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PERT-V, A TWO-DIMENSIONAL
PERTURBATION CODE
FOR FAST REACTOR ANALYSIS

September 1969

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BNWL-1162

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PERT-V, A TWO-DIMENSIONAL PERTURBATION
CODE FOR FAST REACTOR ANALYSIS

R. W. Hardie
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Reactor and Plant Technology Department
FFTF Project

September 1969

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PERT-V, A TWO-DIMENSIONAL PERTURBATION
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R. W. Hardie and W. W. Little, Jr.

ABSTRACT

PERT-V is a two-dimensional perturbation theory code for use in fast reactor analysis. The code will:

- compute reactivity coefficient traverses using first order perturbation theory,
- compute the effective delayed neutron fraction, the neutron generation time, and the inhour/ δk conversion factor, and
- compute activity traverses.

The code was written to be compatible with the BNW one- and two-dimensional diffusion theory codes 1DX and 2DB, and the Los Alamos one- and two-dimensional transport theory codes DTF-IV and 2DF. All five codes use the same input module.

PERT-V is written entirely in FORTRAN-IV. Variable dimensioning is utilized to make maximum use of available core storage. Running time for a 13 group 30 x 30 mesh problem on a UNIVAC 1108 is about 1 minute.

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PERT-V, A TWO-DIMENSIONAL PERTURBATION
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R. W. Hardie and W. W. Little, Jr.

I. INTRODUCTION

PERT-V is designed to calculate reactivity coefficient traverses, the effective delayed neutron fraction, the neutron generation time, the inhour/ δk conversion factor, and activity traverses using flux output from neutronics codes. The code will accept fluxes and adjoint fluxes from the BNW diffusion theory codes 1DX⁽¹⁾ and 2DB⁽²⁾ and the LASL transport theory codes DTF-IV⁽³⁾ and 2DF.⁽⁴⁾

First order perturbation theory based on the multigroup diffusion model is used to calculate reactivity coefficients. Each component of the perturbation equation, in addition to the total reactivity coefficient, is printed at each mesh point in the specified row or column for a 2-D problem and at all mesh points in a 1-D problem.

PERT-V utilizes variable dimensioning to make maximum use of the available core memory. A 65K core and five peripheral storage devices are required for the current version. All coding is in FORTRAN-IV.

II. MATHEMATICAL MODELS

The perturbation equation is derived beginning with the familiar multigroup time independent diffusion equation for an unperturbed system. That is,

$$\begin{aligned} \vec{\nabla} \cdot \frac{1}{3\Sigma_{tr}^i} \vec{\nabla} \phi_i - \Sigma_a^i \phi_i - \sum_{j=i+1}^{IGM} \Sigma(i \rightarrow j) \phi_j + \frac{\chi_i}{k_{eff}} \sum_{j=1}^{IGM} (\nu \Sigma_f)^j \phi_j \\ + \sum_{j=1}^{i-1} \Sigma(j \rightarrow i) \phi_j = 0, \end{aligned} \quad (2.1)$$

where:

- IGM = number of energy groups,
- ϕ_i = flux in group i ($n\text{-cm}^{-2}\text{-sec}^{-1}$),
- χ_i = fission source born in group i ($\sum_{i=1}^{IGM} \chi_i = 1.0$),
- Σ_a^i = macroscopic absorption cross section for group i (cm^{-1}),
- Σ_{tr}^i = macroscopic transport cross section for group i (cm^{-1}),
- $\Sigma(i \rightarrow j)$ = macroscopic transfer cross section from group i to group j (cm^{-1}),
- k_{eff} = effective multiplication factor,
- $(\nu \Sigma_f)^i$ = macroscopic fission source cross section for group i (cm^{-1}).

Equation (2.1) is subtracted from a similar expression for a perturbed system, the difference multiplied by the adjoint flux (ϕ_i^+), integrated over the volume of the reactor, and summed over IGM energy groups. The result

(after some algebra) is the perturbation equation expressed as the sum of four components. Thus,

$$\frac{\delta k_{\text{eff}}}{k_{\text{eff}}} = \frac{F + A + L + S}{I} , \quad (2.2)$$

where:

$$I = \frac{1}{k_{\text{eff}}} \int dV \left\{ \sum_{j=1}^{\text{IGM}} (x_j \phi_j^+) \sum_{i=1}^{\text{IGM}} (v_{\Sigma_f^i} \phi_i) \right\} , \quad (2.3)$$

$$F = \frac{1}{k_{\text{eff}}} \int dV \left\{ \sum_{j=1}^{\text{IGM}} (x_j \phi_j^+) \sum_{i=1}^{\text{IGM}} (\delta[v_{\Sigma_f^i}] \phi_i) \right\} , \quad (2.4)$$

$$A = - \int dV \left\{ \sum_{i=1}^{\text{IGM}} (\delta[\Sigma_a^i] \phi_i \phi_i^+) \right\} , \quad (2.5)$$

$$L = \int dV \left\{ \sum_{i=1}^{\text{IGM}} \left(\vec{\nabla} \phi_i \cdot \vec{\nabla} \phi_i^+ \right) \frac{\delta[\Sigma_{\text{tr}}^i]}{3(\Sigma_{\text{tr}}^i)^2} \right\} , \quad (2.6)$$

and

$$S = \int dV \left\{ \sum_{i=1}^{\text{IGM}} \left(\sum_{j=i+1}^{\text{IGM}} \delta[\Sigma(i \rightarrow j)] \phi_i (\phi_j^+ - \phi_i^+) \right) \right\} . \quad (2.7)$$

The components in Equation (2.2) can be identified as the worth resulting from changes in the fission source rate, the absorption rate, the leakage, and the downscattering rate, respectively. The calculation of the term $\frac{\vec{\nabla}\phi_i \cdot \vec{\nabla}\phi_i^\dagger}{(\Sigma_{tr}^i)^2}$ in Equation (2.6) is consistent with the technique used in

2DB (see Sections II and III in Reference 2).

Expressions for the neutron generation time and beta effective are obtained by reducing the time dependent diffusion and precursor density equations to the familiar lumped parameter kinetics equations.

As a result, the neutron generation time is calculated using the algorithm

$$\Lambda = \frac{1}{k_{eff}} \int dV \left\{ \sum_{i=1}^{IGM} \phi_i \phi_i^\dagger / v_i \right\} / I . \quad (2.8)$$

The effective delayed neutron fraction for precursor group k is computed by the expression

$$\beta_{eff}^k = \frac{1}{k_{eff}} \int dV \left\{ \sum_{i=1}^{IGM} \left(\sum_{\ell=1}^{NIBC} f_{\ell \Sigma f, \ell}^k \right) \phi_i \sum_{j=1}^{IGM} D_{Xj}^k \phi_j^\dagger \right\} / I , \quad (2.9)$$

where: NIBC = number of fissionable isotopes for β_{eff} calculation,

f_{ℓ}^k = absolute delayed neutron yield (per fission) in precursor group k for isotope ℓ ,

$\Sigma_{f, \ell}^i$ = macroscopic fission cross section in energy group i for isotope ℓ (cm^{-1}),

D_{Xj}^k = delayed fission source for precursor group k in energy group j.

III. SIMPLIFIED LOGICAL FLOW DIAGRAM

A simplified logical flow chart for PERT-V is given on the following page. With the exception of three minor subroutines--CLEAR (sets an array equal to a specified constant), ERR02 (prints error messages), and SWITCH (switches tape designations)--all subroutines and their functions are shown in the flow diagram.

IV. INPUT INSTRUCTIONS

The following pages describe the input data for PERT-V. Most input is read in via generalized input subroutines. The format for data read in through the generalized input subroutines must adhere to the following form: All cards must contain six data fields of 12 columns each. The last nine columns of each field contain the data, 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.

<u>Variable</u>	<u>Columns</u>	<u>Description</u>
<u>CARD 1: FORMAT (12A6)</u>		
<i>To run a series of cases, repeat from this card.</i>		
ID(12)	1-72	Identification card.
<u>CARD 2: FORMAT (12I6)</u>		
ND	1-6	Input flux format: If ND

<u>Variable</u>	<u>Columns</u>	<u>Description</u>
		= 1, one-dimensional fluxes and adjoint fluxes, = 2, two-dimensional fluxes and adjoint fluxes, = 3, one-dimensional fluxes, no adjoint fluxes, = 4, two-dimensional fluxes, no adjoint fluxes. If ND > 0, fluxes are from cards; if ND < 0, fluxes are from tape (logical unit 14).
ML	7-12	Input cross section format: = -N, read N input cross section materials from logical unit 15, = +N, read N input cross section materials from cards.
NPRT	13-18	Print option: = 0, delete printing of fluxes, power, cross sections (mini), = 1, delete printing of group fluxes and cross sections (midi), = 2, print everything (maxi).
IGM	19-24	Number of energy groups.
IST	25-30	Number of downscattering terms.
IHT	31-36	Position of transport cross section.
NDELK	37-42	Number of reactivity coefficient traverses.
NACT	43-48	Number of activity traverses.
NIBC	49-54	Number of fissionable materials for β_{eff} calculation (if zero, no Λ or β_{eff} calculation).
IPG	55-60	Number of delayed neutron groups in β_{eff} calculation.
IPS	61-66	Format for delayed neutron spectrum: = 0, one input delayed spectrum, = 1, input delay spectrum for each delay group.
NPDEL	67-72	Plot option: = 0, no effect, = 1, plot reactivity coefficient traverses.

CARD 3: FORMAT (10I6)

IGE	1-6	Geometry specification: = 0, plane (1-D) or X-Y (2-D), = 1, cylinder (1-D) or R-Z (2-D), = 2, sphere (1-D) or R- θ (2-D), = 3, triangular (2-D only).
-----	-----	--

<u>Variable</u>	<u>Columns</u>	<u>Description</u>
IM	7-12	Number of radial intervals (≥ 3).
JM	13-18	Number of axial intervals (≥ 3 for 2-D problem, = 1 for 1-D problem).
IZM	19-24	Number of material zones.
MT	25-30	Total number of materials, including mixes.
M01	31-36	Number of mixture specifications.
B01	37-42	Left boundary condition: = 0, vacuum, = 1, reflective, = 2, periodic.
B02	43-48	Right boundary condition.
B03	49-54	Top boundary condition.
B04	55-60	Bottom boundary condition.

CARD 4: FORMAT (4E12.6)

ZKEFF	1-12	Value of k_{eff} to be used in the perturbation equation. If zero, the value calculated by the code is used.
FLP0	13-24	If FLP0 is negative, the total power is normalized to $ FLP0 $ Mwt using the conversion factor of 215 MeV/fission. If positive, FLP0 is the total center point flux. The adjoint flux is always normalized such that $\sum_{i=1}^{IGM} x_i \phi_i^{\dagger} = 1 \text{ for the center mesh interval.}$
VF	25-36	Volume factor. This quantity multiplies I in Equation (2.2) to account for partial reactor configurations. For example, for an R-Z half-core calculation, set $VF=2.0$; for an R-Z full-core calculation, set $VF=1.0$.
BUCK	37-48	Buckling (cm^{-2}). Caution -- a given input mix cannot be used directly in two or more zones. This can be avoided by mixing with a density of 1.0.

CARD 5: FORMAT (A6,E6.2,10A6)

HOLN(ML)	1-6	Identification card for first material. Name.
----------	-----	--

<u>Variable</u>	<u>Columns</u>	<u>Description</u>
ATW(ML)	7-12	Atomic weight of first material. If this material is a mix ($\Sigma_{\text{mix}} = \sum_i N_i \sigma_i$), the atomic weight should be calculated using $A_{\text{mix}} = \sum_i N_i A_i$. This will result in the worth printed out as $\delta k/k$ per kg.
AA(10)	13-72	Miscellaneous additional information for first material.

CARD 6: FORMAT (6E12.5)

Optional--required for ML>0. Any number of cross section processes can be on the beginning of this card, but the following cross sections must appear.

C(ITL,IGM,ML)	. . .
C(ITL,IGM,ML)	σ_f (barns) -- for first group of first isotope.
C(ITL,IGM,ML)	σ_a .
C(ITL,IGM,ML)	$\nu \sigma_f$.
C(ITL,IGM,ML)	σ_{tr} .
C(ITL,IGM,ML)	$\sigma(i \rightarrow i)$.

. . .

. . .

Continue through $\sigma(i-IST \rightarrow i)$. Repeat through group IGM. Repeat from Card 5 for ML isotopes (if ML<0, simply repeat Card 5 for each isotope).

CARD 7: FORMAT (6E12.5)

Optional--required if ND>0.

NO(IMJM)	1-12	Flux for first mesh interval in group 1.
NO(IMJM)	13-24	Flux for second mesh interval in group 1. Continue for all mesh intervals and all groups. Each new group begins a new card.

. . .

Variable	Columns	Description
CARD 8: <u>FORMAT (6E12.5)</u>		
<i>Optional--required if ND=1 or 2.</i>		
N1(IMJM)	1-12	Adjoint flux for first mesh interval in group IGM. Since output fluxes from 1DX, 2DB, DTF-IV, and 2DF are in inverted order (i.e., last energy group first), PERT-V reads the fluxes this way and then inverts them.
N1(IMJM)	13-24	Adjoint flux for second mesh interval in group IGM. Continue for all mesh intervals and all groups (ending with group 1).

. . .

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

R1(IM+1)	1-12	Radial position of first mesh boundary (0.0).
R1(IM+1)	13-24	Radial position of second mesh boundary (cm).

. . .

CARD 10: FORMAT [6(I1,I2,E9.4)]

Optional--required if |ND|=2 or 4.

Z1(JM+1)	1-12	Axial position of first mesh boundary (0.0).
Z1(JM+1)	13-24	Axial position of second mesh boundary. Dimensions should be in cm for R-Z, X-Y, and triangular calculations, and in fractions of a circle for R- θ calculations.

. . .

CARD 11: FORMAT [6(I1,I2,I9)]

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

. . .

* Generalized input format (see page 7)

Variable	Columns	Description
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CARD 12: FORMAT [6(I1,I2,I9)]

M2(IZM)	1-12	Material number for first zone.
---------	------	---------------------------------

M2(IZM)	13-24	Material number for second zone.
---------	-------	----------------------------------

. . .

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

Optional--required if BUCK $\neq$ 0.

GAM(IZM)	1-12	Buckling modifier for first zone.
----------	------	-----------------------------------

GAM(IZM)	13-24	Buckling modifier for second zone.
----------	-------	------------------------------------

. . .

CARD 14: FORMAT [6(I1,I2,E9.4)]

K6(IGM)	1-12	Fission fraction (spectrum) in first energy group.
---------	------	--

K6(IGM)	13-24	Fission fraction in second energy group.
---------	-------	--

. . .

CARD 15: 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 group.
---------	-------	------------------------------------

. . .

CARD 16: FORMAT [6(I1,I2,I9)]

Optional--required if M01>0.

I0(M01)	1-12	Material number of Mix 1.
---------	------	---------------------------

. . .

I0(M01)	N-(N+12)	Material number of Mix 2.
---------	----------	---------------------------

. . .

Variable	Columns	Description
<u>CARD 17: FORMAT [6(I1,I2,I9)]</u>		
<i>Optional--required if M01>0.</i>		
I1(M01)	1-12	0.
I1(M01)	13-24	Material number of first material in Mix 1.
I1(M01)	25-36	Material number of second material in Mix 1.
. . .		
I1(M01)	N-(N+12)	0.
I1(M01)	(N+13)-(N+24)	Material number of first material in Mix 2.
. . .		
<u>CARD 18: FORMAT [6(I1,I2,E9.4)]</u>		
<i>Optional--required if M01>0.</i>		
I2(M01)	1-12	0 (to clear storage area for Mix 1).
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 (to clear storage area for Mix 2).
I2(M01)	(N+13)-(N+24)	Concentration of first material in Mix 2.
. . .		
<u>CARD 19: FORMAT [6(I1,I2,I9)]</u>		
<i>Optional--required if NIBC>0.</i>		
NBET(NIBC)	1-12	Material number of first fissionable isotope used in the calculation of β_{eff} (see Equation (2.9)).
NBET(NIBC)	13-24	Material number of second fissionable isotope used in the calculation of β_{eff} .
. . .		

Variable	Columns	Description
----------	---------	-------------

CARD 20: FORMAT [6(I1,I2,E9.4)]

Optional--required if NIBC>0.

BETA(NIBC)	1-12	Absolute delayed neutron yield per fission of first fissionable isotope used in the calculation of β_{eff} .
------------	------	---

BETA(NIBC)	13-24	Absolute delayed neutron yield per fission of second fissionable isotope used in the calculation of β_{eff} .
------------	-------	--

. . .

CARD 21: FORMAT [6(I1,I2,E9.4)]

Optional--required if NIBC>0.

AB(IPG,NIBC)	1-12	Fractional delayed neutron yield in first delayed group for first delayed isotope.
--------------	------	--

AB(IPG,NIBC)	13-24	Fractional delayed neutron yield in second delayed group for first delayed isotope.
--------------	-------	---

. . .

Repeat above sequence for each delayed isotope.

CARD 22: FORMAT [6(I1,I2,E9.4)]

Optional--required if NIBC>0.

AL(IPG)	1-12	Decay constant for first delayed neutron group (sec^{-1}).
---------	------	---

AL(IPG)	13-24	Decay constant for second delayed neutron group.
---------	-------	--

. . .

CARD 23: FORMAT [6(I1,I2,E9.4)]

Optional--required if NIBC>0.

D7(IGM,IPG)	1-12	Delayed fission fraction for first delayed group in first energy group.
-------------	------	---

D7(IGM,IPG)	13-24	Delayed fission fraction for first delayed group in second energy group.
-------------	-------	--

. . .

If (IPS=1), repeat above sequence for each delayed group.

Variable	Columns	Description
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CARD 24: FORMAT [6(I1,I2,I9)]

Optional--required if NDELK>0.

MATDK(NDELK)	1-12	Material number for first reactivity traverse.
--------------	------	--

MATDK(NDELK)	13-24	Material number for second reactivity traverse.
--------------	-------	---

. . .

CARD 25: FORMAT [6(I1,I2,I9)]

Optional--required if NDELK>0 and |ND| = 2 or 4.

NCR(NDELK)	1-12	Negative/positive = column/row number for first reactivity traverse.
------------	------	--

NCR(NDELK)	13-24	Negative/positive = column/row number for second reactivity traverse.
------------	-------	---

. . .

CARD 26: 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 27: FORMAT [6(I1,I2,I9)]

Optional--required if NACT>0.

NX(NACT)	1-12	Cross section position for first activity traverse.
----------	------	---

NX(NACT)	13-24	Cross section position for second activity traverse.
----------	-------	--

. . .

CARD 28: FORMAT [2I6,6E6.2]

Optional--required if NPDEL=1 and NDELK>0.

NREPLT	1-6	= 1, plot on previous graph, = 2, plot on new graph.
--------	-----	---

<u>Variable</u>	<u>Columns</u>	<u>Description</u>
NTYPLT	7-12	= 1, plot total reactivity coefficient traverse only, = 2, plot total and each component of the reactivity coefficient traverse.
XL	13-18	Value of the X-axis at the left boundary.
XR	19-24	Value of the X-axis at the right boundary.
YB	25-30	Value of the Y-axis at the bottom boundary.
YT	31-36	Value of the Y-axis at the top boundary.
DEL	37-42	Length of dashed line used to plot the total reactivity coefficient traverse (not used if NTYPLT = 2). If DEL = 0.0, a solid line is drawn.
GAP	43-48	Length of gap between the dashed lines specified above.

Repeat above card for each reactivity coefficient traverse (i.e., there should be NDELK cards).

PERT-V

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
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BOTTOM BOUNDARY CONDITION BO4																																																																															
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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
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[illegible]

V. STORAGE REQUIREMENTS

PERT-V uses variable dimensioning by storing the subscripted variables in one array, A(35000). The variable dimensioned arrays require N storage locations ($N \leq 35000$), where:

$$\begin{aligned}
 N &= \text{MAX}(N_1, N_2) \\
 N_1 &= 4 + 8 \times \text{IM} \times \text{JM} \\
 &\quad + 5 \times \text{IM} \\
 &\quad + 3 \times \text{JM} \\
 &\quad + 4 \times \text{M01} \\
 &\quad + 6 \times \text{IZM} \\
 &\quad + 2 \times (\text{NIBC} + \text{NACT} + \text{NDELK}) \\
 &\quad + \text{IGM} \times (3 + \text{IST} + \text{IHT}) \\
 &\quad + \text{ML} \times (2 + \text{IZM}) \\
 &\quad + \text{MT} \times (\text{IST} + \text{IHT} + 1) \\
 &\quad + \text{MAX}(\text{IM}, \text{JM}) \times (5 + 2 \times \text{IGM}) \\
 &\quad + \text{IPG} \times (1 + \text{IGM} + \text{NIBC}) \\
 &\quad + \text{NPDEL} \times (\text{MAX}(\text{IM}, \text{JM}) + 2)
 \end{aligned}$$

and

$$N_2 = \text{MT} \times (\text{IHT} + \text{IST} + 1) \times (\text{IGM} + 1) + 2 \times \text{ML} + 1.$$

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

PERT-V also requires five peripheral storage devices -- two for fluxes, one for cross section data, and two scratch units -- each device requires about 200,000 words. Since the code was written for a UNIVAC 1108, high speed drums are used for storage; however, only minor coding changes are required to use either tape or disc storage.

REFERENCES

1. R. W. Hardie and W. W. Little, Jr. 1DX, A One-Dimensional Diffusion Code for Generating Effective Nuclear Cross Sections, BNWL-954, Pacific Northwest Laboratory, Richland, Washington, March 1969.
2. W. W. Little, Jr. and R. W. Hardie. 2DB User's Manual -- Revision 1, BNWL-831 REV1. Pacific Northwest Laboratory, Richland, Washington, 1969.
3. K. D. Lathrop. DTF-IV, A FORTRAN-IV Program for Solving the Multi-group Transport Equation with Anisotropic Scattering, LA-3373. Los Alamos Scientific Laboratory, Los Alamos, New Mexico, 1965.
4. Unpublished Data. 2DF, A Two-Dimensional Transport Code from the Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

APPENDIX A

SAMPLE PROBLEM

The following pages show the input data (excluding input fluxes) and computer output (midi print) for a 2-group, 2 zone, 20 x 20 problem, in R-Z geometry. The plots at the end of this section were generated using the CALCOMP plotter.

* * * * * P E R T - V * * * * *

PERT-V SAMPLE PROBLEM

ND	1/2/3/4=1-D FLUXES/2-D FLUXES/1-D FLUX/2-D FLUX (IF NEG, FROM TAPE)	2
ML	NEGATIVE/POSITIVE=NUMBER OF MATERIALS FROM TAPE/CARDS	5
HPRT	PRINT OPTION (0/1/2=MINI/MIDI/MAXI)	1
IGM	NUMBER OF ENERGY GROUPS	2
IST	NUMBER OF DOWNSCATTERING TERMS	1
IHT	POSITION OF TRANSPORT CROSS SECTION	4
HDELK	NUMBER OF REACTIVITY COEFFICIENT CALCULATIONS	3
NACT	NUMBER OF ACTIVITY TRAVERSES	1
NIBC	NUMBER OF MATERIALS FOR BETA EFFECTIVE CALCULATION	2
IPG	NUMBER OF DELAYED NEUTRON GROUPS	12
IPS	0/1=ONE DELAYED SPECTRUM/INPUT SPECTRUM FOR EACH GROUP	0
HPDEL	0/1=NO EFFECT/PLOT REACTIVITY COEFFICIENTS	1
IGE	GEOMETRY (0/1/2/3=PL/CYL/SPH IF 1-D, X-Y/R-Z/R-THETA/TRIANGULAR IF 2-D)	1
IM	NUMBER OF RADIAL INTERVALS	20
JM	NUMBER OF AXIAL INTERVALS (=1 FOR 1-D PROBLEMS)	20
IZM	NUMBER OF MATERIAL ZONES	2
MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	7
M01	NUMBER OF MIXTURE SPECIFICATIONS	11
B01	LEFT BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	1
B02	RIGHT BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	0
B03	TOP BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	0
B04	BOTTOM BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE/PERIODIC)	1
ZKEFF	KEFF FOR PERT. EQUATION (IF ZERO, USE CALCULATED VALUE)	0.0000
FLP0	NEGATIVE/POSITIVE=POWER (MW)/TOTAL CENTER POINT FLUX	-1.0000+02
VF	VOLUME FACTOR	2.0000+00
BUCK	BUCKLING (CM-2)	0.0000

LAST = 3794

A-3

1	2	3	4	5
PU239	2 GROUPS			
U238	2 GROUPS			
C	2 GROUPS			
FE	2 GROUPS			
NA	2 GROUPS			

R1 21

21

004

[illegible]

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NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

NNNNNNNNNNNNNNNNNNNN

MATERIAL NUMBERS BY ZONE

M2 2 7
6

FISSION SPECTRUM

KE 2

.98700-00 .13000-01

NEUTRON VELOCITIES

V7 2

.76310+09 .11600+09

MIXTURE SPECIFICATIONS (10/11/12=MIX NUMBER/MAT. NUMBER FOR MIX/MATERIAL DENSITY)

10	11	6	6	6	6	7	7	7
6								
7								
11	11							
0		1	2	3	4	5	0	4
5								
12	11							
.00000	.15000-02	.80000-02	.19200-01	.12000-01	.11000-01	.00000	.15000-01	.50000-01
.50000-02								.20000-01

MATERIAL NUMBERS FOR BETA EFFECTIVE CALCULATION

NBET 2 2
1

ABSOLUTE NEUTRON YIELD PER DELAYED FISSION FOR ABOVE MATERIALS

BETA 2

.63000-02 .41200-01

FRACTIONAL YIELDS BY GROUP FOR DELAY MATERIAL 1

	MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	6	0	.00000000
2	6	1	.15000000-02
3	6	2	.79999999-02
4	6	3	.19200000-01
5	6	4	.12000000-01
6	6	5	.11000000-01
7	7	0	.00000000
8	7	2	.15000000-01
9	7	3	.30000000-01
10	7	4	.20000000-01
11	7	5	.49999999-02

CROSS-SECTION EDIT

GROUP 1	SIGF	SIGA	NUSIGF	SIGTR	GXG	G-1XG	G-2XG	.	.	.
MAT 1	.17244+01	.18487+01	.51150+01	.68356+01	.47659+01	.00000				
MAT 2	.10010+00	.23289-00	.28144-00	.63357+01	.60052+01	.00000				
MAT 3	.00000	.83362-05	.00000	.26395+01	.24508+01	.00000				
MAT 4	.00000	.59177-02	.00000	.25576+01	.25175+01	.00000				
MAT 5	.00000	.71501-03	.00000	.36962+01	.30665+01	.00000				
MAT 6	.53873-02	.47152-02	.99240-02	.17638-00	.16546-00	.00000				
MAT 7	.15015-02	.36155-02	.42216-02	.24082-00	.22896-00	.00000				
GROUP 2	SIGF	SIGA	NUSIGF	SIGTR	GXG	G-1XG	G-2XG	.	.	.
MAT 1	.22842+01	.32401+01	.64950+01	.13918+02	.10677+02	.79040-01				
MAT 2	.00000	.53219-00	.00000	.13158+02	.12620+02	.97561-01				
MAT 3	.00000	.45693-10	.00000	.44855+01	.44855+01	.18842-00				
MAT 4	.00000	.21543-01	.00000	.46214+01	.47999+01	.34240-01				
MAT 5	.00000	.42342-02	.00000	.49845+01	.49803+01	.88955-01				
MAT 6	.34263-02	.94227-02	.97435-02	.32495-00	.31553-00	.59960-02				
MAT 7	.00000	.84349-02	.60000	.45329-00	.44486-00	.82455-02				

PERT-V SAMPLE PROBLEM

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 .314+03 LITERS	ZONE 2 .109+04 LITERS
1 PU239	239.050	1.870+02	0.000
2 U238	238.050	9.933+02	6.461+03
3 C	12.011	1.203+02	6.541+02
4 FE	55.847	3.496+02	2.027+03
5 NA	22.990	1.519+02	2.067+02

PERT-V SAMPLE PROBLEM

CENTER POINT FLUX (N/CM ² -SEC)	-	-	-	4.45726+15
TOTAL POWER (MWT)	-	-	-	1.00000+02
DENOMINATOR OF PERT. EQUATION	-	-	-	4.52883+18
SOURCE RATE	-	-	-	8.38713+18
ABSORPTION RATE	-	-	-	7.36852+18
LEAKAGE RATE	-	-	-	7.15960+17
CALCULATED KEFF	-	-	-	1.03746

PERT-V SAMPLE PROBLEM

TOTAL FLUX

1	2	3	4	5
1	4457259+16	4314626+16	4174405+16	3991171+16
2	4404839+16	4357582+16	4125278+16	3944179+16
3	4300705+16	4250557+16	4027695+16	3850039+16
4	4146308+16	4013536+16	3883011+16	3712044+16
5	3901484+16	3817491+16	3693281+16	3530965+16
6	3696280+16	3577794+16	3461309+16	3309985+16
7	3407489+16	3298180+16	3190713+16	3050688+16
8	3082316+16	2983352+16	2886050+16	2758880+16
9	2726846+16	2639206+16	2553031+16	2440394+16
10	2348767+16	2273190+16	2198871+16	2101721+16
11	1952147+16	1869248+16	1827389+16	1746516+16
12	1601151+16	1583837+16	1498888+16	1432261+16
13	1299845+16	1285773+16	1216566+16	1162576+16
14	1043808+16	1032496+16	9768271+15	9334745+15
15	8273341+15	8183697+15	7742367+15	7398253+15
16	6442591+15	6373667+15	6028897+15	5760877+15
17	4884109+15	4831107+15	4570386+15	4367205+15
18	3538298+15	3499863+15	3310965+15	3163784+15
19	2348257+15	2322738+15	2197337+15	2098653+15
20	1259362+15	1245665+15	1178357+15	1125931+15
1	3768071+16	3508995+16	3218547+16	2565624+16
2	3723681+16	3467624+16	3160565+16	2535270+16
3	3635564+16	3385548+16	3105117+16	2474971+16
4	3504768+16	3263666+16	2993248+16	2385848+16
5	3333334+16	3103830+16	2846545+16	2268247+16
6	3123735+16	2908486+16	2667172+16	2124770+16
7	2879250+16	2680630+16	2457938+16	1957321+16
8	2604013+16	2424126+16	2222396+16	1768709+16
9	2303206+16	2143820+16	1965020+16	1562524+16
10	1983372+16	1845837+16	1691482+16	1343451+16
11	1647979+16	1533544+16	1404821+16	1114322+16
12	1351317+16	1257121+16	1151531+16	912753+15
13	1096789+16	1020312+16	9344489+15	7406817+15
14	8866099+15	8191751+15	7502423+15	5950541+15
15	6979151+15	6492359+15	5946643+15	4721739+15
16	5434575+15	505815+15	4631655+15	3682539+15
17	4119944+15	3833135+15	3512292+15	2796415+15
18	2984750+15	277208+15	2545267+15	2293885+15
19	1980867+15	1843236+15	1689541+15	1348050+15
1	2000000+01	6000000+01	6000000+01	2000000+01
2	6000000+01	1000000+02	1000000+02	1000000+02
3	1000000+02	1400000+02	1400000+02	1400000+02
4	1400000+02	1800000+02	1800000+02	1800000+02
5	1800000+02	2200000+02	2200000+02	2200000+02
6	2200000+02	2600000+02	2600000+02	2600000+02
7	2600000+02	3000000+02	3000000+02	3000000+02
8	3000000+02	3400000+02	3400000+02	3400000+02
9	3400000+02	3800000+02	3800000+02	3800000+02
10	3800000+02	4200000+02	4200000+02	4200000+02
11	4200000+02	4600000+02	4600000+02	4600000+02
12	4600000+02	5000000+02	5000000+02	5000000+02
13	5000000+02	5400000+02	5400000+02	5400000+02
14	5400000+02	5800000+02	5800000+02	5800000+02
15	5800000+02	6200000+02	6200000+02	6200000+02
16	6200000+02	6600000+02	6600000+02	6600000+02
17	6600000+02	7000000+02	7000000+02	7000000+02
18	7000000+02	7400000+02	7400000+02	7400000+02
19	7400000+02	7800000+02	7800000+02	7800000+02

20	1062186+15	9883463+14	9059197+14	8167329+14	7229645+14	6850000+02
1	2216164+16	1861842+16	1469982+16	1118538+16	8395029+15	2000000+01
2	2189904+16	1832954+16	1452995+16	1105208+16	8284991+15	6000000+01
3	2137733+16	1795642+16	1417750+16	1078720+16	8086233+15	1000000+02
4	2066353+16	1730511+16	1366195+16	1039420+16	7791411+15	1400000+02
5	1958823+16	1645329+16	1298511+16	9878259+15	7404559+15	1800000+02
6	1834584+16	1540573+16	1215602+16	9246363+15	6931185+15	2200000+02
7	1689492+16	1418433+16	1118592+16	8507257+15	6378431+15	2600000+02
8	1525890+16	1279338+16	1008770+16	7671407+15	5755415+15	3000000+02
9	1346774+16	1127951+16	8873635+15	6750833+15	5074024+15	3400000+02
10	1156175+16	9651613+15	7546357+15	5759765+15	4351266+15	3800000+02
11	9570427+15	7933361+15	6243657+15	4854113+15	3707652+15	4150000+02
12	7835073+15	6500343+15	5212205+15	4111845+15	3174199+15	4450000+02
13	6362787+15	5296947+15	4298352+15	3431264+15	2675389+15	4750000+02
14	5119387+15	4278958+15	3502346+15	2822321+15	2219993+15	5050000+02
15	4089622+15	3414821+15	2813656+15	2284500+15	1810397+15	5350000+02
16	3179894+15	2677598+15	2217838+15	1811600+15	1444527+15	5650000+02
17	2418907+15	2042865+15	1699116+15	1394483+15	1117450+15	5950000+02
18	1757633+15	1487885+15	1241419+15	1022500+15	8224801+14	6250000+02
19	1168965+15	9911835+14	8267745+14	6842947+14	5518773+14	6550600+02
20	6271513+14	5321193+14	4433378+14	3681007+14	2972279+14	6850000+02
1	6173815+15	4428140+15	3035831+15	1898739+15	9315777+14	2000000+01
2	6100135+15	4375311+15	2999639+15	1876117+15	9204731+14	6000000+01
3	5953779+15	4273410+15	2927798+15	1831227+15	8984403+14	1000000+02
4	5736793+15	4114980+15	2821423+15	1764792+15	8658433+14	1400000+02
5	5452317+15	3911421+15	2682254+15	1677932+15	8232547+14	1800000+02
6	5104723+15	3663119+15	2512760+15	1572334+15	7714903+14	2200000+02
7	4698827+15	3374615+15	2316294+15	1450107+15	7116575+14	2600000+02
8	4295330+15	3052035+15	2097313+15	1314195+15	6452091+14	3000000+02
9	3751611+15	2703502+15	1861634+15	1168286+15	5739831+14	3400000+02
10	3231183+15	2339815+15	1616624+15	1016293+15	5001885+14	3800000+02
11	2776082+15	2024083+15	1401721+15	8842491+14	4355114+14	4150000+02
12	2395263+15	1753369+15	1221637+15	7728585+14	3811812+14	4450000+02
13	2034937+15	1498756+15	1045003+15	6657061+14	3288381+14	4750000+02
14	1701193+15	1260483+15	8862659+14	5642103+14	2791493+14	5050000+02
15	1386582+15	1040541+15	7347915+14	4692075+14	2325202+14	5350000+02
16	1130724+15	8591867+14	5948667+14	3809284+14	1890744+14	5650000+02
17	8710507+14	6548715+14	4658213+14	2990424+14	1486727+14	5950000+02
18	6434759+14	4853681+14	3462029+14	2227385+14	1109441+14	6250600+02
19	4338798+14	3273936+14	2335460+14	1508134+14	7532343+13	6550600+02
20	2334329+14	1767278+14	1265179+14	8175437+13	4108857+13	6850600+02

PERT-V SAMPLE PROBLEM

FISSION SOURCE*ADJOINT FLUX

	1	2	3	4	5		6	7	8	9	10
1	.100000+01	.989263-00	.967973-00	.936471-00	.895304-00	1	.845164-00	.786909-00	.721551-00	.650253-00	.574329-00
2	.988216-00	.977605-00	.956583-00	.925430-00	.884740-00	2	.835189-00	.777615-00	.713021-00	.642525-00	.567525-00
3	.964806-00	.954443-00	.933891-00	.903493-00	.863731-00	3	.815371-00	.759149-00	.696727-00	.627285-00	.553997-00
4	.930083-00	.920092-00	.900270-00	.870976-00	.832634-00	4	.785977-00	.731762-00	.670938-00	.604582-00	.533933-00
5	.884522-00	.875014-00	.856150-00	.828274-00	.791812-00	5	.747413-00	.695824-00	.637948-00	.574817-00	.507660-00
6	.828767-00	.819853-00	.802174-00	.776026-00	.741847-00	6	.700218-00	.651842-00	.597580-00	.538385-00	.475394-00
7	.763637-00	.755418-00	.739170-00	.715005-00	.683487-00	7	.645069-00	.600487-00	.550435-00	.495833-00	.437635-00
8	.690154-00	.682719-00	.667974-00	.646129-00	.617506-00	8	.600487-00	.562525-00	.522547-00	.478273-00	.428195-00
9	.609573-00	.603008-00	.589638-00	.570678-00	.545466-00	9	.514749-00	.479045-00	.438650-00	.395210-00	.348576-00
10	.523450-00	.517800-00	.506522-00	.490012-00	.463337-00	10	.441917-00	.412056-00	.376715-00	.339035-00	.293819-00
11	.432527-00	.427897-00	.416237-00	.404903-00	.386925-00	11	.365069-00	.339690-00	.308707-00	.279870-00	.246857-00
12	.353262-00	.349439-00	.336637-00	.320637-00	.301597-00	12	.298085-00	.277289-00	.238376-00	.201082-00	.162525-00
13	.285825-00	.282722-00	.267587-00	.242862-00	.224759-00	13	.241135-00	.224294-00	.184711-00	.150398-00	.117206-00
14	.228979-00	.226496-00	.215719-00	.204286-00	.189325-00	14	.193151-00	.179658-00	.147940-00	.120361-00	.913857-00
15	.181271-00	.179304-00	.175463-00	.169632-00	.162882-00	15	.152898-00	.142215-00	.117206-00	.913857-00	.614924-00
16	.141229-00	.139696-00	.136656-00	.132158-00	.126303-00	16	.119123-00	.110814-00	.913857-00	.614924-00	.307149-00
17	.107441-00	.106274-00	.103961-00	.100539-00	.960690-00	17	.906281-00	.843161-00	.655880-00	.405681-00	.149346-00
18	.785920-00	.777385-00	.760460-00	.735436-00	.702750-00	18	.662884-00	.616892-00	.450681-00	.225000-00	.025000-00
19	.534707-00	.528914-00	.517406-00	.500379-00	.478152-00	19	.451124-00	.419809-00	.270939-00	.100000-00	.000000-00
20	.309702-00	.306344-00	.299676-00	.289821-00	.276939-00						

PERT-V SAMPLE PROBLEM

POWER DENSITY (MW/LITER)

1	2	3	4	5	6	7	8	9	10
1	5221123-00	5054059-00	4889821-00	4675206-00	20000000+01	4413905-00	3770326-00	3399710-00	3005770-00
2	5159728-00	4994608-00	4832282-00	4620168-00	60000000+01	4361913-00	3725837-00	3359549-00	2970223-00
3	5037767-00	4876515-00	4717992-00	4510845-00	10000000+02	4258637-00	3637467-00	3279771-00	2899588-00
4	4856941-00	4701424-00	4548541-00	4348760-00	14000000+02	4105520-00	3506442-00	3161476-00	2794840-00
5	4619823-00	4471831-00	4326342-00	4136223-00	18000000+02	3904745-00	3334624-00	3006337-00	2657443-00
6	4329920-00	4191133-00	4054689-00	3876387-00	22000000+02	4329920-00	3124558-00	2816637-00	2489395-00
7	3981763-00	3863720-00	3737830-00	3573325-00	26000000+02	3981763-00	2879542-00	2595343-00	2293288-00
8	3611062-00	3572241-00	3381144-00	3232174-00	30000000+02	3611062-00	2603759-00	2346226-00	2072426-00
9	3194982-00	3160565-00	2991341-00	2859380-00	34000000+02	3194982-00	2302481-00	2074073-00	1831037-00
10	2752594-00	2722948-00	2576933-00	2463094-00	38000000+02	2752594-00	1982393-00	1785000-00	1574648-00
11	5781386-01	5718384-01	5408119-01	5165495-01	41500000+02	5781386-01	1513560-01	1370126-01	12325670-01
12	4491177-01	4442155-01	4200722-01	4011908-01	44500000+02	4491177-01	1127129-01	1089561-01	1040405-01
13	3480880-01	3442827-01	3255410-01	3108856-01	47500000+02	3480880-01	8110365-02	7840034-02	7486447-02
14	2687587-01	2658167-01	2599771-01	2399993-01	50500000+02	2687587-01	5455532-02	5273712-02	5035977-02
15	2061836-01	2039290-01	1994441-01	1841055-01	53500000+02	2061836-01	3141121-02	3036450-02	2899619-02
16	1564786-01	1547622-01	1463120-01	1397109-01	56500000+02	1564786-01	1513560-01	1463120-01	14040405-01
17	1165298-01	1152508-01	1089561-01	1040405-01	59500000+02	1165298-01	8110365-02	7840034-02	7486447-02
18	8385094-02	8295030-02	7840034-02	7486447-02	62500000+02	8385094-02	5455532-02	5273712-02	5035977-02
19	5640352-02	5640352-02	5273712-02	5035977-02	65500000+02	5640352-02	3141121-02	3036450-02	2899619-02
20	3247539-02	3211872-02	3036450-02	2899619-02	68500000+02	3247539-02	3770326-00	3399710-00	3005770-00
1	4413905-00	4110477-00	3770326-00	3399710-00	20000000+01	4413905-00	3725837-00	3359549-00	2970223-00
2	4361913-00	4062021-00	3725837-00	3359549-00	60000000+01	4361913-00	3637467-00	3279771-00	2899588-00
3	4258637-00	3965773-00	3637467-00	3279771-00	10000000+02	4258637-00	3506442-00	3161476-00	2794840-00
4	4105520-00	3823070-00	3506442-00	3161476-00	14000000+02	4105520-00	3334624-00	3006337-00	2657443-00
5	3904745-00	3635946-00	3334624-00	3006337-00	18000000+02	3904745-00	3124558-00	2816637-00	2489395-00
6	3659290-00	3407180-00	3124558-00	2816637-00	22000000+02	3659290-00	2879542-00	2595343-00	2293288-00
7	3373007-00	3140366-00	2879542-00	2595343-00	26000000+02	3373007-00	2603759-00	2346226-00	2072426-00
8	3050761-00	2840047-00	2603759-00	2346226-00	30000000+02	3050761-00	2302481-00	2074073-00	1831037-00
9	2698650-00	2511935-00	2302481-00	2074073-00	34000000+02	2698650-00	1982393-00	1785000-00	1574648-00
10	2324413-00	2163254-00	1982393-00	1785000-00	38000000+02	2324413-00	1513560-01	1370126-01	12325670-01
11	4869017-01	4522922-01	4131971-01	3701226-01	41500000+02	4869017-01	1127129-01	1089561-01	1040405-01
12	3781173-01	3511826-01	3207622-01	2872639-01	44500000+02	3781173-01	8110365-02	7840034-02	7486447-02
13	2929780-01	2720799-01	2484933-01	2225578-01	47500000+02	2929780-01	5455532-02	5273712-02	5035977-02
14	2261618-01	2100230-01	1918286-01	1718651-01	50500000+02	2261618-01	3141121-02	3036450-02	2899619-02
15	1734873-01	1611137-01	1471843-01	1319394-01	53500000+02	1734873-01	1513560-01	1463120-01	14040405-01
16	1316555-01	1222776-01	1117379-01	1002328-01	56500000+02	1316555-01	8110365-02	7840034-02	7486447-02
17	9804620-02	9107509-02	8325305-02	7473555-02	59500000+02	9804620-02	5455532-02	5273712-02	5035977-02
18	7055540-02	6554917-02	5994000-02	5384501-02	62500000+02	7055540-02	3141121-02	3036450-02	2899619-02
19	4746413-02	4410261-02	4034074-02	3625974-02	65500000+02	4746413-02	3770326-00	3399710-00	3005770-00

20	.2733020-02	11	.2539719-02	12	.2323566-02	13	.2089319-02	14	.1842805-02	15	.6850000+02
1	.2596678-00	12	.2181776-00	13	.4287525-01	14	.3056431-01	15	.2172813-01	16	.2000000+01
2	.2565913-00	13	.2155883-00	14	.4235621-01	15	.3019339-01	16	.2146401-01	17	.6000000+01
3	.2504793-00	14	.2104436-00	15	.4132314-01	16	.2945515-01	17	.2093846-01	18	.1000000+02
4	.2414140-00	15	.2028117-00	16	.3978572-01	17	.2835667-01	18	.2015681-01	19	.1400000+02
5	.2295201-00	16	.1927954-00	17	.3775789-01	18	.2690827-01	19	.1912710-01	20	.1800000+02
6	.2149667-00	17	.1805330-00	18	.3525636-01	19	.2512324-01	20	.1786019-01	21	.2200000+02
7	.1979720-00	18	.1661997-00	19	.3230161-01	20	.2301750-01	21	.1637034-01	22	.2600000+02
8	.1788117-00	19	.1500096-00	20	.2891006-01	21	.2060974-01	22	.1467685-01	23	.3000000+02
9	.1578386-00	20	.1322209-00	21	.2509220-01	22	.1792313-01	23	.1280842-01	24	.3400000+02
10	.1355283-00	21	.1131594-00	22	.2062724-01	23	.1499548-01	24	.1081469-01	25	.3800000+02
11	.2739291-01	22	.2211553-01	23	.1657528-01	24	.1231595-01	25	.9046115-02	26	.4150000+02
12	.2127260-01	23	.1725482-01	24	.1356298-01	25	.1017655-01	26	.7605345-02	27	.4450000+02
13	.1652422-01	24	.1349800-01	25	.1067094-01	26	.8286709-02	27	.6292732-02	28	.4750000+02
14	.1281001-01	25	.1053888-01	26	.8452093-02	27	.6664237-02	28	.5130911-02	29	.5050000+02
15	.9877952-02	26	.8179364-02	27	.6630440-02	28	.5290440-02	29	.4120353-02	30	.5350000+02
16	.7538040-02	27	.6276771-02	28	.5130393-02	29	.4131898-02	30	.3248457-02	31	.5650000+02
17	.5644157-02	28	.4721682-02	29	.3884221-02	30	.3151080-02	31	.2496030-02	32	.5950000+02
18	.4081235-02	29	.3426875-02	30	.2832931-02	31	.2310959-02	32	.1841195-02	33	.6250000+02
19	.2756130-02	30	.2320598-02	31	.1925131-02	32	.1576698-02	33	.1261462-02	34	.6550000+02
20	.1591005-02	31	.1341878-02	32	.1115638-02	33	.9159017-03	34	.7346599-03	35	.6850000+02
1	.1533667-01	16	.1066022-01	17	.7176110-02	18	.4503971-02	19	.2360224-02	20	.2000000+01
2	.1515013-01	17	.1053060-01	18	.7088942-02	19	.4449334-02	20	.2331623-02	21	.6000000+01
3	.1477906-01	18	.1027290-01	19	.6915732-02	20	.4340814-02	21	.2274835-02	22	.1000000+02
4	.1422762-01	19	.9890269-02	20	.6658803-02	21	.4179976-02	22	.2190717-02	23	.1400000+02
5	.1350215-01	20	.9387676-02	21	.6321844-02	22	.3969316-02	23	.2080640-02	24	.1800000+02
6	.1261162-01	21	.8772283-02	22	.5910238-02	23	.3712483-02	24	.1946606-02	25	.2200000+02
7	.1156842-01	22	.8054203-02	23	.5431588-02	24	.3414610-02	25	.1791415-02	26	.2600000+02
8	.1039016-01	23	.7247797-02	24	.4896537-02	25	.3082744-02	26	.1618865-02	27	.3000000+02
9	.9103171-02	24	.6373762-02	25	.4319797-02	26	.2726313-02	27	.1433922-02	28	.3400000+02
10	.7748830-02	25	.5461786-02	26	.3721024-02	27	.2357305-02	28	.1242724-02	29	.3800000+02
11	.6561546-02	26	.4665743-02	27	.3199027-02	28	.2035630-02	29	.1076009-02	30	.4150000+02
12	.5585018-02	27	.4007127-02	28	.2765338-02	29	.1767579-02	30	.9368288-03	31	.4450000+02
13	.4678610-02	28	.3388394-02	29	.2354574-02	30	.1512303-02	31	.8038519-03	32	.4750000+02
14	.3858755-02	29	.2820101-02	30	.1973196-02	31	.1273539-02	32	.6793334-03	33	.5050000+02
15	.3130211-02	30	.2306769-02	31	.1624504-02	32	.1053384-02	33	.5631639-03	34	.5350000+02
16	.2489119-02	31	.1847762-02	32	.1308839-02	33	.8523073-03	34	.4568547-03	35	.5650000+02
17	.1926110-02	32	.1438625-02	33	.1024117-02	34	.6693604-03	35	.3596115-03	36	.5950000+02
18	.1428689-02	33	.1072350-02	34	.7664642-03	35	.5024743-03	36	.2704616-03	37	.6250000+02
19	.9828140-03	34	.7403668-03	35	.5307763-03	36	.3487545-03	37	.1879873-03	38	.6550000+02
20	.5738082-03	35	.4332310-03	36	.3111721-03	37	.2047514-03	38	.1104653-03	39	.6850000+02

PERT-V SAMPLE PROBLEM

ZONE	ZONE VOLUME	ZONE AV. FLUX	ZONE AV. POWER
1	.314159+03	.242775+16	.284436-00
2	.109327+04	.574253+15	.975396-02

PERT-V SAMPLE PROBLEM

BETA(1) =	6.5194-05
BETA(2) =	4.8038-04
BETA(3) =	3.7058-04
BETA(4) =	5.6273-04
BETA(5) =	1.7671-04
BETA(6) =	6.0047-05
BETA(7) =	3.1324-05
BETA(8) =	3.3011-04
BETA(9) =	3.9035-04
BETA(10) =	9.3490-04
BETA(11) =	5.4215-04
BETA(12) =	1.8072-04
TOTAL BETA =	4.1252-03
ONE INHOUR =	1.2010-05
GENERATION TIME =	3.6027-07

PERT-V SAMPLE PROBLEM

REACTIVITY COEFFICIENTS FOR MATERIAL 1 PU239

ROW 1

	ΔK/K PER KG	ΔK (NUSIGF)	ΔK (SIGA)	ΔK (SIGTR)	ΔK (SIGXU)	ΔK (INT6)	AVG RADII	AVG AXII
1	.4036-02	.6688-02	-.2641-02	.3167-06	-.1184-04	.4036-02	.2083+01	.2000+01
2	.3951-02	.6545-02	-.2584-02	.1774-05	-.1160-04	.3972-02	.6250+01	.2000+01
3	.3785-02	.6267-02	-.2474-02	.3627-05	-.1112-04	.3868-02	.1042+02	.2000+01
4	.3547-02	.5866-02	-.2315-02	.6256-05	-.1044-04	.3728-02	.1458+02	.2000+01
5	.3247-02	.5363-02	-.2115-02	.9489-05	-.9586-05	.3555-02	.1875+02	.2000+01
6	.2900-02	.4780-02	-.1864-02	.1512-04	-.8609-05	.3355-02	.2292+02	.2000+01
7	.2523-02	.4146-02	-.1632-02	.1691-04	-.7559-05	.3134-02	.2708+02	.2000+01
8	.2132-02	.3488-02	-.1370-02	.2061-04	-.6491-05	.2899-02	.3125+02	.2000+01
9	.1745-02	.2837-02	-.1110-02	.2398-04	-.5460-05	.2657-02	.3542+02	.2000+01
10	.1379-02	.2218-02	-.8620-03	.2679-04	-.4514-05	.2414-02	.3958+02	.2000+01
11	.1047-02	.1657-02	-.6351-03	.2860-04	-.3692-05	.2177-02	.4375+02	.2000+01
12	.7611-03	.1171-02	-.4365-03	.2978-04	-.3010-05	.1951-02	.4792+02	.2000+01
13	.5018-03	.7329-03	-.2525-03	.2372-04	-.2394-05	.1756-02	.5187+02	.2000+01
14	.3035-03	.4259-03	-.1348-03	.1400-04	-.1596-05	.1572-02	.5562+02	.2000+01
15	.1770-03	.2401-03	-.7618-04	.8038-05	-.9743-06	.1407-02	.5938+02	.2000+01
16	.9910-04	.1306-03	-.3550-04	.4578-05	-.5576-06	.1260-02	.6312+02	.2000+01
17	.5260-04	.6747-04	-.1721-04	.2635-05	-.2990-06	.1132-02	.6687+02	.2000+01
18	.2567-04	.3198-04	-.7727-05	.1567-05	-.1467-06	.1021-02	.7062+02	.2000+01
19	.1074-04	.1276-04	-.2953-05	.9918-06	-.6163-07	.9237-03	.7437+02	.2000+01
20	.3225-05	.3287-05	-.7393-06	.6953-06	-.1817-07	.8394-03	.7813+02	.2000+01

PERT-V SAMPLE PROBLEM

REACTIVITY COEFFICIENTS FOR MATERIAL 1							ROW	5
	$\Delta K/K$ PER KG	ΔK (NUSIGF)	ΔK (SIGA)	ΔK (SIGTR)	ΔK (SIGXJ)	ΔK (INTG)	AVG RADII	AVG AXII
1	.3177-02	.5237-02	-.2063-02	.1260-04	-.9483-05	.3177-02	.2083+01	.1800+02
2	.3110-02	.5135-02	-.2019-02	.1310-04	-.9287-05	.3127-02	.6250+01	.1800+02
3	.2979-02	.4907-02	-.1933-02	.1405-04	-.8905-05	.3045-02	.1042+02	.1800+02
4	.2791-02	.4593-02	-.1808-02	.1539-04	-.8357-05	.2934-02	.1458+02	.1800+02
5	.2555-02	.4198-02	-.1652-02	.1702-04	-.7673-05	.2797-02	.1875+02	.1800+02
6	.2282-02	.3741-02	-.1471-02	.1882-04	-.6888-05	.2640-02	.2292+02	.1800+02
7	.1985-02	.3244-02	-.1274-02	.2065-04	-.6044-05	.2466-02	.2708+02	.1800+02
8	.1677-02	.2739-02	-.1069-02	.2236-04	-.5185-05	.2281-02	.3125+02	.1800+02
9	.1372-02	.2219-02	-.8661-03	.2382-04	-.4354-05	.2090-02	.3542+02	.1800+02
10	.1083-02	.1734-02	-.6722-03	.2489-04	-.3592-05	.1899-02	.3958+02	.1800+02
11	.8219-03	.1294-02	-.4950-03	.2542-04	-.2929-05	.1712-02	.4375+02	.1800+02
12	.5973-03	.9144-03	-.3460-03	.2527-04	-.2378-05	.1534-02	.4792+02	.1800+02
13	.3929-03	.5720-03	-.1963-03	.1913-04	-.1882-05	.1380-02	.5187+02	.1800+02
14	.2375-03	.3322-03	-.1047-03	.1124-04	-.1251-05	.1236-02	.5562+02	.1800+02
15	.1384-03	.1873-03	-.5447-04	.6426-05	-.7627-06	.1109-02	.5938+02	.1800+02
16	.7752-04	.1019-03	-.2755-04	.3645-05	-.4362-06	.9906-03	.6312+02	.1800+02
17	.4116-04	.5266-04	-.1335-04	.2089-05	-.2338-06	.8898-03	.6687+02	.1800+02
18	.2009-04	.2497-04	-.5999-05	.1236-05	-.1148-06	.8022-03	.7062+02	.1800+02
19	.8408-05	.9972-05	-.2294-05	.7783-06	-.4821-07	.7260-03	.7437+02	.1800+02
20	.2522-05	.2568-05	-.5749-06	.5428-06	-.1421-07	.6598-03	.7813+02	.1800+02

PERT-V SAMPLE PROBLEM

REACTIVITY COEFFICIENTS FOR MATERIAL 5					COLUMN 1	
	ΔK/K PER KG	ΔK (HUSIOF)	ΔK (SIGA)	ΔK (SIGTR)	ΔK (SIGAX)	ΔK (JHTG)
						AVG RADII
						AVG AXII
1	-.1564-13	.0000	-.2154-04	.3738-05	-.1386-03	-.1564-03
2	-.1470-13	.0000	-.2104-04	.9545-05	-.1355-03	-.1517-03
3	-.1268-13	.0000	-.2065-04	.2088-04	-.1297-03	-.1441-03
4	-.1027-13	.0000	-.1863-04	.3720-04	-.1213-03	-.1337-03
5	-.7011-04	.0000	-.1664-04	.5771-04	-.1110-03	-.1213-03
6	-.3272-04	.0000	-.1478-04	.3142-04	-.9936-04	-.1063-03
7	.7381-05	.0000	-.1253-04	.1071-03	-.8722-04	-.9065-04
8	.4791-04	.0000	-.1021-04	.1335-03	-.7536-04	-.7281-04
9	.8641-04	.0000	-.7926-05	.1589-03	-.6454-04	-.5512-04
10	.1262-03	.0000	-.5765-05	.1812-03	-.5524-04	-.3759-04
11	.1110-03	.0000	-.3757-05	.1623-03	-.4748-04	-.2722-04
12	.7333-04	.0000	-.2362-05	.1121-03	-.3645-04	-.2666-04
13	.4809-04	.0000	-.1451-05	.7566-04	-.2613-04	-.1645-04
14	.3170-04	.0000	-.8718-06	.5041-04	-.1784-04	-.1367-04
15	.2130-04	.0000	-.5117-06	.3350-04	-.1168-04	-.1177-04
16	.1481-04	.0000	-.2910-06	.2243-04	-.7330-05	-.1039-04
17	.1081-04	.0000	-.1577-06	.1533-04	-.4354-05	-.9349-05
18	.8398-05	.0000	-.7851-07	.1086-04	-.2386-05	-.8517-05
19	.6983-05	.0000	-.3297-07	.8152-05	-.1136-05	-.7823-05
20	.6222-05	.0000	-.9048-06	.6632-05	-.4012-06	-.7221-05

ACTIVITY 1 MATERIAL 1 CROSS SECTION POSITION 2

1	1	1040112+16	1	1028994+17	4	974370+16	5	9318315+16	20000000+01
2	1	1027965+17	3	1006951+17	4	9629829+16	5	9209357+16	60000000+01
3	1	1003851+17	3	9951868+16	4	9403794+16	5	8993088+16	10000000+02
4	1	9681467+16	3	9718350+16	4	9069106+16	5	8672863+16	14000000+02
5	1	9214262+16	3	9577912+16	4	8631160+16	5	8253848+16	18000000+02
6	1	8644917+16	3	915647+16	4	8097498+16	5	7743253+16	22000000+02
7	1	8552341+16	3	852341+16	4	78887+16	5	7150663+16	26000000+02
8	1	7984192+16	3	7898537+16	4	7478120+16	5	6488649+16	30000000+02
9	1	7245794+16	3	7168069+16	4	6786152+16	5	6038633+16	34000000+02
10	1	6448362+16	3	6379117+16	4	6038633+16	5	5773721+16	38000000+02
11	1	5616305+16	3	5555919+16	4	5259143+16	5	5027883+16	41500000+02
12	1	4769685+16	3	4718326+16	4	4465884+16	5	4269125+16	44500000+02
13	1	3979546+16	3	3936636+16	4	3725704+16	5	3561273+16	47500000+02
14	1	3275102+16	3	3239744+16	4	3065930+16	5	2930428+16	50500000+02
15	1	2658947+16	3	2630211+16	4	2488951+16	5	2378833+16	53500000+02
16	1	2125895+16	3	2102900+16	4	1989869+16	5	1901772+16	56500000+02
17	1	1666458+16	3	1648419+16	4	1559768+16	5	1490689+16	59500000+02
18	1	1268976+16	3	1255234+16	4	1187704+16	5	1135096+16	62500000+02
19	1	9208422+15	3	9108660+15	4	8618491+15	5	8236742+15	65500000+02
20	1	6091047+15	3	6025030+15	4	5700695+15	5	5448154+15	68500000+02
1	1	5206712+15	6	5171928+15	9	3001041+15	10	2867987+15	71500000+02
2	1	8801023+16	6	8201441+16	9	6802853+16	10	6435722+16	74500000+02
3	1	8698051+16	6	8105404+16	9	6723998+16	10	5964776+16	77500000+02
4	1	8493656+16	6	7914780+16	9	6565482+16	10	5823933+16	80500000+02
5	1	8191014+16	6	7632515+16	9	6330730+16	10	5615322+16	83500000+02
6	1	7795010+16	6	7263163+16	9	6023486+16	10	5342224+16	86500000+02
7	1	7312449+16	6	6813072+16	9	5648972+16	10	509212+16	89500000+02
8	1	6752404+16	6	6290702+16	9	5214175+16	10	4622394+16	92500000+02
9	1	6126772+16	6	5707167+16	9	4728314+16	10	4189848+16	95500000+02
10	1	5451183+16	6	5077081+16	9	4203622+16	10	3722381+16	98500000+02
11	1	4746461+16	6	4419921+16	9	3656557+16	10	3234809+16	10150000+02
12	1	4029621+16	6	3751598+16	9	3160750+16	10	2739964+16	10450000+02
13	1	3361086+16	6	3128641+16	9	2584075+16	10	2281775+16	10750000+02
14	1	275452+16	6	2573886+16	9	2125117+16	10	1876164+16	11050000+02
15	1	2244777+16	6	2089143+16	9	1724845+16	10	1523181+16	11350000+02
16	1	1794547+16	6	1670113+16	9	1379233+16	10	1218666+16	11650000+02
17	1	1406637+16	6	1309146+16	9	1081613+16	10	9563932+15	11950000+02
18	1	1071109+16	6	9969358+15	9	8241113+15	10	729252+15	12250000+02
19	1	7772386+15	6	7234827+15	9	5983713+15	10	5298603+15	12550000+02
20	1	5141181+15	6	4785686+15	9	3959560+15	10	3507944+15	12850000+02
1	1	2706272+15	11	2519031+15	13	2310116+15	14	1846671+15	13150000+02
2	1	5245938+16	11	4457714+16	13	3600341+16	14	2132239+16	13450000+02
3	1	5184167+16	11	4405121+16	13	3566649+16	14	2106932+16	13750000+02

3	.5061527+16	.4300690+16	.3461863+16	.2702274+16	.2056672+16	.1000000+02
4	.4879338+16	.4145937+16	.3356184+16	.2604891+16	.1932177+16	.1400000+02
5	.4641899+16	.3943184+16	.3191438+16	.2476691+16	.1845331+16	.1800000+02
6	.4351587+16	.3695617+16	.2990095+16	.2319977+16	.1765240+16	.2200000+02
7	.4010403+16	.3407345+16	.2755282+16	.2137154+16	.1626232+16	.2600000+02
8	.3636917+16	.3083640+16	.2490698+16	.1931110+16	.1469932+16	.3000000+02
9	.3236544+16	.2731146+16	.2200107+16	.1705117+16	.1299423+16	.3400000+02
10	.2798367+16	.2358812+16	.1864930+16	.1462769+16	.1118835+16	.3800000+02
11	.2363914+16	.1975474+16	.1577051+16	.1241421+16	.9579302+15	.4150000+02
12	.1966306+16	.1641937+16	.1329276+16	.1058479+16	.8238500+15	.4450000+02
13	.1617024+16	.1353087+16	.1105608+16	.8888097+15	.6975463+15	.4750000+02
14	.1314079+16	.1102877+16	.9073911+15	.7351583+15	.5812520+15	.5050000+02
15	.1053832+16	.8863698+15	.7332599+15	.5978610+15	.4757279+15	.5350000+02
16	.8275660+15	.6986915+15	.5805679+15	.4758090+15	.3806410+15	.5650000+02
17	.6318933+15	.5348711+15	.4460550+15	.3670442+15	.2949088+15	.5950000+02
18	.4598890+15	.3898890+15	.3260117+15	.2691234+15	.2169541+15	.6250000+02
19	.3046025+15	.2587171+15	.2167340+15	.1792971+15	.1448739+15	.6550000+02
20	.1603974+15	.1363088+15	.1142777+15	.9462599+14	.7653877+14	.6850000+02
			16	19	20	
1	.1587745+16	.1147948+16	.7905658+15	.4940309+15	.2333383+15	.2000000+01
2	.1560891+16	.1130318+16	.7811844+15	.4881711+15	.2355102+15	.6000000+01
3	.1531453+16	.1107263+16	.7625676+15	.4765458+15	.2298993+15	.1000000+02
4	.1475984+16	.1067196+16	.7350136+15	.4593477+15	.2216007+15	.1400000+02
5	.1403336+16	.1014784+16	.6969872+15	.4368784+15	.2107632+15	.1800000+02
6	.1314665+16	.9508651+15	.6551438+15	.4095641+15	.1975972+15	.2200000+02
7	.1211542+16	.8767141+15	.6043652+15	.3779787+15	.1823862+15	.2600000+02
8	.1095982+16	.7938872+15	.5478086+15	.3428708+15	.1654987+15	.3000000+02
9	.9706593+15	.7044750+15	.4869633+15	.3051877+15	.1473966+15	.3400000+02
10	.8391007+15	.6111734+15	.4236877+15	.2660772+15	.1286308+15	.3800000+02
11	.7229394+15	.5290919+15	.3681013+15	.2317367+15	.1121600+15	.4150000+02
12	.6258237+15	.4602966+15	.3214207+15	.2028569+15	.9830112+14	.4450000+02
13	.5334615+15	.3944467+15	.2765372+15	.1750067+15	.8491913+14	.4750000+02
14	.4473830+15	.3325338+15	.2340698+15	.1485450+15	.7218061+14	.5050000+02
15	.3682878+15	.2750815+15	.1943722+15	.1236864+15	.6018694+14	.5350000+02
16	.2961554+15	.2221652+15	.1575282+15	.1004931+15	.4897029+14	.5650000+02
17	.2304668+15	.1734784+15	.1253767+15	.7888347+14	.3849603+14	.5950000+02
18	.1700535+15	.1284123+15	.9155134+14	.5865034+14	.2867023+14	.6250000+02
19	.1138146+15	.8612671+14	.6152023+14	.3948175+14	.1934775+14	.6550000+02
20	.6019629+14	.4560549+14	.3262096+14	.2098040+14	.1034105+14	.6850000+02

ZONE	ZONE VOLUME	ZONE AV. ACTIVITY
1	.314159+03	.572307+16
2	.109327+04	.950725+15

APPENDIX B

SOURCE DECK LISTING

This section contains a listing of the PERT-V source deck.

-IL PDP INCL

B-1

ABC* FCOPY

COMMON

1 NINP, NOUT, NCR1, NSCR1, NSCR2, NFLUX1, NFLUX2, PERT0001

2 DENOM, ICARD, IGEP, IHA, IHF, IHG, IHN, PERT0002

3 III, IIJJ, IJIGM, IJMAX, IMJM, IP, ITEMP, PERT0003

4 ITEMP1, ITL, JP, NDIM, NFP, NFXIN, NNCR, PERT0004

5 PI2, TEMP, TEMP1, TSD, PERT0005

COMMON ID(12), ND, ML, NPRT, IGM, IST, IHT, PERT0006

1 NDELK, NACT, NIBC, IPG, IPS, NPDEL, IGE, PERT0007

2 IM, JM, IZM, MT, MO1, B01, B02, PERT0008

3 B03, B04, ZKEFF, FLPO, VF, BUCK, PERT0009

COMMON LATW, LHOLN, LC0, LN0, LN1, LA0, LA1, PERT0010

1 LI0, LI1, LI2, LI3, LK6, LM0, LM2, PERT0011

2 LR1, LR4, LR5, LV0, LV7, LZ1, LZ4, PERT0012

3 LZ5, LVOL, LMASS, LGAM, LPOW, LSORC1, LSORC2, PERT0013

4 LNBET, LBETA, LD7, LAB, LAL, LZPHI, LZPOW, PERT0014

5 LMA, LNX, LZACT, LDEL, LNCR, LMATDK, LCP, PERT0015

6 LCX, LFLUX, LADJF, LX, LY, PERT0016

INTEGER B01, B02, B03, B04, PERT0017

REAL I2, I3, K6, N0, N1, MASS, PERT0018

END PERT0019

PERT0020

PERT0021


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-ITC  FOR MAIN,MAIN
C
C      * * * * *  DESCRIPTION OF SUBROUTINES  * * * * *
C
C  MAIN      CONTROLS THE OPERATION OF THE CODE.
C
C  INP       CONTROLS THE READING AND PRINTING OF ALL INPUT DATA.
C
C  REAG2     READS FLOATING POINT DATA IN GENERALIZED FORMAT.
C
C  REAI2     READS INTEGER DATA IN GENERALIZED FORMAT.
C
C  CLEAR     SETS AN ARRAY OF A GIVEN LENGTH EQUAL TO A SPECIFIED
C            CONSTANT.
C
C  ERRO2     PRINTS ERROR MESSAGES.
C
C  SWITCH    SWITCHS TAPE DESIGNATIONS.
C
C  XSINP     READS CROSS SECTIONS (FROM CARDS OR TAPE), PERFORMS
C            ADJOINT REVERSALS IF REQUIRED, AND WRITES CROSS SECTIONS
C            TO DRUM BY GROUP.
C
C  FXINP     READS FLUXES (FROM CARDS OR TAPE) AND WRITES THEM TO
C            DRUM BY GROUP.
C
C  MAPR      PRODUCES A PICTURE PRINT BY ZONE AND MATERIAL.
C
C  SETUP     MIXES CROSS SECTIONS AND CALCULATES GEOMETRIC PARAMETERS.
C
C  PRT       PRINTS (IM,JM) ARRAYS.
C
C  GRAM      CALCULATES AND PRINTS MATERIAL INVENTORIES BY ZONE.
C
C  NORM      CALCULATES KEFF AND NORMALIZES FLUXES.
C
C  ABETA     CALCULATES BETA EFFECTIVE AND THE GENERATION TIME.
C
C  SLOPE     COMPUTES (GRAD FLUX*GRAD ADJOINT)/SIGTR**2.
C
C  CALC      CALCULATES AND PRINTS REACTIVITY COEFFICIENTS FOR THE
C            SPECIFIED ROW OR COLUMN.
C
C  PLOT      PLOTS REACTIVITY COEFFICIENTS CALCULATED BY CALC.
C
C  ACT       CALCULATES ACTIVITY TRAVERSES.
C
C      * * * * *  INTERNAL VARIABLES  * * * * *
C
C  NINP      INPUT UNIT
C  NOUT      OUTPUT UNIT
C  NCR1      CROSS SECTION LOGICAL DRUM UNIT
C  NSCR1     SCRATCH LOGICAL DRUM UNIT
C  NSCR2     SCRATCH LOGICAL DRUM UNIT
C  NFLUX1    FLUX LOGICAL DRUM UNIT
C  NFLUX2    ADJOINT FLUX LOGICAL DRUM UNIT
C  DENOM     DENOMINATOR OF PERT. EQUATION
C  ICARD     = ML
C  IGEP      IGE + 1
C  IHA       POSITION OF SIGA
C  IHF       POSITION OF SIGF
C  IHG       POSITION OF SELF-SCATTER

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PERT0022
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PERT0082
PERT0083

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C	IHN	POSITION OF NU*SIGF	PERT0084
C	III	TEMPORARY	PERT0085
C	IIJJ	TEMPORARY	PERT0086
C	IJIGM	IM*JM*IGM	PERT0087
C	IJMAX	IMAX(IM,JM)	PERT0088
C	IMJM	IM*JM	PERT0089
C	IP	IM + 1	PERT0090
C	ITEMP	TEMPORARY	PERT0091
C	ITEMP1	TEMPORARY	PERT0092
C	ITL	TOTAL CROSS SECTION LENGTH (=IST + IHT + 1)	PERT0093
C	JP	JM + 1	PERT0094
C	NDIM	1/2=ONE-DIMENSION/TWO-DIMENSION PROBLEM	PERT0095
C	NFP	1/2=NORMALIZE FLUXES TO CENTER PT FLUX/TOTAL POWER	PERT0096
C	NFXIN	FLUX INPUT TAPE NUMBER	PERT0097
C	NNCR	TEMPORARY	PERT0098
C	PI2	2*PI = 6.28318	PERT0099
C	TEMP	TEMPORARY	PERT0100
C	TEMP1	TEMPORARY	PERT0101
C	ISD	(MW-SEC)/(FISSIONS)	PERT0102
C			PERT0103
C	* * * * * INPUT VARIABLES (CARDS 1-4) * * * * *		PERT0104
C			PERT0105
C	ID(12)	IDENTIFICATION CARD	PERT0106
C			PERT0107
C	ND	1/2/3/4=1-D FLUXES/2-D FLUXES/1-D FLUX/2-D FLUX (IF	PERT0108
C		NEGATIVE, FLUXES ARE FROM TAPE)	PERT0109
C	ML	NEG/POS=NUMBER OF MATERIALS FROM TAPE/CARDS	PERT0110
C	NPRT	PRINT OPTION (0/1/2=MINI/MIDI/MAXI)	PERT0111
C	IGM	NUMBER OF ENERGY GROUPS	PERT0112
C	IST	NUMBER OF DOWNSCATTERING TERMS	PERT0113
C	IHT	POSITION OF TRANSPORT CROSS SECTION	PERT0114
C	NDELK	NUMBER OF REACTIVITY COEFFICIENT CALCULATIONS	PERT0115
C	NACT	NUMBER OF ACTIVITY TRAVERSES	PERT0116
C	NIBC	NUMBER OF MATERIALS FOR BETA EFFECTIVE CALCULATION	PERT0117
C	IPG	NUMBER OF DELAYED NEUTRON GROUPS	PERT0118
C	IPS	0/1=ONE DELAYED SPECTRUM/INPUT SPECTRUM FOR EACH	PERT0119
C		DELAYED GROUP	PERT0120
C	NPDEL	0/1=NO EFFECT/PLOT REACTIVITY COEFFICIENTS	PERT0121
C			PERT0122
C	IGE	GEOMETRY (0/1/2/3=PLANE/CYLINDER/SPHERE IF 1-D	PERT0123
C		PROBLEM, OR X-Y/R-Z/R-THETA/TRIANGULAR IF 2-D)	PERT0124
C	IM	NUMBER OF RADIAL INTERVALS	PERT0125
C	JM	NUMBER OF AXIAL INTERVALS	PERT0126
C	I2M	NUMBER OF MATERIAL ZONES	PERT0127
C	MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	PERT0128
C	M01	NUMBER OF MIXTURE SPECIFICATIONS	PERT0129
C	B01	LEFT BOUNDARY CONDITION (0/1/2=VAC/REFL/PER)	PERT0130
C	B02	RIGHT BOUNDARY CONDITION (0/1/2=VAC/REFL/PER)	PERT0131
C	B03	TOP BOUNDARY CONDITION (0/1/2=VAC/REFL/PER)	PERT0132
C	B04	BOTTOM BOUNDARY CONDITION (0/1/2=VAC/REFL/PER)	PERT0133
C			PERT0134
C	ZKEFF	KEFF FOR PERT. EQ. (IF ZERO, USE CALCULATED VALUE)	PERT0135
C	FLPC	NEG/POS=POWER (MWT)/TOTAL CENTER POINT FLUX	PERT0136
C	VF	VOLUME FACTOR	PERT0137
C	BUCK	BUCKLING (CY-2)	PERT0138
C			PERT0139
C	* * * * * SUBSCRIPTED VARIABLES * * * * *		PERT0140
C			PERT0141
C	ATW(ML)	MATERIAL ATOMIC WEIGHT	PERT0142
C	HOLN(ML)	MATERIAL NAME	PERT0143
C	CC(ITL,MT)	CROSS SECTION ARRAY FOR CURRENT GROUP	PERT0144
C	NO(IM,JM)	FLUX	PERT0145

C	N1(IM,JM)	ADJOINT FLUX	PERT0146
C	A0(IP)	RADIAL AREA ELEMENT	PERT0147
C	A1(IM)	AXIAL AREA ELEMENT	PERT0148
C	I0(M01)	MIX NUMBER	PERT0149
C	I1(M01)	MATERIAL NUMBER FOR MIX	PERT0150
C	I2(M01)	MATERIAL DENSITY	PERT0151
C	I3(M01)	MATERIAL DENSITIES FOR GRAM CALCULATION	PERT0152
C	K6(IGM)	FISSION SPECTRUM	PERT0153
C	M0(IM,JM)	ZONE NUMBERS	PERT0154
C	M2(IZM)	MATERIAL NUMBERS BY ZONE	PERT0155
C	R1(IP)	RADII	PERT0156
C	R4(IM)	AVERAGE RADII	PERT0157
C	R5(IM)	DELTA-R	PERT0158
C	V0(IM,JM)	VOLUME ELEMENTS	PERT0159
C	V7(IGM)	NEUTRON VELOCITIES	PERT0160
C	Z1(JP)	AXII	PERT0161
C	Z4(JM)	AVERAGE AXII	PERT0162
C	Z5(JM)	DELTA-Z	PERT0163
C	VOL(IZM)	ZONE VOLUME (LITERS)	PERT0164
C	MASS(ML,IZM)	MATERIAL INVENTORY IN EACH ZONE	PERT0165
C	GAM(IZM)	BUCKLING COEFFICIENTS	PERT0166
C	POW(IM,JM)	POWER DENSITY	PERT0167
C	SORC1(IM,JM)	TEMPORARY	PERT0168
C	SORC2(IM,JM)	TEMPORARY	PERT0169
C	NBET(NIBC)	MATERIAL NUMBERS FOR BETA EFFECTIVE CALCULATION	PERT0170
C	BETA(NIBC)	ABSOLUTE NEUTRON YIELD PER DELAYED FISSION	PERT0171
C	D7(IGM,IPG)	DELAYED NEUTRON SPECTRUM	PERT0172
C	AB(IPG,NIBC)	DELAYED NEUTRON FRACTIONS	PERT0173
C	AL(IPG)	DECAY CONSTANTS(SEC-1)	PERT0174
C	ZPHI(IZM)	ZONE AVERAGED FLUXES	PERT0175
C	ZPOW(IZM)	ZONE AVERAGED POWERS	PERT0176
C	MA(NACT)	MATERIAL NUMBERS FOR ACTIVITY TRAVERSES	PERT0177
C	NX(NACT)	CROSS SECTION POSITION FOR ACTIVITY TRAVERSES	PERT0178
C	ZACT(IZM)	ZONE AVERAGED ACTIVITIES	PERT0179
C	DEL(IM,JM)	(GRAD PHI*GRAD ADJ)/SIGTR**2	PERT0180
C	NCR(NDELK)	NEG/POS=COLUMN/ROW NUMBER FOR DELTA K/K CALCULATION	PERT0181
C	MATDK(NDELK)	MATERIAL NUMBER FOR DELTA K/K CALCULATION	PERT0182
C	CP(5,IJMAX)	COMPONENTS IN PERTURBATION EQUATION	PERT0183
C	CX(ITL,IGM)	CROSS SECTION ARRAY FOR MATERIAL MATDK	PERT0184
C	FLUX(IGM,IJMAX)	FLUX FOR COLUMN/ROW NCR	PERT0185
C	ADJF(IGM,IJMAX)	ADJOINT FOR COLUMN/ROW NCR	PERT0186
C	X(IJMAX+2)	USED FOR PLOTTING REACTIVITY COEFFICIENTS	PERT0187
C	Y(IJMAX+2)	USED FOR PLOTTING REACTIVITY COEFFICIENTS	PERT0188
C			PERT0189
	INCLUDE ABC		PERT0190
	COMMON A(35000)		PERT0191
10	CALL INP		PERT0192
	GO TO (18,14), NDIM		PERT0193
14	CALL MAPR(A(LM0),A(LM2),IM,JM,A(LA1))		PERT0194
18	CALL SETUP(A(LK6),A(LI0),A(LI1),A(LI2),A(LM0),A(LM2),A(LN0),		PERT0195
	1 A(LR1),A(LR4),A(LR5),A(LZ1),A(LZ4),A(LZ5),A(LA0),		PERT0196
	2 A(LA1),A(LC0),A(LV0),ITL,IM,JM,MT,A(LGAM))		PERT0197
	CALL GRAM(A(LMASS),A(LVOL),A(LATW),A(LHCLN),IM,JM,A(LM0),A(LM2),		PERT0198
	1 A(LVC),A(LI0),A(LI1),A(LI2),ML,A(LI3))		PERT0199
	CALL NORM(A(LC0),ITL,A(LN0),A(LN1),IM,A(LSORC1),A(LSORC2),A(LM0),		PERT0200
	1 A(LM2),A(LVC),A(LK6),A(LPOW),A(LZ5),A(LA0),A(LR5),		PERT0201
	2 A(LR4),A(LA1),A(LZ4),A(LZPHI),A(LZPOW),A(LVOL))		PERT0202
	IF(NIBC) 30,30,20		PERT0203
20	CALL ABETA(A(LPOW),IM,A(LSORC1),A(LN0),A(LN1),A(LC0),ITL,A(LM0),		PERT0204
	1 A(LV7),A(LNBET),A(LBETA),A(LMASS),ML,A(LD7),A(LSORC2),		PERT0205
	2 A(LATW),A(LVOL),A(LV0),IGM,IPG,A(LAB),A(LAL))		PERT0206
30	IF(NDELK) 50,50,40		PERT0207

B-5

40	CALL SLOPE(A(LN0),A(LN1),IM,A(LR5),A(LZ5),A(LR4),A(LC0),ITL,	PERT0208
1	A(LM0),A(LM2),A(LDEL),A(LV0),A(LA0),A(LA1))	PERT0209
	CALL CALC(A(LNCR),A(LMATDK),A(LATW),A(LCP),A(LC0),ITL,A(LN0),	PERT0210
1	IM,A(LN1),A(LDEL),A(LK6),A(LCX),A(LFLUX),IGM,A(LADJF),	PERT0211
2	A(LHOLN),A(LV0),A(LR4),A(LZ4),A(LX),A(LY))	PERT0212
50	IF(NACT) 10,10,60	PERT0213
60	CALL ACT(A(LMA),A(LNX),A(LN0),IM,A(LC0),ITL,A(LSORC1),A(LZACT),	PERT0214
1	A(LM0),A(LV0),A(LVOL),A(LZ4))	PERT0215
	GO TO 10	PERT0216
	END	PERT0217

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-ITC FOR INP,INP                                PERT0218
  SUBROUTINE INP                                PERT0219
    INCLUDE ARC                                PERT0220
    COMMON A(35000)                            PERT0221
C    THIS SUBROUTINE CONTROLS THE READING OF ALL INPUT DATA    PERT0222
    NINP = 5                                    PERT0223
    NOUT = 6                                    PERT0224
    NCR1 = 7                                    PERT0225
    NSCR1 = 8                                   PERT0226
    NSCR2 = 9                                   PERT0227
    NFLUX1 = 10                                 PERT0228
    NFLUX2 = 11                                 PERT0229
    NFXIN = 14                                  PERT0230
C    SET UP DRUM UNITS                                PERT0231
    DIMENSION JLPTAB(35)                        PERT0232
    CALL SETDR( 7, 150000,200000,JLPTAB)        PERT0233
    CALL SETDR( 8, 350000,200000,JLPTAB(8))     PERT0234
    CALL SETDR( 9, 550000,200000,JLPTAB(15))    PERT0235
    CALL SETDR(10, 750000,200000,JLPTAB(22))    PERT0236
    CALL SETDR(11, 950000,200000,JLPTAB(29))    PERT0237
    REWIND 7                                    PERT0238
    REWIND 8                                    PERT0239
    REWIND 9                                    PERT0240
    REWIND 10                                   PERT0241
    REWIND 11                                   PERT0242
    WRITE(NOUT,10)                              PERT0243
10    FORMAT(1H1,40X,38H * * * * P E R T - V * * * *///)    PERT0244
    READ(NINP,20) (ID(I), I=1,12)              PERT0245
20    FORMAT(12A6)                              PERT0246
    WRITE(NOUT,30) (ID(I), I=1,12)             PERT0247
30    FORMAT(/11X,12A6/)                        PERT0248
    READ(NINP,40) ND, ML, NPRT, IGM, IST, IHT, NDELK, NACT, NIBC, IPG, PERT0249
1    IPS, NPDEL, IGE, IM, JM, IZM, MT, M01, B01, B02,    PERT0250
2    B03, B04, ZKEFF, FLPO, VF, BUCK          PERT0251
40    FORMAT(12I6/10I6/6E12.6)                PERT0252
    WRITE(NOUT,60) ND, ML, NPRT, IGM, IST, IHT    PERT0253
60    FORMAT(                                PERT0254
192H ND 1/2/3/4=1-D FLUXES/2-D FLUXES/1-D FLUX/2-D FLUX (IPERT0255
2F NEG, FROM TAPE) 19/                          PERT0256
392H ML NEGATIVE/POSITIVE=NUMBER OF MATERIALS FROM TAPE/CARPERT0257
4DS 19/                                          PERT0258
592H NPRT PRINT OPTION (0/1/2=MINI/MIDI/MAXI)    PERT0259
6 19/                                          PERT0260
792H IGM NUMBER OF ENERGY GROUPS              PERT0261
8 19/                                          PERT0262
992H IST NUMBER OF DOWNSCATTERING TERMS         PERT0263
1 19/                                          PERT0264
292H IHT POSITION OF TRANSPORT CROSS SECTION    PERT0265
3 19/                                          PERT0266
    WRITE(NOUT,70) NDELK, NACT, NIBC, IPG, IPS, NPDEL    PERT0267
70    FORMAT(                                PERT0268
192H NDELK NUMBER OF REACTIVITY COEFFICIENT CALCULATIONS    PERT0269
2 19/                                          PERT0270
592H NACT NUMBER OF ACTIVITY TRAVERSES          PERT0271
4 19/                                          PERT0272
392H NIBC NUMBER OF MATERIALS FOR BETA EFFECTIVE CALCULATION    PERT0273
6 19/                                          PERT0274
692H IPG NUMBER OF DELAYED NEUTRON GROUPS       PERT0275
6 19/                                          PERT0276
792H IPS 0/1=ONE DELAYED SPECTRUM/INPUT SPECTRUM FOR EACH GRPERT0277
70H IP 19/                                  PERT0278
892H NPDEL 0/1=NO EFFECT/PLOT REACTIVITY COEFFICIENTS    PERT0279

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      7 WRITE(NOUT,80) IGE, IM, JM, IZM, MT, M01
      80 FORMAT(
192H IGE GEOMETRY (0/1/2/3=PL/CYL/SPH IF 1-D, X-Y/R-Z/R-THE
21A/TRIANGULAR IF 2-D) I9/
392H IM NUMBER OF RADIAL INTERVALS I9/
4 I9/
592H JM NUMBER OF AXIAL INTERVALS (=1 FOR 1-D PROBLEMS) I9/
6 I9/
192H IZM NUMBER OF MATERIAL ZONES I9/
8 I9/
992H MT TOTAL NUMBER OF MATERIALS INCLUDING MIXES I9/
1 I9/
292H M01 NUMBER OF MIXTURE SPECIFICATIONS I9/
3 I9/
      0 WRITE(NOUT,90) B01, B02, B03, B04
      0 FORMAT(
192H B01 LEFT BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE
2/PERIODIC) I9/
392H B02 RIGHT BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE
2/PERIODIC) I9/
592H B03 TOP BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE
2/PERIODIC) I9/
792H B04 BOTTOM BOUNDARY CONDITION (0/1/2=VACUUM/REFLECTIVE
2/PERIODIC) I9/)
      100 WRITE(NOUT,100) ZKEFF, FLPO, VF, BUCK
      100 FORMAT(
191H ZKEFF KEFF FOR PERT. EQUATION (IF ZERO, USE CALCULATED V
2ALUE) 1PE10.4/
391H FLPO NEGATIVE/POSITIVE=POWER (MWT)/TOTAL CENTER POINT FL
4UX 1PE10.4/
591H VF VOLUME FACTOR 1PE10.4/
6 1PE10.4/
791H BUCK BUCKLING (CM-2) 1PE10.4/)
8 1PE10.4/)
      IGP = IGM + 1
      IHG = IHT + 1
      ITL = IHG + IST
      IHN = IHT - 1
      IHA = IHT - 2
      IHF = IHT - 3
      ICARD = ML
      ML = IABS(ML)
      PI2 = 6.28318
      IGEP = IGE + 1
      TSD = 215.*1.602*10.**(-19)
      IF(FLPO) 120,120,130
      120 NFP = 2
      GO TO 140
      130 NFP = 1
      140 FLPO = ABS(FLPO)
      ITEMP = IABS(ND)
      GO TO (150,160,150,160), ITEMP
      150 NDIM = 1
      JM = 1
      GO TO 170
      160 NDIM = 2
      170 IP = IM + 1
      JP = JM + 1
      IMJM = IM*JM
      IJGM = IMJM*IGM
      IJMAX = MAX0(IM,JM)

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 PERT0339
 PERT0340
 PERT0341

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C      SET UP DIMENSION POINTERS
      LATW = 1
      LHOLN = LATW + ML
      LCO = LHOLN + ML
      LNO = LCO + ITL*MT
      LN1 = LNO + IMJM
      LA0 = LN1 + IMJM
      LA1 = LA0 + IP
      LI0 = LA1 + IM
      LI1 = LI0 + MO1
      LI2 = LI1 + MO1
      LI3 = LI2 + MO1
      LK6 = LI3 + MO1
      LMO = LK6 + IGM
      LM2 = LMO + IMJM
      LR1 = LM2 + IZM
      LR4 = LR1 + IP
      LR5 = LR4 + IM
      LV0 = LR5 + IM
      LV7 = LV0 + IMJM
      LZ1 = LV7 + IGM
      LZ4 = LZ1 + JP
      LZ5 = LZ4 + JM
      LVOL = LZ5 + JM
      LMASS = LVOL + IZM
      LGAM = LMASS + ML*IZM
      LPOW = LGAM + IZM
      LSORC1 = LPOW + IMJM
      LSORC2 = LSORC1 + IMJM
      LNBET = LSORC2 + IMJM
      LBETA = LNBET + NIBC
      LD7 = LBETA + NIBC
      LAB = LD7 + IGM*IPG
      LAL = LAB + NIBC*IPG
      LZPHI = LAL + IPG
      LZPOW = LZPHI + IZM
      LMA = LZPOW + IZM
      LNX = LMA + NACT
      LZACT = LNX + NACT
      LDEL = LZACT + IZM
      LNCR = LDEL + IMJM
      LMATDK = LNCR + NDELK
      LCP = LMATDK + NDELK
      LCX = LCP + 5*IJMAX
      LFLUX = LCX + ITL*IGM
      LADJF = LFLUX + IGM*IJMAX
      LX = LADJF + IGM*IJMAX
      LY = LX + (IJMAX+2)*NPDEL
      LAST = LY + (IJMAX+2)*NPDEL
      ITEMP = 1 + 2*ML + IGP*ITL*MT
      LAST = MAX0(LAST,ITEMP)
      WRITE(NOUT,190) LAST
190  FORMAT(7H LAST =,I6)
      IF(LAST - 35000) 196,196,192
192  CALL ERRO2(6H INP,192,1)
C      READ CROSS SECTIONS, PERFORM ADJOINT REVERSALS, AND WRITE XS DATA
C      TO DRUM (BY GROUP)
196  CALL XSINP(A(LNO),ITL,IGM,MT,A(LATW),A(LHOLN))
      DO 200 I=LCO, LAST
200  A(I) = 0.0
C      READ FLUXES AND WRITE FLUXES TO DRUM
      CALL FXINP(A(LNO))
      PERT0342
      PERT0343
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      PERT0345
      PERT0346
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      PERT0399
      PERT0400
      PERT0401
      PERT0402
      PERT0403

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	WRITE(NOUT,250)	PERT0404
250	FORMAT(16H0MESH BOUNDARIES)	PERT0405
	CALL REAG2(6H R1,A(LR1),IP)	PERT0406
	GO TO (270,260),NDIM	PERT0407
260	CALL REAG2(6H Z1,A(LZ1),JP)	PERT0408
270	WRITE(NOUT,280)	PERT0409
280	FORMAT(30H0ZONE NUMBERS BY MESH INTERVAL)	PERT0410
	CALL REA12(6H M0,A(LM0),IMJM)	PERT0411
	WRITE(NOUT,290)	PERT0412
290	FORMAT(25H0MATERIAL NUMBERS BY ZONE)	PERT0413
	CALL REA12(6H M2,A(LM2),IZM)	PERT0414
	IF(BUCK) 295,305,295	PERT0415
295	WRITE(NOUT,300)	PERT0416
300	FORMAT(27H0BUCKLING MODIFIERS BY ZONE)	PERT0417
	CALL REAG2(6H GAM,A(LGAM),IZM)	PERT0418
305	WRITE(NOUT,310)	PERT0419
310	FORMAT(17H0FISSION SPECTRUM)	PERT0420
	CALL REAG2(6H K6,A(LK6),IGM)	PERT0421
	WRITE(NOUT,320)	PERT0422
320	FORMAT(19H0NEUTRON VELOCITIES)	PERT0423
	CALL REAG2(6H V7,A(LV7),IGM)	PERT0424
	IF(M01) 350,350,330	PERT0425
330	WRITE(NOUT,340)	PERT0426
340	FORMAT(83H0MIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER 1R FOR MIX/MATERIAL DENSITY))	PERT0427
	CALL REA12(6H I0,A(LI0),M01)	PERT0428
	CALL REA12(6H I1,A(LI1),M01)	PERT0429
	CALL REAG2(6H I2,A(LI2),M01)	PERT0430
350	IF(NIBC) 400,400,360	PERT0431
360	WRITE(NOUT,370)	PERT0432
370	FORMAT(48H0MATERIAL NUMBERS FOR BETA EFFECTIVE CALCULATION)	PERT0433
	CALL REA12(6H NBET,A(LNBET),NIBC)	PERT0434
	WRITE(NOUT,380)	PERT0435
380	FORMAT(63H0ABSOLUTE NEUTRON YIELD PER DELAYED FISSION FOR ABOVE MAT 1TERIALS)	PERT0436
	CALL REAG2(6H BETA,A(LBETA),NIBC)	PERT0437
	DO 384 K=1,NIRC	PERT0438
	WRITE(NOUT,382) K	PERT0439
382	FORMAT(46H0FRACTIONAL YIELDS BY GROUP FOR DELAY MATERIAL, I6)	PERT0440
	KK = (K-1)*IPG + LAB	PERT0441
	CALL REAG2(6H AB,A(KK),IPG)	PERT0442
384	CONTINUE	PERT0443
	WRITE(NOUT,385)	PERT0444
385	FORMAT(23H0DECAY CONSTANTS(SEC-1))	PERT0445
	CALL REAG2(6H AL,A(LAL),IPG)	PERT0446
	IF(IPS) 386,389,386	PERT0447
386	DO 388 K=1,IPG	PERT0448
	WRITE(NOUT,387) K	PERT0449
387	FORMAT(45H0DELAYED NEUTRON SPECTRUM FOR PRECURSOR GROUP, I6)	PERT0450
	KK = (K-1)*IGM + LD7	PERT0451
	CALL REAG2(6H D7,A(KK),IGM)	PERT0452
388	CONTINUE	PERT0453
	GO TO 400	PERT0454
389	WRITE(NOUT,390)	PERT0455
390	FORMAT(25H0DELAYED FISSION SPECTRUM)	PERT0456
	CALL REAG2(6H D7,A(LD7),IGM)	PERT0457
	IF(IPG - 1) 400,400,392	PERT0458
392	DO 394 K=2,IPG	PERT0459
	DO 394 I = 1,IGM	PERT0460
	KK = LD7 + (K-1)*IGM + I - 1	PERT0461
	KKK = LD7 + I - 1	PERT0462
394	A(KK) = A(KKK)	PERT0463
		PERT0464
		PERT0465

400	IF(NDELK) 440,440,410	PERT0466
410	WRITE(NOUT,420)	PERT0467
420	FORMAT(43H0MATERIAL NUMBERS FOR DELTA K/K CALCULATION)	PERT0468
	CALL REAI2(6H MATDK,A(LMATDK),NDELK)	PERT0469
	GO TO (440,425),NDIM	PERT0470
425	WRITE(NOUT,430)	PERT0471
430	FORMAT(53H0NEG/POS=COLUMN/ROW NUMBERS FOR DELTA K/K CALCULATION)	PERT0472
	CALL REAI2(6H NCR,A(LNCR),NDELK)	PERT0473
440	IF(NACT) 480,480,450	PERT0474
450	WRITE(NOUT,460)	PERT0475
460	FORMAT(40H0MATERIAL NUMBERS FOR ACTIVITY TRAVERSES)	PERT0476
	CALL REAI2(6H MA,A(LMA),NACT)	PERT0477
	WRITE(NOUT,470)	PERT0478
470	FORMAT(46H0CROSS SECTION POSITION FOR ACTIVITY TRAVERSES)	PERT0479
	CALL REAI2(6H NX,A(LNX),NACT)	PERT0480
480	RETURN	PERT0481
	END	PERT0482

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-1T  FOR REAG2,REAG2
      SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)
      DIMENSION ARRAY(10),V(12),K(12),IN(12)
      COMMON      NINP, NOUT, NCR1, NSCR1, NSCR2, NFLUX1, NFLUX2
      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     RFPFAT
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)
180   RETURN

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-IT	FOR REAI2,REAI2	PERT0546
	SUBROUTINE REAI2(HOLL,IARRAY,NCOUNT)	PERT0547
	DIMENSION IARRAY(1), IV(12), K(12), IN(12)	
	COMMON NINP, NOUT, NCR1, NSCR1, NSCR2, NFLUX1, NFLUX2	PERT0549
	JFLAG = 0	
	J=1	PERT0550
1	IF(JFLAG) 2,10,2	
2	DO 4 JJ=1,6	
	K(JJ) = K(JJ+6)	
	IN(JJ) = IN(JJ+6)	
4	IV(JJ) = IV(JJ+6)	
	JFLAG = 0	
	GO TO 21	
10	READ(NINP,20) (K(I),IN(I),IV(I),I=1,6)	PERT0551
20	FORMAT(6(I1,I2,I9))	PERT0552
21	DO 70 I=1,6	
	L=K(I)+1	
	GO TO (30,40,52,80,62,70,22), L	PERT0554
C	FILL	PERT0556
22	JJ=J	PERT0557
	DO 25 M=JJ,NCOUNT	PERT0558
	IARRAY(J) = IV(I)	PERT0559
25	J=J+1	PERT0560
	GO TO 80	PERT0561
C	NO MODIFICATION	PERT0562
30	IARRAY(J)=IV(I)	PERT0563
	J=J+1	PERT0564
	GO TO 70	PERT0565
C	REPEAT	PERT0566
40	L=IN(I)	PERT0567
	DO 50 M=1,L	PERT0568
	IARRAY(J)=IV(I)	PERT0569
	J=J+1	PERT0570
50	CONTINUE	PERT0571
	GO TO 70	PERT0572
C	INTERPOLATE	PERT0573
52	IF(I-6) 54,53,53	
53	READ(NINP,20) (K(M),IN(M),IV(M),M=1,6)	
	JFLAG = 1	
54	L = IN(I) + 1	
	IDEL = (IV(I+1) - IV(I))/L	
	DO 56 M=1,L	
	IARRAY(J) = IV(I) + IDEL*(M-1)	
56	J = J + 1	
	GO TO 70	
C	CYCLE	PERT0575
62	L = IN(I)	PERT0576
	N = IV(I)	PERT0577
	DO 65 LL=1,L	PERT0578
	DO 65 NN=1,N	PERT0579
	IARRAY(J) = IARRAY(J-N)	PERT0580
65	J = J + 1	PERT0581
70	CONTINUE	PERT0582
	GO TO 1	
C	TERMINATE	PERT0584
80	J=J-1	PERT0585
	WRITE (NOUT,90) HOLL,J , (IARRAY(I),I=1,J)	PERT0586
	IF(J -NCOUNT)100,110,100	PERT0587
90	FORMAT(6X,A6,I6/(10I12))	PERT0588
100	CALL ERRO2(6H**REAI,100,1)	PERT0589
110	RETURN	PERT0590
	END	PERT0591

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

PERT0592
PERT0593
PERT0594
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PERT0596
PERT0597
PERT0598
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```
-IT FOR ERRO2,ERRO2
  SUBROUTINE ERRO2( HOL,JSUBR,I)
  COMMON      NINP, NOUT, NCR1, NSCR1, NSCR2, NFLUX1, NFLUX2
  WRITE (NOUT,1)      HOL,JSUBR
1  FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)
  GO TO (3,4),I
3  CALL EXIT
4  RETURN
  END
```

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PERT0599
PERT0600
PERT0601
PERT0602
PERT0603
PERT0604
PERT0605
PERT0606
PERT0607
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```
-IT  FOR  SWITCH,SWITCH
      SUBROUTINE SWITCH(ITEMP1,ITEMP2)
C     THIS SUBROUTINE SWITCHS TAPE DESIGNATIONS
      ITEMP3 = ITEMP1
      ITEMP1 = ITEMP2
      ITEMP2 = ITEMP3
      RETURN
      END
```

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PERT0608
PERT0609
PERT0610
PERT0611
PERT0612
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PERT0614
PERT0615
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-ITC FOR XSINP,XSINP
SUBROUTINE XSINP(C,JTL,JGM,JMT,ATW,HOLN)
DIMENSION C(JTL,JGM,JMT), ATW(1), HOLN(1)
C C(JTL,JGM,JMT) CROSS SECTION ARRAY STORED STARTING AT A(LN0)
INCLUDE ABC
DIMENSION AA(10)
C THIS SUBROUTINE READS (FROM TAPE OR CARDS), CHECKS, AND WRITES
C INPUT CROSS SECTIONS TO DRUM.
WRITE(NOUT,5) (ID(I), I=1,12)
5 FORMAT(1H1,12A6,///)
WRITE(NOUT,10)
10 FORMAT(56H CROSS SECTIONS WERE READ IN FOR THE FOLLOWING MATERIALS
1/)
DO 50 I=1,ML
READ(NINP, 20) HOLN(I), ATW(I), (AA(J), J=1,10)
20 FORMAT(A6, E6.2, 10A6)
IF(ICARD) 25,25,30
25 READ(15) ((C(L,IIG,I), L=1,ITL), IIG=1,IGM)
GO TO 50
30 DO 35 IIG=1,IGM
35 READ(NINP,40) (C(L,IIG,I), L=1,ITL)
40 FORMAT(6E12.5)
50 WRITE(NOUT, 60) I, HOLN(I), (AA(J), J=2,10)
60 FORMAT(I3, 6X, A6, 6X, 10A6)
IF(ICARD) 70,80,80
70 REWIND 15
C CHECK ON CROSS SECTION CONSISTENCY AND ORDER
80 ITEMP = 0
DO 140 I=1,ML
DO 140 IIG=1,IGM
TEMP = C(IHA,IIG,I) + C(IHG,IIG,I)
DO 110 K=1,IST
KK = IIG + K
M = IHG + K
IF(KK - IGM) 100, 100, 110
100 TEMP = TEMP + C(M,KK,I)
110 CONTINUE
IF(ABS((TEMP - C(IHT,IIG,I))/C(IHT,IIG,I)) - .01) 135, 120, 120
120 ITEMP = 1
GO TO 138
130 FORMAT(1H /,16H CHECK MATERIAL I2,5X, 7H GROUP I2)
135 IF(ABS((TEMP - C(IHT,IIG,I))/C(IHT,IIG,I)) - .0001) 140, 138, 138
138 WRITE(NOUT,130) I, IIG
140 CONTINUE
IF(ITEMP) 160, 160, 150
150 CALL EXIT
C WRITE CROSS SECTION TAPE
160 DO 300 IIG=1,IGM
300 WRITE(NCR1) ((C(L,IIG,M), L=1,ITL), M=1,MT)
REWIND NCR1
RETURN
END

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PERT0616
 PERT0617
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 PERT0667

-ITC FOR FXINP,FXINP	PERT0668
SUBROUTINE FXINP(NC)	PERT0669
DIMENSION NC(1)	PERT0670
INCLUDE ABC	PERT0671
C THIS SUBROUTINE READS (FROM TAPE OR CARDS) INPUT FLUXES AND WRITES	PERT0672
C THEM TO DRUM.	PERT0673
ITEMP = IARS(ND)	PERT0674
ITEMP1 = 0	PERT0675
IF(NPRT-2) 100, 40, 40	PERT0676
40 WRITE(NOUT,50)	PERT0677
50 FORMAT(13H0INPUT FLUXES)	PERT0678
55 IF(NPRT-2) 100, 58, 58	PERT0679
58 IF(ITEMP1) 60, 60, 80	PERT0680
60 WRITE(NOUT,70) IJIGM	PERT0681
70 FORMAT(6X,6H NC,16)	PERT0682
GO TO 100	PERT0683
80 WRITE(NOUT,90) IJIGM	PERT0684
90 FORMAT(6X,6H N1,16)	PERT0685
100 DO 180 IIG=1,IGM	PERT0686
IF(ND) 110, 110, 120	PERT0687
110 READ(NFXIN) (NC(I), I=1,IMJM)	PERT0688
GO TO 135	PERT0689
120 READ(NINP,130) (NC(I), I=1,IMJM)	PERT0690
130 FORMAT(6E12.5)	PERT0691
135 IF(NPRT-2) 180, 140, 140	PERT0692
140 WRITE(NOUT,150) (NC(I), I=1,IMJM)	PERT0693
150 FORMAT(10E12.5)	PERT0694
180 WRITE(NFLUX1) (NC(I), I=1,IMJM)	PERT0695
IF(ITEMP1) 360, 360, 310	PERT0696
C REVERSE ADJOINT FLUXES BY GROUP	PERT0697
310 DO 340 IIG=1,IGM	PERT0698
BACKSPACE NFLUX1	PERT0699
READ(NFLUX1) (NC(I), I=1,IMJM)	PERT0700
BACKSPACE NFLUX1	PERT0701
340 WRITE(NFLUX2) (NC(I), I=1,IMJM)	PERT0702
REWIND NFLUX1	PERT0703
REWIND NFLUX2	PERT0704
CALL SWITCH(NFLUX1,NSCR1)	PERT0705
IF(ND) 350,350,400	PERT0706
350 REWIND NFXIN	PERT0707
GO TO 400	PERT0708
360 REWIND NFLUX1	PERT0709
ITEMP1 = 1	PERT0710
IF(ITEMP-2) 370,370,400	PERT0711
370 CALL SWITCH(NFLUX1,NSCR1)	PERT0712
IF(ND) 380,380,55	PERT0713
C READ THROUGH AN END OF FILE.	PERT0714
380 CALL NTRAN(NFXIN,8,1)	PERT0715
GO TO 55	PERT0716
400 RETURN	PERT0717
END	PERT0718

-ITC FOR MAPR,MAPR	PERT0719
SUBROUTINE MAPR (M0,M2, JIM,JJM, K)	PERT0720
INCLUDE ABC	PERT0721
DIMENSION MU(JIM,JJM), M2(1), K(1)	PERT0722
C PRODUCE A PICTURE PRINT BY ZONE AND MATERIAL	PERT0723
WRITE(NOUT,10) (ID(I), I=1,11)	PERT0724
10 FORMAT(1H1,11A6///)	PERT0725
20 DO 30 JJ=1,JM	PERT0726
J=JM-JJ+1	PERT0727
30 WRITE (NOUT,40) (M0(I,J),I=1,IM)	PERT0728
40 FORMAT(5H ,55I2)	PERT0729
WRITE(NOUT,50)	PERT0730
50 FORMAT(2H A/2H X/2H I/2H A/2H L//8H RADIAL)	PERT0731
WRITE (NOUT,10) (ID(I), I = 1, 11)	PERT0732
DO 70 JJ=1,JM	PERT0733
J=JM-JJ+1	PERT0734
DO 60 L=1,IM	PERT0735
N=M0(L,J)	PERT0736
60 K(L)=IABS (M2(N))	PERT0737
70 WRITE (NOUT,40) (K(L),L=1,IM)	PERT0738
WRITE(NOUT,50)	PERT0739
RETURN	PERT0740
END	PERT0741

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-ITC FOR SETUP, SETUP
SUBROUTINE SETUP(K6, IO, I1, I2, M0, M2, N0, R1, R4, R5, Z1, Z4,
1      Z5, A0, A1, C0, V0, JTL, JIM, JJM, JMT, GAM)
INCLUDE ABC
DIMENSION K6(1), IO(1), I1(1), I2(1), R1(1), R4(1), R5(1), Z1(1),
1      Z4(1), Z5(1), A0(1), A1(1), C0(JTL,JMT), V0(JIM,JJM),
2      M0(1), M2(1), N0(1), GAM(1)
C MIX CROSS-SECTIONS
IF(M01) 70, 70, 60
60 WRITE(NOUT, 65) (J, IO(J), I1(J), I2(J), J = 1, M01)
65 FORMAT(1H1,3X, 16H MIXTURE NUMBER ,18H MIX COMMAND ,
124H MATERIAL ATOMIC DENSITY//(I4,1X,I8,8X,I8,8X,E20.8))
70 IF(NPRT-1) 85,75,75
75 WRITE(NOUT,80)
80 FORMAT(/19HCROSS-SECTION EDIT)
85 REWIND NCR1
DO 180 IIG=1,IGM
READ(NCR1) ((C0(I,J),I=1,ITL),J=1,MT)
IF(M01) 90, 145, 90
90 DO 140 M=1,M01
IF(IO(M)-MT) 100, 100, 95
95 CALL ERRO2(6H SETUP,95,1)
100 IF(I1(M)-MT) 105, 105, 95
105 N=IO(M)
L=I1(M)
E01=I2(M)
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(NPRT-1) 175,155,155
155 IF(IHT - 4) 161,156,161
156 WRITE(NOUT,160) IIG
160 FORMAT(6HUGROUP,I3, 84H SIGF SIGA NUSIGF SIGTR
1      GXG G-1XG G-2XG . . .)
GO TO 164
161 WRITE(NOUT,163) IIG
163 FORMAT(6HUGROUP,I3)
164 DO 165 N=1,MT
165 WRITE(NOUT,170) N,(C0(I,N),I=1,ITL)
170 FORMAT(4H MAT,I3,10E11.5/(7X,10E11.5))
175 WRITE(NSCR1) ((C0(I,J),I=1,ITL),J=1,MT)
180 CONTINUE
REWIND NCR1
REWIND NSCR1
CALL SWITCH(NCR1,NSCR1)
IF(BUCK) 200, 245, 200
200 TEMP = BUCK
220 DO 240 IIG=1,IGM
READ(NCR1) ((C0(I,J), I=1,ITL),J=1,MT)
DO 235 MTZ = 1,MT
DO 230 KZ=1,IZM
IF(M2(KZ) - MTZ) 230, 225, 230
225 TEMP1 = (TEMP*GAM(KZ))/(3.*C0(4,MTZ))
C0(2,MTZ) = C0(2,MTZ) + TEMP1
C0(5,MTZ) = C0(5,MTZ) - TEMP1
GO TO 235
230 CONTINUE
235 CONTINUE
WRITE(NSCR1) ((C0(I,J), I=1,ITL),J=1,MT)

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 PERT0803

240	CONTINUE	PERT0804
	REWIND NCR1	PERT0805
	REWIND NSCR1	PERT0806
	CALL SWITCH(NSCR1,NCR1)	PERT0807
245	CONTINUE	PERT0808
C	CALCULATE AREAS AND VOLUMES	PERT0809
	GO TO (510,310), NDIM	PERT0810
C	TWO-DIMENSION	PERT0811
310	DO 345 I=1,IM	PERT0812
	R4(I)=(R1(I+1)+R1(I))*0.5	PERT0813
	R5(I)=R1(I+1)-R1(I)	PERT0814
	IF(R5(I)) 320, 320, 325	PERT0815
320	CALL ERRO2 (6H SETUP,320,1)	PERT0816
325	GO TO (330,335,340,342), IGEP	PERT0817
330	A0(I)=1.0	PERT0818
	A0(IP)=1.0	PERT0819
	A1(I)=R5(I)	PERT0820
	GO TO 345	PERT0821
335	A0(I)=PI2*R1(I)	PERT0822
	A0(IP)=PI2*R1(IP)	PERT0823
	A1(I)=PI2*R5(I)*R4(I)	PERT0824
	GO TO 345	PERT0825
340	A0(I)=PI2*R1(I)	PERT0826
	A0(IP)=PI2*R1(IP)	PERT0827
	A1(I)=R5(I)	PERT0828
	GO TO 345	PERT0829
342	A0(I) = 2.*R5(I)	PERT0830
	A0(IP) = 2.*R5(I)	PERT0831
	A1(I) = 2.*R5(I)	PERT0832
345	CONTINUE	PERT0833
	DO 370 J=1,JM	PERT0834
	Z4(J)=(Z1(J+1)+Z1(J))*0.5	PERT0835
	Z5(J)=Z1(J+1)-Z1(J)	PERT0836
	IF(Z5(J)) 350, 350, 355	PERT0837
350	CALL ERRO2 (6H SETUP,350,1)	PERT0838
355	CONTINUE	PERT0839
	DO 370 I=1,IM	PERT0840
	GO TO (360,365,365,360), IGEP	PERT0841
360	V0(I,J)=R5(I)*Z5(J)	PERT0842
	GO TO 370	PERT0843
365	V0(I,J)=PI2*R5(I)*Z5(J)*R4(I)	PERT0844
370	CONTINUE	PERT0845
	GO TO 580	PERT0846
C	ONE-DIMENSION	PERT0847
510	Z5(1) = 1.0	PERT0848
	DO 570 I=1,IM	PERT0849
	R4(I)=(R1(I+1)+R1(I))*0.5	PERT0850
	R5(I)=R1(I+1)-R1(I)	PERT0851
	IF(R5(I)) 520, 520, 530	PERT0852
520	CALL ERRO2 (6H SETUP,520,1)	PERT0853
530	GO TO (540,550,560), IGEP	PERT0854
540	A0(I)=1.0	PERT0855
	A0(IP)=1.0	PERT0856
	V0(I,1) = R5(I)	PERT0857
	GO TO 570	PERT0858
550	A0(I)=PI2*R1(I)	PERT0859
	A0(IP)=PI2*R1(IP)	PERT0860
	V0(I,1) = PI2*R5(I)*R4(I)	PERT0861
	GO TO 570	PERT0862
560	A0(I) = 2.*PI2*R1(I)*R1(I)	PERT0863
	A0(IP) = 2.*PI2*R1(IP)*R1(IP)	PERT0864
	V0(I,1) =(2.*PI2*(R1(I+1)**3 - R1(I)**3))/3.0	PERT0865

570 CONTINUE
580 CONTINUE
RETURN
END

B-22

PERT0866
PERT0867
PERT0868
PERT0869
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-IT FOR PRT,PRT
      SUBROUTINE PRT (JIM,JJM, N2, Z4, NOUT)
      DIMENSION N2(JIM,JJM), Z4(1)
      REAL N2
C      THIS SUBROUTINE PRINTS (IM,JM) ARRAYS
      IM = JIM
      JM = JJM
      DO 50 I=1,IM,5
      I1=I
      I2=I+4
      IF(I2-IM) 20, 20, 10
10      I2=IM
20      WRITE ( NOUT,30 ) ( JJ,JJ=I1,I2)
30      FORMAT( 5I20)
      DO 50 JJ=1,JM
      J=JJ
40      FORMAT(I5,E15.7,5E20.7)
50      WRITE(NOUT,40 ) J,(N2(K,J),K=I1,I2),Z4(J)
      RETURN
      END

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PERT0870
PERT0871
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PERT0889

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-ITC  FOR GRAM,GRAM
      SUBROUTINE GRAM(MASS, VOL, ATW, HOLN,JIM,JJM, MO, M2, VO,
1         IO, I1, I2,JML, I3)
      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)
C      THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS
      EV = 1.0
      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 J = 1, JM
      DO 30 I = 1, IM
      K = MO(I,J)
30     VOL(K) = VOL(K) + VO(I, J)*.001
      DO 39 M=1,M01
      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,M01
      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, M01
      IF(IO(MAA) - NNAA) 160, 140, 160
140    L = I1(MAA)
      IF(L) 160, 160, 150
150    E01 = I3(MAA)*I3(M)
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/.6023) + MASS(L,N)
160    CONTINUE
      GO TO 190
170    IF(L) 190, 190, 180
180    E01 = I3(M)
      MASS(L,N) = ((E01*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,I2X))
      WRITE(NOUT,230) (VOL(K), K = L, LL)
230    FORMAT(25X, 5(E8.3, 7H LITERS, 5X))
      DO 240 K = 1, ML
240    WRITE(NOUT,250) K, HOLN(K), ATW(K), (MASS(K, I), I = L, LL)
250    FORMAT( I3,1X, A6, F13.3, 1X, 1PE13.3, 1P4E20.3)
      IF(LL - IZM) 260, 270, 270
260    CONTINUE

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270 RETURN
END

B-25

PERT0952
PERT0953
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-ITC FOR NORM,NORM
SUBROUTINE NORM(CO,JTL,N0,N1,JIM,SORC1,SORC2,M0,M2,V0,K6,POW,
1      Z5,A0,R5,R4,A1,Z4,ZPHI,ZPOW,VOL)
1  DIMENSION CO(JTL,1), NO(JIM,1), N1(JIM,1), SORC1(JIM,1),
1      SORC2(JIM,1), M0(JIM,1), M2(1), V0(JIM,1), K6(1),
2      POW(JIM,1), Z5(1), A0(1), R5(1), R4(1), A1(1), Z4(1),
3      ZPHI(1), ZPOW(1), VOL(1)
INCLUDE ABC
C THIS SUBROUTINE NORMALIZES THE FLUXES (REGULAR AND ADJOINT)
CFX = 0.0
POWER = 0.0
DENOM = 0.0
RL = 0.0
RABS = 0.0
RSORS = 0.0
CALL CLEAR(0.0,SORC1,IMJM)
CALL CLEAR(0.0,SORC2,IMJM)
CALL CLEAR(0.0,POW,IMJM)
IF (IGE - 3) 30,10,30
10  TEMP1 = Z5(1)
DO 15 I = 1,IM
15  R5(I) = 2.*Z5(1)/3.
DO 20 J = 1,JM
20  Z5(J) = 1.0
30  DO 700 IIG = 1,IGM
READ(NCR1) ((CO(I1,J), I1=1,ITL), J=1,MT)
READ(NFLUX1) ((NO(I,J), I=1,IM), J=1,JM)
READ(NFLUX2) ((N1(I,J), I=1,IM), J=1,JM)
CFX = CFX + NO(1,1)
DO 35 J = 1,JM
DO 35 I = 1,IM
ITEMP = M0(I,J)
ITEMP = M2(ITEMP)
POWER = POWER + CO(IHF,ITEMP)*NO(I,J)*V0(I,J)
POW(I,J) = POW(I,J) + CO(IHF,ITEMP)*NO(I,J)*TSD*1000.
SORC1(I,J) = SORC1(I,J) + CO(IHN,ITEMP)*NO(I,J)
SORC2(I,J) = SORC2(I,J) + K6(IIG)*N1(I,J)
RABS = RABS + CO(IHA,ITEMP)*NO(I,J)*V0(I,J)
35  RSORS = RSORS + CO(IHN,ITEMP)*NO(I,J)*V0(I,J)
C CALCULATE LEAKAGE
40  DO 100 J=1,JM
IF(B01) 60,50,60
50  I = 1
ITEMP = M0(I,J)
ITEMP = M2(ITEMP)
RL = RL + (Z5(J)*A0(I)*NO(I,J))/(3.*((CO(IHT,ITEMP)*.5*R5(I))
1      + .71))
60  IF(B02) 100,70,100
70  I = IM
ITEMP = M0(I,J)
ITEMP = M2(ITEMP)
RL = RL + (Z5(J)*A0(IP)*NO(I,J))/(3.*((CO(IHT,ITEMP)*.5*R5(I))
1      + .71))
100 CONTINUE
IF(NDIM - 1) 105,700,105
105 DO 300 I=1,IM
IF(B04) 200,110,200
110 J = 1
ITEMP = M0(I,J)
ITEMP = M2(ITEMP)
GO TO (130,130,120,125), IGE
120 TFMP = .5*PI2*Z5(J)*R4(I)

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125 GO TO 140
TEMP = .5 * R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 140,200,140
130 TEMP = .5*Z5(J)
140 RL = RL + (A1(I)*NO(I,J))/(3.*((CO(IHT,ITEMP)*TEMP) + .71))
200 IF(B03) 300,240,300
240 J = JM
ITEMP = M0(I,J)
ITEMP = M2(ITEMP)
GO TO (260,260,250,255), IGEP
250 TEMP = .5*PI2*Z5(J)*R4(I)
GO TO 270
255 TEMP = .5*R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 300,270,300
260 TEMP = .5*Z5(J)
270 RL = RL + (A1(I)*NO(I,J))/(3.*((CO(IHT,ITEMP)*TEMP) + .71))
300 CONTINUE
700 CONTINUE
IF (IGE - 3) 730,710,730
710 DO 715 I = 1,IM
715 R5(I) = TEMP1/1.73205
DO 720 J = 1,JM
720 Z5(J) = TEMP1
730 AK = RSORS/(RABS + RL)
CAD = SORC2(1,1)
POWER = POWER*TSO
REWIND NCR1
REWIND NFLUX1
RFWIND NFLUX2
GO TO (740,780), NFP
740 CONST = FLPO/CFX
GO TO 800
780 CONST = FLPO/POWER
800 IF(ZKEFF) 820,810,820
810 ZKEFF = AK
820 DO 840 J=1,JM
DO 840 I=1,IM
POW(I,J) = POW(I,J)*CONST
DENOM = DENOM + (CONST*SORC1(I,J)*SORC2(I,J)*V0(I,J))/(CAD*ZKEFF)
840 SORC2(I,J) = SORC2(I,J)/CAD
POWER = POWER*CONST
CFX = CFX*CONST
WRITE(NOUT,850) (ID(I), I=1,12)
850 FORMAT(1H1,12A6//)
RSORS = CONST*RSORS
RABS = CONST*RABS
RL = CONST*RL
WRITE(NOUT,860) CFX, POWER, DENOM, RSORS, RABS, RL, AK
860 FORMAT(44HOCENTER POINT FLUX (N/CM2-SEC) - - - 1PE12.5//
1 44H TOTAL POWER (MWT) - - - 1PE12.5//
2 44H DENOMINATOR OF PERT. EQUATION - - - 1PE12.5//
3 44H SOURCE RATE - - - 1PE12.5//
1 44H ABSORPTION RATE - - - 1PE12.5//
5 44H LEAKAGE RATE - - - 1PE12.5//
6 44H CALCULATED KEFF - - - 1PE12.5)
CALL CLEAR(0.0,SORC1,IMJM)
DO 1000 IIG=1,IGM
READ(NFLUX1) ((NC(I,J), I=1,IM), J=1,JM)
READ(NFLUX2) ((N1(I,J), I=1,IM), J=1,JM)
DO 900 J=1,JM

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DO 900 I=1,IM
  N0(I,J) = N0(I,J)*CONST
  N1(I,J) = N1(I,J)/CAD
C    TOTAL FLUX
900  SORC1(I,J) = SORC1(I,J) + N0(I,J)
    IF(NPRT - 2) 950,910,950
910  WRITE(NOUT,850) (ID(I), I=1,12)
    WRITE(NOUT,920) IIG
920  FORMAT(/15H FLUX FOR GROUP,I3/)
    CALL PRT(IM,JM,N0,Z4,NOUT)
    WRITE(NOUT,850) (ID(I), I=1,12)
    WRITE(NOUT,930) IIG
930  FORMAT(/23H ADJOINT FLUX FOR GROUP,I3/)
    CALL PRT(IM,JM,N1,Z4,NOUT)
950  WRITE(NSCR1) ((N0(I,J), I=1,IM), J=1,JM)
1000 WRITE(NSCR2) ((N1(I,J), I=1,IM), J=1,JM)
    REWIND NFLUX1
    REWIND NFLUX2
    REWIND NSCR1
    REWIND NSCR2
    CALL SWITCH(NFLUX1,NSCR1)
    CALL SWITCH(NFLUX2,NSCR2)
    IF(NPRT) 1050,1050,1010
1010 WRITE(NOUT,850) (ID(I), I=1,12)
    WRITE(NOUT,1020)
1020 FORMAT(/11H TOTAL FLUX/)
    CALL PRT(IM,JM,SORC1,Z4,NOUT)
    WRITE(NOUT,850) (ID(I), I=1,12)
    WRITE(NOUT,1030)
1030 FORMAT(/28H FISSION SOURCE*ADJOINT FLUX/)
    CALL PRT(IM,JM,SORC2,Z4,NOUT)
    WRITE(NOUT,850) (ID(I), I=1,12)
    WRITE(NOUT,1040)
1040 FORMAT(/26H POWER DENSITY (MW/LITER) /)
    CALL PRT(IM,JM,POW,Z4,NOUT)
C    CALCULATE ZONE AVERAGED FLUXES AND POWERS
1050 CALL CLEAR(0.0,ZPHI,IZM)
    CALL CLEAR(0.0,ZPOW,IZM)
    DO 1100 J=1,JM
      DO 1100 I=1,IM
        KZ = M0(I,J)
        ZPHI(KZ) = ZPHI(KZ) + V0(I,J)*SORC1(I,J)
1100  ZPOW(KZ) = ZPOW(KZ) + V0(I,J)*POW(I,J)
      DO 1120 KZ=1,IZM
        ZPHI(KZ) = ZPHI(KZ)*.001/VOL(KZ)
        ZPOW(KZ) = ZPOW(KZ)*.001/VOL(KZ)
1120  WRITE(NOUT,850) (ID(I), I=1,12)
    WRITE(NOUT,1160) (KZ, VOL(KZ), ZPHI(KZ), ZPOW(KZ), KZ=1,IZM)
1160 FORMAT( 61H0      ZONE      ZONE      ZONE AV.
1ONE AV. /
2      61H      VOLUME      FLUX
3POWER  // (I9,E19.6,2E15.6))
    RETURN
    END

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-ITC FOR ABETA,ABETA
SUBROUTINE ABETA(POW,JIM,SORC1,N0,N1,CO,JTL,M0,V7,NBET,BETA,
1          MASS,JML,D7,SORC2,ATW,VOL,V0,JGM,JPG,AB,AL)
1  DIMENSION    POW(JIM,1), SORC1(JIM,1), N0(JIM,1), N1(JIM,1),
1          CO(JTL,1), M0(JIM,1), V7(1), NBET(1), BETA(1),
1          MASS(JML,1), AL(1), SORC2(JIM,1), ATW(1), VOL(1),
2          V0(JIM,1), D7(JGM,1), AB(JPG,1)
1  INCLUDE ABC
C  THIS SUBROUTINE CALCULATES BETA EFFECTIVE AND THE GENERATION TIME
TEMP = .0
TFMP1 = .0
WRITE (NOUT,10) (ID(I), I=1,12)
10  FORMAT (1H1,12A6,////)
DO 20 KZ=1,IZM
DO 20 M=1,ML
20  MASS(M,KZ) = (MASS(M,KZ)*.6023)/(ATW(M)*VOL(KZ))
DO 250 K = 1,IPG
CALL CLEAR(0.0,POW,IMJM)
CALL CLEAR(0.0,SORC1,IMJM)
CALL CLEAR(0.0,SORC2,IMJM)
DO 100 IIG=1,IGM
READ(NFLUX1) ((N0(I,J), I=1,IM), J=1,JM)
READ(NFLUX2) ((N1(I,J), I=1,IM), J=1,JM)
READ(NCR1) ((CO(I,J), I=1,ITL), J=1,MT)
DO 100 J=1,JM
DO 100 I=1,IM
C  FLUX*ADJOINT FLUX/VELOCITY
SORC1(I,J) = SORC1(I,J) + (N0(I,J)*N1(I,J))/V7(IIG)
C  DELAYED FISSION SOURCE*ADJOINT FLUX
SORC2(I,J) = SORC2(I,J) + D7(IIG,K)*N1(I,J)
C  DELAYED NEUTRON PRODUCTION RATE
KZ = M0(I,J)
DO 100 L=1,NIBC
M = NBET(L)
100  POW(I,J) = POW(I,J) + BETA(L)*MASS(M,KZ)*CO(IHF,M)*N0(I,J)*AB(K,L)
BEFF = 0.0
ALIFE = 0.0
DO 200 J=1,JM
DO 200 I=1,IM
BEFF = BEFF + SORC2(I,J)*POW(I,J)*V0(I,J)
200  ALIFE = ALIFE + SORC1(I,J)*V0(I,J)
BEFF = BEFF/(DENOM*ZKEFF)
ALIFE = ALIFE/(DENOM*ZKEFF)
TFMP = TEMP + BEFF
TEMP1 = TEMP1 + BEFF/(AL(K) + 1./3600.)
WRITE(NOUT,210) K,BEFF
210  FORMAT (6HUBETA(I3,6H) = ,6X,1PE14.4)
REWIND NFLUX1
REWIND NFLUX2
REWIND NCR1
250  CONTINUE
TEMP1 = (ALIFE + TEMP1)/3600.
WRITE (NOUT,300) TEMP, TEMP1, ALIFE
300  FORMAT (16HTOTAL BETA = ,5X,1PE14.4//
1 16H ONE INHOUR = ,5X,1PE14.4//
1 21H GENERATION TIME = ,1PE14.4)
RETURN
END

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-ITC FOR SLOPE,SLOPE
SUBROUTINE SLOPE(N0,N1,JIM,R5,Z5,R4,C0,JTL,M0,M2,DEL,VO,A0,A1)
  DIMENSION N0(JIM,1), N1(JIM,1), R5(1), Z5(1), R4(1), C0(JTL,1),
1    M0(JIM,1), M2(1), DEL(JIM,1), VO(JIM,1), A0(1), A1(1)
  INCLUDE ABC
C    THIS SUBROUTINE CALCULATES (GRAD FLUX*GRAD ADJOINT)/SIGTR**2
  IF (IGE - 3) 10,2,10
2    DO 4 I = 1,IM
4    R5(I) = 2.*Z5(1)/3.
    TEMP1 = Z5(1)
    DO 6 J = 1,JM
6    Z5(J) = 1.0
10   DO 1400 IIG=1,IGM
    READ(NCR1) ((C0(II,J), II=1,ITL), J=1,MT)
    READ(NFLUX1) ((N0(I,J), I=1,IM), J=1,JM)
    READ(NFLUX2) ((N1(I,J), I=1,IM), J=1,JM)
    DO 1200 J=1,JM
    DO 1200 I=1,IM
    ITEMP = M0(I,J)
    ITEMP = M2(ITEMP)
    IF (I-1) 14,14,12
12   ITEMP1 = M0(I-1,J)
    ITEMP1 = M2(ITEMP1)
14   ITEMPR = M0(I+1,J)
    ITEMPR = M2(ITEMPR)
    IF (J-1) 18,18,16
16   ITEMPB = M0(I,J-1)
    ITEMPB = M2(ITEMPB)
18   ITEMPT = M0(I,J+1)
    ITEMPT = M2(ITEMPT)
    SL1 = 0.0
    SL2 = 0.0
    SR1 = 0.0
    SR2 = 0.0
    SB1 = 0.0
    SB2 = 0.0
    ST1 = 0.0
    ST2 = 0.0
    IF(I-1) 30,30,100
30   IF(B01-1) 40,110,50
C    VACUUM BOUNDARY
40   SIGTR = C0(IHT,ITEMP)
    SL1 = (N0(I,J))/(.5*R5(I) + (.71/SIGTR))/SIGTR
    SL2 = (N1(I,J))/(.5*R5(I) + (.71/SIGTR))/SIGTR
    GO TO 110
C    PERIODIC BOUNDARY
50   ITEMPP = M0(IM,J)
    ITEMPP = M2(ITEMPP)
    SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(IM)*C0(IHT,ITEMPP))/
1    (R5(I) + R5(IM))
    SL1 = ((N0(I,J) - N0(IM,J))/(.5*R5(I) + .5*R5(IM)))/SIGTR
    SL2 = ((N1(I,J) - N1(IM,J))/(.5*R5(I) + .5*R5(IM)))/SIGTR
    GO TO 110
C    INTERIOR INTERVAL
100  SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(I-1)*C0(IHT,ITEMPL))/
1    (R5(I) + R5(I-1))
    SL1 = ((N0(I,J) - N0(I-1,J))/(.5*R5(I) + .5*R5(I-1)))/SIGTR
    SL2 = ((N1(I,J) - N1(I-1,J))/(.5*R5(I) + .5*R5(I-1)))/SIGTR
110  IF(I-IM) 200,130,130
130  IF(B02-1) 140,210,150
C    VACUUM BOUNDARY
140  SIGTR = C0(IHT,ITEMP)

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SR1 = -(N0(I,J)/(.5*R5(I) + (.71/SIGTR)))/SIGTR
SR2 = -(N1(I,J)/(.5*R5(I) + (.71/SIGTR)))/SIGTR
GO TO 210
C PERIODIC BOUNDARY
150 ITEMPP = M0(1,J)
ITEMPP = M2(ITEMPP)
SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(1)*C0(IHT,ITEMPP))/
1 (R5(1) + R5(I))
SR1 = ((N0(1,J) - N0(I,J))/(.5*R5(1) + .5*R5(I)))/SIGTR
SR2 = ((N1(1,J) - N1(I,J))/(.5*R5(1) + .5*R5(I)))/SIGTR
GO TO 210
C INTERIOR INTERVAL
200 SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(I+1)*C0(IHT,ITEMPR))/
1 (R5(I) + R5(I+1))
SR1 = ((N0(I+1,J) - N0(I,J))/(.5*R5(I+1) + .5*R5(I)))/SIGTR
SR2 = ((N1(I+1,J) - N1(I,J))/(.5*R5(I+1) + .5*R5(I)))/SIGTR
210 IF(NDIM-1) 220,1000,220
220 IF(J-1) 230,230,300
230 IF(B04-1) 240,310,280
C VACUUM BOUNDARY
240 SIGTR = C0(IHT,ITEMP)
GO TO (250,250,260,255), IGEP
250 TEMP = .5*Z5(J)
GO TO 270
255 TEMP = .5*R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 270,310,270
260 TEMP = .5*PI2*Z5(J)*R4(I)
270 SB1 = (N0(I,J)/(TEMP + (.71/SIGTR)))/SIGTR
SB2 = (N1(I,J)/(TEMP + (.71/SIGTR)))/SIGTR
GO TO 310
C PERIODIC BOUNDARY
280 ITEMPP = M0(I,JM)
ITEMPP = M2(ITEMPP)
SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(JM)*C0(IHT,ITEMPP))/
1 (Z5(J) + Z5(JM))
GO TO (285,285,290,288), IGEP
285 TEMP = .5*Z5(J) + .5*Z5(JM)
GO TO 295
288 TEMP = R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 295,310,295
290 TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(JM))
295 SB1 = ((N0(I,J) - N0(I,JM))/TEMP)/SIGTR
SB2 = ((N1(I,J) - N1(I,JM))/TEMP)/SIGTR
GO TO 310
C INTERIOR INTERVAL
300 SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(J-1)*C0(IHT,ITEMPB))/
1 (Z5(J) + Z5(J-1))
GO TO (302,302,304,303), IGEP
302 TEMP = .5*Z5(J) + .5*Z5(J-1)
GO TO 306
303 TEMP = R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 306,310,306
304 TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(J-1))
306 SB1 = ((N0(I,J) - N0(I,J-1))/TEMP)/SIGTR
SB2 = ((N1(I,J) - N1(I,J-1))/TEMP)/SIGTR
310 IF(J-JM) 400,330,330
330 IF(B03-1) 340,1000,380
C VACUUM BOUNDARY
340 SIGTR = C0(IHT,ITEMP)

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GO TO (350,350,360,355), IGEP
350 TEMP = .5*Z5(J)
GO TO 370
355 TFMP = .5*R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 1000,370,1000
360 TEMP = .5*PI2*Z5(J)*R4(I)
370 ST1 = -(N0(I,J))/(TEMP + (.71/SIGTR))/SIGTR
ST2 = -(N1(I,J))/(TEMP + (.71/SIGTR))/SIGTR
GO TO 1000
C PERIODIC BOUNDARY
380 ITEMPP = M0(I,1)
ITEMPP = M2(ITEMPP)
SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(1)*C0(IHT,ITEMPP))/
1 (Z5(J) + Z5(1))
GO TO (385,385,390,388), IGEP
385 TEMP = .5*Z5(J) + .5*Z5(1)
GO TO 395
388 TFMP = R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 1000,395,1000
390 TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(1))
395 ST1 = ((N0(I,1) - N0(I,J))/TEMP)/SIGTR
ST2 = ((N1(I,1) - N1(I,J))/TEMP)/SIGTR
GO TO 1000
C INTERIOR INTERVAL
400 SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(J+1)*C0(IHT,ITEMPT))/
1 (Z5(J) + Z5(J+1))
GO TO (402,402,404,403), IGEP
402 TEMP = .5*Z5(J) + .5*Z5(J+1)
GO TO 406
403 TEMP = R5(I)
ITEMP1 = I - 2*(I/2) - J + 2*(J/2)
IF (ITEMP1) 1000,406,1000
404 TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(J+1))
406 ST1 = ((N0(I,J+1) - N0(I,J))/TEMP)/SIGTR
ST2 = ((N1(I,J+1) - N1(I,J))/TEMP)/SIGTR
1000 GO TO (1010,1010,1020,1030), IGEP
1010 TEMP = Z5(J)
GO TO 1050
1020 TEMP = Z5(J)*PI2*R4(I)
GO TO 1050
1030 TFMP = R5(I)
1050 DEL(I,J) = .5*(SL1*SL2*Z5(J)*A0(I)*R5(I) + SR1*SR2*Z5(J)*A0(I+1)*
1 R5(I) + SB1*SB2*A1(I)*TEMP + ST1*ST2*A1(I)*TEMP)/V0(I,J)
1200 CONTINUE
1400 WRITE(NSCR1) ((DEL(I,J), I=1,IM), J=1,JM)
IF (IGE - 3) 1500,1410,1500
1410 DO 1420 I = 1,IM
1420 R5(I) = TEMP1/1.73205
DO 1430 J = 1,JM
1430 Z5(J) = TEMP1
1500 CONTINUE
REWIND NSCR1
REWIND NFLUX1
REWIND NFLUX2
REWIND NCR1
RETURN
END

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-ITC FOR CALC,CALC
  SUBROUTINE CALC(NCR,MATDK,ATW,CP,CO,JTL,NO,JIM,N1,DEL,K6,CX,
1      FLUX,JGM,ADJF,HOLN,VO,R4,Z4,X,Y)
  DIMENSION NCR(1), MATDK(1), ATW(1), CP(5,1), CO(JTL,1),
1      NO(JIM,1), N1(JIM,1), DEL(JIM,1), K6(1), CX(JTL,1),
2      FLUX(JGM,1), ADJF(JGM,1), HOLN(1), VO(JIM,1),
3      R4(1), Z4(1), X(1), Y(1)
  INCLUDE ABC
C   THIS SUBROUTINE CALCULATES AND PRINTS REACTIVITY COEFFICIENTS
  DO 2000 III=1,NDELK
  GO TO (100,120), NDIM
100  NCR(III) = 1
120  NNCR = IABS(NCR(III))
  MAT = MATDK(III)
C   CONVERSION FROM ATOMS TO KG
  CT = 602.3/ATW(MAT)
  ITEMP = 5*IJMAX
  CALL CLEAR(0.0,CP,ITEMP)
  WRITE(NOUT,130) (ID(I), I=1,12)
130  FORMAT(1H1,12A6//)
  IF (NCR(III)) 135,135,140
135  IIJJ = JM
  I = NNCR
  GO TO 145
140  IIJJ = IM
  J = NNCR
145  DO 600 IIG=1,IGM
  READ(NCR1) ((CO(II,J), II=1,ITL), J=1,MT)
  READ(NFLUX1) ((NO(I,J), I=1,IM), J=1,JM)
  READ(NFLUX2) ((N1(I,J), I=1,IM), J=1,JM)
  READ(NSCR1) ((DEL(I,J), I=1,IM), J=1,JM)
  DO 150 II=1,ITL
  CX(II,IIG) = CO(II,MAT)
150  DO 300 K = 1,IIJJ
  IF (NCR(III)) 190,190,200
190  J = K
  GO TO 210
200  I = K
C   FISSION SOURCE*ADJOINT
210  CP(1,K) = K6(IIG) * N1(I,J) + CP(1,K)
C   NU SIGF*FLUX
  CP(2,K) = CX(IHN,IIG) * NO(I,J) + CP(2,K)
C   SIGA*FLUX*ADJOINT
  CP(3,K) = CX(IHA,IIG) * NO(I,J) * N1(I,J) + CP(3,K)
C   LEAKAGE COMPONENT
  CP(4,K) = CX(IHT,IIG) * DEL(I,J)/3. + CP(4,K)
  FLUX(IIG,K) = NO(I,J)
300  ADJF(IIG,K) = N1(I,J)
600  CONTINUE
C   DOWNSCATTERING COMPONENT
  IF(IGM-1) 1010,1010,620
620  DO 1000 IIG=1,IGM
800  DO 890 I=1,IIJJ
  DO 880 NN=1,IST
  JJG = NN + IIG
  IF(JJG - IGM) 850,850,890
850  L = IHG + NN
  CP(5,I) = FLUX(IIG,I)*CX(L,JJG)*(ADJF(IIG,I) -ADJF(JJG,I))+CP(5,I)
880  CONTINUE
890  CONTINUE
1000  CONTINUE
1010  IF(NCR(III)) 1100,1100,1125

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1100 WRITE(NOUT,1120) MAT, HOLN(MAT), NNCR
1120 FORMAT( 37HUREACTIVITY COEFFICIENTS FOR MATERIAL,I3, 6X,A6,
1 13H COLUMN,I3//)
GO TO 1135
1125 WRITE(NOUT,1130) MAT, HOLN(MAT), NNCR
1130 FORMAT( 37HUREACTIVITY COEFFICIENTS FOR MATERIAL,I3, 6X,A6,
1 10H ROW,I3//)
1135 WRITE(NOUT,1140)
1140 FORMAT(125H0          *K/K PER KG          *K          *K
1          *K          *K          *K          AVG RADII          AVG A
2XII / 99H          (NUSIGF)          (SIGA)
3 (SIGTR)          (SIGIXJ)          (INTG)          /)
SUM = 0.0
TOT = 0.0
DO 1300 I=1,IIJJ
C FISSIONS
CP(2,I) = (CP(1,I)*CP(2,I)*CT)/(ZKEFF*DENOM*VF)
C ABSORPTIONS
CP(3,I) = - (CP(3,I)*CT)/(DENOM*VF)
C LEAKAGE
CP(4,I) = (CP(4,I)*CT)/(DENOM*VF)
C SLOWING DOWN
CP(5,I) = - (CP(5,I)*CT)/(DENOM*VF)
CP(1,I) = CP(2,I) + CP(3,I) + CP(4,I) + CP(5,I)
IF(NCR(III)) 1150,1150,1250
1150 SUM = SUM + CP(1,I)*VO(NNCR,I)
TOT = TOT + VO(NNCR,I)
ST = SUM/TOT
1160 FORMAT(I4, 8E15.4)
WRITE(NOUT,1160) I, (CP(KK,I), KK=1,5), ST, R4(NNCR), Z4(I)
GO TO 1300
1250 SUM = SUM + CP(1,I)*VO(I,NNCR)
TOT = TOT + VO(I,NNCR)
ST = SUM/TOT
WRITE(NOUT,1160) I, (CP(KK,I), KK=1,5), ST, R4(I), Z4(NNCR)
1300 CONTINUE
IF(NPDEL) 1400,1400,1350
1350 CALL PLOT(NCR,X,Y,R4,Z4,HOLN,CP,MAT)
1400 REWIND NCR1
REWIND NFLUX1
REWIND NFLUX2
2000 REWIND NSCR1
RETURN
END

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-ITC  FOR  PLOT,PLOT                                PERT1479
      SUBROUTINE PLOT(NCR,X,Y,R4,Z4,HOLN,CP,MAT)      PERT1480
      DIMENSION  NCR(1), X(1), Y(1), R4(1), Z4(1), HOLN(1), CP(5,1)  PERT1481
      INCLUDE ABC                                     PERT1482
C     THIS SUBROUTINE PLOTS REACTIVITY COEFFICIENTS USING THE CALCOMP  PERT1483
C     PLOTTER                                          PERT1484
C                                                     PERT1485
C     NREPLT      1/2=PLOT ON PREVIOUS GRAPH/PLOT ON NEW GRAPH      PERT1486
C     NTYPLT      1/2=PLOT TOTAL REACTIVITY COEFFICIENT ONLY/PLOT    PERT1487
C                  TOTAL AND EACH COMPONENT                        PERT1488
C     XL          VALUE OF X-AXIS AT LEFT BOUNDARY                 PERT1489
C     XR          VALUE OF X-AXIS AT RIGHT BOUNDARY                PERT1490
C     YB          VALUE OF Y-AXIS AT BOTTOM BOUNDARY                PERT1491
C     YT          VALUE OF Y-AXIS AT TOP BOUNDARY                  PERT1492
C     DEL         LENGTH OF DASHED LINE---NOT USED IF NTYPLT = 2---IF  PERT1493
C                  DEL = 0.0, A SOLID LINE IS DRAWN                PERT1494
C     GAP         LENGTH OF GAP BETWEEN DASHED LINES              PERT1495
C                                                     PERT1496
      READ(NINP,50) NREPLT, NTYPLT, XL, XR, YB, YT, DEL, GAP      PERT1497
50    FORMAT(2I6,6E6.2)                                           PERT1498
      IF(NCR(III)) 60, 60, 80                                       PERT1499
60    DO 70 I=1,IIJJ                                              PERT1500
70    X(I) = Z4(I)                                                 PERT1501
      GO TO 100                                                       PERT1502
80    DO 90 I=1,IIJJ                                              PERT1503
90    X(I) = R4(I)                                                 PERT1504
100   X(IIJJ+1) = XL                                              PERT1505
      X(IIJJ+2) = (XR-XL)/9.0                                         PERT1506
      Y(IIJJ+1) = YB                                              PERT1507
      Y(IIJJ+2) = (YT-YB)/6.0                                         PERT1508
      DIMENSION  IBUF(1024)                                         PERT1509
      CALL CPLOTS(IBUF,1024,12)                                       PERT1510
      IF(NREPLT-1) 200, 200, 110                                       PERT1511
110   UP = 5.25                                                    PERT1512
      IF(III-1) 120, 120, 130                                       PERT1513
120   CALL CPLOT(0.0,2.0,-3)                                         PERT1514
      GO TO 135                                                       PERT1515
130   CALL CPLOT(12.0,0.0,-3)                                         PERT1516
135   CALL BOX(0.0,0.0,9.0,6.0)                                       PERT1517
      CALL SYMBOL(2.0,5.5,0.15,ID,0.0,36)                             PERT1518
      IF(NCR(III)) 140, 140, 160                                       PERT1519
140   CALL AXIS(0.0,0.0,20HAXIAL POSITION (CM),-20,9.0,.0,XL,X(IIJJ+2))  PERT1520
      GO TO 180                                                       PERT1521
160   CALL AXIS(0.0,0.0,20HRADIAL POSITION (CM),-20,9.0,.0,XL,X(IIJJ+2))  PERT1522
180   CALL AXIS(0.0,0.0,22HDELTA K/K PER KILOGRAM,22,6.0,90.0,YB,  PERT1523
1    Y(IIJJ+2))                                                    PERT1524
200   UP = UP - .25                                                  PERT1525
      DIMENSION  Z(4), Q(4)                                           PERT1526
      Z(1) = 8.25                                                    PERT1527
      Z(2) = 8.75                                                    PERT1528
      Z(3) = 0.0                                                     PERT1529
      Z(4) = 1.0                                                     PERT1530
      Q(3) = 0.0                                                     PERT1531
      Q(4) = 1.0                                                     PERT1532
      CALL SYMBOL(6.0,UP,0.1,HOLN(MAT),0.0,6)                       PERT1533
      IF(NCR(III)) 204, 204, 206                                       PERT1534
204   CALL SYMBOL(7.0,UP,0.1, 4HR = ,0.0,4)                         PERT1535
      CALL NUMBER(7.5,UP,0.1,R4(NNCR),0.0,2)                         PERT1536
      GO TO 208                                                       PERT1537
206   CALL SYMBOL(7.0,UP,0.1,4HZ = ,0.0,4)                         PERT1538
      CALL NUMBER(7.5,UP,0.1,Z4(NNCR),0.0,2)                         PERT1539
208   IF(NTYPLT-1) 210, 210, 310                                       PERT1540

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210	DO 220 I=1,IIJJ	PERT1541
220	Y(I) = CP(1,I)	PERT1542
	IF(DEL) 240,240,230	PERT1543
230	CALL DASH(X,Y,IIJJ,DEL,GAP)	PERT1544
	GO TO 250	PERT1545
240	CALL LINE(X,Y,IIJJ,1,0,0)	PERT1546
250	Q(1) = UP	PERT1547
	Q(2) = UP	PERT1548
	CALL DASH(Z,Q,2,DEL,GAP)	PERT1549
	GO TO 500	PERT1550
310	DO 400 M=1,5	PERT1551
	Q(1) = UP - .25 - FLOAT(M)*.25	PERT1552
	Q(2) = Q(1)	PERT1553
	DO 320 I=1,IIJJ	PERT1554
320	Y(I) = CP(M,I)	PERT1555
	GO TO (330,340,350,360,370),M	PERT1556
330	CALL LINE(X,Y,IIJJ,1,0,0)	PERT1557
	CALL DASH(Z,Q,2,Q,Q,0,0)	PERT1558
	CALL SYMBOL(7.5,Q(1),0.1,7H TOTAL ,0.0,7)	PERT1559
	GO TO 400	PERT1560
340	CALL DASH(X,Y,IIJJ,.025,.05)	PERT1561
	CALL DASH(Z,Q,2,.025,.05)	PERT1562
	CALL SYMBOL(7.5,Q(1),0.1,7H NUSIGF,0.0,7)	PERT1563
	GO TO 400	PERT1564
350	CALL DASH(X,Y,IIJJ,.1,.1)	PERT1565
	CALL DASH(Z,Q,2,.1,.1)	PERT1566
	CALL SYMBOL(7.5,Q(1),0.1,7H SIGA ,0.0,7)	PERT1567
	GO TO 400	PERT1568
360	CALL DASH(X,Y,IIJJ,.05,.05)	PERT1569
	CALL DASH(Z,Q,2,.05,.05)	PERT1570
	CALL SYMBOL(7.5,Q(1),0.1,7H SIGTR ,0.0,7)	PERT1571
	GO TO 400	PERT1572
370	CALL DASH(X,Y,IIJJ,.015,.025)	PERT1573
	CALL DASH(Z,Q,2,.015,.025)	PERT1574
	CALL SYMBOL(7.5,Q(1),0.1,7H SIGIXJ,0.0,7)	PERT1575
400	CONTINUE	PERT1576
500	IF(III - NDELK) 600,550,550	PERT1577
550	CALL CPlot(12.0,-2.0,-999)	PERT1578
600	RETURN	PERT1579
	END	PERT1580

```

-ITC FOR ACT,ACT
SUBROUTINE ACT(MA,NX,NO,JIM,CO,JTL,SORC1,ZACT,M0,V0,VOL,Z4)
DIMENSION MA(1), NX(1), NO(JIM,1), CO(JTL,1), SORC1(JIM,1),
1 ZACT(1), M0(JIM,1), V0(JIM,1), VOL(1), Z4(1)
INCLUDE ARC
C THIS SUBROUTINE CALCULATES ACTIVITY TRAVERSES
DO 200 N=1,NACT
CALL CLEAR(0.0,SORC1,IMJM)
KK = MA(N)
NN = NX(N)
DO 100 IIG=1,IGM
READ(NFLUX1) ((NO(I,J), I=1,IM), J=1,JM)
READ(NCR1) ((CO(II,J), II=1,ITL), J=1,MT)
DO 100 J=1,JM
DO 100 I=1,IM
100 SORC1(I,J) = SORC1(I,J) + CO(NN,KK)*NO(I,J)
CALL CLEAR(0.0,ZACT,IZM)
DO 140 J=1,JM
DO 140 I=1,IM
KZ = M0(I,J)
140 ZACT(KZ) = ZACT(KZ) + SORC1(I,J)*V0(I,J)
DO 160 KZ=1,IZM
160 ZACT(KZ) = ZACT(KZ)*.001/VOL(KZ)
WRITE(NOUT,170) N, KK, NN
170 FORMAT( 9H1ACTIVITY I3,5X, 9H MATERIAL I3,5X,23H CROSS SECTION POS
1ITION I3//)
CALL PRT(IM,JM,SORC1,Z4,NOUT)
WRITE(NOUT,180) (KZ, VOL(KZ), ZACT(KZ), KZ=1,IZM)
180 FORMAT( ///45H ZONE ZONE ZONE AV. /
1 45H VOLUME ACTIVITY //
2 (I9,F19.6,F15.6))
REWIND NFLUX1
200 REWIND NCR1
RETURN
END

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