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3DB, A THREE-DIMENSIONAL DIFFUSION THEORY BURNUP CODE

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March 1970

AEC RESEARCH & DEVELOPMENT REPORT

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UC-32, Mathematics
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3DB, A THREE-DIMENSIONAL DIFFUSION THEORY BURNUP CODE

By

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Reactor and Plant Technology Department
FFTF Project

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II. FORMULATION OF DIFFERENCE EQUATIONS

Neutron Balance Equations

The multigroup diffusion equations can be written in the form

$$D_g \nabla^2 \phi_g - \Sigma_g^r \phi_g + S_g = 0, \quad g = 1, 2, \ldots \text{IGM} \tag{2.1}$$

where

$$S_g = \frac{\chi_g}{k_{eff}} \sum_{g'=1}^{IGM} (\nu\Sigma_f)_{g'} \phi_{g'} + \sum_{g'=1}^{g-1} \Sigma(g' \to g) \phi_{g'} \tag{2.2}$$

and:

IGM = 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 (= $1/3\ \Sigma_g^{tr}$),
$(\nu\Sigma_f)_g$ = fission source cross section for group g,
$\Sigma(g' \to g)$ = group transfer cross section from g´ to g,
Σ_g^r = removal cross section for group g

$$\left[= \Sigma_g^a + \sum_{g'=g+1}^{IGM} \Sigma(g \to g')\right],$$

χ_g = fission source fraction in group g,
k_{eff} = effective multiplication constant.

To obtain the spatial difference equations, the mesh point is placed in the center of the associated mesh volume and Equations (2.1) and (2.2) are integrated over this volume. Thus, for the (i,j,k) mesh point at position $X = X_i$, $Y = Y_j$ and $Z = Z_k$, the X integration would be from $X_i - \frac{\delta X_i}{2}$ to $X_i + \frac{\delta X_i}{2}$, the Y integration from $Y_j - \frac{\delta Y_j}{2}$ to $Y_j + \frac{\delta Y_j}{2}$, and the Z integration from $Z_k - \frac{\delta Z_k}{2}$ to $Z_k + \frac{\delta Z_k}{2}$. In Figure 2.1, o represents the (i,j,k) mesh point, 1 the (i-1,j,k,) mesh point, 2 the (i+1,j,k) mesh point, 3 the (i,j-1,k) mesh point, etc.

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

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

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

$$\sum_{k=1}^{6} \frac{\overline{D}_k A_k}{\ell_k} (\phi_k - \phi_o) - \Sigma_o^r \phi_o V_o + S_o V_o = 0 \ , \qquad (2.4)$$

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

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

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

$$\phi_o = \frac{S_o V_o + \sum_{k=1}^{6} C_k \phi_k}{C_7} \ , \qquad (2.6)$$

where

$$C_k = \frac{\overline{D}_k A_k}{\ell_k} \quad k=1, \ldots 6 \qquad (2.7)$$

Vacuum

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

$$C_k = \frac{D_k A_k}{0.5\ \delta R_{IM} + 0.71\ \lambda_{tr}}$$

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, $\phi_k = 0$.

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.

Discussion of Triangular-Z Mesh Option

Since most fast reactors are composed of hexagonal subassemblies, a triangular-Z mesh option is available in 3DB. Hexagons are formed by appropriate grouping of six triangular mesh intervals.

In the triangular-Z 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 mesh volume. See Figure 2.3 for a simple 3 x 4 mesh example in an arbitrary Z plane. In contrast to the other geometry options, however, the mesh boundaries must be equally spaced. In fact, the X_i and Y_j mesh boundaries must be computed by the expressions

$$X_i = (i-1)\frac{FTF}{2\sqrt{3}}, \qquad i=1, \ldots, IM+1 \qquad (2.9)$$

$$Y_j = (j-1)\frac{FTF}{2}, \qquad j=1, \ldots, JM+1 \qquad (2.10)$$

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

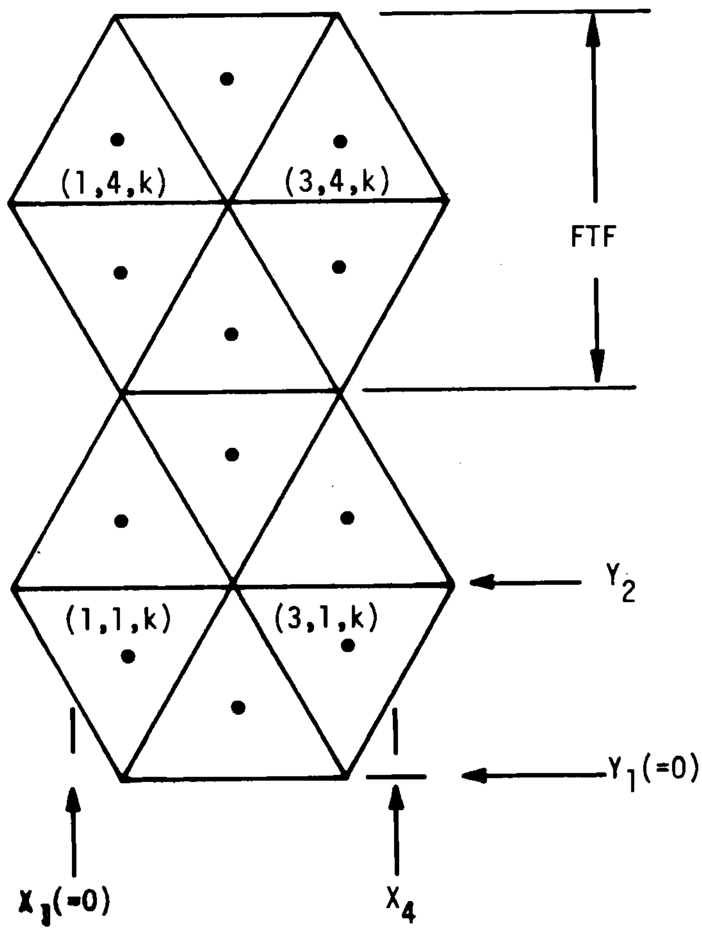

FIGURE 2.3. Triangular Mesh Example (3 x 4) in an Arbitrary Z Plane.

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. Within each group, the flux profiles are sequentially calculated for each X-Y plane, beginning with the bottom (K=1) plane. One mesh sweep through an X-Y plane is defined as an inner iteration, and a sweep through all X-Y planes is termed a Z iteration. The number of inner iterations (in a given plane) per Z iteration and the number of Z iterations is controlled via input parameters. 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 $|1-\lambda| < \varepsilon$, where ε is an input parameter.

Fission source over-relaxation is employed in 3DB to accelerate convergence. The procedure is as follows: After the new fission source rate profile, $F_1^{\nu+1}$, is calculated, a second "new" value, $F_2^{\nu+1}$, is computed by magnifying the difference between the new fission source rate and the old fission source rate. Thus,

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

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

The group-fluxes within each X-Y plane are computed using successive line over-relaxation (SLOR). That is, the fluxes in either the X or Y direction are simultaneously computed (by the familiar Crout reduction technique) and then over-relaxed using the algorithm

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

where β is the over-relaxation factor. In R-θ-Z problems, it is recommended that direct inversion be performed along the Y (i.e., θ) direction. In triangular-Z problems, the inversion direction must be along the X direction. In all other situations, direct inversion should be along the dimension with the most mesh points.

An alternating direction SLOR scheme (using line inversion in the X direction and then in the Y direction in alternation) is included as an option to enhance convergence for problems involving tight mesh spacing in both dimensions.

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

$$\beta' = 1.0 + 0.6(\beta-1) \quad .$$

The global flux in each group is normalized (by balancing the total source and loss rate) immediately before each group-flux calculation. Also, the flux in each X-Y plane is rebalanced before the first inner iteration for the plane.

IV. SEARCH OPTIONS

The 3DB 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 ($|\lambda^{\nu+1} - \lambda^{\nu}| < \varepsilon'$) 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 $|1-\lambda| < \varepsilon$.

Time Absorption (α calculation)

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

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

If we now assume that

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

we can obviously rewrite Equation (4.1) in the form

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

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)

3DB can perform a 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 two materials mixed at full density, Materials 8 and 9. Let us further assume that Materials 8 and 9 are to be simultaneously interchanged such that they occupy a fixed volume fraction, β, of the zone mixture. The I0, I1, and I2 vectors could then be set up as shown in the following tabulation.

Mix Number (I0)	Material Number (I1)	Material Density (I2)
10	0	0
10	8	1.0
10	9	-1.0
10	10	0
10	8	α - 1.0
10	9	$\beta - \alpha + 1.0$

The first row (10,0,0) instructs the code to clear the storage area for Mix 10. The second row (10,8,1.0) and third row (10,9,-1.0) cause Material 8 and Material 9 to be added to Mix 10 with densities of 1.0 and -1.0, respectively. The fourth row (10,10,0) causes the current contents of Mix 10 to be multiplied by the eigenvalue. Finally, rows five (10,8, α - 1.0) and six (10,9,$\beta - \alpha + 1.0$) instruct the code to add Materials 8 and 9 to Mix 10 with densities of α - 1.0 and $\beta - \alpha + 1.0$, respectively.

All of the foregoing can be summarized by the expression

$$\Sigma_{10} = 1.0 \cdot \Sigma_8 \cdot EV - 1.0 \cdot \Sigma_9 \cdot EV + (\alpha - 1.0)\Sigma_8 + (\beta - \alpha + 1.0)\Sigma_9 \qquad (4.4)$$

where

Σ_{10} = macroscopic cross section for Mix 10,
Σ_8 = full density cross section for Material 8,
Σ_9 = full density cross section for Material 9,
EV = eigenvalue.

Note that for an initial eigenvalue guess of 1.0, Equation (4.4) reduces to $\Sigma_{10} = \alpha \cdot \Sigma_8 + (\beta - \alpha)\Sigma_9$. Therefore, α and $\beta - \alpha$ are simply the initial volume fractions of Materials 8 and 9, respectively.

Zone Dimensions (δ calculation)

3DB searches on reactor dimensions by varying the dimensions of each mesh interval in the X, Y, and Z direction. Each mesh width, δX_i, is computed from the expression

$$\delta X_i = \delta X_i^o \, [1 + (\text{mesh modifier})_i \, \text{EV}] \quad , \tag{4.5}$$

where δX_i^o is the initial mesh spacing and EV is the eigenvalue. Different mesh modifiers can be specified for each mesh interval in each spatial direction.

Buckling (B^2 calculation)

In a buckling search, the quantity $D_i \gamma B^2$, where γ is the zone dependent buckling modifier, is added to the ith 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

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

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

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

the particular march-out algorithm used can be written as

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

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

$$\vec{N}_{J+1}^{\nu+1} = \vec{N}_J + \frac{\delta t}{2} \left(\vec{f}_J + \vec{f}_{J+1}^{\nu}\right) , \qquad (5.4)$$

where ν 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

3DB 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

$$N = \frac{kS}{1-k} , \tag{6.1}$$

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 indicies 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. 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.

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2. Unpublished Code. (2DF, A Two-Dimensional Transport Code from the Los Alamos Scientific Laboratory), Los Alamos, New Mexico.

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4. R. W. Hardie and W. W. Little, Jr. 1DX, A One-Dimensional Diffusion Code for Generating Effective Nuclear Cross Sections, BNWL-954, Battelle-Northwest, Richland, Washington, 1969.

5. W. W. Little, Jr., and R. W. Hardie. 2DB User's Manual -- Revision 1, BNWL-831 REV1, Battelle-Northwest, Richland, Washington, 1969.

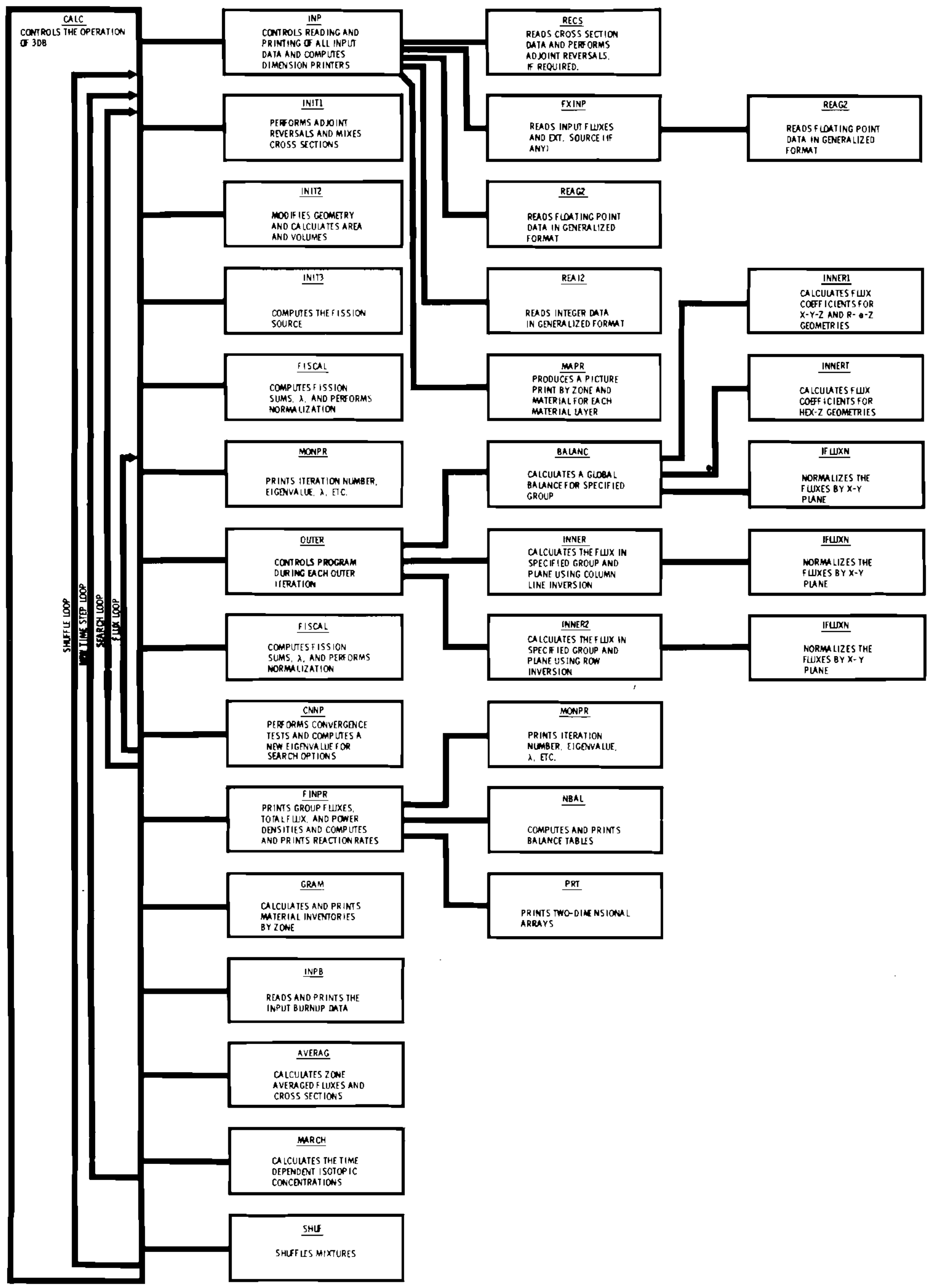
APPENDIX A

SIMPLIFIED LOGICAL FLOW DIAGRAM

APPENDIX A

SIMPLIFIED LOGICAL FLOW DIAGRAM

A simplified logical flow chart for 3DB is given on the following page. With the exception of four minor subroutines -- CLEAR (sets an array equal to a specified constant), ERRO2 (prints error messages), SWITCH (switches tape designations) and DRUMR (reads and writes data from/to drum) -- all subroutines and their functions are shown in the flow diagram.


CALC
CONTROLS THE OPERATION OF 3DB
SHUFFLE LOOP
NEW TIME STEP LOOP
SEARCH LOOP
FLUX LOOP
INP
CONTROLS READING AND PRINTING OF ALL INPUT DATA AND COMPUTES DIMENSION PRINTERS
RECS
READS CROSS SECTION DATA AND PERFORMS ADJOINT REVERSALS, IF REQUIRED.
FXINP
READS INPUT FLUXES AND EXT. SOURCE (IF ANY)
REAG2
READS FLOATING POINT DATA IN GENERALIZED FORMAT
REAG2
READS FLOATING POINT DATA IN GENERALIZED FORMAT
REAI2
READS INTEGER DATA IN GENERALIZED FORMAT
MAPR
PRODUCES A PICTURE PRINT BY ZONE AND MATERIAL FOR EACH MATERIAL LAYER
INIT1
PERFORMS ADJOINT REVERSALS AND MIXES CROSS SECTIONS
INIT2
MODIFIES GEOMETRY AND CALCULATES AREA AND VOLUMES
INIT3
COMPUTES THE FISSION SOURCE
FISCAL
COMPUTES FISSION SUMS, λ, AND PERFORMS NORMALIZATION
MONPR
PRINTS ITERATION NUMBER, EIGENVALUE, λ, ETC.
OUTER
CONTROLS PROGRAM DURING EACH OUTER ITERATION
BALANC
CALCULATES A GLOBAL BALANCE FOR SPECIFIED GROUP
INNER1
CALCULATES FLUX COEFFICIENTS FOR X-Y-Z AND R-θ-Z GEOMETRIES
INNERT
CALCULATES FLUX COEFFICIENTS FOR HEX-Z GEOMETRIES
IFLUXN
NORMALIZES THE FLUXES BY X-Y PLANE
INNER
CALCULATES THE FLUX IN SPECIFIED GROUP AND PLANE USING COLUMN LINE INVERSION
IFLUXN
NORMALIZES THE FLUXES BY X-Y PLANE
INNER2
CALCULATES THE FLUX IN SPECIFIED GROUP AND PLANE USING ROW INVERSION
IFLUXN
NORMALIZES THE FLUXES BY X-Y PLANE
FISCAL
COMPUTES FISSION SUMS, λ, AND PERFORMS NORMALIZATION
CNNP
PERFORMS CONVERGENCE TESTS AND COMPUTES A NEW EIGENVALUE FOR SEARCH OPTIONS
FINPR
PRINTS GROUP FLUXES, TOTAL FLUX, AND POWER DENSITIES AND COMPUTES AND PRINTS REACTION RATES
MONPR
PRINTS ITERATION NUMBER, EIGENVALUE, λ, ETC.
NBAL
COMPUTES AND PRINTS BALANCE TABLES
PRT
PRINTS TWO-DIMENSIONAL ARRAYS
GRAM
CALCULATES AND PRINTS MATERIAL INVENTORIES BY ZONE
INPB
READS AND PRINTS THE INPUT BURNUP DATA
AVERAG
CALCULATES ZONE AVERAGED FLUXES AND CROSS SECTIONS
MARCH
CALCULATES THE TIME DEPENDENT ISOTOPIC CONCENTRATIONS
SHUF
SHUFFLES MIXTURES

APPENDIX B

INPUT INSTRUCTIONS

APPENDIX B

INPUT INSTRUCTIONS

The following pages describe the input data for 3DB. 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, either 6(I1,I2,I9) for integer data or 6(I1,I2,E9.4) for floating point data. The last nine columns of each field contain the data, D, associated with the particular field (see exception below); 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,
4 - repeat previous D data entries N times (if D is a floating point number, code converts to an integer),
5 - ignore this data field,
6 - fill the remaining locations of this array with associated data entry.

Variable	Columns	Description
CARD 1: FORMAT (11A6,I6)		
To run a series of cases, repeat from this card.		
ID(11)	1-66	Identification card.
MAXT	67-72	Maximum running time (minutes). Not used if zero.
CARD 2: FORMAT (12I6)		
A02	1-6	Problem Type: = 0, regular calculation, = 1, adjoint calculation.

Variable	Columns	Description
I04	7-12	Eigenvalue Type: = 0, source (S), = 1, k_{eff}, = 2, time absorption (α), = 3, concentration (C), = 4, zone thickness (δ), = 5, buckling (B^2).
S02	13-18	Parametric Eigenvalue Type: = 0, none, = 1, k_{eff}, = 2, α.
IGM	19-24	Number of energy groups ($\leq$ 50).
NXCM	25-30	Number of downscattering terms.
IHT	31-36	Position of transport cross section in cross section table (=4 if the fission cross section is the first entry).
M07	37-42	Input flux guess: = 0, none, = 1, $\phi(x)*\phi(y)*\phi(z)$ from cards, = 2, $\phi(x,y,z)$ from cards, = 3, $\phi(E,x,y,z)$ from cards, = 4, $\phi(x,y,z)$ from tape (logical unit 14), = 5, $\phi(E,x,y,z)$ from tape (logical unit 14), = 6, $\phi(E,x,y)$ from tape (logical unit 14) $*\phi(z)$ from cards.
M08	43-48	External source--same options as M07. If source is from tape, the logical unit is 10.
D05	49-54	Maximum number of outer iterations.
I07	55-60	Maximum number of Z iterations per group. Recommended value $\approx$ 5.
G07	61-66	Maximum number of inner (X-Y) iterations per Z iteration. Recommended value $\approx$ 2.
S04	67-72	X-Y inversion direction: = 0, code chooses, = 1, alternate every Z iteration, = 2, X direction, = 3, Y direction.

Variable	Columns	Description
CARD 3: FORMAT (12I6)		
IGE	1-6	Geometry: = 0, X-Y-Z, = 1, R-θ-Z, = 2, TRIANGULAR-Z.
IZM	7-12	Number of material zones.
NLAY	13-18	Number of material layers.
MT	19-24	Total number of materials, including mixes.
MO1	25-30	Number of mixture specifications.
MCR	31-36	Number of input cross section materials: = negative, |MCR| materials from tape (logical unit 15), = positive, MCR materials from cards.
IM	37-42	Number of intervals in the X direction.
JM	43-48	Number of intervals in the Y direction.
KM	49-54	Number of intervals in the Z direction.
IZ	55-60	Number of zones in the X direction (δ option only).
JZ	61-66	Number of zones in the Y direction (δ option only).
KZ	67-72	Number of zones in the Z direction (δ option only).
CARD 4: FORMAT (9I6)		
BO1	1-6	Left boundary condition: = 0, vacuum, = 1, reflective.
BO2	7-12	Right boundary condition.
BO3	13-18	Back boundary condition.
BO4	19-24	Front boundary condition.
BO5	25-30	Top boundary condition.

Variable	Columns	Description
BO6	31-36	Bottom boundary condition.
NACT	37-42	Number of activity traverses.
NPRT	43-48	Print option: = 0, mini print -- deletes fluxes, power densities, cross sections, balance tables, = 1, maxi print -- prints items specified on print modifier cards 34-37.
NPUN	49-54	Flux output option: = 0, none, = 1, $\phi(x,y,z)$ to cards, = 2, $\phi(E,x,y,z)$ to cards, = 3, $\phi(x,y,z)$ to tape (logical unit 16), = 4, $\phi(E,x,y,z)$ to tape (logical unit 16).

CARD 5: FORMAT (6E12.6)

Variable	Columns	Description
EV	1-12	Initial eigenvalue guess. (Used only in search calculations.)
EVM	13-24	Initial eigenvalue modifier. This value should decrease reactivity -- i.e., EV + EVM should produce a lower k_{eff} than EV. Since EV and EVM are 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.)
SO3	25-36	Parametric eigenvalue (see third word on Card 2).
BUCK	37-48	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	Lower limit on $\lvert\lambda-1\rvert$, where $\lambda-1$ is, in essence, the predicted change in the current reactivity. After LAL is reached, the eigenvalue slope is no longer altered. LAL is used only in search calculations. Recommended value $\approx$ 0.005.

Variable	Columns	Description
LAH	61-72	Upper limit on $\|\lambda-1\|$. If $\|\lambda-1\|$ is greater than LAH, LAH rather than $\|\lambda-1\|$ is used in predicting the new eigenvalue. LAH is used only in search calculations. Recommended value $\approx$ 0.5.

CARD 6: FORMAT (6E12.6)

Variable	Columns	Description
EPS	1-12	Convergence criterion on the total fission source rate.
EPSA	13-24	Parametric eigenvalue convergence criterion. The eigenvalue is recalculated when $\|\lambda^{\nu+1}-\lambda^{\nu}\|$ is less than EPSA, where ν is the outer iteration index. EPSA is only used in search calculations. Recommended value $\approx$ 10xEPS.
G06	25-36	Inner (X-Y) iteration convergence criterion. That is, $\mathrm{Max}(\|\phi^{\nu+1}-\phi^{\nu}\|/\phi^{\nu})$ where ν is the inner iteration index. If zero, EPS is used. Recommended value $\approx$ 10xEPS.
EPS2	37-48	Z iteration convergence criterion. That is, $\mathrm{Max}(\|\phi^{\nu+1}-\phi^{\nu}\|/\phi^{\nu})$ where ν is the Z iteration index. If zero, EPS is used. Recommended value $\approx$ 10xEPS.
ORF	49-60	Over-relaxation factor. If instabilities arise, reduce ORF. Recommended value $\approx$ 1.5.
S01	61-72	If X negative, the total power is normalized to $\|X\|$ Mwt using the conversion factor of 215 MeV/fission. If positive, X=total source/k_{eff}.

CARD 7: FORMAT (A6,2E6.2,9A6)

Variable	Columns	Description
HOLN(MCR)	1-6	Identification card for first isotope. Name
ATW(MCR)	7-12	Atomic weight of first isotope (a.m.u.).
ALAM(MCR)	13-18	Decay constant for first isotope (days^{-1}). This value is only used in burnup calculations.
AA(9)	19-72	Miscellaneous additional identification.

Variable	Columns	Description

CARD 8: FORMAT (6E12.5)

Optional -- required if MCR>0.

. . .

C(ITL,IGM,MCR)		σ_f(barns) -- for first group of first material.
C(ITL,IGM,MCR)		σ_a.
C(ITL,IGM,MCR)		$\nu\sigma_f$.
C(ITL,IGM,MCR)		σ_{tr}.
C(ITL,IGM,MCR)		$\sigma(g\rightarrow g)$.
C(ITL,IGM,MCR)		$\sigma(g-1\rightarrow g)$.

. . .

Continue through $\sigma(g\text{-}NXCM\rightarrow g)$. Repeat through group IGM. Repeat from Card 7 for |MCR| materials.

CARD 9: FORMAT [6(I1,I2,E9.4)]*

Optional -- required if M07=1.

RF(IM)	1-12	Flux guess for first interval in X direction.
RF(IM)	13-24	Flux guess for second interval in X direction.

. . .

CARD 9': FORMAT [6(I1,I2,E9.4)]

Optional -- required if M07=1.

ZF(JM)	1-12	Flux guess for first interval in Y direction.
ZF(JM)	13-24	Flux guess for second interval in Y direction.

. . .

CARD 9": FORMAT [6(I1,I2,E9.4)]

Optional -- required if M07=1.

HF(KM)	1-12	Flux guess for first interval in Z direction.
HF(KM)	13-24	Flux guess for second interval in Z direction.

. . .

* *Generalized input format (see page B-1).*

Variable	Columns	Description

CARD 10: FORMAT (6E12.6)

Optional -- required if M07=2.

NO(IM,JM)	1-12	Flux guess for first mesh interval in first X-Y plane.
NO(IM,JM)	13-24	Flux guess for second mesh interval in first X-Y plane.

. . .

Repeat above card for all X-Y planes, each plane starting on a new card.

CARD 11: FORMAT (6E12.6)

Optional -- required if M07=3.

NO(IM,JM)	1-12	Flux guess for first mesh interval in first X-Y plane for first energy group.
NO(IM,JM)	13-24	Flux guess for second mesh interval in first X-Y plane for first energy group.

. . .

Repeat above card for all X-Y planes and then repeat for all energy groups, each plane and group starting on a new card.

CARD 12: FORMAT [6(I1,I2,E9.4)]

Optional -- required if M07=6.

HF(KM)	1-12	Flux shape factor for first X-Y plane.
HF(KM)	13-24	Flux shape factor for second X-Y plane.

. . .

If I04=1 (source calculation), the external source may be read in using the same format as the flux guess (i.e., if M08=1, submit cards analogous to 9, 9', and 9"; if M08=2, submit card analogous to 10; if M08=3, submit card analogous to 11; and if M08=3, submit card analogous to 12).

CARD 13: FORMAT [6(I1,I2,E9.4)]

XO(IM+1)	1-12	Position of first mesh boundary in X direction (cm).
XO(IM+1)	13-24	Position of second mesh boundary in X direction.

. . .

Variable	Columns	Description
CARD 14: FORMAT [6(I1,I2,E9.4)]		
YO(JM+1)	1-12	Position of first mesh boundary in Y direction (cm for X-Y-Z and triangular geometry and fractions of a circle for R-θ-Z geometry).
YO(JM+1)	13-24	Position of second mesh boundary in Y direction.
. . .		
CARD 15: FORMAT [6(I1,I2,E9.4)]		
ZO(KM+1)	1-12	Position of first mesh boundary in Z direction (cm).
ZO(KM+1)	13-24	Position of second mesh boundary in Z direction.
. . .		
CARD 16: FORMAT [6(I1,I2,I9)]		
LYN(KM)	1-12	Material layer number of first X-Y plane.
LYN(KM)	13-24	Material layer number of second X-Y plane. Layer numbers must be in ascending order (e.g., 1-1-1-2-2-3-3-3, not 1-1-1-2-2-1-1-1, even though layer 3 may have the same material specifications as 1).
. . .		
CARD 17: FORMAT [6(I1,I2,I9)]		
MO(IM,JM)	1-12	Zone number for first mesh interval for first material layer.
MO(IM,JM)	13-24	Zone number for second mesh interval for first material layer.
. . .		
CARD 17': FORMAT [6(I1,I2,I9)]		
MO(IM,JM)	1-12	Zone number for first mesh interval for second material layer.
MO(IM,JM)	13-24	Zone number for second mesh interval for second material layer.
. . .		

Repeat above for all material layers.

Variable	Columns	Description
CARD 18: FORMAT [6(I1,I2,I9)]		
M2(IZM)	1-12	Material number for first zone.
M2(IZM)	13-24	Material number for second zone.
. . .		
CARD 19: FORMAT [6(I1,I2,E9.4)]		
Optional -- required if BUCK≠0 or if I04=5.		
GAM(IZM)	1-12	Buckling modifier for first zone.
GAM(IZM)	13-24	Buckling modifier for second zone.
. . .		
CARD 20: FORMAT [6(I1,I2,E9.4)]		
K7(IGM)	1-12	Fission fraction (spectrum) in first energy group.
K7(IGM)	13-24	Fission fraction in second energy group.
. . .		
CARD 21: FORMAT [6(I1,I2,E9.4)]		
V7(IGM)	1-12	Neutron velocity for first energy group (cm/sec).
V7(IGM)	13-24	Neutron velocity for second energy group.
. . .		
CARD 22: FORMAT [6(I1,I2,I9)]		
Optional -- required if M01>0.		
IO(M01)	1-12	Material number of Mix 1.
IO(M01)	13-24	Material number of Mix 1.
. . .		
IO(M01)	N-(N+12)	Material number of Mix 2.
IO(M01)	(N+13)-(N+24)	Material number of Mix 2.
. . .		

Variable	Columns	Description
CARD 23: FORMAT [6(I1,I2,I9)]		
I1(M01)	1-12	0 (to clear storage area for Mix 1).
I1(M01)	13-24	Number of first material in Mix 1.
I1(M01)	25-36	Number of second material in Mix 1.
. . .		
I1(M01)	N-(N+12)	0 (to clear storage area for Mix 2).
I1(M01)	(N+13)-(N+24)	Number of first material in Mix 2.
. . .		
CARD 24: FORMAT [6(I1,I2,E9.4)]		
Optional -- required if M01>0.		
I2(M01)	1-12	0.
I2(M01)	13-24	Concentration of first material in Mix 1 (atoms/barn-cm).
I2(M01)	25-36	Concentration of second material in Mix 1.
. . .		
I2(M01)	N-(N+12)	0.
I2(M01)	(N+13)-(N+24)	Concentration of first material in Mix 2.
. . .		
CARD 25: FORMAT [6(I1,I2,I9)]		
Optional -- required if I04=4.		
IX2(IM)	1-12	Dimensional search (δ calculation) zone number for first X interval.
IX2(IM)	13-24	Dimensional search zone number for second X interval.
. . .		
CARD 26: FORMAT [6(I1,I2,E9.4)]		
Optional -- required if I04=4.		
X3(IZ)	1-12	Modifier for first dimensional search zone in X direction.

Variable	Columns	Description
X3(IZ)	13-24	Modifier for second dimensional search zone in X direction.

. . .

CARD 27: FORMAT [6(I1,I2,I9)]

Optional -- required if I04=4.

IY2(JM)	1-12	Dimensional search zone number for first Y interval.
IY2(JM)	13-24	Dimensional search zone number for second Y interval.

. . .

CARD 28: FORMAT [6(I1,I2,E9.4)]

Optional -- required if I04=4.

Y3(JZ)	1-12	Modifier for first dimensional search zone in Y direction.
Y3(JZ)	13-24	Modifier for second dimensional search zone in Y direction.

. . .

CARD 29: FORMAT [6(I1,I2,I9)]

Optional -- required if I04=4.

IZ2(KM)	1-12	Dimensional search zone number for first Z interval.
IZ2(KM)	13-24	Dimensional search zone number for second Z interval.

. . .

CARD 30: FORMAT [6(I1,I2,E9.4)]

Optional -- required if I04=4.

Z3(KZ)	1-12	Modifier for first dimensional search zone in Z direction.
Z3(KZ)	13-24	Modifier for second dimensional search zone in Z direction.

. . .

Variable	Columns	Description

CARD 31: FORMAT [6(I1,I2,I9)]

Optional -- required if NACT>0.

MA(NACT)	1-12	Material number for first activity traverse.
MA(NACT)	13-24	Material number for second activity traverse.

. . .

CARD 32: FORMAT [6(I1,I2,I9)]

Optional -- required if NACT>0.

NX(NACT)	1-12	Cross section position for first activity traverse.
NA(NACT)	13-24	Cross section position for second activity traverse.

. . .

CARD 33: FORMAT [6(I1,I2,I9)]

Optional -- required if NACT>0.

KMODR(NACT)	1-12	Activity print modifiers for first X-Y plane (0/1 = no print/print).
KMODR(NACT)	13-24	Activity print modifiers for second X-Y plane.

. . .

CARD 34: FORMAT [6(I1,I2,I9)]

Optional -- required if NPRT=1.

IGMOD(IGM)	1-12	Group flux print modifiers for first group.
IGMOD(IGM)	13-24	Group flux print modifiers for second group.

. . .

CARD 35: FORMAT [6(I1,I2,I9)]

Optional -- required if NPRT=1.

KMODG(KM)	1-12	Group flux print modifiers for first X-Y plane.
KMODG(KM)	13-24	Group flux print modifiers for second X-Y plane.

. . .

Variable	Columns	Description
CARD 36: FORMAT [6(I1,I2,I9)]		
Optional -- required if NPRT=1.		
KMODF(KM)	1-12	Total flux print modifiers for first X-Y plane.
KMODF(KM)	13-24	Total flux print modifiers for second X-Y plane.
. . .		
CARD 37: FORMAT [6(I1,I2,I9)]		
Optional -- required if NPRT=1.		
KMODP(KM)	1-12	Power print modifiers for first X-Y plane.
KMODP(KM)	13-24	Power print modifiers for second X-Y plane.
. . .		
CARD 38: FORMAT (4I6,E12,6)		
Burnup control card.		
NCON	1-6	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	Print option: = 0, mini print, = 1, maxi print.
NPUN	13-18	Flux dump option: = 0, none, = 1, $\phi(x,y,z)$ to cards, = 2, $\phi(E,x,y,z)$ to cards, = 3, $\phi(x,y,z)$ to tape (logical unit 16), = 4, $\phi(E,x,y,z)$ to tape (logical unit 16).
ITEMP1	19-24	= 0, no effect, = 1, punch material densities (I2 array) for previous time step--will function with NCON=0.
DELT	25-36	Length of time step (days). If zero, code proceeds to next case. If negative, code shuffles mixture.

Variable	Columns	Description
CARD 39: FORMAT (12I6)		
Optional -- required if NCON>0.		
MATN(NCON)	1-6	This card contains all burnup parameters for the first burnable isotope. Material sequence number of first burnable isotope.
NBR(NCON)	7-12	Control for breeding ratio calculation: = 0, no effect, = 1, fertile isotope, = 2, fissile isotope.
LD(NCON)	13-18	= 0, no decay source, = N, decay source from burnable isotope N.
LCN(NCON,2)	19-24	= 0, no capture source, = N, capture source from burnable isotope N. See Eq. (5.1).
LCN(NCON,2)	25-30	= 0, no capture source, = N, capture source from burnable isotope N.
LFN(NCON,7)	31-36	= 0, no fission source, = N, fission source from burnable isotope N. See Eq. (5.1).
LFN(NCON,7)	37-48	= 0, no fission source, = N, fission source from burnable isotope N.

. . .

Repeat above card for all burnable isotopes. Repeat from CARD 38 for additional time steps.

CARD 40: FORMAT (3I6)

Optional -- required if DELT<0.

Variable	Columns	Description
ITEMP	1-6	This card replaces the densities of materials in any mixture in the IO table by the densities of the same materials in another mixture in this table. = 0, end of shuffling data, = 1, this card contains shuffling data.
ITEMP1	7-12	Mixture number to be replaced.

Variable	Columns	Description
ITEMP2	13-18	Mixture number replacing ITEMP1. The materials to be replaced must be common to both mixtures.

Repeat above card for all mixtures to be shuffled, then submit card with 0 in column 6 indicating the end of shuffling data.

3 D B

Columns 1–72	Columns 67–72
ID(11) IDENTIFICATION CARD	MAXT MAX. RUNNING TIME (MIN.)

1–6	7–12	13–18	19–24	25–30	31–36	37–42	43–48	49–54	55–60	61–66	67–72
A02 PROBLEM TYPE: =0, REGULAR =1, ADJOINT	I04 EIGENVALUE TYPE: =0, SOURCE(S) =1, k_{eff} =2, ABSORPTION (a) =3, CONCENTRATION (C) =4, ZONE THICKNESS (δ) =5, BUCKLING (B^2)	S02 PARAMETRIC EIGENVALUE TYPE: =0, NONE, =1, k_{eff} =2, α	IGM NUMBER OF GROUPS	NXCM NUMBER OF DOWNSCATTERING TERMS	IHT POSITION OF TRANSPORT CROSS SECTION IN CROSS SECTION TABLE	M07 FLUX GUESS: =0, NONE =1, φ(x)*φ(y)*φ(z) FROM CARDS =2, φ(x, y, z) FROM CARDS =3, φ(E, x, y, z) FROM CARDS =4, φ(x, y, z) FROM TAPE =5, φ(E, x, y, z) FROM TAPE =6, φ(E, x, y) FROM TAPE *φ(z) FROM CARDS	M08 EXTERNAL SOURCE SAME OPTIONS AS M07	D05 MAXIMUM NUMBER OF OUTER ITERATIONS	I07 MAXIMUM NUMBER OF Z ITERATIONS PER GROUP	G07 MAXIMUM NUMBER OF INNER (X-Y) ITERATIONS PER Z ITERATION	S04 X-Y INVERSION DIRECTION: =0, CODE CHOOSES =1, ALTERNATE DIRECTION =2, X =3, Y

1–6	7–12	13–18	19–24	25–30	31–36	37–42	43–48	49–54	55–60	61–66	67–72
IGE GEOMETRY: =0, X-Y-Z =1, R-θ-Z =2, TRIANGULAR-Z	IZM NUMBER OF MATERIAL ZONES	NLAY NUMBER OF MATERIAL LAYERS	MT TOTAL NUMBER OF MATERIALS INCLUDING MIXES	M01 NUMBER OF MIXTURE SPECIFICATIONS	MCR =-N, N INPUT MATERIALS FROM TAPE =+N, N INPUT MATERIALS FROM CARDS	IM NUMBER OF INTERVALS IN THE X DIRECTION	JM NUMBER OF INTERVALS IN THE Y DIRECTION	KM NUMBER OF INTERVALS IN THE Z DIRECTION	IZ NUMBER OF X ZONES (δ OPTION ONLY)	JZ NUMBER OF Y ZONES (δ OPTION ONLY)	KZ NUMBER OF Z ZONES (δ OPTION ONLY)

1–6	7–12	13–18	19–24	25–30	31–36	37–42	43–48	49–54
B01 LEFT BOUNDARY CONDITION: =0, VACUUM =1, REFLECTIVE	B02 RIGHT BOUNDARY CONDITION: =0, VACUUM =1, REFLECTIVE	B03 BACK BOUNDARY CONDITION: =0, VACUUM =1, REFLECTIVE	B04 FRONT BOUNDARY CONDITION: =0, VACUUM =1, REFLECTIVE	B05 TOP BOUNDARY CONDITION: =0, VACUUM =1, REFLECTIVE	B06 BOTTOM BOUNDARY CONDITION: =0, VACUUM =1, REFLECTIVE	NACT NUMBER OF ACTIVITY TRAVERSES	NPRT PRINT OPTION: =0, MINI =1, MAXI	NPUN FLUX OUTPUT OPTION: =0, NONE =1, φ(X, Y, Z) TO CARDS =2, φ(E, X, Y, Z) TO CARDS =3, φ(X, Y, Z) TO TAPE =4, φ(E, X, Y, Z) TO TAPE

1–12	13–24	25–36	37–48	49–60	61–72
EV FIRST EIGENVALUE GUESS	EVM EIGENVALUE MODIFIER	S03 PARAMETRIC EIGENVALUE	BUCK BUCKLING (cm^{-2})	LAL LAMBDA LOWER	LAH LAMBDA UPPER

1–12	13–24	25–36	37–48	49–60	61–72
EPS EIGENVALUE CONVERGENCE CRITERION	EPSA PARAMETER CONVERGENCE CRITERION	G06 INNER (X-Y) ITERATION CONVERGENCE CRITERION (IF 0.0, USE EPS)	EPS2 Z ITERATION CONVERGENCE CRITERION (IF 0.0, USE EPS)	O98 OVER-RELAXATION FACTOR	S01 =-N, NORMALIZE φ'S TO N M_{wt} =+N, NORMALIZE φ'S TO FISSION SOURCE RATE OF N

1–6	7–12	13–18	19–72
HOL(MCR) MATERIAL NAME	ATW(MCR) ATOMIC WEIGHT	ALAM(MCR) DECAY CONSTANT (DAY^{-1})	AA(9) MISCELLANEOUS INFORMATION

Columns 1–72	Columns 73–80
CROSS SECTION DATA FOR ABOVE MATERIAL (FROM TAPE OR CARDS)	C(IT), IGM, MCR)
REPEAT ABOVE TWO CARDS FOR MCR MATERIALS	

Condition	Cols 1–12	13–24	25–36	37–48	49–60	61–72	73–80
IF (MO7) > 0	INPUT FLUX GUESS						
IF (IO4) = 0	EXTERNAL SOURCE						
	FIRST POINT IN X DIRECTION (0.0)	SECOND POINT IN X DIRECTION	● ● ●				XO (IM+1)
	FIRST POINT IN Y DIRECTION (0.0)	SECOND POINT IN Y DIRECTION	● ● ●				YO (JM+1)
	FIRST POINT IN Z DIRECTION (0.0)	SECOND POINT IN Z DIRECTION	● ● ●				ZO (KM+1)
	MATERIAL LAYER NUMBER OF FIRST XY PLANE	MATERIAL LAYER NUMBER OF SECOND XY PLANE	● ● ●				LYN (KM)
	ZONE NUMBER FOR FIRST MESH INTERVAL FOR FIRST MATERIAL LAYER	ZONE NUMBER FOR SECOND MESH INTERVAL FOR FIRST MATERIAL LAYER	● ● ●				MO (IM, JM)
	● ● ● REPEAT ABOVE CARD FOR ALL MATERIAL LAYERS						MO (IM, JM)
	MATERIAL NUMBER FOR FIRST ZONE	MATERIAL NUMBER FOR SECOND ZONE	● ● ●				M2 (IZM)
IF (BUCK) ≠ 0 OR IF (IO4) = 5	BUCKLING MODIFIER FOR FIRST ZONE	BUCKLING MODIFIER FOR SECOND ZONE	● ● ●				GAM (IZM)
	FISSION SPECTRUM IN FIRST GROUP	FISSION SPECTRUM IN SECOND GROUP	● ● ●				K7 (IGM)
	NEUTRON VELOCITY IN FIRST GROUP	NEUTRON VELOCITY IN SECOND GROUP	● ● ●				V7 (IGM)
IF (MO1) > 0	MATERIAL NUMBER OF MIX 1	MATERIAL NUMBER OF MIX 1	MATERIAL NUMBER OF MIX 1	● ● ●	MATERIAL NUMBER OF MIX 2	● ● ●	IO (MO1)
IF (MO1) > 0	0	FIRST MATERIAL IN MIX 1	SECOND MATERIAL IN MIX 1	● ● ●	0	● ● ●	I1 (MO1)
IF (MO1) > 0	0	DENSITY OF FIRST MATERIAL IN MIX 1	DENSITY OF SECOND MATERIAL IN MIX 1	● ● ●	0	● ● ●	I2(MO1)

	1–12	13–24	25–36	37–48	49–60	61–72	73–80
IF (IDM) = 4	DELTA ZONE NUMBER FOR FIRST X INTERVAL	DELTA ZONE NUMBER FOR SECOND X INTERVAL	● ● ●				IX2(IM)
	MODIFIER FOR FIRST X ZONE	MODIFIER FOR SECOND X ZONE	● ● ●				X3(IZ)
	DELTA ZONE NUMBER FOR FIRST Y INTERVAL	DELTA ZONE NUMBER FOR SECOND Y INTERVAL	● ● ●				IY2(JM)
	MODIFIER FOR FIRST Y ZONE	MODIFIER FOR SECOND Y ZONE	● ● ●				Y3(JZ)
	DELTA ZONE NUMBER FOR FIRST Z INTERVAL	DELTA ZONE NUMBER FOR SECOND Z INTERVAL	● ● ●				IZ2(KM)
	MODIFIER FOR FIRST Z ZONE	MODIFIER FOR SECOND Z ZONE	● ● ●				Z3(KZ)
IF (INACT) > 0	MATERIAL NUMBER FOR FIRST ACTIVITY TRAVERSE	MATERIAL NUMBER FOR SECOND ACTIVITY TRAVERSE	● ● ●				MA(NACT)
	CROSS SECTION POSITION FOR FIRST ACTIVITY TRAVERSE	CROSS SECTION POSITION FOR SECOND ACTIVITY TRAVERSE	● ● ●				NX(NACT)
	ACTIVITY PRINT MODIFIERS FOR FIRST XY PLANE	ACTIVITY PRINT MODIFIERS FOR SECOND XY PLANE	● ● ●				KMODR(KM)
IF (INPRT) = 1	GROUP FLUX PRINT MODIFIERS FOR FIRST GROUP	GROUP FLUX PRINT MODIFIERS FOR SECOND GROUP	● ● ●				IGMOD (IGM)
	GROUP FLUX PRINT MODIFIERS FOR FIRST XY PLANE	GROUP FLUX PRINT MODIFIERS FOR SECOND XY PLANE	● ● ●				KMODG (KM)
	TOTAL FLUX PRINT MODIFIERS FOR FIRST XY PLANE	TOTAL FLUX PRINT MODIFIERS FOR SECOND XY PLANE	● ● ●				KMODF (KM)
	POWER PRINT MODIFIERS FOR FIRST XY PLANE	POWER PRINT MODIFIERS FOR SECOND XY PLANE	● ● ●				KMODP (KM)

Columns 1–6	Columns 7–12	Columns 13–18	Columns 19–24	Columns 25–36
NCON = 0, END OF PROBLEM = N, TAKE TIME STEP OF DELT AND READ BURNUP DATA FOR N ISOTOPES < 0, TAKE TIME STEP OF DELT	NPRT PRINT OPTION	NPUN FLUX OUTPUT OPTION	ITEMP1 = 0, NO EFFECT = 1, PUNCH I2 ARRAY FOR PREVIOUS TIME STEP	DELT > 0, LENGTH OF TIME STEP (DAYS) = 0, END OF PROBLEM < 0, SHUFFLE MIXTURES

IF (NCON) > 0

Columns 1–6	Columns 7–12	Columns 13–18	Columns 19–24	Columns 25–30	Columns 31–36	Columns 37–42
MATN(NCON) MATERIAL SEQUENCE NUMBER FOR FIRST BURNABLE ISOTOPE	NBR(NCON) = 0, NO EFFECT = 1, FERTILE ISOTOPE = 2, FISSILE ISOTOPE	LD(NCON) = 0, NO DECAY SOURCE = N, DECAY SOURCE FROM BURNABLE ISOTOPE N	LCN(NCON, 2) = 0, NO CAPTURE SOURCE = N, CAPTURE SOURCE FROM BURNABLE ISOTOPE N	● ● ●	LFN(NCON, 7) = 0, NO FISSION PRODUCT SOURCE = N, FISSION PRODUCT SOURCE FROM BURNABLE ISOTOPE N	● ● ●

● ● ● REPEAT ABOVE CARD FOR NCON BURNABLE ISOTOPES

IF (DELT) < 0

Columns 1–6	Columns 7–12	Columns 13–18
ITEMP = 0, END OF SHUFFLING DATA = 1, THIS CARD CONTAINS SHUFFLING DATA	ITEMP1 MIXTURE NUMBER TO BE REPLACED	ITEMP2 MIXTURE NUMBER REPLACING ITEMP1

● ● ● REPEAT ABOVE CARD FOR ALL MIXTURES TO BE SHUFFLED, THEN SUBMIT CARD WITH 0 IN COLUMN 6 INDICATING THE END OF SHUFFLING DATA

APPENDIX C

STORAGE REQUIREMENTS

APPENDIX C

STORAGE REQUIREMENTS

3DB uses variable dimensioning by storing the subscripted variables in one array, A(22000). The variable dimensioned arrays require N storage locations ($N \leq 22000$), where:

$$N = MAX(N_1, N_2)$$

$$\begin{aligned} N_1 = 18 &+ 16 \times IM \times JM \\ &+ 8 \times IM \\ &+ 5 \times JM \\ &+ 6 \times KM \\ &+ 4 \times (MO1 + IZM) \\ &+ 14 \times IGM \\ &+ MT \times ITL \\ &+ 2 \times NACT \\ &+ |MCR| \times (15 + 4 \times IZM) \\ &+ NPRT \times (3 \times KM + IGM) \\ &+ 2 \times MAX(IM,JM) \\ &+ IZ + JZ + KZ + IM + JM + KM \quad [IF\ (I04) = 4] \end{aligned}$$

and

$$N_2 = MT \times ITL \times (IGM + 1) + 3 \times ML.$$

For most problems, $N_1 > N_2$, and thus, $N = N_1$.

3DB also requires 11 peripheral storage units. A list of these storage units is given in Table C-1, along with the number of words in each unit, and a brief description of the data stored. Since the code was written for a UNIVAC 1108, unbuffered drums (4.24×10^{-3} sec average access time and 4.2×10^{-6} sec/word transfer rate) are used for storage; however, only minor coding changes are required to use either tape or disc storage.

TABLE C-1. Description of Peripheral Storage Units

Logical Unit Number	Name	Length	Description of Data Stored
1	NSORCE	215,000	External Source
2	NSCRAT	215,000	Scratch Unit
3	NFLUX1	215,000	Fluxes
4	NCXS	215,000	Flux Constants
17	NFO	45,000	Fission Source (Previous Iteration)
18	NMO	45,000	Zone Numbers by Mesh Interval
19	NF2	45,000	Fission Source
20	NS2	45,000	Group Source
21	NCR1	45,000	Cross Sections
22	NDUM	45,000	Scratch Unit
23	NTEMP	45,000	Scratch Unit

For the data to fit on drum, the following requirements must be met.

$$IM \times JM \times KM \times IGM \leq 215,000$$

$$5 \times IM \times JM \times KM + IM + JM \leq 215,000$$

$$IM \times JM \times KM \leq 45,000$$

$$ITL \times MT \times IGM \leq 45,000.$$

APPENDIX D

SAMPLE PROBLEM

APPENDIX D

SAMPLE PROBLEM

The following pages show the input data and computer output for a simplified 2-group, 2-zone, 1-step burnup problem in X-Y-Z geometry (see Figure D-1). To reduce running time, the number of mesh intervals in each direction is 10. Atom densities at t = 0.0 days are given in Table D-1.

TABLE D-1. Atom Densities (atoms-barn^{-1}-cm^{-1}) for 3DB Sample Problem

Material	Zone 1 (Core)	Zone 2 (Blanket)
U^{238}	0.0080	0.0400
Pu^{239}	0.0016	0.0
Pu^{240}	0.0001	0.0
Pu^{241}	0.0	0.0
Fission Products	0.0	0.0
C	0.0200	0.0
Na	0.0060	0.0
Fe	0.0130	0.0062

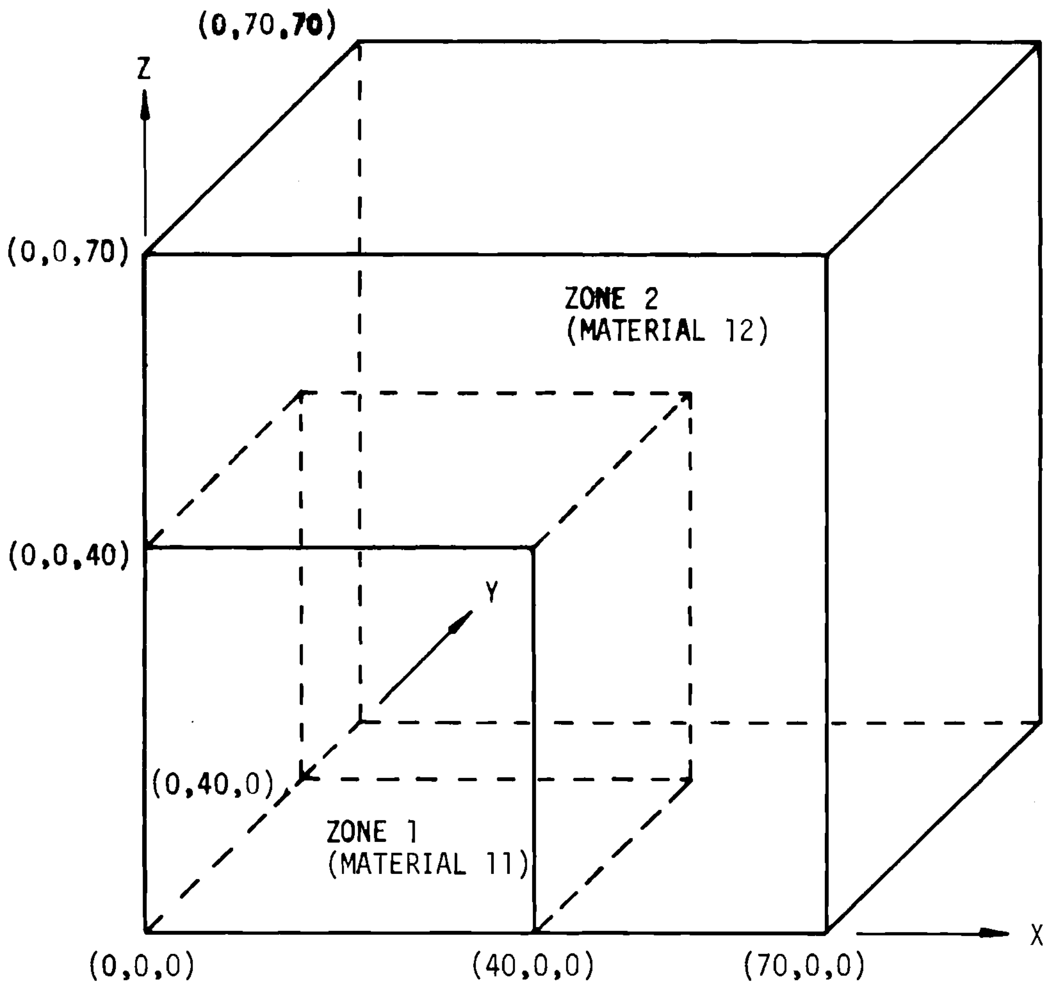


FIGURE D-1. Diagram of 3DB Sample Problem.

```
 3DB SAMPLE CASE    (10X10X10, 2 ZONE, 2 GROUP)                                  10        ID
      0      1      0      2      1      4      1      0     20      5      5      0
      0      2      2     12     13     10     10     10     10      0      0      0
      1      0      0      1      0      1      1      1      0
          0.0          0.0         0.0          0.0          0.0          0.0
       .00001          0.0       .0001        .0001          1.5        -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  .118888+02  .901306+01  .126336-00
FIS PR  1.00    0.0 2 GROUPS            CORE
  .000000     .180334-00  .000000     .106936+02  .103924+02  .000000
  .           .450420-00  .000000     .142171+02  .137666+02  .120810+00
C      12.011   0.0 2 GROUPS            CORE
  .000000     .833620-05  .000000     .263926+01  .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            BLANKET
  .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            BLANKET
  .000000     .670574-02  .000000     .265143+01  .259971+01  .000000
  .000000     .120269-01  .000000     .449904+01  .448701+01  .450092-01
2 8       1.0         .023                                                           RF
2 8       1.0         .023                                                           ZF
2 5       1.0         .023                                                           HF
2 5       0.02 3     40.0        70.03                                               X0
2 5       0.02 3     40.0        70.03                                               Y0
2 5       0.02 3     40.0        70.03                                               Z0
1 6         11 4        23                                                          LYN
1 6         11 4        24 5       10110         24 3        103                     M0
110         24 9       103                                                           M0
            11         123                                                           M2
          .987       .0133                                                           K7
```

```
   7.63085+8    1.16360+83                                                                V7
1 9       111 4        123                                                                I0
            0            1           2           3           4           5                I1
            6            7           8           0           9           2                I1
          103                                                                             I1
            0        .0080       .0016       .0001          .0          .0                I2
        .0200        .0060       .0130           0       .0400          .0                I2
       .00623                                                                             I2
           23                                                                             MA
           13                                                                             NX
           11 9         03                                                             KMODR
1 2        03                                                                          IGMOD
110        03                                                                          KMODG
           11 9         03                                                             KMODF
           11 4          0          11 4        03                                     KMODP
      6     0     0      0        50.0
      1     1     0      0     0     0     0     0     0     0     0     0
      2     2     0      1     6     0     0     0     0     0     0     0
      3     1     0      2     0     0     0     0     0     0     0     0
      4     2     0      3     0     0     0     0     0     0     0     0
      5     0     0      0     0     1     2     3     4     6     0     0
      9     1     0      0     0     0     0     0     0     0     0     0
      0
```

* * * * 3 D B * * * *

3DB SAMPLE CASE (10X10X10, 2 ZONE, 2 GROUP) 10

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
IHT	POSITION OF SIGMA TRANSPORT IN CROSS SECTION TABLE	4
M07	FLUX GUESS (0/1/2/3/4/5/6=NONE/PHI(X)*PHI(Y)*PHI(Z)/PHI(X,Y,Z)/ PHI(E,X,Y,Z) FROM CARDS/PHI(X,Y,Z)/PHI(E,X,Y,Z) FROM TAPE/ PHI(E,X,Y) FROM TAPE*PHI(Z) FROM CARDS)	1
M08	EXTERNAL SOURCE GUESS (SAME OPTIONS AS M07)	0
O05	MAXIMUM NUMBER OF OUTER ITERATIONS	20
I07	MAXIMUM NUMBER OF Z ITERATIONS PER GROUP	5
G07	MAXIMUM NUMBER OF INNER (XY) ITERATIONS PER Z ITERATION	5
S04	XY INVERSION DIRECTION (0/1/2/3=CODE CHOOSES/ALTERNATE/X/Y)	0
IGE	GEOMETRY (0/1/2=X-Y-Z/R-THETA-Z/TRIANGULAR-Z)	0
IZM	NUMBER OF MATERIAL ZONES	2
NLAY	NUMBER OF MATERIAL LAYERS	2
MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	12
M01	NUMBER OF MIXTURE SPECIFICATIONS	13
MCR	NUMBER OF INPUT CROSS SECTION MATERIALS (NEG/POS=FROM TAPE/CARDS)	10
IM	NUMBER OF INTERVALS IN THE X DIRECTION	10
JM	NUMBER OF INTERVALS IN THE Y DIRECTION	10
KM	NUMBER OF INTERVALS IN THE Z DIRECTION	10
IZ	NUMBER OF ZONES IN THE X DIRECTION (DELTA OPTION ONLY)	0
JZ	NUMBER OF ZONES IN THE Y DIRECTION (DELTA OPTION ONLY)	0
KZ	NUMBER OF ZONES IN THE Z DIRECTION (DELTA OPTION ONLY)	0
B01	LEFT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	1
B02	RIGHT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	0
B03	BACK BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	0
B04	FRONT BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	1
B05	TOP BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	0
B06	BOTTOM BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)	1
NACT	NUMBER OF ACTIVITY TRAVERSES	1
NPRT	PRINT OPTION (0/1=MINI/MAXI)	1
NPUN	FLUX OUTPUT OPTION (0/1/2/3/4=NONE/PHI(X,Y,Z)/PHI(E,X,Y,Z) TO CARDS/ PHI(X,Y,Z)/PHI(E,X,Y,Z) TO TAPE)	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	0.0000
LAH	LAMBDA UPPER	0.0000
EPS	EIGENVALUE CONVERGENCE CRITERION	1.0000-05
EPSA	PARAMETER CONVERGENCE CRITERION	0.0000
G06	INNER (XY) ITERATION CONVERGENCE CRITERION (IF 0, USE EPS)	1.0000-04
EPS2	Z ITERATION CONVERGENCE CRITERION (IF 0, USE EPS)	1.0000-04
ORF	OVER-RELAXATION FACTOR	1.5000+00
S01	NEGATIVE/POSITIVE=POWER (MWT)/NEUTRON SOURCE RATE	-1.0000+02

LAST 2253

```
3DB SAMPLE CASE    (10X10X10, 2 ZONE, 2 GROUP)


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          BLANKET
 10       FE            2 GROUPS          BLANKET

FLUX GUESS  (RF/ZF/HF=X PROFILE/Y PROFILE/Z PROFILE)
        RF     10
  .10000+01  .59111-00  .78222-00  .67333-00  .56444-00  .45556-00  .34667-00  .23778-00  .12889-00  .20000-01
        ZF     10
  .10000+01  .39111-00  .78222-00  .67333-00  .56444-00  .45556-00  .34667-00  .23778-00  .12889-00  .20000-01
        HF     10
  .10000+01  .39111-00  .78222-00  .67333-00  .56444-00  .45556-00  .34667-00  .23778-00  .12889-00  .20000-01
```

```
MESH BOUNDARIES (X0/Y0/Z0=X/Y/Z POINTS)
       X0     11
 -.00000      .66667+01   .13333+02   .20000+02   .26667+02   .33333+02   .40000+02   .47500+02   .55000+02   .62500+02
  .70000+02
       Y0     11
 -.00000      .66667+01   .13333+02   .20000+02   .26667+02   .33333+02   .40000+02   .47500+02   .55000+02   .62500+02
  .70000+02
       Z0     11
 -.00000      .66667+01   .13333+02   .20000+02   .26667+02   .33333+02   .40000+02   .47500+02   .55000+02   .62500+02
  .70000+02

LAYER NUMBERS BY XY PLANE
      LYN     10
        1          1          1          1          1          1          2          2          2          2

ZONE NUMBERS BY MESH INTERVAL FOR LAYER  1
      MG    100
        1          1          1          1          1          1          2          2          2          2
        1          1          1          1          1          1          2          2          2          2
        1          1          1          1          1          1          2          2          2          2
        1          1          1          1          1          1          2          2          2          2
        1          1          1          1          1          1          2          2          2          2
        1          1          1          1          1          1          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2

ZONE NUMBERS BY MESH INTERVAL FOR LAYER  2
      M0    100
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2          2          2
        2          2          2          2          2          2          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
      MZ      2
       11         12

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

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

MIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER FOR MIX/MATERIAL DENSITY)
        I0      13
        11         11         11         11         11         11         11         11         11         12
        12         12         12
        11      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

MATERIAL NUMBERS FOR ACTIVITY TRAVERSES
        MA      1
        2

CROSS SECTION POSITION FOR ACTIVITY TRAVERSES
        IX      1
        1

REACTION RATE PRINT MODIFIERS BY XY PLANE
     KMODR     10
        1          0          0          0          0          0          0          0          0          0

FLUX PRINT MODIFIERS BY GROUP
     IGMOD      2
        0          0

PRINT MODIFIERS BY XY PLANE (KMODG/KMODF/KMODP=GROUP FLUX/TOTAL FLUX/POWER)
     KMODG     10
        0          0          0          0          0          0          0          0          0          0
     KMODF     10
        1          0          0          0          0          0          0          0          0          0
     KMODP     10
        1          0          0          0          0          1          0          0          0          0
```

```
LAYER  1 FOR XY PLANES   1   2   3   4   5   6

ZONE NUMBER BY MESH INTERVAL


    2 2 2 2 2 2 2 2 2 2
    2 2 2 2 2 2 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 2 2 2 2
    1 1 1 1 1 1 2 2 2 2
    1 1 1 1 1 1 2 2 2 2
    1 1 1 1 1 1 2 2 2 2
    1 1 1 1 1 1 2 2 2 2
    1 1 1 1 1 1 2 2 2 2
Y

A
X
I
S

 X AXIS
```

MATERIAL NUMBER BY MESH INTERVAL

```
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    11111111111112121212
    11111111111112121212
    11111111111112121212
    11111111111112121212
    11111111111112121212
    11111111111112121212
Y

A
X
I
S

 X AXIS
```

```
LAYER  2 FOR XY PLANES    7    8    9   10

ZONE NUMBER BY MESH INTERVAL


     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
     2 2 2 2 2 2 2 2 2 2
Y

A
X
I
S

 X AXIS
```

MATERIAL NUMBER BY MESH INTERVAL

```
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
    12121212121212121212
Y

A
X
I
S

 X AXIS
```

TIME = .000 DAYS

	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	SIGF	SIGA	NUSIGF	SIGTR	GXG	G-1XG	G-2XG	. . .
MAT 1	.10010+00	.23289-00	.28144-00	.63357+01	.60052+01	.00000		
MAT 2	.17244+01	.18487+01	.51159+01	.66936+01	.47659+01	.00000		
MAT 3	.69707-00	.97364-00	.21036+01	.65400+01	.54921+01	.00000		
MAT 4	.17371+01	.18916+01	.52827+01	.74529+01	.54350+01	.00000		
MAT 5	.00000	.18033-00	.00000	.10694+02	.10392+02	.00000		
MAT 6	.00000	.83362-05	.00000	.26393+01	.24508+01	.00000		
MAT 7	.00000	.71361-03	.00000	.30902+01	.30005+01	.00000		
MAT 8	.00000	.59177-02	.00000	.25576+01	.25175+01	.00000		
MAT 9	.37218-01	.18952-00	.10533+00	.69490+01	.66472+01	.00000		
MAT 10	.00000	.67057-02	.00000	.26514+01	.25997+01	.00000		
MAT 11	.36295-02	.49997-02	.10646-01	.16662-00	.15596-00	.00000		
MAT 12	.14887-02	.76222-02	.42151-02	.29440-00	.28201-00	.00000		

GROUP 2	SIGF	SIGA	NUSIGF	SIGTR	GXG	G-1XG	G-2XG	. . .
MAT 1	.00000	.53219-00	.00000	.13158+02	.12626+02	.97561-01		
MAT 2	.22842+01	.32441+01	.64950+01	.13918+02	.10677+02	.79040-01		
MAT 3	.20518-01	.15846+01	.57755-01	.13945+02	.12361+02	.74674-01		
MAT 4	.25085+01	.28757+01	.74430+01	.11889+02	.90131+01	.12634-00		
MAT 5	.00000	.45042-00	.00000	.14217+02	.13767+02	.12081+00		
MAT 6	.00000	.45693-10	.00000	.44855+01	.44855+01	.18842-00		
MAT 7	.00000	.42342-02	.00000	.49846+01	.49803+01	.88955-01		
MAT 8	.00000	.21543-01	.00000	.48214+01	.47999+01	.34240-01		
MAT 9	.00000	.40450-00	.00000	.12209+02	.11804+02	.11234+00		
MAT 10	.00000	.12027-01	.00000	.44990+01	.44870+01	.45009-01		
MAT 11	.35563-02	.99055-02	.10390-01	.31123-00	.30132-00	.56616-02		
MAT 12	.00000	.16255-01	.00000	.51625-00	.50000-00	.47729-02		

TIME (MINUTES)	OUTER ITERATIONS	Z IT. PER OUT. IT.	IN. IT. PER OUT. IT.	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
.07	0	0	0	.00000000	.00000000	.00000000
.32	1	10	500	.00000000	.99731699-00	.99731699-00
.58	2	10	499	.00000000	.10238455+01	.10265999+01
.85	3	10	499	.00000000	.10250773+01	.10012031+01
1.12	4	10	494	.00000000	.10231226+01	.99809310-00
1.37	5	10	475	.00000000	.10222544+01	.99915139-00
1.61	6	10	436	.00000000	.10219192+01	.99967209-00
1.85	7	10	360	.00000000	.10217900+01	.99987357-00
2.05	8	[illegible]	248	.00000000	.10217462+01	.99995124-00
2.17	9	4	29	.00000000	.10217212+01	.99998140-00
2.26	10	2	29	.00000000	.10217192+01	.99999368-00

FINAL NEUTRON BALANCE TABLE

GROUP	FISSION SOURCE	IN SCATTER	OUT SCATTER	ABSORPTION	LEFT LEAKAGE	RIGHT LEAKAGE	BACK LEAKAGE	FRONT LEAKAGE	TOP LEAKAGE	BOTTOM LEAKAGE	TOTAL LEAKAGE
1	8.123+18	-1.787+12	3.760+18	4.056+18	0.000	1.022+17	1.022+17	0.000	1.022+17	0.000	3.065+17
2	1.070+17	3.760+18	2.[illegible]31+13	3.784+18	0.000	2.776+16	2.775+16	0.000	2.775+16	0.000	8.326+16
3	8.230+18	3.760+18	3.760+18	7.840+18	0.000	1.299+17	1.299+17	0.000	1.299+17	0.000	3.898+17

	X	AVG. X	Y	AVG. Y	Z	AVG. Z
1	-.0000	3.3333	-.0000	3.3333	-.0000	3.3333
2	6.6667	10.0000	6.6667	10.0000	6.6667	10.0000
3	13.3333	16.6667	13.3333	16.6667	13.3333	16.6667
4	20.0000	23.3333	20.0000	23.3333	20.0000	23.3333
5	26.6667	30.0000	26.6667	30.0000	26.6667	30.0000
6	33.3333	36.6667	33.3333	36.6667	33.3333	36.6667
7	40.0000	43.7500	40.0000	43.7500	40.0000	43.7500
8	47.5000	51.2500	47.5000	51.2500	47.5000	51.2500
9	55.0000	58.7500	55.0000	58.7500	55.0000	58.7500
10	62.5000	66.2500	62.5000	66.2500	62.5000	66.2500
11	70.0000	6.6667	70.0000	6.6667	70.0000	6.6667

TOTAL FLUX

K = 1 HEIGHT = .3333+01

	1	2	3	4	5	
1	.2025264+17	.1958898+17	.1828361+17	.1637930+17	.1393789+17	.3333333+01
2	.1958398+17	.1894677+17	.1768359+17	.1584098+17	.1347870+17	.1000000+02
3	.1828360+17	.1768359+17	.1650339+17	.1478185+17	.1257509+17	.1666667+02
4	.1637936+17	.1584095+17	.1478183+17	.1323669+17	.1125603+17	.2333333+02
5	.1393785+17	.1347865+17	.1257505+17	.1125600+17	.9563903+16	.3000000+02
6	.1103555+17	.1067105+17	.9953272+16	.8903951+16	.7554004+16	.3666667+02
7	.6206526+16	.6000899+16	.5595416+16	.5000379+16	.4226362+16	.4375000+02
8	.3037145+16	.2936199+16	.2736749+16	.2444101+16	.2064906+16	.5125000+02
9	.1417147+16	.1369887+16	.1276725+16	.1140441+16	.9657028+15	.5875000+02
10	.5114228+15	.4943585+15	.4607694+15	.4118201+15	.3496032+15	.6625000+02

	6	7	8	9	10	
1	.1103561+17	.6206572+16	.3037178+16	.1417167+16	.5114279+15	.3333333+01
2	.1067110+17	.6000949+16	.2936139+16	.1369904+16	.4943626+15	.1000000+02
3	.9953319+16	.5595451+16	.2736775+16	.1276740+16	.4607724+15	.1666667+02
4	.8903985+16	.5000495+16	.2444121+16	.1140453+16	.4118219+15	.2333333+02
5	.7554014+16	.4226377+16	.2064917+16	.9657104+15	.3496036+15	.3000000+02
6	.5942973+16	.3299350+16	.1608561+16	.7611350+15	.2779473+15	.3666667+02
7	.3269361+16	.1976670+16	.1070068+16	.5321539+15	.1992335+15	.4375000+02
8	.1508558+16	.1070067+16	.6272128+15	.3288005+15	.1268215+15	.5125000+02
9	.7011310+15	.5321522+15	.3288003+15	.1795757+15	.7095817+14	.5875000+02
10	.2779480+15	.1992356+15	.1268227+15	.7095691+14	.2849680+14	.6625000+02

MAXIMUM TOTAL FLUX = .2025264+17 AT I = 1, J = 1, K = 1

POWER DENSITY (MW/LITER)

K = 1 HEIGHT = .3333+01

	1	2	3	4	5	
1	.2537932+01	.2454765+01	.2291161+01	.2052551+01	.1746587+01	.3333333+01
2	.2454766+01	.2374286+01	.2215991+01	.1985081+01	.1689045+01	.1000000+02
3	.2291161+01	.2215991+01	.2068193+01	.1852356+01	.1575809+01	.1666667+02
4	.2052548+01	.1985079+01	.1852354+01	.1658723+01	.1410511+01	.2333333+02
5	.1746582+01	.1689039+01	.1575804+01	.1410508+01	.1198460+01	.3000000+02
6	.1382860+01	.1337184+01	.1247238+01	.1115746+01	.9465789-00	.3666667+02
7	.2197482-00	.2124801-00	.1981544-00	.1771530-00	.1498646-00	.4375000+02
8	.1083564+00	.1047559+00	.9765568-01	.8723755-01	.7374756-01	.5125000+02
9	.5068321-01	.4918827-01	.4584724-01	.4096187-01	.3470025-01	.5875000+02
10	.1674885-01	.1311604-01	.1688640-01	.1509495-01	.1281875-01	.6625000+02

	6	7	8	9	10	
1	.1382867+01	.2197400-00	.1093579+00	.5086377-01	.1874096-01	.3333333+01
2	.1337190+01	.2124815-00	.1047578+00	.4918856-01	.1811612-01	.1000000+02
3	.1247244+01	.1981555-00	.9765661-01	.4584762-01	.1688644-01	.1666667+02
4	.1115750+01	.1771536-00	.8723802-01	.4096193-01	.1509493-01	.2333333+02
5	.9465302-00	.1498646-00	.7374772-01	.3470035-01	.1281868-01	.3000000+02
6	.7446905-00	.1161735+00	.5752128-01	.2737195-01	.1019794-01	.3666667+02
7	.1161737+00	.7056822-01	.3836673-01	.1916853-01	.7318773-02	.4375000+02
8	.5752128-01	.3936074-01	.2254534-01	.1166823-01	.4666658-02	.5125000+02
9	.2737194-01	.1916658-01	.1186625-01	.6503251-02	.2619756-02	.5875000+02
10	.1019803-01	.7318962-02	.4666728-02	.2619793-02	.1071525-02	.6625000+02

POWER DENSITY (MWT/LITER)

K = 6 HEIGHT = .3667+02

	1	2	3	4	5	
1	.1382849+01	.1337165+01	.1247217+01	.1115725+01	.9465589-00	.3333333+01
2	.1337175+01	.1292932+01	.1205971+01	.1078778+01	.9151547-00	.1000000+02
3	.1247233+01	.1205976+01	.1124751+01	.1006015+01	.8532946-00	.1666667+02
4	.1115744+01	.1078782+01	.1006020+01	.8996423-00	.7628246-00	.2333333+02
5	.9465791-00	.9151673-00	.8533018-00	.7628277-00	.6464123-00	.3000000+02
6	.7446918-00	.7199287-00	.6711332-00	.5997010-00	.5076066-00	.3666667+02
7	.1161744+00	.1123674+00	.1046836+00	.9350222-01	.7898731-01	.4375000+02
8	.5752178-01	.5560139-01	.5181498-01	.4626589-01	.3910176-01	.5125000+02
9	.2737226-01	.2645751-01	.2465642-01	.2202757-01	.1867054-01	.5875000+02
10	.1019818-01	.9857583-02	.9188064-02	.8214766-02	.6982455-02	.6625000+02

	6	7	8	9	10	
1	.7446711-00	.1161699+00	.5751946-01	.2737107-01	.1019774-01	.3333333+01
2	.7199136-00	.1123040+00	.5559954-01	.2645653-01	.9857214-02	.1000000+02
3	.6711230-00	.1046811+00	.5181357-01	.2465564-01	.9187768-02	.1666667+02
4	.5996947-00	.9350039-01	.4626484-01	.2202697-01	.8214535-02	.2333333+02
5	.5076033-00	.7398612-01	.3910104-01	.1967010-01	.6982281-02	.3000000+02
6	.3974324-00	.6114349-01	.3053810-01	.1476324-01	.5569933-02	.3666667+02
7	.6114395-01	.3724161-01	.2051549-01	.1041216-01	.4023018-02	.4375000+02
8	.3553848-01	.2051561-01	.1221583-01	.6519954-02	.2589668-02	.5125000+02
9	.1476352-01	.1041231-01	.6520014-02	.3614153-02	.1468320-02	.5875000+02
10	.5570152-02	[illegible]	.2589909-02	.1468332-02	.6049533-03	.6625000+02

MAXIMUM POWER DENSITY = .2537932+01 AT I = 1, J = 1, K = 1

ACTIVITY 1 MATERIAL 2 CROSS SECTION POSITION 1

K = 1 HEIGHT = .3333+01

	1	2	3	4	5	
1	.3858435+17	.3731937+17	.3483692+17	.3119960+17	.2654147+17	.3333333+01
2	.3731939+17	.3609531+17	.3368735+17	.3017378+17	.2566667+17	.1000000+02
3	.3483092+17	.3368734+17	.3143767+17	.2815513+17	.2394497+17	.1666667+02
4	.3119977+17	.3017375+17	.2815511+17	.2520930+17	.2143101+17	.2333333+02
5	.2654139+17	.2566666+17	.2394490+17	.2143096+17	.1820426+17	.3000000+02
6	.2099755+17	.2030373+17	.1893728+17	.1693915+17	.1436730+17	.3666667+02
7	.1177769+17	.1138735+17	.1061755+17	.9487700+16	.8017599+16	.4375000+02
8	.5754384+16	.5562951+16	.5185053+16	.4630537+16	.3911465+16	.5125000+02
9	.2681493+16	.2592650+16	.2415726+16	.2157767+16	.1826993+16	.5875000+02
10	.9635753+15	.9314127+15	.8681199+15	.7758695+15	.6586057+15	.6625000+02
	6	7	8	9	10	
1	.2099766+17	.1177777+17	.5754447+16	.2681531+16	.9635858+15	.3333333+01
2	.2030363+17	.1138747+17	.5562958+16	.2592084+16	.9314273+15	.1000000+02
3	.1893737+17	.1061762+17	.5185103+16	.2415756+16	.8681266+15	.1666667+02
4	.1693922+17	.9487751+16	.4630377+16	.2157791+16	.7758738+15	.2333333+02
5	.1436733+17	.8017624+16	.3911489+16	.1827009+16	.6586074+15	.3000000+02
6	.1129505+17	.6199469+16	.3046244+16	.1439731+16	.5235439+15	.3666667+02
7	.6199464+16	.3744639+16	.2025419+16	.1006281+16	.3751811+15	.4375000+02
8	.3046233+16	.2025415+16	.1196524+16	.6216490+15	.2387341+15	.5125000+02
9	.1439722+16	.1006277+16	.6216481+15	.3391628+15	.1334796+15	.5875000+02
10	.5235444+15	.3751827+15	.2387360+15	.1334809+15	.5339326+14	.6625000+02

MAXIMUM ACTIVITY = .3858435+17 AT I = 1, J = 1, K = 1

3DB SAMPLE CASE (10X10X10, 2 ZONE, 2 GROUP)

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

	MATERIAL	ATOMIC WT.	ZONE 1 .540+02 LITERS	ZONE 2 .279+03 LITERS
1	U238	238.050	2.024+02	0.000
2	PU239	239.050	4.064+01	0.000
3	PU240	240.050	2.551+00	0.000
4	PU241	241.060	0.000	0.000
5	FIS PR	1.000	0.000	0.000
6	C	12.011	2.553+01	0.000
7	NA	22.990	1.466+01	0.000
8	FE	55.847	7.715+01	0.000
9	U238	238.050	0.000	4.411+03
10	FE	55.847	0.000	1.604+02

BURNUP DATA

BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	LAMBDA (DAYS-1)	NBR	DECAY	SOURCE ISOTOPE FOR CAPTURE		FISSION						
1	1	U235	.000	1	0	0	0	0	0	0	0	0	0	0
2	2	PU239	.000	2	0	1	6	0	0	0	0	0	0	0
3	3	PU240	.000	1	0	2	0	0	0	0	0	0	0	0
4	4	PU241	.790-07	2	0	3	0	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	0

ZONE 1

BURNABLE ISOTOPE NO.	MATERIAL NO.	NAME	ATOM DENSITY	FISSION RATE	ABSORPTION RATE	SIGMA FISSION	SIGMA ABSORPTION
1	1	U238	8.000-03	3.862+17	1.867+18	6.802-02	3.288-01
2	2	PU239	1.600-03	2.162+18	2.606+18	1.904+00	2.295+00
3	3	PU240	1.000-04	3.408+16	8.297+16	4.803-01	1.169+00
4	4	PU241	0.000	0.000	0.000	1.984+00	2.207+00
5	5	FIS P	0.000	0.000	0.000	0.000	2.669-01
6	9	U236	0.000	0.000	0.000	2.529-02	2.584-01

ZONE FLUX(N/CM+2*SEC) = 1.1089+16
ZONE POWER(MW) = 8.8935+01
ZONE VOLUME(LITERS) = 6.4000+01

ZONE 2

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	6.968-02	3.238-01
2	2	PU239	0.000	0.000	0.000	1.894+00	2.272+00
3	3	PU240	0.000	0.000	0.000	4.915-01	1.159+00
4	4	PU241	0.000	0.000	0.000	1.972+00	2.191+00
5	5	FIS PR	0.000	0.000	0.000	0.000	2.624-01
6	9	U238	4.000-02	3.212+17	3.160+18	2.591-02	2.548-01

ZONE FLUX(N/CM+2*SEC) = 1.1110+15
ZONE POWER(MW) = 1.1065+01
ZONE VOLUME(LITERS) = 2.7900+02

BREEDING RATIO = 1.6764

T I M E = 50.000 D A Y S

	MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	11	0	.00000000
2	11	1	.78736469-02
3	11	2	.15265894-02
4	11	3	.12324215-03
5	11	4	.35440069-05
6	11	5	.17183968-03
7	11	6	.20000000-01
8	11	7	.59999999-02
9	11	8	.13000000-01
10	12	0	.00000000
11	12	9	.39950580-01
12	12	2	.44153018-04
13	12	10	.61999999-02

TIME (MINUTES)	OUTER ITERATIONS	Z IT. PER OUT. IT.	IN. IT. PER OUT. IT.	EIGENVALUE SLOPE	EIGENVALUE	LAMBDA
2.32	0	0	0	.00000000	.10217192+01	.00000000
2.58	1	10	473	.00000000	.10021944+01	.10021944+01
2.85	2	10	485	.00000000	.10001473+01	.99795745-00
3.09	3	10	424	.00000000	.99970737-00	.99956007-00
3.30	4	9	326	.00000000	.99962035-00	.99991294-00
3.50	5	8	236	.00000000	.99959780-00	.99997743-00
3.63	6	4	78	.00000000	.99958906-00	.99999125-00

ACTIVITY 1 MATERIAL 2 CROSS SECTION POSITION 1

K = 1 HEIGHT = .3333+01

	1	2	3	4	5	
1	.3934142+17	.3805747+17	.3553108+17	.3184330+17	.2710970+17	.3333333+01
2	.3805736+17	.3681475+17	.3436971+17	.3080080+17	.2622021+17	.1000000+02
3	.3553088+17	.3436963+17	.3208463+17	.2874939+17	.2446928+17	.1666667+02
4	.3184306+17	.3080067+17	.2874934+17	.2575477+17	.2191186+17	.2333333+02
5	.2710939+17	.2622000+17	.2446915+17	.2191177+17	.1862758+17	.3000000+02
6	.2147084+17	.2076470+17	.1937366+17	.1733894+17	.1471872+17	.3666667+02
7	.1209928+17	.1170023+17	.1091311+17	.9757607+16	.8253805+16	.4375000+02
8	.5957160+16	.5759943+16	.5370736+16	.4799320+16	.4058829+16	.5125000+02
9	.2797421+16	.2704613+16	.2521649+16	.2253988+16	.1910812+16	.5875000+02
10	.1011229+16	.9776711+15	.9116130+15	.8153486+15	.6929922+15	.6625000+02
	6	7	8	9	10	
1	.2147126+17	.1209960+17	.5957353+16	.2797534+16	.1011267+16	.3333333+01
2	.2076503+17	.1170050+17	.5760107+16	.2704711+16	.9777041+15	.1000000+02
3	.1937392+17	.1091334+17	.5370878+16	.2521735+16	.9116414+15	.1666667+02
4	.1733915+17	.9757801+16	.4799440+16	.2254063+16	.8153726+15	.2333333+02
5	.1471885+17	.8253947+16	.4058922+16	.1910872+16	.6930114+15	.3000000+02
6	.1158619+17	.6393867+16	.3167761+16	.1509076+16	.5520576+15	.3666667+02
7	.6393806+16	.3833857+16	.2116290+16	.1059058+16	.3970526+15	.4375000+02
8	.3167708+16	.2116273+16	.1247671+16	.6578160+15	.2538669+15	.5125000+02
9	.1509036+16	.1059036+16	.6578065+15	.3608621+15	.1426236+15	.5875000+02
10	.5520443+15	.3970442+15	.2538624+15	.1426229+15	.5727131+14	.6625000+02

MAXIMUM ACTIVITY = .3934142+17 AT I = 1, J = 1, K = 1

3DB SAMPLE CASE (10X10X10, 2 ZONE, 2 GROUP)

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

	MATERIAL	ATOMIC WT.	ZONE 1 .640+02 LITERS	ZONE 2 .279+03 LITERS
1	U238	238.050	1.992+02	0.000
2	PU239	239.050	3.878+01	4.889+00
3	PU240	240.050	3.144+00	0.000
4	PU241	241.060	9.078-02	0.000
5	FIS PR	1.000	1.826-02	0.000
6	C	12.011	2.553+01	0.000
7	NA	22.990	1.460+01	0.000
8	FE	55.847	7.715+01	0.000
9	U238	238.050	0.000	4.405+03
10	FE	55.847	0.000	1.604+02

APPENDIX E

SOURCE DECK LISTING

```
-IL PDP   INCL                                                              3DB 0001
ABC*   FCOPY                                                                3DB 0002
       COMMON      NINP,     NOUT, NSORCE, NSCRAT, NFLUX1,    NCXS,    NFO, 3DB 0003
     1             NMO,      NF2,     NS2,    NCR1,   NDUM,  NTEMP,    ALA, 3DB 0004
     2             B07,      CNT,     CVT,     DAY,   DELT, E0(51), E1(51), 3DB 0005
     3          E2(51), E3(51), E4(51), E5(51), E6(51), E7(51), E8(51),    3DB 0006
     4          E9(51),E10(51),E11(51),    E01,    E02,    E03,     EQ,    3DB 0007
     5             EVP,     EVPP,     FEF,    GBAR,    GLH,   IGEP,    IGP, 3DB 0008
     6             IGV,      IHA,     IHF,     IHS,     II,   IMJM,     IP, 3DB 0009
     7           ITEMP,   ITEMP1,  ITEMP2,     ITL,  ITLMT,    IZP,     JP, 3DB 0010
     8              KP,    KPAGE,     LAP,    LAPP,    LAR,     LC,    LLC, 3DB 0011
     9              ML,     NCON,   NGOTO,   NINIT,   ORFP,    POD,    P02, 3DB 0012
     1            PBAR,     SBAR,     SK7,     T06,     T7,    T11,   TEMP, 3DB 0013
     2           TEMP1,    TEMP2,   TEMP3,   TEMP4,     TI,    TSD,    V11  3DB 0014
       COMMON   ID(11),     MAXT,     A02,     I04,    S02,    IGM,   NXCM, 3DB 0015
     1             IHT,      M07,     M08,     D05,    I07,    G07,    S04, 3DB 0016
     2             IGE,      IZM,    NLAY,      MT,    M01,    MCR,     IM, 3DB 0017
     3              JM,       KM,      IZ,      JZ,     KZ,    B01,    B02, 3DB 0018
     4             B03,      B04,     B05,     B06,   NACT,   NPRT,   NPUN, 3DB 0019
     5             NP1,      NP2,     NP3,      EV,    EVM,    S03,   BUCK, 3DB 0020
     6             LAL,      LAH,     EPS,    EPSA,    G06,   EPS2,    ORF, 3DB 0021
     7             S01                                                      3DB 0022
       COMMON     LATW,    LHOLN,   LALAM,     LC0,    LN0,    LN2,    LA0, 3DB 0023
     1             LA1,      LF0,     LF2,     LI0,    LI1,    LI2,    LI3, 3DB 0024
     2             LK6,      LK7,     LM0,     LM2,    LX0,    LX1,   LIX2, 3DB 0025
     3             LX3,      LX4,     LX5,     LS2,    LV0,    LV7,    LY0, 3DB 0026
     4             LY1,     LIY2,     LY3,     LY4,    LY5,   LCXS,   LVOL, 3DB 0027
     5           LMASS,    LMATN,    LNBR,     LLD,   LLCN,   LLFN,  LPHIB, 3DB 0028
     6            LAXS,     LFXS,  LMASSP,    LCXR,   LCXT,    LHA,    LPA, 3DB 0029
     7            LGAM,      LZ0,     LZ1,    LIZ2,    LZ3,    LZ4,    LZ5, 3DB 0030
     8           LDUM1,  LIDUM1,    LDUM2,  LIDUM2,   LLYN,    LA2,    LEE, 3DB 0031
     2          LIGMOD,  LKMODG,  LKMODP,  LKMODF, LKMODR,    LMA,    LNX  3DB 0032
       INTEGER     A02,      B01,     B02,     B03,    B04,    B07,    CNT, 3DB 0033
     1             CVT,      D05,     G07,     P02,    S02,    S04,    T06, 3DB 0034
     2             B05,      B06                                            3DB 0035
       REAL        LAH,      LAL,     LAP,    LAPP,    LAR                  3DB 0036
       END                                                                  3DB 0037
```

```
-ITC FR5  CALC,CALC
C
C     * * * * *  DESCRIPTION OF SUBROUTINES  * * * * *
C
C     CALC           CONTROLS THE OPERATION OF THE CODE.
C
C     INP            CONTROLS THE READING AND PRINTING OF ALL INPUT DATA
C                    AND COMPUTES THE VARIABLE DIMENSION POINTERS.
C
C     ERRO2          PRINTS ERROR MESSAGES.
C
C     SWITCH         SWITCHS DRUM DESIGNATIONS.
C
C     DRUMR          READS/WRITES DATA FROM/TO DRUM.
C
C     RECS           READS CROSS SECTIONS FROM CARDS, PERFORMS ADJOINT
C                    REVERSALS IF REQUIRED, AND WRITES CROSS SECTIONS
C                    TO DRUM.
C
C     FXINP          READS INPUT FLUXES AND EXT. SOURCE (IF ANY) AND
C                    WRITES THE DATA TO DRUM.
C
C     REAG2          READS FLOATING POINT DATA IN GENERALIZED FORMAT.
C
C     REAI2          READS INTEGER DATA IN GENERALIZED FORMAT.
C
C     MAPR           PRODUCES A PICTURE BY ZONE AND MATERIAL FOR EACH
C                    MATERIAL LAYER.
C
C     INIT1          PERFORMS ADJOINT REVERSALS AND MIXES CROSS SECTIONS.
C
C     INIT2          MODIFIES GEOMETRY AND CALCULATES AREAS AND VOLUMES.
C
C     INIT3          COMPUTES THE FISSION SOURCE.
C
C     CLEAR          SETS AN ARRAY OF A GIVEN LENGTH EQUAL TO A GIVEN
C                    CONSTANT.
C
C     FISCAL         COMPUTES FISSION SUMS AND PERFORMS NORMALIZATION.
C
C     MONPR          MONITOR PRINT--PRINTS ITERATION NUMBER, EIGENVALUE,
C                    LAMBDA, ETC. AFTER EACH OUTER ITERATION.
C
C     OUTER          CONTROLS PROGRAM DURING EACH OUTER ITERATION.
C
C     BALANC         DOES A GLOBAL BALANCE FOR SPECIFIED GROUP.
C
C     INNER1         CALCULATES COEFFICIENTS FOR THE FLUX EQUATION FOR
C                    X-Y-Z AND R-THETA-Z GEOMETRIES.
C
C     INNERT         CALCULATES COEFFICIENTS FOR THE FLUX EQUATION FOR
C                    HEX-Z GEOMETRY.
C
C     INNER          CALCULATES THE FLUX IN SPECIFIED GROUP AND PLANE
C                    USING COLUMN LINE INVERSION.
C
C     INNER2         CALCULATES THE FLUX IN SPECIFIED GROUP AND PLANE
C                    USING ROW LINE INVERSION.
C
C     IFLUXN         NORMALIZES THE FLUXES BY X-Y PLANE.
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C                                                                       3DB 0098
C     CNNP          PERFORMS CONVERGENCE TESTS AND COMPUTES A NEW       3DB 0099
C                   EIGENVALUE FOR SEARCH OPTIONS.                      3DB 0100
C                                                                       3DB 0101
C     FINPR         FINAL PRINT--PRINTS GROUP FLUXES, TOTAL FLUX, AND   3DB 0102
C                   POWER DENSITIES AND COMPUTES AND PRINTS REACTION    3DB 0103
C                   RATES.                                              3DB 0104
C                                                                       3DB 0105
C     NBAL          COMPUTES AND PRINTS BALANCE TABLES.                 3DB 0106
C                                                                       3DB 0107
C     PRT           PRINTS ANY (IM,JM) ARRAY.                           3DB 0108
C                                                                       3DB 0109
C     GRAM          CALCULATES AND PRINTS MATERIAL INVENTORIES BY ZONE. 3DB 0110
C                                                                       3DB 0111
C     INPB          READS AND PRINTS THE INPUT BURNUP DATA.             3DB 0112
C                                                                       3DB 0113
C     AVERAG        CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS      3DB 0114
C                   SECTIONS, ABSORPTION CROSS SECTIONS, AND THE        3DB 0115
C                   BREEDING RATIO.                                     3DB 0116
C                                                                       3DB 0117
C     MARCH         CALCULATES THE TIME DEPEND. ISOTOPIC CONCENTRATIONS.3DB 0118
C                                                                       3DB 0119
C     SHUF          SHUFFLES MIXTURES.                                  3DB 0120
C                                                                       3DB 0121
C     * * * * *  INTERNAL VARIABLES  * * * * *                          3DB 0122
C                                                                       3DB 0123
C     NINP          INPUT UNIT                                          3DB 0124
C     NOUT          OUTPUT UNIT                                         3DB 0125
C     NSORCE        EXTERNAL SOURCE DRUM UNIT                           3DB 0126
C     NSCRAT        SCRATCH DRUM UNIT FOR LARGE DATA BLOCKS             3DB 0127
C     NFLUX1        FLUX DRUM UNIT                                      3DB 0128
C     NCXS          FLUX CONSTANTS DRUM UNIT                            3DB 0129
C     NFO           OLD FISSION SOURCE DRUM UNIT                        3DB 0130
C     NMO           ZONE NUMBERS BY MESH INTERVAL DRUM UNIT             3DB 0131
C     NF2           NEW FISSION SOURCE DRUM UNIT                        3DB 0132
C     NS2           GROUP SOURCE DRUM UNIT                              3DB 0133
C     NCR1          CROSS SECTION DRUM UNIT                             3DB 0134
C     NDUM          SCRATCH DRUM UNIT FOR SMALL DATA BLOCKS             3DB 0135
C     NTEMP         SCRATCH DRUM UNIT FOR SMALL DATA BLOCKS             3DB 0136
C     ALA           LAMBDA                                              3DB 0137
C     B07           USED FOR INTERNAL COMPUTATION IN FISCAL AND INIT    3DB 0138
C     CNT           CONVERGENCE TRIGGER FOR LAMBDA                      3DB 0139
C     CVT           CONVERGENCE TRIGGER                                 3DB 0140
C     DAY           BURNUP TIME IN DAYS                                 3DB 0141
C     DELT          LENGTH (DAYS) OF TIME STEP--IF NEG, SHUFFLE MIXES   3DB 0142
C     E0(IGP)       FISSION RATE                                        3DB 0143
C     E1(IGP)       FISSION SOURCE                                      3DB 0144
C     E2(IGP)       IN-SCATTER (AND EXTRANEOUS SOURCE)                  3DB 0145
C     E3(IGP)       OUT-SCATTER                                         3DB 0146
C     E4(IGP)       ABSORPTIONS                                         3DB 0147
C     E5(IGP)       LEFT LEAKAGE                                        3DB 0148
C     E6(IGP)       RIGHT LEAKAGE                                       3DB 0149
C     E7(IGP)       BACK LEAKAGE                                        3DB 0150
C     E8(IGP)       FRONT LEAKAGE                                       3DB 0151
C     E9(IGP)       TOTAL LEAKAGE                                       3DB 0152
C     E10(IGP)      TOP LEAKAGE                                         3DB 0153
C     E11(IGP)      BOTTOM LEAKAGE                                      3DB 0154
C     E01           TEMPORARY                                           3DB 0155
C     E02           TEMPORARY                                           3DB 0156
C     E03           TEMPORARY                                           3DB 0157
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C      EQ           TEMPORARY FOR CNNP                                  3DB 0158
C      EVP          PREVIOUS EIGENVALUE                                 3DB 0159
C      EVPP         EIGENVALUE FOR TWO ITERATIONS BACK                  3DB 0160
C      FEF          ENERGY RELEASED PER FISSION (=215 MEV)              3DB 0161
C      GBAR         GROUP INDICATOR FOR TAPE MOTION IN OUTER            3DB 0162
C      GLH          MAXIMUM TIME IN SECONDS                             3DB 0163
C      IGEP         IGE + 1                                             3DB 0164
C      IGP          IGM + 1                                             3DB 0165
C      IGV          GROUP INDICATOR FOR INNER AND OUTER                 3DB 0166
C      IHA          POSITION OF ABSORPTION CROSS SECTION                3DB 0167
C      IHF          POSITION OF FISSION CROSS SECTION                   3DB 0168
C      IHS          POSITION OF SIGMA SELF SCATTER                      3DB 0169
C      II           INNER ITERATION COUNT FOR A SINGLE GROUP            3DB 0170
C      IMJM         IM*JM                                               3DB 0171
C      IP           IM + 1                                              3DB 0172
C      ITEMP        TEMPORARY                                           3DB 0173
C      ITEMP1       TEMPORARY                                           3DB 0174
C      ITEMP2       TEMPORARY                                           3DB 0175
C      ITL          CROSS SECTION TABLE LENGTH                          3DB 0176
C      ITLMT        ITL*MT                                              3DB 0177
C      IZP          IZM + 1                                             3DB 0178
C      JP           JM + 1                                              3DB 0179
C      KP           KM + 1                                              3DB 0180
C      KPAGE        PAGE COUNTER FOR MONITOR PRINT                      3DB 0181
C      LAP          LAMBDA FOR PREVIOUS EIGENVALUE                      3DB 0182
C      LAPP         LAMBDA FOR TWO ITERATIONS BACK                      3DB 0183
C      LAR          LAMBDA FOR PREVIOUS ITERATION                       3DB 0184
C      LC           LOOP COUNT  (TOTAL II IN A SINGLE OUTER ITERATION)  3DB 0185
C      LLC          Z ITERATION LOOP COUNT                              3DB 0186
C      ML           ABSOLUTE VALUE OF MCR                               3DB 0187
C      NCON         NEG/ZERO/POS=TAKE TIME STEP OF DELT/END OF PROBLEM/ 3DB 0188
C                   TAKE TIME STEP OF DELT AND READ BURNUP DATA         3DB 0189
C      NGOTO        TEMPORARY                                           3DB 0190
C      NINIT        TEMPORARY                                           3DB 0191
C      ORFP         ORF FOR 1 - LAMBDA LESS THAN 10*EPS                 3DB 0192
C      POD          PARAMETER OSCILLATION DAMPER (= 1.0)                3DB 0193
C      PO2          OUTER ITERATION COUNT                               3DB 0194
C      PBAR         TEMPORARY                                           3DB 0195
C      SBAR         TEMPORARY                                           3DB 0196
C      SK7          SUM OF K7 OVER ALL GROUPS                           3DB 0197
C      T06          0/1=NOT DELTA/DELTA CALCULATION                     3DB 0198
C      T7           ALPHA/VELOCITY                                      3DB 0199
C      T11          PREVIOUS FISSION TOTAL                              3DB 0200
C      TEMP         TEMPORARY                                           3DB 0201
C      TEMP1        TEMPORARY                                           3DB 0202
C      TEMP2        TEMPORARY                                           3DB 0203
C      TEMP3        TEMPORARY                                           3DB 0204
C      TEMP4        TEMPORARY                                           3DB 0205
C      TI           TIME                                                3DB 0206
C      TSD          (MW-SEC)/(FISSIONS)                                 3DB 0207
C      V11          TOTAL SOURCE FOR THE GROUP                          3DB 0208
C                                                                       3DB 0209
C      * * * * *  INPUT VARIABLES (CARDS 1-5)  * * * * *                3DB 0210
C                                                                       3DB 0211
C      ID(11)       IDENTIFICATION CARD                                 3DB 0212
C      MAXT         MAX TIME (MINUTES)                                  3DB 0213
C      A02          0/1=REGULAR/ADJOINT CALCULATION                     3DB 0214
C      I04          EIGENVALUE TYPE  (0/1/2/3/4/5=SOURCE/ALPHA/         3DB 0215
C                   CONCENTRATION/DELTA/BUCKLING)                       3DB 0216
C      S02          PARAMETRIC EIGENVALUE TYPE  (0/1/2=NONE/KEFF/ALPHA) 3DB 0217
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C       IGM            NUMBER OF GROUPS                                      3DB 0218
C       NXCM           NUMBER OF DOWNSCATTERING TERMS                        3DB 0219
C       IHT            POSITION OF SIGMA TRANSPORT IN CROSS SECTION TABLE    3DB 0220
C       M07            FLUX GUESS (0/1/2/3/4/5/6=NONE/PHI(X)*PHI(Y)*PHI(Z)/3DB 0221
C                      PHI(X,Y,Z)/PHI(E,X,Y,Z) FROM CARDS/PHI(X,Y,Z)/        3DB 0222
C                      PHI(E,X,Y,Z) FROM TAPE/PHI(E,X,Y) FROM TAPE*PHI(Z)    3DB 0223
C                      FROM CARDS)                                           3DB 0224
C       M08            EXTERNAL SOURCE  (SAME OPTIONS AS M07)                3DB 0225
C       D05            MAXIMUM NUMBER OF OUTER ITERATIONS                    3DB 0226
C       I07            MAXIMUM NUMBER OF Z ITERATIONS PER GROUP              3DB 0227
C       G07            MAXIMUM NUMBER OF INNER (XY) ITERATIONS PER Z         3DB 0228
C                      ITERATION                                             3DB 0229
C       S04            XY INVERSION DIRECTION  (0/1/2/3=CODE CHOOSES/        3DB 0230
C                      ALTERNATE/X/Y)                                        3DB 0231
C       IGE            GEOMETRY  (0/1/2=X-Y-Z/R-THETA-Z/TRIANGULAR-Z)        3DB 0232
C       IZM            NUMBER OF MATERIAL ZONES                              3DB 0233
C       NLAY           NUMBER OF MATERIAL LAYERS                             3DB 0234
C       MT             TOTAL NUMBER OF MATERIALS INCLUDING MIXES             3DB 0235
C       M01            NUMBER OF MIXTURE SPECIFICATIONS                      3DB 0236
C       MCR            NUMBER OF INPUT CROSS SECTION MATERIALS  (NEG/        3DB 0237
C                      POS=FROM TAPE/CARDS)                                  3DB 0238
C       IM             NUMBER OF INTERVALS IN THE X DIRECTION                3DB 0239
C       JM             NUMBER IF INTERVALS IN THE Y DIRECTION                3DB 0240
C       KM             NUMBER OF INTERVALS IN THE Z DIRECTION                3DB 0241
C       IZ             NUMBER OF ZONES IN THE X DIRECTION (DELTA OPT. ONLY)3DB 0242
C       JZ             NUMBER OF ZONES IN THE Y DIRECTION (DELTA OPT. ONLY)3DB 0243
C       KZ             NUMBER OF ZONES IN THE Z DIRECTION (DELTA OPT. ONLY)3DB 0244
C       B01            LEFT   BOUNDARY CONDITION  (0/1=VACUUM/REFLECTIVE)    3DB 0245
C       B02            RIGHT  BOUNDARY CONDITION  (0/1=VACUUM/REFLECTIVE)    3DB 0246
C       B03            BACK   BOUNDARY CONDITION  (0/1=VACUUM/REFLECTIVE)    3DB 0247
C       B04            FRONT  BOUNDARY CONDITION  (0/1=VACUUM/REFLECTIVE)    3DB 0248
C       B05            TOP    BOUNDARY CONDITION  (0/1=VACUUM/REFLECTIVE)    3DB 0249
C       B06            BOTTOM BOUNDARY CONDITION  (0/1=VACUUM/REFLECTIVE)    3DB 0250
C       NACT           NUMBER OF ACTIVITY TRAVERSES                          3DB 0251
C       NPRT           PRINT OPTION  (0/1=MINI/MAXI)                         3DB 0252
C       NPUN           FLUX OUTPUT OPTION  (0/1/2/3/4=NONE/PHI(X,Y,Z)/       3DB 0253
C                      PHI(E,X,Y,Z) TO CARDS/PHI(X,Y,Z)/PHI(E,X,Y,Z)         3DB 0254
C                      TO TAPE)                                              3DB 0255
C       NP1            RESERVED FOR FUTURE USE                               3DB 0256
C       NP2            RESERVED FOR FUTURE USE                               3DB 0257
C       NP3            RESERVED FOR FUTURE USE                               3DB 0258
C       EV             FIRST EIGENVALUE GUESS                                3DB 0259
C       EVM            EIGENVALUE MODIFIER                                   3DB 0260
C       S03            PARAMETRIC EIGENVALUE                                 3DB 0261
C       BUCK           BUCKLING                                              3DB 0262
C       LAL            LAMBDA LOWER                                          3DB 0263
C       LAH            LAMBDA UPPER                                          3DB 0264
C       EPS            EIGENVALUE CONVERGENCE CRITERION                      3DB 0265
C       EPSA           PARAMETER CONVERGENCE CRITERION                       3DB 0266
C       G06            INNER (XY) ITERATION CONVERGENCE CRITERION            3DB 0267
C       EPS2           Z ITERATION CONVERGENCE CRITERION                     3DB 0268
C       ORF            OVER-RELAXATION FACTOR                                3DB 0269
C       S01            NEG/POS=POWER (MWT)/NEUTRON SOURCE RATE               3DB 0270
C                                                                            3DB 0271
C       * * * * *  SUBSCRIPTED VARIABLES  * * * * *                          3DB 0272
C                                                                            3DB 0273
C       ATW(ML)        MATERIAL ATOMIC WEIGHT                                3DB 0274
C       HOLN(ML)       MATERIAL NAME                                         3DB 0275
C       ALAM(ML)       DECAY CONSTANT  (DAYS-1)                              3DB 0276
C       CO(ITL,MT)     CROSS SECTION ARRAY FOR CURRENT GROUP                 3DB 0277
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C       NO(IM,JM)       TOTAL FLUX  (OLD)                                         3DB 0278
C       N2(IM,JM)       TOTAL FLUX  (NEW)                                         3DB 0279
C       A0(IP)          AREA ELEMENT IN X DIRECTION                               3DB 0280
C       A1(IM)          AREA ELEMENT IN Y DIRECTION                               3DB 0281
C       F0(IM,JM)       FISSIONS  (OLD)                                           3DB 0282
C       F2(IM,JM)       FISSIONS  (NEW)                                           3DB 0283
C       I0(M01)         MIX NUMBER                                                3DB 0284
C       I1(M01)         MATERIAL NUMBER FOR MIX                                   3DB 0285
C       I2(M01)         MATERIAL DENSITY                                          3DB 0286
C       I3(M01)         MATERIAL DENSITIES FOR GRAM CALCULATION                   3DB 0287
C       K6(IGM)         FISSION SPECTRUM  (EFFECTIVE)                             3DB 0288
C       K7(IGM)         FISSION SPECTRUM  (INPUT)                                 3DB 0289
C       M0(IM,JM)       ZONE NUMBERS                                              3DB 0290
C       M2(IZM)         MATERIAL NUMBERS BY ZONE                                  3DB 0291
C       X0(IP)          INITIAL POINTS ALONG X AXIS                               3DB 0292
C       X1(IP)          CURRENT POINTS ALONG X AXIS                               3DB 0293
C       IX2(IM)         X ZONE NUMBERS  (DELTA CALCULATION ONLY)                  3DB 0294
C       X3(IZ)          X ZONE MODIFIERS  (DELTA CALCULATION ONLY)                3DB 0295
C       X4(IM)          AVERAGE X                                                 3DB 0296
C       X5(IM)          DELTA X                                                   3DB 0297
C       S2(IM,JM)       SOURCE                                                    3DB 0298
C       V0(IM,JM)       VOLUME ELEMENTS FOR XY PLANE                              3DB 0299
C       V7(IGM)         NEUTRON VELOCITIES                                        3DB 0300
C       Y0(JP)          INITIAL POINTS ALONG Y AXIS                               3DB 0301
C       Y1(JP)          CURRENT POINTS ALONG Y AXIS                               3DB 0302
C       IY2(JM)         Y ZONE NUMBERS  (DELTA CALCULATION ONLY)                  3DB 0303
C       Y3(JZ)          Y ZONE MODIFIERS  (DELTA CALCULATION ONLY)                3DB 0304
C       Y4(JM)          AVERAGE Y                                                 3DB 0305
C       Y5(JM)          DELTA Y                                                   3DB 0306
C       CXS(IM,JM,5)    CONSTANTS INVOLVING CROSS SECTIONS FOR FLUX CALC.         3DB 0307
C       VOL(IZM)        ZONE VOLUME (LITERS)                                      3DB 0308
C       MASS(ML,IZM)    MATERIAL INVENTORY IN EACH ZONE                           3DB 0309
C       MATN(ML)        MATERIAL NUMBER FOR BURNABLE ISOTOPES                     3DB 0310
C       NBR(ML)         0/1/2=NO EFFECT/FERTILE/FISSILE ISOTOPE                   3DB 0311
C       LD(ML)          SOURCE ISOTOPE FOR DECAY                                  3DB 0312
C       LCN(ML,2)       SOURCE ISOTOPES FOR CAPTURE                               3DB 0313
C       LFN(ML,7)       SOURCE ISOTOPES FOR FISSION                               3DB 0314
C       PHIB(IZM)       ZONE AVERAGED FLUX                                        3DB 0315
C       AXS(ML,IZM)     SPECTRUM AVERAGED ABSORPTION CROSS SECTION                3DB 0316
C       FXS(ML,IZM)     SPECTRUM AVERAGED FISSION CROSS SECTION                   3DB 0317
C       MASSP(ML,IZM)   MATERIAL INVENTORY IN EACH ZONE (PREVIOUS)                3DB 0318
C       CXR(JM)         CONSTANTS FOR RIGHT BOUNDARY                              3DB 0319
C       CXT(IM)         CONSTANTS FOR BACK BOUNDARY                               3DB 0320
C       HA(IM OR JM)    TEMP STORAGE FOR LINE INVERSION                           3DB 0321
C       PA(IM OR JM)    TEMP STORAGE FOR LINE INVERSION                           3DB 0322
C       GAM(IZM)        BUCKLING COEFFICIENTS                                     3DB 0323
C       Z0(KP)          INITIAL POINTS ALONG Z AXIS                               3DB 0324
C       Z1(KP)          CURRENT POINTS ALONG Z AXIS                               3DB 0325
C       IZ2(KM)         Z ZONE NUMBERS  (DELTA CALCULATION ONLY)                  3DB 0326
C       Z3(KZ)          Z ZONE MODIFIERS  (DELTA CALCULATION ONLY)                3DB 0327
C       Z4(KM)          AVERAGE Z                                                 3DB 0328
C       Z5(KM)          DELTA Z                                                   3DB 0329
C       DUM1(IM,JM)     DUMMY ARRAY                                               3DB 0330
C       IDUM1(IM,JM)    DUMMY ARRAY                                               3DB 0331
C       DUM2(IM,JM)     DUMMY ARRAY                                               3DB 0332
C       IDUM2(IM,JM)    DUMMY ARRAY                                               3DB 0333
C       LYN(KM)         LAYER NUMBER BY XY PLANE                                  3DB 0334
C       A2(IM)          AREA ELEMENT IN Z DIRECTION                               3DB 0335
C       EE(11,IGP)      SAME AS E1(IGP) TO E11(IGP) SUMMED OVER ALL PLANES        3DB 0336
C       IGMOD(IGM)      GROUP FLUX PRINT MODIFIERS BY GROUP                       3DB 0337
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C       KMODG(KM)      GROUP PRINT MODIFIERS BY XY PLANE
C       KMODP(KM)      POWER PRINT MODIFIERS
C       KMODF(KM)      TOTAL FLUX PRINT MODIFIERS
C       KMODR(KM)      REACTION RATE PRINT MODIFIERS
C       MA(NACT)       MATERIAL FOR REACTION RATE TRAVERSES
C       NX(NACT)       CROSS SECTION POSITION FOR REACTION RATE TRAVERSES
C
        INCLUDE ABC
        COMMON A(22000)
C       SET UP DRUM UNITS
        DIMENSION  JLPTAB(77)
        CALL SETDR( 1, 135000,215000,JLPTAB)
        CALL SETDR( 2, 350000,215000,JLPTAB(8))
        CALL SETDR( 3, 565000,215000,JLPTAB(15))
        CALL SETDR( 4, 780000,215000,JLPTAB(22))
        CALL SETDR(17, 995000, 45000,JLPTAB(29))
        CALL SETDR(18,1040000, 45000,JLPTAB(36))
        CALL SETDR(19,1085000, 45000,JLPTAB(43))
        CALL SETDR(20,1130000, 45000,JLPTAB(50))
        CALL SETDR(21,1175000, 45000,JLPTAB(57))
        CALL SETDR(22,1220000, 45000,JLPTAB(64))
        CALL SETDR(23,1265000, 45000,JLPTAB(71))
100     CALL INP
200     CALL INIT1(A(LK7),A(LV7),A(LI0),A(LI1),A(LI2),A(LC0),ITL,A(LM2),
       1         A(LGAM))
        CALL INIT2(A(LX0),A(LX1),A(LIX2),A(LX3),A(LX4),A(LX5),A(LY0),
       1         A(LY1),A(LIY2),A(LY3),A(LY4),A(LY5),A(LZ0),A(LZ1),
       2         A(LIZ2),A(LZ3),A(LZ4),A(LZ5),A(LA0),A(LA1),A(LA2),
       3         A(LV0),IM)
        CALL INIT3(A(LK6),A(LK7),A(LC0),ITL,A(LN0),IM,A(LF0),A(LLYN),
       1         A(LM0),A(LM2),A(LV0),A(LZ5))
        CALL FISCAL(A(LN0),A(LF0),A(LV0),A(LC0),A(LK6),A(LM0),A(LM2),
       1          ITL,MT,A(LLYN),A(LZ5))
C       CALL MONITOR PRINT
300     CALL MONPR
        GO TO (600,500,500,500), NGOTO
C       PERFORM AN OUTER ITERATION
500     CALL OUTER(A(LA0),A(LA1),A(LC0),A(LF0),A(LK6),A(LM0),A(LM2),
       1         A(LN0),A(LN2),A(LS2),A(LV0),A(LV7),A(LY5),A(LF2),
       2         ITL,MT,A(LCXS),IM,JM,A(LX5),A(LX4),A(LY4),A(LCXR),
       3         A(LCXT),A(LHA),A(LPA),A(LLYN),A(LZ5),A(LEE),A(LIDUM1),
       4         A(LIDUM2),A(LDUM1),A(LDUM2),A(LA2),A(LZ4))
C       PERFORM FISSION CALCULATION
        CALL FISCAL(A(LN0),A(LF0),A(LV0),A(LC0),A(LK6),A(LM0),A(LM2),
       1          ITL,MT,A(LLYN),A(LZ5))
C       PERFORM CONVERGENCE AND NEW PARAMETER CALCULATIONS
        CALL CNNP(A(LF2),A(LK6))
        GO TO (600,300,200), NGOTO
C       600/300/200=FINAL PRINT/MONITOR PRINT/SEARCH CALCULATION
600     CALL FINPR(A(LX1),A(LX4),A(LY1),A(LY4),A(LZ1),A(LZ4),A(LC0),
       1         ITL,A(LN2),IM,A(LLYN),A(LM0),A(LF2),A(LN0),A(LM2),
       2         A(LIGMOD),A(LKMODG),A(LKMODF),A(LKMODP),A(LMA),A(LNX),
       3         A(LS2),A(LKMODR),A(LEE))
        CALL GRAM(A(LMASS),A(LVOL),A(LATW),A(LHOLN),IM,JM,A(LM0),A(LM2),
       1        A(LV0),A(LI0),A(LI1),A(LI2),ML,A(LI3),A(LZ5),A(LLYN))
        CALL INPB(A(LMATN),A(LNBR),A(LLD),A(LLCN),A(LLFN),A(LALAM),
       1        A(LHOLN),ML,A(LI2))
        IF(NCON)  700,100,700
700     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,
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     2             A(LNBR),A(LZ5),A(LLYN))
      IF (DELT) 900,100,800
800   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,
     2             A(LI0),A(LI1),A(LI2),A(LM2))
      GO TO 200
900   CALL SHUF(A(LI0),A(LI1),A(LI2))
      GO TO 200
      END
```

```
-ITC FR5  INP,INP                                                      3DB 0407
      SUBROUTINE INP                                                   3DB 0408
      INCLUDE ABC                                                      3DB 0409
      COMMON A(22000)                                                  3DB 0410
C     THIS SUBROUTINE CONTROLS THE READING AND PRINTING OF INITIAL DATA 3DB 0411
      CALL ETIME                                                       3DB 0412
      NINP = 5                                                         3DB 0413
      NOUT = 6                                                         3DB 0414
      NSORCE = 1                                                       3DB 0415
      NSCRAT = 2                                                       3DB 0416
      NFLUX1 = 3                                                       3DB 0417
      NCXS = 4                                                         3DB 0418
      NFO = 17                                                         3DB 0419
      NMO = 18                                                         3DB 0420
      NF2 = 19                                                         3DB 0421
      NS2 = 20                                                         3DB 0422
      NCR1 = 21                                                        3DB 0423
      NDUM = 22                                                        3DB 0424
      NTEMP = 23                                                       3DB 0425
      REWIND NSORCE                                                    3DB 0426
      REWIND NSCRAT                                                    3DB 0427
      REWIND NFLUX1                                                    3DB 0428
      REWIND NCXS                                                      3DB 0429
      REWIND NFO                                                       3DB 0430
      REWIND NMO                                                       3DB 0431
      REWIND NF2                                                       3DB 0432
      REWIND NS2                                                       3DB 0433
      REWIND NCR1                                                      3DB 0434
      REWIND NDUM                                                      3DB 0435
      REWIND NTEMP                                                     3DB 0436
      WRITE(NOUT, 10)                                                  3DB 0437
10    FORMAT(1H1,42X,35H  *  *  *  *    3 D B    *  *  *  *   ///)     3DB 0438
      READ(NINP,20)   (ID(I), I=1,11), MAXT, A02, I04, S02, IGM, NXCM, 3DB 0439
     1                IHT, M07, M08, D05, I07, G07, S04, IGE, IZM,     3DB 0440
     2                NLAY, MT, M01, MCR, IM, JM, KM, IZ, JZ, KZ,      3DB 0441
     3                B01, B02, B03, B04, B05, B06, NACT, NPRT, NPUN,  3DB 0442
     4                NP1, NP2, NP3, EV, EVM, S03, BUCK, LAL, LAH, EPS, 3DB 0443
     5                EPSA, G06, EPS2, ORF, S01                        3DB 0444
20    FORMAT(11A6,I6/12I6/12I6/12I6/6E12.6/6E12.6)                     3DB 0445
      WRITE(NOUT,30) (ID(I),I=1,11), MAXT                              3DB 0446
30    FORMAT(/10X,11A6,I6/)                                            3DB 0447
      WRITE(NOUT,60)   A02, I04, S02, IGM, NXCM, IHT                   3DB 0448
60    FORMAT(                                                          3DB 0449
     192H    A02        0/1=REGULAR CALCULATION/ADJOINT CALCULATION    3DB 0450
     2                                 I9/                             3DB 0451
     392H    I04        EIGENVALUE TYPE  (0/1/2/3/4/5=SOURCE/KEFF/ALPHA/CON3DB 0452
     4CENTRATION/DELTA/BUCKLING)       I9/                             3DB 0453
     592H    S02        PARAMETRIC EIGENVALUE TYPE  (0/1/2=NONE/KEFF/ALPHA)3DB 0454
     6                                 I9/                             3DB 0455
     792H    IGM        NUMBER OF GROUPS                               3DB 0456
     8                                 I9/                             3DB 0457
     992H  NXCM         NUMBER OF DOWNSCATTERING TERMS                 3DB 0458
     1                                 I9/                             3DB 0459
     292H    IHT        POSITION OF SIGMA TRANSPORT IN CROSS SECTION TABLE 3DB 0460
     3                                 I9)                             3DB 0461
      WRITE(NOUT,70)  M07, M08, D05, I07, G07, S04                     3DB 0462
70    FORMAT(                                                          3DB 0463
     192H    M07        FLUX GUESS (0/1/2/3/4/5/6=NONE/PHI(X)*PHI(Y)*PHI(Z)3DB 0464
     2/PHI(X,Y,Z)/                     /                               3DB 0465
     392H               PHI(E,X,Y,Z) FROM CARDS/PHI(X,Y,Z)/PHI(E,X,Y,Z) FRO3DB 0466
```

```
     4M TAPE/                                    /                                3DB 0467
     592H              PHI(E,X,Y) FROM TAPE*PHI(Z) FROM CARDS)                    3DB 0468
     6                                        I9/                                 3DB 0469
     592H     M08      EXTERNAL SOURCE GUESS (SAME OPTIONS AS M07)                3DB 0470
     6                                        I9/                                 3DB 0471
     792H     D05      MAXIMUM NUMBER OF OUTER ITERATIONS                         3DB 0472
     8                                        I9/                                 3DB 0473
     992H     I07      MAXIMUM NUMBER OF Z ITERATIONS PER GROUP                   3DB 0474
     1                                        I9/                                 3DB 0475
     292H     G07      MAXIMUM NUMBER OF INNER (XY) ITERATIONS PER Z ITERA3DB 0476
     3TION                                    I9/                                 3DB 0477
     492H     S04      XY INVERSION DIRECTION (0/1/2/3=CODE CHOOSES/ALTERN3DB 0478
     5ATE/X/Y)                                I9/)                                3DB 0479
      WRITE(NOUT,80)  IGE, IZM, NLAY, MT, M01, MCR                                3DB 0480
80    FORMAT(                                                                     3DB 0481
     192H     IGE      GEOMETRY (0/1/2=X-Y-Z/R-THETA-Z/TRIANGULAR-Z)              3DB 0482
     2                                        I9/                                 3DB 0483
     292H     IZM      NUMBER OF MATERIAL ZONES                                   3DB 0484
     4                                        I9/                                 3DB 0485
     592H    NLAY      NUMBER OF MATERIAL LAYERS                                  3DB 0486
     6                                        I9/                                 3DB 0487
     792H      MT      TOTAL NUMBER OF MATERIALS INCLUDING MIXES                  3DB 0488
     8                                        I9/                                 3DB 0489
     992H     M01      NUMBER OF MIXTURE SPECIFICATIONS                           3DB 0490
     1                                        I9/                                 3DB 0491
     292H     MCR      NUMBER OF INPUT CROSS SECTION MATERIALS (NEG/POS=FR3DB 0492
     30M TAPE/CARDS)                          I9)                                 3DB 0493
      WRITE(NOUT,90)  IM, JM, KM, IZ, JZ, KZ                                      3DB 0494
90    FORMAT(                                                                     3DB 0495
     192H      IM      NUMBER OF INTERVALS IN THE X DIRECTION                     3DB 0496
     2                                        I9/                                 3DB 0497
     392H      JM      NUMBER OF INTERVALS IN THE Y DIRECTION                     3DB 0498
     4                                        I9/                                 3DB 0499
     592H      KM      NUMBER OF INTERVALS IN THE Z DIRECTION                     3DB 0500
     6                                        I9/                                 3DB 0501
     792H      IZ      NUMBER OF ZONES IN THE X DIRECTION (DELTA OPTION ON3DB 0502
     8LY)                                     I9/                                 3DB 0503
     992H      JZ      NUMBER OF ZONES IN THE Y DIRECTION (DELTA OPTION ON3DB 0504
     1LY)                                     I9/                                 3DB 0505
     292H      KZ      NUMBER OF ZONES IN THE Z DIRECTION (DELTA OPTION ON3DB 0506
     3LY)                                     I9/)                                3DB 0507
      WRITE(NOUT,95)    B01, B02, B03, B04, B05, B06                              3DB 0508
95    FORMAT(                                                                     3DB 0509
     192H     B01      LEFT   BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)          3DB 0510
     2                                        I9/                                 3DB 0511
     392H     B02      RIGHT  BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)          3DB 0512
     4                                        I9/                                 3DB 0513
     592H     B03      BACK   BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)          3DB 0514
     6                                        I9/                                 3DB 0515
     792H     B04      FRONT  BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)          3DB 0516
     8                                        I9/                                 3DB 0517
     992H     B05      TOP    BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)          3DB 0518
     1                                        I9/                                 3DB 0519
     292H     B06      BOTTOM BOUNDARY CONDITION (0/1=VACUUM/REFLECTIVE)          3DB 0520
     3                                        I9)                                 3DB 0521
      WRITE(NOUT,100)  NACT, NPRT, NPUN                                           3DB 0522
100   FORMAT(                                                                     3DB 0523
     192H    NACT      NUMBER OF ACTIVITY TRAVERSES                               3DB 0524
     2                                        I9/                                 3DB 0525
     792H    NPRT      PRINT OPTION (0/1=MINI/MAXI)                               3DB 0526
```

```
      6                               I9/                                3DB 0527
      392H  NPUN       FLUX OUTPUT OPTION (0/1/2/3/4=NONE/PHI(X,Y,Z)/PHI(E3DB 0528
      4,X,Y,Z) TO CARDS/                /                                3DB 0529
      592H             PHI(X,Y,Z)/PHI(E,X,Y,Z) TO TAPE)                  3DB 0530
      8                               I9/)                               3DB 0531
       WRITE(NOUT,110)  EV, EVM, S03, BUCK, LAL, LAH                     3DB 0532
110    FORMAT(1H1///                                                     3DB 0533
      191H    EV       FIRST EIGENVALUE GUESS                            3DB 0534
      2                             1PE10.4/                             3DB 0535
      391H    EVM      EIGENVALUE MODIFIER                               3DB 0536
      2                             1PE10.4/                             3DB 0537
      591H    S03      PARAMETRIC EIGENVALUE                             3DB 0538
      2                             1PE10.4/                             3DB 0539
      791H   BUCK      BUCKLING (CM-2)                                   3DB 0540
      2                             1PE10.4/                             3DB 0541
      991H    LAL      LAMBDA LOWER                                      3DB 0542
      2                             1PE10.4/                             3DB 0543
      291H    LAH      LAMBDA UPPER                                      3DB 0544
      2                             1PE10.4/)                            3DB 0545
       WRITE(NOUT,120)   EPS, EPSA, G06, EPS2,ORF, S01                   3DB 0546
120    FORMAT(                                                           3DB 0547
      191H    EPS      EIGENVALUE CONVERGENCE CRITERION                  3DB 0548
      2                             1PE10.4/                             3DB 0549
      391H   EPSA      PARAMETER CONVERGENCE CRITERION                   3DB 0550
      2                             1PE10.4/                             3DB 0551
      591H    G06      INNER (XY) ITERATION CONVERGENCE CRITERION (IF 0, U3DB 0552
      2SE EPS)                      1PE10.4/                             3DB 0553
      791H   EPS2      Z ITERATION CONVERGENCE CRITERION (IF 0, USE EPS) 3DB 0554
      2                             1PE10.4/                             3DB 0555
      991H    ORF      OVER-RELAXATION FACTOR                            3DB 0556
      2                             1PE10.4/                             3DB 0557
      291H    S01      NEGATIVE/POSITIVE=POWER (MWT)/NEUTRON SOURCE RATE 3DB 0558
      2                             1PE10.4/)                            3DB 0559
C      CHECK ON DRUM SIZE                                                3DB 0560
       IF(IM*JM*KM - 45000)  140, 130, 130                               3DB 0561
130    CALL ERRO2(6H   INP,130,1)                                        3DB 0562
140    IF(IM*JM*KM*IGM - 215000)  160, 150, 150                          3DB 0563
150    CALL ERRO2(6H   INP,150,1)                                        3DB 0564
160    IF(IM*JM*KM*5+IM+JM - 215000)  180, 170, 170                      3DB 0565
170    CALL ERRO2(6H   INP,170,1)                                        3DB 0566
180    IF(ITL*MT*IGM - 45000)  200, 190, 190                             3DB 0567
190    CALL ERRO2(6H   INP,190,1)                                        3DB 0568
200    IF(IZ + JZ + KZ)  230, 210, 230                                   3DB 0569
210    IF(I04 - 4)  230, 220, 230                                        3DB 0570
220    CALL ERRO2 (6H   INP,220,1)                                       3DB 0571
230    IF(S02)   240, 260, 240                                           3DB 0572
240    IF(S03)  260, 250, 260                                            3DB 0573
250    CALL ERRO2 (6H   INP,250,1)                                       3DB 0574
260    FEF = 215.0                                                       3DB 0575
       IF(G06)  270,270,280                                              3DB 0576
270    G06 = EPS                                                         3DB 0577
280    IF(EPS2)  290,290,295                                             3DB 0578
290    EPS2 = EPS                                                        3DB 0579
295    TSD = FEF*1.602*10.**(-19)                                        3DB 0580
       GLH = MAXT*60                                                     3DB 0581
       POD = 1.0                                                         3DB 0582
       KPAGE = 100                                                       3DB 0583
       IHS = IHT + 1                                                     3DB 0584
       ITL = IHS + NXCM                                                  3DB 0585
       IHA = IHT - 2                                                     3DB 0586
```

```
      IHF = IHT - 3
      IZP = IZM + 1
      IP  = IM + 1
      JP  = JM + 1
      KP = KM + 1
      ML = IABS(MCR)
      IGP = IGM + 1
      IGEP = IGE + 1
      IMJM = IM*JM
      ITLMT = ITL*MT
      EQ = .0
      LAP = .0
      LAPP = .0
      LAR = 0.0
      DAY = 0.0
      ALA = .0
      LC = 0
      LLC = 0
      P02 = 0
      CVT = 0
      CNT = 0
      NCON = 0
      T06 = 0
      IF(I04-4)  310, 300, 310
300   T06 = 1
310   ORFP =1.0*(ORF - 1.0) + 1.0
C     COMPUTE DIMENSION POINTERS
      LATW = 1
      LHOLN = LATW + ML
      LALAM = LHOLN + ML
      LCO = LALAM + ML
      LNO = LCO + ITL*MT
      LN2 = LNO + IMJM
      LAO = LN2 + IMJM
      LA1 = LAO + IP
      LFO = LA1 + IM
      LF2 = LFO + IMJM
      LIO = LF2 + IMJM
      LI1 = LIO + M01
      LI2 = LI1 + M01
      LI3 = LI2 + M01
      LK6 = LI3 + M01
      LK7 = LK6 + IGM
      LMO = LK7 + IGM
      LM2 = LMO + IMJM
      LXO = LM2 + IZM
      LX1 = LXO + IP
      LIX2 = LX1 + IP
      LX3 = LIX2 + T06*IM
      LX4 = LX3 + T06*IZ
      LX5 = LX4 + IM
      LS2 = LX5 + IM
      LVO = LS2 + IMJM
      LV7 = LVO + IMJM
      LYO = LV7 + IGM
      LY1 = LYO + JP
      LIY2 = LY1 + JP
      LY3 = LIY2 + JM*T06
      LY4 = LY3 + JZ*T06
      LY5 = LY4 + JM
```

```
      LCXS = LY5 + JM                                                   3DB 0647
      LVOL = LCXS + IMJM*5                                              3DB 0648
      LMASS = LVOL + IZM                                                3DB 0649
      LMATN = LMASS + ML*IZM                                            3DB 0650
      LNBR = LMATN + ML                                                 3DB 0651
      LLD = LNBR + ML                                                   3DB 0652
      LLCN = LLD + ML                                                   3DB 0653
      LLFN = LLCN + ML*2                                                3DB 0654
      LPHIB = LLFN + ML*7                                               3DB 0655
      LAXS = LPHIB + IZM                                                3DB 0656
      LFXS = LAXS + ML*IZM                                              3DB 0657
      LMASSP = LFXS + ML*IZM                                            3DB 0658
      LCXR = LMASSP + ML*IZM                                            3DB 0659
      LCXT = LCXR + JM                                                  3DB 0660
      LHA = LCXT + IM                                                   3DB 0661
      LPA = LHA + MAX0(IM,JM)                                           3DB 0662
      LGAM = LPA + MAX0(IM,JM)                                          3DB 0663
      LZ0 = LGAM + IZM                                                  3DB 0664
      LZ1 = LZ0 + KP                                                    3DB 0665
      LIZ2 = LZ1 + KP                                                   3DB 0666
      LZ3 = LIZ2 + T06*KM                                               3DB 0667
      LZ4 = LZ3 + T06*KZ                                                3DB 0668
      LZ5 = LZ4 + KM                                                    3DB 0669
      LDUM1 = LZ5 + KM                                                  3DB 0670
      LIDUM1 = LDUM1 + IMJM                                             3DB 0671
      LDUM2 = LIDUM1 + IMJM                                             3DB 0672
      LIDUM2 = LDUM2 + IMJM                                             3DB 0673
      LLYN = LIDUM2 + IMJM                                              3DB 0674
      LA2 = LLYN + KM                                                   3DB 0675
      LEE = LA2 + IM                                                    3DB 0676
      LIGMOD = LEE + 11*IGP                                             3DB 0677
      LKMODG = LIGMOD + IGM*NPRT                                        3DB 0678
      LKMODP = LKMODG + KM*NPRT                                         3DB 0679
      LKMODF = LKMODP + KM*NPRT                                         3DB 0680
      LKMODR = LKMODF + KM*NPRT                                         3DB 0681
      LMA = LKMODR + KM                                                 3DB 0682
      LNX = LMA + NACT                                                  3DB 0683
      LAST = LNX + NACT                                                 3DB 0684
      ITEMP = 1 + 3*ML + IGP*ITL*MT                                     3DB 0685
      LAST = MAX0(LAST,ITEMP)                                           3DB 0686
      WRITE(NOUT,320)  LAST                                             3DB 0687
320   FORMAT(5H LAST,I6)                                                3DB 0688
C     READ CROSS SECTIONS AND WRITE CROSS SECTION TAPE                  2DB 0689
      CALL RECS(A(LN0),A(LC0),ITL,IGM,MT,A(LATW),A(LHOLN),A(LALAM))     2DB 0690
      DO 325  I=LC0, LAST                                               2DB 0691
325   A(I) = .0                                                         2DB 0692
C     READ FLUXES AND WRITE FLUX TAPE                                   3DB 0693
      CALL FXINP(A(LN0),A(LX0), A(LY0),A(LZ0),A(LN2),IM,0)              3DB 0694
C     READ EXTERNAL SOURCE                                              3DB 0695
      IF (I04) 328,326,328                                              3DB 0696
326   CALL FXINP(A(LN0),A(LX0), A(LY0),A(LZ0),A(LN2),IM,1)              3DB 0697
328   WRITE(NOUT,330)                                                   3DB 0698
330   FORMAT(40H1MESH BOUNDARIES (X0/Y0/Z0=X/Y/Z POINTS))               3DB 0699
      CALL REAG2(6H    X0,A(LX0),IP)                                    3DB 0700
      CALL REAG2(6H    Y0,A(LY0),JP)                                    3DB 0701
      CALL REAG2(6H    Z0,A(LZ0),KP)                                    3DB 0702
      WRITE(NOUT,335)                                                   3DB 0703
335   FORMAT(26H0LAYER NUMBERS BY XY PLANE)                             3DB 0704
      CALL REAI2(6H   LYN,A(LLYN),KM)                                   3DB 0705
      DO 345  N=1,NLAY                                                  3DB 0706
```

```
      WRITE(NOUT,340)  N
340   FORMAT(40HOZONE NUMBERS BY MESH INTERVAL FOR LAYERI3)
      CALL REAI2(6H    MO,A(LMO),IMJM)
345   CALL DRUMR(NMO,A(LMO),IMJM,1)
      REWIND NMO
      WRITE(NOUT,350)
350   FORMAT(25HOMATERIAL NUMBERS BY ZONE)
      CALL REAI2(6H    M2,A(LM2),IZM)
      IF(I04 - 5)  351,352,351
351   IF(BUCK)  352, 358, 352
352   WRITE(NOUT,354)
354   FORMAT(30HOBUCKLING COEFFICIENTS BY ZONE)
      CALL REAG2(6H   GAM,A(LGAM),IZM)
358   WRITE(NOUT,360)
360   FORMAT(17HOFISSION SPECTRUM)
      CALL REAG2(6H    K7,A(LK7),IGM)
      WRITE(NOUT,370)
370   FORMAT(17HONEUTRON VELOCITY)
      CALL REAG2(6H    V7,A(LV7),IGM)
      IF(MO1) 400, 400, 380
380   WRITE(NOUT,390)
390   FORMAT(82HOMIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER
     1 FOR MIX/MATERIAL DENSITY))
      CALL REAI2(6H    I0,A(LI0),MO1)
      CALL REAI2(6H    I1,A(LI1),MO1)
      CALL REAG2(6H    I2,A(LI2),MO1)
400   CONTINUE
C     CHECK FOR DELTA CALCULATION
      IF(I04 - 4)    440, 410, 440
410   WRITE(NOUT,420)
420   FORMAT(81HODELTA OPTION DATA (IX2/IY2/IZ2/X3/Y3/Z3=X/Y/Z ZONE NUMB
     1ERS/X/Y/Z ZONE MODIFIERS))
      CALL REAI2(6H   IX2,A(LIX2),IM)
      CALL REAG2(6H    X3,A(LX3),IZ)
      CALL REAI2(6H   IY2,A(LIY2),JM)
      CALL REAG2(6H    Y3,A(LY3),JZ)
      CALL REAI2(6H   IZ2,A(LIZ2),KM)
      CALL REAG2(6H    Z3,A(LZ3),KZ)
440   IF(NACT)  480, 480, 450
450   WRITE(NOUT,460)
460   FORMAT(40HOMATERIAL NUMBERS FOR ACTIVITY TRAVERSES)
      CALL REAI2(6H    MA,A(LMA),NACT)
      WRITE(NOUT,470)
470   FORMAT(46HOCROSS SECTION POSITION FOR ACTIVITY TRAVERSES)
      CALL REAI2(6H    NX,A(LNX),NACT)
      WRITE(NOUT,475)
475   FORMAT(42HOREACTION RATE PRINT MODIFIERS BY XY PLANE)
      CALL REAI2(6H KMODR,A(LKMODR),KM)
480   IF(NPRT)  520, 520, 490
490   WRITE(NOUT,500)
500   FORMAT(30HOFLUX PRINT MODIFIERS BY GROUP)
      CALL REAI2(6H IGMOD,A(LIGMOD),IGM)
      WRITE(NOUT,510)
510   FORMAT(76HOPRINT MODIFIERS BY XY PLANE (KMODG/KMODF/KMODP=GROUP FL
     1UX/TOTAL FLUX/POWER))
      CALL REAI2(6H KMODG,A(LKMODG),KM)
      CALL REAI2(6H KMODF,A(LKMODF),KM)
      CALL REAI2(6H KMODP,A(LKMODP),KM)
520   CALL MAPR(A(LMO),A(LM2),IM,JM,A(LFO),A(LLYN))
      IF(LAST-22000)  570, 570, 560
```

```
560   CALL ERRO2(6H   INP,560,1)                    3DB 0767
570   RETURN                                        3DB 0768
      END                                           3DB 0769
```

```
-IT FR5  ERRO2,ERRO2                                                    3DB 0770
      SUBROUTINE ERRO2( HOL,JSUBR,I)                                    3DB 0771
      COMMON     NINP,   NOUT, NSORCE, NSCRAT, NFLUX1,   NCXS,     NFO  3DB 0772
      WRITE (NOUT,1)           HOL,JSUBR                                3DB 0773
1     FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)                    3DB 0774
      GO TO (3,4),I                                                     3DB 0775
3     STOP                                                              3DB 0776
4     RETURN                                                            3DB 0777
      END                                                               3DB 0778
```

```
-IT  FR5   SWITCH,SWITCH
      SUBROUTINE SWITCH(ITEMP1,ITEMP2)
C     THIS SUBROUTINE SWITCHS TAPE DESIGNATIONS
      ITEMP3 = ITEMP1
      ITEMP1 = ITEMP2
      ITEMP2 = ITEMP3
      RETURN
      END
```

```
-IT  FR5   DRUMR,DRUMR
      SUBROUTINE DRUMR(NUNIT,N2,IMJM,K)
C     THIS SUBROUTINE READS DATA FROM DRUM OR WRITES DATA TO DRUM
C     CALL DRUMR(NFLUX1,N2,IMJM,2) REPLACES THE FOLLOWING STATEMENT
C     READ(NFLUX1)  (N2(I), I=1,IMJM)
C     CALL DRUMR(NFLUX1,N2,IMJM,1) REPLACES THE FOLLOWING STATEMENT
C     WRITE(NFLUX1)  (N2(I), I=1,IMJM)
      ITEMP9 = IMJM
      CALL NTRAN(NUNIT,K,ITEMP9,N2,L)
10    IF(L+1)  20, 10, 30
20    CALL ERRO2(6H DRUMR,20,1)
30    RETURN
      END
```

```
-ITC FR5  RECS,RECS
      SUBROUTINE RECS (C,CO,JTL,JGM,JMT,ATW,HOLN,ALAM)
      INCLUDE ABC
      DIMENSION C(JTL,JGM,JMT), CO(JTL,JMT), ATW(1), HOLN(1), ALAM(1)
      DIMENSION AA(9)
C     THIS SUBROUTINE READS CROSS SECTIONS, PERFORMS ADJOINT
C     REVERSALS IF REQUIRED, AND WRITES CROSS SECTION TAPE
      WRITE(NOUT,5)  (ID(I), I=1,11)
5     FORMAT(1H1,11A6,///)
10    WRITE (NOUT, 20 )
20    FORMAT (55H CROSS SECTIONS ARE READ-IN FOR THE FOLLOWING MATERIALS
     1/)
      DO 50  I=1,ML
      READ(NINP, 30)  HOLN(I), ATW(I), ALAM(I), (AA(J), J=1,9)
      ALAM(I) = ALAM(I)/(24.*3600.)
30    FORMAT(A6, 2E6.2, 9A6)
      IF(MCR)  35,35,40
35    READ(15)  ((C(L,IIG,I), L=1,ITL), IIG=1,IGM)
      GO TO 50
40    DO 45  IIG=1,IGM
45    READ(NINP,60)  (C(L,IIG,I), L=1,ITL)
50    WRITE(NOUT, 55)  I, HOLN(I), (AA(J), J=1,9)
55    FORMAT(I3, 6X, A6, 6X, 9A6)
60    FORMAT(6E12.5)
C     CHECK ON CROSS SECTION CONSISTENCY AND ORDER
      ITEMP = 0
      IF(MCR)  70,70,90
70    REWIND 15
90    DO 140  J=1,ML
      DO 140  I=1,IGM
      G = C(IHA,I,J)  + C(IHS,I,J)
      DO 110  K = 1, NXCM
      KK = I + K
      M = IHS + K
      IF(KK - IGM)  100, 100, 110
100   G = G + C(M,KK,J)
110   CONTINUE
      IF(ABS((G - C(IHT,I,J) )/C(IHT,I,J)) - .01)  135, 120, 120
120   ITEMP = 1
130   FORMAT(1H /,16H CHECK MATERIAL I2,5X, 7H GROUP I2)
135   IF(ABS((G - C(IHT,I,J ))/C(IHT,I,J)) - .0001)  140, 138, 138
138   WRITE(NOUT,130)  J, I
140   CONTINUE
      IF (ITEMP) 160,160,150
150   CALL EXIT
C     A02=0/1=FLUX CALCULATION/ADJOINT CALCULATION
160   IF(A02)  170, 280, 170
170   DO 190  IIG=1,IGM
      IGBAR=IGM-IIG+1
      DO 180  M=1,MT
      DO 180  L = 1,IHS
      TEMP=C(L,IIG,M)
      C(L,IIG,M)=C(L,IGBAR,M)
180   C(L,IGBAR,M)=TEMP
      IF (IGBAR - IIG -1) 200, 200, 190
190   CONTINUE
200   CONTINUE
      KK = ITL - IHS
      IF (KK) 280, 280, 210
210   CONTINUE
```

```
      DO 240  M = 1,MT
      DO 240  IIG = 1,IGM
      IGBAR = IGM - IIG + 1
      DO 240  L = 1,KK
      IF (L - IIG) 220, 240, 240
220   I = L + IHS
      ITEMP = IGBAR + L
      IF (IIG - ITEMP) 230, 230, 240
230   TEMP = C(I, IIG, M)
      C(I,IIG,M) = C(I,ITEMP,M)
      C(I,ITEMP,M) = TEMP
240   CONTINUE
C     WRITE CROSS SECTION TAPE
280   DO 300  IIG=1,IGM
      DO 290  M=1,MT
      DO 290  L=1,ITL
290   CO(L,M)=C(L,IIG,M)
300   CALL DRUMR(NCR1,CO,ITLMT,1)
      REWIND NCR1
      RETURN
      END
```

```
-ITC FR5  FXINP,FXINP
      SUBROUTINE FXINP(NO,RF,ZF,HF,N2,JIM,ITEMP)
      DIMENSION  NO(JIM,1), RF(1), ZF(1), HF(1), N2(JIM,1)
      REAL          NO, N2
      INCLUDE ABC
C     THIS SUBROUTINE READS INPUT FLUXES (IF(ITEMP)=0) AND THE EXTERNAL
C     SOURCE (IF(ITEMP)=1)
      IF(ITEMP)  50, 50, 70
50    ITEMP1 = M07 + 1
      NI = 14
      GO TO 80
70    ITEMP1 = M08 + 1
      CALL SWITCH(NSORCE,NFLUX1)
      NI = 10
80    DO 800  IIG=1,IGM
      DO 800  KK=1,KM
      GO TO (100,200,300,315,300,330,350), ITEMP1
100   DO 150  KJ=1,JM
      DO 150  KI=1,IM
150   NO(KI,KJ) = 1.0
      GO TO 800
200   IF(IIG-1)  210, 210, 240
210   IF(KK-1)  215, 215, 240
215   IF(ITEMP)  218, 218, 228
218   WRITE(NOUT,220)
220   FORMAT(53H0FLUX GUESS  (RF/ZF/HF=X PROFILE/Y PROFILE/Z PROFILE))
      GO TO 235
228   WRITE(NOUT,230)
230   FORMAT(55H0SOURCE GUESS  (RF/ZF/HF=X PROFILE/Y PROFILE/Z PROFILE))
235   CALL REAG2(6H    RF,RF,IM)
      CALL REAG2(6H    ZF,ZF,JM)
      CALL REAG2(6H    HF,HF,KM)
240   DO 250  KJ=1,JM
      DO 250  KI=1,IM
250   NO(KI,KJ) = RF(KI)*ZF(KJ)*HF(KK)
      GO TO 800
300   IF(IIG-1)  310, 310, 1100
310   IF(ITEMP1-3)  315, 315, 330
315   READ(NINP,320)  ((NO(I,J), I=1,IM), J=1,JM)
320   FORMAT(6E12.6)
      GO TO 800
330   READ(NI)  ((NO(I,J), I=1,IM), J=1,JM)
      GO TO 800
350   IF(KK-1)  360,360,390
360   READ(NI)  ((N2(I,J), I=1,IM), J=1,JM)
      IF(IIG-1)  365,365,390
365   IF(ITEMP)  368,368,378
368   WRITE(NOUT,370)
370   FORMAT(15H0Z FLUX PROFILE)
      GO TO 385
378   WRITE(NOUT,380)
380   FORMAT(17H0Z SOURCE PROFILE)
385   CALL REAG2(6H    HF,HF,KM)
390   DO 400  KJ=1,JM
      DO 400  KI=1,IM
400   NO(KI,KJ) = N2(KI,KJ)*HF(KK)
800   CALL DRUMR(NFLUX1,NO,IMJM,1)
      GO TO 1400
1100  DO 1200  IIG=1,IGM
      REWIND NFLUX1
```

```
      DO 1200  KK=1,KM                                              3DB 0941
      CALL DRUMR(NFLUX1,NO,IMJM,2)                                  3DB 0942
 1200 CALL DRUMR(NSCRAT,NO,IMJM,1)                                  3DB 0943
      CALL SWITCH(NFLUX1, NSCRAT)                                   3DB 0944
      REWIND NSCRAT                                                 3DB 0945
 1400 REWIND NFLUX1                                                 3DB 0946
      IF(ITEMP)  1450, 1450, 1420                                   3DB 0947
 1420 CALL SWITCH(NSORCE,NFLUX1)                                    3DB 0948
 1450 IF(ITEMP1 - 4)  1500,1500,1460                                3DB 0949
 1460 REWIND NI                                                     3DB 0950
 1500 RETURN                                                        3DB 0951
      END                                                           3DB 0952
```

```
-IT  FR5 REAG2,REAG2
      SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)
      DIMENSION ARRAY(1),V(12),K(12),IN(12)
      COMMON      NINP,    NOUT, NSORCE, NSCRAT, NFLUX1,    NCXS,      NFO
      JFLAG=0
      J=1
10    IF(JFLAG)20,40,20
20    DO 30 JJ=1,6
      K(JJ)=K(JJ+6)
      IN(JJ)=IN(JJ+6)
30    V(JJ)=V(JJ+6)
      JFLAG=0
      GO TO 60
40    READ (NINP,50)        (K(I),IN(I),V(I),I=1,6)
50    FORMAT(6(I1,I2,E9.4))
60    DO 140 I=1,6
      L=K(I)+1
      GO TO (70,80,100,150,132,140,62), L
C     FILL
62    JJ=J
      DO 65  M=JJ,NCOUNT
      ARRAY(J) = V(I)
65    J=J+1
      GO TO 150
C     NO MODIFICATION
70    ARRAY(J)=V(I)
      J=J+1
      GO TO 140
C     REPEAT
80    L=IN(I)
      DO 90 M=1,L
      ARRAY(J)=V(I)
      J=J+1
90    CONTINUE
      GO TO 140
C     INTERPOLATE
100   IF(I-6) 120,110,110
110   READ (NINP,50)        (K(JJ),IN(JJ),V(JJ),JJ=7,12)
      JFLAG=1
120   L=IN(I)+1
      DEL=(V(I+1)-V(I))/FLOAT (L)
      DO 130 M=1,L
      ARRAY(J)=V(I)+DEL*FLOAT (M-1)
      J=J+1
130   CONTINUE
      GO TO 140
C     CYCLE
132   L=IN(I)
      N=INT(.00001+V(I))
      DO 135  LL=1,L
      DO 135  NN=1,N
      ARRAY(J) = ARRAY(J-N)
135   J=J+1
140   CONTINUE
      GO TO 10
C     TERMINATE
150   J=J-1
      WRITE (NOUT,160)       HOLL,J      ,( ARRAY(I),I=1,J)
      IF(J  -NCOUNT)170,180,170
160   FORMAT(6X,A6,I6/(10E12.5))
```

```
170   CALL ERRO2( 6H**REAG,170,1)                    3DB 1013
180   RETURN                                         3DB 1014
      END                                            3DB 1015
```

```
-IT  FR5 REAI2,REAI2                                                        3DB 1016
      SUBROUTINE REAI2(HOLL,IARRAY,NCOUNT)                                  3DB 1017
      DIMENSION  IARRAY(1), IV(12), K(12), IN(12)                           3DB 1018
      COMMON     NINP,    NOUT, NSORCE, NSCRAT, NFLUX1,    NCXS,     NFO    3DB 1019
      JFLAG = 0                                                             3DB 1020
      J=1                                                                   3DB 1021
 1    IF(JFLAG)  2,10,2                                                     3DB 1022
 2    DO 4   JJ=1,6                                                         3DB 1023
      K(JJ)  = K(JJ+6)                                                      3DB 1024
      IN(JJ)  = IN(JJ+6)                                                    3DB 1025
 4    IV(JJ)  = IV(JJ+6)                                                    3DB 1026
      JFLAG = 0                                                             3DB 1027
      GO TO 21                                                              3DB 1028
 10   READ(NINP,20)          (K(I),IN(I),IV(I),I=1,6)                       3DB 1029
 20   FORMAT(6(I1,I2,I9))                                                   3DB 1030
 21   DO 70   I=1,6                                                         3DB 1031
      L=K(I)+1                                                              3DB 1032
      GO TO (30,40,52,80,62,70,22), L                                       3DB 1033
C     FILL                                                                  3DB 1034
 22   JJ=J                                                                  3DB 1035
      DO 25   M=JJ,NCOUNT                                                   3DB 1036
      IARRAY(J) = IV(I)                                                     3DB 1037
 25   J=J+1                                                                 3DB 1038
      GO TO 80                                                              3DB 1039
C     NO MODIFICATION                                                       3DB 1040
 30   IARRAY(J)=IV(I)                                                       3DB 1041
      J=J+1                                                                 3DB 1042
      GO TO 70                                                              3DB 1043
C     REPEAT                                                                3DB 1044
 40   L=IN(I)                                                               3DB 1045
      DO 50 M=1,L                                                           3DB 1046
      IARRAY(J)=IV(I)                                                       3DB 1047
      J=J+1                                                                 3DB 1048
 50   CONTINUE                                                              3DB 1049
      GO TO 70                                                              3DB 1050
C     INTERPOLATE                                                           3DB 1051
 52   IF(I-6)  54,53,53                                                     3DB 1052
 53   READ(NINP,20)          (K(M),IN(M),IV(M),M=1,6)                       3DB 1053
      JFLAG = 1                                                             3DB 1054
 54   L = IN(I) + 1                                                         3DB 1055
      IDEL = (IV(I+1) - IV(I))/L                                            3DB 1056
      DO 56  M=1,L                                                          3DB 1057
      IARRAY(J) = IV(I) + IDEL*(M-1)                                        3DB 1058
 56   J = J + 1                                                             3DB 1059
      GO TO 70                                                              3DB 1060
C     CYCLE                                                                 3DB 1061
 62   L = IN(I)                                                             3DB 1062
      N = IV(I)                                                             3DB 1063
      DO 65  LL=1,L                                                         3DB 1064
      DO 65  NN=1,N                                                         3DB 1065
      IARRAY(J) = IARRAY(J-N)                                               3DB 1066
 65   J = J + 1                                                             3DB 1067
 70   CONTINUE                                                              3DB 1068
      GO TO 1                                                               3DB 1069
C     TERMINATE                                                             3DB 1070
 80   J=J-1                                                                 3DB 1071
      WRITE (NOUT,90)        HOLL,J      ,(IARRAY(I),I=1,J)                 3DB 1072
      IF(J  -NCOUNT)100,110,100                                             3DB 1073
 90   FORMAT(6X,A6,I6/(10I12))                                              3DB 1074
 100  CALL ERRO2( 6H**REAI,100,1)                                           3DB 1075
 110  RETURN                                                                3DB 1076
      END                                                                   3DB 1077
```

```
-ITC FR5  MAPR,MAPR
      SUBROUTINE MAPR(MO,M2,JIM,JJM,K,LYN)
      DIMENSION MO(JIM,JJM), M2(1), K(1), LYN(1)
      INCLUDE ABC
C     PRODUCE A PICTURE PRINT BY ZONE AND MATERIAL
      ITEMP2 = 0
      DO 200 NN=1,NLAY
      ITEMP1 = ITEMP2 + 1
      DO 10  KK=1,KM
      IF(LYN(KK) -NN)  10,10,5
5     ITEMP2 = KK - 1
      GO TO 15
10    CONTINUE
      ITEMP2 = KM
15    DO 16  I=ITEMP1,ITEMP2
16    K(I) = I
      CALL DRUMR(NMO,MO,IMJM,2)
      WRITE(NOUT,17) NN, (K(I), I=ITEMP1,ITEMP2)
17    FORMAT(6H1LAYER,I3,14H FOR XY PLANES, 25I4, (30I4))
      WRITE(NOUT,18)
18    FORMAT(//29H ZONE NUMBER BY MESH INTERVAL///)
20    DO 30 JJ=1,JM
      J=JM-JJ+1
30    WRITE (NOUT,40)          (MO(I,J),I=1,IM)
40    FORMAT( 5H     ,55I2)
      WRITE(NOUT,50)
50    FORMAT(2H Y/2H  /2H A/2H X/2H I/2H S//8H   X AXIS)
      WRITE(NOUT,55)
55    FORMAT(1H1,//33H MATERIAL NUMBER BY MESH INTERVAL///)
      DO 70 JJ=1,JM
      J=JM-JJ+1
      DO  60 L=1,IM
      N=MO(L,J)
60    K(L)=IABS (M2(N))
70    WRITE (NOUT,40)      (K(L),L=1,IM)
200   WRITE(NOUT,50)
      REWIND NMO
      RETURN
      END
```

```
-ITC FR5  INIT1,INIT1
      SUBROUTINE INIT1(K7,V7,I0,I1,I2,C0,JTL,M2,GAM)
      INCLUDE ABC
      DIMENSION  K7(1), V7(1), I0(1), I1(1), I2(1), C0(JTL,1), M2(1),
     1           GAM(1)
      REAL          I2,      K7
      IF (P02) 20, 10, 20
10    WRITE(NOUT,15)  DAY
15    FORMAT(1H1,30X,11H T I M E  =F8.3,8H D A Y S///)
20    CONTINUE
C     ADJOINT REVERSALS
      IF(A02) 25, 45, 25
25    IF(P02) 45, 30, 45
30    IF(NCON)  45, 35, 45
35    IIG=1
      IGBAR=IGM
40    TEMP=K7(IIG)
      K7(IIG)=K7(IGBAR)
      K7(IGBAR)=TEMP
      TEMP=V7(IIG)
      V7(IIG)=V7(IGBAR)
      V7(IGBAR)=TEMP
      IIG=IIG+1
      IGBAR=IGBAR-1
      IF(IIG-IGBAR) 40, 45, 45
45    CONTINUE
C
C     MIX CROSS-SECTIONS
      B07=1
      IF(P02) 50, 55, 50
50    GO TO (245,245,85,245,185),  I04
55    IF(M01)  70, 70, 60
60    WRITE(NOUT, 65 )  (J, I0(J), I1(J), I2(J), J = 1, M01)
65    FORMAT(1H0,3X, 16H MIXTURE NUMBER ,18H   MIX COMMAND      ,
     124H MATERIAL ATOMIC DENSITY//(I5,1X,I8,8X,I8,8X,E20.8))
70    IF(NPRT)     85,85,75
75    WRITE (NOUT,80 )
80    FORMAT(/19H1CROSS-SECTION EDIT)
85    REWIND NCR1
      DO 180  IIG=1,IGM
      ITLMT = ITL*MT
      CALL DRUMR(NCR1,C0,ITLMT,2)
      IF(M01) 90, 145, 90
90    DO 140  M=1,M01
      IF(I0(M)-MT) 100, 100, 95
95    CALL ERRO2(6H**INIT,95,1)
100   IF(I1(M)-MT) 105, 105, 95
105   N=I0(M)
      L=I1(M)
      E01=I2(M)
      IF(L) 125, 125, 110
110   IF(E01) 125, 115, 125
115   IF (N-L) 125, 120, 125
120   E01 = EV
      L = 0
125   DO 140  I=1,ITL
      IF (L) 130, 135, 130
130   C0(I,N)=C0(I,N)+C0(I,L)*E01
      GO TO 140
135   C0(I,N)=C0(I,N)*E01
```

```
140   CONTINUE
145   IF(PO2) 175, 150, 175
150   IF(NPRT)    175,175,155
155   IF(IHT-4)  161, 156, 161
156   WRITE (NOUT,160 )  IIG
160   FORMAT(6H0GROUP,I3,  84H   SIGF        SIGA       NUSIGF      SIGTR
     1     GXG        G-1XG       G-2XG         . . .)
      GO TO 164
161   WRITE(NOUT,163) IIG
163   FORMAT(6H0GROUP,I3)
164   DO 165  N=1,MT
165   WRITE (NOUT,170 )            N,(CO(I,N),I=1,ITL)
170   FORMAT(4H MAT,I3,10E11.5/(7X,10E11.5))
175   CALL DRUMR(NDUM,CO,ITLMT,1)
180   CONTINUE
      REWIND NCR1
      REWIND NDUM
      CALL SWITCH(NDUM,NCR1)
185   IF(I04-5)  190, 205, 190
190   IF(BUCK)  200, 245, 200
200   TEMP = BUCK
      GO TO 220
205   IF(PO2)  210, 210, 215
210   BUCK = 0.
215   TEMP = EV - BUCK
      BUCK = EV
220   DO 240   IIG=1,IGM
      CALL DRUMR(NCR1,CO,ITLMT,2)
      DO 235  MTZ = 1,MT
      DO 230   KZ=1,IZM
      IF(M2(KZ) - MTZ)  230, 225, 230
225   TEMP1 = (TEMP*GAM(KZ))/(3.*CO(IHT,MTZ))
      CO(IHA,MTZ) = CO(IHA,MTZ) + TEMP1
      CO(IHS,MTZ) = CO(IHS,MTZ) - TEMP1
      GO TO 235
230   CONTINUE
235   CONTINUE
      CALL DRUMR(NDUM,CO,ITLMT,1)
240   CONTINUE
      REWIND NCR1
      REWIND NDUM
      CALL SWITCH(NDUM,NCR1)
245   CONTINUE
      RETURN
      END
```

```
-ITC FR5  INIT2,INIT2
      SUBROUTINE INIT2(X0,X1,IX2,X3,X4,X5,Y0,Y1,IY2,Y3,Y4,Y5,Z0,Z1,IZ2,
     1                 Z3,Z4,Z5,A0,A1,A2,V0,JIM)
      INCLUDE ABC
      DIMENSION  X0(1), X1(1),IX2(1), X3(1), X4(1), X5(1), Y0(1),
     1           Y1(1),IY2(1), Y3(1), Y4(1), Y5(1), Z0(1), Z1(1),
     2          IZ2(1), Z3(1), Z4(1), Z5(1), A0(1), A1(1), A2(1),
     3           V0(JIM,1)
C     MODIFY GEOMETRY
      IF(P02)270, 250, 270
250   IF(NCON)  375, 255, 375
255   DO 260  I=1,IP
260   X1(I)=X0(I)
      DO 265 J=1,JP
265   Y1(J)=Y0(J)
      DO 268  K=1,KP
268   Z1(K) = Z0(K)
270   IF(I04-4)  305, 275, 305
275   DO 280 I=1,IM
      K = IX2(I)
280   X1(I+1)=X1(I)+(X0(I+1)-X0(I))*(1.0+ EV*X3(K))
      DO 285 J=1,JM
      K = IY2(J)
285   Y1(J+1)=Y1(J)+(Y0(J+1)-Y0(J))*(1.0+ EV*Y3(K))
      DO 288  K=1,KM
      KK = IZ2(K)
288   Z1(K+1) = Z1(K) + (Z0(K+1)-Z0(K))*(1.0 + EV*Z3(KK))
      IF(IGE-2) 305, 290, 305
290   IF(ABS (Y1(JP)-1.0)-1.0E-04) 305, 305, 300
300   CALL ERRO2(6H**INIT,300,1)
305   CONTINUE
C     CALCULATE AREAS AND VOLUMES.
      PI2=6.28318
      IF(P02) 310, 315, 310
310   IF(I04 - 4)  375, 315, 375
315   CONTINUE
      DO 345 I=1,IM
      X4(I)=(X1(I+1)+X1(I))*0.5
      X5(I)=X1(I+1)-X1(I)
      IF( X5(I) ) 320, 320, 325
320   CALL ERRO2 (6H*X5(I),320,1)
325   CONTINUE
      GO TO (330,     340,342), IGEP
C     X-Y-Z
330   A0(I)=1.0
      A0(IP)=1.0
      A1(I)=X5(I)
      A2(I) = X5(I)
      GO TO 345
C     R-THETA-Z
340   A0(I)=PI2*X1(I)
      A0(IP)=PI2*X1(IP)
      A1(I)=X5(I)
      A2(I) = PI2*X5(I)*X4(I)
      GO TO 345
C     HEX-Z
342   A0(I) = 2.*X5(I)
      A0(IP) = 2.*X5(I)
      A1(I) = 2.*X5(I)
      A2(I) = X5(I)
```

```
345   CONTINUE
      DO 370  J=1,JM
      Y4(J)=(Y1(J+1)+Y1(J))*0.5
      Y5(J)=Y1(J+1)-Y1(J)
      IF(Y5(J)) 350, 350, 355
350   CALL ERRO2 (6H*Y5(J),350,1)
355   CONTINUE
      DO 370  I=1,IM
      GO TO (360,    365,360), IGEP
360   VO(I,J)=X5(I)*Y5(J)
      GO TO 370
365   VO(I,J)=PI2*X5(I)*Y5(J)*X4(I)
370   CONTINUE
      DO 373  K=1,KM
      Z4(K) = (Z1(K+1) + Z1(K))*0.5
      Z5(K) = Z1(K+1) - Z1(K)
      IF(Z5(K))  372, 372, 373
372   CALL ERRO2(6H*Z5(K),372,1)
373   CONTINUE
375   CONTINUE
380   RETURN
      END
```

```
-ITC FR5  INIT3,INIT3
      SUBROUTINE INIT3(K6,K7,CO,JTL,NO,JIM,FO,LYN,MO,M2,VO,Z5)
      INCLUDE ABC
      DIMENSION  K6(1), K7(1), CO(JTL,1), NO(JIM,1), FO(JIM,1), LYN(1),
     1           MO(JIM,1), M2(1), VO(JIM,1), Z5(1)
      REAL       K6,     K7,      NO
C     MATERIAL ADDRESSES
      IF(PO2) 405, 385, 405
385   SK7=0.
      DO 400 IIG=1,IGM
      IF(SO2-1) 395, 390, 395
390   K6(IIG)=K7(IIG)/SO3
      GO TO 400
395   K6(IIG)=K7(IIG)
400   SK7=SK7+K7(IIG)
C     FISSION NEUTRONS
405   [illegible]E1(IGP)
      DO 500  IIG=1,IGM
      EO(IIG) = .0
      CALL DRUMR(NCR1,CO,ITLMT,2)
      DO 480  K=1,KM
      CALL DRUMR(NFLUX1,NO,IMJM,2)
      IF(IIG - 1)  418, 418, 415
415   CALL DRUMR(NFO,FO,IMJM,2)
      GO TO 419
418   CALL CLEAR(0.0,FO,IMJM)
419   IF(K - 1)  428, 428, 420
420   IF(LYN(K) - LYN(K - 1))  428, 430, 428
428   CALL DRUMR(NMO,MO,IMJM,2)
430   DO 460  J=1,JM
      DO 460  I=1,IM
      ITEMP = MO(I,J)
      ITEMP = M2(ITEMP)
      EO(IIG) = EO(IIG) + VO(I,J)*Z5(K)*NO(I,J)*CO(IHF,ITEMP)
      IF(AO2)  435, 440, 435
435   FO(I,J) = FO(I,J) + K7(IIG)*NO(I,J)
      GO TO 460
440   FO(I,J) = FO(I,J) + CO(IHT-1,ITEMP)*NO(I,J)
460   CONTINUE
480   CALL DRUMR(NDUM,FO,IMJM,1)
      CALL SWITCH(NDUM,NFO)
      REWIND NDUM
      REWIND NFO
500   REWIND NMO
      REWIND NFLUX1
      REWIND NCR1
      RETURN
      END
```

```
-IT FR5  CLEAR,CLEAR
      SUBROUTINE CLEAR (X,Y,N)
      DIMENSION Y(1)
      DO 1 I=1,N
1     Y(I)=X
      RETURN
      END
```

```
-ITC FR5  FISCAL,FISCAL                                                3DB 1359
      SUBROUTINE FISCAL(NO,FO,VO,CO,K6,MO,M2,JTL,JMT,LYN,Z5)          3DB 1360
      INCLUDE ABC                                                      3DB 1361
      DIMENSION  NO(1), FO(1), VO(1), CO(JTL,JMT),K6(1), MO(1), M2(1), 3DB 1362
     1           LYN(1), Z5(1)                                         3DB 1363
      REAL         K6,      NO                                         3DB 1364
      LAR = ALA                                                        3DB 1365
C     FISSION SUMS                                                     3DB 1366
      IF(B07)  90,90,10                                                3DB 1367
10    IF(A02) 20, 40, 20                                               3DB 1368
20    DO 35  IIG=1,IGM                                                 3DB 1369
      CALL DRUMR(NCR1,CO,ITLMT,2)                                      3DB 1370
      E1(IIG)=0.                                                       3DB 1371
      DO 30  KK=1,KM                                                   3DB 1372
      IF(KK-1) 26, 26, 24                                              3DB 1373
24    IF(LYN(KK) - LYN(KK-1))  26, 28, 26                              3DB 1374
26    CALL DRUMR(NMO,MO,IMJM,2)                                        3DB 1375
28    CALL DRUMR(NFO,FO,IMJM,2)                                        3DB 1376
      DO 30  I=1,IMJM                                                  3DB 1377
      ITEMP=MO(I)                                                      3DB 1378
      ITEMP=M2(ITEMP)                                                  3DB 1379
30    E1(IIG)=E1(IIG)+CO(IHT-1,ITEMP)*FO(I)*VO(I)*Z5(KK)               3DB 1380
      REWIND NMO                                                       3DB 1381
35    REWIND NFO                                                       3DB 1382
      REWIND NCR1                                                      3DB 1383
      GO TO 70                                                         3DB 1384
40    E01=0.                                                           3DB 1385
      DO 50  KK=1,KM                                                   3DB 1386
      CALL DRUMR(NFO,FO,IMJM,2)                                        3DB 1387
      DO 50  I=1,IMJM                                                  3DB 1388
50    E01=E01+VO(I)*FO(I)*Z5(KK)                                       3DB 1389
      DO 60  IIG=1,IGM                                                 3DB 1390
60    E1(IIG)=K6(IIG)*E01                                              3DB 1391
      REWIND NFO                                                       3DB 1392
70    E1(IGP)=0.                                                       3DB 1393
      EO(IGP)=0.                                                       3DB 1394
      DO 80  IIG=1,IGM                                                 3DB 1395
      EO(IGP)=EO(IGP)+EO(IIG)                                          3DB 1396
80    E1(IGP)=E1(IGP)+E1(IIG)                                          3DB 1397
      IF(B07)  140, 90, 140                                            3DB 1398
90    ALA = E1(IGP)/T11                                                3DB 1399
      TEMP=1.0/ALA                                                     3DB 1400
      IF(I04-1) 230, 100, 140                                          3DB 1401
100   DO 110  IIG=1,IGM                                                3DB 1402
      E1(IIG)=E1(IIG)*TEMP                                             3DB 1403
110   K6(IIG)=K6(IIG)*TEMP                                             3DB 1404
      E1(IGP)=E1(IGP)*TEMP                                             3DB 1405
      IF(A02) 120, 140, 120                                            3DB 1406
120   DO 135  KK=1,KM                                                  3DB 1407
      CALL DRUMR(NFO,FO,IMJM,2)                                        3DB 1408
      DO 130  I=1,IMJM                                                 3DB 1409
130   FO(I) = FO(I)*TEMP                                               3DB 1410
135   CALL DRUMR(NDUM,FO,IMJM,1)                                       3DB 1411
      CALL SWITCH(NDUM,NFO)                                            3DB 1412
      REWIND NDUM                                                      3DB 1413
      REWIND NFO                                                       3DB 1414
C     NORMALIZATION                                                    3DB 1415
140   B07=0                                                            3DB 1416
150   IF(S01)  160, 230, 170                                           3DB 1417
160   E01 = ABS(S01)/(EO(IGP)*TSD)                                     3DB 1418
```

```
      GO TO 180
170   E01=S01/E1(IGP)
180   DO 190 IIG=1,IGP
190   E1(IIG)=E01*E1(IIG)
      DO 200  KK=1,KM
      CALL DRUMR(NFO,FO,IMJM,2)
      DO 195  I=1,IMJM
195   FO(I) = E01*FO(I)
200   CALL DRUMR(NDUM,FO,IMJM,1)
      CALL SWITCH(NDUM,NFO)
      REWIND NDUM
      REWIND NFO
230   RETURN
      END
```

```
-ITC FR5  MONPR,MONPR                                                     3DB 1433
      SUBROUTINE MONPR                                                    3DB 1434
      INCLUDE ABC                                                         3DB 1435
C MP  830   MONITOR PRINT                                                 3DB 1436
      CALL ETIMEF(TI)                                                     3DB 1437
      TI = TI/60.                                                         3DB 1438
      KPAGE = KPAGE + 1                                                   3DB 1439
      IF(KPAGE - 40)  220, 160, 160                                       3DB 1440
160   KPAGE = 0                                                           3DB 1441
210   WRITE(NOUT, 213)                                                    3DB 1442
213   FORMAT(104H1     TIME              OUTER         Z IT. PER    IN. IT. P3DB 1443
     1ER       EIGENVALUE      EIGENVALUE        LAMBDA    /              3DB 1444
     2        104H   (MINUTES)      ITERATIONS      OUT. IT.      OUT. IT.3DB 1445
     3            SLOPE                                    /)             3DB 1446
220   WRITE(NOUT, 225)     TI, P02, LLC, LC, EQ, EV, ALA                  3DB 1447
225   FORMAT(4X, F6.2, 10X, I4, 11X, I4, 9X, I5, 6X, E15.8, E15.8,E15.8)3DB 1448
230   P02=P02+1                                                           3DB 1449
      LC=0                                                                3DB 1450
      LLC = 0                                                             3DB 1451
      IF(P02-D05)430,430,330                                              3DB 1452
330   NGOTO = 1                                                           3DB 1453
      GO TO 630                                                           3DB 1454
430   NGOTO = 4                                                           3DB 1455
630   RETURN                                                              3DB 1456
      END                                                                 3DB 1457
```

```
-ITC FR5  OUTER,OUTER
      SUBROUTINE OUTER(A0,A1,C0,F0,K6,M0,M2,N0,N2,S2,V0,V7,Y5,F2,JTL,
     1                 JMT,CXS,JIM,JJM,X5,X4,Y4,CXR,CXT,HA,PA,LYN,Z5,
     2                 EE,IDUM1,IDUM2,DUM1,DUM2,A2,Z4)
      DIMENSION  A0(1), A1(1), F0(1), K6(1), M0(1), M2(1),
     1           N0(1), N2(1),        S2(1),
     2           V0(1), V7(1), Y5(1), F2(1), C0(JTL,JMT),  HA(1), PA(1),
     3          CXS(JIM,JJM,5), X5(1), X4(1), Y4(1), CXR(1), CXT(1),
     4          LYN(1), Z5(1), EE(11,1), IDUM1(1), IDUM2(1), DUM1(1),
     5          DUM2(1), A2(1), Z4(1)
      REAL          K6,      N0,      N2
      INTEGER        GBAR, PBAR, SBAR
      INCLUDE ABC
      IGV=1
C     SOURCE CALCULATION
2     CALL DRUMR(NCR1,C0,ITLMT,2)
      DO 75  KK=1,KM
      IF(KK-1)  6,6,4
4     IF(LYN(KK) - LYN(KK-1))  6,8,6
6     CALL DRUMR(NM0,M0,IMJM,2)
8     CALL DRUMR(NF0,F0,IMJM,2)
      IF (I04) 15,12,15
12    CALL DRUMR(NSORCE,S2,IMJM,2)
      GO TO 30
15    DO 20  I=1,IMJM
20    S2(I)=0.
30    IF(A02) 60, 40, 60
40    DO 50  I=1,IMJM
50    S2(I)=S2(I)+K6(IGV)*F0(I)
      GO TO 75
60    DO 70   I=1,IMJM
      ITEMP1=M0(I)
      ITEMP1=M2(ITEMP1)
70    S2(I)=S2(I)+C0(IHT-1,ITEMP1)*F0(I)
75    CALL DRUMR(NS2,S2,IMJM,1)
      REWIND NM0
      REWIND NF0
      REWIND NS2
80    GBAR=IGV+IHS-ITL
      IF(GBAR-1)  90, 100, 100
90    GBAR=1
100   PBAR = IHS + IGV - 1
      IF(PBAR - ITL)  115,115,110
110   PBAR = ITL
115   IF(GBAR - IGV)  120, 160, 160
120   DO 135  KK=1,KM
      IF(KK-1)  126,126,124
124   IF(LYN(KK)-LYN(KK-1))  126,128,126
126   CALL DRUMR(NM0,M0,IMJM,2)
128   CALL DRUMR(NS2,S2,IMJM,2)
      CALL DRUMR(NSCRAT,N2,IMJM,2)
      DO 130  I=1,IMJM
      ITEMP1=M0(I)
      ITEMP1=M2(ITEMP1)
130   S2(I) = S2(I) + N2(I)*C0(PBAR,ITEMP1)
135   CALL DRUMR(NDUM,S2,IMJM,1)
      CALL SWITCH(NDUM,NS2)
      REWIND NM0
      REWIND NS2
      REWIND NDUM
```

```
      GBAR=GBAR+1
      PBAR=PBAR-1
      IF(GBAR - IGV)  120, 160, 160
160   IF(IGV - IGM)  180, 170, 180
170   REWIND NCR1
180   V11=0.
      DO 195  KK=1,KM
      CALL DRUMR(NS2,S2,IMJM,2)
      DO 190  I=1,IMJM
      S2(I) = S2(I)*V0(I)*Z5(KK)
190   V11 = V11 + S2(I)
195   CALL DRUMR(NDUM,S2,IMJM,1)
      CALL SWITCH(NDUM,NS2)
      REWIND NDUM
      REWIND NS2
      E2(IGV) = V11 - E1(IGV)
C     SOURCE-ALPHA
200   IF(I04 - 2)  210, 240, 210
210   IF(S02 - 2)  230, 220, 230
220   T7 = S03/V7(IGV)
      GO TO 250
230   T7 = 0.0
      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
      DO 274  KK=1,KM
      CALL DRUMR(NFLUX1,N2,IMJM,2)
274   CALL DRUMR(NDUM,N2,IMJM,1)
      REWIND NDUM
      CALL BALANC(EE,N2,IDUM2,DUM2,DUM1,IDUM1,MO,LYN,CXS,CXR,CXT,CO,
     1            VO,M2,IM,JM,Z5,ITL,AO,Y5,X5,X4,Y4,A1,A2,Z4,1)
      NINIT = 0
278   NINIT = NINIT + 1
      LLC = LLC + 1
      FDIFF = .0
      CALL CLEAR(0.0,N2,IMJM)
      CALL DRUMR(NMO,IDUM2,IMJM,2)
      CALL DRUMR(NDUM,DUM2,IMJM,2)
      DO 400  KK=1,KM
      DO 283  I=1,IMJM
      DUM1(I) = N2(I)
      N2(I) = DUM2(I)
      IDUM1(I) = MO(I)
283   MO(I) = IDUM2(I)
      CALL DRUMR(NS2,S2,IMJM,2)
      IF(KK-KM)  284,286,286
284   CALL DRUMR(NDUM,DUM2,IMJM,2)
      IF(LYN(KK) - LYN(KK+1))  285,287,285
285   CALL DRUMR(NMO,IDUM2,IMJM,2)
      GO TO 287
286   CALL CLEAR(0.0,DUM2,IMJM)
287   II=0
      ITEMP9 = IM*JM*5
      CALL DRUMR(NCXS,CXS,ITEMP9,2)
      CALL DRUMR(NCXS,CXT,IM,2)
      CALL DRUMR(NCXS,CXR,JM,2)
```

```
      V11 = .0                                                          3DB 1578
      DO 298  KJ=1,JM                                                   3DB 1579
      DO 298 KI=1,IM                                                    3DB 1580
      I = KI + (KJ-1)*IM                                                3DB 1581
      V11 = V11 + S2(I)                                                 3DB 1582
      S2(I) = S2(I) + CXS(KI,KJ,4)*DUM1(I) + CXS(KI,KJ,5)*DUM2(I)       3DB 1583
298   FO(I) = N2(I)                                                     3DB 1584
      ITEMP2 = S04 + 1                                                  3DB 1585
      GO TO (310,322,340,330), ITEMP2                                   3DB 1586
310   IF(IGE - 1)  325,330,325                                          3DB 1587
322   IF (P02 - 2 * (P02/2))   330,330,340                              3DB 1588
325   IF (IM - JM) 330,330,340                                          3DB 1589
330   CALL INNER(NO, N2, CXS, S2, MO, M2, VO, CO, IM, JM, ITL, CXR, CXT,3DB 1590
     1          HA, PA,KK,DUM1,DUM2,Z5)                                 3DB 1591
      GO TO 350                                                         3DB 1592
340   CALLINNER2(NO, N2, CXS, S2, MO, M2, VO, CO, IM, JM, ITL, CXR, CXT,3DB 1593
     1          HA, PA,KK,DUM1,DUM2,Z5)                                 3DB 1594
350   DO 393  I=1,IMJM                                                  3DB 1595
      TEMP2 = ABS(1.0 - FO(I)/N2(I))                                    3DB 1596
      IF(FDIFF - TEMP2)  392,393,393                                    3DB 1597
392   FDIFF = TEMP2                                                     3DB 1598
393   CONTINUE                                                          3DB 1599
400   CALL DRUMR(NTEMP,N2,IMJM,1)                                       3DB 1600
      REWIND NS2                                                        3DB 1601
      REWIND NMO                                                        3DB 1602
      REWIND NCXS                                                       3DB 1603
      REWIND NDUM                                                       3DB 1604
      REWIND NTEMP                                                      3DB 1605
      CALL SWITCH(NTEMP,NDUM)                                           3DB 1606
      IF(NINIT - I07)  404,415,415                                      3DB 1607
404   IF(FDIFF - EPS2)  415,415,278                                     3DB 1608
415   DO 418  KK=1,KM                                                   3DB 1609
      CALL DRUMR(NDUM,N2,IMJM,2)                                        3DB 1610
418   CALL DRUMR(NSCRAT,N2,IMJM,1)                                      3DB 1611
      REWIND NDUM                                                       3DB 1612
      DO 430  K = 1,IZM                                                 3DB 1613
      ITEMP1 = M2(K)                                                    3DB 1614
430   CO(IHS,ITEMP1) = CO(IHS,ITEMP1) + T7                              3DB 1615
      EO(IGV) = .0                                                      3DB 1616
      DO 490  KK=1,KM                                                   3DB 1617
      CALL DRUMR(NDUM,N2,IMJM,2)                                        3DB 1618
      IF(IGV-1)  457,457,458                                            3DB 1619
457   CALL CLEAR(0.0,F2,IMJM)                                           3DB 1620
      GO TO 459                                                         3DB 1621
458   CALL DRUMR(NF2,F2,IMJM,2)                                         3DB 1622
459   IF(KK-1)  468,468,460                                             3DB 1623
460   IF(LYN(KK) - LYN(KK-1))  468,470,468                              3DB 1624
468   CALL DRUMR(NMO,MO,IMJM,2)                                         3DB 1625
470   DO 485  I=1,IMJM                                                  3DB 1626
      ITEMP = MO(I)                                                     3DB 1627
      ITEMP = M2(ITEMP)                                                 3DB 1628
      EO(IGV) = EO(IGV) + CO(IHF,ITEMP)*N2(I)*VO(I)*Z5(KK)              3DB 1629
      IF(A02)  475,480,475                                              3DB 1630
475   F2(I) = F2(I) + K6(IGV)*N2(I)                                     3DB 1631
      GO TO 485                                                         3DB 1632
480   F2(I) = F2(I) + CO(IHT-1,ITEMP)*N2(I)                             3DB 1633
485   CONTINUE                                                          3DB 1634
490   CALL DRUMR(NTEMP,F2,IMJM,1)                                       3DB 1635
      REWIND NMO                                                        3DB 1636
      REWIND NF2                                                        3DB 1637
```

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      REWIND NDUM                                                       3DB 1638
      REWIND NTEMP                                                      3DB 1639
      CALL SWITCH(NF2,NTEMP)                                            3DB 1640
      REWIND NSCRAT                                                     3DB 1641
      SBAR = IGV - (ITL-IHS)                                            3DB 1642
      IF(SBAR) 500, 500, 497                                            3DB 1643
497   DO 498  IS=1,SBAR                                                 3DB 1644
      DO 498  KK=1,KM                                                   3DB 1645
C     SKIP ONE RECORD                                                   3DB 1646
498   CALL NTRAN(NSCRAT,6,IMJM)                                         3DB 1647
500   IGV = IGV + 1                                                     3DB 1648
      IF(IGV - IGM)  2,2,510                                            3DB 1649
510   T11 = E1(IGP)                                                     3DB 1650
      REWIND NCR1                                                       3DB 1651
      REWIND NSCRAT                                                     3DB 1652
      REWIND NFLUX1                                                     3DB 1653
      CALL SWITCH(NSCRAT,NFLUX1)                                        3DB 1654
      IF (I04) 514,512,514                                              3DB 1655
512   REWIND NSORCE                                                     3DB 1656
C     OVER-RELAX FISSION SOURCE                                         3DB 1657
514   ORFF = 1.0 + .6*(ORF - 1.0)                                       3DB 1661
      E02 = .0                                                          3DB 1662
      IF(A02)  520,580,520                                              3DB 1663
520   E1(IGP) = .0                                                      3DB 1664
C     FOR ADJOINT CALCULATION, S2(I) STORES ORFED F2(I)                 3DB 1665
      DO 525  KK=1,KM                                                   3DB 1666
      CALL DRUMR(NF0,F0,IMJM,2)                                         3DB 1667
      CALL DRUMR(NF2,F2,IMJM,2)                                         3DB 1668
      DO 522  I=1,IMJM                                                  3DB 1669
522   S2(I) = F0(I) + ORFF*(F2(I) - F0(I))                              3DB 1670
525   CALL DRUMR(NS2,S2,IMJM,1)                                         3DB 1671
      REWIND NS2                                                        3DB 1672
      REWIND NF2                                                        3DB 1673
      REWIND NF0                                                        3DB 1674
      DO 540  IIG = 1,IGM                                               3DB 1675
      CALL DRUMR(NCR1,C0,ITLMT,2)                                       3DB 1676
      E1(IIG) = .0                                                      3DB 1677
      DO 530  KK=1,KM                                                   3DB 1678
      IF(KK-1)  527,527,526                                             3DB 1679
526   IF(LYN(KK) - LYN(KK-1))  527,528,527                              3DB 1680
527   CALL DRUMR(NM0,M0,IMJM,2)                                         3DB 1681
528   CALL DRUMR(NF2,F2,IMJM,2)                                         3DB 1682
      CALL DRUMR(NS2,S2,IMJM,2)                                         3DB 1683
      DO 530  I=1,IMJM                                                  3DB 1684
      ITEMP = M0(I)                                                     3DB 1685
      ITEMP = M2(ITEMP)                                                 3DB 1686
      E1(IIG) = E1(IIG) + C0(IHT-1,ITEMP)*F2(I)*V0(I)*Z5(KK)            3DB 1687
530   E02 = E02         + C0(IHT-1,ITEMP)*S2(I)*V0(I)*Z5(KK)            3DB 1688
      REWIND NM0                                                        3DB 1689
      REWIND NF2                                                        3DB 1690
      REWIND NS2                                                        3DB 1691
540   E1(IGP) = E1(IGP) + E1(IIG)                                       3DB 1692
      TEMP1 = E1(IGP)/E02                                               3DB 1693
      DO 555  KK=1,KM                                                   3DB 1694
      CALL DRUMR(NS2,S2,IMJM,2)                                         3DB 1695
      DO 550  I=1,IMJM                                                  3DB 1696
550   F0(I) = TEMP1*S2(I)                                               3DB 1697
555   CALL DRUMR(NF0,F0,IMJM,1)                                         3DB 1698
      REWIND NF0                                                        3DB 1699
      REWIND NS2                                                        3DB 1700
```

```
      REWIND NCR1
      GO TO 620
580   E01 = 0.0
      DO 595  KK=1,KM
      CALL DRUMR(NF0,F0,IMJM,2)
      CALL DRUMR(NF2,F2,IMJM,2)
      DO 590  I=1,IMJM
      E01 = E01 + V0(I)*F2(I)*Z5(KK)
      F2(I) = F0(I) + ORFF*(F2(I) - F0(I))
590   E02 = E02 + V0(I)*F2(I)*Z5(KK)
595   CALL DRUMR(NDUM,F2,IMJM,1)
      CALL SWITCH(NDUM,NF2)
      REWIND NF0
      REWIND NF2
      REWIND NDUM
      TEMP1 = E01/E02
      DO 605  KK=1,KM
      CALL DRUMR(NF2,F2,IMJM,2)
      DO 600  I=1,IMJM
600   F0(I) = TEMP1*F2(I)
605   CALL DRUMR(NF0,F0,IMJM,1)
      REWIND NF0
      REWIND NF2
      DO 610  IIG = 1,IGM
610   E1(IIG) = K6(IIG)*E01
      IF(I04) 620,611,620
C     ACCELERATION FOR EXTRANEOUS SOURCE PROBLEMS
611   TEMP1 = (1.0 - EV*T11/E01)/(1.0 - EV)
      IF (T11/E01 - .01) 620,620,612
612   IF (T11/E01 - 1./(EV + .0001)) 613,613,620
613   DO 615  KK=1,KM
      CALL DRUMR(NF0,F0,IMJM,2)
      DO 614  I=1,IMJM
614   F0(I) = TEMP1*F0(I)
615   CALL DRUMR(NDUM,F0,IMJM,1)
      CALL SWITCH(NDUM,NF0)
      REWIND NDUM
      REWIND NF0
      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
```

```
-ITC FR5 BALANC,BALANC
      SUBROUTINE BALANC(EE,N2,IDUM2,DUM2,DUM1,IDUM1,MO,LYN,CXS,CXR,CXT,
     1                  CO,VO,M2,JIM,JJM,Z5,JTL,AO,Y5,X5,X4,Y4,A1,A2,Z4,
     2                  IFLAG)
      INCLUDE ABC
      DIMENSION EE(11,1),N2(1), IDUM2(1), DUM2(1), DUM1(1), IDUM1(1),
     1          MO(1), LYN(1), CXS(JIM,JJM,1), CXR(1), CXT(1),
     2          CO(JTL,1), VO(1), M2(1), Z5(1), AO(1), Y5(1), X5(1),
     3          X4(1), Y4(1), A1(1), A2(1), Z4(1)
      REAL      N2
C     THIS SUBROUTINE REBALANCES THE FLUX FOR GROUP IGV OVER THE WHOLE
C     REACTOR
10    DO 20  LL=3,11
20    EE(LL,IGV) = .0
      CALL CLEAR(0.0,N2,IMJM)
      CALL DRUMR(NMO,IDUM2,IMJM,2)
      CALL DRUMR(NDUM,DUM2,IMJM,2)
      DO 200  KK=1,KM
      DO 30  I=1,IMJM
      DUM1(I) = N2(I)
      N2(I) = DUM2(I)
      IDUM1(I) = MO(I)
30    MO(I) = IDUM2(I)
      IF(KK-KM)  40,60,40
40    CALL DRUMR(NDUM,DUM2,IMJM,2)
      IF(LYN(KK) - LYN(KK+1))  50,70,50
50    CALL DRUMR(NMO,IDUM2,IMJM,2)
      GO TO 70
60    CALL CLEAR(0.0,DUM2,IMJM)
70    IF(IFLAG - 1)  75,75,100
75    IF(IGE-1)  80,80,90
80    CALL INNER1(MO, M2, CXS, VO, CO, AO, Y5, X5, X4, Y4, A1, IM, JM,
     1            ITL, CXR,CXT,IDUM1,IDUM2,A2,Z4,Z5,KK)
      GO TO 100
90    CALL INNERT(MO, M2, CXS, VO, CO, AO, Y5, X5, X4, Y4, A1, IM, JM,
     1            ITL, CXR,CXT,IDUM1,IDUM2,A2,Z4,Z5,KK)
100   ITEMP9 = IM*JM*5
      CALL DRUMR(NCXS,CXS,ITEMP9,IFLAG)
      CALL DRUMR(NCXS,CXT,IM,IFLAG)
      CALL DRUMR(NCXS,CXR,JM,IFLAG)
      CALL IFLUXN(N2,CO,VO,CXS,MO,M2,ITL,IM,JM,CXR,CXT,KK,DUM1,DUM2,Z5,
     1            1)
      IF(KK-1)  140,140,150
140   EE(11,IGV) = E11(IGV)
150   IF(KK-KM)  170,160,160
160   EE(10,IGV) = E10(IGV)
170   EE(3,IGV) = EE(3,IGV) + E3(IGV)
      EE(4,IGV) = EE(4,IGV) + E4(IGV)
      EE(5,IGV) = EE(5,IGV) + E5(IGV)
      EE(6,IGV) = EE(6,IGV) + E6(IGV)
      EE(7,IGV) = EE(7,IGV) + E7(IGV)
      EE(8,IGV) = EE(8,IGV) + E8(IGV)
      EE(9,IGV) = EE(9,IGV) + E9(IGV)
200   CONTINUE
      REWIND NMO
      REWIND NDUM
      REWIND NCXS
      TEMP = (E1(IGV) + E2(IGV))/(EE(3,IGV) + EE(4,IGV) + EE(5,IGV) +
     1       EE(6,IGV) + EE(7,IGV) + EE(8,IGV) + EE(10,IGV) +EE(11,IGV))
      DO 210  LL=3,11
```

```
210    EE(LL,IGV) = TEMP*EE(LL,IGV)                    3DB 1809
       DO 230  KK=1,KM                                 3DB 1810
       CALL DRUMR(NDUM,N2,IMJM,2)                      3DB 1811
       DO 220  I=1,IMJM                                3DB 1812
220    N2(I) = TEMP*N2(I)                              3DB 1813
230    CALL DRUMR(NTEMP,N2,IMJM,1)                     3DB 1814
       REWIND NDUM                                     3DB 1815
       REWIND NTEMP                                    3DB 1816
       CALL SWITCH(NDUM,NTEMP)                         3DB 1817
       RETURN                                          3DB 1818
       END                                             3DB 1819
```

```
-ITC FR5  INNER1,INNER1
      SUBROUTINE INNER1(M0, M2, CXS, V0, C0, A0, Y5, X5, X4, Y4, A1,
     2              JIM,JJM,JTL,CXR,CXT,IDUM1,IDUM2,A2,Z4,Z5,KK)
      DIMENSION  M0(1), M2(1),CXS(JIM,JJM,5),V0(1), C0(JTL,1),
     1           A0(1), Y5(1), X5(1), X4(1), Y4(1), A1(1),CXR(1), CXT(1)
     2         , IDUM1(1), IDUM2(1), A2(1), Z4(1), Z5(1)
      INCLUDE ABC
C     THIS SUBROUTINE CALCULATES COEFFICIENTS FOR THE FLUX EQUATION
      PI2 = 6.28318
      DO  55  KJ = 1, JM
      DO  55  KI = 1, IM
      GO TO (   10, 5), IGEP
5     TEMP = PI2*(Y4(KJ) - Y4(KJ-1))*X4(KI)
      GO TO 15
10    TEMP = Y4(KJ) - Y4(KJ-1)
15    I = KI + (KJ-1)*IM
      ITEMP = M0(I)
      ITEMP = M2(ITEMP)
      CXS(KI,KJ,3) = V0(I)*(C0(IHT,ITEMP) - C0(IHS,ITEMP))*Z5(KK)
      IF(I - 1)  45,45,18
18    ITEMP1 = M0(I-1)
      ITEMP1 = M2(ITEMP1)
      IF (ITEMP - ITEMP1) 25,20,25
20    CXS(KI,KJ,1)=A0(KI)*Y5(KJ)*Z5(KK)/(3.*C0(IHT,ITEMP)*(X4(KI)-
     1              X4(KI-1)))
      GO TO 30
25    CXS(KI,KJ,1) = A0(KI)*Y5(KJ)*Z5(KK)*(X5(KI-1)+X5(KI))/((X4(KI)-
     1               X4(KI-1))*(3.*(X5(KI-1)*C0(IHT,ITEMP1) + X5(KI)*
     2               C0(IHT,ITEMP))))
30    IF(I - IM)  45,45,32
32    ITEMP3 = M0(I - IM)
      ITEMP3 = M2(ITEMP3)
      IF (ITEMP - ITEMP3) 40,35,40
35    CXS(KI,KJ,2) = A1(KI)*Z5(KK)/(3.*C0(IHT,ITEMP)*TEMP)
      GO TO 45
40    CXS(KI,KJ,2) = A1(KI)*Z5(KK)*(Y5(KJ-1) + Y5(KJ))/(TEMP*
     1 (3.*(Y5(KJ-1)*C0(IHT,ITEMP3) + Y5(KJ)*C0(IHT,ITEMP))))
45    IF(KK-1)  49,49,46
46    ITEMP3 = IDUM1(I)
      ITEMP3 = M2(ITEMP3)
      IF(ITEMP - ITEMP3)  48,47,48
47    CXS(KI,KJ,4) = A2(KI)*Y5(KJ)/(3.*C0(IHT,ITEMP)*(Z4(KK) -Z4(KK-1)))
      GO TO 49
48    CXS(KI,KJ,4) = A2(KI)*Y5(KJ)*(Z5(KK-1) + Z5(KK))/((Z4(KK) -
     1               Z4(KK-1))*(3.*(Z5(KK-1)*C0(IHT,ITEMP3) + Z5(KK)*
     2               C0(IHT,ITEMP))))
49    IF(KK-KM)  50,55,55
50    ITEMP3 = IDUM2(I)
      ITEMP3 = M2(ITEMP3)
      IF(ITEMP - ITEMP3)  52,51,52
51    CXS(KI,KJ,5) = A2(KI)*Y5(KJ)/(3.*C0(IHT,ITEMP)*(Z4(KK+1) -Z4(KK)))
      GO TO 55
52    CXS(KI,KJ,5) = A2(KI)*Y5(KJ)*(Z5(KK+1) + Z5(KK))/((Z4(KK+1) -
     1               Z4(KK))*(3.*(Z5(KK+1)*C0(IHT,ITEMP3) + Z5(KK)*
     2               C0(IHT,ITEMP))))
55    CONTINUE
      DO 200  KJ = 1, JM
      DO 200  KI = 1, IM
      GO TO (58,56), IGEP
56    TEMP = .5*PI2*Y5(KJ)*X4(KI)
```

```
      GO TO 60
58    TEMP = .5*Y5(KJ)
60    I = KI + (KJ-1)*IM
      ITEMP = M0(I)
      ITEMP = M2(ITEMP)
      TEMP1 = CXS(KI+1,KJ,1)
      TEMP2 = CXS(KI,KJ+1,2)
      IF(KJ - 1)  65,65,100
65    IF(B04 - 1)  90,95,95
90    CXS(KI,KJ,2) = A1(KI)*Z5(KK)/(3.*C0(IHT,ITEMP)*(TEMP + .71/
     1 C0(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) 115,120,120
115   TEMP2 = A1(KI)*Z5(KK)/(3.*C0(IHT,ITEMP)*(TEMP + .71/
     1 C0(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)*Y5(KJ)*Z5(KK)/(3.*C0(IHT,ITEMP)*
     1 (.5*X5(KI) + .71/C0(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)*Y5(KJ)*Z5(KK)/(3.*C0(IHT,ITEMP)*
     1 (.5*X5(KI) + .71/C0(IHT,ITEMP)))
      CXR(KJ) = TEMP1
      GO TO 165
160   TEMP1 = .0
      CXR(KJ) = TEMP1
165   IF(KK-1)  170,170,182
170   IF(B06)  175,175,180
175   CXS(KI,KJ,4) = A2(KI)*Y5(KJ)/(3.*C0(IHT,ITEMP)*(.5*Z5(KK) + .71/
     1                C0(IHT,ITEMP)))
      GO TO 195
180   CXS(KI,KJ,4) = .0
182   IF(KK-KM)  195,184,184
184   IF(B05)  185,185,190
185   CXS(KI,KJ,5) = A2(KI)*Y5(KJ)/(3.*C0(IHT,ITEMP)*(.5*Z5(KK) + .71/
     1                C0(IHT,ITEMP)))
      GO TO 195
190   CXS(KI,KJ,5) = .0
195   CXS(KI,KJ,3) = CXS(KI,KJ,3) + CXS(KI,KJ,1) + CXS(KI,KJ,2)
     1  + TEMP1 + TEMP2 + CXS(KI,KJ,4) + CXS(KI,KJ,5)
200   CONTINUE
      RETURN
      END
```

```
-ITC FR5  INNERT,INNERT
      SUBROUTINE INNERT(MO, M2, CXS, VO, CO, AO, Y5, X5, X4, Y4, A1,
     2                  JIM,JJM,JTL,CXR,CXT,IDUM1,IDUM2,A2,Z4,Z5,KK)
      DIMENSION  MO(1), M2(1),CXS(JIM,JJM,5),VO(1), CO(JTL,1),
     1           AO(1), Y5(1), X5(1), X4(1), Y4(1), A1(1),CXR(1), CXT(1)
     2         , IDUM1(1), IDUM2(1), A2(1), Z4(1), Z5(1)
      INCLUDE ABC
C     THIS SUBROUTINE CALCULATES COEFFICIENTS FOR TRIANGULAR GEOMETRY
      DO  55  KJ = 1, JM
      DO  55  KI = 1, IM
      TEMP = KI - 2* (KI/2) - (KJ - 2* (KJ/2))
      TEMP = ABS(TEMP)
      I = KI + (KJ-1) *IM
      ITEMP = MO(I)
      ITEMP = M2(ITEMP)
      CXS(KI,KJ,3) = VO(I)*(CO(IHT,ITEMP) - CO(IHS,ITEMP))*Z5(KK)
      IF(I - 1)  45, 45, 18
18    ITEMP1 = MO(I-1)
      ITEMP1 = M2(ITEMP1)
      IF(ITEMP - ITEMP1)  25, 20, 25
20    CXS(KI,KJ,1) = AO(KI)*Z5(KK)/(2.*CO(IHT,ITEMP)*Y5(1))
      GO TO 30
25    CXS(KI,KJ,1) = AO(KI)*Z5(KK)/((CO(IHT,ITEMP1) + CO(IHT,ITEMP))
     1               *Y5(1))
30    IF(I - IM)  45, 45, 32
32    ITEMP3 = MO(I - IM)
      ITEMP3 = M2(ITEMP3)
      IF(ITEMP - ITEMP3)  40, 35, 40
35    CXS(KI,KJ,2) = A1(KI)*Z5(KK)*TEMP/(2.*CO(IHT,ITEMP)*Y5(1))
      GO TO 45
40    CXS(KI,KJ,2) = A1(KI)*Z5(KK)*TEMP/((CO(IHT,ITEMP3) + CO(IHT,ITEMP)
     1               )*Y5(1))
45    IF(KK-1)  49,49,46
46    ITEMP3 = IDUM1(I)
      ITEMP3 = M2(ITEMP3)
      IF(ITEMP - ITEMP3)  48,47,48
47    CXS(KI,KJ,4) = A2(KI)*Y5(KJ)/(3.*CO(IHT,ITEMP)*(Z4(KK) -Z4(KK-1)))
      GO TO 49
48    CXS(KI,KJ,4) = A2(KI)*Y5(KJ)*(Z5(KK-1) + Z5(KK))/((Z4(KK) -
     1               Z4(KK-1))*(3.*(Z5(KK-1)*CO(IHT,ITEMP3) + Z5(KK)*
     2               CO(IHT,ITEMP))))
49    IF(KK-KM)  50,55,55
50    ITEMP3 = IDUM2(I)
      ITEMP3 = M2(ITEMP3)
      IF(ITEMP - ITEMP3)  52,51,52
51    CXS(KI,KJ,5) = A2(KI)*Y5(KJ)/(3.*CO(IHT,ITEMP)*(Z4(KK+1) -Z4(KK)))
      GO TO 55
52    CXS(KI,KJ,5) = A2(KI)*Y5(KJ)*(Z5(KK+1) + Z5(KK))/((Z4(KK+1) -
     1               Z4(KK))*(3.*(Z5(KK+1)*CO(IHT,ITEMP3) + Z5(KK)*
     2               CO(IHT,ITEMP))))
55    CONTINUE
      DO 200  KJ = 1, JM
      DO 200  KI = 1, IM
      TEMP = KI - 2*(KI/2) - (KJ-2*(KJ/2))
      TEMP = ABS(TEMP)
      I = KI + (KJ-1)*IM
      ITEMP = MO(I)
      ITEMP = M2(ITEMP)
      TEMP1 = CXS(KI+1,KJ,1)
      TEMP2 = CXS(KI,KJ+1,2)
```

```
      IF(KJ-1)  65, 65, 100
65    IF(B04-1)  90, 95, 95
90    CXS(KI,KJ,2) = A1(KI)*Z5(KK)*TEMP/(3.*CO(IHT,ITEMP)*(Y5(1)/3.
     1                + .71/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, 120
115   TEMP = KI - 2*(KI/2) - (KJ + 1- 2*((KJ+1)/2))
      TEMP = ABS(TEMP)
      TEMP2 = A1(KI)*Z5(KK)*TEMP/(3.*CO(IHT,ITEMP)*(Y5(1)/3. + .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(KK)/(3.*CO(IHT,ITEMP)*(Y5(1)/3.
     1  + .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(KK)/(3.*CO(IHT,ITEMP)*(Y5(1)/3. + .71/
     1        CO(IHT,ITEMP)))
      CXR(KJ) = TEMP1
      GO TO 165
160   TEMP1 = .0
      CXR(KJ) = TEMP1
165   IF(KK-1)  170,170,182
170   IF(B06)  175,175,180
175   CXS(KI,KJ,4) = A2(KI)*Y5(KJ)/(3.*CO(IHT,ITEMP)*(.5*Z5(KK) + .71/
     1                CO(IHT,ITEMP)))
      GO TO 195
180   CXS(KI,KJ,4) = .0
182   IF(KK-KM)  195,184,184
184   IF(B05)  185,185,190
185   CXS(KI,KJ,5) = A2(KI)*Y5(KJ)/(3.*CO(IHT,ITEMP)*(.5*Z5(KK) + .71/
     1                CO(IHT,ITEMP)))
      GO TO 195
190   CXS(KI,KJ,5) = .0
195   CXS(KI,KJ,3) = CXS(KI,KJ,3) + CXS(KI,KJ,1) + CXS(KI,KJ,2)
     1  + TEMP1 + TEMP2 + CXS(KI,KJ,4) + CXS(KI,KJ,5)
200   CONTINUE
      RETURN
      END
```

```
-ITC FR5  INNER,INNER
      SUBROUTINE INNER(NO, N2, CXS, S2, MO, M2, VO, CO,JIM,JJM, JTL,
     1                 CXR,CXT, HA, PA,KK,DUM1,DUM2,Z5)
      INCLUDE ABC
      DIMENSION  NO(1), N2(1),CXS(JIM,JJM,5),S2(1), MO(1), M2(1),
     1           VO(1), CO(JTL,1), CXR(1), CXT(1), HA(1), PA(1)
     2         , DUM1(1), DUM2(1), Z5(1)
      REAL         NO,      N2
      CALL IFLUXN (N2, CO, VO, CXS, MO, M2, ITL, IM, JM, CXR, CXT,
     1            KK,DUM1,DUM2,Z5,2)
2     DO 4  I=1, IMJM
4     NO(I) = N2(I)
C     BEGIN FLUX CALCULATION
      IKB = IM - 1
      JKB = JM - 1
C     FLUX CALCULATION USING SOR WITH LINE INVERSION
C
C     CALCULATION OF LEFT BOUNDARY FLUX
      KI = 1
      KJ = 1
      I = KI + (KJ - 1)*IM
      HA(KJ)= CXS(KI,KJ+1,2)/CXS(KI,KJ,3)
      PA(KJ)= (S2(I) + CXS(KI+1,KJ,1)*N2(I+1))/CXS(KI,KJ,3)
      DO  5 KJ = 2,JKB
      I = KI + (KJ - 1)*IM
      HA(KJ) = CXS(KI,KJ+1,2)/(CXS(KI,KJ,3)- CXS(KI,KJ,2)*HA(KJ-1))
5     PA(KJ) = (S2(I) + CXS(KI+1,KJ,1)*N2(I+1) + CXS(KI,KJ,2)*PA(KJ-1))/
     1  (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))
      KJ = JM
      I = KI + (KJ - 1)*IM
      N2(I)  = (S2(I) + CXS(KI+1,KJ,1)*N2(I+1) + CXS(KI,KJ,2)*PA(KJ-1))/
     1  (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))
      DO 10 KJJ = 2,JM
      KJ = JM - KJJ + 1
      I = KI + (KJ - 1)*IM
10    N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)
      DO 15 KJ = 1,JM
      I = KI + (KJ - 1)*IM
15    N2(I) = NO(I) + ORF*(N2(I) - NO(I))
C     PRINCIPAL FLUX LOOP
      DO 40 KI = 2,IKB
      KJ = 1
      I = KI + (KJ - 1)*IM
      HA(KJ)= CXS(KI,KJ+1,2)/CXS(KI,KJ,3)
      PA(KJ)= (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI+1,KJ,1)*N2(I+1))/
     1  CXS(KI,KJ,3)
      DO 25 KJ = 2,JKB
      I = KI + (KJ - 1)*IM
      HA(KJ) = CXS(KI,KJ+1,2)/(CXS(KI,KJ,3)- CXS(KI,KJ,2)*HA(KJ-1))
25    PA(KJ) = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI+1,KJ,1)*N2(I+1) +
     1 CXS(KI,KJ,2)*PA(KJ-1))/(CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))
      KJ = JM
      I = KI + (KJ - 1)*IM
      N2(I)  = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI+1,KJ,1)*N2(I+1) +
     1 CXS(KI,KJ,2)*PA(KJ-1))/(CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))
      DO 30 KJJ = 2,JM
      KJ = JM - KJJ + 1
      I = KI + (KJ - 1)*IM
30    N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)
      DO 35 KJ = 1,JM
```

```
      I = KI + (KJ - 1)*IM                                           3DB 2103
35    N2(I) = NO(I) + ORF*(N2(I) - NO(I))                            3DB 2104
40    CONTINUE                                                       3DB 2105
C     CALCULATION OF RIGHT BOUNDARY FLUX                             3DB 2106
      KI = IM                                                        3DB 2107
      KJ = 1                                                         3DB 2108
      I = KI + (KJ - 1)*IM                                           3DB 2109
      HA(KJ)= CXS(KI,KJ+1,2)/CXS(KI,KJ,3)                            3DB 2110
      PA(KJ)= (S2(I) + CXS(KI,KJ,1)*N2(I-1))/CXS(KI,KJ,3)            3DB 2111
      DO 45 KJ = 2,JKB                                               3DB 2112
      I = KI + (KJ - 1)*IM                                           3DB 2113
      HA(KJ) = CXS(KI,KJ+1,2)/(CXS(KI,KJ,3)- CXS(KI,KJ,2)*HA(KJ-1))  3DB 2114
45    PA(KJ) = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*PA(KJ-1))/ 3DB 2115
     1  (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))                       3DB 2116
      KJ = JM                                                        3DB 2117
      I = KI + (KJ - 1)*IM                                           3DB 2118
      N2(I)  = (S2(I) + CXS(KI,KJ,1)*N2(I-1) + CXS(KI,KJ,2)*PA(KJ-1))/ 3DB 2119
     1  (CXS(KI,KJ,3) - CXS(KI,KJ,2)*HA(KJ-1))                       3DB 2120
      DO 50 KJJ = 2,JM                                               3DB 2121
      KJ = JM - KJJ + 1                                              3DB 2122
      I = KI + (KJ - 1)*IM                                           3DB 2123
50    N2(I) = PA(KJ) + HA(KJ) * N2(I+IM)                             3DB 2124
      DO 55 KJ = 1,JM                                                3DB 2125
      I = KI + (KJ - 1)*IM                                           3DB 2126
55    N2(I) = NO(I) + ORF*(N2(I) - NO(I))                            3DB 2127
      TEMP1 = .0                                                     3DB 2128
      DO 90 I = 1,IMJM                                               3DB 2129
      TEMP2 = ABS (1.0 - NO(I)/N2(I))                                3DB 2130
      IF (TEMP1 - TEMP2) 80,90,90                                    3DB 2131
80    TEMP1 = TEMP2                                                  3DB 2132
90    CONTINUE                                                       3DB 2133
C                                                                    3DB 2134
C     INNER ITERATION CONTROL                                        3DB 2135
133   LC = LC + 1                                                    3DB 2136
      II = II + 1                                                    3DB 2137
      IF (II - G07) 533, 1033, 1033                                  3DB 2138
533   IF(TEMP1 - G06)  1033,1033,2                                   3DB 2139
1033  RETURN                                                         3DB 2140
      END                                                            3DB 2141
```

```
-ITC FR5  INNER2,INNER2                                                   3DB 2142
      SUBROUTINEINNER2(NO, N2, CXS, S2, MO, M2, VO, CO,JIM,JJM, JTL,      3DB 2143
     1                CXR,CXT, HA, PA,KK,DUM1,DUM2,Z5)                    3DB 2144
      INCLUDE ABC                                                         3DB 2145
      DIMENSION  NO(1), N2(1),CXS(JIM,JJM,5),S2(1), MO(1), M2(1),         3DB 2146
     1           VO(1), CO(JTL,1), CXR(1), CXT(1), HA(1), PA(1)           3DB 2147
     2         , DUM1(1), DUM2(1), Z5(1)                                  3DB 2148
      REAL       NO,      N2                                              3DB 2149
      CALL IFLUXN (N2, CO, VO, CXS, MO, M2, ITL, IM, JM, CXR, CXT,        3DB 2150
     1           KK,DUM1,DUM2,Z5,2)                                       3DB 2151
2     DO 4  I=1, IMJM                                                     3DB 2152
4     NO(I) = N2(I)                                                       3DB 2153
C     BEGIN FLUX CALCULATION                                              3DB 2154
      IKB = IM - 1                                                        3DB 2155
      JKB = JM - 1                                                        3DB 2156
C     FLUX CALCULATION USING SOR WITH LINE INVERSION                      3DB 2157
C                                                                         3DB 2158
C     CALCULATION OF BOTTOM BOUNDARY FLUX                                 3DB 2159
      KI = 1                                                              3DB 2160
      KJ = 1                                                              3DB 2161
      I = KI + (KJ - 1)*IM                                                3DB 2162
      HA(KI)= CXS(KI+1,KJ,1)/CXS(KI,KJ,3)                                 3DB 2163
      PA(KI)= (S2(I) + CXS(KI,KJ+1,2)*N2(I+IM))/CXS(KI,KJ,3)              3DB 2164
      DO  5 KI = 2,IKB                                                    3DB 2165
      I = KI + (KJ - 1)*IM                                                3DB 2166
      HA(KI) = CXS(KI+1,KJ,1)/(CXS(KI,KJ,3)- CXS(KI,KJ,1)*HA(KI-1))       3DB 2167
5     PA(KI) = (S2(I) + CXS(KI,KJ+1,2)*N2(I+IM)+ CXS(KI,KJ,1)*PA(KI-1))/3DB 2168
     1  (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1))                            3DB 2169
      KI = IM                                                             3DB 2170
      I = KI + (KJ - 1)*IM                                                3DB 2171
      N2(I)  = (S2(I) + CXS(KI,KJ+1,2)*N2(I+IM)+ CXS(KI,KJ,1)*PA(KI-1))/3DB 2172
     1  (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1))                            3DB 2173
      DO 10 KII = 2,IM                                                    3DB 2174
      KI = IM - KII + 1                                                   3DB 2175
      I = KI + (KJ - 1)*IM                                                3DB 2176
10    N2(I) = PA(KI) + HA(KI) * N2(I+1)                                   3DB 2177
      DO 15 KI = 1,IM                                                     3DB 2178
      I = KI + (KJ - 1)*IM                                                3DB 2179
15    N2(I) = NO(I) + ORF*(N2(I) - NO(I))                                 3DB 2180
C     PRINCIPAL FLUX LOOP                                                 3DB 2181
      DO 40 KJ = 2,JKB                                                    3DB 2182
      KI = 1                                                              3DB 2183
      I = KI + (KJ - 1)*IM                                                3DB 2184
      HA(KI)= CXS(KI+1,KJ,1)/CXS(KI,KJ,3)                                 3DB 2185
      PA(KI)= (S2(I) + CXS(KI,KJ,2)*N2(I-IM)+ CXS(KI,KJ+1,2)*N2(I+IM))/  3DB 2186
     1  CXS(KI,KJ,3)                                                      3DB 2187
      DO 25 KI = 2,IKB                                                    3DB 2188
      I = KI + (KJ - 1)*IM                                                3DB 2189
      HA(KI) = CXS(KI+1,KJ,1)/(CXS(KI,KJ,3)- CXS(KI,KJ,1)*HA(KI-1))       3DB 2190
25    PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM)+ CXS(KI,KJ+1,2)*N2(I+IM)+  3DB 2191
     1 CXS(KI,KJ,1)*PA(KI-1))/(CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1))      3DB 2192
      KI = IM                                                             3DB 2193
      I = KI + (KJ - 1)*IM                                                3DB 2194
      N2(I)  = (S2(I) + CXS(KI,KJ,2)*N2(I-IM)+ CXS(KI,KJ+1,2)*N2(I+IM)+  3DB 2195
     1 CXS(KI,KJ,1)*PA(KI-1))/(CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1))      3DB 2196
      DO 30 KII = 2,IM                                                    3DB 2197
      KI = IM - KII + 1                                                   3DB 2198
      I = KI + (KJ - 1)*IM                                                3DB 2199
30    N2(I) = PA(KI) + HA(KI) * N2(I+1)                                   3DB 2200
      DO 35 KI = 1,IM                                                     3DB 2201
```

```
      I = KI + (KJ - 1)*IM
35    N2(I) = NO(I) + ORF*(N2(I) - NO(I))
40    CONTINUE
C     CALCULATION OF TOP BOUNDARY FLUX
      KJ = JM
      KI = 1
      I = KI + (KJ - 1)*IM
      HA(KI)= CXS(KI+1,KJ,1)/CXS(KI,KJ,3)
      PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM))/CXS(KI,KJ,3)
      DO 45 KI = 2,IKB
      I = KI + (KJ - 1)*IM
      HA(KI) = CXS(KI+1,KJ,1)/(CXS(KI,KJ,3)- CXS(KI,KJ,1)*HA(KI-1))
45    PA(KI) = (S2(I) + CXS(KI,KJ,2)*N2(I-IM)+ CXS(KI,KJ,1)*PA(KI-1))/
     1 (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1))
      KI = IM
      I = KI + (KJ - 1)*IM
      N2(I)  = (S2(I) + CXS(KI,KJ,2)*N2(I-IM)+ CXS(KI,KJ,1)*PA(KI-1))/
     1 (CXS(KI,KJ,3) - CXS(KI,KJ,1)*HA(KI-1))
      DO 50 KII = 2,IM
      KI = IM - KII + 1
      I = KI + (KJ - 1)*IM
50    N2(I) = PA(KI) + HA(KI) * N2(I+1)
      DO 55 KI = 1,IM
      I = KI + (KJ - 1)*IM
55    N2(I) = NO(I) + ORF*(N2(I) - NO(I))
      TEMP1 = .0
      DO 90 I = 1,IMJM
      TEMP2 = ABS (1.0 - NO(I)/N2(I))
      IF (TEMP1 - TEMP2) 80,90,90
80    TEMP1 = TEMP2
90    CONTINUE
C
C     INNER ITERATION CONTROL
133   LC = LC + 1
      II = II + 1
      IF (II - G07) 533, 1033, 1033
533   IF(TEMP1 - G06)  1033,1033,2
1033  RETURN
      END
```

```
-ITC FR5 IFLUXN,IFLUXN
      SUBROUTINE IFLUXN (N2, CO, VO, CXS, MO, M2, JTL,JIM,JJM, CXR, CXT,
     1                   KK,DUM1,DUM2,Z5,IFLAG)
      INCLUDE ABC
      DIMENSION  N2(1), CO(JTL,1), VO(1),CXS(JIM,JJM,5),MO(1), M2(1),
     1          CXR(1), CXT(1), DUM1(1), DUM2(1), Z5(1)
      REAL         N2
C     THIS SUBROUTINE NORMALIZES FLUXES BEFORE EACH INNER ITERATION
C     ABSORPTION AND OUT-SCATTER
      E3(IGV) = 0.0
      E4(IGV) = 0.0
      DO 10  I=1, IMJM
      TEMP = VO(I)*N2(I)*Z5(KK)
      ITEMP = MO(I)
      ITEMP = M2(ITEMP)
      E3(IGV) = E3(IGV) + (CO(IHT,ITEMP) - CO(IHS,ITEMP) - CO(IHA,ITEMP)
     1          )*TEMP
10    E4(IGV) = E4(IGV) + CO(IHA,ITEMP)*TEMP
C     LEFT LEAKAGE
      IF(B01)  20, 20, 40
20    E5(IGV) = 0.0
      DO 30  KJ = 1, JM
      I = (KJ - 1)*IM + 1
30    E5(IGV) = E5(IGV) + CXS(1,KJ,1)*N2(I)
      GO TO 50
40    E5(IGV) = .0
C     RIGHT LEAKAGE
50    IF(B02)  60, 60, 80
60    E6(IGV) = 0.0
      DO 70  KJ = 1, JM
      I = KJ*IM
70    E6(IGV) = E6(IGV) + CXR(KJ)*N2(I)
      GO TO 90
80    E6(IGV) = 0.0
C     BACK LEAKAGE
90    IF(B03-1)  120, 140, 140
120   E7(IGV) = 0.0
      DO 130  KI = 1, IM
      I = IMJM - IM + KI
130   E7(IGV) = E7(IGV) + CXT(KI)*N2(I)
      GO TO 150
140   E7(IGV) = 0.0
C     FRONT LEAKAGE
150   IF(B04)  160, 160, 180
160   E8(IGV) = 0.0
      DO 170 KI = 1, IM
170   E8(IGV) = E8(IGV) + CXS(KI,1,2)*N2(KI)
      GO TO 190
180   E8(IGV) = 0.0
C     TOP AND BOTTOM LEAKAGE
190   E10(IGV) = 0.0
      E11(IGV) = 0.0
      DO 195  KJ=1,JM
      DO 195  KI=1,IM
      I = KI + (KJ-1)*IM
      E10(IGV) = E10(IGV) + CXS(KI,KJ,5)*(N2(I) - DUM2(I))
195   E11(IGV) = E11(IGV) + CXS(KI,KJ,4)*(N2(I)-DUM1(I))
      E9(IGV) = E5(IGV) + E6(IGV) + E7(IGV) + E8(IGV) + E10(IGV) +
     2          E11(IGV)
      IF(IFLAG-1)  220,220,198
```

```
198    TEMP = V11/(E3(IGV) + E4(IGV) + E9(IGV))
       DO 200 I = 1, IMJM
200    N2(I) = TEMP*N2(I)
       E3(IGV) = TEMP*E3(IGV)
       E4(IGV) = TEMP*E4(IGV)
       E5(IGV) = TEMP*E5(IGV)
       E6(IGV) = TEMP*E6(IGV)
       E7(IGV) = TEMP*E7(IGV)
       E8(IGV) = TEMP*E8(IGV)
       E9(IGV) = TEMP*E9(IGV)
       E10(IGV) = TEMP*E10(IGV)
       E11(IGV) = TEMP*E11(IGV)
220    RETURN
       END
```

```
-ITC FR5  CNNP,CNNP
      SUBROUTINE CNNP (F2,K6)
      DIMENSION F2(1), K6(1)
      REAL        K6
      INCLUDE ABC
C     CONVERGENCE TESTS
      IF(MAXT)  25, 25, 10
10    CALL ETIMEF(TEMP)
      IF(TEMP - GLH)  25, 15, 15
15    NGOTO = 1
      WRITE(NOUT,20)
20    FORMAT(53H1 * *  RUNNING TIME EXCEEDED--FORCED CONVERGENCE  * *//)
      GO TO 135
25    CONTINUE
30    E01=1.0-ALA
      IF(ABS (E01)-10.0*EPS)  40,  40,  45
40    ORF = ORFP
45    CONTINUE
      E02=ABS(E01)
50    IF(E1(IGP)) 55, 130, 55
55    IF (E02 - EPS)  60, 60, 70
60    CVT=1
70    DO 75  KK=1,KM
      CALL CLEAR(0.0,F2,IMJM)
75    CALL DRUMR(NF2,F2,IMJM,1)
      REWIND NF2
      GO TO 105
80    EV=EV+POD*EQ*E01
      GO TO 170
C     FINAL PRINT
90    NGOTO=1
      IF (I04 - 1)  135,  95,  80
95    EV=0.0
      DO 100   I=1,IGM
100   EV=EV+K6(I)
      EV=SK7/EV
      GO TO 135
105   IF(CVT-1) 110, 90, 110
110   IF(I04-1) 115, 120, 140
C     MONITOR PRINT
115   NGOTO=2
      GO TO 135
120   EV=0.
      DO 125 I=1,IGM
125   EV=EV+K6(I)
      EV=SK7/EV
      GO TO 115
130   CALL ERRO2(6H**CNNP,130,1)
135   RETURN
140   CONTINUE
C
C     CALCULATE NEW PARAMETERS FOR SEARCH CALCULATIONS
145   E03=ABS (ALA-LAR)
      IF (LAPP)  270, 150, 270
150   IF (LAP)  230, 155, 230
155   IF (EQ) 200, 160, 200
160   IF (E03-EPSA) 175, 175, 165
C     MONITOR PRINT.
165   NGOTO=2
      RETURN
```

```
C     FINAL PRINT EXIT.
170   NGOTO=1
      RETURN
175   LAP=ALA
      EVP=EV
      IF (E01) 185,185,180
180   EV=EV-EVM
      GO TO 190
185   EV=EV+EVM
190   IF (I04-2)   195,  165,  195
C     MIX X-SECS.
195   NGOTO=3
      RETURN
200   IF (CVT) 170, 205,170
205   EV=EV+POD*EQ*E01
210   IF ((LAPP-1.0)/(LAP-1.0))  215, 190, 190
215   TEMP1=AMIN1(EVP,EVPP)
      IF (EV-TEMP1)  220, 225, 225
220   EV=(EVPP+EVP)/2.
      GO TO 190
225   TEMP1=AMAX1(EVP,EVPP)
      IF (EV-TEMP1)  190, 220, 220
230   IF (E03-EPSA)  235, 235, 165
235   EQ=(EVP-EV)/(LAP-ALA)
240   IF (CNT)  260, 245, 260
245   IF (E02-LAL)  265, 265, 250
250   IF (E02-LAH)  260, 260, 255
255   E01=SIGN (LAH,E01)
260   LAPP=LAP
      LAP=ALA
      EVPP=EVP
      EVP=EV
      GO TO 205
265   CNT=1
      LAP=0.0
      LAPP=0.0
      GO TO 205
270   IF (E03-EPSA) 275, 275, 165
C     CALCULATE QUADRATIC COEFFICIENTS.
275   TEMP1=EVP-EV
      TEMP2=EVPP-EV
      TEMP3=EVPP-EVP
      TEMP4=TEMP1*(EVP+EV)
      TEMP5=-TEMP2*(EV+EVPP)
      TEMP6=TEMP3*(EVPP+EVP)
      DENOM=TEMP3*TEMP2*TEMP1
      EQA=((LAPP-1.0)*TEMP1*EVP*EV-(LAP-1.0)*TEMP2
     1*EV*EVPP+(ALA-1.0)*TEMP3*EVPP*EVP)/DENOM
      EQB=-(LAPP*TEMP4+LAP*TEMP5+ALA*TEMP6)/DENOM
      EQC=(LAPP*TEMP1-LAP*TEMP2+ALA*TEMP3)/DENOM
      DISCR=EQB*EQB-4.0*EQA*EQC
      IF (DISCR)  235, 280, 280
280   IF (E02-LAL)  265, 265, 285
285   TEMP1=EQC+EQC
      TEMP=SQRT (DISCR)
      EQ=1.0/(EQB+EV*TEMP1)
      LAPP=LAP
      LAP=ALA
      EVPP=EVP
      EVP=EV
```

```
      EV1=(TEMP-EQB)/TEMP1                                          3DB 2435
      EV2=-(TEMP+EQB)/TEMP1                                         3DB 2436
      EVA=ABS (EV-EV1)                                              3DB 2437
      EVB=ABS (EV-EV2)                                              3DB 2438
      IF (EVA-EVB)  290, 290, 295                                   3DB 2439
290   EV=EV1                                                        3DB 2440
      GO TO 210                                                     3DB 2441
295   EV=EV2                                                        3DB 2442
      GO TO 210                                                     3DB 2443
      END                                                           3DB 2444
```

```
-ITC FR5  FINPR,FINPR                                                    3DB 2445
      SUBROUTINE FINPR(X1,X4,Y1,Y4,Z1,Z4,CO,JTL,N2,JIM,LYN,MO,F2,NO,M2, 3DB 2446
     1            IGMOD,KMODG,KMODF,KMODP,MA,NX,S2,KMODR,EE)             3DB 2447
      DIMENSION  X1(1), X4(1), Y1(1), Y4(1), Z1(1), Z4(1), CO(JTL,1),    3DB 2448
     1          N2(JIM,1), LYN(1), MO(JIM,1), NO(JIM,1), M2(1), IGMOD(1), 3DB 2449
     2          KMODG(1), KMODF(1), KMODP(1), MA(1), NX(1), S2(JIM,1),   3DB 2450
     3          KMODR(1), F2(JIM,1), EE(11,1)                            3DB 2451
      REAL          NO,       N2                                         3DB 2452
      INCLUDE ABC                                                        3DB 2453
C     FINAL PRINT                                                        3DB 2454
      ICARD = 1                                                          3DB 2455
      CALL MONPR                                                         3DB 2456
      IF(NPRT)  90,90,10                                                 3DB 2457
10    CALL NBAL(EE)                                                      3DB 2458
      J = MINO(IP,JP)                                                    3DB 2459
      WRITE(NOUT,40) (I, X1(I), X4(I), Y1(I), Y4(I), Z1(I), Z4(I),I=1,J)3DB 2460
40    FORMAT(123H1                    X                    AVG. X        3DB 2461
     1   Y                    AVG. Y                    Z              AVG.3DB 2462
     2 Z//(I4,6F20.4))                                                   3DB 2463
      J = J + 1                                                          3DB 2464
      IF(J - 1 - KP)  45,82,82                                           3DB 2465
45    IF(IP - JP)  50,46,70                                              3DB 2466
50    K = MAXO(JP,KP)                                                    3DB 2467
      GO TO 52                                                           3DB 2468
46    K = KP                                                             3DB 2469
52    WRITE(NOUT,60)  (I, Y1(I), Y4(I), Z1(I), Z4(I), I=J,K)             3DB 2470
60    FORMAT(I4,40X,4F20.4)                                              3DB 2471
      GO TO 90                                                           3DB 2472
70    K = MAXO(IP,KP)                                                    3DB 2473
      WRITE(NOUT,80)  (I,X1(I), X4(I), Z1(I), Z4(I), I=J,K)              3DB 2474
80    FORMAT(I4,2F20.4,40X,2F20.4)                                       3DB 2475
      GO TO 90                                                           3DB 2476
82    IF(IP - JP)  85,90,87                                              3DB 2477
85    WRITE(NOUT,86)  (I, Y1(I), Y4(I), I=J,JP)                          3DB 2478
86    FORMAT(I4,40X,2F20.4)                                              3DB 2479
      GO TO 90                                                           3DB 2480
87    WRITE(NOUT,88)  (I,X1(I), X4(I), I=J,IP)                           3DB 2481
88    FORMAT(I4,2F20.4)                                                  3DB 2482
90    IF(NPUN)  92,92,93                                                 3DB 2483
92    IF(NPRT)  280,280,93                                               3DB 2484
93    DO 228  IIG=1,IGM                                                  3DB 2485
      CALL DRUMR(NCR1,CO,ITLMT,2)                                        3DB 2486
      DO 225  K=1,KM                                                     3DB 2487
      CALL DRUMR(NFLUX1,N2,IMJM,2)                                       3DB 2488
94    IF(K - 1)  97,97,95                                                3DB 2489
95    IF(LYN(K) - LYN(K-1))  97,98,97                                    3DB 2490
97    CALL DRUMR(NMO,MO,IMJM,2)                                          3DB 2491
98    IF(IIG-1)  100,100,110                                             3DB 2492
100   CALL CLEAR(0.0,F2,IMJM)                                            3DB 2493
      CALL CLEAR(0.0,NO,IMJM)                                            3DB 2494
      GO TO 120                                                          3DB 2495
110   CALL DRUMR(NF2,F2,IMJM,2)                                          3DB 2496
      CALL DRUMR(NDUM,NO,IMJM,2)                                         3DB 2497
120   DO 125  J=1,JM                                                     3DB 2498
      DO 125  I=1,IM                                                     3DB 2499
      ITEMP = MO(I,J)                                                    3DB 2500
      ITEMP = M2(ITEMP)                                                  3DB 2501
      NO(I,J) = NO(I,J) + N2(I,J)                                        3DB 2502
125   F2(I,J) = F2(I,J) + CO(IHF,ITEMP)*N2(I,J)*1000.*TSD                3DB 2503
      CALL DRUMR(NFO,F2,IMJM,1)                                          3DB 2504
```

```
      CALL DRUMR(NS2,NO,IMJM,1)
      IF(NPRT)  217,217,211
211   IF(IGMOD(IIG))  217,217,212
212   IF(KMODG(K))  217,217,214
214   WRITE(NOUT,216)  IIG
216   FORMAT(1H1,20X,14HFLUX FOR GROUP,I3//)
      CALL PRT(IM,JM,N2,Y4,NOUT,K,Z4)
217   IF(NPUN)  225,225,218
218   GO TO (225,219,225,222), NPUN
219   PUNCH 220, ((N2(I,J), I=1,IM), J=1,JM)
220   FORMAT(1P6E12.6)
      GO TO 225
222   WRITE(16)  ((N2(I,J), I=1,IM), J=1,JM)
225   CONTINUE
      CALL SWITCH(NS2,NDUM)
      CALL SWITCH(NFO,NF2)
      REWIND NMO
      REWIND NS2
      REWIND NDUM
      REWIND NFO
      REWIND NF2
228   CONTINUE
      REWIND NCR1
      REWIND NFLUX1
      TEMP = 0.0
      DO 242  K=1,KM
      CALL DRUMR(NDUM,NO,IMJM,2)
      IF(NPRT)  233,233,230
230   IF(KMODF(K))  233,233,231
231   WRITE(NOUT,232)
232   FORMAT(1H1,20X,11H TOTAL FLUX//)
      CALL PRT(IM,JM,NO,Y4,NOUT,K,Z4)
233   DO 236  J=1,JM
      DO 236  I=1,IM
      IF(NO(I,J) - TEMP)  236,236,234
234   TEMP = NO(I,J)
      ITEMP1 = I
      ITEMP2 = J
      ITEMP3 = K
236   CONTINUE
      IF(NPUN)  242,242,237
237   GO TO (238,242,240,242), NPUN
238   PUNCH 220,  ((NO(I,J), I=1,IM), J=1,JM)
      GO TO 242
240   WRITE(16)  ((NO(I,J), I=1,IM), J=1,JM)
242   CONTINUE
      REWIND NDUM
      WRITE(NOUT,243)  TEMP,ITEMP1,ITEMP2,ITEMP3
243   FORMAT(//   22H MAXIMUM TOTAL FLUX = E12.7,7H AT I =I3,5H, J =I3,
     1          5H, K =I3)
      IF(NPUN-3)  248,245,245
C     PUT AN END OF FILE MARK AND REWIND 16
245   CALL  NTRAN(16,9,11)
248   IF(NPRT)  280,280,250
250   TEMP = 0.0
      DO 260  K=1,KM
      CALL DRUMR(NF2,F2,IMJM,2)
      IF(KMODP(K))  260,260,255
255   WRITE(NOUT,256)
256   FORMAT( 1H1,20X,27H POWER DENSITY  (MWT/LITER))
```

```
      CALL PRT(IM,JM,F2,Y4,NOUT,K,Z4)                                   3DB 2565
      DO 259  J=1,JM                                                    3DB 2566
      DO 259  I=1,IM                                                    3DB 2567
      IF(F2(I,J) - TEMP)  259,259,257                                   3DB 2568
257   TEMP = F2(I,J)                                                    3DB 2569
      ITEMP1 = I                                                        3DB 2570
      ITEMP2 = J                                                        3DB 2571
      ITEMP3 = K                                                        3DB 2572
259   CONTINUE                                                          3DB 2573
260   CONTINUE                                                          3DB 2574
      REWIND NF2                                                        3DB 2575
      WRITE(NOUT,270)  TEMP,ITEMP1,ITEMP2,ITEMP3                        3DB 2576
270   FORMAT(//25H MAXIMUM POWER DENSITY = E12.7,7H AT I =I3,5H, J =I3, 3DB 2577
     1          5H, K =I3)                                              3DB 2578
280   IF(NACT)  550,550,290                                             3DB 2579
290   DO 500  N=1,NACT                                                  3DB 2580
      MMA = MA(N)                                                       3DB 2581
      NNX = NX(N)                                                       3DB 2582
      TEMP = 0.0                                                        3DB 2583
      DO 400  IIG=1,IGM                                                 3DB 2584
      CALL DRUMR(NCR1,CO,ITLMT,2)                                       3DB 2585
      DO 380  K=1,KM                                                    3DB 2586
      CALL DRUMR(NFLUX1,NO,IMJM,2)                                      3DB 2587
      IF(IIG-1)  300,300,320                                            3DB 2588
300   CALL CLEAR(0.0,S2,IMJM)                                           3DB 2589
      GO TO 330                                                         3DB 2590
320   CALL DRUMR(NS2,S2,IMJM,2)                                         3DB 2591
330   DO 370  J=1,JM                                                    3DB 2592
      DO 370  I=1,IM                                                    3DB 2593
370   S2(I,J) = S2(I,J) + CO(NNX,MMA)*NO(I,J)                           3DB 2594
      IF(IIG-IGM)  380,371,371                                          3DB 2595
371   DO 373  J=1,JM                                                    3DB 2596
      DO 373  I=1,IM                                                    3DB 2597
      IF(S2(I,J) - TEMP)  373,373,372                                   3DB 2598
372   TEMP = S2(I,J)                                                    3DB 2599
      ITEMP1 = I                                                        3DB 2600
      ITEMP2 = J                                                        3DB 2601
      ITEMP3 = K                                                        3DB 2602
373   CONTINUE                                                          3DB 2603
      IF(KMODR(K))  380,380,374                                         3DB 2604
374   WRITE(NOUT,376)  N,MMA,NNX                                        3DB 2605
376   FORMAT(9H1ACTIVITY I3,5X, 9H MATERIAL I3,5X,23H CROSS SECTION POSI3DB 2606
     1TION I3/)                                                         3DB 2607
      CALL PRT(IM,JM,S2,Y4,NOUT,K,Z4)                                   3DB 2608
380   CALL DRUMR(NDUM,S2,IMJM,1)                                        3DB 2609
      CALL SWITCH(NDUM,NS2)                                             3DB 2610
      REWIND NDUM                                                       3DB 2611
400   REWIND NS2                                                        3DB 2612
      WRITE(NOUT,420)  TEMP,ITEMP1,ITEMP2,ITEMP3                        3DB 2613
420   FORMAT(//      20H MAXIMUM ACTIVITY = E12.7,7H AT I =I3,5H, J =I3, 3DB 2614
     1          5H, K =I3)                                              3DB 2615
      REWIND NFLUX1                                                     3DB 2616
500   REWIND NCR1                                                       3DB 2617
550   RETURN                                                            3DB 2618
      END                                                               3DB 2619
```

```
-ITC FR5 NBAL,NBAL                                                    3DB 2620
      SUBROUTINE NBAL(EE)                                             3DB 2621
      DIMENSION  EE(11,1)                                             3DB 2622
      INCLUDE ABC                                                     3DB 2623
      DO 5  LL=1,11                                                   3DB 2624
5     EE(LL,IGP) = .0                                                 3DB 2625
      DO 10  IIG=1,IGM                                                3DB 2626
      EE(1,IIG) = E1(IIG)                                             3DB 2627
      EE(2,IIG) = E2(IIG)                                             3DB 2628
      EE(9,IIG) = EE(5,IIG) + EE(6,IIG) + EE(7,IIG) + EE(8,IIG)       3DB 2629
     1            + EE(10,IIG)+EE(11,IIG)                             3DB 2630
      DO 10  LL=1,11                                                  3DB 2631
10    EE(LL,IGP) = EE(LL,IGP) + EE(LL,IIG)                            3DB 2632
      WRITE(NOUT,20)                                                  3DB 2633
20    FORMAT(1H1 28H FINAL NEUTRON BALANCE TABLE///                   3DB 2634
     1130H GROUP       FISSION       IN         OUT      ABSORPTION    LEFT3DB 2635
     2      RIGHT         BACK       FRONT        TOP       BOTTOM     TOTAL3DB 2636
     3  /                                                             3DB 2637
     4130H                SOURCE     SCATTER    SCATTER              LEAKAG3DB 2638
     5E    LEAKAGE     LEAKAGE     LEAKAGE    LEAKAGE    LEAKAGE     LEAKAG3DB 2639
     6E /)                                                            3DB 2640
      DO 30  IIG=1,IGM                                                3DB 2641
25    FORMAT(I4,5X,1P11E11.3)                                         3DB 2642
30    WRITE(NOUT,25)  IIG, (EE(LL,IIG), LL=1,8), (EE(LL,IIG), LL=10,11),3DB 2643
     1                EE(9,IIG)                                       3DB 2644
      WRITE(NOUT,35)                                                  3DB 2645
35    FORMAT(1H )                                                     3DB 2646
      IIG = IGP                                                       3DB 2647
      WRITE(NOUT,25)  IIG, (EE(LL,IIG), LL=1,8), (EE(LL,IIG), LL=10,11),3DB 2648
     1                EE(9,IIG)                                       3DB 2649
      RETURN                                                          3DB 2650
      END                                                             3DB 2651
```

```
-IT FR5  PRT,PRT                                                3DB 2652
      SUBROUTINE PRT (JIM,JJM, N2, Y4, NOUT,KK,Z4)              3DB 2653
      DIMENSION N2(JIM,JJM), Y4(1), Z4(1)                       3DB 2654
      REAL N2                                                   3DB 2655
      WRITE(NOUT,5)  KK, Z4(KK)                                 3DB 2656
5     FORMAT(4H K =I3,4X,9H HEIGHT =E10.4)                      3DB 2657
      IM = JIM                                                  3DB 2658
      JM = JJM                                                  3DB 2659
      DO 50  I=1,IM,5                                           3DB 2660
      I1=I                                                      3DB 2661
      I2=I+4                                                    3DB 2662
      IF(I2-IM) 20, 20, 10                                      3DB 2663
10    I2=IM                                                     3DB 2664
20    WRITE ( NOUT,30 ) ( JJ,JJ=I1,I2)                          3DB 2665
30    FORMAT( 5I20)                                             3DB 2666
      DO 50  JJ=1,JM                                            3DB 2667
      J=JJ                                                      3DB 2668
40    FORMAT(I5,E15.7,5E20.7)                                   3DB 2669
50    WRITE(NOUT,40 ) J,(N2(K,J),K=I1,I2),Y4(J)                 3DB 2670
      RETURN                                                    3DB 2671
      END                                                       3DB 2672
```

```
-ITC  FR5  GRAM,GRAM
      SUBROUTINE GRAM(MASS, VOL,  ATW, HOLN,JIM,JJM, MO, M2, VO,
     1                  IO, I1, I2,JML, I3,Z5,LYN)
      INCLUDE ABC
      DIMENSION MASS(JML,1), VOL(1), ATW(1), HOLN(1), MO(JIM,JJM),
     1          M2(1), VO(JIM,JJM), IO(1), I1(1), I2(1), I3(1)
     2         , Z5(1), LYN(1)
      REAL          I2,       I3,    MASS
C     THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS
      WRITE(NOUT,10) (ID(I), I=1,11)
10    FORMAT(1H1,11A6///)
      WRITE(NOUT, 20)
20    FORMAT(45H MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE /   )
      CALL CLEAR(0.0,VOL,IZM)
      ITEMP = ML*IZM
      CALL CLEAR(0.0,MASS,ITEMP)
      DO 30  KK=1,KM
      IF(KK-1)  28,28,24
24    IF(LYN(KK) - LYN(KK-1))  28,29,28
28    CALL DRUMR(NMO,MO,IMJM,2)
29    DO 30  J = 1, JM
      DO 30  I = 1, IM
      K = MO(I,J)
30    VOL(K) = VOL(K) + VO(I, J)*.001*Z5(KK)
      REWIND NMO
      DO 39  M=1,MO1
      I3(M) = I2(M)
      IF(IO(M) - I1(M))  39,35,39
35    IF(I2(M))  39,36,39
36    DO 38  MM=1,M
      IF(IO(M) - IO(MM))  38,37,38
37    I3(MM) = I2(MM)*EV
38    CONTINUE
39    CONTINUE
      DO 190 N =1, IZM
      NN = M2(N)
      DO 190 M = 1,MO1
      IF(IO(M) - NN)   190, 40, 190
40    L = I1(M)
      IF(L - ML)  170, 170, 50
50    NNAA = L
      IF(L - IO(M))  130,190, 130
130   DO 160 MAA = 1, MO1
      IF(IO(MAA) - NNAA)  160, 140, 160
140   L = I1(MAA)
      IF(L)  160, 160, 150
150   EO1 = I3(MAA)*I3(M)
      MASS(L,N) = ((EO1*ATW(L)*VOL(N))/.6023) + MASS(L,N)
160   CONTINUE
      GO TO 190
170   IF(L)  190, 190, 180
180   EO1 = I3(M)
      MASS(L,N) = ((EO1*ATW(L)*VOL(N))/.6023) + MASS(L,N)
190   CONTINUE
      DATA   ZONE/6H ZONE /
      DO 260 L = 1, IZM, 5
      LL = L + 4
      IF(LL - IZM) 210, 210, 200
200   LL = IZM
210   WRITE(NOUT,220)  ((ZONE, K), K=L, LL)
```

```
220   FORMAT(//26H   MATERIAL   ATOMIC WT.   ,3X, 5(A6,I2,12X))        3DB 2733
      WRITE(NOUT,230)  (VOL(K), K = L, LL)                             3DB 2734
230   FORMAT(25X, 5(E8.3, 7H LITERS, 5X))                              3DB 2735
      DO 240 K = 1, ML                                                 3DB 2736
240   WRITE(NOUT,250)  K, HOLN(K), ATW(K), (MASS(K, I), I = L, LL)     3DB 2737
250   FORMAT( I3,1X, A6, F13.3, 1X, 1PE13.3, 1P4E20.3)                 3DB 2738
      IF(LL - IZM)  260, 270, 270                                      3DB 2739
260   CONTINUE                                                         3DB 2740
270   RETURN                                                           3DB 2741
      END                                                              3DB 2742
```

```
-ITC FR5 INPB,INPB                                                      3DB 2743
      SUBROUTINE INPB(MATN,NBR,LD,LCN,LFN,ALAM,HOLN,JML,I2)             3DB 2744
      INCLUDE ABC                                                       3DB 2745
      DIMENSION  MATN(1), NBR(1), LD(1),LCN(JML,1),LFN(JML,1), ALAM(1), 3DB 2746
     1 HOLN(1), I2(1)                                                   3DB 2747
      REAL          I2                                                  3DB 2748
C     THIS SUBROUTINE READS AND PRINTS THE BURNUP DATA                  3DB 2749
      READ(NINP,10)  ITEMP, NPRT, NPUN, ITEMP1, DELT                    3DB 2750
10    FORMAT(4I6, E12.0)                                                3DB 2751
      IF(DELT)  14,14,12                                                3DB 2752
12    DAY = DAY + DELT                                                  3DB 2753
14    CVT = 0                                                           3DB 2754
      CNT = 0                                                           3DB 2755
      P02 = 0                                                           3DB 2756
      ALA = 0.0                                                         3DB 2757
      LAP = 0.0                                                         3DB 2758
      LAPP = 0.0                                                        3DB 2759
      LAR = 0.0                                                         3DB 2760
      EQ = 0.0                                                          3DB 2761
      KPAGE = 100                                                       3DB 2762
      IF(ITEMP)  190, 15, 20                                            3DB 2763
15    NCON = ITEMP                                                      3DB 2764
      GO TO 190                                                         3DB 2765
20    NCON = ITEMP                                                      3DB 2766
      DO 40  N = 1, NCON                                                3DB 2767
30    FORMAT(12I6)                                                      3DB 2768
40    READ(NINP,30)  MATN(N),NBR(N),LD(N),(LCN(N,K),K=1,2),(LFN(N,K),   3DB 2769
     1 K=1,7)                                                           3DB 2770
      WRITE(NOUT,60)                                                    3DB 2771
60    FORMAT(12H1BURNUP DATA///)                                        3DB 2772
      WRITE(NOUT,70)                                                    3DB 2773
70    FORMAT(130H BURNABLE        MATERIAL          NAME          LAMBDA3DB 2774
     1      NBR            *  *  *  *  *  *  SOURCE ISOTOPE FOR  *  *  *  *3DB 2775
     2  *  *    /                                                       3DB 2776
     3        130H  ISOTOPE           NO.                      (DAYS-1) 3DB 2777
     4                          DECAY              CAPTURE          FISS3DB 2778
     5ION      /9H      NO.   )                                         3DB 2779
      DO 90  N=1, NCON                                                  3DB 2780
80    FORMAT(3X, I3, 12X, I3, 10X, A6, 8X, E8.3,  I9,15X, I3, 13X, 2I3, 3DB 2781
     1      10X, 7I3)                                                   3DB 2782
      ITEMP = MATN(N)                                                   3DB 2783
      ALAM(ITEMP) = 24.*3600.*ALAM(ITEMP)                               3DB 2784
      WRITE(NOUT,80)    N, MATN(N), HOLN(ITEMP), ALAM(ITEMP), NBR(N),   3DB 2785
     1LD(N),    (LCN(N,K),K=1,2), (LFN(N,K),K=1,7)                      3DB 2786
90    ALAM(ITEMP) = ALAM(ITEMP)/(3600.*24.)                             3DB 2787
190   IF(ITEMP1)  230,230,200                                           3DB 2788
200   PUNCH 210, (I2(I), I=1,M01)                                       3DB 2789
210   FORMAT(6(3X,E9.4))                                                3DB 2790
230   RETURN                                                            3DB 2791
      END                                                               3DB 2792
```

```
-ITC FR5 AVERAG,AVERAG
      SUBROUTINE AVERAG(PHIB,AXS,FXS,MATN,MASS,ATW,VOL,CO,N2,MO,VO,
     1                 HOLN, JML, JTL, NBR,Z5,LYN)
      DIMENSION PHIB(1), AXS(JML,1), FXS(JML,1), MATN(1), MASS(JML,1),
     1          ATW(1), VOL(1), CO(JTL,1), N2(1), MO(1), VO(1), HOLN(1)
     2        , NBR(1), Z5(1), LYN(1)
      REAL          N2,    MASS
      INCLUDE ABC
C     THIS SUBROUTINE CALCULATES ZONE AVERAGED FLUXES, FISSION CROSS
C     SECTIONS, AND ABSORPTION CROSS SECTIONS.
      RL = 0.0
      RC = 0.0
      DO 10  KZ=1,IZM
      PHIB(KZ) = 0.0
      DO 10  KN =1,NCON
      AXS(KN,KZ) = 0.0
      FXS(KN,KZ) = 0.0
      LN = MATN(KN)
10    MASS(LN,KZ) = (MASS(LN,KZ)*.6023)/(ATW(LN)*VOL(KZ))
      DO 105  IIG=1,IGM
      CALL DRUMR(NCR1,CO,ITLMT,2)
      DO 100  KK=1,KM
      IF(KK-1)  30,30,20
20    IF(LYN(KK) - LYN(KK-1))  30,40,30
30    CALL DRUMR(NMO,MO,IMJM,2)
40    CALL DRUMR(NFLUX1,N2,IMJM,2)
      DO 100  I=1,IMJM
      KZ = MO(I)
      PHIB(KZ) = PHIB(KZ) + N2(I)*VO(I)*Z5(KK)
      DO 100  KN=1,NCON
      LN = MATN(KN)
      AXS(KN,KZ) = AXS(KN,KZ) + CO(IHA,LN)*N2(I)*VO(I)*Z5(KK)
100   FXS(KN,KZ) = FXS(KN,KZ) + CO(IHF,LN)*N2(I)*VO(I)*Z5(KK)
105   REWIND NMO
      DO 250  KZ=1,IZM
      TEMP3 = PHIB(KZ)
      PHIB(KZ) = PHIB(KZ)/(VOL(KZ)*1000.)
      WRITE(NOUT,110)  KZ
110   FORMAT(1H1,45X,9H Z O N E ,I3/)
      WRITE(NOUT,120)
120   FORMAT(115H BURNABLE        MATERIAL          NAME          ATOM
     1        FISSION     ABSORPTION        SIGMA          SIGMA    /
     2        115H   ISOTOPE             NO.                    DENSITY
     3          RATE            RATE            FISSION        ABSORPTION/
     4          7H     NO./)
      TEMP4 = 0.0
      DO 200  KN=1,NCON
      LN = MATN(KN)
      TEMP1 = AXS(KN,KZ)*MASS(LN,KZ)
      TEMP2 = FXS(KN,KZ)*MASS(LN,KZ)
      TEMP4 = TEMP4 + TEMP2
      AXS(KN,KZ) = AXS(KN,KZ)/TEMP3
      FXS(KN,KZ) = FXS(KN,KZ)/TEMP3
130   FORMAT(4X,I3,11X,I3,10X,A6,2X,1P5E15.3)
      WRITE(NOUT,130)  KN, LN, HOLN(LN), MASS(LN,KZ), TEMP2, TEMP1,
     1 FXS(KN,KZ), AXS(KN,KZ)
      ITEMP = NBR(KN)
      IF(ITEMP - 1)  200, 140, 160
140   RC = RC + TEMP1 - TEMP2
      GO TO 200
```

```
160   RL = RL + TEMP1                                                  3DB 2853
200   CONTINUE                                                         3DB 2854
      TEMP4 = TEMP4*TSD                                                3DB 2855
      WRITE(NOUT,210)  PHIB(KZ),TEMP4,VOL(KZ)                          3DB 2856
210   FORMAT(//24H ZONE FLUX(N/CM+2*SEC) =1PE11.4/                     3DB 2857
     1         24H ZONE POWER(MW)        =1PE11.4/                     3DB 2858
     2         24H ZONE VOLUME(LITERS)   =1PE11.4)                     3DB 2859
250   CONTINUE                                                         3DB 2860
      TEMP = RC/RL                                                     3DB 2861
      WRITE(NOUT,350)  TEMP                                            3DB 2862
350   FORMAT( /24H BREEDING RATIO        =F8.4 )                       3DB 2863
      REWIND NCR1                                                      3DB 2864
      REWIND NFLUX1                                                    3DB 2865
      RETURN                                                           3DB 2866
      END                                                              3DB 2867
```

```
-ITC FR5 MARCH,MARCH
      SUBROUTINE MARCH(PHIB,MATN,FXS,AXS,VOL,MASS,MASSP,ALAM,LD,LCN,
     1                 LFN,JML,I0,I1,I2,M2)
      DIMENSION  PHIB(1), MATN(1), FXS(JML,1),AXS(JML,1),VOL(1),
     1           MASS(JML,1),MASSP(JML,1),ALAM(1), LD(1), LCN(JML,1),
     2           LFN(JML,1),I0(1), I1(1), I2(1), M2(1)
      REAL        I2,    MASS,   MASSP
      INCLUDE ABC
C     THIS SUBROUTINE COMPUTES THE TIME DEPENDENT ISOTOPIC CONCENTRATION
      TEMP = DELT * 24. * 3600. / 10.
      TEMP1 = .0
      DO 5 KZ = 1,IZM
      PHIB(KZ) = PHIB(KZ) * 10.**(-24)
      DO 5 KN = 1,NCON
      LN = MATN(KN)
5     TEMP1 = TEMP1 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ)
      DO 200 KT = 1,10
      TEMP3 = .0
      DO 20 KZ = 1,IZM
      DO 20 KN = 1,NCON
      LN = MATN(KN)
20    MASSP(LN,KZ) = MASS(LN,KZ)
      DO 100 KZ = 1,IZM
      DO 50 KKK = 1,5
      DO 50 KN = 1,NCON
      LN = MATN(KN)
      TEMP2=-(MASS(LN,KZ)+MASSP(LN,KZ))*(ALAM(LN)+AXS(KN,KZ)*PHIB(KZ))
      IF (LD(KN)) 30, 30, 28
28    KK = LD(KN)
      KK = MATN(KK)
      TEMP2 = TEMP2 + ALAM(KK)*(MASS(KK,KZ) + MASSP(KK,KZ))
30    DO 32 K = 1,2
      KK = LCN(KN,K)
      KL = MATN(KK)
      IF (KK) 32,32,31
31    TEMP2 = TEMP2 + (AXS(KK,KZ) - FXS(KK,KZ))*PHIB(KZ)*
     1 (MASS(KL,KZ) + MASSP(KL,KZ))
32    CONTINUE
      DO 36 K = 1,7
      KK = LFN(KN,K)
      KL = MATN(KK)
      IF (KK) 36,36,34
34    TEMP2 = TEMP2 + FXS(KK,KZ)*PHIB(KZ)*(MASS(KL,KZ)+MASSP(KL,KZ))
36    CONTINUE
50    MASS(LN,KZ) = MASSP(LN,KZ) + .5*TEMP*TEMP2
      DO 100 KN = 1,NCON
      LN = MATN(KN)
100   TEMP3 = TEMP3 + FXS(KN,KZ)*PHIB(KZ)*MASS(LN,KZ)*VOL(KZ)
      IF(TEMP3)  200,200,110
110   DO 120 KZ = 1,IZM
120   PHIB(KZ) = PHIB(KZ) * TEMP1/TEMP3
200   CONTINUE
      DO 500 KZ = 1,IZM
500   PHIB(KZ) = PHIB(KZ)*10.**(24)
      DO 540  KZ=1,IZM
      DO 540  M=1,M01
      IF(I0(M) - M2(KZ))  540,520,540
520   DO 530  KN=1,NCON
      LN = MATN(KN)
      IF(LN - I1(M))  530,525,530
```

```
525   I2(M) = MASS(LN,KZ)                                    3DB 2928
530   CONTINUE                                               3DB 2929
540   CONTINUE                                               3DB 2930
      RETURN                                                 3DB 2931
      END                                                    3DB 2932
```

```
-ITC FR5 SHUF,SHUF                                                    3DB 2933
      SUBROUTINE SHUF(I0,I1,I2)                                       3DB 2934
      INCLUDE ABC                                                     3DB 2935
      DIMENSION I0(1), I1(1), I2(1)                                   3DB 2936
      REAL           I2                                               3DB 2937
C     THIS SUBROUTINE SHUFFLES MIXTURES.                              3DB 2938
      DELT = .0                                                       3DB 2939
      WRITE(NOUT,10)  DAY                                             3DB 2940
10    FORMAT(1H1,10X,51H  M I X T U R E S   S H U F F L E D   A T   T I M E3DB 2941
     1  =,F8.3,8H D A Y S///)                                         3DB 2942
      I = 0                                                           3DB 2943
15    I = I + 1                                                       3DB 2944
      READ(NINP,20)  ITEMP,ITEMP1,ITEMP2                              3DB 2945
20    FORMAT(3I6)                                                     3DB 2946
      IF(ITEMP)  25,100,25                                            3DB 2947
25    WRITE(NOUT,30)  I,ITEMP1,ITEMP2                                 3DB 2948
30    FORMAT(I6, 6X, 4H MIX,I6,19H IS REPLACED BY MIX, I6 )           3DB 2949
      DO 90  II=1,M01                                                 3DB 2950
      IF(ITEMP2 - I0(II))  90,40,90                                   3DB 2951
40    DO 70  JJ=1,M01                                                 3DB 2952
      IF(ITEMP1 - I0(JJ))  70,50,70                                   3DB 2953
50    IF(I1(II) - I1(JJ))  70,60,70                                   3DB 2954
60    I2(JJ) = I2(II)                                                 3DB 2955
      GO TO 90                                                        3DB 2956
70    CONTINUE                                                        3DB 2957
90    CONTINUE                                                        3DB 2958
      GO TO 15                                                        3DB 2959
100   RETURN                                                          3DB 2960
      END                                                             3DB 2961
```

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