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2DB USER'S MANUAL -- REVISION I

By

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FFTF Project

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2DB USER'S MANUAL -- REVISION I

W. W. Little, Jr. and R. W. Hardie

ABSTRACT

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

The code can be used to:

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

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

TABLE OF CONTENTS

ABSTRACT	
I. INTRODUCTION	1
II. FORMULATION OF DIFFERENCE EQUATIONS	3
Neutron Balance Equations	3
Discussion of Boundary Conditions.	6
Discussion of Triangular Mesh Option.	8
III. SOLUTION OF DIFFERENCE EQUATIONS	10
IV. SEARCH OPTIONS	12
Time Absorption (α calculation)	12
Material Concentration (C calculation)	13
Zone Dimensions (δ calculation)	14
Buckling (B^2 calculation)	14
V. BURNUP MODEL	15
Remarks on Burnup Equations.	16
VI. SOURCE OPTION.	17
VII. REMARKS ON CODE OPERATION.	18
VIII. REPRESENTATIVE RUNNING TIMES ON A UNIVAC 1108	20
REFERENCES	21
APPENDIX A: SIMPLIFIED LOGICAL FLOW DIAGRAM	A-1
APPENDIX B: INPUT INSTRUCTIONS	B-1
APPENDIX C: STORAGE REQUIREMENTS.	C-1
APPENDIX D: SAMPLE PROBLEM.	D-1
APPENDIX E: FORTRAN-IV SOURCE DECK LISTING	E-1

2DB USER'S MANUAL -- REVISION I

W. W. Little, Jr. and R. W. Hardie

I. INTRODUCTION

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

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

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

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

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

II. FORMULATION OF DIFFERENCE EQUATIONS

Neutron Balance Equations

The multigroup diffusion equations can be written in the form

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

where

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

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

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

χ_g = fission source fraction in group g ,

k_{eff} = effective multiplication constant.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

where

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

and

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

Fig. 2.1. Mesh Description

Discussion of Boundary Conditions

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

Zero Flux Gradient

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

Zero Flux

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

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

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

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

Periodic Flux

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

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

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

and

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

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

Fig. 2.2. Schematic Diagram of 1-D Reactor

Discussion of Triangular Mesh Option

Since most fast reactors are composed of hexagonal subassemblies, a triangular mesh option has been added to 2DB. Hexagons are formed by appropriate grouping of six triangular mesh intervals.

In the triangular mesh option, the (i,j) coordinate grid is composed of a rectangular array of triangles. As in the other geometry options, the mesh points are placed in the center of each interval, or triangle. See Figure 2.3 for a simple 3×4 mesh example.

Fig. 2.3. Triangular Mesh Example (3 x 4)

In contrast to the other geometry options, however, the mesh boundaries must be equally spaced. In fact, the radial (RB_i) and axial (ZB_j) mesh boundaries must be computed by the expressions

$$RB_i = (i-1) \frac{FTF}{2\sqrt{3}} , \quad i=1, \dots, IM+1 \quad (2.9)$$

$$ZB_j = (j-1) \frac{FTF}{2} , \quad j=1, \dots, JM+1 \quad (2.10)$$

where FTF is the flat-to-flat hexagon width.

Only vacuum and reflective boundary conditions are available with the triangular mesh option. The user is cautioned against using reflective left and right boundaries since this implies no surface leakage from each mesh interval on the left and right border.

III. SOLUTION OF DIFFERENCE EQUATIONS

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

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

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

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

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

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

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

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

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

The flux over-relaxation factor, β , is an input parameter. The fission source over-relaxation factor, β' , is computed internally from the ad hoc expression

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

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

It should be mentioned that an alternating direction SLOR scheme (using line inversion for rows and then columns in alternation) is included as an option to enhance convergence for problems involving tight mesh spacing in both dimensions.

IV. SEARCH OPTIONS:

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

Time Absorption (α calculation)

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

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

If we now assume that

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

we can obviously rewrite Equation (4.1) in the form

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

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

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

Material Concentration (C calculation)

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

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

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

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

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

All of the foregoing can be summarized by the expression

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

where:

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

σ_2 = microscopic cross section for Material 2,

σ_4 = microscopic cross section for Material 4,

EV = eigenvalue.

Zone Dimensions (δ calculation)

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

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

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

Buckling (B^2 calculation)

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

V. BURNUP MODEL

The basic burnup equation for each zone has the form

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

where:

N^i = density of nuclide i ,

λ^i = decay constant for nuclide i ,

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

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

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

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

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

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

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

the particular march-out algorithm used can be written as

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

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

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

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

where v is the iteration index.

Remarks on Burnup Equations

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

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

VI. SOURCE OPTION

2DB will compute the effective multiplication constant and flux profiles resulting from an arbitrary (in space and energy) extraneous source distribution. The following suggestions will assist the user in running source problems:

1. A source problem is meaningless (and will not converge) if $k > 1.0$.
2. Convergence can be accelerated by giving the code an estimate of k (Card 4, Word 1).
3. At least a trace of fission multiplication must be present in the system (i.e., $k > 0$).
4. A good estimate of the initial total neutron production rate (Card 5, Word 6) will enhance convergence. This value can be estimated using the simple expression

$$N = \frac{kS}{1-k} \quad , \quad (6.1)$$

where:

N = total neutron production rate from fission,

S = total neutron source rate from extraneous source,

k = multiplication constant.

VII. REMARKS ON CODE OPERATION

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

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

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

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

5. A flux dump is given only when:

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

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

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

VIII. REPRESENTATIVE RUNNING TIMES ON A UNIVAC 1108

2DB running times for problems involving typical fast reactor compositions are shown in Table 8.1. All problems are run using an initial flat flux and a k_{eff} convergence criterion of 10^{-5} .

Table 8.1
Representative Running Times for k_{eff} Calculations

<u>Case</u>	<u>Geometry</u>	<u>No. of Groups</u>	<u>Mesh Size</u>	<u>Approx. Time (minutes)</u>
1	R-Z	2	20 x 20	0.2
2	R- θ	4	20 x 30	0.7
3	X-Y	5	40 x 40	2.3
4	Triangular	5	51 x 34	2.5
5	R-Z	20	20 x 20	3.0
6	R-Z	20	33 x 29	6.1
7	R-Z	26	24 x 18	4.1
8	R-Z	26	33 x 29	7.5

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APPENDIX A

SIMPLIFIED LOGICAL FLOW DIAGRAM

APPENDIX A

SIMPLIFIED LOGICAL FLOW DIAGRAM

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

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

INPB	Reads and prints input data; sets core storage requirements.
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.
S864	Reads input source from cards.
S8830	Monitor print.
S8847	Computes and prints total neutron balance.
S8850	Final print.

Fig. A.1. 2DB Calling Sequence

APPENDIX B

INPUT INSTRUCTIONS

APPENDIX B
INPUT INSTRUCTIONS

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

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

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

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
I04	7-12	I6	Eigenvalue type: = 0, source, = 1, k_{eff} , = 2, time absorption (α), = 3, concentration (C), = 4, zone thickness (δ), = 5, buckling (B^2).
S02	13-18	I6	Parametric eigenvalue type: = 0, none, = 1, k_{eff} , = 2, α .
IGM	19-24	I6	Number of energy groups ($1 \leq N \leq 50$).
NXCM	25-30	I6	Number of downscattering terms.
MCR	31-36	I6	Number of materials (cross sections) from cards.
MTP	37-42	I6	Number of materials from tape.
M07	43-48	I6	Initial flux guess: = 0, none, = 1, $X(R)*X(Z)$ from cards, = 2, $X(R,Z,E)$ from cards, = 3, $X(R,Z,E)$ from tape.
D05	49-54	I6	Maximum number of outer iterations Representative value ≈ 50 .
G07	55-60	I6	Maximum number of inner iterations per group. Representative value $\approx 5-10$.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
S04	61-66	I6	Trigger for alternating the direction of line inversion (used in X-Y and R-Z geometry only): = 0, no effect, = 1, alternate directions.
NPUN	67-72	I6	Flux dump option: = 0, no punch, = 1, punch flux dump, = 2, punch flux and I2 card, = 3, write flux on tape, = 4, write flux on tape and punch I2.
<u>CARD 3</u>			
IGE	1-6	I6	Geometry specification: = 0, X-Y, = 1, R-Z, = 2, R- θ , = 3, triangular.
IM	7-12	I6	Number of radial intervals (≥ 3).
JM	13-18	I6	Number of axial intervals (≥ 3).
IZM	19-24	I6	Number of material zones.
MT	25-30	I6	Total number of materials, including mixes.
M01	31-36	I6	Number of mixture specifications.
B01	37-42	I6	Left boundary condition: = 0, vacuum, = 1, reflective.
B02	43-48	I6	Right boundary condition.
B03	49-54	I6	Top boundary condition: = 0, vacuum, = 1, reflective, = 2, periodic.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
B04	55-60	I6	Bottom boundary condition.
IZ	61-66	I6	Number of radial zones (δ option only).
JZ	67-72	I6	Number of axial zones (δ option only).
<u>CARD 4</u>			
EV	1-12	E12	Initial eigenvalue guess. (Used only in search calculations.)
EVM	13-24	E12	Initial eigenvalue modifier. This value should <u>decrease</u> reactivity--i.e., EV + EVM should produce a lower reactivity than EV. Since EVM is completely problem dependent, no representative values can be given. However, this parameter is rather important, so some thought should be given to estimating a reasonable value. (Used only in search calculations.)
S03	25-36	E12	Parametric eigenvalue (see third word on Card 2).
BUCK	37-48	E12	Buckling (cm^{-2}). Caution--search (and burnup) calculations that include a buckling term cannot be performed using input cross sections (mixes) directly in zones. Furthermore, a given input mix cannot be used directly in two or more zones in k_{eff} or search problems that have a buckling term. These problems can be avoided by mixing with a density of 1.0. If searching on buckling, BUCK should be zero.
LAL	49-60	E12	Lower limit on $ \lambda-1 $, where $\lambda-1$ is, in essence, the predicted change in the current re-

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
			activity. After LAL is reached, the eigenvalue slope is no longer altered. LAL is used only in search calculations. Recommended value .005.
LAH	61-72	E12	Upper limit on $ \lambda-1 $. If $ \lambda-1 $ is greater than LAH, LAH rather than $ \lambda-1 $ is used in predicting the new eigenvalue. LAH is used only in search calculations. Recommended value .5.
<u>CARD 5</u>			
EPS	1-12	E12	Convergence criterion on the total fission source rate. The maximum error in k_{eff} is actually about 3xEPS.
EPSA	13-24	E12	Parametric eigenvalue convergence criterion. The eigenvalue is recalculated when $ \lambda^{v+1}-\lambda^v $ is less than EPSA. EPSA is only used in search calculations. Recommended value 10xEPS.
G06	25-36	E12	Flux convergence test (if zero, no test). That is, $\text{Max}(\phi^{v+1}-\phi^v /\phi^v)$.
POD	37-48	E12	Parameter oscillation damper. Ratio of the computed eigenvalue change to the predicted eigenvalue change. POD can be used to accelerate convergence or damp out oscillations. (Used only in search calculations.)
ORF	49-60	E12	Over-relaxation factor. If instabilities arise, reduce ORF. Recommended value -1.5.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
S01	61-72	E12	If X negative, the total power is normalized to $ X $ Mwt using the conversion factor of 215 MeV/fission. If positive, $X = \text{total source}/k_{\text{eff}}$.

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	$\nu\sigma_f$.
C(ITL,IGM, MCR)	37-48	E12	σ_{tr} .
C(ITL,IGM, MCR)	49-60	E12	$\sigma(g \rightarrow g)$
C(ITL,IGM, MCR)	61-72	E12	$\sigma(g-l \rightarrow g)$.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
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CARD 8

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

...

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

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

CARD 9 (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.

CARD 9' (Optional, required if M07=1)

ZF(JM)	1-12	E12(GI)	Initial flux guess for first axial interval.
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ZF(JM)	13-24	E12(GI)	Initial flux guess for second axial interval.
--------	-------	---------	---

...

This flux profile is used for all energy groups.

CARD 9'' (Optional, required if M07=2)

NO(IMJM)	1-12	E12	Initial flux guess for first mesh point in first group.
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NO(IMJM)	13-24	E12	Initial flux guess for second mesh point in first group. Continue for all mesh points and all energy groups. Each new group begins on a new card.
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...

* Generalized input format.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
<u>CARD 9</u> (Optional, required if I04=0)			
SO(IMJM)	1-12	E12(GI)	Extraneous source for first mesh point of first group.
SO(IMJM)	13-24	E12(GI)	Extraneous source for second mesh point of first group. Continues 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 $^{\circ}$).
...			
<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>CARD 13</u>			
M2(IZM)	1-12	I12(GI)	Material number for first zone.

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
M2(IZM)	13-24	I12(GI)	Material number for second zone.

...

CARD 14

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

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

...

CARD 15

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

...

V7(IGM)	13-24	E12(GI)	Neutron velocity for second energy group.
---------	-------	---------	---

CARD 16 (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.
---------	--------	---------	---------------------------

...

CARD 17 (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.
---------	-------	---------	-------------------------------------

...

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

CARD 18 (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.
...			

CARD 19 (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.
...			

CARD 20 (Optional, required if I04=4)

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

CARD 21 (Optional, required if I04=4)

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

<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
Z2(JM)	13-24	I12(GI)	Dimensional search zone number for second axial interval.

...

CARD 22 (Optional, required if I04=4)

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

...

CARD 23 (Burnup Control Card)

NCON	1-6	I6	Burnup control: = 0, end of problem, read input data for next case, = N, read burnup parameters for N isotopes and take time step of DELT, < 0, take time step of DELT.
NPRT	7-12	I6	Print control: = 0, partial print, = 1, full print.
DELT	13-24	E12	Length of time step (days). If zero, code proceeds to next case.

CARD 24 (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.
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<u>Variable</u>	<u>Columns</u>	<u>Format</u>	<u>Description</u>
NBR(NCON)	7-12	I6	Control for breeding ratio calculation: = 0, no effect, = 1, fertile isotope, = 2, fissile isotope.
LD(NCON)	13-18	I6	= 0, no decay source, = N, decay source from burnable isotope N.
LCN(NCON,2)	19-24	I6	= 0, no capture source, = N, capture source from burnable isotope N. See Eq. (5.1).
LCN(NCON,2)	25-30	I6	= 0, no capture source, = N, capture source from burnable isotope N.
LFN(NCON,7)	31-36	I6	= 0, no fission source, = N, fission source from burnable isotope N. See Eq. (5.1).
LFN(NCON,7)	37-48	I6	= 0, no fission source, = N, fission source from burnable isotope N.
...			

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

B-7c

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	
HOLNMCR1 NAME OF 1ST ISOTOPE												ATWIMCR1 ATOMIC WT. OF 1ST ISOTOPE												ALAMMCR1 DECAY CONSTANT OF 1ST ISOTOPE (DAYS ⁻¹)												A(9) MISCELLANEOUS INFORMATION FOR 1ST ISOTOPE (H66)																																																																																																																											
CROSS SECTION DATA FOR 1ST ISOTOPE (NEZ.5)																																																																														CITL1GM, MCR1																																																																																	
• • • (REPEAT ABOVE TWO CARDS FOR EACH ISOTOPE)																																																																																																																																																															
FLUX GUESS IN FIRST RADIAL INTERVAL												FLUX GUESS IN SECOND RADIAL INTERVAL												• • •																								RF1(M)																																																																																																															
FLUX GUESS IN FIRST AXIAL INTERVAL												FLUX GUESS IN SECOND AXIAL INTERVAL												• • •																								ZF1(M)																																																																																																															
FLUX GUESS IN 1ST MESH INTERVAL FOR GROUP 1												FLUX GUESS IN 2ND MESH INTERVAL FOR GROUP 1												• • •																								N01(MJ)																																																																																																															
• • • (REPEAT ABOVE CARD FOR ALL GROUPS)																																																																														N01(MJ)																																																																																	
SOURCE IN 1ST MESH INTERVAL FOR GROUP 1												SOURCE IN 2ND MESH INTERVAL FOR GROUP 1																																																																																																																																																			
• • • (REPEAT ABOVE CARD FOR ALL GROUPS)																																																																																																																																																															
1ST RADIAL POINT (0.0)												2ND RADIAL POINT												• • •																								R01(M+1)																																																																																																															
1ST AXIAL POINT (0.0)												2ND AXIAL POINT												• • •																								Z01(M+1)																																																																																																															
ZONE NUMBER FOR 1ST MESH INTERVAL												ZONE NUMBER FOR 2ND MESH INTERVAL												• • •																								M01(MJ)																																																																																																															
MATERIAL NUMBER FOR 1ST ZONE												MATERIAL NUMBER FOR 2ND ZONE												• • •																								M21(ZM)																																																																																																															
FISSION SPECTRUM IN 1ST GROUP												FISSION SPECTRUM IN 2ND GROUP												• • •																								K71(GM)																																																																																																															
NEUTRON VELOCITY IN 1ST GROUP												NEUTRON VELOCITY IN 2ND GROUP												• • •																								V71(GM)																																																																																																															
MATERIAL NUMBER OF MIX 1												• • •												MATERIAL NUMBER OF MIX 2												• • •												I0(MD)																																																																																																															
0												1ST MATERIAL IN MIX 1												2ND MATERIAL IN MIX 1												• • •												I1(MD)																																																																																																															
0												DENSITY OF 1ST MATERIAL IN MIX 1												DENSITY OF 2ND MATERIAL IN MIX 1												• • •												I2(MD)																																																																																																															

1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80	
ZONE NUMBER FOR 1ST RADIAL INTERVAL												ZONE NUMBER FOR 2ND RADIAL INTERVAL												...												R2(I,M)																																																																																																																											
MODIFIER FOR 1ST RADIAL ZONE												MODIFIER FOR 2ND RADIAL ZONE												...												R3(I,Z)																																																																																																																											
ZONE NUMBER FOR 1ST AXIAL INTERVAL												ZONE NUMBER FOR 2ND AXIAL INTERVAL												...												Z2(I,M)																																																																																																																											
MODIFIER FOR 1ST AXIAL ZONE												MODIFIER FOR 2ND AXIAL ZONE												...												Z3(I,Z)																																																																																																																											
NC(0) - 0, END OF PROBLEM - N, TAKE TIME STEP OF DELT AND READ BURNUP DATA FOR N ISOTOPE. < 0, TAKE TIME STEP OF DELT				NPRT - 0, PARTIAL PRINT - 1, FULL PRINT				DELT LENGTH OF TIME STEP (DAYS)																																																																																																																																																							
MATN(0,N) MATERIAL SEQUENCE NUMBER FOR 1ST BURNABLE ISOTOPE				NBRN(0,N) - 0, NO EFFECT - 1, FERTILE ISOTOPE - 2, FISSION ISOTOPE				LDIN(0,N) - 0, NO DECAY SOURCE - N, DECAY SOURCE FROM BURNABLE ISOTOPE N				LNIN(0,N, Z) - 0, NO CAPTURE SOURCE - N, CAPTURE SOURCE FROM BURNABLE ISOTOPE N				...				LNIN(0,N, Z) - 0, NO FISSION PRODUCT SOURCE - N, FISSION PRODUCT SOURCE FROM BURNABLE ISOTOPE N																																																																																																																																											
... (REPEAT ABOVE CARD FOR ALL BURNABLE ISOTOPES) ...																																																																																																																																																															
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	

B-15

BNWL-831 REV1

BNWL-831 REV1

APPENDIX C

STORAGE REQUIREMENTS

APPENDIX C

STORAGE REQUIREMENTS

The variable dimensioned arrays require N storage locations where

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

$$N_1 = 5 + 10 \times \text{IM} \times \text{JM}$$

$$+ 7 \times \text{IM}$$

$$+ 5 \times \text{JM}$$

$$+ 4 \times \text{MOI}$$

$$+ 3 \times (\text{IGM} + \text{IZM})$$

$$+ \text{ML} \times (15 + 4 \times \text{IZM})$$

$$+ \text{MT} \times \text{ITL}$$

$$+ 2 \times \text{MAX}(\text{IM}, \text{JM})$$

$$+ \text{IZ} + \text{JZ} + \text{IM} + \text{JM} \quad (\text{if } \delta \text{ calculation})$$

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

and:

IM = number of radial intervals

JM = number of axial intervals

IGM = number of energy groups

IZM = number of material zones

MOI = number of mixture specifications

ML = number of materials from cards or tape

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

MT = total number of materials, including mixes

IZ = number of radial zone modifiers

JZ = number of axial zone modifiers.

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

APPENDIX D

SAMPLE PROBLEM

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

2 D B SAMPLE CASE											
0	1	0	2	1	10	0	0	100	10	0	0
1	20	20	2	12	13	1	0	0	1	0	0
0.0		0.0		0.0		0.0		0.001		0.5	
.00001		.001		0.0		1.0		1.4		-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		.139455+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		.118886+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	.245083+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	.664718+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											

D-1

BNWL-831 REV1

	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
2	2	0	6	0	0	0
3	1	0	0	0	0	0
4	2	0	0	0	0	0
5	0	0	0	1	2	3
9	1	0	0	0	0	0
-1	0	50.0				
0						

* * * * 2 D B * * * *

2 D B SAMPLE CASE

2

A02	0/1=REGULAR CALCULATION/ADJOINT CALCULATION	0
I04	EIGENVALUE TYPE (0/1/2/3/4/5=SOURCE/KEFF/ALPHA/CONCENTRATION/DELTA/BUCKLING)	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 (0/1/2/3=NONE/X(R)*X(Z)/X(R,Z,E)/X(R,Z,E) FROM TAPE)	0
D05	OUTER ITERATION MAX	100
G07	INNER ITERATION MAX PER GROUP	10
S04	INVERSION DIRECTION (0/1=NO EFFECT/ALTERNATE DIRECTIONS)	0
NPUN	FLUX DUMP (0/1/2/3/4=NONE/CARDS/CARDS+I2/TAPE/TAPE+I2)	0
IGE	GEOMETRY (0/1/2/3=X-Y/R-Z/R-THETA/TRIANGULAR)	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 (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	0
B04	BOTTOM BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	1
I2	RADIAL ZONES (DELTA-OPTION ONLY)	0
J2	AXIAL ZONES (DELTA-OPTION ONLY)	0
EV	FIRST EIGENVALUE GUESS	0.0000
EVM	EIGENVALUE MODIFIER	0.0000
S03	PARAMETRIC EIGENVALUE	0.0000
BUCK	BUCKLING (CM-2)	0.0000
LAL	LAMBDA LOWER	1.0000+03
LAH	LAMBDA UPPER	5.0000+01
EPS	EIGENVALUE CONVERGENCE CRITERION	1.0000+05
EPSA	PARAMETER CONVERGENCE CRITERION	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

D-3

BNWL-831 REV1

2 D B SAMPLE CASE

CROSS SECTIONS ARE READ-IN FOR THE FOLLOWING MATERIALS

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	.22615+02	.25846+02	.29077+02
.32308+02	.35538+02	.38769+02	.42000+02	.46286+02	.50571+02	.54857+02	.59143+02	.63429+02	.67714+02
.72000+02									
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	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
.96700-00 .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	11	12
12		12	12							
I1	13									
0		1	2	3	4	5	6	7	8	0
9		2	10							
I2	13									
.00000	.80000-02	.16000-02	.10000-03	.00000	.00000	.20000-01	.60000-02	.13000-01	.00000	
.40000-01	.00000	.62000-02								

D-6

BNML-831 REV1

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	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	1	1	2	2	2	2	2	2
1	1	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	1	1	2	2	2	2	2	2
1	1	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	1	1	2	2	2	2	2	2
1	1	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	1	1	2	2	2	2	2	2
1	1	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	1	1	2	2	2	2	2	2
1	1	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	1	1	2	2	2	2	2	2
1	1	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-7

BNWL-831 REV1

**A
X
I
A
L**

D-8

BNWL-837 REV7

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	.40000000-01
12	12	2	.00000000
13	12	10	.61999999-02

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	.286+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	.402+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
.04	0	0	.00000000	.00000000	.00000000
.06	1	20	.00000000	.61088087-00	.61088087-00
.08	2	20	.00000000	.90818236-00	.14866767+01
.10	3	20	.00000000	.96537480-00	.10629746+01
.12	4	20	.00000000	.97870443-00	.10138077+01
.14	5	20	.00000000	.98406757-00	.10054798+01
.17	6	20	.00000000	.98584874-00	.10018100+01
.19	7	20	.00000000	.98642689-00	.10005864+01
.21	8	20	.00000000	.98661625-00	.10001920+01
.23	9	18	.00000000	.98667763-00	.10000622+01
.24	10	11	.00000000	.98669479-00	.10000174+01
.25	11	6	.00000000	.98670115-00	.10000064+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	-6.185+11	3.845+18	4.204+18	0.000	2.507+17	1.104+17	0.000	3.611+17
2	1.108+17	3.845+18	2.464+13	3.858+18	0.000	6.780+16	2.993+16	0.000	9.773+16
3	8.521+18	3.845+18	3.845+18	8.062+18	0.000	3.185+17	1.403+17	0.000	4.588+17

D-12

BNWL-831 REV1

	RADII	AVG RADII	AXII	AVG AXII
1	- .0000	1.6154	- .0000	1.4615
2	3.2368	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	24.2368	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	3.2368	68.0000	2.9231

FLUX FOR GROUP 1

	1	2	3	4	5	
1	.4069521+16	.4035218+16	.3967039+16	.3865861+16	.3732987+16	.1461538+01
2	.4041265+16	.4007196+16	.3939482+16	.3838994+16	.3707027+16	.4384615+01
3	.3984960+16	.3951357+16	.3884570+16	.3785459+16	.3655299+16	.7307692+01
4	.3901020+16	.3868112+16	.3802707+16	.3705647+16	.3578182+16	.1023077+02
5	.3790061+16	.3758073+16	.3694496+16	.3600148+16	.3476245+16	.1315385+02
6	.3652904+16	.3622052+16	.3560735+16	.3469741+16	.3350242+16	.1607692+02
7	.3490562+16	.3461058+16	.3402418+16	.3315395+16	.3201111+16	.1900000+02
8	.3304244+16	.3276288+16	.3220725+16	.3138266+16	.3029971+16	.2192308+02
9	.3095345+16	.3069128+16	.3017021+16	.2939688+16	.2838117+16	.2484615+02
10	.2865443+16	.2841145+16	.2792850+16	.2721172+16	.2627018+16	.2776923+02
11	.2616293+16	.2594081+16	.2549932+16	.2484400+16	.2398309+16	.3069231+02
12	.2349828+16	.2329855+16	.2290156+16	.2231224+16	.2153792+16	.3361538+02
13	.2068159+16	.2050564+16	.2015588+16	.1963663+16	.1895428+16	.3653846+02
14	.1539336+16	.1526221+16	.1500151+16	.1461442+16	.1410563+16	.4014286+02
15	.1026653+16	.1017888+16	.1000462+16	.9745837+15	.9405605+15	.4442857+02
16	.6910349+15	.6752082+15	.6636238+15	.6464195+15	.6237980+15	.4871429+02
17	.4462820+15	.4424573+15	.4348534+15	.4235619+15	.4087181+15	.5300000+02
18	.2842015+15	.2817632+15	.2769165+15	.2697208+15	.2602652+15	.5728571+02
19	.1684091+15	.1669636+15	.1640908+15	.1598269+15	.1542267+15	.6157143+02
20	.8004766+14	.7936057+14	.7799517+14	.7596914+14	.7330915+14	.6585714+02
	6	7	8	9	10	
1	.3570127+16	.3379381+16	.3163201+16	.2924373+16	.2665972+16	.1461538+01
2	.3545281+16	.3355838+16	.3141139+16	.2903949+16	.2647327+16	.4384615+01
3	.3495770+16	.3308925+16	.3097175+16	.2863249+16	.2610168+16	.7307692+01
4	.3421957+16	.3238985+16	.3031628+16	.2802564+16	.2554757+16	.1023077+02
5	.3324386+16	.3146530+16	.2944976+16	.2722333+16	.2481489+16	.1315385+02
6	.3203779+16	.3032244+16	.2837857+16	.2623139+16	.2390880+16	.1607692+02
7	.3061036+16	.2896979+16	.2711066+16	.2505712+16	.2283603+16	.1900000+02
8	.2897230+16	.2741755+16	.2565558+16	.2370930+16	.2160428+16	.2192308+02
9	.2713608+16	.2567759+16	.2402449+16	.2219826+16	.2022291+16	.2484615+02
10	.2511586+16	.2376344+16	.2223021+16	.2053593+16	.1870275+16	.2776923+02
11	.2292743+16	.2169328+16	.2028720+16	.1873595+16	.1705641+16	.3069231+02
12	.2058822+16	.1947487+16	.1821156+16	.1681375+16	.1529858+16	.3361538+02
13	.1811718+16	.1713549+16	.1602094+16	.1478655+16	.1344630+16	.3653846+02
14	.1348122+16	.1274854+16	.1191590+16	.1099214+16	.9985814+15	.4014286+02
15	.8987899+15	.8497482+15	.7939725+15	.7320333+15	.6644965+15	.4442857+02
16	.5960253+15	.5634192+15	.5263490+15	.4852262+15	.4405071+15	.4871429+02
17	.3905003+15	.3691279+15	.3448620+15	.3180091+15	.2889334+15	.5300000+02
18	.2486684+15	.2350789+15	.2196778+15	.2026836+15	.1843619+15	.5728571+02
19	.1473636+15	.1393306+15	.1302427+15	.1202399+15	.1094930+15	.6157143+02
20	.7005121+14	.6624130+14	.6193641+14	.5720621+14	.5213513+14	.6585714+02
	11	12	13	14	15	
1	.2391336+16	.2104022+16	.1807780+16	.1304100+16	.8472099+15	.1461538+01
2	.2374587+16	.2089265+16	.1795086+16	.1294936+16	.8412408+15	.4384615+01
3	.2341204+16	.2059850+16	.1769781+16	.1276654+16	.8293460+15	.7307692+01
4	.2291419+16	.2015975+16	.1732032+16	.1249377+16	.8115808+15	.1023077+02

D-14

BNML-831 REV1

5	.2225576+16	.1957937+16	.1682087+16	.1213277+16	.7880709+15	.1315385+02
6	.2144133+16	.1886125+16	.1620268+16	.1168574+16	.7589484+15	.1607692+02
7	.2047662+16	.1801019+16	.1546968+16	.1115532+16	.7243754+15	.1900000+02
8	.1936845+16	.1703189+16	.1462640+16	.1054435+16	.6845288+15	.2192308+02
9	.1812487+16	.1593291+16	.1367783+16	.9855643+15	.6395842+15	.2484615+02
10	.1675528+16	.1472077+16	.1262927+16	.9091214+15	.5896933+15	.2776923+02
11	.1527079+16	.1340426+16	.1148610+16	.8250674+15	.5349575+15	.3069231+02
12	.1366494+16	.1199442+16	.1025409+16	.7326909+15	.4754325+15	.3361538+02
13	.1201473+16	.1050698+16	.8941628+15	.6293930+15	.4113220+15	.3653846+02
14	.8903207+15	.7743187+15	.6481927+15	.4785024+15	.3283279+15	.4014286+02
15	.5912713+15	.5145818+15	.4331588+15	.3359261+15	.2411833+15	.4442857+02
16	.3927164+15	.3425324+15	.2910142+15	.2317636+15	.1718608+15	.4871429+02
17	.2580853+15	.2260560+15	.1936642+15	.1568743+15	.1190148+15	.5300000+02
18	.1650418+15	.1451375+15	.1251676+15	.1025784+15	.7908481+14	.5728571+02
19	.9820962+14	.8664065+14	.7508013+14	.6201681+14	.4833568+14	.6157143+02
20	.4682446+14	.4139328+14	.3597599+14	.2985481+14	.2341747+14	.6585714+02
	16	17	18	19	20	
1	.5489614+15	.3520040+15	.2194798+15	.1272660+15	.5910957+14	.1461538+01
2	.5450873+15	.3495176+15	.2179294+15	.1263675+15	.5869251+14	.4384615+01
3	.5373635+15	.3445609+15	.2148392+15	.1245770+15	.5786159+14	.7307692+01
4	.5258375+15	.3371660+15	.2102306+15	.1219079+15	.5662334+14	.1023077+02
5	.5105799+15	.3273808+15	.2041365+15	.1183808+15	.5498790+14	.1315385+02
6	.4916828+15	.3152700+15	.1966017+15	.1140244+15	.5296947+14	.1607692+02
7	.4692581+15	.3009156+15	.1876851+15	.1088769+15	.5058709+14	.1900000+02
8	.4434362+15	.2844199+15	.1774630+15	.1029884+15	.4786572+14	.2192308+02
9	.4143675+15	.2659122+15	.1660344+15	.9642408+14	.4483772+14	.2484615+02
10	.3822306+15	.2455615+15	.1535300+15	.8926880+14	.4154471+14	.2776923+02
11	.3472597+15	.2236009+15	.1401252+15	.8163256+14	.3803934+14	.3069231+02
12	.3098186+15	.2003705+15	.1260561+15	.7365544+14	.3438648+14	.3361538+02
13	.2705728+15	.1763764+15	.1116342+15	.6550907+14	.3066256+14	.3653846+02
14	.2215458+15	.1467447+15	.9389114+14	.5549769+14	.2608690+14	.4014286+02
15	.1680453+15	.1138327+15	.7398169+14	.4419018+14	.2089890+14	.4442857+02
16	.1230916+15	.8519779+14	.5626341+14	.3398006+14	.1617544+14	.4871429+02
17	.8711616+14	.6141936+14	.4114973+14	.2510956+14	.1202716+14	.5300000+02
18	.5883816+14	.4209055+14	.2853574+14	.1756439+14	.8457902+13	.5728571+02
19	.3637121+14	.2629243+14	.1798188+14	.1114085+14	.5386462+13	.6157143+02
20	.1774013+14	.1290570+14	.8874036+13	.5520389+13	.2675806+13	.6585714+02

FLUX FOR GROUP 2

	1	2	3	4	5	
1	.1905837+16	.1889656+16	.1857486+16	.1809718+16	.1746928+16	.1461538+01
2	.1892503+16	.1876433+16	.1844485+16	.1797045+16	.1734688+16	.4384615+01
3	.1865920+16	.1850073+16	.1818566+16	.1771783+16	.1710288+16	.7307692+01
4	.1826261+16	.1810745+16	.1779897+16	.1734092+16	.1673884+16	.1023077+02
5	.1773775+16	.1758698+16	.1728722+16	.1684213+16	.1625708+16	.1315385+02
6	.1708791+16	.1694257+16	.1665362+16	.1622457+16	.1566061+16	.1607692+02
7	.1631700+16	.1617812+16	.1590200+16	.1549200+16	.1495308+16	.1900000+02
8	.1542953+16	.1529868+16	.1503676+16	.1464872+16	.1413864+16	.2192308+02
9	.1443037+16	.1430732+16	.1406268+16	.1369940+16	.1322185+16	.2484615+02
10	.1332460+16	.1321086+16	.1298473+16	.1264892+16	.1220745+16	.2776923+02
11	.1211721+16	.1201367+16	.1180781+16	.1150209+16	.1110012+16	.3069231+02
12	.1081271+16	.1072623+16	.1053635+16	.1026324+16	.9904134+15	.3361538+02
13	.9414666+15	.9334078+15	.9173841+15	.8935840+15	.8622850+15	.3653846+02
14	.6858410+15	.6799645+15	.6682797+15	.6509226+15	.6280934+15	.4014286+02
15	.4499334+15	.4460723+15	.4383945+15	.4269886+15	.4119846+15	.4442857+02
16	.2946477+15	.2921153+15	.2870797+15	.2795991+15	.2697590+15	.4871429+02
17	.1909757+15	.1893325+15	.1860651+15	.1812121+15	.1748303+15	.5300000+02
18	.1200949+15	.1190609+15	.1170053+15	.1139530+15	.1099411+15	.5728571+02
19	.6934813+14	.6875101+14	.6756415+14	.6580233+14	.6348781+14	.6157143+02
20	.2963739+14	.2938225+14	.2887518+14	.2812265+14	.2713444+14	.6585714+02
	6	7	8	9	10	
1	.1669867+16	.1579445+16	.1476708+16	.1362816+16	.1239006+16	.1461538+01
2	.1658158+16	.1568360+16	.1466334+16	.1353230+16	.1230280+16	.4384615+01
3	.1634817+16	.1546263+16	.1445652+16	.1334120+16	.1212883+16	.7307692+01
4	.1599993+16	.1513294+16	.1414794+16	.1305606+16	.1186923+16	.1023077+02
5	.1553908+16	.1469664+16	.1373954+16	.1267866+16	.1152560+16	.1315385+02
6	.1496850+16	.1415644+16	.1323388+16	.1221133+16	.1110004+16	.1607692+02
7	.1429168+16	.1351565+16	.1263404+16	.1165691+16	.1059507+16	.1900000+02
8	.1351263+16	.1277809+16	.1194359+16	.1101868+16	.1001364+16	.2192308+02
9	.1263572+16	.1194792+16	.1116647+16	.1030028+16	.9359026+15	.2484615+02
10	.1166554+16	.1102956+16	.1030684+16	.9505617+15	.8634788+15	.2776923+02
11	.1060665+16	.1002738+16	.9368948+15	.8638710+15	.7844668+15	.3069231+02
12	.9463189+15	.8945458+15	.8356740+15	.7703451+15	.6992471+15	.3361538+02
13	.8238471+15	.7787037+15	.7273490+15	.6703213+15	.6081815+15	.3653846+02
14	.6000508+15	.5671038+15	.5295997+15	.4879041+15	.4423656+15	.4014286+02
15	.3935506+15	.3718868+15	.3472188+15	.3197867+15	.2898310+15	.4442857+02
16	.2576709+15	.2434693+15	.2273101+15	.2093686+15	.1898424+15	.4871429+02
17	.1669945+15	.1577972+15	.1473489+15	.1357803+15	.1232485+15	.5300000+02
18	.1050190+15	.9924894+14	.9270700+14	.8548555+14	.7769784+14	.5728571+02
19	.6065053+14	.5732852+14	.5356891+14	.4942943+14	.4498080+14	.6157143+02
20	.2592373+14	.2450741+14	.2290648+14	.2114670+14	.1925947+14	.6585714+02
	11	12	13	14	15	
1	.1106556+16	.9667362+15	.8207479+15	.5789561+15	.3701342+15	.1461538+01
2	.1098753+16	.9599111+15	.8149481+15	.5748609+15	.3675127+15	.4384615+01
3	.1083195+16	.9463022+15	.8033828+15	.5666945+15	.3622848+15	.7307692+01
4	.1059977+16	.9259906+15	.7861197+15	.5545034+15	.3544799+15	.1023077+02

5	.1029239+16	.8990960+15	.7632580+15	.5383560+15	.3441410+15	.1315385+02
6	.9911640+15	.8657729+15	.7349249+15	.5183386+15	.3313227+15	.1607692+02
7	.9459721+15	.8262070+15	.7012711+15	.4945515+15	.3160886+15	.1900000+02
8	.8939182+15	.7806091+15	.6624633+15	.4671005+15	.2985069+15	.2192308+02
9	.8352853+15	.7292088+15	.6186745+15	.4360826+15	.2786452+15	.2484615+02
10	.7703809+15	.6722490+15	.5700698+15	.4015573+15	.2565627+15	.2776923+02
11	.6995355+15	.6099848+15	.5167900+15	.3634823+15	.2323053+15	.3069231+02
12	.6231066+15	.5427022+15	.4589454+15	.3215526+15	.2059192+15	.3361538+02
13	.5414880+15	.4707831+15	.3966804+15	.2747559+15	.1775540+15	.3653846+02
14	.3932386+15	.3404006+15	.2832415+15	.2072996+15	.1410145+15	.4014286+02
15	.2575813+15	.2232541+15	.1871692+15	.1443286+15	.1029737+15	.4442857+02
16	.1689653+15	.1470493+15	.1245863+15	.9883417+14	.7295324+14	.4871429+02
17	.1099507+15	.9614877+14	.8220642+14	.6640283+14	.5020192+14	.5300000+02
18	.6948527+14	.6102690+14	.5254751+14	.4296902+14	.3303277+14	.5728571+02
19	.4030966+14	.3552115+14	.3073883+14	.2534028+14	.1969753+14	.6157143+02
20	.1728266+14	.1526105+14	.1324540+14	.1096975+14	.8580831+13	.6585714+02
	16	17	18	19	20	
1	.2368646+15	.1502654+15	.9251636+14	.5223754+14	.2174085+14	.1461538+01
2	.2351853+15	.1491997+15	.9186047+14	.5186753+14	.2158698+14	.4384615+01
3	.2318365+15	.1470748+15	.9055303+14	.5113011+14	.2128039+14	.7307692+01
4	.2268375+15	.1439038+15	.8860275+14	.5003064+14	.2082341+14	.1023077+02
5	.2202168+15	.1397063+15	.8602301+14	.4857734+14	.2021969+14	.1315385+02
6	.2120115+15	.1345086+15	.8283219+14	.4678173+14	.1947433+14	.1607692+02
7	.2022666+15	.1283445+15	.7905457+14	.4465924+14	.1859420+14	.1900000+02
8	.1910350+15	.1212564+15	.7472180+14	.4223017+14	.1758839+14	.2192308+02
9	.1783790+15	.1132087+15	.6987547+14	.3952120+14	.1646874+14	.2484615+02
10	.1643747+15	.1045441+15	.6457104+14	.3656734+14	.1525058+14	.2776923+02
11	.1491271+15	.9509452+14	.5888371+14	.3341433+14	.1395347+14	.3069231+02
12	.1328040+15	.8510050+14	.5291545+14	.3012070+14	.1260167+14	.3361538+02
13	.1157172+15	.7478661+14	.4680096+14	.2675842+14	.1122387+14	.3653846+02
14	.9442526+14	.6206924+14	.3928618+14	.2262943+14	.9531941+13	.4014286+02
15	.7131616+14	.4799243+14	.3087308+14	.1797391+14	.7616592+13	.4442857+02
16	.5200275+14	.3578775+14	.2340334+14	.1377784+14	.5875897+13	.4871429+02
17	.3660333+14	.2567343+14	.1703792+14	.1013446+14	.4348302+13	.5300000+02
18	.2449175+14	.1743535+14	.1170996+14	.7025671+13	.3030160+13	.5728571+02
19	.1477278+14	.1062750+14	.7200020+13	.4347834+13	.1882961+13	.6157143+02
20	.6478142+13	.4689295+13	.3193746+13	.1936605+13	.8414535+12	.6585714+02

TOTAL FLUX

1	2	3	4	5		
1	.5975358+16	.5924874+16	.5824525+16	.5675578+16	.5479914+16	.1461538+01
2	.5933768+16	.5883629+16	.5783966+16	.5636039+16	.5441715+16	.4384615+01
3	.5850880+16	.5801430+16	.5703136+16	.5557241+16	.5365587+16	.7307692+01
4	.5727280+16	.5678857+16	.5582604+16	.5439739+16	.5252066+16	.1023077+02
5	.5563837+16	.5516771+16	.5423218+16	.5284361+16	.5101953+16	.1315385+02
6	.5361694+16	.5316309+16	.5226097+16	.5092198+16	.4916303+16	.1607692+02
7	.5122262+16	.5078869+16	.4992618+16	.4864596+16	.4696419+16	.1900000+02
8	.4847197+16	.4806096+16	.4724401+16	.4603138+16	.4443835+16	.2192308+02
9	.4538382+16	.4499860+16	.4423289+16	.4309628+16	.4160302+16	.2484615+02
10	.4197903+16	.4162231+16	.4091324+16	.3986064+16	.3847763+16	.2776923+02
11	.3828014+16	.3795448+16	.3730713+16	.3634608+16	.3508322+16	.3069231+02
12	.3431098+16	.3401878+16	.3343790+16	.3257548+16	.3144205+16	.3361538+02
13	.3009626+16	.2983972+16	.2932972+16	.2857247+16	.2757713+16	.3653846+02
14	.2225177+16	.2206186+16	.2168431+16	.2112364+16	.2038656+16	.4014286+02
15	.1476586+16	.1463960+16	.1438856+16	.1401572+16	.1352545+16	.4442857+02
16	.9756826+15	.9673235+15	.9507636+15	.9260186+15	.8935576+15	.4871429+02
17	.6372577+15	.6317897+15	.6209186+15	.6047740+15	.5835484+15	.5300000+02
18	.4042964+15	.4008242+15	.3939218+15	.3836738+15	.3702063+15	.5728571+02
19	.2377572+15	.2357147+15	.2316549+15	.2256293+15	.2177145+15	.6157143+02
20	.1096851+15	.1087428+15	.1068704+15	.1040918+15	.1004436+15	.6585714+02
6	7	8	9	10		
1	.5239994+16	.4958825+16	.4639909+16	.4287188+16	.3904978+16	.1461538+01
2	.5203439+16	.4924199+16	.4607473+16	.4257179+16	.3877607+16	.4384615+01
3	.5130587+16	.4855188+16	.4542827+16	.4197369+16	.3823051+16	.7307692+01
4	.5021950+16	.4752279+16	.4446421+16	.4166170+16	.3741680+16	.1023077+02
5	.4878294+16	.4616194+16	.4318930+16	.3990199+16	.3634049+16	.1315385+02
6	.4700629+16	.4447888+16	.4161245+16	.3844272+16	.3500889+16	.1607692+02
7	.4490204+16	.4248545+16	.3974470+16	.3671403+16	.3343109+16	.1900000+02
8	.4248493+16	.4019564+16	.3759917+16	.3472798+16	.3161792+16	.2192308+02
9	.3977180+16	.3762551+16	.3519096+16	.3249854+16	.2958194+16	.2484615+02
10	.3678140+16	.3479300+16	.3253706+16	.3004155+16	.2733754+16	.2776923+02
11	.3353408+16	.3171766+16	.2965615+16	.2737466+16	.2490108+16	.3069231+02
12	.3005141+16	.2842533+16	.2656830+16	.2451720+16	.2229105+16	.3561538+02
13	.2635566+16	.2492253+16	.2329443+16	.2148976+16	.1952812+16	.3653846+02
14	.1948173+16	.1841958+16	.1721189+16	.1587118+16	.1440947+16	.4014286+02
15	.1292340+16	.1221635+16	.1141191+16	.1051820+16	.9543281+15	.4442857+02
16	.8536961+15	.8068886+15	.7536591+15	.6945947+15	.6303494+15	.4871429+02
17	.5574947+15	.5269251+15	.4922169+15	.4537893+15	.4121819+15	.5300000+02
18	.3536874+15	.3343279+15	.3123848+15	.2881691+15	.2620597+15	.5728571+02
19	.2080141+15	.1966591+15	.1838116+15	.1696694+15	.1544738+15	.6157143+02
20	.9597494+14	.9074871+14	.8484289+14	.7835291+14	.7139459+14	.6585714+02
11	12	13	14	15		

D-18

BNWL-831 REV1

1	.3497892+16	.3070759+16	.2628528+16	.1883062+16	.1217344+16	.1461538+01
2	.3473340+16	.3049176+16	.2610034+16	.1869797+16	.1208754+16	.4384615+01
3	.3424399+16	.3006152+16	.2573164+16	.1843348+16	.1191625+16	.7307692+01
4	.3351396+16	.2941966+16	.2518152+16	.1803880+16	.1166061+16	.1023077+02
5	.3254815+16	.2857633+16	.2445345+16	.1751633+16	.1132212+16	.1315385+02
6	.3135297+16	.2751898+16	.2355193+16	.1686913+16	.1090271+16	.1607692+02
7	.2993634+16	.2627226+16	.2248239+16	.1610083+16	.1040464+16	.1900000+02
8	.2830764+16	.2483798+16	.2125103+16	.1521536+16	.9830357+15	.2192308+02
9	.2647773+16	.2322500+16	.1986457+16	.1421647+16	.9182294+15	.2484615+02
10	.2445909+16	.2144326+16	.1832996+16	.1310679+16	.8462560+15	.2776923+02
11	.2226615+16	.1950410+16	.1665400+16	.1188550+16	.7672628+15	.3069231+02
12	.1991601+16	.1742144+16	.1484354+16	.1054244+16	.6813516+15	.3361538+02
13	.1742961+16	.1521481+16	.1290843+16	.9041489+15	.5888766+15	.3653846+02
14	.1283559+16	.1114809+16	.9314342+15	.6858019+15	.4693424+15	.4014286+02
15	.8494526+15	.7378359+15	.6203200+15	.4802547+15	.3441570+15	.4442857+02
16	.5616817+15	.4895817+15	.4156065+15	.3305978+15	.2448141+15	.4871429+02
17	.3680359+15	.3222048+15	.2758707+15	.2232771+15	.1692168+15	.5300000+02
18	.2345271+15	.2061644+15	.1777151+15	.1455474+15	.1121176+15	.5728571+02
19	.1385193+15	.1221618+15	.1058190+15	.8735708+14	.6803321+14	.6157143+02
20	.6410712+14	.5665433+14	.4922140+14	.4082456+14	.3199830+14	.6585714+02
	16	17	18	19	20	
1	.7858259+15	.5022693+15	.3119961+15	.1795036+15	.8085042+14	.1461538+01
2	.7802726+15	.4987173+15	.3097898+15	.1782350+15	.8027949+14	.4384615+01
3	.7692000+15	.4916357+15	.3053922+15	.1757071+15	.7914198+14	.7307692+01
4	.7526750+15	.4810698+15	.2988334+15	.1719385+15	.7744675+14	.1023077+02
5	.7307968+15	.4670871+15	.2901595+15	.1669581+15	.7520759+14	.1315385+02
6	.7036943+15	.4497787+15	.2794338+15	.1608061+15	.7244380+14	.1607692+02
7	.6715246+15	.4292601+15	.2667396+15	.1535361+15	.6918130+14	.1900000+02
8	.6344712+15	.4056763+15	.2521848+15	.1452186+15	.6545411+14	.2192308+02
9	.5927465+15	.3792110+15	.2359099+15	.1359453+15	.6130645+14	.2484615+02
10	.5466053+15	.3501055+15	.2181011+15	.1258361+15	.5679528+14	.2776923+02
11	.4963867+15	.3186955+15	.1990069+15	.1150469+15	.5199281+14	.3069231+02
12	.4426234+15	.2854710+15	.1789715+15	.1037761+15	.4698815+14	.3361538+02
13	.3862900+15	.2511630+15	.1584351+15	.9226749+14	.4188643+14	.3653846+02
14	.3159711+15	.2088140+15	.1331773+15	.7812712+14	.3561884+14	.4014286+02
15	.2393615+15	.1618251+15	.1048548+15	.6216409+14	.2851549+14	.4442857+02
16	.1750943+15	.1209855+15	.7966675+14	.4775790+14	.2205133+14	.4871429+02
17	.1237195+15	.8709279+14	.5818764+14	.3524402+14	.1637540+14	.5300000+02
18	.8332991+14	.5952590+14	.4024570+14	.2459006+14	.1148800+14	.5728571+02
19	.5114399+14	.3691993+14	.2518190+14	.1548868+14	.7269424+13	.6157143+02
20	.2421827+14	.1759499+14	.1206778+14	.7456994+13	.3517200+13	.6585714+02

POWER DENSITY (MWT/LITER)

	1	2	3	4	5	
1	.7487714-00	.7424452-00	.7298702-00	.7112055-00	.6866865-00	.1461538+01
2	.7435596-00	.7372767-00	.7247878-00	.7062509-00	.6818997-00	.4384615+01
3	.7331729-00	.7269762-00	.7146588-00	.6963765-00	.6723600-00	.7307692+01
4	.7176844-00	.7116163-00	.6995547-00	.6816521-00	.6581346-00	.1023077+02
5	.6972029-00	.6913051-00	.6795818-00	.6621814-00	.6393236-00	.1315385+02
6	.6718720-00	.6661847-00	.6548801-00	.6381011-00	.6160594-00	.1607692+02
7	.6418681-00	.6364305-00	.6256222-00	.6095797-00	.5885052-00	.1900000+02
8	.6073988-00	.6022484-00	.5920111-00	.5768156-00	.5568531-00	.2192308+02
9	.5686999-00	.5638727-00	.5542775-00	.5400346-00	.5213225-00	.2484615+02
10	.5260327-00	.5215626-00	.5126772-00	.4994871-00	.4821566-00	.2776923+02
11	.4796793-00	.4755985-00	.4674866-00	.4554438-00	.4396190-00	.3069231+02
12	.4299382-00	.4262767-00	.4189979-00	.4081910-00	.3939883-00	.3361538+02
13	.3771185-00	.3739639-00	.3675134-00	.3580246-00	.3455524-00	.3653846+02
14	.7893116-01	.7825871-01	.7692191-01	.7493705-01	.7232817-01	.4014286+02
15	.5264278-01	.5219334-01	.5129980-01	.4997287-01	.4822829-01	.4442857+02
16	.3492083-01	.3462206-01	.3402805-01	.3314589-01	.3198597-01	.4871429+02
17	.2286361-01	.2268749-01	.2229760-01	.2171861-01	.2095748-01	.5300000+02
18	.1457275-01	.1444773-01	.1419920-01	.1383023-01	.1334539-01	.5728571+02
19	.8635365-02	.8561247-02	.8413939-02	.8195305-02	.7908148-02	.6157143+02
20	.4104533-02	.4069302-02	.3999289-02	.3895402-02	.3759009-02	.6585714+02
	6	7	8	9	10	
1	.6566217-00	.6213877-00	.5814234-00	.5372227-00	.4893262-00	.1461538+01
2	.6520409-00	.6170486-00	.5773588-00	.5334623-00	.4858963-00	.4384615+01
3	.6429117-00	.6084009-00	.5692579-00	.5259674-00	.4790599-00	.7307692+01
4	.6292983-00	.5955052-00	.5571773-00	.5147899-00	.4688634-00	.1023077+02
5	.6112965-00	.5784521-00	.5412013-00	.5000068-00	.4553761-00	.1315385+02
6	.5890330-00	.5573615-00	.5214415-00	.4817205-00	.4386898-00	.1607692+02
7	.5626641-00	.5323813-00	.4980363-00	.4600581-00	.4189183-00	.1900000+02
8	.5323745-00	.5036871-00	.4711501-00	.4351705-00	.3961971-00	.2192308+02
9	.4983753-00	.4714799-00	.4409721-00	.4072327-00	.3706838-00	.2484615+02
10	.4609011-00	.4359843-00	.4077148-00	.3764431-00	.3425584-00	.2776923+02
11	.4202068-00	.3974453-00	.3716124-00	.3430228-00	.3120259-00	.3069231+02
12	.3765624-00	.3561235-00	.3329160-00	.3072138-00	.2793178-00	.3361538+02
13	.3302466-00	.3122887-00	.2918875-00	.2692738-00	.2446928-00	.3653846+02
14	.6912649-01	.6536958-01	.6110009-01	.5636341-01	.5120338-01	.4014286+02
15	.4608646-01	.4357179-01	.4071183-01	.3753583-01	.3407280-01	.4442857+02
16	.3056186-01	.2888995-01	.2698913-01	.2488051-01	.2258749-01	.4871429+02
17	.2002334-01	.1892744-01	.1768318-01	.1630627-01	.1481538-01	.5300000+02
18	.1275075-01	.1205394-01	.1126423-01	.1039283-01	.9453361-02	.5728571+02
19	.7556231-02	.7144331-02	.6678338-02	.6165438-02	.5614377-02	.6157143+02
20	.3591954-02	.3396597-02	.3175859-02	.2933312-02	.2673287-02	.6585714+02
	11	12	13	14	15	
1	.4383118-00	.3847845-00	.3293639-00	.6686951-01	.4344163-01	.1461538+01
2	.4352352-00	.3820800-00	.3270465-00	.6639928-01	.4313556-01	.4384615+01

3	.4291025-00	.3766888-00	.3224265-00	.6546185-01	.4252533-01	.7307692+01
4	.4199546-00	.3686458-00	.3155333-00	.6406320-01	.4161471-01	.1023077+02
5	.4076521-00	.3580030-00	.3064102-00	.6221212-01	.4040922-01	.1315385+02
6	.3926754-00	.3448287-00	.2951137-00	.5991995-01	.3891593-01	.1607692+02
7	.3751236-00	.3292064-00	.2817117-00	.5720013-01	.3714316-01	.1900000+02
8	.3547142-00	.3112336-00	.2662820-00	.5406734-01	.3509998-01	.2192308+02
9	.3317834-00	.2910214-00	.2489087-00	.5053591-01	.3279539-01	.2484615+02
10	.3064874-00	.2686942-00	.2296789-00	.4661622-01	.3023718-01	.2776923+02
11	.2790068-00	.2443943-00	.2086776-00	.4230626-01	.2743054-01	.3069231+02
12	.2495559-00	.2182956-00	.1859906-00	.3756935-01	.2437833-01	.3361538+02
13	.2183967-00	.1906430-00	.1617413-00	.3227283-01	.2109102-01	.3653846+02
14	.4565219-01	.3970406-01	.3323681-01	.2453574-01	.1683538-01	.4014286+02
15	.3034886-01	.2638576-01	.2221070-01	.1722499-01	.1236694-01	.4442857+02
16	.2013697-01	.1756373-01	.1492208-01	.1188394-01	.8812357-02	.4871429+02
17	.1323361-01	.1159127-01	.9930351-02	.8043905-02	.6102619-02	.5300000+02
18	.8462703-02	.7442087-02	.6418110-02	.5259822-02	.4055162-02	.5728571+02
19	.5035808-02	.4442596-02	.3849817-02	.3179981-02	.2478406-02	.6157143+02
20	.2400977-02	.2122487-02	.1844709-02	.1530839-02	.1200757-02	.6585714+02
	16	17	18	19	20	
1	.2814861-01	.1804940-01	.1125407-01	.6525707-02	.3030909-02	.1461538+01
2	.2794996-01	.1792191-01	.1117457-01	.6479634-02	.3009524-02	.4384615+01
3	.2755391-01	.1766775-01	.1101612-01	.6387823-02	.2966918-02	.7307692+01
4	.2696290-01	.1728856-01	.1077981-01	.6250962-02	.2903425-02	.1023077+02
5	.2618056-01	.1678682-01	.1046733-01	.6070106-02	.2819566-02	.1315385+02
6	.2521159-01	.1616582-01	.1008097-01	.5846726-02	.2716069-02	.1607692+02
7	.2406173-01	.1542978-01	.9623762-02	.5582784-02	.2593910-02	.1900000+02
8	.2273768-01	.1458395-01	.9099613-02	.5280846-02	.2454368-02	.2192308+02
9	.2124716-01	.1363495-01	.8513600-02	.4944253-02	.2299104-02	.2484615+02
10	.1959930-01	.1259144-01	.7872424-02	.4577357-02	.2130251-02	.2776923+02
11	.1780613-01	.1146539-01	.7185076-02	.4185801-02	.1950510-02	.3069231+02
12	.1588630-01	.1027422-01	.6463667-02	.3776765-02	.1763205-02	.3361538+02
13	.1387392-01	.9043898-02	.5724166-02	.3359051-02	.1572257-02	.3653846+02
14	.1136001-01	.7524500-02	.4814373-02	.2845706-02	.1337635-02	.4014286+02
15	.8616712-02	.5836898-02	.3793494-02	.2265901-02	.1071615-02	.4442857+02
16	.6311657-02	.4368612-02	.2884969-02	.1742366-02	.8294136-03	.4871429+02
17	.4466978-02	.3149346-02	.2109998-02	.1287521-02	.6167060-03	.5300000+02
18	.3016993-02	.2158240-02	.1463202-02	.9006339-03	.4336884-03	.5728571+02
19	.1864975-02	.1348174-02	.9220409-03	.5712596-03	.2761969-03	.6157143+02
20	.9096451-03	.6617540-03	.4550261-03	.2830641-03	.1372050-03	.6585714+02

1

1

5	.3439489+14	.3019245+14	.2584338+14	.5114068+13	.3321788+13	.1315385+02
6	.3313197+14	.2908146+14	.2489066+14	.4925643+13	.3199033+13	.1607692+02
7	.3163505+14	.2776404+14	.2376039+14	.4702062+13	.3053305+13	.1900000+02
8	.2991407+14	.2624844+14	.2245913+14	.4444535+13	.2885348+13	.2192308+02
9	.2798052+14	.2454403+14	.2099400+14	.4154238+13	.2695902+13	.2484615+02
10	.2584761+14	.2266135+14	.1937233+14	.3832024+13	.2485607+13	.2776923+02
11	.2353061+14	.2061240+14	.1760135+14	.3477729+13	.2254891+13	.3069231+02
12	.2104765+14	.1841192+14	.1568831+14	.3088354+13	.2003987+13	.3361538+02
13	.1842093+14	.1608063+14	.1364368+14	.2652944+13	.1733759+13	.3653846+02
14	.3752779+13	.3263819+13	.2732187+13	.2016927+13	.1383929+13	.4014286+02
15	.2494788+13	.2169006+13	.1825801+13	.1415956+13	.1016607+13	.4442857+02
16	.1655333+13	.1443803+13	.1226649+13	.9769028+12	.7244075+12	.4871429+02
17	.1087851+13	.9528450+12	.8163109+12	.6612380+12	.5016572+12	.5300000+02
18	.6956649+12	.6117665+12	.5275919+12	.4323764+12	.3333489+12	.5728571+02
19	.4139616+12	.3651974+12	.3164689+12	.2614059+12	.2037388+12	.6157143+02
20	.1973689+12	.1744760+12	.1516417+12	.1258404+12	.9870650+11	.6585714+02
	16	17	18	19	20	
1	.2313920+13	.1483727+13	.9251257+12	.5364368+12	.2491517+12	.1461538+01
2	.2297591+13	.1473247+13	.9185906+12	.5326494+12	.2473937+12	.4384615+01
3	.2265034+13	.1452354+13	.9055651+12	.5251022+12	.2438913+12	.7307692+01
4	.2216450+13	.1421183+13	.8861396+12	.5138517+12	.2386719+12	.1023077+02
5	.2152138+13	.1379938+13	.8604522+12	.4989846+12	.2317784+12	.1315385+02
6	.2072485+13	.1328890+13	.8286921+12	.4806219+12	.2232706+12	.1607692+02
7	.1977963+13	.1268384+13	.7911079+12	.4589249+12	.2132286+12	.1900000+02
8	.1869121+13	.1198853+13	.7480209+12	.4341044+12	.2017578+12	.2192308+02
9	.1746594+13	.1120842+13	.6998483+12	.4064352+12	.1889945+12	.2484615+02
10	.1611134+13	.1035062+13	.6471413+12	.3762750+12	.1751141+12	.2776923+02
11	.1463728+13	.9424961+12	.5906387+12	.3440876+12	.1603387+12	.3069231+02
12	.1305911+13	.8445776+12	.5313363+12	.3104634+12	.1449416+12	.3361538+02
13	.1140486+13	.7434406+12	.4705466+12	.2761257+12	.1292449+12	.3653846+02
14	.9338336+12	.6185406+12	.3957583+12	.2339270+12	.1099582+12	.4014286+02
15	.7083245+12	.4798136+12	.3118384+12	.1862649+12	.8809037+11	.4442857+02
16	.5184407+12	.3591153+12	.2371544+12	.1432285+12	.6818059+11	.4871429+02
17	.3672015+12	.2588873+12	.1734491+12	.1058386+12	.5069529+11	.5300000+02
18	.2480075+12	.1774149+12	.1202803+12	.7403520+11	.3565062+11	.5728571+02
19	.1533075+12	.1108246+12	.7579495+11	.4695951+11	.2270428+11	.6157143+02
20	.7477601+11	.5439845+11	.3740467+11	.2326879+11	.1127861+11	.6585714+02

2 D B SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 .211+03 LITERS	ZONE 2 .897+03 LITERS
1 U238	238.050	6.659+02	0.000
2 PU239	239.050	1.337+02	0.000
3 PU240	240.050	8.393+00	0.000
4 PU241	241.060	0.000	0.000
5 FIS PR	1.000	0.000	0.000
6 C	12.011	8.399+01	0.000
7 NA	22.990	4.823+01	0.000
8 FE	55.847	2.538+02	0.000
9 U238	238.050	0.000	1.418+04
10 FE	55.847	0.000	5.156+02

BURNUP DATA

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

Z O N E 1

FLUX = 3.3289+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	3.276-01
2	2	PU239	1.600-03	2.133+18	2.567+18	1.901+00	2.289+00
3	3	PU240	1.000-04	3.387+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

D-26

BNML-831 REV1

Z O N E 2

FLUX = 3.7837+14

VOLUME = 8.9680+02 LITERS

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

BREEDING RATIO = 1.7918

D-27

BNWL-831 REV1

T I M E = 50.000 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

D-28

BNWL-831 REV1

TIME (MINUTES)	OUTER ITERATIONS	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.32	0	0	.00000000	.98670115-00	.00000000
.34	1	20	.00000000	.98105279-00	.98105278-00
.36	2	20	.00000000	.98041426-00	.99934911-00
.38	3	19	.00000000	.98029203-00	.99987532-00
.39	4	12	.00000000	.98027081-00	.99997833-00
.40	5	6	.00000000	.98026446-00	.99999350-00

2 D B SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1	ZONE 2
		.211+03 LITERS	.897+03 LITERS
1 U238	238.050	6.627+02	0.000
2 PU239	239.050	1.318+02	5.318+00
3 PU240	240.050	8.992+00	0.000
4 PU241	241.060	8.471+02	0.000
5 FIS 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

Z O N E 1

FLUX = 3.3479+15

VOLUME = 2.1059+02 LITERS

BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	7.962-03	3.837+17	1.840+18	6.835-02	3.278-01
2	2	PU239	1.577-03	2.115+18	2.547+18	1.902+00	2.290+00
3	3	PU240	1.071-04	3.644+16	8.815+16	4.825-01	1.167+00
4	4	PU241	1.005-06	1.404+15	1.562+15	1.982+00	2.204+00
5	5	FIS PR	5.208-05	0.000	9.767+15	0.000	2.060-01
6	9	U238	0.000	0.000	0.000	2.541-02	2.577-01

D-31

BNWL-831 REV1

		Z O N E 2	FLUX = 3.8248+14		VOLUME = 8.9686+02 LITERS		
BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	0.000	0.000	0.000	7.000-02	3.229-01
2	2	PU239	1.494-05	9.699+15	1.162+16	1.893+00	2.267+00
3	3	PU240	0.000	0.000	0.000	4.936-01	1.157+00
4	4	PU241	0.000	0.000	0.000	1.969+00	2.187+00
5	5	FIS PR	0.000	0.000	0.000	0.000	2.615-01
6	9	U238	3.998-02	3.570+17	3.486+18	2.603-02	2.542-01

BREEDING RATIO = 1.8115

T I M E = 100.000 D A Y S

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

.00000000
.79245275-02
.15552556-02
.11407686-03
.20546332-05
.10367872-03
.20000000-01
.59999999-02
.13000000-01
.00000000
.39966496-01
.29965182-04
.61999999-02

TIME (MINUTES)	OUTER ITERATIONS	IN. IT. PER LOOP	EIGENVALUE SLOPE	EIGENVALUE	LAMDA
.42	0	0	.00000000	.98026446-00	.00000000
.44	1	20	.00000000	.97477419-00	.97477418-00
.46	2	20	.00000000	.97411337-00	.99932206-00
.48	3	19	.00000000	.97398218-00	.99986529-00
.49	4	14	.00000000	.97395724-00	.99997438-00
.50	5	6	.00000000	.97395130-00	.99999388-00

2 D B SAMPLE CASE

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 .211+03 LITERS	ZONE 2 .897+03 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 U238	238.050	0.000	1.417+04
10 FE	55.847	0.000	5.156+02

BNWL-831 REV1

APPENDIX E

FORTRAN-IV SOURCE DECK LISTING

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-IL PDP INCL
ABC* FCOPY
COMMON NSORCE
COMMON NINP, NOUT, NCR1, NFLUX1, NSCRAT, ALA, B07,
1 CNT, CVT, DAY, DELT, E0(51), E1(51), E2(51),
2 E3(51), E4(51), E5(51), E6(51), E7(51), E8(51), E9(51),
3 E01, E02, E03, EQ, EVP, EVPP, FEF,
4 GBAR, GLH, IGE, IGP, IGV, IHS, IHT,
5 II, IMJM, IP, ITEMP, ITEMP1, ITEMP2, ITL,
6 IZP, JP, K07, KPAGE, LAP, LAPP, LAR,
7 LC, ML, NCON, NGOTO, NPRT, ORFP, P02,
8 PBAR, SSAR, SK7, T06, T7, T11, TEMP,
9 TEMP1, TEMP2, TEMP3, TEMP4, TI, TSD, V11,
COMMON ID(11), MAXT, A02, I04, S02, IGM, NXCM,
1 MCR, MTP, M07, D05, G07, S04, NPUN,
2 IGE, IM, JM, IZM, MT, M01, B01,
3 B02, B03, B04, IZ, JZ, EV, EVM,
4 S03, BUCK, LAL, LAH, EPS, EPSA, G06,
5 POD, ORF, S01
COMMON LATW, LHOLN, LALAM, LC0, LN0, LN2, LA0,
1 LA1, LF0, LF2, LI0, LI1, LI2, LI3,
2 LK6, LK7, LM0, LM2, LR0, LR1, LR2,
3 LR3, LR4, LR5, LS2, LVC, LV7, LZ0,
4 LZ1, LZ2, LZ3, LZ4, LZ5, LCXS, LVOL,
5 LMASS, LMATN, LNBR, LLD, LLCN, LLFN, LPHIB,
6 LAXS, LFXS, LMASSP, LCXR, LCXT, LHA, LPA,
INTEGER A02, B01, B02, B03, B04, B07, CNT,
1 CVT, D05, G07, P02, S02, S04, T06,
2 R2, Z2
REAL I2, I3, K6, K7, LAH, LAL, LAP,
1 LAPP, LAR, NC, N2, MASS, MASSP
END

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2DB 0001
2DB 0002
2DB 0003
2DB 0004
2DB 0005
2DB 0006
2DB 0007
2DB 0008
2DB 0009
2DB 0010
2DB 0011
2DB 0 12
2DB 0013
2DB 0014
2DB 0015
2DB 0016
2DB 0017
2DB 0018
2DB 0019
2DB 0020
2DB 0021
2DB 0022
2DB 0023
2DB 0024
2DB 0025
2DB 0026
2DB 0027
2DB 0028
2DB 0029
2DB 0030
2DB 0031
2DB 0032

```

-ITC FOR	CALC,CALC	2DB 0033
C		2DB 0034
C	***** DESCRIPTION OF SUBROUTINES *****	2DB 0035
C		2DB 0036
C	CALC	2DB 0037
C	MAIN PROGRAM--SETS UP TAPE UNITS AND CALLS INP, INIT,	2DB 0038
C	FISCAL, S8830, ERRO2, OUTER, CNNP, S8850, GRAM,	2DB 0039
C	INPB, AVERAG, AND MARCH.	2DB 0040
C		2DB 0041
C	INP	2DB 0042
C	SUBROUTINE TO CONTROL THE READING AND PRINTING OF ALL	2DB 0043
C	INPUT DATA, COMPUTE VARIABLE DIMENSION POINTERS AND	2DB 0044
C	PROGRAM CONSTANTS. INP IS CALLED BY CALC AND CALLS	2DB 0045
C	S860, S862, S864, REAG2, REA12, MAPR, AND ERRO2.	2DB 0046
C		2DB 0047
C	ERRO2	2DB 0048
C	ERRO2 IS USED TO PRINT AN ERROR MESSAGE. IT IS CALLED	2DB 0049
C	BY CALC, INP, REA12, REAG2, INIT, AND CNNP.	2DB 0050
C		2DB 0051
C	S860	2DB 0052
C	SUBROUTINE TO READ CROSS SECTIONS FROM CARDS, PERFORM	2DB 0053
C	ADJOINT REVERSALS IF REQUIRED, AND WRITE CROSS SECTION	2DB 0054
C	TAPE. S860 IS CALLED BY INP.	2DB 0055
C		2DB 0056
C	S862	2DB 0057
C	S862 READS INPUT FLUXES AND PREPARES A FLUX TAPE. IT IS	2DB 0058
C	CALLED BY INP AND CALLS REAG2.	2DB 0059
C		2DB 0060
C	S864	2DB 0061
C	S864 READS INPUT SOURCE AND PREPARES A SOURCE TAPE. IT	2DB 0062
C	IS CALLED BY INP AND CALLS REAG2.	2DB 0063
C		2DB 0064
C	REAG2	2DB 0065
C	SUBROUTINE TO READ FLOATING POINT DATA. REAG2 IS CALLED	2DB 0066
C	BY INP, S862, AND S864. REAG2 CALLS ERROR.	2DB 0067
C		2DB 0068
C	REA12	2DB 0069
C	SUBROUTINE TO READ INTEGER DATA. REA12 IS CALLED BY INP	2DB 0070
C	AND CALLS ERRO2.	2DB 0071
C		2DB 0072
C	MAPR	2DB 0073
C	SUBROUTINE TO PRODUCE A PICTURE BY ZONE AND	2DB 0074
C	MATERIAL. MAPR IS CALLED BY INP.	2DB 0075
C		2DB 0076
C	INIT	2DB 0077
C	INIT PERFORMS ADJOINT REVERSALS(S806), MIXES CROSS	2DB 0078
C	SECTIONS(S807), MODIFIES GEOMETRY(S810), AND CALCULATES	2DB 0079
C	AREAS AND VOLUMES(S811), AND FISSION NEUTRONS(S821).	2DB 0080
C	INIT IS CALLED BY CALC AND CALLS CLEAR AND ERRO2.	2DB 0081
C		2DB 0082
C	CLEAR	2DB 0083
C	CLEAR SETS AN ARRAY OF A SPECIFIED LENGTH TO A GIVEN	2DB 0084
C	CONSTANT. THE SUBROUTINE IS CALLED BY INIT AND GRAM.	2DB 0085
C		2DB 0086
C	FISCAL	2DB 0087
C	CALCULATES FISSION SUMS(S822) AND PERFORMS	2DB 0088
C	NORMALIZATION(S823). FISCAL IS CALLED BY CALC.	2DB 0089
C		2DB 0090
C	S8830	2DB 0091
C	S8830 IS THE MONITOR PRINT SUBROUTINE--PRINTS TIME,	
C	EIGENVALUE, LAMBDA, ETC. AFTER EACH OUTER ITERATION.	
C	IT IS CALLED BY CALC AND S8850.	
C		
C	OUTER	
C	PERFORMS A COMPLETE OUTER ITERATION. CALLS INNER1,	
C	INNER, AND INNERP. OUTER IS CALLED BY CALC.	
C		
C	INNER	
C	CALCULATES THE FLUX IN SPECIFIED GROUP. IT IS CALLED	
C	BY OUTER AND CALLS IFLUXN.	
C		
C	INNER1	
C	CALCULATES COEFFICIENTS FOR THE FLUX EQUATION. INNER1	
C	IS CALLED BY OUTER.	

C	INNERT	INNERT CALCULATES COEFFICIENTS FOR THE FLUX EQUATION FOR TRIANGULAR GEOMETRY. INNERT IS CALLED BY OUTER.	2DB 0092
C			2DB 0093
C			2DB 0094
C	INNER2	CALCULATES THE FLUX IN SPECIFIED GROUP. IT IS CALLED BY OUTER AND CALLS IFLUXN.	2DB 0095
C			2DB 0096
C			2DB 0097
C	INNERP	CALCULATES THE FLUX IN SPECIFIED GROUP FOR PERIODIC B. C. IT IS CALLED BY OUTER AND CALLS IFLUXN.	2DB 0098
C			2DB 0099
C			2DB 0100
C	IFLUXN	SUBROUTINE TO NORMALIZE THE FLUXES BEFORE EACH GROUP FLUX CALCULATION. IT IS CALLED BY INNER, INNER2, AND INNERP.	2DB 0101
C			2DB 0102
C			2DB 0103
C			2DB 0104
C	CNNP	PERFORMS CONVERGENCE TESTS(S851) AND COMPUTES A NEW EIGENVALUE FOR SEARCH OPTIONS(S852). CNNP IS CALLED BY CALC AND CALLS ERRO2 AND CLEAR.	2DB 0105
C			2DB 0106
C			2DB 0107
C			2DB 0108
C	S8850	FINAL PRINT SUBROUTINE--PRINTS THE MONITOR LINE, GROUP FLUXES, TOTAL FLUX, POWER DENSITY, AND FISSION SOURCE RATE. IT IS CALLED BY CALC AND CALLS PRT, S8830, AND S8847.	2DB 0109
C			2DB 0110
C			2DB 0111
C			2DB 0112
C			2DB 0113
C	S8847	SUBROUTINE TO COMPUTE AND PRINT GROUP TOTALS. S8847 IS CALLED BY S8850.	2DB 0114
C			2DB 0115
C			2DB 0116
C	PRT	SUBROUTINE TO PRINT ANY IM*JM ARRAY. IT IS CALLED BY S8850.	2DB 0117
C			2DB 0118
C			2DB 0119
C	GRAM	CALCULATES AND PRINTS THE MASS OF EACH MATERIAL IN EACH ZONE AND THE ZONE VOLUME. IT IS CALLED BY CALC AND CALLS CLEAR.	2DB 0120
C			2DB 0121
C			2DB 0122
C			2DB 0123
C	INPB	SUBROUTINE TO READ AND PRINT THE INPUT BURNUP DATA. IT IS CALLED BY CALC.	2DB 0124
C			2DB 0125
C			2DB 0126
C	AVERAG	AVERAG CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS SECTIONS, ABSORPTION CROSS SECTIONS, AND BREEDING RATIO. THE SUBROUTINE IS CALLED BY CALC.	2DB 0127
C			2DB 0128
C			2DB 0129
C			2DB 0130
C	MARCH	SUBROUTINE TO CALCULATE THE TIME DEPENDENT ISOTOPIC CONCENTRATIONS. MARCH IS CALLED BY CALC.	2DB 0131
C			2DB 0132
C			2DB 0133
C	* * * * *	INTERNAL VARIABLES * * * * *	2DB 0134
C			2DB 0135
C	NINP	INPUT TAPE	2DB 0136
C	NOUT	OUTPUT TAPE	2DB 0137
C	NCR1	CROSS SECTION TAPE	2DB 0138
C	NFLUX1	FLUX TAPE	2DB 0139
C	NSCRAT	SCRATCH TAPE	2DB 0140
C	NSORCE	SOURCE TAPE	2DB 0141
C	ALA	LAMBDA	2DB 0142
C	B07	USED FOR INTERNAL COMPUTATION IN FISCAL AND INIT	2DB 0143
C	CNT	CONVERGENCE TRIGGER FOR LAMBDA	2DB 0144
C	CVT	CONVERGENCE TRIGGER	2DB 0145
C	DAY	BURNUP TIME IN DAYS	2DB 0146
C	DELT	LENGTH OF TIME STEP (DAYS)	2DB 0147
C	E0(IGP)	FISSION RATE	2DB 0148
C	E1(IGP)	FISSION SOURCE	2DB 0149
C	E2(IGP)	IN-SCATTER (AND EXTRANEOUS SOURCE)	2DB 0150

C	E3(IGP)	OUT-SCATTER	2DB 0151
C	E4(IGP)	ABSORPTIONS	2DB 0152
C	E5(IGP)	LEFT LEAKAGE	2DB 0153
C	E6(IGP)	RIGHT LEAKAGE	2DB 0154
C	E7(IGP)	TOP LEAKAGE	2DB 0155
C	E8(IGP)	BOTTOM LEAKAGE	2DB 0156
C	E9(IGP)	TOTAL LEAKAGE	2DB 0157
C	E01	TEMPORARY	2DB 0158
C	E02	TEMPORARY	2DB 0159
C	E03	TEMPORARY	2DB 0160
C	EQ	TEMPORARY FOR S852 (CNNP)	2DB 0161
C	EVP	PREVIOUS EIGENVALUE	2DB 0162
C	EVPP	EIGENVALUE FOR TWO ITERATIONS BACK	2DB 0163
C	FEF	ENERGY RELEASED PER FISSION (=215 MEV)	2DB 0164
C	GBAR	GROUP INDICATOR FOR TAPE MOTION IN S824 (OUTER)	2DB 0165
C	GLH	MAXIMUM TIME IN SECONDS	2DB 0166
C	IGEP	IGE + 1	2DB 0167
C	IGP	IGM + 1	2DB 0168
C	IGV	GROUP INDICATOR FOR INNER AND OUTER	2DB 0169
C	IHS	POSITION OF SIGMA SELF SCATTER	2DB 0170
C	IHT	POSITION OF SIGMA TRANSPORT	2DB 0171
C	II	INNER ITERATION COUNT FOR A SINGLE GROUP	2DB 0172
C	IMJM	IM*JM	2DB 0173
C	IP	IM + 1	2DB 0174
C	ITEMP	TEMPORARY	2DB 0175
C	ITEMP1	TEMPORARY	2DB 0176
C	ITEMP2	TEMPORARY	2DB 0177
C	ITL	CROSS SECTION TABLE LENGTH	2DB 0178
C	IZP	IZM + 1	2DB 0179
C	JP	JM + 1	2DB 0180
C	K07	NOT USED	2DB 0181
C	KPAGE	PAGE COUNTER FOR MONITOR PRINT	2DB 0182
C	LAP	LAMBDA FOR PREVIOUS EIGENVALUE	2DB 0183
C	LAPP	LAMBDA FOR TWO ITERATIONS BACK	2DB 0184
C	LAR	LAMBDA FOR PREVIOUS ITERATION	2DB 0185
C	LC	LOOP COUNT (TOTAL II IN A SINGLE OUTER ITERATION)	2DB 0186
C	ML	MCR + MTP	2DB 0187
C	NCON	NEG/ZERO/POS=TAKE TIME STEP OF DELT/END OF PROBLEM/	2DB 0188
C		TAKE TIME STEP OF DELT AND READ BURNUP DATA	2DB 0189
C	NGOTO	TEMPORARY	2DB 0190
C	NPRT	0/1=PARTIAL PRINT/FULL PRINT	2DB 0191
C	ORFP	ORF FOR 1 - LAMBDA LESS THAN 10*EPS	2DB 0192
C	P02	OUTER ITERATION COUNT	2DB 0193
C	PBAR	TEMPORARY	2DB 0194
C	SBAR	TEMPORARY	2DB 0195
C	SK7	SUM OF K7 OVER ALL GROUPS	2DB 0196
C	T06	0/1=NOT DELTA/DELTA CALCULATION	2DB 0197
C	T7	ALPHA/VELOCITY	2DB 0198
C	T11	PREVIOUS FISSION TOTAL	2DB 0199
C	TEMP	TEMPORARY	2DB 0200
C	TEMP1	TEMPORARY	2DB 0201
C	TEMP2	TEMPORARY	2DB 0202
C	TEMP3	TEMPORARY	2DB 0203
C	TEMP4	TEMPORARY	2DB 0204
C	TI	TIME	2DB 0205
C	TSD	(MW-SEC)/(FISSIONS)	2DB 0206
C	V11	TOTAL SOURCE FOR THE GROUP	2DB 0207
C			2DB 0208
C	*****	INPUT VARIABLES (CARDS 1-5) *****	2DB 0209

C			2DB 0210
C	ID(11)	IDENTIFICATION CARD	2DB 0211
C	MAXT	MAXIMUM TIME IN MINUTES	2DB 0212
C	A02	0/1=FLUX CALCULATION/ADJOINT CALCULATION	2DB 0213
C	I04	EIGENVALUE TYPE (1/2/3/4/5=KEFF/ALPHA/CONCENTRATION/	2DB 0214
C		DELTA/BUCKLING)	2DB 0215
C	S02	PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA)	2DB 0216
C	IGM	NUMBER OF GROUPS	2DB 0217
C	NXCM	NUMBER OF DOWNSCATTERING TERMS	2DB 0218
C	MCR	NUMBER OF MATERIALS FROM CARDS	2DB 0219
C	MTP	NUMBER OF MATERIALS FROM TAPE	2DB 0220
C	M07	FLUX GUESS 0/1/2/3=NONE/X(R)*X(Z)/X(R,Z,E)/X(R,Z,E)	2DB 0221
C		FROM TAPE	2DB 0222
C	D05	OUTER ITERATION MAX	2DB 0223
C	G07	INNER ITERATION MAX PER GROUP	2DB 0224
C	S04	INVERSION DIRECTION (0/1=NO EFFECT/ALTERNATE DIRECT	2DB 0225
C	NPUN	FLUX DUMP 0/1/2/3/4=NONE/CARDS/CARDS+I2/TAPE/	2DB 0226
C		TAPE+I2	2DB 0227
C	IGE	GEOMETRY (0/1/2/3=X-Y/R-Z/R-THETA/TRIANGULAR)	2DB 0228
C	IM	NUMBER OF RADIAL INTERVALS	2DB 0229
C	JM	NUMBER OF AXIAL INTERVALS	2DB 0230
C	IZM	NUMBER OF MATERIAL ZONES	2DB 0231
C	MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	2DB 0232
C	M01	NUMBER OF MIXTURE SPECIFICATIONS	2DB 0233
C	B01	LEFT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0234
C	B02	RIGHT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	2DB 0235
C	B03	TOP BOUNDARY CONDITION (0/1/2=VAC/REFL/PERIODIC)	2DB 0236
C	B04	BOTTOM BOUNDARY CONDITION (0/1/2=VAC/REFL/PERIODIC)	2DB 0237
C	I2	RADIAL ZONES (DELTA-OPTION ONLY)	2DB 0238
C	J2	AXIAL ZONES (DELTA-OPTION ONLY)	2DB 0239
C	EV	FIRST EIGENVALUE GUESS	2DB 0240
C	EVM	EIGENVALUE MODIFIER	2DB 0241
C	S03	PARAMETRIC EIGENVALUE	2DB 0242
C	BUCK	BUCKLING	2DB 0243
C	LAL	LAMBDA LOWER	2DB 0244
C	LAH	LAMBDA UPPER	2DB 0245
C	EPS	EIGENVALUE CONVERGENCE CRITERIA	2DB 0246
C	EPSA	POINTWISE CONVERGENCE CRITERIA	2DB 0247
C	G06	INNER ITERATION TEST (IF ZERO, NO TEST)	2DB 0248
C	POD	PARAMETER OSCILLATION DAMPER	2DB 0249
C	ORF	OVER-RELAXATION FACTOR	2DB 0250
C	S01	NEG/POS=POWER (MWT)/NEUTRON SOURCE RATE	2DB 0251
C			2DB 0252
C	* * * * * SUBSCRIPTED VARIABLES * * * * *		2DB 0253
C			2DB 0254
C	ATW(ML)	MATERIAL ATOMIC WEIGHT	2DB 0255
C	HOLN(ML)	MATERIAL NAME	2DB 0256
C	ALAM(ML)	DECAY CONSTANT (DAYS-1)	2DB 0257
C	CO(ITL,MT)	CROSS SECTION ARRAY FOR CURRENT GROUP	2DB 0258
C	N0(IM,JM)	TOTAL FLUX (OLD)	2DB 0259
C	N2(IM,JM)	TOTAL FLUX (NEW)	2DB 0260
C	A0(IP)	RADIAL AREA ELEMENT	2DB 0261
C	A1(IM)	AXIAL AREA ELEMENT	2DB 0262
C	F0(IM,JM)	FISSIONS (OLD)	2DB 0263
C	F2(IM,JM)	FISSIONS (NEW)	2DB 0264
C	I0(M01)	MIX NUMBER	2DB 0265
C	I1(M01)	MATERIAL NUMBER FOR MIX	2DB 0266
C	I2(M01)	MATERIAL DENSITY	2DB 0267
C	I3(M01)	MATERIAL DENSITIES FOR GRAM CALCULATION	2DB 0268

C	K6(IGM)	FISSION SPECTRUM (EFFECTIVE)	2DB 0269
C	K7(IGM)	FISSION SPECTRUM (INPUT)	2DB 0270
C	M0(IM,JM)	ZONE NUMBERS	2DB 0271
C	M2(IZM)	MATERIAL NUMBERS BY ZONE	2DB 0272
C	R0(IP)	INITIAL RADII	2DB 0273
C	R1(IP)	CURRENT RADII	2DB 0274
C	R2(IM)	RADIAL ZONE NUMBERS (DELTA CALCULATION ONLY)	2DB 0275
C	R3(IZ)	RADIAL ZONE MODIFIERS (DELTA CALCULATION ONLY)	2DB 0276
C	R4(IM)	AVERAGE RADII	2DB 0277
C	R5(IM)	DELTA-R	2DB 0278
C	S2(IM,JM)	FIXED SOURCE	2DB 0279
C	V0(IM,JM)	VOLUME ELEMENTS	2DB 0280
C	V7(IGM)	NEUTRON VELOCITIES	2DB 0281
C	Z0(JP)	INITIAL AXII	2DB 0282
C	Z1(JP)	CURRENT AXII	2DB 0283
C	Z2(JM)	AXIAL ZONE NUMBERS (DELTA CALCULATION ONLY)	2DB 0284
C	Z3(JZ)	AXIAL ZONE MODIFIERS (DELTA CALCULATION ONLY)	2DB 0285
C	Z4(JM)	AVERAGE AXII	2DB 0286
C	Z5(JM)	DELTA-Z	2DB 0287
C	CXS(IM,JM,3)	CONSTANTS INVOLVING CROSS SECTIONS FOR FLUX CALC.	2DB 0288
C	VOL(IZM)	ZONE VOLUME (LITERS)	2DB 0289
C	MASS(ML,IZM)	MATERIAL INVENTORY IN EACH ZONE	2DB 0290
C	MATN(ML)	MATERIAL NUMBER FOR BURNABLE ISOTOPES	2DB 0291
C	NBR(ML)	0/1/2=NO EFFECT/FERTILE/FISSILE ISOTOPE	2DB 0292
C	LD(ML)	SOURCE ISOTOPE FOR DECAY	2DB 0293
C	LCN(ML,2)	SOURCE ISOTOPES FOR CAPTURE	2DB 0294
C	LFN(ML,7)	SOURCE ISOTOPES FOR FISSION	2DB 0295
C	PHIB(IZM)	ZONE AVERAGED FLUX	2DB 0296
C	AXS(ML,IZM)	SPECTRUM AVERAGED ABSORPTION CROSS SECTION	2DB 0297
C	FXS(ML,IZM)	SPECTRUM AVERAGED FISSION CROSS SECTION	2DB 0298
C	MASSP(ML,IZM)	MATERIAL INVENTORY IN EACH ZONE (PREVIOUS)	2DB 0299
C	CXR(JM)	CONSTANTS FOR RIGHT BOUNDARY	2DB 0300
C	CXT(IM)	CONSTANTS FOR TOP BOUNDARY	2DB 0301
C	HA(IM OR JM)	TEMP STORAGE FOR LINE INVERSION	2DB 0302
C	PA(IM OR JM)	TEMP STORAGE FOR LINE INVERSION	2DB 0303
C			2DB 0304
	INCLUDE ABC		2DB 0305
	COMMON A(25000)		2DB 0306
	DIMENSION JLPTAB(28)		2DB 0307
	CALL SETDR(3,525000,52000,JLPTAB)		2DB 0308
	CALL SETDR(4,577000,52000,JLPTAB(8))		2DB 0309
	CALL SETDR(8,629000,200000,JLPTAB(15))		2DB 0310
	CALL SETDR(9,829000,150000,JLPTAB(22))		2DB 0311
1	CONTINUE		2DB 0312
	REWIND 3		2DB 0313
	REWIND 4		2DB 0314
	REWIND 8		2DB 0315
	REWIND 9		2DB 0316
	CALL ETIME		2DB 0317
	CALL INP		2DB 0318
102	CALL INIT(A(LK6), A(LK7), A(LI0), A(LI1), A(LI2), A(LM0), A(LM2),		2DB 0319
	1 A(LN0), A(LR0), A(LR1), A(LR2), A(LR3), A(LR4), A(LR5),		2DB 0320
	2 A(LZ0), A(LZ1), A(LZ2), A(LZ3), A(LZ4), A(LZ5), A(LA0),		2DB 0321
	3 A(LA1), A(LF0), A(LC0), A(LV0), ITL, IM, A(LV7),		2DB 0322
	4 JM, MT)		2DB 0323
	CALL FISCAL (A(LN0),A(LF0),A(LV0),A(LC0),A(LK6),		2DB 0324
	2 A(LM0),A(LM2),ITL,MT)		2DB 0325
C	CALL MONITOR PRINT		2DB 0326
101	CALL S8830		2DB 0327

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GO TO (100, 106, 106, 107), NGOTO                2DB 0328
106 CALL ERRO2(6H*MONPR,106,1)                    2DB 0329
C PERFORM AN OUTER ITERATION                      2DB 0330
107 CALL OUTER( A(LA0), A(LA1), A(LC0), A(LF0), A(LK6),
1          A(LM0), A(LM2), A(LN0), A(LN2),        2DB 0332
2          A(LS2), A(LV0), A(LV7), A(LZ5),        2DB 0333
3          A(LF2), ITL, MT, A(LCXS), IM, JM, A(LR5), A(LR4), 2DB 0334
4          A(LZ4), A(LCXR), A(LCXT), A(LHA), A(LPA)) 2DB 0335
C PERFORM FISSION CALCULATION                    2DB 0336
CALL FISCAL (A(LN0),A(LF0),A(LV0),A(LC0),A(LK6),
2          A(LM0),A(LM2),ITL,MT)                  2DB 0337
C PERFORM CONVERGENCE AND NEW PARAMETER CALCULATIONS 2DB 0339
CALL CNNP (A(LF2), A(LK6))                        2DB 0340
GO TO (100, 101, 102), NGOTO                      2DB 0341
C 100/101/102=FINAL PRINT/MONITOR PRINT/SEARCH CALCULATION 2DB 0342
100 CALL S8850(A(LF2),A(LN2),A(LR1),A(LZ1),A(LR4),A(LZ4),
1          IM,JM,A(LN2),A(LC0),A(LN0),A(LM0),A(LM2),A(LF0),ITL,MT) 2DB 0344
CALL GRAM(A(LMASS), A(LVOL), A(LATW), A(LHOLN), IM, JM, 2DB 0345
1          A(LM0), A(LM2), A(LV0), A(LI0), A(LI1), A(LI2), ML, 2DB 0346
2          A(LI3)) 2DB 0347
CALL INPB(A(LMATN),A(LNBR),A(LLD),A(LLCN),A(LLFN),A(LALAM),
1          A(LHOLN),ML,A(LI2)) 2DB 0348
IF(NCON) 170,1,170 2DB 0349
170 CALL AVERAG(A(LPHIB),A(LAXS),A(LFXS),A(LMATN),A(LMASS),A(LATW),
1          A(LVOL),A(LC0),A(LN2),A(LM0),A(LV0),A(LHOLN),ML,ITL, 2DB 0352
2          A(LNBR)) 2DB 0353
IF (DELT) 180,1,180 2DB 0354
180 CALL MARCH(A(LPHIB),A(LMATN),A(LFXS),A(LAXS),A(LVOL),A(LMASS),
1          A(LMASSP),A(LALAM),A(LLD),A(LLCN),A(LLFN),ML, 2DB 0355
2          A(LI0),A(LI1),A(LI2),A(LM2)) 2DB 0357
GO TO 102 2DB 0358
END 2DB 0359

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-ITC FOR INP,INP                                2DB 0360
  SUBROUTINE INP                                2DB 0361
  INCLUDE ABC                                  2DB 0362
  COMMON A(25000)                             2DB 0363
C  THIS SUBROUTINE CONTROLS THE READING OF ALL INPUT DATA 2DB 0364
  NCR1 = 3                                     2DB 0365
  NSCRAT = 4                                  2DB 0366
  NINP = 5                                    2DB 0367
  NOUT = 6                                    2DB 0368
  NFLUX1 = 8                                  2DB 0369
  NSORCE = 9                                  2DB 0370
  WRITE (NOUT,5)                               2DB 0371
5  FORMAT (1H1)                                2DB 0372
  WRITE(NOUT,10)                               2DB 0373
10 FORMAT(42X,35H * * * * 2 D B * * * * /// ) 2DB 0374
  READ(NINP,20) (ID(I),I=1,11), MAXT          2DB 0375
20 FORMAT(11A6,I6)                             2DB 0376
  WRITE(NOUT,30) (ID(I),I=1,11), MAXT          2DB 0377
30 FORMAT(10X,1H ,11A6,I6/)                   2DB 0378
  READ(NINP,40) A02, I04, S02, IGM, NXCM, MCR, MTP, M07, D05, 2DB 0379
1  G07, S04, NPUN, IGE, IM, JM, IZM, MT, M01, B01, B02, B03, B04, 2DB 0380
2  IZ, JZ                                       2DB 0381
40 FORMAT(12I6)                                2DB 0382
  WRITE(NOUT,60) A02, I04, S02, IGM, NXCM, MCR 2DB 0383
60 FORMAT(                                     2DB 0384
192H A02          0/1=REGULAR CALCULATION/ADJOINT CALCULATION 2DB 0385
2              I9/                               2DB 0386
392H I04          EIGENVALUE TYPE (0/1/2/3/4/5=SOURCE/KEFF/ALPHA/CON2DB 0387
4CENTRATION/DELTA/BUCKLING) I9/                2DB 0388
592H S02          PARAMETRIC EIGENVALUE TYPE (0/1/2=NONE/KEFF/ALPHA)2DB 0389
6              I9/                               2DB 0390
792H IGM          NUMBER OF GROUPS              2DB 0391
8              I9/                               2DB 0392
992H NXCM         NUMBER OF DOWNSCATTERING TERMS 2DB 0393
1              I9/                               2DB 0394
292H MCR          NUMBER OF MATERIALS FROM CARDS 2DB 0395
3              I9/                               2DB 0396
  WRITE(NOUT,70) MTP, M07, D05, G07, S04, NPUN 2DB 0397
70 FORMAT(                                     2DB 0398
192H MTP          NUMBER OF MATERIALS FROM TAPE 2DB 0399
2              I9/                               2DB 0400
392H M07          FLUX GUESS (0/1/2/3=NONE/X(R)*X(Z)/X(R,Z,E)/X(R,Z,E)2DB 0401
4) FROM TAPE) I9/                               2DB 0402
592H D05          OUTER ITERATION MAX           2DB 0403
6              I9/                               2DB 0404
792H G07          INNER ITERATION MAX PER GROUP 2DB 0405
8              I9/                               2DB 0406
992H S04          INVERSION DIRECTION (0/1=NO EFFECT/ALTERNATE DIRECT2DB 0407
1IONS) I9/                                       2DB 0408
292H NPUN         FLUX DUMP (0/1/2/3/4=NONE/CARDS/CARDS+I2/TAPE/TAPE+2DB 0409
3I2) I9/)                                       2DB 0410
  WRITE(NOUT,80) IGE, IM, JM, IZM, MT, M01     2DB 0411
80 FORMAT(                                     2DB 0412
192H IGE          GEOMETRY (0/1/2/3=X-Y/R-Z/R-THETA/TRIANGULAR) 2DB 0413
2              I9/                               2DB 0414
392H IM           NUMBER OF RADIAL INTERVALS    2DB 0415
4              I9/                               2DB 0416
592H JM           NUMBER OF AXIAL INTERVALS     2DB 0417
6              I9/                               2DB 0418

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792H  IZM      NUMBER OF MATERIAL ZONES                2DB 0419
8      I9/                2DB 0420
992H  MT      TOTAL NUMBER OF MATERIALS INCLUDING MIXES 2DB 0421
1      I9/                2DB 0422
292H  M01     NUMBER OF MIXTURE SPECIFICATIONS          2DB 0423
3      I9/                2DB 0424
      WRITE(NOUT,90) B01, B02, B03, B04, IZ, JZ        2DB 0425
90    FORMAT(                2DB 0426
192H  B01     LEFT   BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE) 2DB 0427
2      I9/                2DB 0428
392H  B02     RIGHT  BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE) 2DB 0429
4      I9/                2DB 0430
592H  B03     TOP    BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE) 2DB 0431
6/PERIODIC) I9/                2DB 0432
792H  B04     BOTTOM BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE) 2DB 0433
8/PERIODIC) I9/                2DB 0434
992H  IZ      RADIAL ZONES (DELTA-OPTION ONLY)          2DB 0435
1      I9/                2DB 0436
292H  JZ      AXIAL ZONES (DELTA-OPTION ONLY)           2DB 0437
3      I9/                2DB 0438
      READ(NINP,100) EV, EVM, S03, BUCK, LAL, LAH, EPS, EPSA, G06, 2DB 0439
1      POD, ORF, S01      2DB 0440
100   FORMAT(6E12,6)      2DB 0441
      WRITE(NOUT,110) EV, EVM, S03, BUCK, LAL, LAH      2DB 0442
110   FORMAT(                2DB 0443
191H  EV      FIRST EIGENVALUE GUESS                    2DB 0444
2      1PE10.4/          2DB 0445
391H  EVM      EIGENVALUE MODIFIER                      2DB 0446
2      1PE10.4/          2DB 0447
591H  S03      PARAMETRIC EIGENVALUE                    2DB 0448
2      1PE10.4/          2DB 0449
791H  BUCK     BUCKLING (CM-2)                          2DB 0450
2      1PE10.4/          2DB 0451
991H  LAL      LAMBDA LOWER                             2DB 0452
2      1PE10.4/          2DB 0453
291H  LAH      LAMBDA UPPER                             2DB 0454
2      1PE10.4/          2DB 0455
      WRITE(NOUT,120) EPS, EPSA, G06, POD, ORF, S01      2DB 0456
120   FORMAT(                2DB 0457
191H  EPS      EIGENVALUE CONVERGENCE CRITERION          2DB 0458
2      1PE10.4/          2DB 0459
391H  EPSA     PARAMETER CONVERGENCE CRITERION          2DB 0460
2      1PE10.4/          2DB 0461
591H  G06      INNER ITERATION TEST (IF ZERO, NO TEST)    2DB 0462
2      1PE10.4/          2DB 0463
791H  POD      PARAMETER OSCILLATION DAMPER              2DB 0464
2      1PE10.4/          2DB 0465
991H  ORF      OVER-RELAXATION FACTOR                   2DB 0466
2      1PE10.4/          2DB 0467
291H  S01      NEGATIVE/POSITIVE=POWER (MWT)/NEUTRON SOURCE RATE 2DB 0468
2      1PE10.4/          2DB 0469
      IF(IZ + JZ) 230, 210, 230                        2DB 0470
210   IF(I04 - 4) 230, 220, 230                        2DB 0471
220   CALL ERRO2 (JH***I04,220,1)                      2DB 0472
230   CONTINUE                                           2DB 0473
      IF(S02) 240, 260, 240                             2DB 0474
240   IF(S03) 260, 250, 260                             2DB 0475
250   CALL ERRO2 (6H***S03,250,1)                      2DB 0476
260   CONTINUE                                           2DB 0477

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FEF = 215.0	2DB 0478
TSD = FEF*1.602*10.**(-19)	2DB 0479
GLH = MAXT*60	2DB 0480
KPAGE = 100	2DB 0481
IHS = 5	2DB 0482
ITL = NXCM + 5	2DB 0483
IHT = 4	2DB 0484
IZP = IZM + 1	2DB 0485
IP = IM + 1	2DB 0486
JP = JM + 1	2DB 0487
ML = MCR + MTP	2DB 0488
IGP = IGM + 1	2DB 0489
IGEP = IGE + 1	2DB 0490
IMJM = IM*JM	2DB 0491
EQ = .0	2DB 0492
LAP = .0	2DB 0493
LAPP = .0	2DB 0494
LAR = 0.0	2DB 0495
DAY = 0.0	2DB 0496
ALA = .0	2DB 0497
LC = 0	2DB 0498
PO2 = 0	2DB 0499
CVT = 0	2DB 0500
CNT = 0	2DB 0501
NCON = 0	2DB 0502
NPRT = 1	2DB 0503
T06 = 0	2DB 0504
IF(I04-4) 310, 300, 310	2DB 0505
300 T06 = 1	2DB 0506
310 CONTINUE	2DB 0507
ORFP = 1.0*(ORF - 1.0) + 1.0	2DB 0508
C COMPUTE DIMENSION POINTERS	2DB 0509
LATW = 1	2DB 0510
LHOLN = LATW + ML	2DB 0511
LALAM = LHOLN + ML	2DB 0512
LCO = LALAM + ML	2DB 0513
LN0 = LCO + ITL*MT	2DB 0514
LN2 = LN0 + IMJM	2DB 0515
LA0 = LN2 + IMJM	2DB 0516
LA1 = LA0 + IP	2DB 0517
LF0 = LA1 + IM	2DB 0518
LF2 = LF0 + IMJM	2DB 0519
LI0 = LF2 + IMJM	2DB 0520
LI1 = LI0 + M01	2DB 0521
LI2 = LI1 + M01	2DB 0522
LI3 = LI2 + M01	2DB 0523
LK6 = LI3 + M01	2DB 0524
LK7 = LK6 + ICM	2DB 0525
LM0 = LK7 + IGM	2DB 0526
LM2 = LM0 + IMJM	2DB 0527
LR0 = LM2 + IZM	2DB 0528
LR1 = LR0 + IP	2DB 0529
LR2 = LR1 + IP	2DB 0530
LR3 = LR2 + T06*IM	2DB 0531
LR4 = LR3 + T06*IZ	2DB 0532
LR5 = LR4 + IM	2DB 0533
LS2 = LR5 + IM	2DB 0534
LV0 = LS2 + IMJM	2DB 0535
LV7 = LV0 + IMJM	2DB 0536

	LZ0 = LV7 + IGM	2DB 0537
	LZ1 = LZ0 + JP	2DB 0538
	LZ2 = LZ1 + JP	2DB 0539
	LZ3 = LZ2 + JM*T06	2DB 0540
	LZ4 = LZ3 + JZ*T06	2DB 0541
	LZ5 = LZ4 + JM	2DB 0542
	LCXS = LZ5 + JM	2DB 0543
	LVOL = LCXS + IMJM*3	2DB 0544
	LMASS = LVOL + IZM	2DB 0545
	LMATN = LMASS + ML*IZM	2DB 0546
	LNBR = LMATN + ML	2DB 0547
	LLD = LNBR + ML	2DB 0548
	LLCN = LLD + ML	2DB 0549
	LLFN = LLCN + ML*2	2DB 0550
	LPHIB = LLFN + ML*7	2DB 0551
	LAXS = LPHIB + IZM	2DB 0552
	LFXS = LAXS + ML*IZM	2DB 0553
	LMASSP = LFXS + ML*IZM	2DB 0554
	LCXR = LMASSP + ML*IZM	2DB 0555
	LCXT = LCXR + JM	2DB 0556
	LHA = LCXT + IM	2DB 0557
	LPA = LHA + MAX0(IM,JM)	2DB 0558
	LAST = LPA + MAX0(IM,JM)	2DB 0559
	ITEMP = 1 + 3*ML + IGP*ITL*MT	2DB 0560
	IF(LAST - ITEMP) 316,318,318	2DB 0561
316	LAST = ITEMP	2DB 0562
318	WRITE(NOUT,320) LAST	2DB 0563
320	FORMAT(5H LAST,I6)	2DB 0564
C	READ CROSS SECTIONS AND WRITE CROSS SECTION TAPE	2DB 0565
	CALL S860(A(LNO),A(LCO),ITL,IGM,MT,A(LATW),A(LHOLN),A(LALAM))	2DB 0566
	DO 325 I=LCO, LAST	2DB 0567
325	A(I) = .0	2DB 0568
C	READ FLUXES AND WRITE FLUX TAPE	2DB 0569
	CALL S862(A(LNO), A(LRO), A(LZO))	2DB 0570
C	READ EXTERNAL SOURCE	2DB 0571
	IF (IO4) 328,326,328	2DB 0572
326	WRITE (NOUT,327)	2DB 0573
327	FORMAT (16H0EXTERNAL SOURCE)	2DB 0574
	CALL S864 (A(LS2))	2DB 0575
328	CONTINUE	2DB 0576
	WRITE(NOUT,330)	2DB 0577
330	FORMAT(51H0MESH BOUNDARIES (R0/Z0=RADIAL POINTS/AXIAL POINTS))	2DB 0578
C	READ RADIAL INTERVALS	2DB 0579
	CALL REAG2(6H R0,A(LRO),IP)	2DB 0580
C	READ AXIAL INTERVALS	2DB 0581
	CALL REAG2(6H Z0,A(LZO),JP)	2DB 0582
C	READ ZONE NUMBERS	2DB 0583
	WRITE(NOUT,340)	2DB 0584
340	FORMAT(30H0ZONE NUMBERS BY MESH INTERVAL)	2DB 0585
	CALL REA12 (6H M0,A(LM0),IMJM)	2DB 0586
C	READ MATERIAL NUMBERS	2DB 0587
	WRITE(NOUT,350)	2DB 0588
350	FORMAT(25H0MATERIAL NUMBERS BY ZONE)	2DB 0589
	CALL REA12(6H M2,A(LM2),IZM)	2DB 0590
C	READ FISSION FRACTIONS	2DB 0591
	WRITE(NOUT,360)	2DB 0592
360	FORMAT(17H0FISSION SPECTRUM)	2DB 0593
	CALL REAG2(6H K7,A(LK7),IGM)	2DB 0594
C	READ VELOCITIES	2DB 0595

	WRITE(NOUT,370)	2DB 0596
370	FORMAT(17H0NEUTRON VELOCITY)	2DB 0597
	CALL REAG2(6H V7,A(LV7),IGM)	2DB 0598
	IF(M01) 400, 400, 380	2DB 0599
380	WRITE(NOUT,390)	2DB 0600
390	FORMAT(82HGMIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER	2DB 0601
	1 FOR MIX/MATERIAL DENSITY))	2DB 0602
	CALL REAI2(6H I0,A(LI0),M01)	2DB 0603
	CALL REAI2(6H I1,A(LI1),M01)	2DB 0604
	CALL REAG2(6H I2,A(LI2),M01)	2DB 0605
400	CONTINUE	2DB 0606
C	CHECK FOR DELTA CALCULATION	2DB 0607
	IF(I04 - 4) 440, 410, 440	2DB 0608
410	WRITE(NOUT,420)	2DB 0609
420	FORMAT(85HDELTA OPTION DATA (R2/Z2/R3/Z3=RADIAL/AXIAL ZONE NOS.	2DB 0610
	1/RADIAL/AXIAL ZONE MODIFIERS))	2DB 0611
	CALL REAI2(6H R2,A(LR2),IM)	2DB 0612
	CALL REAG2(6H R3,A(LR3),IZ)	2DB 0613
	CALL REAI2(6H Z2,A(LZ2),JM)	2DB 0614
	CALL REAG2(6H Z3,A(LZ3),JZ)	2DB 0615
440	CONTINUE	2DB 0616
C	END OF INPUT DATA	2DB 0617
	CALL MAPR(A(LM0),A(LM2),IM,JM,A(LC0))	2DB 0618
	IF(LAST-25000) 470, 470, 450	2DB 0619
450	WRITE(NOUT,460)	2DB 0620
460	FORMAT(26H PROGRAM CAPACITY EXCEEDED)	2DB 0621
	STOP	2DB 0622
470	RETURN	2DB 0623
	END	2DB 0624

E-13

BNWL-831 REV1

-IT FOR	ERRO2,ERRO2	2DB 0625
	SUBROUTINE ERRO2(HOL,JSUBR,I)	2DB 0626
	COMMON NSORCE, NINP, NOUT, NCR1, NFLUX1, NSCRAT	2DB 0627
	WRITE (NOUT,1) HOL,JSUBR	2DB 0628
1	FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)	2DB 0629
	GO TO (3,4),I	2DB 0630
3	STOP	2DB 0631
4	RETURN	2DB 0632
	END	2DB 0633

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-ITC FOR S860,S860                                2DB 0634
  SUBROUTINE S860 (C,CU,JTL,JGM,JMT,ATW,HOLN,ALAM)  2DB 0635
  INCLUDE ABC                                       2DB 0636
  DIMENSION C(JTL,JGM,JMT), CU(JTL,JMT), ATW(1), HOLN(1), ALAM(1) 2DB 0637
  DIMENSION AA(9)                                   2DB 0638
C   THIS SUBROUTINE READS CROSS SECTIONS, PERFORMS ADJOINT 2DB 0639
C   REVERSALS IF REQUIRED, AND WRITES CROSS SECTION TAPE 2DB 0640
  WRITE(NOUT,5) (ID(I), I=1,11)                   2DB 0641
5   FORMAT(1H1,11A6,///)                           2DB 0642
10  WRITE (NOUT, 20 )                               2DB 0643
20  FORMAT (55H CROSS SECTIONS ARE READ-IN FOR THE FOLLOWING MATERIALS2DB 0644
1/)                                                  2DB 0645
  DO 50 I=1,ML                                       2DB 0646
  READ(NINP,30) HOLN(I), ATW(I), ALAM(I), (AA(J), J=1,9) 2DB 0647
  ALAM(I) = ALAM(I)/(24.*3600.)                     2DB 0648
30  FORMAT(A6, 2E6.2, 9A6)                         2DB 0649
  IF(MCR) 35,35,40                                  2DB 0650
35  READ(15) ((C(L,IIG,I), L=1,ITL), IIG=1,IGM)    2DB 0651
  GO TO 50                                           2DB 0652
40  DO 45 IIG=1,IGM                                 2DB 0653
45  READ(NINP,60) (C(L,IIG,I), L=1,ITL)            2DB 0654
50  WRITE(NOUT,55) I, HOLN(I), (AA(J), J=1,9)      2DB 0655
55  FORMAT(13, 6X, A6, 6X, 9A6)                   2DB 0656
60  FORMAT(6E12.5)                                   2DB 0657
C   CHECK ON CROSS SECTION CONSISTENCY AND ORDER 2DB 0658
  ITEMP = 0                                         2DB 0659
  IF(MCR) 70,70,90                                  2DB 0660
70  REWIND 15                                         2DB 0661
90  DO 140 J=1,ML                                    2DB 0662
  DO 140 I=1,IGM                                    2DB 0663
  G = C(2,I,J) + C(5,I,J)                          2DB 0664
  DO 110 K = 1, NXCM                                2DB 0665
  KK = I + K                                         2DB 0666
  M = 5 + K                                         2DB 0667
  IF(KK - IGM) 100, 100, 110                       2DB 0668
  G = G + C(M,KK,J)                                 2DB 0669
110  CONTINUE                                       2DB 0670
  IF(ABS((G - C(4,I,J))/C(4,I,J)) - .01) 135, 120, 120 2DB 0671
120  ITEMP = 1                                       2DB 0672
130  FORMAT(1H /,16H CHECK MATERIAL 12,5X, 7H GROUP 12) 2DB 0673
135  IF(ABS((G - C(4,I,J))/C(4,I,J)) - .0001) 140, 138, 138 2DB 0674
138  WRITE(NOUT,130) J, I                          2DB 0675
140  CONTINUE                                       2DB 0676
  IF (ITEMP) 160,160,150                           2DB 0677
150  CALL EXIT                                       2DB 0678
C   AQ2=0/1=FLUX CALCULATION/ADJOINT CALCULATION 2DB 0679
160  IF(AQ2) 170, 280, 170                         2DB 0680
170  DO 190 IIG=1,IGM                              2DB 0681
  IGBAR=IGM-IIG+1                                   2DB 0682
  DO 180 M=1,MT                                     2DB 0683
  DO 180 L = 1,IHS                                 2DB 0684
  TEMP=C(L,IIG,M)                                  2DB 0685
  C(L,IIG,M)=C(L,IGBAR,M)                         2DB 0686
180  C(L,IGBAR,M)=TEMP                             2DB 0687
  IF (IGBAR - IIG -1) 200, 200, 190                2DB 0688
190  CONTINUE                                       2DB 0689
200  CONTINUE                                       2DB 0690
  KK = ITL - IHS                                    2DB 0691
  IF (KK) 280, 280, 210                            2DB 0692

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210	CONTINUE	2DB 0693
	DO 240 M = 1,MT	2DB 0694
	DO 240 IIG = 1,IGM	2DB 0695
	IGBAR = IGM - IIG + 1	2DB 0696
	DO 240 L = 1,KK	2DB 0697
	IF (L - IIG) 220, 240, 240	2DB 0698
220	I = L + IHS	2DB 0699
	ITEMP = IGBAR + L	2DB 0700
	IF (IIG - ITEMP) 230, 230, 240	2DB 0701
230	TEMP = C(I, IIG, M)	2DB 0702
	C(I, IIG, M) = C(I, ITEMP, M)	2DB 0703
	C(I, ITEMP, M) = TEMP	2DB 0704
240	CONTINUE	2DB 0705
C	WRITE CROSS SECTION TAPE	2DB 0706
280	DO 300 IIG=1,IGM	2DB 0707
	DO 290 M=1,MT	2DB 0708
	DO 290 L=1,ITL	2DB 0709
290	CO(L,M)=C(L,IIG,M)	2DB 0710
300	WRITE (NCR1) ((CO(L,M),L=1,ITL),M=1,MT)	2DB 0711
	REWIND NCR1	2DB 0712
	RETURN	2DB 0713
	END	2DB 0714

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-1TC	FOR S862,S862	2DB	0715
	SUBROUTINE S862(NO,RF,ZF)	2DB	0716
	INCLUDE ABC	2DB	0717
	DIMENSION NO(1), RF(1), ZF(1)	2DB	0718
C	THIS SUBROUTINE READS THE INPUT FLUXES AND PREPARES A FLUX TAPE	2DB	0719
	WRITE(NOUT,5)	2DB	0720
5	FORMAT(1H1)	2DB	0721
C	M07=0/1/2/3=NO FLUX INPUT/X(R)*X(Z)/X(R,Z,E)/TAPE	2DB	0722
	KK = M07 + 1	2DB	0723
	DO 1000 IIG = 1, IGM	2DB	0724
	GO TO (50, 60, 70, 120), KK	2DB	0725
50	DO 59 I=1, IM	2DB	0726
	DO 59 J = 1, JM	2DB	0727
	ITEMP = (J - 1)*IM + I	2DB	0728
59	NO(ITEMP) = 1.0	2DB	0729
	GO TO 200	2DB	0730
60	IF(IIG - 1) 62, 62, 64	2DB	0731
62	WRITE(NOUT,63)	2DB	0732
63	FORMAT(55H0FLUX GUESS (RF/ZF=TOTAL RADIAL FLUX/TOTAL AXIAL FLUX))	2DB	0733
	CALL REAG2(6H RF,RF,IM)	2DB	0734
	CALL REAG2(6H ZF,ZF,JM)	2DB	0735
64	DO 69 I = 1, IM	2DB	0736
	DO 69 J = 1, JM	2DB	0737
	ITEMP = (J - 1)*IM + I	2DB	0738
69	NO(ITEMP) = RF(I)*ZF(J)	2DB	0739
	GO TO 200	2DB	0740
70	READ(NINP,100) (NO(I), I=1, IMJM)	2DB	0741
100	FORMAT(6E12.6)	2DB	0742
	GO TO 200	2DB	0743
120	READ(14) (NO(I), I=1, IMJM)	2DB	0744
200	WRITE(NFLUX1) (NO(I), I=1, IMJM)	2DB	0745
1000	CONTINUE	2DB	0746
	IF(M07 - 3) 1020,1010,1020	2DB	0747
1010	REWIND 14	2DB	0748
1020	REWIND NFLUX1	2DB	0749
	RETURN	2DB	0750
	END	2DB	0751

-ITC FOR S864,S864	2DB 0752
SUBROUTINE S864 (S2)	2DB 0753
INCLUDE ABC	2DB 0754
DIMENSION S2(1)	2DB 0755
C THIS SUBROUTINE READS THE EXTERNAL SOURCE AND PREPARES A SOURCE TA2DB	0756
DO 50 IIG = 1,IGM	2DB 0757
CALL REAG2 (6H S0,S2,IMJM)	2DB 0758
WRITE (NSORCE) (S2(I), I = 1,IMJM)	2DB 0759
50 CONTINUE	2DB 0760
REWIND NSORCE	2DB 0761
RETURN	2DB 0762
END	2DB 0763

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-IT  FOR REAG2,REAG2                                2DB 0764
      SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)            2DB 0765
      DIMENSION ARRAY(1),V(12),K(12),IN(12)          2DB 0766
      COMMON NSORCE, NINP, NOUT, NCR1, NFLUX1, NSCRAT  2DB 0767
      JFLAG=0                                         2DB 0768
      J=1                                             2DB 0769
10    IF(JFLAG)20,40,20                              2DB 0770
20    DO 30 JJ=1,6                                    2DB 0771
      K(JJ)=K(JJ+6)                                  2DB 0772
      IN(JJ)=IN(JJ+6)                                2DB 0773
30    V(JJ)=V(JJ+6)                                  2DB 0774
      JFLAG=0                                         2DB 0775
      GO TO 60                                        2DB 0776
40    READ (NINP,50) (K(I),IN(I),V(I),I=1,6)         2DB 0777
50    FORMAT(6(I1,I2,E9.4))                          2DB 0778
60    DO 140 I=1,6                                    2DB 0779
      L=K(I)+1                                         2DB 0780
      GO TO (70,80,100,150),L                        2DB 0781
C      NO MODIFICATION                               2DB 0782
70    ARRAY(J)=V(I)                                   2DB 0783
      J=J+1                                           2DB 0784
      GO TO 140                                       2DB 0785
C      REPEAT                                         2DB 0786
80    L=IN(I)                                         2DB 0787
      DO 90 M=1,L                                    2DB 0788
      ARRAY(J)=V(I)                                  2DB 0789
      J=J+1                                           2DB 0790
90    CONTINUE                                       2DB 0791
      GO TO 140                                       2DB 0792
C      INTERPOLATE                                   2DB 0793
100   IF(I-6) 120,110,110                          2DB 0794
110   READ (NINP,50) (K(JJ),IN(JJ),V(JJ),JJ=7,12)   2DB 0795
      JFLAG=1                                         2DB 0796
120   L=IN(I)+1                                       2DB 0797
      DEL=(V(I+1)-V(I))/FLOAT (L)                   2DB 0798
      DO 130 M=1,L                                   2DB 0799
      ARRAY(J)=V(I)+DEL*FLOAT (M-1)                 2DB 0800
      J=J+1                                           2DB 0801
130   CONTINUE                                       2DB 0802
140   CONTINUE                                       2DB 0803
      GO TO 10                                       2DB 0804
C      TERMINATE                                     2DB 0805
150   J=J-1                                           2DB 0806
      WRITE (NOUT,160) HOLL,J , ( ARRAY(I),I=1,J)    2DB 0807
      IF(J -NCOUNT)170,180,170                      2DB 0808
160   FORMAT(6X,A6,I6/(10E12.5))                   2DB 0809
170   CALL ERRO2( 6H**REAG,170,1)                  2DB 0810
180   RETURN                                          2DB 0811
      END                                            2DB 0812

```

-IT	FOR REAI2,REAI2	2DB 0813
	SUBROUTINE REAI2(HOLL,IARRAY,NCOUNT)	2DB 0814
	DIMENSION IARRAY(1),IV(6),K(6),IN(6)	2DB 0815
	COMMON NSORCE, NINP, NOUT, NCR1, NFLUX1, NSCRAT	2DB 0816
	J=1	2DB 0817
10	READ(NINP,20) (K(I),IN(I),IV(I),I=1,6)	2DB 0818
20	FORMAT(6(I1,I2,I9))	2DB 0819
	DO 70I=1,6	2DB 0820
	L=K(I)+1	2DB 0821
	GO TO (30,40,60,80),L	2DB 0822
C	NO MODIFICATION	2DB 0823
30	IARRAY(J)=IV(I)	2DB 0824
	J=J+1	2DB 0825
	GO TO 70	2DB 0826
C	REPEAT	2DB 0827
40	L=IN(I)	2DB 0828
	DO 50 M=1,L	2DB 0829
	IARRAY(J)=IV(I)	2DB 0830
	J=J+1	2DB 0831
50	CONTINUE	2DB 0832
	GO TO 70	2DB 0833
C	INTERPOLATE	2DB 0834
60	CALL ERRO2(6H REAI,60,1)	2DB 0835
70	CONTINUE	2DB 0836
	GO TO 10	2DB 0837
C	TERMINATE	2DB 0838
80	J=J-1	2DB 0839
	WRITE (NOUT,90) HOLL,J, (IARRAY(I),I=1,J)	2DB 0840
	IF(J -NCOUNT)100,110,100	2DB 0841
90	FORMAT(6X,A6,I6/(10I12))	2DB 0842
100	CALL ERRO2(6H**REAI,100,1)	2DB 0843
110	RETURN	2DB 0844
	END	2DB 0845

-ITC FOR MAPR,MAPR	2DB 0846
SUBROUTINE MAPR (M0,M2, JIM,JJM, K)	2DB 0847
INCLUDE ABC	2DB 0848
DIMENSION M0(JIM,JJM), M2(1), K(1)	2DB 0849
C PRODUCE A PICTURE PRINT BY ZONE AND MATERIAL	2DB 0850
WRITE(NOUT,10) (ID(I), I=1,11)	2DB 0851
10 FORMAT(1H1,11A6///)	2DB 0852
20 DO 30 JJ=1,JM	2DB 0853
J=JM-JJ+1	2DB 0854
30 WRITE (NOUT,40) (M0(I,J),I=1,IM)	2DB 0855
40 FORMAT(5H ,55I2)	2DB 0856
WRITE(NOUT,50)	2DB 0857
50 FORMAT(2H A/2H X/2H I/2H A/2H L//8H RADIAL)	2DB 0858
WRITE (NOUT,10) (ID(I), I = 1, 11)	2DB 0859
DO 70 JJ=1,JM	2DB 0860
J=JM-JJ+1	2DB 0861
DO 60 L=1,IM	2DB 0862
N=M0(L,J)	2DB 0863
60 K(L)=IABS (M2(N))	2DB 0864
70 WRITE (NOUT,40) (K(L),L=1,IM)	2DB 0865
WRITE(NOUT,50)	2DB 0866
RETURN	2DB 0867
END	2DB 0868

```

-ITC FOR INIT,INIT                                2DB 0869
  SUBROUTINE INIT (K6, K7, I0, I1, I2, M0, M2, N0, R0, R1, R2, 2DB 0870
1      R3, R4, R5, Z0, Z1, Z2, Z3, Z4, Z5, A0, A1, 2DB 0871
2      F0, C0, V0, JTL,JIM, V7,JJM,JMT) 2DB 0872
  INCLUDE ABC 2DB 0873
  DIMENSION K6(1), K7(1), I0(1), I1(1), I2(1), R0(1), R1(1), 2DB 0874
1      R2(1), R3(1), R4(1), R5(1), Z0(1), Z1(1), Z2(1), 2DB 0875
2      Z3(1), Z4(1), Z5(1), A0(1), A1(1), C0(JTL,JMT), 2DB 0876
3      V0(JIM,JJM), M0(1), M2(1), N0(1), F0(1), V7(1) 2DB 0877
  IF (P02) 20, 10, 20 2DB 0878
10  WRITE(NOUT,15) DAY 2DB 0879
15  FORMAT(1H1,30X,11H T I M E =F8.3,8H D A Y S///) 2DB 0880
20  CONTINUE 2DB 0881
  C ADJOINT REVERSALS 2DB 0882
  IF(A02) 25, 45, 25 2DB 0883
25  IF(P02) 45, 30, 45 2DB 0884
30  IF(NCON) 45, 35, 45 2DB 0885
35  IIG=1 2DB 0886
  IGBAR=IGM 2DB 0887
40  TEMP=K7(IIG) 2DB 0888
  K7(IIG)=K7(IGBAR) 2DB 0889
  K7(IGBAR)=TEMP 2DB 0890
  TEMP=V7(IIG) 2DB 0891
  V7(IIG)=V7(IGBAR) 2DB 0892
  V7(IGBAR)=TEMP 2DB 0893
  IIG=IIG+1 2DB 0894
  IGBAR=IGBAR-1 2DB 0895
  IF(IIG-IGBAR) 40, 45, 45 2DB 0896
45  CONTINUE 2DB 0897
  C 2DB 0898
  C MIX CROSS-SECTIONS 2DB 0899
  B07=1 2DB 0900
  IF(P02) 50, 55, 50 2DB 0901
50  GO TO (245,245,85,245,185), I04 2DB 0902
55  IF(M01) 70, 70, 60 2DB 0903
60  WRITE(NOUT, 65 ) (J, I0(J), I1(J), I2(J), J = 1, M01) 2DB 0904
65  FORMAT(1H0,3X, 16H MIXTURE NUMBER ,18H MIX COMMAND , 2DB 0905
124H MATERIAL ATOMIC DENSITY//(14,1X,18,8X,18,8X,E20.8)) 2DB 0906
70  IF(NPRT) 85, 85, 75 2DB 0907
75  WRITE (NOUT,80 ) 2DB 0908
80  FORMAT(/19H1CROSS-SECTION EDIT) 2DB 0909
85  REWIND NCR1 2DB 0910
  DO 180 IIG=1,IGM 2DB 0911
  READ (NCR1) ((C0(I,J),I=1,ITL),J=1,MT) 2DB 0912
  IF(M01) 90, 145, 90 2DB 0913
90  DO 140 M=1,M01 2DB 0914
  IF(I0(M)-MT) 100, 100, 95 2DB 0915
95  CALL ERRO2(6H**INIT,95,1) 2DB 0916
100  IF(I1(M)-MT) 105, 105, 95 2DB 0917
105  N=I0(M) 2DB 0918
  L=I1(M) 2DB 0919
  E01=I2(M) 2DB 0920
  IF(L) 125, 125, 110 2DB 0921
110  IF(E01) 125, 115, 125 2DB 0922
115  IF (N-L) 125, 120, 125 2DB 0923
120  E01 = EV 2DB 0924
  L = 0 2DB 0925
125  DO 140 I=1,ITL 2DB 0926
  IF (L) 130, 135, 130 2DB 0927

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130	CO(I,N)=CO(I,N)+CO(I,L)*E01	2DB 0928
	GO TO 140	2DB 0929
135	CO(I,N)=CO(I,N)*E01	2DB 0930
140	CONTINUE	2DB 0931
145	IF(P02) 175, 150, 175	2DB 0932
150	IF(NPRT) 175, 175, 155	2DB 0933
155	WRITE (NOUT,160) IIG	2DB 0934
160	FORMAT(7H GROUP I3,15H CROSS-SECTIONS)	2DB 0935
	DO 165 N=1,MT	2DB 0936
165	WRITE (NOUT,170) N,(CO(I,N),I=1,ITL)	2DB 0937
170	FORMAT(4H MAT,I3,(10E11.3))	2DB 0938
175	WRITE (NSCRAT) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 0939
180	CONTINUE	2DB 0940
	REWIND NCR1	2DB 0941
	REWIND NSCRAT	2DB 0942
C	SWITCH TAPE DESIGNATIONS	2DB 0943
	ITEMP=NSCRAT	2DB 0944
	NSCRAT=NCR1	2DB 0945
	NCR1=ITEMP	2DB 0946
185	IF(I04-5) 190, 205, 190	2DB 0947
190	IF(BUCK) 200, 245, 200	2DB 0948
200	TEMP = BUCK	2DB 0949
	GO TO 220	2DB 0950
205	IF(P02) 210, 210, 215	2DB 0951
210	BUCK = 0.	2DB 0952
215	TEMP = EV - BUCK	2DB 0953
	BUCK = EV	2DB 0954
220	DO 240 IIG=1,IGM	2DB 0955
	READ(NCR1) ((CO(I,J), I=1,ITL),J=1,MT)	2DB 0956
	DO 235 MTZ = 1,MT	2DB 0957
	DO 230 KZ=1,IZM	2DB 0958
	IF(M2(KZ) - MTZ) 230, 225, 230	2DB 0959
225	TEMP1 = TEMP/(3.*CO(4,MTZ))	2DB 0960
	CO(2,MTZ) = CO(2,MTZ) + TEMP1	2DB 0961
	CO(5,MTZ) = CO(5,MTZ) - TEMP1	2DB 0962
	GO TO 235	2DB 0963
230	CONTINUE	2DB 0964
235	CONTINUE	2DB 0965
	WRITE(NSCRAT) ((CO(I,J), I=1,ITL),J=1,MT)	2DB 0966
240	CONTINUE	2DB 0967
	REWIND NCR1	2DB 0968
	REWIND NSCRAT	2DB 0969
C	SWITCH TAPE DESIGNATIONS	2DB 0970
	ITEMP = NSCRAT	2DB 0971
	NSCRAT = NCR1	2DB 0972
	NCR1 = ITEMP	2DB 0973
245	CONTINUE	2DB 0974
C		2DB 0975
C	MODIFY GEOMETRY	2DB 0976
	IF(P02)270, 250, 270	2DB 0977
250	IF(NCON) 375, 255, 375	2DB 0978
255	DO 260 I=1,IP	2DB 0979
260	R1(I)=R0(I)	2DB 0980
	DO 265 J=1,JP	2DB 0981
265	Z1(J)=Z0(J)	2DB 0982
270	IF(I04-4) 305, 275, 305	2DB 0983
275	DO 280 I=1,IM	2DB 0984
	K=R2(I)	2DB 0985
280	R1(I+1)=R1(I)+(R0(I+1)-R0(I))*(1.0+ EV*R3(K))	2DB 0986

	DO 285 J=1,JM	2DB 0987
	K=Z2(J)	2DB 0988
285	Z1(J+1)=Z1(J)+(Z0(J+1)-Z0(J))*(1.0+ EV*Z3(K))	2DB 0989
	IF(IGE-2) 305, 290, 305	2DB 0990
290	IF(ABS (Z1(JP)-1.0)-1.0E-04) 305, 305, 300	2DB 0991
300	CALL ERRO2(6H**INIT,300,1)	2DB 0992
305	CONTINUE	2DB 0993
C		2DB 0994
C	AREAS AND VOLUMES	2DB 0995
	PI2=6.28318	2DB 0996
	IF(P02) 310, 315, 310	2DB 0997
310	IF(104 - 4) 375, 315, 375	2DB 0998
315	CONTINUE	2DB 0999
	DO 345 I=1,IM	2DB 1000
	R4(I)=(R1(I+1)+R1(I))*0.5	2DB 1001
	R5(I)=R1(I+1)-R1(I)	2DB 1002
	IF(R5(I)) 320, 320, 325	2DB 1003
320	CALL ERRO2 (6H*R5(I),320,1)	2DB 1004
325	CONTINUE	2DB 1005
	GO TO (330,335,340,342), IGEP	2DB 1006
330	A0(I)=1.0	2DB 1007
	A0(IP)=1.0	2DB 1008
	A1(I)=R5(I)	2DB 1009
	GO TO 345	2DB 1010
335	A0(I)=PI2*R1(I)	2DB 1011
	A0(IP)=PI2*R1(IP)	2DB 1012
	A1(I)=PI2*R5(I)*R4(I)	2DB 1013
	GO TO 345	2DB 1014
340	A0(I)=PI2*R1(I)	2DB 1015
	A0(IP)=PI2*R1(IP)	2DB 1016
	A1(I)=R5(I)	2DB 1017
	GO TO 345	2DB 1018
342	A0(I) = 2.*R5(I)	2DB 1019
	A0(IP) = 2.*R5(IP)	2DB 1020
	A1(I) = 2.*R5(I)	2DB 1021
345	CONTINUE	2DB 1022
	DO 370 J=1,JM	2DB 1023
	Z4(J)=(Z1(J+1)+Z1(J))*0.5	2DB 1024
	Z5(J)=Z1(J+1)-Z1(J)	2DB 1025
	IF(Z5(J)) 350, 350, 355	2DB 1026
350	CALL ERRO2 (6H*Z5(J),350,1)	2DB 1027
355	CONTINUE	2DB 1028
	DO 370 I=1,IM	2DB 1029
	GO TO (360,365,365,360), IGEP	2DB 1030
360	V0(I,J)=R5(I)*Z5(J)	2DB 1031
	GO TO 370	2DB 1032
365	V0(I,J)=PI2*R5(I)*Z5(J)*R4(I)	2DB 1033
370	CONTINUE	2DB 1034
375	CONTINUE	2DB 1035
C		2DB 1036
C	MATERIAL ADDRESSES	2DB 1037
380	IF(P02) 405, 385, 405	2DB 1038
385	SK7=0.	2DB 1039
	DO 400 IIG=1,IGM	2DB 1040
	IF(S02-1) 395, 390, 395	2DB 1041
390	K6(IIG)=K7(IIG)/S03	2DB 1042
	GO TO 400	2DB 1043
395	K6(IIG)=K7(IIG)	2DB 1044
400	SK7=SK7+K7(IIG)	2DB 1045

405	CONTINUE	2DB 1046
C	FISSION NEUTRONS	2DB 1047
	T11=E1(IGP)	2DB 1048
410	CALL CLEAR(0.0,F0,IMJM)	2DB 1049
	DO 425 IIG=1,IGM	2DB 1050
	EO(IIG) = .0	2DB 1051
	READ (NFLUX1) (NO(I),I=1,IMJM)	2DB 1052
	READ (NCR1) ((CO(I,J),I=1,ITL),J=1,MT)	2DB 1053
	DO 425 J = 1, JM	2DB 1054
	DO 425 K = 1, IM	2DB 1055
	I = K + (J-1)*IM	2DB 1056
	ITEMP=M0(I)	2DB 1057
	ITEMP=M2(ITEMP)	2DB 1058
	EO(IIG) = EO(IIG) + VO(K,J)*NO(I)*CO(1,ITEMP)	2DB 1059
	IF(A02) 415, 420, 415	2DB 1060
415	F0(I)=F0(I)+K7(IIG)*NO(I)	2DB 1061
	GO TO 425	2DB 1062
420	F0(I)=F0(I)+CO(IHT-1,ITEMP)*NO(I)	2DB 1063
425	CONTINUE	2DB 1064
	REWIND NFLUX1	2DB 1065
	REWIND NCR1	2DB 1066
	RETURN	2DB 1067
	END	2DB 1068
		2DB 1069

E-25

BNWL-831 REV1

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

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2DB 1070
2DB 1071
2DB 1072
2DB 1073
2DB 1074
2DB 1075
2DB 1076
-
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-ITC	FOR FISCAL, FISCAL	2DB 1077
	SUBROUTINE FISCAL (NC, FO, VO, CO, K6, MO, M2, JTL, JMT)	2DB 1078
	INCLUDE ABC	2DB 1079
	DIMENSION NC(1), FO(1), VO(1), CO(JTL, JMT), K6(1), MO(1), M2(1)	2DB 1080
	LAR = ALA	2DB 1081
C	FISSION SUMS	2DB 1082
	IF(B07) 90, 90, 10	2DB 1083
10	IF(A02) 20, 40, 20	2DB 1084
20	DO 30 IIG=1, IGM	2DB 1085
	READ (NCR1) ((CO(I, J), I=1, ITL), J=1, MT)	2DB 1086
	E1(IIG)=0.	2DB 1087
	DO 30 I=1, IMJM	2DB 1088
	ITEMP=MO(I)	2DB 1089
	ITEMP=M2(ITEMP)	2DB 1090
30	E1(IIG)=E1(IIG)+CO(IHT-1, ITEMP)*FO(1)*VO(1)	2DB 1091
	REWIND NCR1	2DB 1092
	GO TO 70	2DB 1093
40	E01=0.	2DB 1094
	DO 50 I=1, IMJM	2DB 1095
50	E01=E01+VO(I)*FO(I)	2DB 1096
	DO 60 IIG=1, IGM	2DB 1097
60	E1(IIG)=K6(IIG)*E01	2DB 1098
70	E1(IGP)=0.	2DB 1099
	E0(IGP)=0.	2DB 1100
	DO 80 IIG=1, IGM	2DB 1101
	E0(IGP)=E0(IGP)+E0(IIG)	2DB 1102
80	E1(IGP)=E1(IGP)+E1(IIG)	2DB 1103
	IF(907) 140, 90, 140	2DB 1104
90	ALA = E1(IGP)/T11	2DB 1105
	TEMP=1.0/ALA	2DB 1106
	IF(I04-1) 230, 100, 140	2DB 1107
100	DO 110 IIG=1, IGM	2DB 1108
	E1(IIG)=E1(IIG)*TEMP	2DB 1109
110	K6(IIG)=K6(IIG)*TEMP	2DB 1110
	E1(IGP)=E1(IGP)*TEMP	2DB 1111
	IF(A02) 120, 140, 120	2DB 1112
120	DO 130 I=1, IMJM	2DB 1113
130	FO(I)=FO(I)*TEMP	2DB 1114
140	CONTINUE	2DB 1115
C		2DB 1116
C	NORMALIZATION	2DB 1117
	B07=0	2DB 1118
150	IF(S01) 160, 230, 170	2DB 1119
160	E01 = ABS(S01)/(E0(IGP)*TSD)	2DB 1120
	GO TO 180	2DB 1121
170	E01=S01/E1(IGP)	2DB 1122
180	DO 190 IIG=1, IGP	2DB 1123
190	E1(IIG)=E01*E1(IIG)	2DB 1124
	DO 200 I=1, IMJM	2DB 1125
200	FO(I)=E01*FO(I)	2DB 1126
230	RETURN	2DB 1127
	END	2DB 1128

[illegible]

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-ITC FOR OUTER,OUTER                                2DB 1154
SUBROUTINE OUTER( AO, A1, CO, FO, K6, MO, M2, NO, N2, 2DB 1155
1      S2, V0, V7, Z5, F2, JTL,JMT, CXS,             2DB 1156
2      JIM, JJM, R5, R4, Z4, CXR, CXT, HA, PA)        2DB 1157
  DIMENSION AO(1), A1(1), FO(1), K6(1), MO(1), M2(1), 2DB 1158
1      NO(1), N2(1), S2(1),                         2DB 1159
2      V0(1), V7(1), Z5(1), F2(1), CO(JTL,JMT), HA(1), PA(1), 2DB 1160
3      CXS(JIM,JJM,3), R5(1), R4(1), Z4(1), CXR(1), CXT(1) 2DB 1161
  INTEGER      GBAR, PBAR, SBAR                      2DB 1162
  INCLUDE ABC                                       2DB 1163
  IGV=1                                             2DB 1164
C  SOURCE CALCULATION                             2DB 1165
10  CONTINUE                                       2DB 1166
    READ(NCR1) ((CO(I,M),I=1,ITL),M=1,MT)          2DB 1167
    IF (IO4) 15,12,15                             2DB 1168
12  READ (NSORCE) (S2(I), I = 1,IMJM)              2DB 1169
    GO TO 30                                       2DB 1170
15  DO 20 I=1,IMJM                                2DB 1171
20  S2(I)=0.                                       2DB 1172
30  IF(AO2) 60, 40, 60                            2DB 1173
40  DO 50 I=1,IMJM                                2DB 1174
50  S2(I)=S2(I)+K6(IGV)*FO(I)                     2DB 1175
    GO TO 80                                       2DB 1176
60  DO 70 I=1,IMJM                                2DB 1177
    ITEMP1=MO(I)                                  2DB 1178
    ITEMP1=M2(ITEMP1)                              2DB 1179
70  S2(I)=S2(I)+CO(IHT-1,ITEMP1)*FO(I)             2DB 1180
80  GBAR=IGV+IHS-ITL                               2DB 1181
    IF(GBAR-1) 90, 100, 100                       2DB 1182
90  GBAR=1                                          2DB 1183
100 PBAR = IHS + IGV - 1                           2DB 1184
    IF(PBAR - ITL) 115,115,110                     2DB 1185
110 PBAR = ITL                                     2DB 1186
115 IF(GBAR - IGV) 120, 140, 140                   2DB 1187
120 READ (NSCRAT) (N2(I),I=1,IMJM)                 2DB 1188
    DO 130 I=1,IMJM                               2DB 1189
    ITEMP1=MO(I)                                  2DB 1190
    ITEMP1=M2(ITEMP1)                              2DB 1191
    ITEMP=ITEMP1                                   2DB 1192
    TEMP=CO(PBAR,ITEMP)                            2DB 1193
130 S2(I)=S2(I)+N2(I)*TEMP                         2DB 1194
    GO TO 150                                       2DB 1195
140 READ (NFLUX1) (N2(I),I=1,IMJM)                 2DB 1196
150 GBAR=GBAR+1                                    2DB 1197
    PBAR=PBAR-1                                    2DB 1198
    IF(GBAR - IGV) 120, 140, 160                   2DB 1199
160 IF(IGV - IGM) 180, 170, 180                   2DB 1200
170 REWIND NCR1                                    2DB 1201
180 V11=0.                                         2DB 1202
    DO 190 I=1,IMJM                                2DB 1203
    S2(I)=S2(I)+V0(I)                              2DB 1204
190 V11=V11+S2(I)                                  2DB 1205
    E2(IGV) = V11 - E1(IGV)                        2DB 1206
C  SOURCE-ALPHA                                    2DB 1207
200 IF(IO4 - 2) 210, 240, 210                      2DB 1208
210 IF(SO2 - 2) 230, 220, 230                      2DB 1209
220 T7 = S03/V7(IGV)                              2DB 1210
    GO TO 250                                       2DB 1211
230 T7 = 0.0                                       2DB 1212

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GO TO 270
240 T7 = EV/V7(IGV)
250 DO 260 K = 1, IZM
ITEMP1 = M2(K)
260 CO(IHS, ITEMP1) = CO(IHS, ITEMP1) - T7
270 CONTINUE
C GROUP FLUX CALCULATION
280 II=0
IF(V11) 290, 370, 290
290 IF(IGE - 3) 292, 294, 292
292 CALL INNER1(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, IM, JM,
1 ITL, CXR, CXT)
GO TO 296
294 CALL INNER2(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, IM, JM,
1 ITL, CXR, CXT)
GO TO 340
296 IF (B03 - 1) 310, 310, 300
300 CALL INNERP(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT,
1 HA, PA)
GO TO 350
310 IF (IGE - 2) 320, 330, 320
320 IF (S04 - 1) 325, 322, 325
322 IF (P02 - 2 * (P02/2)) 330, 330, 340
325 IF (IM - JM) 330, 330, 340
330 CALL INNER(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT,
1 HA, PA)
GO TO 350
340 CALL INNER2(N0, N2, CXS, S2, M0, M2, V0, C0, IM, JM, ITL, CXR, CXT,
1 HA, PA)
350 DO 360 K = 1, IZM
ITEMP1 = M2(K)
360 CO(IHS, ITEMP1) = CO(IHS, ITEMP1) + T7
GO TO 390
370 DO 380 I=1, IMJM
N2(I)=0.
380 N0(I)=0.
390 CONTINUE
WRITE (NSCRAT) (N2(I), I=1, IMJM)
C USE FOLLOWING OPTION IF BACKSPACING REQUIRES EXCESSIVE TIME
C REWIND NSCRAT
C SBAR = IGV - (ITL - IHS)
C IF (SBAR) 440, 440, 420
C 420 DO 430 IS = 1, SBAR
C 430 READ (NSCRAT)
SBAR=ITL-IHS
IF(SBAR) 440, 440, 420
420 DO 430 IS=1, SBAR
430 BACKSPACE NSCRAT
440 CONTINUE
IF(V11) 450, 500, 450
450 IF(A02) 460, 480, 460
460 E0(IGV)=0.0
DO 470 I=1, IMJM
ITEMP1=M0(I)
ITEMP1=M2(ITEMP1)
E0(IGV)=E0(IGV) + CO(1, ITEMP1)*N2(I)*V0(I)
470 F2(I)=F2(I)+K6(IGV)*N2(I)
GO TO 500
480 E0(IGV)=0.0

```

	DO 490 I=1,IMJM	2DB 1272
	ITEMP1=M0(I)	2DB 1273
	ITEMP1=M2(ITEMP1)	2DB 1274
	E0(IGV)=E0(IGV) + C0(1,ITEMP1)*N2(I)*V0(I)	2DB 1275
490	F2(I)=F2(I)+C0(IHT-1,ITEMP1)*N2(I)	2DB 1276
500	CONTINUE	2DB 1277
	IGV=IGV+1	2DB 1278
	IF(IGV-IGM) 10, 10, 510	2DB 1279
510	T11 = E1(IGP)	2DB 1280
C	SWITCH TAPE DESIGNATIONS	2DB 1281
	REWIND NCR1	2DB 1282
	REWIND NSCRAT	2DB 1283
	REWIND NFLUX1	2DB 1284
	ITEMP = NSCRAT	2DB 1285
	NSCRAT = NFLUX1	2DB 1286
	NFLUX1 = ITEMP	2DB 1287
	IF (I04) 514,512,514	2DB 1288
512	REWIND NSORCE	2DB 1289
514	CONTINUE	2DB 1290
C		2DB 1291
C	OVER-RELAX FISSION SOURCE	2DB 1292
	ORFF = 1.0 + .6*(ORF - 1.0)	2DB 1293
	E02 = .0	2DB 1294
	IF(A02) 520,580,520	2DB 1295
520	E1(IGP) = .0	2DB 1296
C	FOR ADJOINT CALCULATION, S2(I) STORES ORFED F2(I)	2DB 1297
	DO 522 I=1,IMJM	2DB 1298
522	S2(I) = F0(I) + ORFF*(F2(I) - F0(I))	2DB 1299
	DO 540 IIG = 1,IGM	2DB 1300
	READ(NCR1) ((C0(I,J)), I=1,ITL), J=1,MT)	2DB 1301
	E1(IIG) = .0	2DB 1302
	DO 530 I=1,IMJM	2DB 1303
	ITEMP = M0(I)	2DB 1304
	ITEMP = M2(ITEMP)	2DB 1305
	E1(IIG) = E1(IIG) + C0(IHT-1,ITEMP)*F2(I)*V0(I)	2DB 1306
530	E02 = E02 + C0(IHT-1,ITEMP)*S2(I)*V0(I)	2DB 1307
540	E1(IGP) = E1(IGP) + E1(IIG)	2DB 1308
	TEMP1 = E1(IGP)/E02	2DB 1309
	DO 550 I=1,IMJM	2DB 1310
550	F0(I) = TEMP1*S2(I)	2DB 1311
	REWIND NCR1	2DB 1312
	GO TO 620	2DB 1313
580	E01 = 0.0	2DB 1314
	DO 590 I=1,IMJM	2DB 1315
	E01 = E01 + V0(I)*F2(I)	2DB 1316
	F2(I) = F0(I) + ORFF*(F2(I) - F0(I))	2DB 1317
590	E02 = E02 + V0(I)*F2(I)	2DB 1318
	TEMP1 = E01/E02	2DB 1319
	DO 600 I=1,IMJM	2DB 1320
600	F0(I) = TEMP1*F2(I)	2DB 1321
	DO 610 IIG = 1,IGM	2DB 1322
610	E1(IIG) = K6(IIG)*E01	2DB 1323
	IF(I04) 620,611,620	2DB 1324
C	ACCELERATION FOR EXTRANEIOUS SOURCE PROBLEMS	2DB 1325
611	TEMP1 = (1.0 - EV*T11/E01)/(1.0 - EV)	2DB 1326
	IF (T11/E01 - .01) 620,620,612	2DB 1327
612	IF (T11/E01 - 1./(EV + .0001)) 613,613,620	2DB 1328
613	DO 614 I = 1,IMJM	2DB 1329
614	F0(I) = TEMP1 * F0(I)	2DB 1330

E-31

BNWL-831 REV1

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DO 616 IIG = 1,IGM
E0(IIG) = TEMP1*E0(IIG)
616 E1(IIG) = TEMP1*E1(IIG)
620 E1(IGP) = 0.0
E0(IGP) = 0.0
DO 640 IIG = 1,IGM
E0(IGP) = E0(IGP) + E0(IIG)
640 E1(IGP) = E1(IGP) + E1(IIG)
RETURN
END
```

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2DB 1331
2DB 1332
2DB 1333
2DB 1334
2DB 1335
2DB 1336
2DB 1337
2DB 1338
2DB 1339
2DB 1340
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-ITC FOR INNER1,INNER1                                2DB 1341
SUBROUTINE INNER1(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, 2DB 1342
2      JIM,JJM,JTL,CXR,CXT)                            2DB 1343
  DIMENSION M0(1), M2(1),CXS(JIM,JJM,3),V0(1), C0(JTL,1), 2DB 1344
1      A0(1), Z5(1), R5(1), R4(1), Z4(1), A1(1),CXR(1), CXT(1)2DB 1345
  INCLUDE ABC                                           2DB 1346
C  THIS SUBROUTINE CALCULATES COEFFICIENTS FOR THE FLUX EQUATION 2DB 1347
  PI2 = 6.28318                                         2DB 1348
  DO 45 KJ = 1, JM                                     2DB 1349
  DO 45 KI = 1, IM                                     2DB 1350
  GO TO (10,10, 5), IGEP                               2DB 1351
5    TEMP = PI2*(Z4(KJ) - Z4(KJ-1))*R4(KI)             2DB 1352
  GO TO 15                                              2DB 1353
10   TEMP = Z4(KJ) - Z4(KJ-1)                         2DB 1354
15   I = KI + (KJ-1)*IM                               2DB 1355
  ITEMP = M0(I)                                         2DB 1356
  ITEMP = M2(ITEMP)                                     2DB 1357
  CXS(KI,KJ,3) = V0(I)*(C0(IHT,ITEMP) - C0(IHS,ITEMP)) 2DB 1358
  IF(I - 1) 45,45,18                                   2DB 1359
18   ITEMP1 = M0(I-1)                                  2DB 1360
  ITEMP1 = M2(ITEMP1)                                  2DB 1361
  IF (ITEMP - ITEMP1) 25,20,25                         2DB 1362
20   CXS(KI,KJ,1)=A0(KI )*Z5(KJ)/(3.*C0(IHT,ITEMP)*(R4(KI)-R4(KI-1))) 2DB 1363
  GO TO 30                                              2DB 1364
25   CXS(KI,KJ,1) = A0(KI)*Z5(KJ)*(R5(KI-1)+R5(KI))/((R4(KI)-R4(KI-1))*2DB 1365
1 (3.*(R5(KI-1)*C0(IHT,ITEMP1) + R5(KI)*C0(IHT,ITEMP)))) 2DB 1366
30   IF(I - IM) 45,45,32                               2DB 1367
32   ITEMP3 = M0(I - IM)                               2DB 1368
  ITEMP3 = M2(ITEMP3)                                  2DB 1369
  IF (ITEMP - ITEMP3) 40,35,40                         2DB 1370
35   CXS(KI,KJ,2) = A1(KI)/(3.*C0(IHT,ITEMP)*TEMP)    2DB 1371
  GO TO 45                                              2DB 1372
40   CXS(KI,KJ,2) = A1(KI)*(Z5(KJ-1) + Z5(KJ))/(TEMP* 2DB 1373
1 (3.*(Z5(KJ-1)*C0(IHT,ITEMP3) + Z5(KJ)*C0(IHT,ITEMP)))) 2DB 1374
45   CONTINUE                                           2DB 1375
  DO 200 KJ = 1, JM                                    2DB 1376
  DO 200 KI = 1, IM                                    2DB 1377
  GO TO (55,55,50), IGEP                               2DB 1378
50   TEMP = .5*PI2*Z5(KJ)*R4(KI)                      2DB 1379
  GO TO 60                                              2DB 1380
55   TEMP = .5*Z5(KJ)                                  2DB 1381
60   I = KI + (KJ-1)*IM                               2DB 1382
  ITEMP = M0(I)                                         2DB 1383
  ITEMP = M2(ITEMP)                                     2DB 1384
  TEMP1 = CXS(KI+1,KJ,1)                               2DB 1385
  TEMP2 = CXS(KI,KJ+1,2)                               2DB 1386
  IF(KJ - 1) 65,65,100                                  2DB 1387
65   IF(B04 - 1) 90,95,70                              2DB 1388
70   GO TO ( 80, 80, 75), IGEP                         2DB 1389
75   TEMP3 = PI2*R4(KI)*.5*(Z5(KJ) + Z5(JM))           2DB 1390
  GO TO 85                                              2DB 1391
80   TEMP3 = .5*(Z5(KJ) + Z5(JM))                     2DB 1392
85   ITEMP3 = I + IM*(JM - 1)                          2DB 1393
  ITEMP3 = M0(ITEMP3)                                  2DB 1394
  ITEMP3 = M2(ITEMP3)                                  2DB 1395
  CXS(KI,KJ,2) = A1(KI)*(Z5(JM) + Z5(KJ))/(TEMP3* 2DB 1396
1 (3.*(Z5(JM)*C0(IHT,ITEMP3) + Z5(KJ)*C0(IHT,ITEMP)))) 2DB 1397
  GO TO 125                                             2DB 1398
90   CXS(KI,KJ,2) = A1(KI)/(3.*C0(IHT,ITEMP)*( TEMP  +.71/ 2DB 1399

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BNWL-831 REV1
 2DB 1400
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 2DB 1434
 -

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1 CO(IHT,ITEMP)))
GO TO 125
95 CXS(KI,KJ,2) = .0
GO TO 125
100 IF (KJ - JM) 125,105,105
105 IF (B03 - 1) 115,120,110
110 TEMP2 = CXS(KI,1,2)
CXT(KI) = TEMP2
GO TO 125
115 TEMP2 = A1(KI)/(3.*CO(IHT,ITEMP)*( TEMP +.71/
1 CO(IHT,ITEMP)))
CXT(KI) = TEMP2
GO TO 125
120 TEMP2 = .0
CXT(KI) = TEMP2
125 IF (KI - 1) 130,130,145
130 IF(B01) 135,135,140
135 CXS(KI,KJ,1) = A0(KI )*Z5(KJ)/(3.*CO(IHT,ITEMP)*
1 (.5*R5(KI) + .71/CO(IHT,ITEMP)))
GO TO 165
140 CXS(KI,KJ,1) = .0
GO TO 165
145 IF (KI - IM) 165,150,150
150 IF(B02) 155,155,160
155 TEMP1 = A0(KI+1)*Z5(KJ)/(3.*CO(IHT,ITEMP)*
1 (.5*R5(KI) + .71/CO(IHT,ITEMP)))
CXR(KJ) = TEMP1
GO TO 165
160 TEMP1 = .0
CXR(KJ) = TEMP1
165 CXS(KI,KJ,3) = CXS(KI,KJ,3) + CXS(KI,KJ,1) + CXS(KI,KJ,2)
1 + TEMP1 + TEMP2
200 CONTINUE
RETURN
END

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-ITC FOR INNERT,INNERT                                2DB 1435
  SUBROUTINE INNERT(M0, M2, CXS, V0, C0, A0, Z5, R5, R4, Z4, A1, 2DB 1436
2      JIM,JJM,JTL,CXR,CXT)                            2DB 1437
  DIMENSION M0(1), M2(1),CXS(JIM,JJM,3),V0(1), C0(JTL,1), 2DB 1438
1      A0(1), Z5(1), R5(1), R4(1), Z4(1), A1(1),CXR(1), CXT(1)2DB 1439
  INCLUDE ABC                                           2DB 1440
C  THIS SUBROUTINE CALCULATES COEFFICIENTS FOR TRIANGULAR GEOMETRY 2DB 1441
  DO 45 KJ = 1, JM                                     2DB 1442
  DO 45 KI = 1, IM                                     2DB 1443
    TEMP = KI - 2* (KI/2) - (KJ - 2* (KJ/2))          2DB 1444
    TEMP = ABS(TEMP)                                   2DB 1445
    I = KI + (KJ-1) *IM                               2DB 1446
    ITEMP = M0(I)                                      2DB 1447
    ITEMP = M2(ITEMP)                                  2DB 1448
    CXS(KI,KJ,3) = V0(I)*(C0(IHT,ITEMP) - C0(IHS,ITEMP)) 2DB 1449
    IF(I - 1) 45, 45, 18                              2DB 1450
18  ITEMP1 = M0(I-1)                                   2DB 1451
    ITEMP1 = M2(ITEMP1)                                2DB 1452
    IF(ITEMP - ITEMP1) 25, 20, 25                     2DB 1453
20  CXS(KI,KJ,1) = A0(KI)/(2.*C0(IHT,ITEMP)*Z5(1))    2DB 1454
    GO TO 30                                            2DB 1455
25  CXS(KI,KJ,1) = A0(KI)/((C0(IHT,ITEMP1) + C0(IHT,ITEMP))*Z5(1)) 2DB 1456
30  IF(I - IM) 45, 45, 32                             2DB 1457
32  ITEMP3 = M0(I - IM)                               2DB 1458
    ITEMP3 = M2(ITEMP3)                               2DB 1459
    IF(ITEMP - ITEMP3) 40, 35, 40                    2DB 1460
35  CXS(KI,KJ,2) = A1(KI)*TEMP/(2.* C0(IHT,ITEMP)*Z5(1)) 2DB 1461
    GO TO 45                                           2DB 1462
40  CXS(KI,KJ,2) = A1(KI)*TEMP/((C0(IHT,ITEMP3)+C0(IHT,ITEMP))*Z5(1)) 2DB 1463
45  CONTINUE                                           2DB 1464
  DO 200 KJ = 1, JM                                    2DB 1465
  DO 200 KI = 1, IM                                    2DB 1466
    TEMP = KI - 2*(KI/2) - (KJ-2*(KJ/2))              2DB 1467
    TEMP = ABS(TEMP)                                   2DB 1468
    I = KI + (KJ-1)*IM                                2DB 1469
    ITEMP = M0(I)                                      2DB 1470
    ITEMP = M2(ITEMP)                                  2DB 1471
    TEMP1 = CXS(KI+1,KJ,1)                             2DB 1472
    TEMP2 = CXS(KI,KJ+1,2)                             2DB 1473
    IF(KJ-1) 65, 65, 100                               2DB 1474
65  IF(B04-1) 90, 95, 95                               2DB 1475
90  CXS(KI,KJ,2) = A1(KI)*TEMP/(3.*C0(IHT,ITEMP)*(Z5(1)/3. + .71/ 2DB 1476
1  C0(IHT,ITEMP)))                                     2DB 1477
    GO TO 125                                          2DB 1478
95  CXS(KI,KJ,2) = .0                                  2DB 1479
    GO TO 125                                          2DB 1480
100 IF(KJ - JM) 125, 105, 105                          2DB 1481
105 IF(B03 - 1) 115, 120, 120                          2DB 1482
115 TEMP = KI - 2*(KI/2) - (KJ + 1- 2*((KJ+1)/2))    2DB 1483
    TEMP = ABS(TEMP)                                   2DB 1484
    TEMP2=A1(KI)*TEMP/( 3.*C0(IHT,ITEMP)*(Z5(1)/3.+ .71/C0(IHT,ITEMP))) 2DB 1485
    CXT(KI) = TEMP2                                    2DB 1486
    GO TO 125                                          2DB 1487
120 TEMP2 = .0                                         2DB 1488
    CXT(KI) = TEMP2                                    2DB 1489
125 IF(KI-1) 130, 130, 145                             2DB 1490
130 IF(B01) 135, 135, 140                             2DB 1491
135 CXS(KI,KJ,1) = A0(KI)/(3.*C0(IHT,ITEMP)*(Z5(1)/3. 2DB 1492
1  + .71/C0(IHT,ITEMP)))                             2DB 1493

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	GO TO 165	2DB 1494
140	CXS(KI,KJ,1) = .0	2DB 1495
	GO TO 165	2DB 1496
145	IF(KI - IM) 165, 150, 150	2DB 1497
150	IF(B02) 155, 155, 160	2DB 1498
155	TEMP1 = AU(KI+1)/(3.*CV(IHT,ITEMP)*(Z5(1)/3.+ .71/CO(IHT,ITEMP)))	2DB 1499
	CXR(KJ) = TEMP1	2DB 1500
	GO TO 165	2DB 1501
160	TEMP1 = .0	2DB 1502
	CXR(KJ) = TEMP1	2DB 1503
165	CXS(KI,KJ,3) = CXS(KI,KJ,3) + CXS(KI,KJ,1) + CXS(KI,KJ,2)	2DB 1504
	1 + TEMP1 + TEMP2	2DB 1505
200	CONTINUE	2DB 1506
	RETURN	2DB 1507
	END	2DB 1508

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-ITC FOR INNER,INNER                                2DB 1509
  SUBROUTINE INNER(N0, N2, CXS, S2, M0, M2, V0, C0, JIM, JJM, JTL, 2DB 1510
1    CXR, CXT, HA, PA)                                2DB 1511
  INCLUDE ABC                                          2DB 1512
  DIMENSION N0(1), N2(1), CXS(JIM, JJM, 3), S2(1), M0(1), M2(1), 2DB 1513
1    V0(1), C0(JTL, 1), CXR(1), CXT(1), HA(1), PA(1) 2DB 1514
  CALL IFLUXN (N2, C0, V0, CXS, M0, M2, ITL, IM, JM, CXR, CXT) 2DB 1515
2  DO 4  I=1, IMJM                                     2DB 1516
4  N0(I) = N2(I)                                       2DB 1517
C  BEGIN FLUX CALCULATION                             2DB 1518
  IKB = IM - 1                                         2DB 1519
  JKB = JM - 1                                         2DB 1520
C  FLUX CALCULATION USING SOR WITH LINE INVERSION      2DB 1521
C                                                    2DB 1522
C  CALCULATION OF LEFT BOUNDARY FLUX                  2DB 1523
  KI = 1                                               2DB 1524
  KJ = 1                                               2DB 1525
  I = KI + (KJ - 1)*IM                                2DB 1526
  HA(KJ) = CXS(KI, KJ+1, 2)/CXS(KI, KJ, 3)            2DB 1527
  PA(KJ) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1))/CXS(KI, KJ, 3) 2DB 1528
  DO 5 KJ = 2, JKB                                     2DB 1529
  I = KI + (KJ - 1)*IM                                2DB 1530
  HA(KJ) = CXS(KI, KJ+1, 2)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1531
5  PA(KJ) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1) + CXS(KI, KJ, 2)*PA(KJ-1))/2DB 1532
1  (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1))          2DB 1533
  KJ = JM                                              2DB 1534
  I = KI + (KJ - 1)*IM                                2DB 1535
  N2(I) = (S2(I) + CXS(KI+1, KJ, 1)*N2(I+1) + CXS(KI, KJ, 2)*PA(KJ-1))/2DB 1536
1  (CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1))          2DB 1537
  DO 10 KJJ = 2, JM                                    2DB 1538
  KJ = JM - KJJ + 1                                   2DB 1539
  I = KI + (KJ - 1)*IM                                2DB 1540
10 N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)                 2DB 1541
  DO 15 KJ = 1, JM                                     2DB 1542
  I = KI + (KJ - 1)*IM                                2DB 1543
15 N2(I) = N0(I) + ORF*(N2(I) - N0(I))                2DB 1544
C  PRINCIPAL FLUX LOOP                                2DB 1545
  DO 40 KI = 2, IKB                                   2DB 1546
  KJ = 1                                               2DB 1547
  I = KI + (KJ - 1)*IM                                2DB 1548
  HA(KJ) = CXS(KI, KJ+1, 2)/CXS(KI, KJ, 3)            2DB 1549
  PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1))/ 2DB 1550
1  CXS(KI, KJ, 3)                                       2DB 1551
  DO 25 KJ = 2, JKB                                     2DB 1552
  I = KI + (KJ - 1)*IM                                2DB 1553
  HA(KJ) = CXS(KI, KJ+1, 2)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1554
25 PA(KJ) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1) + 2DB 1555
1  CXS(KI, KJ, 2)*PA(KJ-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1556
  KJ = JM                                              2DB 1557
  I = KI + (KJ - 1)*IM                                2DB 1558
  N2(I) = (S2(I) + CXS(KI, KJ, 1)*N2(I-1) + CXS(KI+1, KJ, 1)*N2(I+1) + 2DB 1559
1  CXS(KI, KJ, 2)*PA(KJ-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 2)*HA(KJ-1)) 2DB 1560
  DO 30 KJJ = 2, JM                                    2DB 1561
  KJ = JM - KJJ + 1                                   2DB 1562
  I = KI + (KJ - 1)*IM                                2DB 1563
30 N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)                 2DB 1564
  DO 35 KJ = 1, JM                                     2DB 1565
  I = KI + (KJ - 1)*IM                                2DB 1566
35 N2(I) = N0(I) + ORF*(N2(I) - N0(I))                2DB 1567

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40  CONTINUE                                2DB 1568
C    CALCULATION OF RIGHT BOUNDARY FLUX    2DB 1569
    KI = IM                                2DB 1570
    KJ = 1                                  2DB 1571
    I = KI + (KJ - 1)*IM                    2DB 1572
    HA(KJ) = CXS(KI,KJ+1,2)/CXS(KI,KJ,3)    2DB 1573
    PA(KJ) = (S2(I) + CXS(KI,KJ,1)*N2(I-1))/CXS(KI,KJ,3) 2DB 1574
    DO 45 KJ = 2,JKB                        2DB 1575
    I = KI + (KJ - 1)*IM                    2DB 1576
    HA(KJ) = CXS(KI,KJ+1,2)/(CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1)) 2DB 1577
45  PA(KJ) = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*PA(KJ-1))/ 2DB 1578
    1 (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1)) 2DB 1579
    KJ = JM                                  2DB 1580
    I = KI + (KJ - 1)*IM                    2DB 1581
    N2(I) = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*PA(KJ-1))/ 2DB 1582
    1 (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1)) 2DB 1583
    DO 50 KJJ = 2,JM                        2DB 1584
    KJ = JM - KJJ + 1                      2DB 1585
    I = KI + (KJ - 1)*IM                    2DB 1586
50  N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)      2DB 1587
    DO 55 KJ = 1,JM                        2DB 1588
    I = KI + (KJ - 1)*IM                    2DB 1589
55  N2(I) = NO(I) + ORF*(N2(I) - NO(I))    2DB 1590
    TEMP1 = .0                              2DB 1591
    DO 90 I = 1,IMJM                        2DB 1592
    TEMP2 = ABS (1.0 - NO(I)/N2(I))         2DB 1593
    IF (TEMP1 - TEMP2) 80,90,90             2DB 1594
80  TEMP1 = TEMP2                           2DB 1595
90  CONTINUE                                2DB 1596
C                                            2DB 1597
C    INNER ITERATION CONTROL               2DB 1598
133 LC = LC + 1                             2DB 1599
    II = II + 1                             2DB 1600
    IF (II - G07) 533, 1033, 1033          2DB 1601
533 IF (TEMP1 - EPS) 633,633,2             2DB 1602
633 IF(G06) 733, 1033, 733                2DB 1603
733 IF (TEMP1 - G06) 1033, 1033, 2        2DB 1604
1033 CONTINUE                              2DB 1605
    RETURN                                  2DB 1606
    END                                     2DB 1607

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-ITC FOR INNER2,INNER2                                2DB 1608
  SUBROUTINE INNER2(NC, N2, CXS, S2, MO, M2, VO, CO, JIM, JUM, JTL, 2DB 1609
1    CXR, CXT, HA, PA)                                2DB 1610
  INCLUDE ABC                                          2DB 1611
  DIMENSION NC(1), N2(1), CXS(JIM, JUM, 3), S2(1), MO(1), M2(1), 2DB 1612
1    VO(1), CO(JTL, 1), CXR(1), CXT(1), HA(1), PA(1) 2DB 1613
  CALL IFLUXN (N2, CO, VO, CXS, MO, M2, ITL, IM, JM, CXR, CXT) 2DB 1614
2    DO 4 I=1, IMJM                                    2DB 1615
4    N0(I) = N2(I)                                     2DB 1616
C    BEGIN FLUX CALCULATION                           2DB 1617
    IKB = IM - 1                                       2DB 1618
    JKB = JM - 1                                       2DB 1619
C    FLUX CALCULATION USING SOR WITH LINE INVERSION    2DB 1620
C                                                    2DB 1621
C    CALCULATION OF BOTTOM BOUNDARY FLUX              2DB 1622
    KI = 1                                             2DB 1623
    KJ = 1                                             2DB 1624
    I = KI + (KJ - 1)*IM                             2DB 1625
    HA(KI) = CXS(KI+1, KJ, 1)/CXS(KI, KJ, 3)          2DB 1626
    PA(KI) = (S2(I) + CXS(KI, KJ+1, 2)*N2(I+IM))/CXS(KI, KJ, 3) 2DB 1627
    DO 5 KI = 2, IKB                                  2DB 1628
    I = KI + (KJ - 1)*IM                             2DB 1629
    HA(KI) = CXS(KI+1, KJ, 1)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1630
5    PA(KI) = (S2(I) + CXS(KI, KJ+1, 2)*N2(I+IM) + CXS(KI, KJ, 1)*PA(KI-1))/2DB 1631
1    (CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1))        2DB 1632
    KI = IM                                           2DB 1633
    I = KI + (KJ - 1)*IM                             2DB 1634
    N2(I) = (S2(I) + CXS(KI, KJ+1, 2)*N2(I+IM) + CXS(KI, KJ, 1)*PA(KI-1))/2DB 1635
1    (CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1))        2DB 1636
    DO 10 KII = 2, IM                                 2DB 1637
    KI = IM - KII + 1                                 2DB 1638
    I = KI + (KJ - 1)*IM                             2DB 1639
10   N2(I) = PA(KI) + HA(KI) * N2(I+1)                2DB 1640
    DO 15 KI = 1, IM                                  2DB 1641
    I = KI + (KJ - 1)*IM                             2DB 1642
15   N2(I) = N0(I) + ORF*(N2(I) - N0(I))              2DB 1643
C    PRINCIPAL FLUX LOOP                             2DB 1644
    DO 40 KJ = 2, JKB                                 2DB 1645
    KI = 1                                             2DB 1646
    I = KI + (KJ - 1)*IM                             2DB 1647
    HA(KI) = CXS(KI+1, KJ, 1)/CXS(KI, KJ, 3)          2DB 1648
    PA(KI) = (S2(I) + CXS(KI, KJ, 2)*N2(I-IM) + CXS(KI, KJ+1, 2)*N2(I+IM))/2DB 1649
1    CXS(KI, KJ, 3)                                    2DB 1650
    DO 25 KI = 2, IKB                                  2DB 1651
    I = KI + (KJ - 1)*IM                             2DB 1652
    HA(KI) = CXS(KI+1, KJ, 1)/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1653
25   PA(KI) = (S2(I) + CXS(KI, KJ, 2)*N2(I-IM) + CXS(KI, KJ+1, 2)*N2(I+IM) + 2DB 1654
1    CXS(KI, KJ, 1)*PA(KI-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1655
    KI = IM                                           2DB 1656
    I = KI + (KJ - 1)*IM                             2DB 1657
    N2(I) = (S2(I) + CXS(KI, KJ, 2)*N2(I-IM) + CXS(KI, KJ+1, 2)*N2(I+IM) + 2DB 1658
1    CXS(KI, KJ, 1)*PA(KI-1))/(CXS(KI, KJ, 3) - CXS(KI, KJ, 1)*HA(KI-1)) 2DB 1659
    DO 30 KII = 2, IM                                 2DB 1660
    KI = IM - KII + 1                                 2DB 1661
    I = KI + (KJ - 1)*IM                             2DB 1662
30   N2(I) = PA(KI) + HA(KI) * N2(I+1)                2DB 1663
    DO 35 KI = 1, IM                                  2DB 1664
    I = KI + (KJ - 1)*IM                             2DB 1665
35   N2(I) = N0(I) + ORF*(N2(I) - N0(I))              2DB 1666

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```

40    CONTINUE                                2DB 1667
C    CALCULATION OF TOP BOUNDARY FLUX        2DB 1668
    KJ = JM                                  2DB 1669
    KI = 1                                   2DB 1670
    I = KI + (KJ - 1)*IM                     2DB 1671
    HA(KI) = CXS(KI+1,KJ,1)/CXS(KI,KJ,3)      2DB 1672
    PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM))/CXS(KI,KJ,3) 2DB 1673
    DO 45 KI = 2,IKB                          2DB 1674
    I = KI + (KJ - 1)*IM                     2DB 1675
    HA(KI) = CXS(KI+1,KJ,1)/(CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1)) 2DB 1676
45    PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM) + CXS(KI,KJ,1)*PA(KI-1))/ 2DB 1677
    1 (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1)) 2DB 1678
    KI = IM                                  2DB 1679
    I = KI + (KJ - 1)*IM                     2DB 1680
    N2(I) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM) + CXS(KI,KJ,1)*PA(KI-1))/ 2DB 1681
    1 (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1)) 2DB 1682
    DO 50 KII = 2,IM                          2DB 1683
    KI = IM - KII + 1                        2DB 1684
    I = KI + (KJ - 1)*IM                     2DB 1685
50    N2(I) = PA(KI) + HA(KI) * N2(I+1)      2DB 1686
    DO 55 KI = 1,IM                          2DB 1687
    I = KI + (KJ - 1)*IM                     2DB 1688
55    N2(I) = NO(I) + ORF*(N2(I) - NO(I))    2DB 1689
    TEMP1 = .0                                2DB 1690
    DO 90 I = 1,IMJM                          2DB 1691
    TEMP2 = ABS (1.0 - NO(I)/N2(I))          2DB 1692
    IF (TEMP1 - TEMP2) 80,90,90              2DB 1693
80    TEMP1 = TEMP2                          2DB 1694
90    CONTINUE                                2DB 1695
C                                            2DB 1696
C    INNER ITERATION CONTROL                2DB 1697
133   LC = LC + 1                            2DB 1698
    II = II + 1                              2DB 1699
    IF (II - G07) 533, 1033, 1033           2DB 1700
533   IF (TEMP1 - EPS) 633,633,2            2DB 1701
633   IF(G06) 733, 1033, 733               2DB 1702
733   IF (TEMP1 - G06) 1033, 1033, 2       2DB 1703
1033  CONTINUE                                2DB 1704
    RETURN                                    2DB 1705
    END                                        2DB 1706

```


	I = KI + (KJ - 1)*IM	2DB 1825
55	N2(I) = NU(I) + ORF*(N2(I) - NO(I))	2DB 1826
C	CALCULATION OF ERROR CRITERION	2DB 1827
	TEMP1 = .0	2DB 1828
	DO 90 I = 1,IMJM	2DB 1829
	TEMP2 = ABS (1.0 - NO(I)/N2(I))	2DB 1830
	IF (TEMP1 - TEMP2) 80,90,90	2DB 1831
80	TEMP1 = TEMP2	2DB 1832
90	CONTINUE	2DB 1833
C		2DB 1834
C	INNER ITERATION CONTROL	2DB 1835
133	LC = LC + 1	2DB 1836
	II = II + 1	2DB 1837
	IF (II - G07) 533, 1033, 1033	2DB 1838
533	IF (TEMP1 - EPS) 633,633,2	2DB 1839
633	IF(G06) 733, 1033, 733	2DB 1840
733	IF (TEMP1 - G06) 1033, 1033, 2	2DB 1841
1033	CONTINUE	2DB 1842
	RETURN	2DB 1843
	END	2DB 1844

```

-ITC FOR IFLUXN,IFLUXN                                2DB 1845
  SUBROUTINE IFLUXN (N2, CO, VO, CXS, MO, M2, JTL,JIM,JJM, CXR, CXT) 2DB 1846
  INCLUDE ABC                                           2DB 1847
  DIMENSION N2(1), CO(JTL,1), VO(1),CXS(JIM,JJM,3),MO(1), M2(1), 2DB 1848
1    CXR(1), CXT(1)                                     2DB 1849
C    THIS SUBROUTINE NORMALIZES FLUXES BEFORE EACH INNER ITERATION 2DB 1850
C    ABSORPTION AND OUT-SCATTER                        2DB 1851
  E3(IGV) = 0.0                                         2DB 1852
  E4(IGV) = 0.0                                         2DB 1853
  DO 10 I=1, IMJM                                       2DB 1854
    TEMP = VO(I)*N2(I)                                  2DB 1855
    ITEMP = MO(I)                                       2DB 1856
    ITEMP = M2(ITEMP)                                    2DB 1857
    E3(IGV) = E3(IGV) + (CO(4,ITEMP) - CO(5,ITEMP) - CO(2,ITEMP))*TEMP 2DB 1858
10   E4(IGV) = E4(IGV) + CO(2,ITEMP)*TEMP              2DB 1859
C    LEFT LEAKAGE                                       2DB 1860
  IF(B01) 20, 20, 40                                    2DB 1861
20   E5(IGV) = 0.0                                       2DB 1862
  DO 30 KJ = 1, JM                                       2DB 1863
    I = (KJ - 1)*IM + 1                                 2DB 1864
30   E5(IGV) = E5(IGV) + CXS(1,KJ,1)*N2(I)             2DB 1865
  GO TO 50                                               2DB 1866
40   E5(IGV) = .0                                       2DB 1867
C    RIGHT LEAKAGE                                     2DB 1868
50   IF(B02) 60, 60, 80                                 2DB 1869
60   E6(IGV) = 0.0                                       2DB 1870
  DO 70 KJ = 1, JM                                       2DB 1871
    I = KJ*IM                                            2DB 1872
70   E6(IGV) = E6(IGV) + CXR(KJ)*N2(I)                 2DB 1873
  GO TO 90                                               2DB 1874
80   E6(IGV) = 0.0                                       2DB 1875
C    TOP LEAKAGE                                       2DB 1876
90   IF(B03-1) 120, 140, 100                           2DB 1877
100  E7(IGV) = .0                                       2DB 1878
  DO 110 KI = 1, IM                                     2DB 1879
    I = IMJM - IM + KI                                  2DB 1880
110  E7(IGV) = E7(IGV) + CXS(KI,1,2)*(N2(I) - N2(KI)) 2DB 1881
    E8(IGV) = - E7(IGV)                                 2DB 1882
  GO TO 190                                              2DB 1883
120  E7(IGV) = 0.0                                       2DB 1884
  DO 130 KI = 1, IM                                     2DB 1885
    I = IMJM - IM + KI                                  2DB 1886
130  E7(IGV) = E7(IGV) + CXT(KI)*N2(I)                 2DB 1887
  GO TO 150                                              2DB 1888
140  E7(IGV) = 0.0                                       2DB 1889
C    BOTTOM LEAKAGE                                    2DB 1890
150  IF(B04) 160, 160, 180                             2DB 1891
160  E8(IGV) = 0.0                                       2DB 1892
  DO 170 KI = 1, IM                                     2DB 1893
    E8(IGV) = E8(IGV) + CXS(KI,1,2)*N2(KI)             2DB 1894
  GO TO 190                                              2DB 1895
180  E8(IGV) = 0.0                                       2DB 1896
190  E9(IGV) = E5(IGV) + E6(IGV) + E7(IGV) + E8(IGV) 2DB 1897
    TEMP = (E1(IGV) + E2(IGV))/(E3(IGV) + E4(IGV) + E9(IGV)) 2DB 1898
  DO 200 I = 1, IMJM                                    2DB 1899
200  N2(I) = TEMP*N2(I)                                  2DB 1900
    E3(IGV) = TEMP*E3(IGV)                             2DB 1901
    E4(IGV) = TEMP*E4(IGV)                             2DB 1902
    E5(IGV) = TEMP*E5(IGV)                             2DB 1903

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E-44

RNWL-831 PFV1

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

```
2DB 1904
2DB 1905
2DB 1906
2DB 1907
2DB 1908
2DB 1909
```

```

-ITC FOR CNNP,CNNP                                2DB 1910
  SUBROUTINE CNNP (F2,K6)                          2DB 1911
    DIMENSION F2(1), K6(1)                        2DB 1912
    INCLUDE ABC                                    2DB 1913
  C    CONVERGENCE TESTS                          2DB 1914
    IF(MAXT) 25, 25, 10                          2DB 1915
  10  CALL ETIMEF(TEMP)                            2DB 1916
    IF(TEMP - GLH) 25, 15, 15                    2DB 1917
  15  NGOTO = 1                                    2DB 1918
    WRITE(NOUT,20)                                2DB 1919
  20  FORMAT(53H1 * * RUNNING TIME EXCEEDED--FORCED CONVERGENCE * */) 2DB 1920
    GO TO 135                                     2DB 1921
  25  CONTINUE                                    2DB 1922
  30  E01=1.0-ALA                                  2DB 1923
    IF(ABS (E01)-10.0*EPS) 40, 40, 45            2DB 1924
  40  ORF = ORFP                                   2DB 1925
  45  CONTINUE                                    2DB 1926
    E02=ABS(E01)                                  2DB 1927
  50  IF(E1(IGP)) 55, 130, 55                    2DB 1928
  55  IF (E02 - EPS) 60, 60, 70                  2DB 1929
  60  CVT=1                                        2DB 1930
  70  CALL CLEAR (0.0, F2, IMJM)                 2DB 1931
    GO TO 105                                     2DB 1932
  80  EV=EV+POD*EQ*E01                           2DB 1933
    GO TO 170                                     2DB 1934
  C    FINAL PRINT                                2DB 1935
  90  NGOTO=1                                      2DB 1936
    IF (I04 - 1) 135, 95, 80                    2DB 1937
  95  EV=0.0                                       2DB 1938
    DO 100 I=1,IGM                               2DB 1939
  100 EV=EV+K6(I)                                2DB 1940
    EV=SK7/EV                                     2DB 1941
    GO TO 135                                     2DB 1942
  105 IF(CVT-1) 110, 90, 110                     2DB 1943
  110 IF(I04-1) 115, 120, 140                   2DB 1944
  C    MONITOR PRINT                             2DB 1945
  115 NGOTO=2                                     2DB 1946
    GO TO 135                                     2DB 1947
  120 EV=0.                                       2DB 1948
    DO 125 I=1,IGM                               2DB 1949
  125 EV=EV+K6(I)                                2DB 1950
    EV=SK7/EV                                     2DB 1951
    GO TO 115                                     2DB 1952
  130 CALL ERRO2(6H**CNNP,130,1)                 2DB 1953
  135 RETURN                                      2DB 1954
  140 CONTINUE                                    2DB 1955
  C                                                2DB 1956
  C    CALCULATE NEW PARAMETERS FOR SEARCH CALCULATIONS 2DB 1957
  145 E03=ARS (ALA-LAR)                          2DB 1958
    IF (LAPP) 270, 150, 270                     2DB 1959
  150 IF (LAP) 230, 155, 230                     2DB 1960
  155 IF (EQ) 200, 160, 200                     2DB 1961
  160 IF (E03-EP5A) 175, 175, 165               2DB 1962
  C    MONITOR PRINT.                            2DB 1963
  165 NGOTO=2                                     2DB 1964
    RETURN                                       2DB 1965
  C    FINAL PRINT EXIT.                         2DB 1966
  170 NGOTO=1                                     2DB 1967
    RETURN                                     2DB 1968

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175	LAP=ALA	2DB 1969
	EVP=EV	2DB 1970
	IF (E01) 185,185,180	2DB 1971
180	EV=EV-EVM	2DB 1972
	GO TO 190	2DB 1973
185	EV=EV+EVM	2DB 1974
190	IF (I04-2) 195, 165, 195	2DB 1975
C	MIX X-SECS.	2DB 1976
195	NGOTO=3	2DB 1977
	RETURN	2DB 1978
200	IF (CVT) 170, 205,170	2DB 1979
205	EV=EV+POD*EQ*E01	2DB 1980
210	IF ((LAPP-1.0)/(LAP-1.0)) 215, 190, 190	2DB 1981
215	TEMP1=AMIN1(EVP,EVPP)	2DB 1982
	IF (EV-TEMP1) 220, 225, 225	2DB 1983
220	EV=(EVPP+EVP)/2.	2DB 1984
	GO TO 190	2DB 1985
225	TEMP1=AMAX1(EVP,EVPP)	2DB 1986
	IF (EV-TEMP1) 190, 220, 220	2DB 1987
230	IF (E03-EPSA) 235, 235, 165	2DB 1988
235	EQ=(EVP-EV)/(LAP-ALA)	2DB 1989
240	IF (CNT) 260, 245, 260	2DB 1990
245	IF (E02-LAL) 265, 265, 250	2DB 1991
250	IF (E02-LAH) 260, 260, 255	2DB 1992
255	E01=SIGN (LAH,E01)	2DB 1993
260	LAPP=LAP	2DB 1994
	LAP=ALA	2DB 1995
	EVPP=EVP	2DB 1996
	EVP=EV	2DB 1997
	GO TO 205	2DB 1998
265	CNT=1	2DB 1999
	LAP=0.0	2DB 2000
	LAPP=0.0	2DB 2001
	GO TO 205	2DB 2002
270	IF (E03-EPSA) 275, 275, 165	2DB 2003
C	CALCULATE QUADRATIC COEFFICIENTS.	2DB 2004
275	TEMP1=EVP-EV	2DB 2005
	TEMP2=EVPP-EV	2DB 2006
	TEMP3=EVPP-EVP	2DB 2007
	TEMP4=TEMP1*(EVP+EV)	2DB 2008
	TEMP5=-TEMP2*(EV+EVPP)	2DB 2009
	TEMP6=TEMP3*(EVPP+EVP)	2DB 2010
	DENOM=TEMP3*TEMP2*TEMP1	2DB 2011
	EQA=((LAPP-1.0)*TEMP1*EVP*EV-(LAP-1.0)*TEMP2	2DB 2012
	1*EV*EVPP+(ALA-1.0)*TEMP3*EVPP*EVP)/DENOM	2DB 2013
	EQB=-((LAPP*TEMP4+LAP*TEMP5+ALA*TEMP6)/DENOM	2DB 2014
	EQC=(LAPP*TEMP1-LAP*TEMP2+ALA*TEMP3)/DENOM	2DB 2015
	DISCR=EQB*EQB-4.0*EQA*EQC	2DB 2016
	IF (DISCR) 235, 280, 280	2DB 2017
280	IF (E02-LAL) 265, 265, 285	2DB 2018
285	TEMP1=EQC+EQC	2DB 2019
	TEMP=SQRT (DISCR)	2DB 2020
	EQ=1.0/(EQB+EV*TEMP1)	2DB 2021
	LAPP=LAP	2DB 2022
	LAP=ALA	2DB 2023
	EVPP=EVP	2DB 2024
	EVP=EV	2DB 2025
	EV1=(TEMP-EQB)/TEMP1	2DB 2026
	EV2=-(TEMP+EQB)/TEMP1	2DB 2027

E-47

BNWL-831 REV1

EVA=ABS (EV-EV1)
EVB=ABS (EV-EV2)
IF (EVA-EVB) 290, 290, 295
290 EV=EV1
GO TO 210
295 EV=EV2
GO TO 210
END

2DB 2028
2DB 2029
2DB 2030
2DB 2031
2DB 2032
2DB 2033
2DB 2034
2DB 2035
-

```

-ITC FOR S8850,S8850                                2DB 2036
  SUBROUTINE S8850(F2,N2,R1,Z1,R4,Z4,JIM,JJM,FN2,      2DB 2037
1      CO,NO,MO,M2,F0,JTL,JMT)                        2DB 2038
  INCLUDE ABC                                          2DB 2039
  DIMENSION F2(JIM,JJM), N2(JIM,JJM), R1(1), Z1(1), R4(1), Z4(1), 2DB 2040
1      FLUX(6), FN2(1), CO(JTL,JMT), NO(JIM,JJM), MO(JIM,JJM), 2DB 2041
2      M2(1), F0(JIM,JJM)                            2DB 2042
C FP S850 FINAL PRINT                                2DB 2043
  ICARD = 1                                           2DB 2044
  CALL S8830                                           2DB 2045
  IF(NPRT) 280, 280, 10                              2DB 2046
10  CALL S8847                                         2DB 2047
  J=JP                                                2DB 2048
  IF(IP-JP) 30, 30, 20                                2DB 2049
20  J=JP                                              2DB 2050
30  WRITE (NOUT, 40 ) (I,R1(I),R4(I),Z1(I),Z4(I),I=1,J) 2DB 2051
40  FORMAT(      84H1          RADII          AVG RADII  2DB 2052
1      AXII          AVG AXII/(14,4F20.4))            2DB 2053
  J=J+1                                              2DB 2054
  IF(IP-JP) 50, 90, 70                                2DB 2055
50  WRITE (NOUT, 60 ) (I,Z1(I),Z4(I),I=J,JP)          2DB 2056
60  FORMAT(I4,40X,2F20.4)                            2DB 2057
  GO TO 90                                           2DB 2058
70  WRITE (NOUT, 80 ) (I,R1(I),R4(I),I=J,JP)          2DB 2059
80  FORMAT(I4,2F20.4)                                2DB 2060
90  CONTINUE                                         2DB 2061
  DO 100 I=1, IM                                     2DB 2062
  DO 100 J=1, JM                                     2DB 2063
  NO(I,J) = 0.0                                       2DB 2064
100  F2(I,J) = 0.0                                    2DB 2065
  DO 220 IIG=1, IGM                                  2DB 2066
  WRITE (NOUT,110) IIG                                2DB 2067
110  FORMAT(1H1, 20X,14HFLUX FOR GROUP,I3)           2DB 2068
  READ (NFLUX1)((N2(I,J),I=1,IM),J=1,JM)            2DB 2069
  READ(NCR1)((CO(I,J), II = 1, ITL), J = 1, MT)      2DB 2070
  DO 120 I=1, IM                                     2DB 2071
  DO 120 J=1, JM                                     2DB 2072
  NO(I,J) = NO(I,J) + N2(I,J)                        2DB 2073
  ITEMP = MO(I,J)                                    2DB 2074
  ITEMP = M2(ITEMP)                                  2DB 2075
120  F2(I,J) = F2(I,J) + CO(1,ITEMP)*N2(I,J)*1000.*TSD 2DB 2076
  IF(NPUN) 210, 210, 130                             2DB 2077
C PUNCH FLUXES                                       2DB 2078
130  IF(DAY) 210, 140, 210                           2DB 2079
140  GO TO ( 150, 150, 200, 200 ), NPUN              2DB 2080
150  DO 180 I=1,IMJM,6                               2DB 2081
  DO 160 J=1,6                                         2DB 2082
160  FLUX(J) = 0.                                     2DB 2083
  II = MIN0(I+5,IMJM)                                2DB 2084
  JI = 1                                              2DB 2085
  DO 170 J=1,II                                       2DB 2086
  FLUX(JI) = FN2(J)                                  2DB 2087
170  JI = JI + 1                                      2DB 2088
  PUNCH 190 ,(FLUX(J),J=1,6),ICARD                  2DB 2089
180  ICARD = ICARD + 1                                2DB 2090
190  FORMAT(1P6E12.6,4HFLUX,I4)                     2DB 2091
  GO TO 210                                           2DB 2092
200  WRITE(16) ((N2(I,J), I=1,IM), J=1,JM)          2DB 2093
210  CALL PRT(IM,JM,N2,Z4,NOUT)                      2DB 2094

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220	CONTINUE	2DB 2095
	WRITE(NOUT, 230)	2DB 2096
230	FORMAT(1H1//, 19X, 11H TOTAL FLUX//)	2DB 2097
	CALL PRT(IM, JM, NO, Z4, NOUT)	2DB 2098
	WRITE(NOUT, 240)	2DB 2099
240	FORMAT(1H1//, 19X, 26HPOWER DENSITY (MWT/LITER))	2DB 2100
	CALL PRT(IM, JM, F2, Z4, NOUT)	2DB 2101
	WRITE (NOUT, 250)	2DB 2102
250	FORMAT(1H1, 20X, 19HFISSION SOURCE RATE)	2DB 2103
	CALL PRT(IM, JM, F0, Z4, NOUT)	2DB 2104
	IF(NPUN - 3) 270, 260, 260	2DB 2105
C	PUT AN END OF FILE AND REWIND 16	2DB 2106
260	CALL NTRAN(16, 9, 11)	2DB 2107
270	REWIND NCR1	2DB 2108
	REWIND NFLUX1	2DB 2109
280	RETURN	2DB 2110
	END	2DB 2111

-ITC	FOR S8847,S8847	2DB	2112
	SUBROUTINE S8847	2DB	2113
	INCLUDE ABC	2DB	2114
	E2(IGP) = .0	2DB	2115
	E3(IGP) = .0	2DB	2116
	E4(IGP) = .0	2DB	2117
	E5(IGP) = .0	2DB	2118
	E6(IGP) = .0	2DB	2119
	E7(IGP) = .0	2DB	2120
	E8(IGP) = .0	2DB	2121
	E9(IGP) = .0	2DB	2122
	DO 10 I = 1,IGM	2DB	2123
	E2(IGP) = E2(IGP) + E2(I)	2DB	2124
	E3(IGP) = E3(IGP) + E3(I)	2DB	2125
	E4(IGP) = E4(IGP) + E4(I)	2DB	2126
	E5(IGP) = E5(IGP) + E5(I)	2DB	2127
	E6(IGP) = E6(IGP) + E6(I)	2DB	2128
	E7(IGP) = E7(IGP) + E7(I)	2DB	2129
10	E8(IGP) = E8(IGP) + E8(I)	2DB	2130
	E9(IGP) = E9(IGP) + E9(I)	2DB	2131
	WRITE(NOUT,20)	2DB	2132
20	FORMAT (1H1, 28H FINAL NEUTRON BALANCE TABLE//	2DB	2133
	159H GROUP FISSION SOURCE IN-SCATTER OUT-SCATTER ABSORPTION,1X,2DB	2134	
	265H L. L. R. L. T. L. B. L. TOTAL LEAKA2DB	2135	
	3GE//)	2DB	2136
	DO 30 I = 1,IGM	2DB	2137
25	FORMAT (16, 1P9E13.3)	2DB	2138
30	WRITE(NOUT,25) I,E1(I),E2(I),E3(I),E4(I),E5(I),E6(I),E7(I),	2DB	2139
	1 E8(I),E9(I)	2DB	2140
	WRITE(NOUT,35)	2DB	2141
35	FORMAT (1H)	2DB	2142
	I = IGM + 1	2DB	2143
	WRITE(NOUT,25) I,E1(I),E2(I),E3(I),E4(I),E5(I),E6(I),E7(I),	2DB	2144
	1 E8(I),E9(I)	2DB	2145
	RETURN	2DB	2146
	END	2DB	2147

-IT FOR PRT,PRT	2DB 2148
SUBROUTINE PRT (JIM,JJM, N2, Z4, NOUT)	2DB 2149
DIMENSION N2(JIM,JJM), Z4(1)	2DB 2150
REAL N2	2DB 2151
IM = JIM	2DB 2152
JM = JJM	2DB 2153
DO 50 I=1,IM,5	2DB 2154
I1=I	2DB 2155
I2=I+4	2DB 2156
IF(I2-IM) 20, 20, 10	2DB 2157
10 I2=IM	2DB 2158
20 WRITE (NOUT,30) (JJ,JJ=I1,I2)	2DB 2159
30 FORMAT(5I20)	2DB 2160
DO 50 JJ=1,JM	2DB 2161
J=JJ	2DB 2162
40 FORMAT(I5,E15.7,5E20.7)	2DB 2163
50 WRITE(NOUT,40) J,(N2(K,J),K=I1,I2),Z4(J)	2DB 2164
RETURN	2DB 2165
END	2DB 2166

```

-ITC  FOR  GRAM,GRAM                                2DB 2167
      SUBROUTINE GRAM(MASS, VOL,  ATW, HOLN,JIM,JJM, MO, M2, VO,  2DB 2168
1      IO, I1, I2,JML, I3)                            2DB 2169
      INCLUDE ABC                                      2DB 2170
      DIMENSION MASS(JML,1), VOL(1), ATW(1), HOLN(1), MO(JIM,JJM), 2DB 2171
1      M2(1), VO(JIM,JJM), IO(1), I1(1), I2(1), I3(1)    2DB 2172
C      THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS 2DB 2173
      WRITE(NOUT,10) (ID(I), I=1,11)                  2DB 2174
10     FORMAT(1H1,11A6//)                               2DB 2175
      WRITE(NOUT, 20)                                   2DB 2176
20     FORMAT(45H MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE / ) 2DB 2177
      CALL CLEAR(0.0,VOL,IZM)                          2DB 2178
      ITEMP = ML*IZM                                    2DB 2179
      CALL CLEAR(0.0,MASS,ITEMP)                       2DB 2180
      DO 30  J = 1, JM                                  2DB 2181
      DO 30  I = 1, IM                                  2DB 2182
      K = MO(I,J)                                       2DB 2183
30     VOL(K) = VOL(K) + VO(I, J)*.001                 2DB 2184
      DO 39  M=1,M01                                    2DB 2185
      I3(M) = I2(M)                                    2DB 2186
      IF(I0(M) - I1(M)) 39,35,39                       2DB 2187
35     IF(I2(M)) 39,36,39                               2DB 2188
36     DO 38  MM=1,M                                    2DB 2189
      IF(I0(M) - I0(MM)) 38,37,38                     2DB 2190
37     I3(MM) = I2(MM)*EV                             2DB 2191
38     CONTINUE                                         2DB 2192
39     CONTINUE                                         2DB 2193
      DO 190 N =1, IZM                                  2DB 2194
      NN = M2(N)                                        2DB 2195
      DO 190 M = 1,M01                                  2DB 2196
      IF(I0(M) - NN) 190, 40, 190                      2DB 2197
40     L = I1(M)                                        2DB 2198
      IF(L - ML) 170, 170, 50                          2DB 2199
50     NNAA = L                                         2DB 2200
      IF(L - I0(M)) 130,190, 130                       2DB 2201
130    DO 160 MAA = 1, M01                             2DB 2202
      IF(I0(MAA) - NNAA) 160, 140, 160                 2DB 2203
140    L = I1(MAA)                                      2DB 2204
      IF(L) 160, 160, 150                              2DB 2205
150    E01 = I3(MAA)*I3(M)                             2DB 2206
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/ .6023) + MASS(L,N) 2DB 2207
160    CONTINUE                                         2DB 2208
      GO TO 190                                         2DB 2209
170    IF(L) 190, 190, 180                             2DB 2210
180    E01 = I3(M)                                       2DB 2211
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/ .6023) + MASS(L,N) 2DB 2212
190    CONTINUE                                         2DB 2213
      DATA  ZONE/6H ZONE /                             2DB 2214
      DO 260 L = 1, IZM, 5                             2DB 2215
      LL = L + 4                                        2DB 2216
      IF(LL - IZM) 210, 210, 200                      2DB 2217
200    LL = IZM                                         2DB 2218
210    WRITE(NOUT,220) ((ZONE, K), K=L, LL)            2DB 2219
220    FORMAT(/26H MATERIAL ATOMIC WT. ,3X, 5(A6,I2,12X)) 2DB 2220
      WRITE(NOUT,230) (VOL(K), K = L, LL)             2DB 2221
230    FORMAT(25X, 5(E8.3, 7H LITERS, 5X))            2DB 2222
      DO 240 K = 1, ML                                  2DB 2223
240    WRITE(NOUT,250) K, HOLN(K), ATW(K), (MASS(K, I), I = L, LL) 2DB 2224
250    FORMAT( I3,1X, A6, F13.3, 1X, 1P4E13.3, 1P4E20.3) 2DB 2225

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E-53

BNWL-831 REV1

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

2DB 2226
2DB 2227
2DB 2228
2DB 2229
-

-1TC	FOR INPB,INPB	2DB	2230
	SUBROUTINE INPB(MATN,NBR,LD,LCN,LFN,ALAM,HOLN,JML,I2)	2DB	2231
	INCLUDE ABC	2DB	2232
	DIMENSION MATN(1), NBR(1), LD(1),LCN(JML,1),LFN(JML,1), ALAM(1),	2DB	2233
	1 HOLN(1), I2(1)	2DB	2234
C	THIS SUBROUTINE READS AND PRINTS THE BURNUP DATA	2DB	2235
	READ(NINP,10) ITEMP, NPRT, DELT	2DB	2236
10	FORMAT(2I6, E12.0)	2DB	2237
	DAY = DAY + DELT	2DB	2238
	CVT = 0	2DB	2239
	CNT = 0	2DB	2240
	PO2 = 0	2DB	2241
	ALA = 0.0	2DB	2242
	LAP = 0.0	2DB	2243
	LAPP = 0.0	2DB	2244
	LAR = 0.0	2DB	2245
	KPAGE = 100	2DB	2246
	IF(ITEMP) 190, 15, 20	2DB	2247
15	NCON = ITEMP	2DB	2248
	KK = NPUN + 1	2DB	2249
	GO TO (190, 190, 17, 190, 17), KK	2DB	2250
17	PUNCH 18, (I2(I), I=1,M01)	2DB	2251
18	FORMAT(6(3X,E9.4))	2DB	2252
	GO TO 190	2DB	2253
20	NCON = ITEMP	2DB	2254
	DO 40 N = 1, NCON	2DB	2255
30	FORMAT(12I6)	2DB	2256
40	READ(NINP,30) MATN(N),NBR(N),LD(N),(LCN(N,K),K=1,2),(LFN(N,K),	2DB	2257
	1 K=1,7)	2DB	2258
	WRITE(NOUT,60)	2DB	2259
60	FORMAT(12H1BURNUP DATA///)	2DB	2260
	WRITE(NOUT,70)	2DB	2261
70	FORMAT(13UH BURNABLE MATERIAL NAME LAMBDA	2DB	2262
	1 NBR * * * * * SOURCE ISOTOPE FOR * * *	2DB	2263
	2 * * /	2DB	2264
	3 130H ISOTOPE NO. (DAYS-1)	2DB	2265
	4 DECAY CAPTURE FISSION	2DB	2266
	5ION /9H NO.)	2DB	2267
	DO 90 N=1, NCON	2DB	2268
80	FORMAT(3X, I3, 12X, I3, 10X, A6, 8X, E8.3, I9,15X, I3, 13X, 2I3,	2DB	2269
	1 10X, 7I3)	2DB	2270
	ITEMP = MATN(N)	2DB	2271
	ALAM(ITEMP) = 24.*3600.*ALAM(ITEMP)	2DB	2272
	WRITE(NOUT,80) N, MATN(N), HOLN(ITEMP), ALAM(ITEMP), NBR(N),	2DB	2273
	1LD(N), (LCN(N,K),K=1,2), (LFN(N,K),K=1,7)	2DB	2274
90	ALAM(ITEMP) = ALAM(ITEMP)/(3600.*24.)	2DB	2275
190	RETURN	2DB	2276
	END	2DB	2277

```

-ITC FOR AVERAG,AVERAG                                2DB 2278
  SUBROUTINE AVERAG(PHIB,AXS,FXS,MATN,MASS,ATW,VOL,CO,N2,MO,VO, 2DB 2279
1    HOLN,JML,JTL,NBR)                                2DB 2280
  DIMENSION PHIB(1),AXS(JML,1),FXS(JML,1),MATN(1),MASS(JML,1), 2DB 2281
1    ATW(1),VOL(1),CO(JTL,1),N2(1),MO(1),VO(1),HOLN(1) 2DB 2282
2    ,NBR(1)                                           2DB 2283
  INCLUDE ABC                                           2DB 2284
C    THIS SUBROUTINE CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS 2DB 2285
C    SECTIONS, AND ABSORPTION CROSS SECTIONS.          2DB 2286
  RL = 0.0                                              2DB 2287
  RC = 0.0                                              2DB 2288
  DO 10 KZ=1,IZM                                       2DB 2289
  PHIB(KZ) = 0.0                                       2DB 2290
  DO 10 KN=1,NCON                                       2DB 2291
  AXS(KN,KZ) = 0.0                                     2DB 2292
  FXS(KN,KZ) = 0.0                                     2DB 2293
  LN = MATN(KN)                                         2DB 2294
10  MASS(LN,KZ) = (MASS(LN,KZ)*.6023)/(ATW(LN)*VOL(KZ)) 2DB 2295
  DO 100 IIG=1,IGM                                     2DB 2296
  READ(NCR1) ((CO(II,J), II=1,ITL),J=1,MT)            2DB 2297
  READ(NFLUX1) (N2(I), I=1,IMJM)                      2DB 2298
  DO 100 I=1,IMJM                                      2DB 2299
  KZ = MO(I)                                           2DB 2300
  PHIB(KZ) = PHIB(KZ) + N2(I)*VO(I)                   2DB 2301
  DO 100 KN=1,NCON                                      2DB 2302
  LN = MATN(KN)                                         2DB 2303
  AXS(KN,KZ) = AXS(KN,KZ) + CO(2,LN)*N2(I)*VO(I)      2DB 2304
100  FXS(KN,KZ) = FXS(KN,KZ) + CO(1,LN)*N2(I)*VO(I)    2DB 2305
  DO 200 KZ=1,IZM                                       2DB 2306
  TEMP3 = PHIB(KZ)                                     2DB 2307
  PHIB(KZ) = PHIB(KZ)/(VOL(KZ)*1000.)                 2DB 2308
  WRITE(NOUT,110) KZ, PHIB(KZ), VOL(KZ)               2DB 2309
110  FORMAT(1H1,30X,9H Z O N E ,I3,7X,7H FLUX =,1PE10.4,7X,9H VOLUME =,2DB 2310
1    1PE10.4,7H LITERS/)                               2DB 2311
  WRITE(NOUT,120)                                       2DB 2312
120  FORMAT(115H BURNABLE          MATERIAL          NAME          ATOM 2DB 2313
1    FISSION      ABSORPTION      SIGMA          SIGMA /          2DB 2314
2    115H ISOTOPE          NO.          DENSITY 2DB 2315
3    RATE          RATE          FISSION          ABSORPTION/ 2DB 2316
4    7H          NO./) 2DB 2317
  DO 200 KN=1,NCON                                      2DB 2318
  LN = MATN(KN)                                         2DB 2319
  TEMP1 = AXS(KN,KZ)*MASS(LN,KZ)                      2DB 2320
  TEMP2 = FXS(KN,KZ)*MASS(LN,KZ)                      2DB 2321
  AXS(KN,KZ) = AXS(KN,KZ)/TEMP3                       2DB 2322
  FXS(KN,KZ) = FXS(KN,KZ)/TEMP3                       2DB 2323
130  FORMAT(4X,I3,11X,I3,10X,A6,2X,1P5E15.3)          2DB 2324
  WRITE(NOUT,130) KN, LN, HOLN(LN), MASS(LN,KZ), TEMP2, TEMP1, 2DB 2325
1    FXS(KN,KZ), AXS(KN,KZ) 2DB 2326
  ITEMP = NBR(KN)                                       2DB 2327
  IF (ITEMP - 1) 200, 140, 160                         2DB 2328
140  RC = RC + TEMP1 - TEMP2                             2DB 2329
  GO TO 200                                              2DB 2330
160  RL = RL + TEMP1                                     2DB 2331
200  CONTINUE                                           2DB 2332
  TEMP = RC/RL                                          2DB 2333
  WRITE(NOUT,350) TEMP                                  2DB 2334
350  FORMAT(1H //18H BREEDING RATIO =F7.4)             2DB 2335
  REWIND NCR1                                           2DB 2336

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E-56

REWIND NFLUX1
RETURN
END

BNWL-831 REV1

ZDB 2337
ZDB 2338
ZDB 2339
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-ITC FOR MARCH,MARCH                                2DB 2340
  SUBROUTINE MARCH(PHIB,MATN,FXS,AXS,VOL,MASS,MASSP,ALAM,LD,LCN, 2DB 2341
1    LFN,JML,I0,I1,I2,M2)                                2DB 2342
  DIMENSION PHIB(1), MATN(1), FXS(JML,1),AXS(JML,1),VOL(1), 2DB 2343
1    MASS(JML,1),MASSP(JML,1),ALAM(1), LD(1), LCN(JML,1), 2DB 2344
2    LFN(JML,1),I0(1), I1(1), I2(1), M2(1)                2DB 2345
  INCLUDE ABC                                           2DB 2346
C  THIS SUBROUTINE COMPUTES THE TIME DEPENDENT ISOTOPIC CONCENTRATION2DB 2347
  TEMP = DELT * 24. * 3600. / 10.                      2DB 2348
  TEMP1 = .0                                             2DB 2349
  DO 5 KZ = 1,IZM                                       2DB 2350
  PHIB(KZ) = PHIB(KZ) * 10.**(-24)                      2DB 2351
  DO 5 KN = 1,NCON                                       2DB 2352
  LN = MATN(KN)                                          2DB 2353
5  TEMP1 = TEMP1 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ) 2DB 2354
  DO 200 KT = 1,10                                       2DB 2355
  TEMP3 = .0                                             2DB 2356
  DO 20 KZ = 1,IZM                                       2DB 2357
  DO 20 KN = 1,NCON                                       2DB 2358
  LN = MATN(KN)                                          2DB 2359
20  MASSP(LN,KZ) = MASS(LN,KZ)                          2DB 2360
  DO 100 KZ = 1,IZM                                       2DB 2361
  DO 50 KKK = 1,5                                         2DB 2362
  DO 50 KN = 1,NCON                                       2DB 2363
  LN = MATN(KN)                                          2DB 2364
  TEMP2 = -(MASS(LN,KZ)+MASSP(LN,KZ))*(ALAM(LN)+AXS(KN,KZ)*PHIB(KZ)) 2DB 2365
  IF (LD(KN)) 30, 30, 28                                2DB 2366
28  KK = LD(KN)                                          2DB 2367
  KK = MATN(KK)                                          2DB 2368
  TEMP2 = TEMP2 + ALAM(KK)*(MASS(KK,KZ) + MASSP(KK,KZ)) 2DB 2369
30  DO 32 K = 1,2                                         2DB 2370
  KK = LCN(KN,K)                                         2DB 2371
  KL = MATN(KK)                                          2DB 2372
  IF (KK) 32,32,31                                       2DB 2373
31  TEMP2 = TEMP2 + (AXS(KK,KZ) - FXS(KK,KZ))*PHIB(KZ)* 2DB 2374
1  (MASS(KL,KZ) + MASSP(KL,KZ))                          2DB 2375
32  CONTINUE                                             2DB 2376
  DO 36 K = 1,7                                           2DB 2377
  KK = LFN(KN,K)                                         2DB 2378
  KL = MATN(KK)                                          2DB 2379
  IF (KK) 36,36,34                                       2DB 2380
34  TEMP2 = TEMP2 + FXS(KK,KZ)*PHIB(KZ)*(MASS(KL,KZ)+MASSP(KL,KZ)) 2DB 2381
36  CONTINUE                                             2DB 2382
50  MASS(LN,KZ) = MASSP(LN,KZ) + .5*TEMP*TEMP2          2DB 2383
  DO 100 KN = 1,NCON                                       2DB 2384
  LN = MATN(KN)                                          2DB 2385
100  TEMP3 = TEMP3 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ) 2DB 2386
  IF(TEMP3) 200,200,110                                   2DB 2387
110  DO 120 KZ = 1,IZM                                       2DB 2388
120  PHIB(KZ) = PHIB(KZ) * TEMP1/TEMP3                  2DB 2389
200  CONTINUE                                             2DB 2390
  DO 500 KZ = 1,IZM                                       2DB 2391
500  PHIB(KZ) = PHIB(KZ)*10.**(-24)                      2DB 2392
  DO 540 KZ=1,IZM                                         2DB 2393
  DO 540 M=1,MU1                                         2DB 2394
  IF(I0(M) - M2(KZ)) 540,520,540                        2DB 2395
520  DO 530 KN=1,NCON                                       2DB 2396
  LN = MATN(KN)                                          2DB 2397
  IF(LN - I1(M)) 530,525,530                            2DB 2398

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E-58

BNWL-831 REV1

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

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2DB 2399
2DB 2400
2DB 2401
2DB 2402
2DB 2403
-
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