI + (JM - 1)*IM

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      IRM = I - IM                                2DB 1342
      N2(I) = (CXS(KI,JM,1)*N2(I-1) + CXS(KI+1,JM,1)*N2(I+1) 2DB 1343
1 + CXS(KI,JM,2)*N2(IRM) + S2(I))/CXS(KI,JM,3)          2DB 1344
      N2(I) = NO(I) + ORF*(N2(I) - NO(I))              2DB 1345
80  CONTINUE                                         2DB 1346
      N2(IMJM) = (CXS(IM,JM,1)*N2(IMJM-1) + CXS(IM,JM,2)*N2(IMJM-IM) 2DB 1347
1 + S2(IMJM))/CXS(IM,JM,3)                               2DB 1348
      N2(IMJM) = NO(IMJM) + ORF*(N2(IMJM) - NO(IMJM))      2DB 1349
C  CALCULATION OF ERROR CRITERION                    2DB 1350
      E01 = .0                                          2DB 1351
      DO 90 I=1, IMJM                                2DB 1352
      ITEMP1 = M0(I)                                   2DB 1353
      ITEMP = M2(ITEMP1)                               2DB 1354
      E01 = E01 + ABS(N2(I) - NO(I))*V0(I)*C0(IHT-1,ITEMP) 2DB 1355
      O  CONTINUE                                     2DB 1356
C  2DB 1357
C II S833 INNER ITERATION CONTROL                    2DB 1358
133 LC = LC + 1                                       2DB 1359
      II = II + 1                                     2DB 1360
      IF(II - G07) 533, 141, 141                      2DB 1361
533 IF (FLOAT(IGM)*E01 - EPS*E1(IGP)) 633,633,2        2DB 1362
633 IF(G06) 733, 141, 733                             2DB 1363
733 TEMP1 = .0                                         2DB 1364
      DO 933 I=1,IMJM                                2DB 1365
      TEMP2=ABS (1.0-NO(I)/N2(I))                      2DB 1366
      IF(TEMP1-TEMP2)833,933,933                       2DB 1367
833 TEMP1=TEMP2                                       2DB 1368
933 CONTINUE                                         2DB 1369
      IF (TEMP1 - G06) 141,141,2                      2DB 1370
141 CONTINUE                                         2DB 1371
      CALL IFLUXN (N2, C0, V0, CXS, M0, M2, ITL, IM, JM, CXR, CXT) 2DB 1372
      RETURN                                          2DB 1373
      END                                            2DB 1374

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-1TC FOR IFLUXN,IFLUXN          2DB 1375
      SUBROUTINE IFLUXN (N2, C0, V0, CXS, M0, M2, JTL,JIM,JJM, CXR, CXT)2DB 1376
      INCLUDE ABC                2DB 1377
      DIMENSION N2(1), C0(JTL,1), V0(1),CXS(JIM,JJM,3),M0(1), M2(1), 2DB 1378
      1 CXR(1), CXT(1)          2DB 1379
C   THIS SUBROUTINE NORMALIZES FLUXES BEFORE AND AFTER INNER ITERATION2DB 1380
C   ABSORPTION AND OUT-SCATTER 2DB 1381
      E3(IGV) = 0.0              2DB 1382
      E4(IGV) = 0.0              2DB 1383
      DO 10 I=1, IMJM            2DB 1384
      TEMP = V0(I)*N2(I)         2DB 1385
      ITEMP = M0(I)              2DB 1386
      ITEMP = M2(ITEMP)          2DB 1387
      E3(IGV) = E3(IGV) + (C0(4,ITEMP) - C0(5,ITEMP))*TEMP 2DB 1388
10   E4(IGV) = E4(IGV) + C0(2,ITEMP)*TEMP 2DB 1389
      E3(IGV) = E3(IGV) - E4(IGV) 2DB 1390
C   LEFT LEAKAGE                2DB 1391
      IF(B01) 12, 12, 17        2DB 1392
12   E5(IGV) = 0.0              2DB 1393
      DO 15 KJ = 1, JM          2DB 1394
      I = (KJ - 1)*IM + 1       2DB 1395
15   E5(IGV) = E5(IGV) + CXS(1,KJ,1)*N2(I) 2DB 1396
      GO TO 20                  2DB 1397
17   E5(IGV) = .0               2DB 1398
C   RIGHT LEAKAGE              2DB 1399
20   IF(B02) 22, 22, 27        2DB 1400
22   E6(IGV) = 0.0              2DB 1401
      DO 25 KJ = 1, JM          2DB 1402
      I = KJ*IM                 2DB 1403
25   E6(IGV) = E6(IGV) + CXR(KJ)*N2(I) 2DB 1404
      GO TO 30                  2DB 1405
27   E6(IGV) = 0.0              2DB 1406
C   TOP LEAKAGE                2DB 1407
30   IF(B03) 32, 32, 37        2DB 1408
32   E7(IGV) = 0.0              2DB 1409
      DO 35 KI = 1, IM          2DB 1410
      I = IMJM - IM + KI       2DB 1411
35   E7(IGV) = E7(IGV) + CXT(KI)*N2(I) 2DB 1412
      GO TO 40                  2DB 1413
37   E7(IGV) = 0.0              2DB 1414
C   BOTTOM LEAKAGE             2DB 1415
40   IF(B04) 42, 42, 47        2DB 1416
42   E8(IGV) = 0.0              2DB 1417
      DO 45 KI = 1, IM          2DB 1418
45   E8(IGV) = E8(IGV) + CXS(KI,1,2)*N2(KI) 2DB 1419
      GO TO 50                  2DB 1420
47   E8(IGV) = 0.0              2DB 1421
50   E9(IGV) = E5(IGV) + E6(IGV) + E7(IGV) + E8(IGV) 2DB 1422
      TEMP = (E1(IGV) + E2(IGV))/(E3(IGV) + E4(IGV) + E9(IGV)) 2DB 1423
      DO 90 I = 1, IMJM        2DB 1424
90   N2(I) = TEMP*N2(I)        2DB 1425
      E3(IGV) = TEMP*E3(IGV)    2DB 1426
      E4(IGV) = TEMP*E4(IGV)    2DB 1427
      E5(IGV) = TEMP*E5(IGV)    2DB 1428
      E6(IGV) = TEMP*E6(IGV)    2DB 1429
      E7(IGV) = TEMP*E7(IGV)    2DB 1430
      E8(IGV) = TEMP*E8(IGV)    2DB 1431
      E9(IGV) = TEMP*E9(IGV)    2DB 1432
      RETURN                    2DB 1433
      END                      2DB 1434

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-ITC FOR CNNP,CNNP                                2DB 1435
  SUBROUTINE CNNP (F2,K6)                          2DB 1436
    DIMENSION F2(1), K6(1)                        2DB 1437
    INCLUDE ABC                                    2DB 1438
C CN  S851 CONVERGENCE TESTS                      2DB 1439
      IF(MAXT) 49, 49, 41                        2DB 1440
41    CALL ETIMEF(TEMP)                          2DB 1441
      IF(TEMP - GLH) 49, 43, 43                  2DB 1442
43    NGOTO = 1                                    2DB 1443
      WRITE(NOUT,48)                             2DB 1444
48    FORMAT(53H1 * * RUNNING TIME EXCEEDED--FORCED CONVERGENCE * *//) 2DB 1445
      GO TO 9851                                  2DB 1446
49    CONTINUE                                    2DB 1447
151   E01=1.0-ALA                                2DB 1448
      IF(ABS (E01)-10.0*EPS)3051,3051,3151        2DB 1449
3051  GO7=K07                                     2DB 1450
      ORF = ORFP                                  2DB 1451
3151  CONTINUE                                    2DB 1452
      E02=ABS(E01)                                2DB 1453
451   IF(E1(IGP))551,2551,551                    2DB 1454
551   IF (E02 - EPS) 951,951,1051                 2DB 1455
951   CVT=1                                       2DB 1456
1051  CALL CLEAR (0.0, F2, IMJM)                  2DB 1457
      GO TO 1251                                  2DB 1458
10051 EV=EV+POD*EQ*E01                           2DB 1459
      GO TO 652                                   2DB 1460
C     FINAL PRINT                                2DB 1461
1151  NGOTO=1                                     2DB 1462
      IF (I04 - 1) 11151,11151,10051             2DB 1463
11151 EV=0.0                                      2DB 1464
      DO 1951 I=1,IGM                             2DB 1465
1951  EV=EV+K6(I)                                2DB 1466
      EV=SK7/EV                                    2DB 1467
      GO TO 9851                                  2DB 1468
1251  IF(CVT-1)1451,1151,1451                    2DB 1469
1451  IF(I04-1)1551,1651,9951                    2DB 1470
C     MONITOR PRINT                              2DB 1471
1551  NGOTO=2                                     2DB 1472
      GO TO 9851                                  2DB 1473
1651  EV=0.                                       2DB 1474
      DO1751 I=1,IGM                             2DB 1475
1751  EV=EV+K6(I)                                2DB 1476
      EV=SK7/EV                                    2DB 1477
      GO TO 1551                                  2DB 1478
2551  CALL ERRO2(6H**S851,1068,1)                2DB 1479
9851  RETURN                                      2DB 1480
9951  CONTINUE                                    2DB 1481
C                                                2DB 1482
C NP  S852 NEW PARAMETERS.                       2DB 1483
152   E03=ABS (ALA-LAR)                          2DB 1484
      IF (LAPP) 2852,252,2852                    2DB 1485
252   IF (LAP) 2052,352,2052                     2DB 1486
352   IF (EQ) 1252,452,1252                      2DB 1487
452   IF (E03-EP5A)752,752,11652                2DB 1488
C     MONITOR PRINT.                             2DB 1489
11652 NGOTO=2                                     2DB 1490
      RETURN                                      2DB 1491
C     FINAL PRINT EXIT.                          2DB 1492
652   NGOTO=1                                    2DB 1493

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	RETURN	2DB 1494
752	LAP=ALA	2DB 1495
	EVP=EV	2DB 1496
	IF (E01) 952,952,852	2DB 1497
852	EV=EV-EVM	2DB 1498
	GO TO 1152	2DB 1499
952	EV=EV+EVM	2DB 1500
1152	IF (I04-2) 11152,11652,11152	2DB 1501
C	MIX X-SECS.	2DB 1502
11152	NGOTO=3	2DB 1503
	RETURN	2DB 1504
1252	IF (CVT) 652,1552,652	2DB 1505
1552	EV=EV+POD*EQ*E01	2DB 1506
1652	IF ((LAPP-1.0)/(LAP-1.0)) 1752,1152,1152	2DB 1507
1752	TEMP1=MIN1 (EVP,EVPP)	2DB 1508
	IF (EV-TEMP1) 1852,1952,1952	2DB 1509
1852	EV=(EVPP+EVP)/2.	2DB 1510
	GO TO 1152	2DB 1511
1952	TEMP1=MAX1 (EVP,EVPP)	2DB 1512
	IF (EV-TEMP1) 1152,1852,1852	2DB 1513
2052	IF (E03-EP5A) 2152,2152,11652	2DB 1514
2152	EQ=(EVP-EV)/(LAP-ALA)	2DB 1515
2252	IF (CNT) 2652,2352,2652	2DB 1516
2352	IF (E02-LAL) 2752,2752,2452	2DB 1517
2452	IF (E02-LAH) 2652,2652,2552	2DB 1518
2552	E01=SIGN (LAH,E01)	2DB 1519
2652	LAPP=LAP	2DB 1520
	LAP=ALA	2DB 1521
	EVPP=EVP	2DB 1522
	EVP=EV	2DB 1523
	GO TO 1552	2DB 1524
2752	CNT=1	2DB 1525
	LAP=0.0	2DB 1526
	LAPP=0.0	2DB 1527
	GO TO 1552	2DB 1528
2852	IF (E03-EP5A) 2952,2952,11652	2DB 1529
C	CALCULATE QUADRATIC COEFFICIENTS.	2DB 1530
2952	TEMP1=EVP-EV	2DB 1531
	TEMP2=EVPP-EV	2DB 1532
	TEMP3=EVPP-EVP	2DB 1533
	TEMP4=TEMP1*(EVP+EV)	2DB 1534
	TEMP5=-TEMP2*(EV+EVPP)	2DB 1535
	TEMP6=TEMP3*(EVPP+EVP)	2DB 1536
	DENOM=TEMP3*TEMP2*TEMP1	2DB 1537
	EQA=((LAPP-1.0)*TEMP1*EVP*EV-(LAP-1.0)*TEMP2	2DB 1538
	1*EV*EVPP+(ALA-1.0)*TEMP3*EVPP*EVP)/DENOM	2DB 1539
	EQB=-(LAPP*TEMP4+LAP*TEMP5+ALA*TEMP6)/DENOM	2DB 1540
	EQC=(LAPP*TEMP1-LAP*TEMP2+ALA*TEMP3)/DENOM	2DB 1541
	DISCR=EQB*EQB-4.0*EQA*EQC	2DB 1542
	IF (DISCR) 2152,3052,3052	2DB 1543
3052	IF (E02-LAL) 2752,2752,3152	2DB 1544
3152	TEMP1=EQC+EQC	2DB 1545
	TEMP=SQRT (DISCR)	2DB 1546
	EQ=1.0/(EQB+EV*TEMP1)	2DB 1547
	LAPP=LAP	2DB 1548
	LAP=ALA	2DB 1549
	EVPP=EVP	2DB 1550
	EVP=EV	2DB 1551
	EV1=(TEMP-EQB)/TEMP1	2DB 1552
	EV2=-(TEMP+EQB)/TEMP1	2DB 1553
	EVA=ABS (EV-EV1)	2DB 1554
	EVB=ABS (EV-EV2)	2DB 1555

```
3252 IF (EVA-EVB) 3252,3252,3352
      EV=EV1
      GO TO 1652
3352 EV=EV2
      GO TO 1652
      END
```

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2DB 1556
2DB 1557
2DB 1558
2DB 1559
2DB 1560
2DB 1561
-
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-ITC FOR S8850,S8850                                2DB 1562
  SUBROUTINE S8850(F2,N2,R1,Z1,R4,Z4,JIM,JJM,FN2,      2DB 1563
    1          CO,N0,M0,M2,F0,JTL,JMT)                2DB 1564
    INCLUDE ABC                                       2DB 1565
    DIMENSION F2(JIM,JJM), N2(JIM,JJM), R1(1), Z1(1), R4(1), Z4(1), 2DB 1566
    1          FLUX(6), FN2(1), CO(JTL,JMT), N0(JIM,JJM), M0(JIM,JJM), 2DB 1567
    2          M2(1), F0(JIM,JJM)                    2DB 1568
C FP S850 FINAL PRINT                                2DB 1569
  ICARD = 1                                           2DB 1570
  CALL S8830                                           2DB 1571
  IF(NPRT) 9950,9950,150                             2DB 1572
150  CALL S8847                                         2DB 1573
  J=IP                                                2DB 1574
  IF(IP-JP) 1550,1550,1650                           2DB 1575
1650  J=JP                                             2DB 1576
1550  WRITE (NOUT,1750) (I,R1(I),R4(I),Z1(I),Z4(I),I=1,J) 2DB 1577
1750  FORMAT(      84H1          RADII          AVG RADII 2DB 1578
    1          AXII          AVG AXII/(I4,4F20.4))      2DB 1579
  J=J+1                                              2DB 1580
  IF(IP-JP) 1950,1850,2150                           2DB 1581
1950  WRITE (NOUT,2050) (I,Z1(I),Z4(I),I=J,JP)        2DB 1582
2050  FORMAT(I4,40X,2F20.4)                          2DB 1583
  GO TO 1850                                         2DB 1584
2150  WRITE (NOUT,2250) (I,R1(I),R4(I),I=J,IP)        2DB 1585
2250  FORMAT(I4,2F20.4)                              2DB 1586
1850  CONTINUE                                       2DB 1587
  DO 2350 I=1, IM                                    2DB 1588
  DO 2350 J=1, JM                                    2DB 1589
  N0(I,J) = 0.0                                       2DB 1590
2350  F2(I,J) = 0.0                                   2DB 1591
  DO 1050 IIG=1, IGM                                  2DB 1592
  WRITE (NOUT,250) IIG                               2DB 1593
250  FORMAT(1H1, 20X,14HFLUX FOR GROUP,I2)           2DB 1594
  READ (NFLUX1)((N2(I,J),I=1,IM),J=1,JM)            2DB 1595
  READ (NCR1)((CO(IJ,J), II = 1, ITL), J = 1, MT)    2DB 1596
  DO 2550 I=1, IM                                    2DB 1597
  DO 2550 J=1, JM                                    2DB 1598
  N0(I,J) = N0(I,J) + N2(I,J)                        2DB 1599
  ITEMP = M0(I,J)                                     2DB 1600
  ITEMP = M2(ITEMP)                                   2DB 1601
2550  F2(I,J) = F2(I,J) + CO(1,ITEMP)*N2(I,J)*1000.*TSD 2DB 1602
  IF(NPUN) 1450,1450,1041                            2DB 1603
C PUNCH FLUXES                                       2DB 1604
1041  DO 3200 I=1,IMJM,6                             2DB 1605
  DO 3100 J=1,6                                       2DB 1606
3100  FLUX(J) = 0.0                                   2DB 1607
  II = MIN0(I+5,IMJM)                               2DB 1608
  JI = 1                                              2DB 1609
  DO 3110 J=I,II                                       2DB 1610
  FLUX(JI) = FN2(J)                                   2DB 1611
3110  JI = JI + 1                                       2DB 1612
  PUNCH 1042,(FLUX(J),J=1,6),ICARD                  2DB 1613
3200  ICARD = ICARD + 1                                2DB 1614
1042  FORMAT(1P6E12.6,4HFLUX,I4)                    2DB 1615
1450  CALL PRT(IM,JM,N0,Z4,NOUT)                     2DB 1616
1050  CONTINUE                                       2DB 1617
  WRITE(NOUT,21250)                                   2DB 1618
21250  FORMAT(1H1//, 19X,11H TOTAL FLUX//)          2DB 1619
  CALL PRT(IM,JM,N0,Z4,NOUT)                         2DB 1620
  WRITE(NOUT,22250)                                   2DB 1621
22250  FORMAT(1H1//, 19X, 26HPOWER DENSITY (MWT/LITER)) 2DB 1622
  CALL PRT(IM,JM,F2,Z4,NOUT)                         2DB 1623

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	WRITE (NOUT,1250)	2DB 1624
1250	FORMAT(1H1,20X,19HFISSION SOURCE RATE)	2DB 1625
	CALL PRT(IM,JM,F0,Z4,NOUT)	2DB 1626
	REWIND NCRI	2DB 1627
	REWIND NFLUX1	2DB 1628
9950	RETURN	2DB 1629
	END	2DB 1630

-ITC	FOR S8847,S8847	2DB 1631
	SUBROUTINE S8847	2DB 1632
	INCLUDE ABC	2DB 1633
	E2(IGP) = .0	2DB 1634
	E3(IGP) = .0	2DB 1635
	E4(IGP) = .0	2DB 1636
	E5(IGP) = .0	2DB 1637
	E6(IGP) = .0	2DB 1638
	E7(IGP) = .0	2DB 1639
	E8(IGP) = .0	2DB 1640
	E9(IGP) = .0	2DB 1641
	DO 10 I = 1,IGM	2DB 1642
	E2(IGP) = E2(IGP) + E2(I)	2DB 1643
	E3(IGP) = E3(IGP) + E3(I)	2DB 1644
	E4(IGP) = E4(IGP) + E4(I)	2DB 1645
	E5(IGP) = E5(IGP) + E5(I)	2DB 1646
	E6(IGP) = E6(IGP) + E6(I)	2DB 1647
	E7(IGP) = E7(IGP) + E7(I)	2DB 1648
	E8(IGP) = E8(IGP) + E8(I)	2DB 1649
10	E9(IGP) = E9(IGP) + E9(I)	2DB 1650
	WRITE(NOUT,20)	2DB 1651
20	FORMAT (1H1, 28H FINAL NEUTRON BALANCE TABLE///	2DB 1652
	159H GROUP FISSION SOURCE IN-SCATTER OUT-SCATTER ABSORPTION,1X,2DB 1653	
	265H L. L. R. L. T. L. B. L. TOTAL LEAKA2DB 1654	
	3GE//)	2DB 1655
	DO 30 I = 1,IGM	2DB 1656
25	FORMAT (I6, 1P9E13.3)	2DB 1657
30	WRITE(NOUT,25) I,E1(I),E2(I),E3(I),E4(I),E5(I),E6(I),E7(I),	2DB 1658
	1 E8(I),E9(I)	2DB 1659
	WRITE(NOUT,35)	2DB 1660
35	FORMAT (1H)	2DB 1661
	I = IGM + 1	2DB 1662
	WRITE(NOUT,25) I,E1(I),E2(I),E3(I),E4(I),E5(I),E6(I),E7(I),	2DB 1663
	1 E8(I),E9(I)	2DB 1664
	RETURN	2DB 1665
	END	2DB 1666

-IT FOR PRT,PRT	2DB 1667
SUBROUTINE PRT (JIM,JJM, N2, Z4, NOUT)	2DB 1668
DIMENSION N2(JIM,JJM), Z4(1)	2DB 1669
REAL N2	2DB 1670
IM = JIM	2DB 1671
JM = JJM	2DB 1672
DO 850 I=1,IM,5	2DB 1673
I1=I	2DB 1674
I2=I+4	2DB 1675
IF(I2-IM) 450,450,550	2DB 1676
550 I2=IM	2DB 1677
450 WRITE (NOUT,650) (JJ,JJ=I1,I2)	2DB 1678
650 FORMAT(5I20)	2DB 1679
DO 850 JJ=1,JM	2DB 1680
J=JJ	2DB 1681
750 FORMAT(I5,E15.7,5E20.7)	2DB 1682
850 WRITE(NOUT,750) J,(N2(K,J),K=I1,I2),Z4(J)	2DB 1683
RETURN	2DB 1684
END	2DB 1685

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-ITC  FOR  GRAM,GRAM                                2DB 1686
      SUBROUTINE GRAM(MASS, VOL,  ATW, HOLN,JIM,JJM, M0, M2, V0,  2DB 1687
1      IO, I1, I2,JML)                                2DB 1688
      INCLUDE ABC                                    2DB 1689
      DIMENSION MASS(JML,1), VOL(1), ATW(1), HOLN(1), M0(JIM,JJM),  2DB 1690
1      M2(1), V0(JIM,JJM), IO(1), I1(1), I2(1)        2DB 1691
C      THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS  2DB 1692
      WRITE(NOUT,1) (ID(I), I=1,11)                  2DB 1693
1      FORMAT(1H1,11A6///)                            2DB 1694
      WRITE(NOUT, 5)                                  2DB 1695
5      FORMAT(45H MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE / )  2DB 1696
      CALL CLEAR(0.0,VOL,IZM)                          2DB 1697
      ITEMP = ML*IZM                                    2DB 1698
      CALL CLEAR(0.0,MASS,ITEMP)                       2DB 1699
      DO 20  J = 1, JM                                  2DB 1700
      DO 20  I = 1, IM                                  2DB 1701
      K = M0(I,J)                                       2DB 1702
      KK = M2(K)                                       2DB 1703
120      VOL(K) = VOL(K) + V0(I, J)*.001              2DB 1704
      DO 40  N = 1, IZM                                2DB 1705
      NN = M2(N)                                       2DB 1706
      DO 40  M = 1,M01                                  2DB 1707
      IF(IO(M) - NN) 40,22,40                          2DB 1708
22      L = I1(M)                                       2DB 1709
      IF(L - ML) 28,28,24                              2DB 1710
24      NNAA = L                                       2DB 1711
      IF(L - IO(M)) 38, 25, 38                        2DB 1712
25      MM = M - 1                                       2DB 1713
      DO 27  MAA = 1, MM                               2DB 1714
      IF(IO(MAA) - NNAA) 27, 26, 27                   2DB 1715
26      L = I1(MAA)                                    2DB 1716
      IF(L) 27, 27, 29                                 2DB 1717
29      IF(I2(M)) 44, 44, 46                          2DB 1718
44      E01 = I2(MAA)*EV                               2DB 1719
      GO TO 47                                          2DB 1720
46      E01 = I2(MAA)*I2(M)                            2DB 1721
47      MASS(L,N) = ((E01*ATW(L)*VOL(N))/ .6023)      2DB 1722
27      CONTINUE                                       2DB 1723
      GO TO 40                                          2DB 1724
38      DO 35  MAA = 1, M01                             2DB 1725
      IF(IO(MAA) - NNAA) 35,32,35                     2DB 1726
32      L = I1(MAA)                                    2DB 1727
      IF(L) 35,35,33                                   2DB 1728
33      E01 = I2(MAA)*I2(M)                            2DB 1729
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/ .6023) + MASS(L,N)  2DB 1730
35      CONTINUE                                       2DB 1731
      GO TO 40                                          2DB 1732
28      IF(L) 40,40,30                                 2DB 1733
30      E01 = I2(M)                                     2DB 1734
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/ .6023) + MASS(L,N)  2DB 1735
40      CONTINUE                                       2DB 1736
      DATA  ZONE/6H ZONE /                            2DB 1737
      DO 90  L = 1, IZM, 5                             2DB 1738
      LL = L + 4                                       2DB 1739
      IF(LL - IZM) 62, 62, 61                         2DB 1740
61      LL = IZM                                       2DB 1741
62      WRITE(NOUT, 72) ((ZONE, K), K=L, LL)          2DB 1742
72      FORMAT(/ /26H MATERIAL ATOMIC WT. ,3X, 5(A6,I2,12X))  2DB 1743
      WRITE(NOUT, 73) (VOL(K), K = L, LL)             2DB 1744
73      FORMAT(25X, 5(F8.2, 7H LITERS, 5X))          2DB 1745
      DO 75  K = 1, ML                                 2DB 1746
75      WRITE(NOUT, 76) K, HOLN(K), ATW(K), (MASS(K, I), I = L, LL)  2DB 1747

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```
76  FORMAT( I3,1X, A6, F13.3, 1X, 1PE13.3, 1P4E20.3)
    IF(LL - IZM) 90, 94, 94
90  CONTINUE
94  RETURN
    END
```

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2DB 1748
2DB 1749
2DB 1750
2DB 1751
2DB 1752
-
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-ITC	FOR INPB,INPB	2DB	1753
	SUBROUTINE INPB(MATN,NBR,LD,LCN,LFN,ALAM,HOLN,JML)	2DB	1754
	INCLUDE ABC	2DB	1755
	DIMENSION MATN(1), NBR(1), LD(1),LCN(JML,1),LFN(JML,1), ALAM(1),	2DB	1756
	1 HOLN(1)	2DB	1757
C	THIS SUBROUTINE READS AND PRINTS THE BURNUP DATA	2DB	1758
	READ(NINP,10) ITEMP, NPRT, DELT	2DB	1759
10	FORMAT(2I6, E12.0)	2DB	1760
	DAY = DAY + DELT	2DB	1761
	CVT = 0	2DB	1762
	CNT = 0	2DB	1763
	P02 = 0	2DB	1764
	ALA = 0.0	2DB	1765
	LAP = 0.0	2DB	1766
	LAPP = 0.0	2DB	1767
	LAR = 0.0	2DB	1768
	KPAGE = 100	2DB	1769
	IF(ITEMP) 190, 15, 20	2DB	1770
15	NCON = ITEMP	2DB	1771
	GO TO 190	2DB	1772
20	NCON = ITEMP	2DB	1773
	DO 40 N = 1, NCON	2DB	1774
30	FORMAT(12I6)	2DB	1775
40	READ(NINP,30) MATN(N),NBR(N),LD(N),(LCN(N,K),K=1,2),(LFN(N,K),	2DB	1776
	1 K=1,7)	2DB	1777
	WRITE(NOUT,60)	2DB	1778
60	FORMAT(12H1BURNUP DATA///)	2DB	1779
	WRITE(NOUT,70)	2DB	1780
70	FORMAT(130H BURNABLE MATERIAL NAME LAMBDA	2DB	1781
1	NBR * * * * * SOURCE ISOTOPE FOR * * *	2DB	1782
2	* * /	2DB	1783
3	130H ISOTOPE NO. (DAYS-1)	2DB	1784
4	DECAY CAPTURE FISS	2DB	1785
5	ION /9H NO.)	2DB	1786
	DO 90 N=1, NCON	2DB	1787
80	FORMAT(3X, I3, 12X, I3, 10X, A6, 8X, E8.3, I9,15X, I3, 13X, 2I3,	2DB	1788
1	10X, 7I3)	2DB	1789
	ITEMP = MATN(N)	2DB	1790
	ALAM(ITEMP) = 24.*3600.*ALAM(ITEMP)	2DB	1791
	WRITE(NOUT,80) N, MATN(N), HOLN(ITEMP), ALAM(ITEMP), NBR(N),	2DB	1792
	1LD(N), (LCN(N,K),K=1,2), (LFN(N,K),K=1,7)	2DB	1793
90	ALAM(ITEMP) = ALAM(ITEMP)/(3600.*24.)	2DB	1794
190	RETURN	2DB	1795
	END	2DB	1796


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-ITC FOR AVERAG, AVERAG                                2DB 1797
  SUBROUTINE AVERAG(PHIB,AXS,FXS,MATN,MASS,ATW,VOL,CO,N2,M0,V0, 2DB 1798
    1      HOLN, JML, JTL, NBR)                            2DB 1799
    DIMENSION PHIB(1), AXS(JML,1), FXS(JML,1), MATN(1), MASS(JML,1), 2DB 1800
    1      ATW(1), VOL(1), CO(JTL,1), N2(1), M0(1), V0(1), HOLN(1) 2DB 1801
    2      , NBR(1)                                          2DB 1802
    INCLUDE ABC                                              2DB 1803
  C THIS SUBROUTINE CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS 2DB 1804
  C SECTIONS, AND ABSORPTION CROSS SECTIONS.              2DB 1805
    RL = 0.0                                                2DB 1806
    RC = 0.0                                                2DB 1807
    DO 10 KZ=1,IZM                                          2DB 1808
    PHIB(KZ) = 0.0                                          2DB 1809
    DO 10 KN=1,NCON                                          2DB 1810
    AXS(KN,KZ) = 0.0                                        2DB 1811
    FXS(KN,KZ) = 0.0                                        2DB 1812
    LN = MATN(KN)                                           2DB 1813
  10 MASS(LN,KZ) = (MASS(LN,KZ)*.6023)/(ATW(LN)*VOL(KZ)) 2DB 1814
    DO 100 IIG=1,IGM                                        2DB 1815
    READ(NCR1) ((CO(IJ,J)), IJ=1,ITL),J=1,MT)             2DB 1816
    READ(NFLUX1) (N2(I), I=1,IMJM)                        2DB 1817
    DO 100 I=1,IMJM                                         2DB 1818
    KZ = M0(I)                                              2DB 1819
    PHIB(KZ) = PHIB(KZ) + N2(I)*V0(I)                     2DB 1820
    DO 100 KN=1,NCON                                        2DB 1821
    LN = MATN(KN)                                           2DB 1822
    AXS(KN,KZ) = AXS(KN,KZ) + CO(2,LN)*N2(I)*V0(I)        2DB 1823
  100 FXS(KN,KZ) = FXS(KN,KZ) + CO(1,LN)*N2(I)*V0(I)      2DB 1824
    DO 200 KZ=1,IZM                                         2DB 1825
    TEMP3 = PHIB(KZ)                                        2DB 1826
    PHIB(KZ) = PHIB(KZ)/(VOL(KZ)*1000.)                   2DB 1827
    WRITE(NOUT,110) KZ, PHIB(KZ), VOL(KZ)                 2DB 1828
  110 FORMAT(1H1,30X,9H Z O N E ,I3,7X,7H FLUX =,1PE10.4,7X,9H VOLUME =, 2DB 1829
    1 1PE10.4,7H LITERS/)                                  2DB 1830
    WRITE(NOUT,120)                                         2DB 1831
  120 FORMAT(115H BURNABLE MATERIAL NAME ATOM 2DB 1832
    1 FISSION ABSORPTION SIGMA SIGMA / 2DB 1833
    2 115H ISOTOPE NO. DENSITY 2DB 1834
    3 RATE RATE FISSION ABSORPTION/ 2DB 1835
    4 7H NO./) 2DB 1836
    DO 200 KN=1,NCON 2DB 1837
    LN = MATN(KN) 2DB 1838
    TEMP1 = AXS(KN,KZ)*MASS(LN,KZ) 2DB 1839
    TEMP2 = FXS(KN,KZ)*MASS(LN,KZ) 2DB 1840
    AXS(KN,KZ) = AXS(KN,KZ)/TEMP3 2DB 1841
    FXS(KN,KZ) = FXS(KN,KZ)/TEMP3 2DB 1842
  130 FORMAT(4X,I3,11X,I3,10X,A6,2X,1P5E15.3) 2DB 1843
    WRITE(NOUT,130) KN, LN, HOLN(LN), MASS(LN,KZ), TEMP2, TEMP1, 2DB 1844
    1 FXS(KN,KZ), AXS(KN,KZ) 2DB 1845
    ITEMP = NBR(KN) 2DB 1846
    IF(ITEMP - 1) 200, 140, 160 2DB 1847
  140 RC = RC + TEMP1 - TEMP2 2DB 1848
    GO TO 200 2DB 1849
  160 RL = RL + TEMP1 2DB 1850
  200 CONTINUE 2DB 1851
    TEMP = RC/RL 2DB 1852
    WRITE(NOUT,350) TEMP 2DB 1853
  350 FORMAT(1H ///18H BREEDING RATIO =F7.4) 2DB 1854
    REWIND NCR1 2DB 1855

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REWIND NFLUX1
RETURN
END

2DB 1856
2DB 1857
2DB 1858
-

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-ITC FOR MARCH,MARCH                                2DB 1859
  SUBROUTINE MARCH(PHIB,MATN,FXS,AXS,VOL,MASS,MASSP,ALAM,LD,LCN, 2DB 1860
1      LFN,JML,I0,I1,I2,M2)                            2DB 1861
  DIMENSION PHIB(1), MATN(1), FXS(JML,1),AXS(JML,1),VOL(1), 2DB 1862
1      MASS(JML,1),MASSP(JML,1),ALAM(1), LD(1), LCN(JML,1), 2DB 1863
2      LFN(JML,1),I0(1), I1(1), I2(1), M2(1)            2DB 1864
  INCLUDE ABC                                          2DB 1865
C  THIS SUBROUTINE COMPUTES THE TIME DEPENDENT ISOTOPIC CONCENTRATION 2DB 1866
  TEMP = DELT * 24. * 3600. / 10.                    2DB 1867
  TEMP1 = .0                                           2DB 1868
  DO 5 KZ = 1,IZM                                     2DB 1869
  PHIB(KZ) = PHIB(KZ) * 10.**(-24)                    2DB 1870
  DO 5 KN = 1,NCON                                     2DB 1871
  LN = MATN(KN)                                       2DB 1872
5  TEMP1 = TEMP1 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ) 2DB 1873
  DO 200 KT = 1,10                                    2DB 1874
  TEMP3 = .0                                           2DB 1875
  DO 20 KZ = 1,IZM                                    2DB 1876
  DO 20 KN = 1,NCON                                   2DB 1877
  LN = MATN(KN)                                       2DB 1878
20  MASSP(LN,KZ) = MASS(LN,KZ)                        2DB 1879
  DO 100 KZ = 1,IZM                                   2DB 1880
  DO 50 KKK = 1,5                                     2DB 1881
  DO 50 KN = 1,NCON                                   2DB 1882
  LN = MATN(KN)                                       2DB 1883
  TEMP2=-(MASS(LN,KZ)+MASSP(LN,KZ))*(ALAM(LN)+AXS(KN,KZ)*PHIB(KZ)) 2DB 1884
  IF (LD(KN)) 30, 30, 28                             2DB 1885
28  KK = LD(KN)                                       2DB 1886
  KK = MATN(KK)                                       2DB 1887
  TEMP2 = TEMP2 + ALAM(KK)*(MASS(KK,KZ) + MASSP(KK,KZ)) 2DB 1888
30  DO 32 K = 1,2                                     2DB 1889
  KK = LCN(KN,K)                                     2DB 1890
  KL = MATN(KK)                                       2DB 1891
  IF (KK) 32,32,31                                   2DB 1892
31  TEMP2 = TEMP2 + (AXS(KK,KZ) - FXS(KK,KZ))*PHIB(KZ)* 2DB 1893
1  (MASS(KL,KZ) + MASSP(KL,KZ))                     2DB 1894
32  CONTINUE                                          2DB 1895
  DO 36 K = 1,7                                       2DB 1896
  KK = LFN(KN,K)                                     2DB 1897
  KL = MATN(KK)                                       2DB 1898
  IF (KK) 36,36,34                                   2DB 1899
34  TEMP2 = TEMP2 + FXS(KK,KZ)*PHIB(KZ)*(MASS(KL,KZ)+MASSP(KL,KZ)) 2DB 1900
36  CONTINUE                                          2DB 1901
50  MASS(LN,KZ) = MASSP(LN,KZ) + .5*TEMP*TEMP2       2DB 1902
  DO 100 KN = 1,NCON                                  2DB 1903
  LN = MATN(KN)                                       2DB 1904
100  TEMP3 = TEMP3 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ) 2DB 1905
  IF(TEMP3) 200,200,110                              2DB 1906
110  DO 120 KZ = 1,IZM                                2DB 1907
120  PHIB(KZ) = PHIB(KZ) * TEMP1/TEMP3               2DB 1908
200  CONTINUE                                          2DB 1909
  DO 500 KZ = 1,IZM                                   2DB 1910
500  PHIB(KZ) = PHIB(KZ)*10.**(-24)                  2DB 1911
  DO 540 KZ=1,IZM                                     2DB 1912
  DO 540 M=1,M01                                     2DB 1913
  IF(I0(M) - M2(KZ)) 540,520,540                    2DB 1914
520  DO 530 KN=1,NCON                                 2DB 1915
  LN = MATN(KN)                                       2DB 1916
  IF(LN - I1(M)) 530,525,530                         2DB 1917

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

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2DB 1918
2DB 1919
2DB 1920
2DB 1921
2DB 1922
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