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

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FFTF Project

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

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 CODE FOR FAST REACTOR ANALYSIS

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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,

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

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}),
- $\Sigma(i\to j)$ = 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,

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

where:

$$I = \frac{1}{k_{eff}} \int dV \left\{ \sum_{j=1}^{IGM} \left(\chi_j \phi_j^\dagger \right) \sum_{i=1}^{IGM} \left(\nu \Sigma_f^i \phi_i \right) \right\} \quad , \tag{2.3}$$

$$F = \frac{1}{k_{eff}} \int dV \left\{ \sum_{j=1}^{IGM} \left(\chi_j \phi_j^\dagger \right) \sum_{i=1}^{IGM} \left(\delta[\nu \Sigma_f^i] \phi_i \right) \right\} \quad , \tag{2.4}$$

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

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

and

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

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

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

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

$$\beta_{eff}^k = \frac{1}{k_{eff}} \int dV \left\{ \sum_{i=1}^{IGM} \left(\sum_{\ell=1}^{NIBC} f_\ell^k \Sigma_{f,\ell}^i \right) \phi_i \sum_{j=1}^{IGM} D\chi_j^k \phi_j^\dagger \right\} \Big/ I \ , \tag{2.9}$$

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

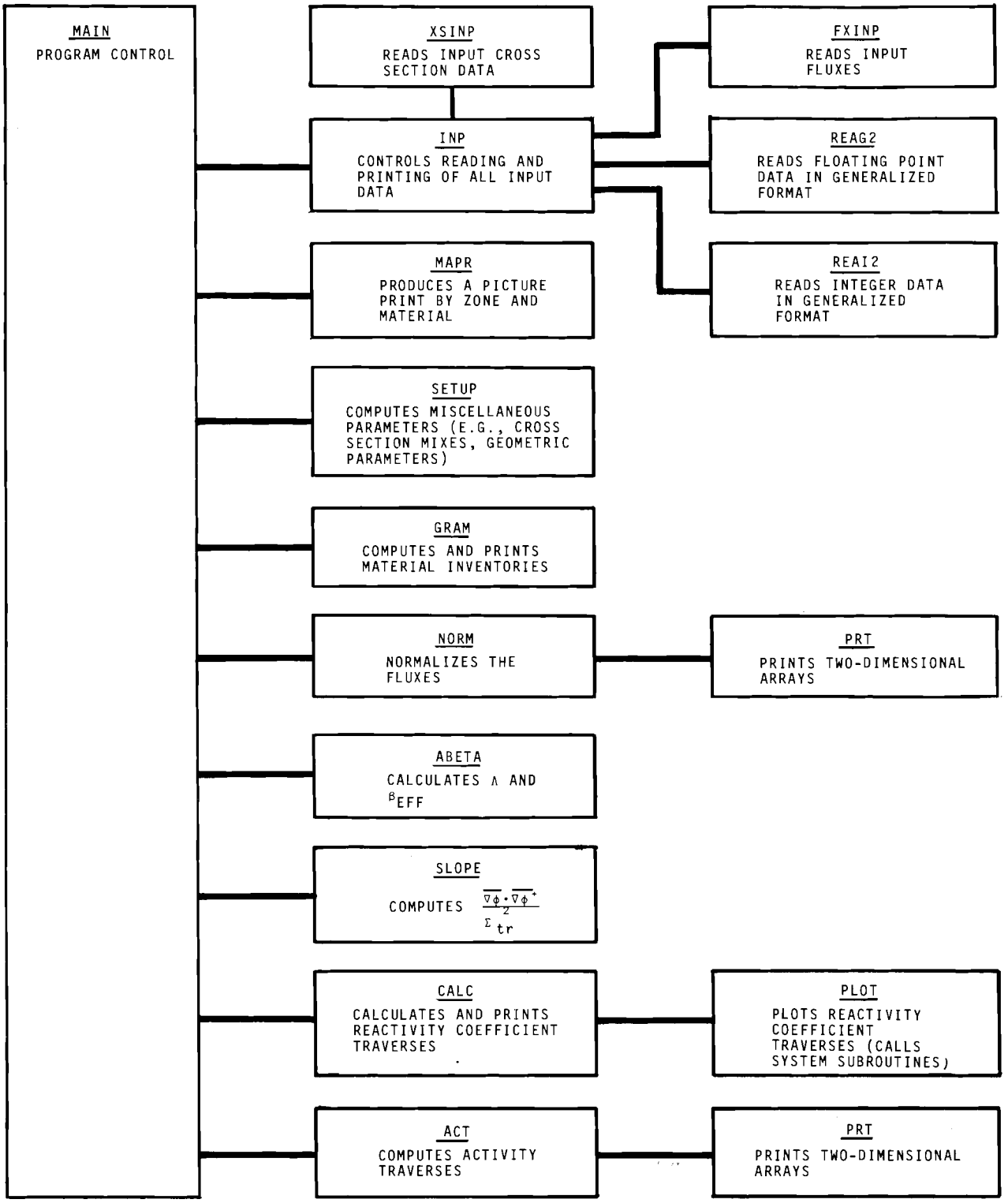
f_ℓ^k = absolute delayed neutron yield (per fission) in precursor group k for isotope ℓ,

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

$D\chi_j^k$ = 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.


MAIN
PROGRAM CONTROL
XSINP
READS INPUT CROSS SECTION DATA
FXINP
READS INPUT FLUXES
INP
CONTROLS READING AND PRINTING OF ALL INPUT DATA
REAG2
READS FLOATING POINT DATA IN GENERALIZED FORMAT
REAI2
READS INTEGER DATA IN GENERALIZED FORMAT
MAPR
PRODUCES A PICTURE PRINT BY ZONE AND MATERIAL
SETUP
COMPUTES MISCELLANEOUS PARAMETERS (E.G., CROSS SECTION MIXES, GEOMETRIC PARAMETERS)
GRAM
COMPUTES AND PRINTS MATERIAL INVENTORIES
NORM
NORMALIZES THE FLUXES
PRT
PRINTS TWO-DIMENSIONAL ARRAYS
ABETA
CALCULATES Λ AND β_{EFF}
SLOPE
COMPUTES $\frac{\overline{\nabla\phi_2 \cdot \nabla\phi^+}}{\Sigma_{tr}}$
CALC
CALCULATES AND PRINTS REACTIVITY COEFFICIENT TRAVERSES
PLOT
PLOTS REACTIVITY COEFFICIENT TRAVERSES (CALLS SYSTEM SUBROUTINES)
ACT
COMPUTES ACTIVITY TRAVERSES
PRT
PRINTS TWO-DIMENSIONAL ARRAYS

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.

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

Variable	Columns	Description
		= 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).

Variable	Columns	Description
IM	7-12	Number of radial intervals ($\geq$ 3).
JM	13-18	Number of axial intervals ($\geq$ 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.
MOI	31-36	Number of mixture specifications.
BOI	37-42	Left boundary condition: = 0, vacuum, = 1, reflective, = 2, periodic.
BO2	43-48	Right boundary condition.
BO3	49-54	Top boundary condition.
BO4	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.
FLPO	13-24	If FLPO is negative, the total power is normalized to |FLPO| Mwt using the conversion factor of 215 MeV/fission. If positive, FLPO is the total center point flux. The adjoint flux is always normalized such that $\sum_{i=1}^{IGM} \chi_i \phi_i^{\dagger} = 1$ 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.

Variable	Columns	Description
ATW(ML)	7-12	Atomic weight of first material. If this material is a mix ($\Sigma_{mix} = \sum_i N_i\sigma_i$), the atomic weight should be calculated using $A_{mix} = \sum_i N_i A_i$. 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 $\sigma(i\text{-}IST \rightarrow i)$. 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: FORMAT (6E12.5)

Optional--required if ND=1 or 2.

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
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≠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.		
IO(M01)	1-12	Material number of Mix 1.
. . .		
IO(M01)	N-(N+12)	Material number of Mix 2.
. . .		

Variable	Columns	Description
CARD 17: FORMAT [6(I1,I2,I9)]		
Optional--required if M01>0.		
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.
. . .		
CARD 18: FORMAT [6(I1,I2,E9.4)]		
Optional--required if M01>0.		
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.
. . .		
CARD 19: FORMAT [6(I1,I2,I9)]		
Optional--required if NIBC>0.		
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.

. . .

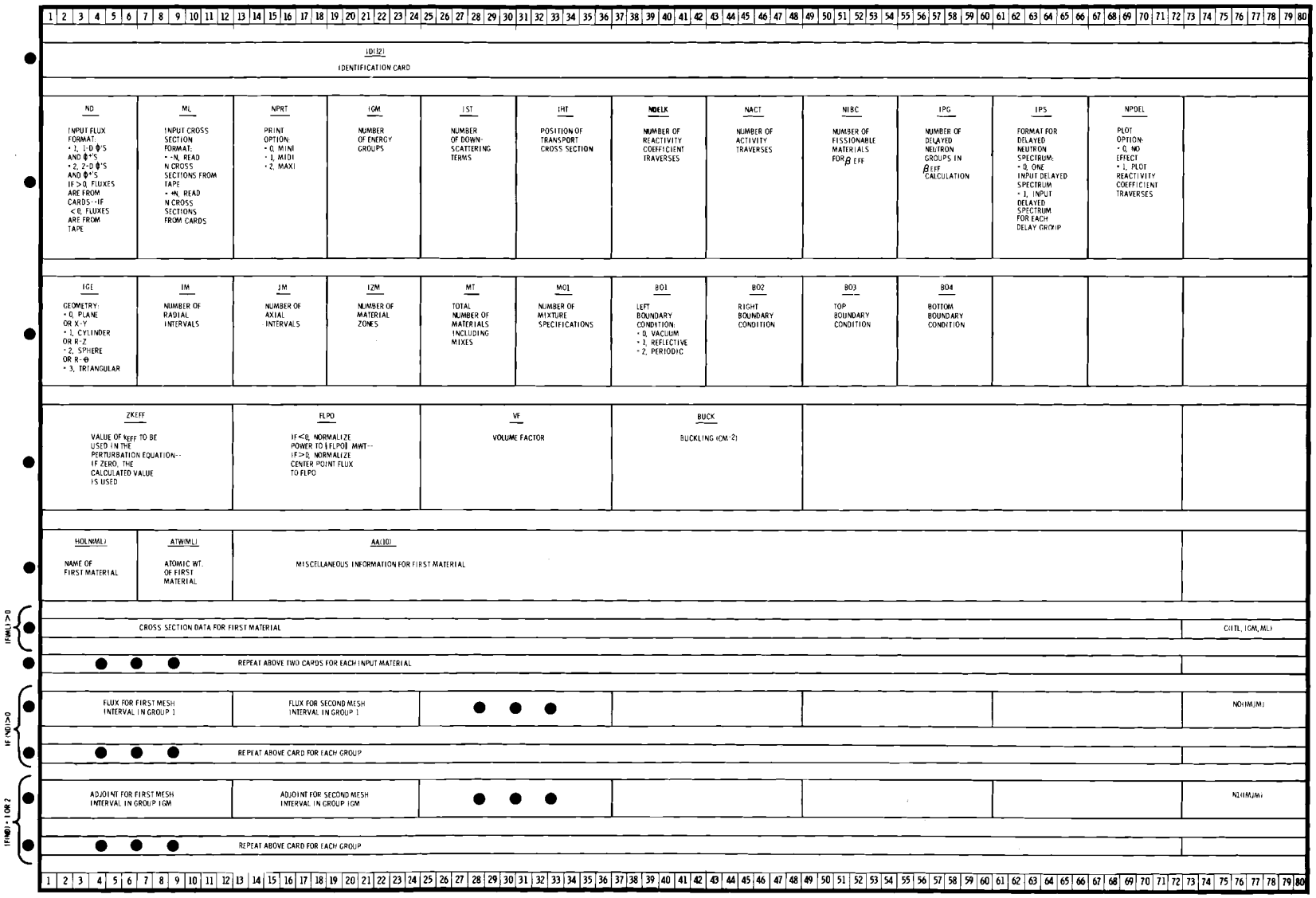
If (IPS=1), repeat above sequence for each delayed group.

Variable	Columns	Description
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.

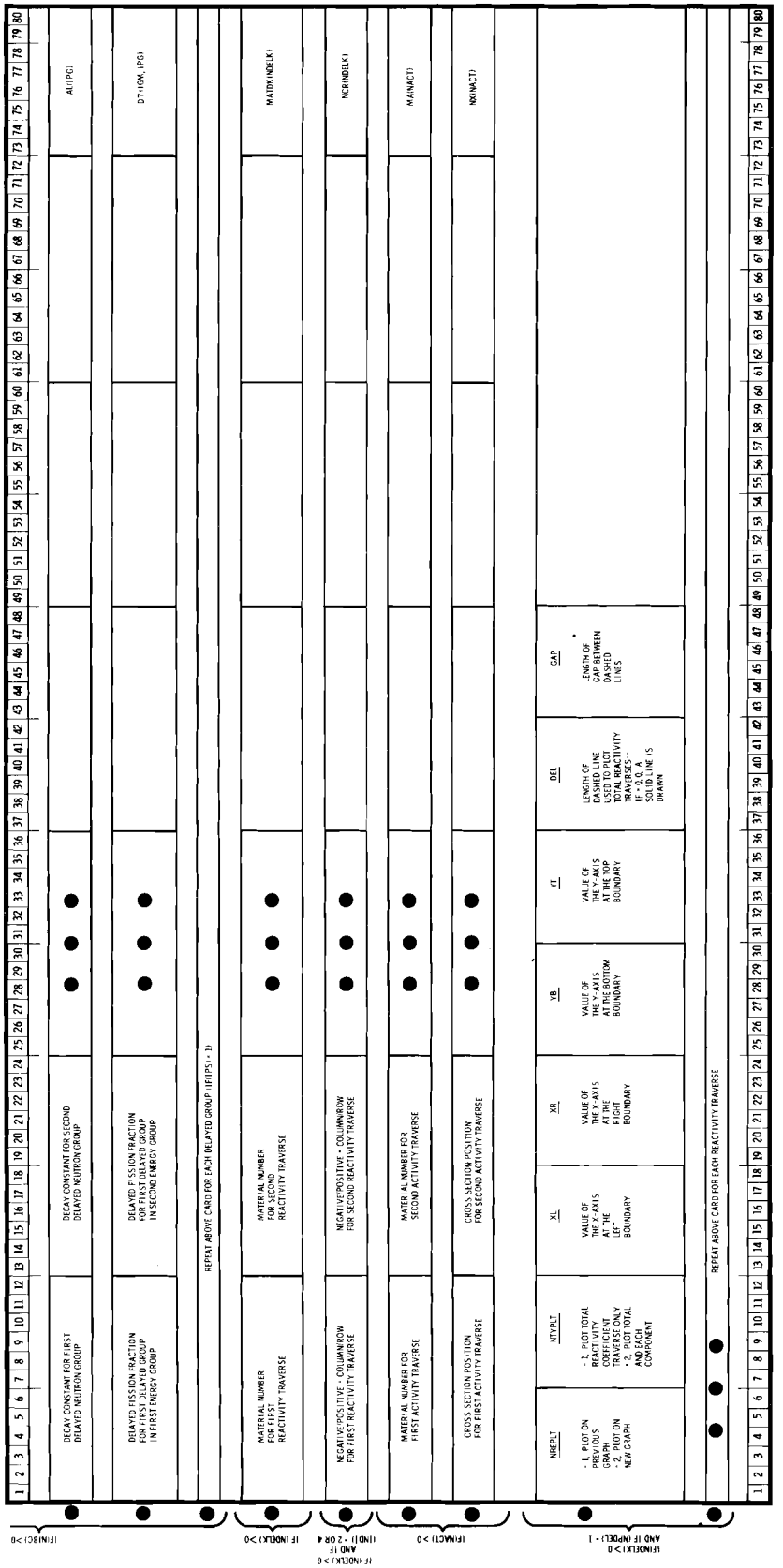
Variable	Columns	Description
NTYPLT	7-12	= 1, plot total reactivity coefficient traverse only, = 2, plot total and each component of the reactivity coefficient traverse.
XL	13-18	Value of the X-axis at the left boundary.
XR	19-24	Value of the X-axis at the right boundary.
YB	25-30	Value of the Y-axis 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
IDI12)
IDENTIFICATION CARD
ND
INPUT FLUX FORMAT: • 1, 1-D Φ'S AND Φ*'S • 2, 2-D Φ'S AND Φ*'S IF >0, FLUXES ARE FROM CARDS; IF <0, FLUXES ARE FROM TAPE
ML
INPUT CROSS SECTION FORMAT: • -N, READ N CROSS SECTIONS FROM TAPE • +N, READ N CROSS SECTIONS FROM CARDS
NPRT
PRINT OPTION: • 0, MINI • 1, MIDI • 2, MAXI
IGM
NUMBER OF ENERGY GROUPS
IST
NUMBER OF DOWN-SCATTERING TERMS
IHT
POSITION OF TRANSPORT CROSS SECTION
NDELK
NUMBER OF REACTIVITY COEFFICIENT TRAVERSES
NACT
NUMBER OF ACTIVITY TRAVERSES
NIBC
NUMBER OF FISSIONABLE MATERIALS FOR β EFF
IPG
NUMBER OF DELAYED NEUTRON GROUPS IN β EFF CALCULATION
IPS
FORMAT FOR DELAYED NEUTRON SPECTRUM: • 0, ONE INPUT DELAYED SPECTRUM • 1, INPUT DELAYED SPECTRUM FOR EACH DELAY GROUP
NPDEL
PLOT OPTION: • 0, NO EFFECT • 1, PLOT REACTIVITY COEFFICIENT TRAVERSES
IGE
GEOMETRY: • 0, PLANE OR X-Y • 1, CYLINDER OR R-Z • 2, SPHERE OR R-θ • 3, TRIANGULAR
IM
NUMBER OF RADIAL INTERVALS
JM
NUMBER OF AXIAL INTERVALS
IZM
NUMBER OF MATERIAL ZONES
MT
TOTAL NUMBER OF MATERIALS INCLUDING MIXES
MO1
NUMBER OF MIXTURE SPECIFICATIONS
BO1
LEFT BOUNDARY CONDITION: • 0, VACUUM • 1, REFLECTIVE • 2, PERIODIC
BO2
RIGHT BOUNDARY CONDITION
BO3
TOP BOUNDARY CONDITION
BO4
BOTTOM BOUNDARY CONDITION
ZKEFF
VALUE OF KEFF TO BE USED IN THE PERTURBATION EQUATION;-- IF ZERO, THE CALCULATED VALUE IS USED
FLPO
IF<0, NORMALIZE POWER TO |FLPO| MWT-- IF>0, NORMALIZE CENTER POINT FLUX TO FLPO
VF
VOLUME FACTOR
BUCK
BUCKLING (CM-2)
HOLNMLI
NAME OF FIRST MATERIAL
ATWMLI
ATOMIC WT. OF FIRST MATERIAL
AA(10)
MISCELLANEOUS INFORMATION FOR FIRST MATERIAL
IF(ML) >0
CROSS SECTION DATA FOR FIRST MATERIAL
(XITL, IGM, ML)
REPEAT ABOVE TWO CARDS FOR EACH INPUT MATERIAL
IF (ND)>0
FLUX FOR FIRST MESH INTERVAL IN GROUP 1
FLUX FOR SECOND MESH INTERVAL IN GROUP 1
(XH(M,JM)
REPEAT ABOVE CARD FOR EACH GROUP
IF(ND) = 1 OR 2
ADJOINT FOR FIRST MESH INTERVAL IN GROUP IGM
ADJOINT FOR SECOND MESH INTERVAL IN GROUP IGM
(XH(M,JM)
REPEAT ABOVE CARD FOR EACH GROUP

Condition	Col. 1–12	Col. 13–24	Col. 25–36	Col. 37–48	Col. 49–60	Col. 61–72	Col. 73–80
	RADIAL POSITION OF FIRST MESH BOUNDARY	RADIAL POSITION OF SECOND MESH BOUNDARY	● ● ●				R1(IM + 1)
IF(IND(1)=2	AXIAL POSITION OF FIRST MESH BOUNDARY	AXIAL POSITION OF SECOND MESH BOUNDARY	● ● ●				Z1(JM + 1)
	ZONE NUMBER FOR FIRST MESH INTERVAL	ZONE NUMBER OF SECOND MESH INTERVAL	● ● ●				MO(IMJM)
	MATERIAL NUMBER FOR FIRST ZONE	MATERIAL NUMBER FOR SECOND ZONE	● ● ●				M2(IZM)
IF BUCK(1)<0	BUCKLING MODIFIER FOR FIRST ZONE	BUCKLING MODIFIER FOR SECOND ZONE	● ● ●				GAM(IZM)
	FISSION FRACTION IN FIRST ENERGY GROUP	FISSION FRACTION IN SECOND ENERGY GROUP	● ● ●				KB(IGM)
	NEUTRON VELOCITY FOR FIRST ENERGY GROUP	NEUTRON VELOCITY FOR SECOND ENERGY GROUP	● ● ●				V7(IGM)
IF(MO(1))>0	MATERIAL NUMBER OF MIX 1	● ● ●	MATERIAL NUMBER OF MIX 2	● ● ●			IO(MOI)
IF(MO(1))>0	0	FIRST MATERIAL IN MIX 1	SECOND MATERIAL IN MIX 1	● ● ●			I1(MOI)
IF(MO(1))>0	0	DENSITY OF FIRST MATERIAL IN MIX 1	DENSITY OF SECOND MATERIAL IN MIX 1	● ● ●			I2(MOI)
IF(NIBC)>0	MATERIAL NUMBER OF FIRST FISSIONABLE ISOTOPE USED TO CALCULATE β_{EFF}	MATERIAL NUMBER OF SECOND FISSIONABLE ISOTOPE USED TO CALCULATE β_{EFF}	● ● ●				NBET(NIBC)
IF(NIBC)>0	ABSOLUTE DELAYED NEUTRON YIELD PER FISSION OF ABOVE ISOTOPE	ABSOLUTE DELAYED NEUTRON YIELD PER FISSION OF ABOVE ISOTOPE	● ● ●				BETA(NIBC)
IF(NIBC)>0	FRACTIONAL DELAYED NEUTRON YIELD IN FIRST DELAYED GROUP FOR FIRST DELAYED ISOTOPE	FRACTIONAL DELAYED NEUTRON YIELD IN SECOND DELAYED GROUP FOR FIRST DELAYED ISOTOPE	● ● ●				AB(IPG, NIBC)
IF(NIBC)>0	REPEAT ABOVE CARD FOR EACH DELAYED ISOTOPE						


DECAY CONSTANT FOR FIRST DELAYED NEUTRON GROUP
DECAY CONSTANT FOR SECOND DELAYED NEUTRON GROUP
AL(1PG)
DELAYED FISSION FRACTION FOR FIRST DELAYED GROUP IN FIRST ENERGY GROUP
DELAYED FISSION FRACTION FOR FIRST DELAYED GROUP IN SECOND ENERGY GROUP
D7-1(GM, 1PG)
REPEAT ABOVE CARD FOR EACH DELAYED GROUP (IFIPS) - 1)
MATERIAL NUMBER FOR FIRST REACTIVITY TRAVERSE
MATERIAL NUMBER FOR SECOND REACTIVITY TRAVERSE
MAIDK(NDELK)
NEGATIVE/POSITIVE - COLUMN/ROW FOR FIRST REACTIVITY TRAVERSE
NEGATIVE/POSITIVE - COLUMN/ROW FOR SECOND REACTIVITY TRAVERSE
NCR(NDELK)
MATERIAL NUMBER FOR FIRST ACTIVITY TRAVERSE
MATERIAL NUMBER FOR SECOND ACTIVITY TRAVERSE
MA(NACT)
CROSS SECTION POSITION FOR FIRST ACTIVITY TRAVERSE
CROSS SECTION POSITION FOR SECOND ACTIVITY TRAVERSE
NX(NACT)
NREPLT
- 1, PLOT ON PREVIOUS GRAPH
- 2, PLOT ON NEW GRAPH
NTYPLT
- 1, PLOT TOTAL REACTIVITY COEFFICIENT TRAVERSE ONLY
- 2, PLOT TOTAL AND EACH COMPONENT
XL
VALUE OF THE X-AXIS AT THE LEFT BOUNDARY
XR
VALUE OF THE X-AXIS AT THE RIGHT BOUNDARY
YB
VALUE OF THE Y-AXIS AT THE BOTTOM BOUNDARY
YT
VALUE OF THE Y-AXIS AT THE TOP BOUNDARY
DEL
LENGTH OF DASHED LINE USED TO PLOT TOTAL REACTIVITY TRAVERSES IF = 0.0, A SOLID LINE IS DRAWN
GAP
LENGTH OF GAP BETWEEN DASHED LINES
REPEAT ABOVE CARD FOR EACH REACTIVITY TRAVERSE
IF(NIBC) > 0
IF(NDELK) > 0
IF(NDELK) > 0 AND IF (NDELJ) - 2 OR 4
IF(NMACT) > 0
IF(NDELK) > 0 AND IF (NPDELJ) - 1

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:

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

$$\begin{aligned} N_1 = {} & 4 + 8 \times IM \times JM \\ & + 5 \times IM \\ & + 3 \times JM \\ & + 4 \times MO1 \\ & + 6 \times IZM \\ & + 2 \times (NIBC + NACT + NDELK) \\ & + IGM \times (3 + IST + IHT) \\ & + ML \times (2 + IZM) \\ & + MT \times (IST + IHT + 1) \\ & + MAX(IM,JM) \times (5 + 2 \times IGM) \\ & + IPG \times (1 + IGM + NIBC) \\ & + NPDEL \times (MAX(IM,JM) + 2) \end{aligned}$$

and

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

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 Multigroup 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.

```
PERT-V SAMPLE PROBLEM                                                                        ID
     2     5     1     2     1     4     3     1     2    12     0     1
     1    20    20     2     7    11     1     0     0     1
        0.0      -100.0         2.0         0.0
PU239 239.05       2 GROUPS
  .172436+01  .184872+01  .511503+01  .669364+01  .476589+01  .000000
  .228419+01  .324006+01  .649503+01  .139176+02  .106775+02  .790403-01
U238  238.05       2 GROUPS
  .100100+00  .232887-00  .281437-00  .633569+01  .600524+01  .000000
  .000000     .532188-00  .000000     .131583+02  .126261+02  .975608-01
C      12.011      2 GROUPS
  .000000     .833620-05  .000000     .263926+01  .245083+01  .000000
  .000000     .456935-10  .000000     .448553+01  .448553+01  .188417-00
FE     55.847      2 GROUPS
  .000000     .591775-02  .000000     .255761+01  .251745+01  .000000
  .000000     .215431-01  .000000     .482144+01  .479990+01  .342399-01
NA     22.990      2 GROUPS
  .000000     .713006-03  .000000     .309019+01  .300053+01  .000000
  .000000     .423424-02  .000000     .498455+01  .498031+01  .889546-01
211        0.02 7      50.0        80.03                                                     R1
2 9        0.02 9      40.0        70.03                                                     Z1
112          11 8        24 9        20120         24 9        203                           M0
              6          73                                                                  M2
           .987        .0133                                                                 K6
       7.631+8     1.164+83                                                                  V7
1 6          61 5        73                                                                  I0
              0           1           2           3           4           5                  I1
              0           2           3           4          53                              I1
              0       .0015       .0080       .0192       .0120       .0110                  I2
              0       .0150       .0300       .0200       .00503                             I2
              1          23                                                                NBET
          .0063      .04123                                                                BETA
           .038        .280        .216        .328        .103        .035                  AB
1 6        0.03                                                                              AB
1 6         0.0        .013        .137        .162        .388        .225                  AB
          .0753                                                                              AB
          .0129       .0311        .134        .331        1.26        3.21                  AL
          .0132       .0321        .139        .358        1.41        4.02                  AL
3                                                                                            AL
             .8         .23
              1           1          53                                                   MATDK
              1           5         -13                                                     NCR
             13                                                                              MA
             23                                                                              NX
     2        1      .0   80.     .0  .005     .0
     1        1      .0   80.     .0  .005     .1     .1
     2        2      .0   90.-.0002 .0003
```

* * * * 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
NPRT	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
NDELK	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
NPDEL	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
MC1	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
FLPO	NEGATIVE/POSITIVE=POWER (MWT)/TOTAL CENTER POINT FLUX	-1.0000+02
VF	VOLUME FACTOR	2.0000+00
BUCK	BUCKLING (CM-2)	0.0000

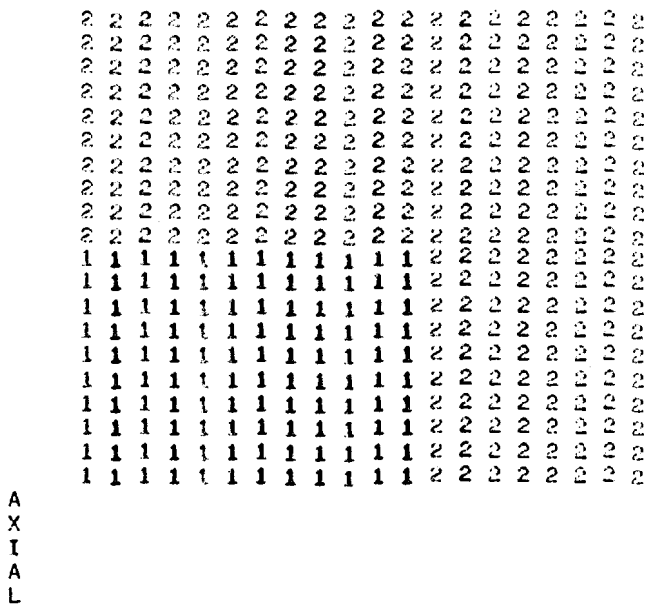
LAST = 3794

```
PERT-V SAMPLE PROBLEM


CROSS SECTIONS WERE READ IN FOR THE FOLLOWING MATERIALS

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

MESH BOUNDARIES
         R1      21
 -.00000    .41667+01   .83333+01   .12500+02   .16667+02   .20833+02   .25000+02   .29167+02   .33333+02   .37500+02
  .41667+02 .45833+02   .50000+02   .53750+02   .57500+02   .61250+02   .65000+02   .68750+02   .72500+02   .76250+02
  .80000+02
         Z1      21
 -.00000    .40000+01   .80000+01   .12000+02   .16000+02   .20000+02   .24000+02   .28000+02   .32000+02   .36000+02
  .40000+02 .43000+02   .46000+02   .49000+02   .52000+02   .55000+02   .58000+02   .61000+02   .64000+02   .67000+02
  .70000+02

ZONE NUMBERS BY MESH INTERVAL
         MO    400
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         1        1        1        1        1        1        1        1        1        1
         1        1        2        2        2        2        2        2        2        2
         2        2        2        2        2        2        2        2        2        2
         2        2        2        2        2        2        2        2        2        2
         2        2        2        2        2        2        2        2        2        2
         2        2        2        2        2        2        2        2        2        2
```

```
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
    2        2        2        2        2        2        2        2        2        2
MATERIAL NUMBERS BY ZONE
      M2     2
       6          7

FISSION SPECTRUM
      K6     2
 .98700-00   .13000-01

NEUTRON VELOCITIES
      V7     2
 .76310+09   .11640+09

MIXTURE SPECIFICATIONS  (I0/I1/I2=MIX NUMBER/MAT. NUMBER FOR MIX/MATERIAL DENSITY)
      I0    11
       6          6          6          6          6          6          7          7          7          7
       7
      I1    11
       0          1          2          3          4          5          0          2          3          4
       5
      I2    11
 .00000     .15000-02  .80000-02  .19200-01  .12000-01  .11000-01  .00000     .15000-01  .30000-01  .20000-01
 .50000-02

MATERIAL NUMBERS FOR BETA EFFECTIVE CALCULATION
     NBET    2
       1          2

ABSOLUTE NEUTRON YIELD PER DELAYED FISSION FOR ABOVE MATERIALS
     BETA    2
 .63000-02   .41200-01

FRACTIONAL YIELDS BY GROUP FOR DELAY MATERIAL     1
```

```
        AB      12
  .38000-01   .28000-00   .21600-00   .32800-00   .10300+00   .35000-01   .00000      .00000      .00000      .00000
  .00000      .00000

FRACTIONAL YIELDS BY GROUP FOR DELAY MATERIAL      2
        AB      12
  .00000      .00000      .00000      .00000      .00000      .00000      .15000-01   .13700-00   .16200-00   .38800-00
  .22500-00   .75000-01

DECAY CONSTANTS(SEC-1)
        AL      12
  .12900-01   .31100-01   .13400-00   .33100-00   .12600+01   .32100+01   .13200-01   .32100-01   .13900-00   .35800-00
  .14100+01   .40200+01

DELAYED FISSION SPECTRUM
        D7      2
  .80000-00   .20000-00

MATERIAL NUMBERS FOR DELTA K/K CALCULATION
      MATDK     3
          1           1           5

NEG/POS=COLUMN/ROW NUMBERS FOR DELTA K/K CALCULATION
        NCR     3
          1           5          -1

MATERIAL NUMBERS FOR ACTIVITY TRAVERSES
        MA      1
          1

CROSS SECTION POSITION FOR ACTIVITY TRAVERSES
        NX      1
          2
```

PERT-V SAMPLE PROBLEM



AXIAL

RADIAL

PERT-V SAMPLE PROBLEM

```
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
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7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7
A
X
I
A
L

RADIAL
```

	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	.66936+01	.47659+01	.00000		
MAT 2	.10010+00	.23289-00	.28144-00	.69357+01	.60052+01	.00000		
MAT 3	.00000	.83562-05	.00000	.26393+01	.24508+01	.00000		
MAT 4	.00000	.59177-02	.00000	.25576+01	.25175+01	.00000		
MAT 5	.00000	.71301-03	.00000	.36902+01	.30005+01	.00000		
MAT 6	.33873-02	.47152-02	.99240-02	.17608-00	.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	.12626+02	.97561-01		
MAT 3	.00000	.45693-10	.00000	.44855+01	.44855+01	.18842-00		
MAT 4	.00000	.21543-01	.00000	.48214+01	.47999+01	.34240-01		
MAT 5	.00000	.42342-02	.00000	.49846+01	.49803+01	.88955-01		
MAT 6	.34263-02	.94227-02	.97425-02	.32495-00	.31553-00	.59060-02		
MAT 7	.00000	.84349-02	.00000	.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	6.481+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	1.319+02	2.067+02

PERT-V SAMPLE PROBLEM

CENTER POINT FLUX (N/CM2-SEC) - - -	4.45726+15
TOTAL POWER (MWT) - - - - - -	1.00000+02
DENOMINATOR OF PERT. EQUATION - - -	4.52883+18
SOURCE RATE - - - - - - - - -	8.38713+18
ABSORPTION RATE - - - - - - - -	7.36832+18
LEAKAGE RATE - - - - - - - -	7.15960+17
CALCULATED KEFF - - - - - - - -	1.03746

PERT-V SAMPLE PROBLEM

TOTAL FLUX

	1	2	3	4	5	
1	.4457259+16	.4409446+16	.4314626+16	.4174405+16	.3991171+16	.2000000+01
2	.4404839+16	.4357582+16	.4263866+16	.4125278+16	.3944179+16	.6000000+01
3	.4300705+16	.4254557+16	.4163036+16	.4027695+16	.3850838+16	.1000000+02
4	.4146308+16	.4101800+16	.4013536+16	.3883011+16	.3712444+16	.1400000+02
5	.3943838+16	.3901484+16	.3817491+16	.3693281+16	.3530965+16	.1800000+02
6	.3696280+16	.3656563+16	.3577794+16	.3461309+16	.3309085+16	.2200000+02
7	.3407489+16	.3370848+16	.3298180+16	.3190713+16	.3050268+16	.2600000+02
8	.3082316+16	.3049143+16	.2983352+16	.2886050+16	.2758880+16	.3000000+02
9	.2726846+16	.2697470+16	.2639206+16	.2553031+16	.2440394+16	.3400000+02
10	.2348767+16	.2323435+16	.2273190+16	.2198871+16	.2101721+16	.3800000+02
11	.1952147+16	.1931065+16	.1889248+16	.1827389+16	.1746516+16	.4150000+02
12	.1601151+16	.1583837+16	.1549494+16	.1498688+16	.1432261+16	.4450000+02
13	.1299845+16	.1285773+16	.1257860+16	.1216566+16	.1162576+16	.4750000+02
14	.1043808+16	.1032496+16	.1010059+16	.9768671+15	.9334745+15	.5050000+02
15	.8273341+15	.8183607+15	.8005627+15	.7742367+15	.7398253+15	.5350000+02
16	.6442591+15	.6372667+15	.6233993+15	.6028897+15	.5760877+15	.5650000+02
17	.4884109+15	.4831076+15	.4725905+15	.4570386+15	.4367205+15	.5950000+02
18	.3538298+15	.3499863+15	.3423649+15	.3310965+15	.3163784+15	.6250000+02
19	.2348257+15	.2322738+15	.2272139+15	.2197337+15	.2099653+15	.6550000+02
20	.1259362+15	.1245665+15	.1218506+15	.1178357+15	.1125931+15	.6850000+02

	6	7	8	9	10	
1	.3768071+16	.3508995+16	.3218547+16	.2902062+16	.2565624+16	.2000000+01
2	.3723681+16	.3467624+16	.3180565+16	.2867775+16	.2535270+16	.6000000+01
3	.3635504+16	.3385448+16	.3105117+16	.2799665+16	.2474971+16	.1000000+02
4	.3504768+16	.3263606+16	.2993248+16	.2698669+16	.2385548+16	.1400000+02
5	.3333334+16	.3103830+16	.2846545+16	.2566212+16	.2268247+16	.1800000+02
6	.3123735+16	.2908486+16	.2667172+16	.2404237+16	.2124770+16	.2200000+02
7	.2879250+16	.2680630+16	.2457938+16	.2215268+16	.1957321+16	.2600000+02
8	.2604013+16	.2424126+16	.2222396+16	.2002511+16	.1768709+16	.3000000+02
9	.2303206+16	.2143820+16	.1965020+16	.1770028+16	.1562524+16	.3400000+02
10	.1983372+16	.1845837+16	.1691482+16	.1523010+16	.1343451+16	.3800000+02
11	.1647979+16	.1533434+16	.1404821+16	.1264330+16	.1114322+16	.4150000+02
12	.1351317+16	.1257212+16	.1151531+16	.1036065+16	.9127453+15	.4450000+02
13	.1096789+16	.1020512+16	.9344489+15	.8406859+15	.7406817+15	.4750000+02
14	.8806099+15	.8191751+15	.7502423+15	.6750557+15	.5950541+15	.5050000+02
15	.6979151+15	.6492359+15	.5946643+15	.5352355+15	.4721739+15	.5350000+02
16	.5434575+15	.5055815+15	.4631655+15	.4170534+15	.3682539+15	.5650000+02
17	.4119944+15	.3833135+15	.3512292+15	.3164063+15	.2796415+15	.5950000+02
18	.2984750+15	.2777208+15	.2545267+15	.2293885+15	.2028998+15	.6250000+02
19	.1980867+15	.1843236+15	.1689541+15	.1523142+15	.1348050+15	.6550000+02

20	.1062186+15	.9883463+14	.9059197+14	.8167329+14	.7229645+14	.6850000+02
	11	12	13	14	15	
1	.2216164+16	.1861642+16	.1469982+16	.1118538+16	.8385029+15	.2000000+01
2	.2189904+16	.1839545+16	.1452496+16	.1105208+16	.8284991+15	.6000000+01
3	.2137733+16	.1795642+16	.1417750+16	.1078720+16	.8086233+15	.1000000+02
4	.2060353+16	.1730511+16	.1366195+16	.1039420+16	.7791411+15	.1400000+02
5	.1958823+16	.1645029+16	.1298511+16	.9878259+15	.7404559+15	.1800000+02
6	.1834584+16	.1540373+16	.1215602+16	.9246363+15	.6931185+15	.2200000+02
7	.1689492+16	.1418033+16	.1118592+16	.8507257+15	.6378431+15	.2600000+02
8	.1525890+16	.1279828+16	.1008770+16	.7671407+15	.5755415+15	.3000000+02
9	.1346774+16	.1127951+16	.8873825+15	.6750833+15	.5074024+15	.3400000+02
10	.1156175+16	.9651613+15	.7546937+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	.5122205+15	.4111845+15	.3174199+15	.4450000+02
13	.6362787+15	.5296907+15	.4298352+15	.3431264+15	.2675389+15	.4750000+02
14	.5119387+15	.4278958+15	.3502346+15	.2822321+15	.2219993+15	.5050000+02
15	.4069622+15	.3414821+15	.2815656+15	.2284500+15	.1810397+15	.5350000+02
16	.3179894+15	.2677598+15	.2217838+15	.1811606+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	.9911825+14	.8287745+14	.6842947+14	.5518773+14	.6550000+02
20	.6271513+14	.5321193+14	.4453578+14	.3681007+14	.2972279+14	.6850000+02
	16	17	18	19	20	
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	.4270410+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	.1677952+15	.8232547+14	.1800000+02
6	.5104723+15	.3663109+15	.2512760+15	.1572324+15	.7714903+14	.2200000+02
7	.4699827+15	.3374615+15	.2316294+15	.1450107+15	.7116575+14	.2600000+02
8	.4245330+15	.3052035+15	.2097313+15	.1314195+15	.6452091+14	.3000000+02
9	.3751611+15	.2703502+15	.1861634+15	.1168296+15	.5739831+14	.3400000+02
10	.3233183+15	.2339815+15	.1616624+15	.1016946+15	.5001885+14	.3800000+02
11	.2776082+15	.2020383+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	.1049003+15	.6657061+14	.3288381+14	.4750000+02
14	.1701193+15	.1260483+15	.8862659+14	.5642103+14	.2791498+14	.5050000+02
15	.1396582+15	.1040541+15	.7347915+14	.4692075+14	.2325202+14	.5350000+02
16	.1120724+15	.8391087+14	.5948667+14	.3809284+14	.1896744+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	.6250000+02
19	.4328798+14	.3272936+14	.2339460+14	.1508134+14	.7532343+13	.6550000+02
20	.2334329+14	.1767278+14	.1265179+14	.8175437+13	.4108857+13	.6850000+02

PERT-V SAMPLE PROBLEM

FISSION SOURCE*ADJOINT FLUX

	1	2	3	4	5	
1	.1000000+01	.9892630-00	.9679673-00	.9364716-00	.8953048-00	.2000000+01
2	.9882169-00	.9776055-00	.9565583-00	.9254304-00	.8847440-00	.6000000+01
3	.9648068-00	.9544439-00	.9338916-00	.9034943-00	.8637631-00	.1000000+02
4	.9300837-00	.9200902-00	.9002710-00	.8709576-00	.8326434-00	.1400000+02
5	.8845229-00	.8750147-00	.8561580-00	.8282674-00	.7918125-00	.1800000+02
6	.8287672-00	.8198538-00	.8021745-00	.7760262-00	.7418479-00	.2200000+02
7	.7636377-00	.7554185-00	.7391170-00	.7150053-00	.6834879-00	.2600000+02
8	.6901545-00	.6827199-00	.6679742-00	.6461629-00	.6176506-00	.3000000+02
9	.6095738-00	.6030008-00	.5899638-00	.5706788-00	.5454666-00	.3400000+02
10	.5234504-00	.5178040-00	.5065922-00	.4900120-00	.4683337-00	.3800000+02
11	.4325727-00	.4278975-00	.4186237-00	.4049035-00	.3869625-00	.4150000+02
12	.3532620-00	.3494394-00	.3418567-00	.3306379-00	.3159671-00	.4450000+02
13	.2858254-00	.2827292-00	.2765873-00	.2675004-00	.2556177-00	.4750000+02
14	.2289794-00	.2264967-00	.2215719-00	.2142862-00	.2047598-00	.5050000+02
15	.1812716-00	.1793047-00	.1754034-00	.1696325-00	.1620882-00	.5350000+02
16	.1412296-00	.1396964-00	.1366556-00	.1321582-00	.1262803-00	.5650000+02
17	.1074414+00	.1062747+00	.1039610+00	.1005394+00	.9606900-01	.5950000+02
18	.7859204-01	.7773853-01	.7604606-01	.7354367-01	.7027506-01	.6250000+02
19	.5347207-01	.5289142-01	.5174006-01	.5003798-01	.4781529-01	.6550000+02
20	.3097072-01	.3063443-01	.2996769-01	.2898215-01	.2769539-01	.6850000+02

	6	7	8	9	10	
1	.8451648-00	.7869098-00	.7215518-00	.6502536-00	.5743294-00	.2000000+01
2	.8351898-00	.7776152-00	.7130211-00	.6425571-00	.5675225-00	.6000000+01
3	.8153717-00	.7591493-00	.6960727-00	.6272656-00	.5539976-00	.1000000+02
4	.7859778-00	.7317602-00	.6709338-00	.6045827-00	.5339336-00	.1400000+02
5	.7474113-00	.6958240-00	.6379485-00	.5748175-00	.5076005-00	.1800000+02
6	.7002182-00	.6518492-00	.5975830-00	.5383885-00	.4753646-00	.2200000+02
7	.6450969-00	.6004879-00	.5504359-00	.4958336-00	.4376958-00	.2600000+02
8	.5829170-00	.5425525-00	.4972547-00	.4478275-00	.3951853-00	.3000000+02
9	.5147492-00	.4790451-00	.4389650-00	.3952103-00	.3485760-00	.3400000+02
10	.4419177-00	.4112056-00	.3767152-00	.3390353-00	.2988195-00	.3800000+02
11	.3650969-00	.3396690-00	.3111017-00	.2798707-00	.2464857-00	.4150000+02
12	.2980858-00	.2772895-00	.2539238-00	.2283769-00	.2010682-00	.4450000+02
13	.2411355-00	.2242947-00	.2055788-00	.1847110-00	.1626525-00	.4750000+02
14	.1931517-00	.1796581-00	.1645120-00	.1479846-00	.1303898-00	.5050000+02
15	.1528981-00	.1422215-00	.1302489-00	.1172062+00	.1033611+00	.5350000+02
16	.1191232+00	.1108140+00	.1015067+00	.9138577-01	.8067247-01	.5650000+02
17	.9062819-01	.8431619-01	.7725417-01	.6958806-01	.6149340-01	.5950000+02
18	.6629884-01	.6168920-01	.5653724-01	.5095304-01	.4506861-01	.6250000+02
19	.4511249-01	.4198097-01	.3848405-01	.3469824-01	.3071491-01	.6550000+02

20	.2613112-01	.2431947-01	.2229758-01	.2011034-01	.1781115-01	.6850000+02
	11	12	13	14	15	
1	.4952549-00	.4146947-00	.3252889-00	.2452955-00	.1840032-00	.2000000+01
2	.4893764-00	.4097642-00	.3214135-00	.2433564-00	.1818055-00	.6000000+01
3	.4776953-00	.3999664-00	.3137118-00	.2375155-00	.1774385-00	.1000000+02
4	.4603639-00	.3854269-00	.3022813-00	.2288470-00	.1709594-00	.1400000+02
5	.4376122-00	.3663350-00	.2872680-00	.2174630-00	.1624564-00	.1800000+02
6	.4097498-00	.3429436-00	.2688661-00	.2035130-00	.1520450-00	.2200000+02
7	.3771722-00	.3155701-00	.2475149-00	.1871847-00	.1398825-00	.2600000+02
8	.3403726-00	.2845976-00	.2228873-00	.1687026-00	.1261654-00	.3000000+02
9	.2999710-00	.2504792-00	.1958434-00	.1483271-00	.1111544+00	.3400000+02
10	.2567868-00	.2137724-00	.1662333-00	.1263757-00	.9522846-01	.3800000+02
11	.2114286-00	.1748772-00	.1371571-00	.1063278+00	.8105673-01	.4150000+02
12	.1724185-00	.1428049-00	.1142412+00	.8993694-01	.6933042-01	.4450000+02
13	.1396077-00	.1160716+00	.9403892-01	.7495969-01	.5839320-01	.4750000+02
14	.1121021+00	.9360856-01	.7653337-01	.6161331-01	.4844033-01	.5050000+02
15	.8904043-01	.7466196-01	.6147194-01	.4988174-01	.3952518-01	.5350000+02
16	.6963623-01	.5860969-01	.4852460-01	.3962638-01	.3160409-01	.5650000+02
17	.5318148-01	.4490579-01	.3734209-01	.3064878-01	.2457348-01	.5950000+02
18	.3904065-01	.3305000-01	.2757941-01	.2272465-01	.1829567-01	.6250000+02
19	.2664115-01	.2259771-01	.1890511-01	.1562182-01	.1261550-01	.6550000+02
20	.1546206-01	.1313201-01	.1100378-01	.9109071-02	.7370203-02	.6850000+02
	16	17	18	19	20	
1	.1352505-00	.9710119-01	.6699504-01	.4276832-01	.2261291-01	.2000000+01
2	.1336350-00	.9594204-01	.6619627-01	.4225912-01	.2234401-01	.6000000+01
3	.1304255-00	.9364024-01	.6461067-01	.4124867-01	.2181055-01	.1000000+02
4	.1256666-00	.9022934-01	.6226269-01	.3975331-01	.2102139-01	.1400000+02
5	.1194258+00	.8576148-01	.5919054-01	.3779863-01	.1999054-01	.1800000+02
6	.1117980+00	.8031016-01	.5544851-01	.3542106-01	.1873784-01	.2200000+02
7	.1029092+00	.7397499-01	.5111047-01	.3267011-01	.1729021-01	.2600000+02
8	.9292765-01	.6688967-01	.4627481-01	.2961103-01	.1568282-01	.3000000+02
9	.8208125-01	.5923343-01	.4107049-01	.2632750-01	.1396012-01	.3400000+02
10	.7069241-01	.5124565-01	.3566138-01	.2292204-01	.1217535-01	.3800000+02
11	.6065837-01	.4423486-01	.3091983-01	.1993748-01	.1061094-01	.4150000+02
12	.5230969-01	.3838067-01	.2694980-01	.1743346-01	.9296672-02	.4450000+02
13	.4442582-01	.3280727-01	.2314880-01	.1502672-01	.8030443-02	.4750000+02
14	.3714317-01	.2760333-01	.1957233-01	.1275003-01	.6828733-02	.5050000+02
15	.3052016-01	.2281492-01	.1625239-01	.1062343-01	.5701933-02	.5350000+02
16	.2455153-01	.1844904-01	.1319779-01	.8653845-02	.4654028-02	.5650000+02
17	.1918601-01	.1448124-01	.1039721-01	.6836250-02	.3683010-02	.5950000+02
18	.1434185-01	.1086391-01	.7823442-02	.5155736-02	.2781764-02	.6250000+02
19	.9918673-02	.7533681-02	.5437601-02	.3589742-02	.1939096-02	.6550000+02
20	.5805620-02	.4417254-02	.3192950-02	.2110337-02	.1140893-02	.6850000+02

PERT-V SAMPLE PROBLEM

POWER DENSITY (MW/LITER)

	1	2	3	4	5	
1	.5221123-00	.5165120-00	.5054059-00	.4889821-00	.4675206-00	.2000000+01
2	.5159728-00	.5104376-00	.4994608-00	.4832282-00	.4620168-00	.6000000+01
3	.5037767-00	.4983713-00	.4876515-00	.4717992-00	.4510845-00	.1000000+02
4	.4856941-00	.4804808-00	.4701424-00	.4548541-00	.4348760-00	.1400000+02
5	.4619823-00	.4570213-00	.4471831-00	.4326342-00	.4136223-00	.1800000+02
6	.4329920-00	.4283397-00	.4191133-00	.4054689-00	.3876387-00	.2200000+02
7	.3991763-00	.3948843-00	.3863720-00	.3737836-00	.3573325-00	.2600000+02
8	.3611062-00	.3572201-00	.3495129-00	.3381144-00	.3232174-00	.3000000+02
9	.3194982-00	.3160565-00	.3092303-00	.2991341-00	.2859380-00	.3400000+02
10	.2752594-00	.2722908-00	.2664029-00	.2576938-00	.2463094-00	.3800000+02
11	.5781386-01	.5718384-01	.5593334-01	.5408119-01	.5165496-01	.4150000+02
12	.4491177-01	.4442155-01	.4344851-01	.4200722-01	.4011908-01	.4450000+02
13	.3480880-01	.3442827-01	.3367296-01	.3255416-01	.3108856-01	.4750000+02
14	.2687587-01	.2658167-01	.2599771-01	.2513280-01	.2399996-01	.5050000+02
15	.2061886-01	.2039290-01	.1994441-01	.1928024-01	.1841055-01	.5350000+02
16	.1564786-01	.1547622-01	.1513560-01	.1463126-01	.1397109-01	.5650000+02
17	.1165298-01	.1152518-01	.1127129-01	.1089561-01	.1040405-01	.5950000+02
18	.8385094-02	.8293030-02	.8110365-02	.7840034-02	.7486447-02	.6250000+02
19	.5640352-02	.5578412-02	.5455532-02	.5273712-02	.5035977-02	.6550000+02
20	.3247539-02	.3211872-02	.3141121-02	.3036450-02	.2899619-02	.6850000+02

	6	7	8	9	10	
1	.4413905-00	.4110477-00	.3770326-00	.3399710-00	.3005779-00	.2000000+01
2	.4361913-00	.4062021-00	.3725837-00	.3359549-00	.2970223-00	.6000000+01
3	.4258637-00	.3965773-00	.3637467-00	.3279771-00	.2899588-00	.1000000+02
4	.4105520-00	.3823070-00	.3506442-00	.3161476-00	.2794840-00	.1400000+02
5	.3904745-00	.3635946-00	.3334624-00	.3006337-00	.2657443-00	.1800000+02
6	.3659290-00	.3407180-00	.3124558-00	.2816637-00	.2489395-00	.2200000+02
7	.3373007-00	.3140366-00	.2879542-00	.2595343-00	.2293288+00	.2600000+02
8	.3050761-00	.2840047-00	.2603759-00	.2346226-00	.2072426-00	.3000000+02
9	.2698658-00	.2511935-00	.2302481-00	.2074073-00	.1831037-00	.3400000+02
10	.2324413-00	.2163254-00	.1982393-00	.1785006-00	.1574648-00	.3800000+02
11	.4869017-01	.4522922-01	.4131971-01	.3701226-01	.3235670-01	.4150000+02
12	.3781173-01	.3511826-01	.3207622-01	.2872639-01	.2511113-01	.4450000+02
13	.2929780-01	.2720799-01	.2484933-01	.2225578-01	.1946553-01	.4750000+02
14	.2261618-01	.2100230-01	.1918286-01	.1718651-01	.1504753-01	.5050000+02
15	.1734873-01	.1611137-01	.1471843-01	.1319394-01	.1156754-01	.5350000+02
16	.1316555-01	.1222776-01	.1117379-01	.1002328-01	.8800804-02	.5650000+02
17	.9804620-02	.9107509-02	.8325305-02	.7473555-02	.6571669-02	.5950000+02
18	.7055548-02	.6554917-02	.5994000-02	.5384501-02	.4740934-02	.6250000+02
19	.4746413-02	.4410261-02	.4034074-02	.3625974-02	.3195954-02	.6550000+02

20	.2733020-02	.2539719-02	.2323566-02	.2089319-02	.1842805-02	.6850000+02
	11	12	13	14	15	
1	.2596678-00	.2181776-00	.4287525-01	.3056431-01	.2172813-01	.2000000+01
2	.2565913-00	.2155883-00	.4235621-01	.3019339-01	.2146401-01	.6000000+01
3	.2504793-00	.2104436-00	.4132314-01	.2945515-01	.2093846-01	.1000000+02
4	.2414140-00	.2028117-00	.3978572-01	.2835667-01	.2015681-01	.1400000+02
5	.2295201-00	.1927954-00	.3775789-01	.2690827-01	.1912710-01	.1800000+02
6	.2149667-00	.1805330-00	.3525686-01	.2512324-01	.1786019-01	.2200000+02
7	.1979720-00	.1661997-00	.3230161-01	.2301750-01	.1637034-01	.2600000+02
8	.1788117-00	.1500096-00	.2891006-01	.2060974-01	.1467685-01	.3000000+02
9	.1578386-00	.1322209-00	.2509220-01	.1792313-01	.1280842-01	.3400000+02
10	.1355283-00	.1131594+00	.2082724-01	.1499548-01	.1081469-01	.3800000+02
11	.2739291-01	.2211553-01	.1657528-01	.1231595-01	.9046115-02	.4150000+02
12	.2127260-01	.1725482-01	.1336298-01	.1017655-01	.7605345-02	.4450000+02
13	.1652422-01	.1349800-01	.1067094-01	.8286709-02	.6292732-02	.4750000+02
14	.1281001-01	.1053888-01	.8452093-02	.6664237-02	.5130911-02	.5050000+02
15	.9877952-02	.8179364-02	.6630440-02	.5290440-02	.4120353-02	.5350000+02
16	.7538040-02	.6276771-02	.5130393-02	.4131898-02	.3248457-02	.5650000+02
17	.5644157-02	.4721682-02	.3884221-02	.3151080-02	.2496030-02	.5950000+02
18	.4081225-02	.3426875-02	.2832931-02	.2310959-02	.1841195-02	.6250000+02
19	.2756130-02	.2320598-02	.1925181-02	.1576698-02	.1261462-02	.6550000+02
20	.1591005-02	.1341878-02	.1115638-02	.9159017-03	.7346599-03	.6850000+02
	16	17	18	19	20	
1	.1533667-01	.1066022-01	.7176110-02	.4503971-02	.2360224-02	.2000000+01
2	.1515013-01	.1053060-01	.7088942-02	.4449334-02	.2331623-02	.6000000+01
3	.1477906-01	.1027290-01	.6915732-02	.4340814-02	.2274835-02	.1000000+02
4	.1422762-01	.9890269-02	.6658803-02	.4179976-02	.2190717-02	.1400000+02
5	.1350215-01	.9387676-02	.6321844-02	.3969316-02	.2080640-02	.1800000+02
6	.1261162-01	.8772283-02	.5910238-02	.3712483-02	.1946606-02	.2200000+02
7	.1156842-01	.8054203-02	.5431588-02	.3414610-02	.1791415-02	.2600000+02
8	.1039016-01	.7247797-02	.4896537-02	.3082744-02	.1618865-02	.3000000+02
9	.9103171-02	.6373762-02	.4319797-02	.2726313-02	.1433922-02	.3400000+02
10	.7748830-02	.5461786-02	.3721024-02	.2357305-02	.1242724-02	.3800000+02
11	.6561546-02	.4665743-02	.3199027-02	.2035630-02	.1076009-02	.4150000+02
12	.5585018-02	.4007127-02	.2765338-02	.1767579-02	.9368288-03	.4450000+02
13	.4678610-02	.3386394-02	.2354574-02	.1512303-02	.8038519-03	.4750000+02
14	.3858755-02	.2820101-02	.1973196-02	.1273539-02	.6739334-03	.5050000+02
15	.3130211-02	.2306769-02	.1624504-02	.1053384-02	.5631639-03	.5350000+02
16	.2489119-02	.1847762-02	.1308839-02	.8523073-03	.4568547-03	.5650000+02
17	.1926110-02	.1438625-02	.1024117-02	.6693604-03	.3596115-03	.5950000+02
18	.1428689-02	.1072350-02	.7664642-03	.5024743-03	.2704616-03	.6250000+02
19	.9828140-03	.7403668-03	.5307763-03	.3487545-03	.1879873-03	.6550000+02
20	.5738082-03	.4332310-03	.3111721-03	.2047514-03	.1104653-03	.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	.374253+15	.973396-02

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 (SIGIXJ)	ΔK (INTG)	AVG RADII	AVG AXII
1	.4036-02	.6688-02	-.2641-02	.8167-06	-.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	-.1884-02	.1312-04	-.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	.2880-04	-.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	-.7018-04	.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 PU239 ROW 5

	ΔK/K PER KG	ΔK (NUSIGF)	ΔK (SIGA)	ΔK (SIGTR)	ΔK (SIGIXJ)	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	.5125-02	-.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	.4595-02	-.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	.2729-02	-.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	-.3400-03	.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	.1106-02	.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 NA COLUMN 1

	ΔK/K PER KG	ΔK (NUSIGF)	ΔK (SIGA)	ΔK (SIGTR)	ΔK (SIGIXJ)	ΔK (INTG)	AVG RADII	AVG AXII
1	-.1564-03	.0000	-.2154-04	.3738-05	-.1386-03	-.1564-03	.2083+01	.2000+01
2	-.1470-03	.0000	-.2154-04	.9545-05	-.1355-03	-.1517-03	.2083+01	.6000+01
3	-.1368-03	.0000	-.2065-04	.2088-04	-.1297-03	-.1441-03	.2083+01	.1000+02
4	-.1087-03	.0000	-.1883-04	.3720-04	-.1213-03	-.1337-03	.2083+01	.1400+02
5	-.7011-04	.0000	-.1664-04	.5771-04	-.1110-03	-.1210-03	.2083+01	.1800+02
6	-.3272-04	.0000	-.1478-04	.8142-04	-.9936-04	-.1065-03	.2083+01	.2200+02
7	.7381-05	.0000	-.1253-04	.1071-03	-.8722-04	-.9865-04	.2083+01	.2600+02
8	.4791-04	.0000	-.1021-04	.1335-03	-.7536-04	-.7281-04	.2083+01	.3000+02
9	.8641-04	.0000	-.7926-05	.1589-03	-.6454-04	-.5812-04	.2083+01	.3400+02
10	.1202-03	.0000	-.5765-05	.1812-03	-.5524-04	-.3759-04	.2083+01	.3800+02
11	.1410-03	.0000	-.3757-05	.1623-03	-.4748-04	-.2722-04	.2083+01	.4150+02
12	.7333-04	.0000	-.2362-05	.1121-03	-.3645-04	-.2066-04	.2083+01	.4450+02
13	.4809-04	.0000	-.1451-05	.7566-04	-.2613-04	-.1645-04	.2083+01	.4750+02
14	.3170-04	.0000	-.8718-06	.5041-04	-.1784-04	-.1367-04	.2083+01	.5050+02
15	.2130-04	.0000	-.5117-06	.3350-04	-.1168-04	-.1177-04	.2083+01	.5350+02
16	.1481-04	.0000	-.2910-06	.2243-04	-.7330-05	-.1039-04	.2083+01	.5650+02
17	.1081-04	.0000	-.1577-06	.1533-04	-.4354-05	-.9349-05	.2083+01	.5950+02
18	.8398-05	.0000	-.7851-07	.1086-04	-.2386-05	-.8517-05	.2083+01	.6250+02
19	.6983-05	.0000	-.3297-07	.8152-05	-.1136-05	-.7823-05	.2083+01	.6550+02
20	.6222-05	.0000	-.9048-08	.6632-05	-.4012-06	-.7221-05	.2083+01	.6850+02

ACTIVITY 1 MATERIAL 1 CROSS SECTION POSITION 2

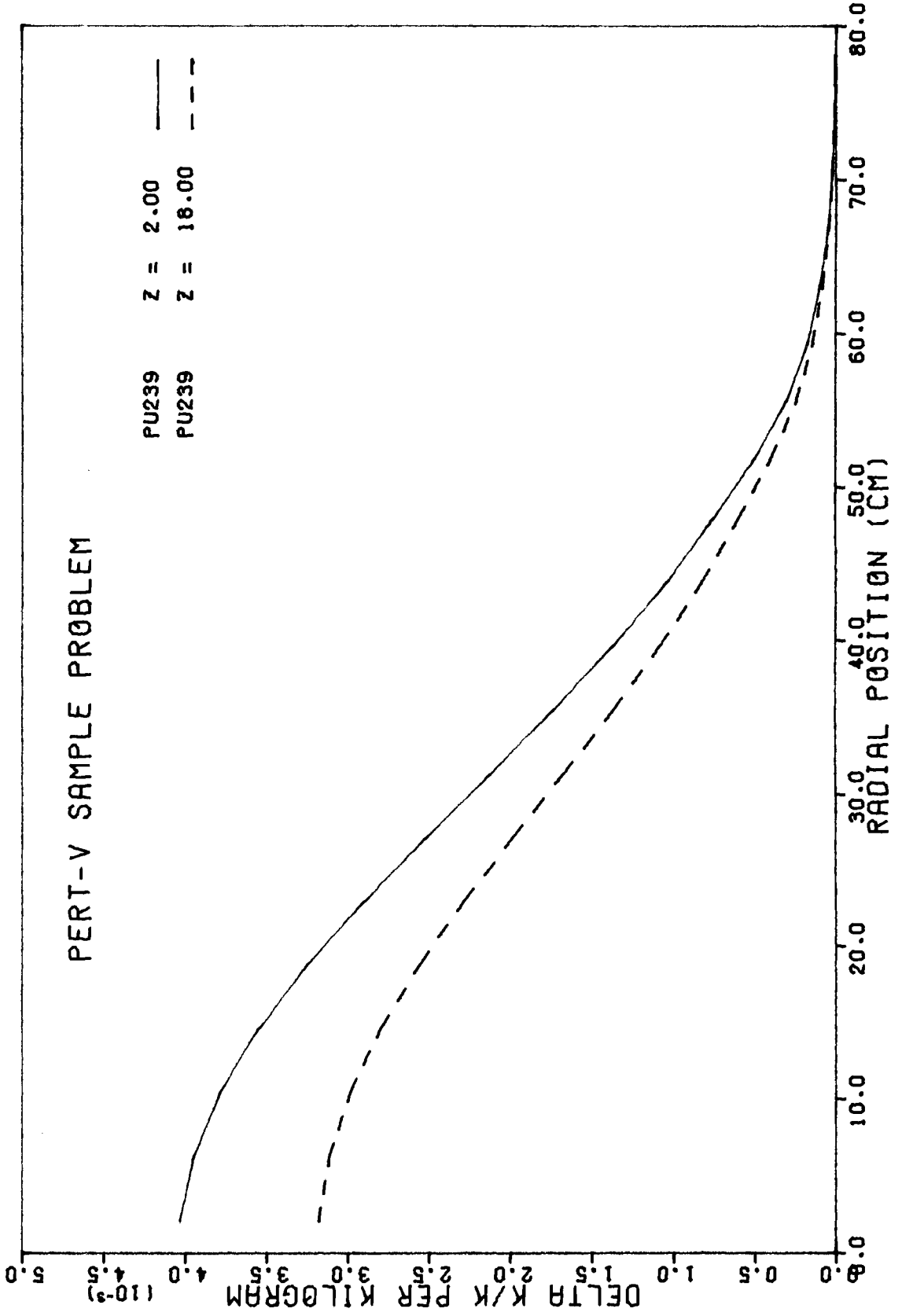
	1	2	3	4	5	
1	.1040112+17	.1028994+17	.1006951+17	.9743706+16	.9318315+16	.2000000+01
2	.1027965+17	.1016975+17	.9951868+16	.9629829+16	.9209357+16	.6000000+01
3	.1003851+17	.9931170+16	.9718350+16	.9403794+16	.8993088+16	.1000000+02
4	.9681467+16	.9577902+16	.9372580+16	.9069106+16	.8672863+16	.1400000+02
5	.9214262+16	.9115647+16	.8920139+16	.8631166+16	.8253848+16	.1800000+02
6	.8644917+16	.8552341+16	.8368795+16	.8097498+16	.7743253+16	.2200000+02
7	.7984102+16	.7898537+16	.7728887+16	.7478120+16	.7150663+16	.2600000+02
8	.7245794+16	.7168069+16	.7013961+16	.6786152+16	.6488649+16	.3000000+02
9	.6448362+16	.6379117+16	.6241815+16	.6038833+16	.5773721+16	.3400000+02
10	.5616305+16	.5555919+16	.5436178+16	.5259143+16	.5027883+16	.3800000+02
11	.4769685+16	.4718526+16	.4616480+16	.4465884+16	.4269125+16	.4150000+02
12	.3979546+16	.3936636+16	.3851541+16	.3725704+16	.3561273+16	.4450000+02
13	.3275102+16	.3239744+16	.3169625+16	.3065930+16	.2930428+16	.4750000+02
14	.2658947+16	.2630211+16	.2573224+16	.2488951+16	.2378833+16	.5050000+02
15	.2125895+16	.2102900+16	.2057299+16	.1989869+16	.1901772+16	.5350000+02
16	.1666458+16	.1648419+16	.1612652+16	.1559768+16	.1490689+16	.5650000+02
17	.1268976+16	.1255234+16	.1227986+16	.1187704+16	.1135096+16	.5950000+02
18	.9208422+15	.9108660+15	.8910864+15	.8618491+15	.8236742+15	.6250000+02
19	.6091047+15	.6025030+15	.5894145+15	.5700695+15	.5448154+15	.6550000+02
20	.3206712+15	.3171928+15	.3102966+15	.3001041+15	.2867987+15	.6850000+02

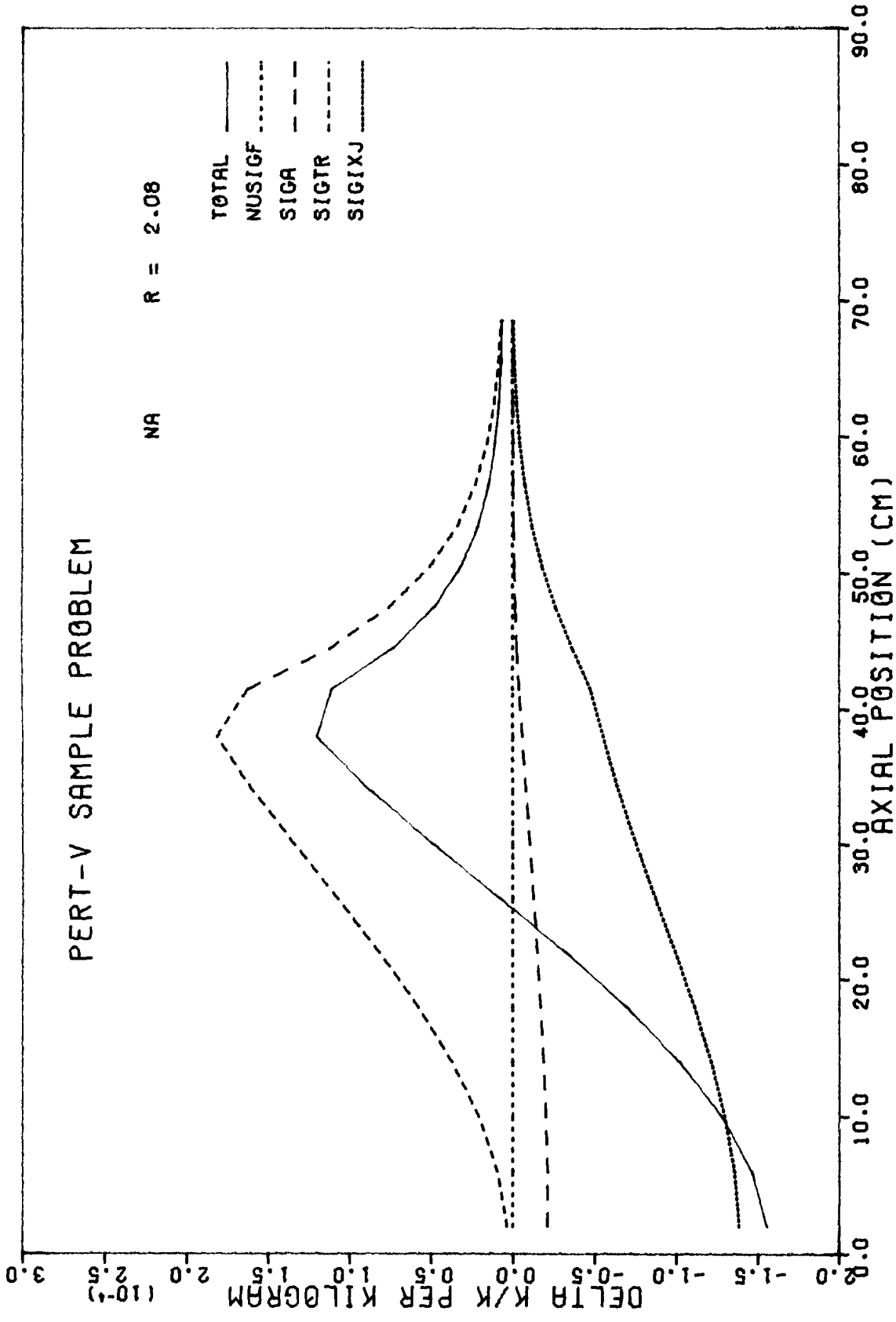
	6	7	8	9	10	
1	.8801023+16	.8201441+16	.7531146+16	.6803853+16	.6035722+16	.2000000+01
2	.8698051+16	.8105404+16	.7442867+16	.6723998+16	.5964776+16	.6000000+01
3	.8493656+16	.7914780+16	.7267635+16	.6565482+16	.5823933+16	.1000000+02
4	.8191014+16	.7632515+16	.7008155+16	.6330730+16	.5615322+16	.1400000+02
5	.7795010+16	.7263163+16	.6668593+16	.6023486+16	.5342224+16	.1800000+02
6	.7312449+16	.6813072+16	.6254766+16	.5648972+16	.5009212+16	.2200000+02
7	.6752404+16	.6290702+16	.5774442+16	.5214175+16	.4622394+16	.2600000+02
8	.6126772+16	.5707167+16	.5237844+16	.4728314+16	.4189848+16	.3000000+02
9	.5451183+16	.5077081+16	.4658455+16	.4203622+16	.3722381+16	.3400000+02
10	.4746461+16	.4419921+16	.4054283+16	.3656557+16	.3234809+16	.3800000+02
11	.4029621+16	.3751598+16	.3440063+16	.3100750+16	.2739964+16	.4150000+02
12	.3361086+16	.3128641+16	.2868070+16	.2584075+16	.2281775+16	.4450000+02
13	.2765452+16	.2573886+16	.2359139+16	.2125117+16	.1876164+16	.4750000+02
14	.2244777+16	.2089143+16	.1914746+16	.1724845+16	.1523181+16	.5050000+02
15	.1794547+16	.1670113+16	.1530772+16	.1379233+16	.1218666+16	.5350000+02
16	.1406637+16	.1309146+16	.1200071+16	.1081618+16	.9563932+15	.5650000+02
17	.1071109+16	.9969358+15	.9140247+15	.8241113+15	.7292552+15	.5950000+02
18	.7772586+15	.7234827+15	.6634230+15	.5983713+15	.5298603+15	.6250000+02
19	.5141181+15	.4785686+15	.4388910+15	.3959560+15	.3507944+15	.6550000+02
20	.2706272+15	.2519031+15	.2310116+15	.2084166+15	.1846671+15	.6850000+02

	11	12	13	14	15	
1	.5245938+16	.4457714+16	.3609341+16	.2801845+16	.2132239+16	.2000000+01
2	.5184167+16	.4405121+16	.3566649+16	.2768634+16	.2106932+16	.6000000+01

3	.5061527+16	.4300690+16	.3461863+16	.2702674+16	.2056672+16	.1000000+02
4	.4879838+16	.4145937+16	.3356184+16	.2604891+16	.1982177+16	.1400000+02
5	.4641899+16	.3943184+16	.3191438+16	.2476691+16	.1884538+16	.1800000+02
6	.4351587+16	.3695697+16	.2990095+16	.2319977+16	.1765246+16	.2200000+02
7	.4014043+16	.3407345+16	.2755282+16	.2137154+16	.1626232+16	.2600000+02
8	.3636017+16	.3083640+16	.2490698+16	.1931110+16	.1469932+16	.3000000+02
9	.3226544+16	.2731146+16	.2200107+16	.1705117+16	.1299425+16	.3400000+02
10	.2798367+16	.2358812+16	.1884930+16	.1462769+16	.1118885+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	.7351586+15	.5812520+15	.5050000+02
15	.1052832+16	.8863698+15	.7332599+15	.5978610+15	.4757279+15	.5350000+02
16	.8275060+15	.6986915+15	.5805679+15	.4758090+15	.3806410+15	.5650000+02
17	.6318933+15	.5348711+15	.4460250+15	.3670462+15	.2949088+15	.5950000+02
18	.4596850+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	17	18	19	20	
1	.1587745+16	.1147948+16	.7905658+15	.4940309+15	.2383388+15	.2000000+01
2	.1568891+16	.1134318+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	.1403330+16	.1014764+16	.6989872+15	.4368784+15	.2107632+15	.1800000+02
6	.1314665+16	.9508651+15	.6551438+15	.4095641+15	.1975972+15	.2200000+02
7	.1211542+16	.8767101+15	.6043652+15	.3779787+15	.1823862+15	.2600000+02
8	.1095982+16	.7938872+15	.5478086+15	.3428708+15	.1654987+15	.3000000+02
9	.9706383+15	.7044750+15	.4869633+15	.3051877+15	.1473966+15	.3400000+02
10	.8391007+15	.6111734+15	.4236877+15	.2660772+15	.1286306+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	.8491918+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	.2304068+15	.1734784+15	.1233767+15	.7888347+14	.3849608+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	.5725O7+16
2	.109327+04	.9507O5+15


PERT-V SAMPLE PROBLEM
PU239 Z = 2.00
PU239 Z = 18.00
DELTA K/K PER KILOGRAM (10-3)
RADIAL POSITION (CM)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0


PERT-V SAMPLE PROBLEM
NA R = 2.08
TOTAL
NUSIGF
SIGA
SIGTR
SIGIXJ
DELTA K/K PER KILOGRAM (10-4)
AXIAL POSITION (CM)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0

APPENDIX B

SOURCE DECK LISTING

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

```
-IL PDP  INCL                                                                  PERT0001
ABC*  FCOPY                                                                    PERT0002
      COMMON       NINP,   NOUT,   NCR1,   NSCR1,  NSCR2, NFLUX1, NFLUX2,    PERT0003
     1             DENOM,  ICARD,  IGEP,    IHA,    IHF,    IHG,    IHN,     PERT0004
     2               III,  IIJJ,   IJIGM,  IJMAX,  IMJM,     IP,   ITEMP,    PERT0005
     3            ITEMP1,  ITL,     JP,    NDIM,   NFP,   NFXIN,   NNCR,    PERT0006
     4              PI2,   TEMP,   TEMP1,   TSD                               PERT0007
      COMMON     ID(12),   ND,     ML,     NPRT,   IGM,    IST,    IHT,     PERT0008
     1            NDELK,   NACT,   NIBC,   IPG,    IPS,   NPDEL,   IGE,     PERT0009
     2              IM,    JM,     IZM,     MT,    M01,    B01,    B02,     PERT0010
     3             B03,    B04,    ZKEFF,  FLPO,   VF,    BUCK              PERT0011
      COMMON       LATW,   LHOLN,  LC0,    LN0,    LN1,    LA0,    LA1,     PERT0012
     1             LI0,    LI1,    LI2,    LI3,    LK6,    LM0,    LM2,     PERT0013
     2             LR1,    LR4,    LR5,    LV0,    LV7,    LZ1,    LZ4,     PERT0014
     3             LZ5,    LVOL,   LMASS,  LGAM,   LPOW,  LSORC1, LSORC2,   PERT0015
     4            LNBET,   LBETA,  LD7,    LAB,    LAL,   LZPHI,  LZPOW,    PERT0016
     5             LMA,    LNX,    LZACT,  LDEL,   LNCR,  LMATDK,  LCP,     PERT0017
     6             LCX,    LFLUX,  LADJF,   LX,     LY                       PERT0018
      INTEGER      B01,    B02,    B03,    B04                               PERT0019
      REAL          I2,     I3,     K6,     N0,     N1,    MASS              PERT0020
      END                                                                      PERT0021
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-ITC  FOR MAIN,MAIN                                                    PERT0022
C                                                                      PERT0023
C     * * * * *  DESCRIPTION OF SUBROUTINES  * * * * *                PERT0024
C                                                                      PERT0025
C    MAIN        CONTROLS THE OPERATION OF THE CODE.                   PERT0026
C                                                                      PERT0027
C    INP         CONTROLS THE READING AND PRINTING OF ALL INPUT DATA.  PERT0028
C                                                                      PERT0029
C    REAG2       READS FLOATING POINT DATA IN GENERALIZED FORMAT.      PERT0030
C                                                                      PERT0031
C    REAI2       READS INTEGER DATA IN GENERALIZED FORMAT.             PERT0032
C                                                                      PERT0033
C    CLEAR       SETS AN ARRAY OF A GIVEN LENGTH EQUAL TO A SPECIFIED  PERT0034
C                CONSTANT.                                             PERT0035
C                                                                      PERT0036
C    ERRO2       PRINTS ERROR MESSAGES.                                PERT0037
C                                                                      PERT0038
C    SWITCH      SWITCHS TAPE DESIGNATIONS.                            PERT0039
C                                                                      PERT0040
C    XSINP       READS CROSS SECTIONS (FROM CARDS OR TAPE), PERFORMS   PERT0041
C                ADJOINT REVERSALS IF REQUIRED, AND WRITES CROSS SECTIONS PERT0042
C                TO DRUM BY GROUP.                                     PERT0043
C                                                                      PERT0044
C    FXINP       READS FLUXES (FROM CARDS OR TAPE) AND WRITES THEM TO  PERT0045
C                DRUM BY GROUP.                                        PERT0046
C                                                                      PERT0047
C    MAPR        PRODUCES A PICTURE PRINT BY ZONE AND MATERIAL.        PERT0048
C                                                                      PERT0049
C    SETUP       MIXES CROSS SECTIONS AND CALCULATES GEOMETRIC PARAMETERS.PERT0050
C                                                                      PERT0051
C    PRT         PRINTS (IM,JM) ARRAYS.                                PERT0052
C                                                                      PERT0053
C    GRAM        CALCULATES AND PRINTS MATERIAL INVENTORIES BY ZONE.   PERT0054
C                                                                      PERT0055
C    NORM        CALCULATES KEFF AND NORMALIZES FLUXES.                PERT0056
C                                                                      PERT0057
C    ABETA       CALCULATES BETA EFFECTIVE AND THE GENERATION TIME.    PERT0058
C                                                                      PERT0059
C    SLOPE       COMPUTES (GRAD FLUX*GRAD ADJOINT)/SIGTR**2.           PERT0060
C                                                                      PERT0061
C    CALC        CALCULATES AND PRINTS REACTIVITY COEFFICIENTS FOR THE PERT0062
C                SPECIFIED ROW OR COLUMN.                              PERT0063
C                                                                      PERT0064
C    PLOT        PLOTS REACTIVITY COEFFICIENTS CALCULATED BY CALC.     PERT0065
C                                                                      PERT0066
C    ACT         CALCULATES ACTIVITY TRAVERSES.                        PERT0067
C                                                                      PERT0068
C     * * * * *  INTERNAL VARIABLES  * * * * *                        PERT0069
C                                                                      PERT0070
C     NINP           INPUT UNIT                                        PERT0071
C     NOUT           OUTPUT UNIT                                       PERT0072
C     NCR1           CROSS SECTION LOGICAL DRUM UNIT                   PERT0073
C     NSCR1          SCRATCH LOGICAL DRUM UNIT                         PERT0074
C     NSCR2          SCRATCH LOGICAL DRUM UNIT                         PERT0075
C     NFLUX1         FLUX LOGICAL DRUM UNIT                            PERT0076
C     NFLUX2         ADJOINT FLUX LOGICAL DRUM UNIT                    PERT0077
C     DENOM          DENOMINATOR OF PERT. EQUATION                     PERT0078
C     ICARD          = ML                                              PERT0079
C     IGEP           IGE + 1                                           PERT0080
C     IHA            POSITION OF SIGA                                  PERT0081
C     IHF            POSITION OF SIGF                                  PERT0082
C     IHG            POSITION OF SELF-SCATTER                          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     TSD             (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  (IFPERT0108
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     IZM             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     FLPO            NEG/POS=POWER (MWT)/TOTAL CENTER POINT FLUX             PERT0136
C     VF              VOLUME FACTOR                                           PERT0137
C     BUCK            BUCKLING  (CM-2)                                        PERT0138
C                                                                             PERT0139
C     * * * * *  SUBSCRIPTED VARIABLES  * * * * *                            PERT0140
C                                                                             PERT0141
C     AIW(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
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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(LHOLN),IM,JM,A(LM0),A(LM2),          PERT0198
      1          A(LV0),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(LV0),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
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40     CALL SLOPE(A(LNO),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(LNO),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)            I9/                                 PERT0256
     392H    ML       NEGATIVE/POSITIVE=NUMBER OF MATERIALS FROM TAPE/CARPERT0257
     4DS                           I9/                                 PERT0258
     592H  NPRT       PRINT OPTION  (0/1/2=MINI/MIDI/MAXI)              PERT0259
     6                             I9/                                 PERT0260
     792H   IGM       NUMBER OF ENERGY GROUPS                           PERT0261
     8                             I9/                                 PERT0262
     992H   IST       NUMBER OF DOWNSCATTERING TERMS                    PERT0263
     1                             I9/                                 PERT0264
     292H   IHT       POSITION OF TRANSPORT CROSS SECTION               PERT0265
     3                             I9)                                 PERT0266
      WRITE(NOUT,70)  NDELK, NACT, NIBC, IPG, IPS, NPDEL                PERT0267
70    FORMAT(                                                           PERT0268
     192H NDELK       NUMBER OF REACTIVITY COEFFICIENT CALCULATIONS     PERT0269
     2                             I9/                                 PERT0270
     592H  NACT       NUMBER OF ACTIVITY TRAVERSES                      PERT0271
     4                             I9/                                 PERT0272
     392H  NIBC       NUMBER OF MATERIALS FOR BETA EFFECTIVE CALCULATION PERT0273
     6                             I9/                                 PERT0274
     692H   IPG       NUMBER OF DELAYED NEUTRON GROUPS                  PERT0275
     6                             I9/                                 PERT0276
     792H   IPS       0/1=ONE DELAYED SPECTRUM/INPUT SPECTRUM FOR EACH GRPERT0277
     7OUP                          I9/                                 PERT0278
     892H NPDEL       0/1=NO EFFECT/PLOT REACTIVITY COEFFICIENTS         PERT0279
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     7                                    I9/)                            PERT0280
      WRITE(NOUT,80)  IGE, IM, JM, IZM, MT, M01                          PERT0281
 80   FORMAT(                                                              PERT0282
     192H   IGE      GEOMETRY  (0/1/2/3=PL/CYL/SPH IF 1-D, X-Y/R-Z/R-THEPERT0283
     2TA/TRIANGULAR IF 2-D)           I9/                                 PERT0284
     392H    IM      NUMBER OF RADIAL INTERVALS                           PERT0285
     4                                I9/                                 PERT0286
     592H    JM      NUMBER OF AXIAL INTERVALS  (=1 FOR 1-D PROBLEMS)     PERT0287
     6                                I9/                                 PERT0288
     192H   IZM      NUMBER OF MATERIAL ZONES                             PERT0289
     8                                I9/                                 PERT0290
     992H    MT      TOTAL NUMBER OF MATERIALS INCLUDING MIXES            PERT0291
     1                                I9/                                 PERT0292
     292H   M01      NUMBER OF MIXTURE SPECIFICATIONS                     PERT0293
     3                                I9)                                 PERT0294
      WRITE(NOUT,90)  B01, B02, B03, B04                                  PERT0295
 0    FORMAT(                                                              PERT0296
     192H   B01      LEFT   BOUNDARY CONDITION  (0/1/2=VACUUM/REFLECTIVEPERT0297
     2/PERIODIC)                      I9/                                 PERT0298
     392H   B02      RIGHT  BOUNDARY CONDITION  (0/1/2=VACUUM/REFLECTIVEPERT0299
     2/PERIODIC)                      I9/                                 PERT0300
     592H   B03      TOP    BOUNDARY CONDITION  (0/1/2=VACUUM/REFLECTIVEPERT0301
     2/PERIODIC)                      I9/                                 PERT0302
     792H   B04      BOTTOM BOUNDARY CONDITION  (0/1/2=VACUUM/REFLECTIVEPERT0303
     2/PERIODIC)                      I9/)                                PERT0304
      WRITE(NOUT,100)  ZKEFF, FLPO, VF, BUCK                              PERT0305
 100  FORMAT(                                                              PERT0306
     191H ZKEFF      KEFF FOR PERT. EQUATION  (IF ZERO, USE CALCULATED VPERT0307
     2ALUE)                          1PE10.4/                             PERT0308
     391H  FLPO      NEGATIVE/POSITIVE=POWER (MWT)/TOTAL CENTER POINT FLPERT0309
     4UX                             1PE10.4/                             PERT0310
     591H    VF      VOLUME FACTOR                                        PERT0311
     6                               1PE10.4/                             PERT0312
     791H  BUCK      BUCKLING (CM-2)                                      PERT0313
     8                               1PE10.4/)                            PERT0314
      IGP = IGM + 1                                                        PERT0315
      IHG = IHT + 1                                                        PERT0316
      ITL = IHG + IST                                                      PERT0317
      IHN = IHT - 1                                                        PERT0318
      IHA = IHT - 2                                                        PERT0319
      IHF = IHT - 3                                                        PERT0320
      ICARD = ML                                                           PERT0321
      ML = IABS(ML)                                                        PERT0322
      PI2 = 6.28318                                                        PERT0323
      IGEP = IGE + 1                                                       PERT0324
      TSD = 215.*1.602*10.**(-19)                                          PERT0325
      IF(FLPO)  120,120,130                                                PERT0326
 120  NFP = 2                                                              PERT0327
      GO TO 140                                                            PERT0328
 130  NFP = 1                                                              PERT0329
 140  FLPO = ABS(FLPO)                                                     PERT0330
      ITEMP = IABS(ND)                                                     PERT0331
      GO TO (150,160,150,160), ITEMP                                       PERT0332
 150  NDIM = 1                                                             PERT0333
      JM = 1                                                               PERT0334
      GO TO 170                                                            PERT0335
 160  NDIM = 2                                                             PERT0336
 170  IP = IM + 1                                                          PERT0337
      JP = JM + 1                                                          PERT0338
      IMJM = IM*JM                                                         PERT0339
      IJIGM = IMJM*IGM                                                     PERT0340
      IJMAX = MAX0(IM,JM)                                                  PERT0341
```

```
C     SET UP DIMENSION POINTERS                                          PERT0342
      LATW = 1                                                           PERT0343
      LHOLN = LATW + ML                                                  PERT0344
      LC0 = LHOLN + ML                                                   PERT0345
      LN0 = LC0 + ITL*MT                                                 PERT0346
      LN1 = LN0 + IMJM                                                   PERT0347
      LA0 = LN1 + IMJM                                                   PERT0348
      LA1 = LA0 + IP                                                     PERT0349
      LI0 = LA1 + IM                                                     PERT0350
      LI1 = LI0 + M01                                                    PERT0351
      LI2 = LI1 + M01                                                    PERT0352
      LI3 = LI2 + M01                                                    PERT0353
      LK6 = LI3 + M01                                                    PERT0354
      LM0 = LK6 + IGM                                                    PERT0355
      LM2 = LM0 + IMJM                                                   PERT0356
      LR1 = LM2 + IZM                                                    PERT0357
      LR4 = LR1 + IP                                                     PERT0358
      LR5 = LR4 + IM                                                     PERT0359
      LV0 = LR5 + IM                                                     PERT0360
      LV7 = LV0 + IMJM                                                   PERT0361
      LZ1 = LV7 + IGM                                                    PERT0362
      LZ4 = LZ1 + JP                                                     PERT0363
      LZ5 = LZ4 + JM                                                     PERT0364
      LVOL = LZ5 + JM                                                    PERT0365
      LMASS = LVOL + IZM                                                 PERT0366
      LGAM = LMASS + ML*IZM                                              PERT0367
      LPOW = LGAM + IZM                                                  PERT0368
      LSORC1 = LPOW + IMJM                                               PERT0369
      LSORC2 = LSORC1 + IMJM                                             PERT0370
      LNBET = LSORC2 + IMJM                                              PERT0371
      LBETA = LNBET + NIBC                                               PERT0372
      LD7 = LBETA + NIBC                                                 PERT0373
      LAB = LD7 + IGM*IPG                                                PERT0374
      LAL = LAB + NIBC*IPG                                               PERT0375
      LZPHI = LAL + IPG                                                  PERT0376
      LZPOW = LZPHI + IZM                                                PERT0377
      LMA = LZPOW + IZM                                                  PERT0378
      LNX = LMA + NACT                                                   PERT0379
      LZACT = LNX + NACT                                                 PERT0380
      LDEL = LZACT + IZM                                                 PERT0381
      LNCR = LDEL + IMJM                                                 PERT0382
      LMATDK = LNCR + NDELK                                              PERT0383
      LCP = LMATDK + NDELK                                               PERT0384
      LCX = LCP + 5*IJMAX                                                PERT0385
      LFLUX = LCX + ITL*IGM                                              PERT0386
      LADJF = LFLUX + IGM*IJMAX                                          PERT0387
      LX = LADJF + IGM*IJMAX                                             PERT0388
      LY = LX + (IJMAX+2)*NPDEL                                          PERT0389
      LAST = LY + (IJMAX+2)*NPDEL                                        PERT0390
      ITEMP = 1 + 2*ML + IGP*ITL*MT                                      PERT0391
      LAST = MAX0(LAST,ITEMP)                                            PERT0392
      WRITE(NOUT,190)  LAST                                              PERT0393
190   FORMAT(7H LAST =,I6)                                               PERT0394
      IF(LAST - 35000)  196,196,192                                      PERT0395
192   CALL ERRO2(6H   INP,192,1)                                         PERT0396
C     READ CROSS SECTIONS, PERFORM ADJOINT REVERSALS, AND WRITE XS DATA  PERT0397
C     TO DRUM (BY GROUP)                                                 PERT0398
196   CALL XSINP(A(LN0),ITL,IGM,MT,A(LATW),A(LHOLN))                     PERT0399
      DO 200  I=LC0,LAST                                                 PERT0400
200   A(I) = 0.0                                                         PERT0401
C     READ FLUXES AND WRITE FLUXES TO DRUM                               PERT0402
      CALL FXINP(A(LN0))                                                 PERT0403
```

```
      WRITE(NOUT,250)                                                   PERT0404
  250 FORMAT(16HOMESH 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(30HOZONE NUMBERS BY MESH INTERVAL)                         PERT0410
      CALL REAI2(6H    M0,A(LM0),IMJM)                                  PERT0411
      WRITE(NOUT,290)                                                   PERT0412
  290 FORMAT(25HOMATERIAL NUMBERS BY ZONE)                              PERT0413
      CALL REAI2(6H    M2,A(LM2),IZM)                                   PERT0414
      IF(BUCK)  295,305,295                                             PERT0415
  295 WRITE(NOUT,300)                                                   PERT0416
  300 FORMAT(27HOBUCKLING MODIFIERS BY ZONE)                            PERT0417
      CALL REAG2(6H   GAM,A(LGAM),IZM)                                  PERT0418
  305 WRITE(NOUT,310)                                                   PERT0419
  310 FORMAT(17HOFISSION SPECTRUM)                                      PERT0420
      CALL REAG2(6H    K6,A(LK6),IGM)                                   PERT0421
      WRITE(NOUT,320)                                                   PERT0422
  320 FORMAT(19HONEUTRON VELOCITIES)                                    PERT0423
      CALL REAG2(6H    V7,A(LV7),IGM)                                   PERT0424
      IF(M01)  350,350,330                                              PERT0425
  330 WRITE(NOUT,340)                                                   PERT0426
  340 FORMAT(83HOMIXTURE SPECIFICATIONS  (I0/I1/I2=MIX NUMBER/MAT. NUMBEPERT0427
     1R FOR MIX/MATERIAL DENSITY))                                      PERT0428
      CALL REAI2(6H    I0,A(LI0),M01)                                   PERT0429
      CALL REAI2(6H    I1,A(LI1),M01)                                   PERT0430
      CALL REAG2(6H    I2,A(LI2),M01)                                   PERT0431
  350 IF(NIBC)  400,400,360                                             PERT0432
  360 WRITE(NOUT,370)                                                   PERT0433
  370 FORMAT(48HOMATERIAL NUMBERS FOR BETA EFFECTIVE CALCULATION)       PERT0434
      CALL REAI2(6H  NBET,A(LNBET),NIBC)                                PERT0435
      WRITE(NOUT,380)                                                   PERT0436
  380 FORMAT(63HOABSOLUTE NEUTRON YIELD PER DELAYED FISSION FOR ABOVE MAPERT0437
     1TERIALS)                                                          PERT0438
      CALL REAG2(6H  BETA,A(LBETA),NIBC)                                PERT0439
      DO 384 K=1,NIBC                                                   PERT0440
      WRITE (NOUT,382) K                                                PERT0441
  382 FORMAT (46HOFRACTIONAL YIELDS BY GROUP FOR DELAY MATERIAL, I6)    PERT0442
      KK = (K-1)*IPG + LAB                                              PERT0443
      CALL REAG2 (6H    AB, A(KK), IPG)                                 PERT0444
  384 CONTINUE                                                          PERT0445
      WRITE (NOUT,385)                                                  PERT0446
  385 FORMAT (23HODECAY CONSTANTS(SEC-1))                               PERT0447
      CALL REAG2 (6H    AL, A(LAL), IPG)                                PERT0448
      IF (IPS) 386,389,386                                              PERT0449
  386 DO 388 K=1,IPG                                                    PERT0450
      WRITE (NOUT,387) K                                                PERT0451
  387 FORMAT (45HODELAYED NEUTRON SPECTRUM FOR PRECURSOR GROUP, I6)     PERT0452
      KK = (K-1)*IGM + LD7                                              PERT0453
      CALL REAG2 (6H    D7, A(KK), IGM)                                 PERT0454
  388 CONTINUE                                                          PERT0455
      GO TO 400                                                         PERT0456
  389 WRITE(NOUT,390)                                                   PERT0457
  390 FORMAT(25HODELAYED FISSION SPECTRUM)                              PERT0458
      CALL REAG2(6H    D7,A(LD7),IGM)                                   PERT0459
      IF (IPG - 1) 400,400,392                                          PERT0460
  392 DO 394 K=2,IPG                                                    PERT0461
      DO 394 I = 1,IGM                                                  PERT0462
      KK = LD7 + (K-1)*IGM + I - 1                                      PERT0463
      KKK = LD7 + I - 1                                                 PERT0464
  394 A(KK) = A(KKK)                                                    PERT0465
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```
400   IF(NDELK)  440,440,410                                                PERT0466
410   WRITE(NOUT,420)                                                       PERT0467
420   FORMAT(43HOMATERIAL 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(53HONEG/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(40HOMATERIAL NUMBERS FOR ACTIVITY TRAVERSES)                   PERT0476
      CALL REAI2(6H    MA,A(LMA),NACT)                                      PERT0477
      WRITE(NOUT,470)                                                       PERT0478
470   FORMAT(46HOCROSS SECTION POSITION FOR ACTIVITY TRAVERSES)             PERT0479
      CALL REAI2(6H    NX,A(LNX),NACT)                                      PERT0480
480   RETURN                                                                PERT0481
      END                                                                   PERT0482
```

```
-IT  FOR REAG2,REAG2                                                    PERT0483
      SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)                               PERT0484
      DIMENSION ARRAY(10),V(12),K(12),IN(12)                            PERT0485
      COMMON          NINP, NOUT, NCR1, NSCR1, NSCR2, NFLUX1, NFLUX2    PERT0486
      JFLAG=0                                                           PERT0487
      J=1                                                               PERT0488
10    IF(JFLAG)20,40,20                                                 PERT0489
20    DO 30 JJ=1,6                                                      PERT0490
      K(JJ)=K(JJ+6)                                                     PERT0491
      IN(JJ)=IN(JJ+6)                                                   PERT0492
30    V(JJ)=V(JJ+6)                                                     PERT0493
      JFLAG=0                                                           PERT0494
      GO TO 60                                                          PERT0495
40    READ (NINP,50)        (K(I),IN(I),V(I),I=1,6)                     PERT0496
50    FORMAT(6(I1,I2,E9.4))                                             PERT0497
60    DO 140 I=1,6                                                      PERT0498
      L=K(I)+1                                                          PERT0499
      GO TO (70,80,100,150,132,140,62), L                               PERT0500
C     FILL                                                              PERT0501
62    JJ=J                                                              PERT0502
      DO 65  M=JJ,NCOUNT                                                PERT0503
      ARRAY(J) = V(I)                                                   PERT0504
65    J=J+1                                                             PERT0505
      GO TO 150                                                         PERT0506
C     NO MODIFICATION                                                   PERT0507
70    ARRAY(J)=V(I)                                                     PERT0508
      J=J+1                                                             PERT0509
      GO TO 140                                                         PERT0510
C     REPEAT                                                            PERT0511
80    L=IN(I)                                                           PERT0512
      DO 90 M=1,L                                                       PERT0513
      ARRAY(J)=V(I)                                                     PERT0514
      J=J+1                                                             PERT0515
90    CONTINUE                                                          PERT0516
      GO TO 140                                                         PERT0517
C     INTERPOLATE                                                       PERT0518
100   IF(I-6) 120,110,110                                               PERT0519
110   READ (NINP,50)        (K(JJ),IN(JJ),V(JJ),JJ=7,12)                PERT0520
      JFLAG=1                                                           PERT0521
120   L=IN(I)+1                                                         PERT0522
      DEL=(V(I+1)-V(I))/FLOAT (L)                                       PERT0523
      DO 130 M=1,L                                                      PERT0524
      ARRAY(J)=V(I)+DEL*FLOAT (M-1)                                     PERT0525
      J=J+1                                                             PERT0526
130   CONTINUE                                                          PERT0527
      GO TO 140                                                         PERT0528
C     CYCLE                                                             PERT0529
132   L=IN(I)                                                           PERT0530
      N=INT(.00001+V(I))                                                PERT0531
      DO 135  LL=1,L                                                    PERT0532
      DO 135  NN=1,N                                                    PERT0533
      ARRAY(J) = ARRAY(J-N)                                             PERT0534
135   J=J+1                                                             PERT0535
140   CONTINUE                                                          PERT0536
      GO TO 10                                                          PERT0537
C     TERMINATE                                                         PERT0538
150   J=J-1                                                             PERT0539
      WRITE (NOUT,160)        HOLL,J      ,( ARRAY(I),I=1,J)            PERT0540
      IF(J  -NCOUNT)170,180,170                                         PERT0541
160   FORMAT(6X,A6,I6/(10E12.5))                                        PERT0542
170   CALL ERRO2( 6H**REAG,170,1)                                       PERT0543
180   RETURN                                                            PERT0544
```

```
-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                                                          PERT0554
      GO TO (30,40,52,80,62,70,22), L
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
```

```
-IT FOR  CLEAR,CLEAR                                                    PERT0592
      SUBROUTINE CLEAR (X,Y,N)                                          PERT0593
      DIMENSION Y(1)                                                    PERT0594
      DO 1 I=1,N                                                        PERT0595
1     Y(I)=X                                                            PERT0596
      RETURN                                                            PERT0597
      END                                                               PERT0598
                                                                        -
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```
-IT FOR  ERRO2,ERRO2                                                    PERT0599
      SUBROUTINE ERRO2( HOL,JSUBR,I)                                    PERT0600
      COMMON          NINP, NOUT, NCR1, NSCR1, NSCR2, NFLUX1, NFLUX2    PERT0601
      WRITE (NOUT,1)            HOL,JSUBR                               PERT0602
1     FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)                    PERT0603
      GO TO (3,4),I                                                     PERT0604
3     CALL EXIT                                                         PERT0605
4     RETURN                                                            PERT0606
      END                                                               PERT0607
```

```
-IT  FOR    SWITCH,SWITCH                                          PERT0608
      SUBROUTINE SWITCH(ITEMP1,ITEMP2)                             PERT0609
C     THIS SUBROUTINE SWITCHS TAPE DESIGNATIONS                    PERT0610
      ITEMP3 = ITEMP1                                              PERT0611
      ITEMP1 = ITEMP2                                              PERT0612
      ITEMP2 = ITEMP3                                              PERT0613
      RETURN                                                       PERT0614
      END                                                          PERT0615
```

```
-ITC FOR   XSINP,XSINP                                                    PERT0616
      SUBROUTINE XSINP(C,JTL,JGM,JMT,ATW,HOLN)                            PERT0617
      DIMENSION  C(JTL,JGM,JMT), ATW(1), HOLN(1)                          PERT0618
C     C(JTL,JGM,JMT)   CROSS SECTION ARRAY STORED STARTING AT A(LN0)      PERT0619
      INCLUDE ABC                                                         PERT0620
      DIMENSION AA(10)                                                    PERT0621
C     THIS SUBROUTINE READS (FROM TAPE OR CARDS), CHECKS, AND WRITES      PERT0622
C     INPUT CROSS SECTIONS TO DRUM.                                       PERT0623
      WRITE(NOUT,5)   (ID(I), I=1,12)                                     PERT0624
5     FORMAT(1H1,12A6,///)                                                PERT0625
      WRITE(NOUT,10)                                                      PERT0626
10    FORMAT(56H CROSS SECTIONS WERE READ IN FOR THE FOLLOWING MATERIALSPERT0627
     1/)                                                                  PERT0628
      DO 50  I=1,ML                                                       PERT0629
      READ(NINP, 20)  HOLN(I), ATW(I), (AA(J), J=1,10)                    PERT0630
20    FORMAT(A6, E6.2, 10A6)                                              PERT0631
      IF(ICARD)  25,25,30                                                 PERT0632
25    READ(15)  ((C(L,IIG,I), L=1,ITL), IIG=1,IGM)                        PERT0633
      GO TO 50                                                            PERT0634
30    DO 35  IIG=1,IGM                                                    PERT0635
35    READ(NINP,40)    (C(L,IIG,I), L=1,ITL)                              PERT0636
40    FORMAT(6E12.5)                                                      PERT0637
50    WRITE(NOUT, 60)  I, HOLN(I), (AA(J), J=2,10)                        PERT0638
60    FORMAT(I3, 6X, A6, 6X, 10A6)                                        PERT0639
      IF(ICARD)  70,80,80                                                 PERT0640
70    REWIND 15                                                           PERT0641
C     CHECK ON CROSS SECTION CONSISTENCY AND ORDER                        PERT0642
80    ITEMP = 0                                                           PERT0643
      DO 140  I=1,ML                                                      PERT0644
      DO 140  IIG=1,IGM                                                   PERT0645
      TEMP = C(IHA,IIG,I) + C(IHG,IIG,I)                                  PERT0646
      DO 110  K=1,IST                                                     PERT0647
      KK = IIG + K                                                        PERT0648
      M = IHG + K                                                         PERT0649
      IF(KK - IGM)  100, 100, 110                                         PERT0650
100   TEMP = TEMP + C(M,KK,I)                                             PERT0651
110   CONTINUE                                                            PERT0652
      IF(ABS((TEMP - C(IHT,IIG,I))/C(IHT,IIG,I)) - .01)  135, 120, 120    PERT0653
120   ITEMP = 1                                                           PERT0654
      GO TO 138                                                           PERT0655
130   FORMAT(1H /,16H CHECK MATERIAL I2,5X, 7H GROUP I2)                  PERT0656
135   IF(ABS((TEMP - C(IHT,IIG,I))/C(IHT,IIG,I)) - .0001)  140, 138, 138PERT0657
138   WRITE(NOUT,130)  I, IIG                                             PERT0658
140   CONTINUE                                                            PERT0659
      IF(ITEMP)  160, 160, 150                                            PERT0660
150   CALL EXIT                                                           PERT0661
C     WRITE CROSS SECTION TAPE                                            PERT0662
160   DO 300  IIG=1,IGM                                                   PERT0663
300   WRITE(NCR1)  ((C(L,IIG,M), L=1,ITL), M=1,MT)                        PERT0664
      REWIND NCR1                                                         PERT0665
      RETURN                                                              PERT0666
      END                                                                 PERT0667
```

```
-ITC FOR EXINP,EXINP                                                          PERT0668
      SUBROUTINE EXINP(NO)                                                    PERT0669
      DIMENSION  NO(1)                                                        PERT0670
      INCLUDE ABC                                                             PERT0671
C     THIS SUBROUTINE READS (FROM TAPE OR CARDS) INPUT FLUXES AND WRITES      PERT0672
C     THEM TO DRUV.                                                           PERT0673
      ITEMP = IABS(ND)                                                        PERT0674
      ITEMP1 = 0                                                              PERT0675
      IF(NPRT-2) 100, 40, 40                                                  PERT0676
40    WRITE(NOUT,50)                                                          PERT0677
50    FORMAT(13HOINPUT 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    NO,I6)                                                  PERT0682
      GO TO 100                                                               PERT0683
80    WRITE(NOUT,90)   IJIGM                                                  PERT0684
90    FORMAT(6X,6H    N1,I6)                                                  PERT0685
100   DO 180   IIG=1,IGM                                                     PERT0686
      IF(ND) 110, 110, 120                                                    PERT0687
110   READ(NFXIN)  (NO(I), I=1,IMJM)                                          PERT0688
      GO TO 135                                                               PERT0689
120   READ(NINP,130)  (NO(I), I=1,IMJM)                                       PERT0690
130   FORMAT(6E12.5)                                                          PERT0691
135   IF(NPRT-2)  180, 140, 140                                               PERT0692
140   WRITE(NOUT,150) (NO(I), I=1,IMJM)                                       PERT0693
150   FORMAT(10E12.5)                                                         PERT0694
180   WRITE(NFLUX1)   (NO(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)  (NO(I), I=1,IMJM)                                         PERT0700
      BACKSPACE NFLUX1                                                        PERT0701
340   WRITE(NFLUX2) (NO(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,5,1)                                                   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 M0(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
```

```
-ITC FOR  SETUP,SETUP                                                    PERT0742
      SUBROUTINE SETUP(K6, I0, I1, I2, M0, M2, N0, R1, R4, R5, Z1, Z4,   PERT0743
     1                 Z5, A0, A1, C0, V0, JTL, JIM, JJM, JMT, GAM)      PERT0744
      INCLUDE ABC                                                        PERT0745
      DIMENSION  K6(1), I0(1), I1(1), I2(1), R1(1), R4(1), R5(1), Z1(1),PERT0746
     1           Z4(1), Z5(1), A0(1), A1(1), C0(JTL,JMT), V0(JIM,JJM),   PERT0747
     2           M0(1), M2(1), N0(1), GAM(1)                             PERT0748
C     MIX CROSS-SECTIONS                                                 PERT0749
      IF(M01)  70, 70, 60                                                PERT0750
60    WRITE(NOUT, 65 )  (J, I0(J), I1(J), I2(J), J = 1, M01)             PERT0751
65    FORMAT(1H1,3X, 16H MIXTURE NUMBER ,18H   MIX COMMAND       ,       PERT0752
     124H MATERIAL ATOMIC DENSITY//(I4,1X,I8,8X,I8,8X,E20.8))            PERT0753
70    IF(NPRT-1)  85,75,75                                               PERT0754
75    WRITE (NOUT,80 )                                                   PERT0755
80    FORMAT(/19H1CROSS-SECTION EDIT)                                    PERT0756
85    REWIND NCR1                                                        PERT0757
      DO 180  IIG=1,IGM                                                  PERT0758
      READ (NCR1)    ((C0(I,J),I=1,ITL),J=1,MT)                          PERT0759
      IF(M01) 90, 145, 90                                                PERT0760
90    DO 140  M=1,M01                                                    PERT0761
      IF(I0(M)-MT) 100, 100, 95                                          PERT0762
95    CALL ERRO2(6H SETUP,95,1)                                          PERT0763
100   IF(I1(M)-MT) 105, 105, 95                                          PERT0764
105   N=I0(M)                                                            PERT0765
      L=I1(M)                                                            PERT0766
      E01=I2(M)                                                          PERT0767
      DO 140  I=1,ITL                                                    PERT0768
      IF (L) 130, 135, 130                                               PERT0769
130   C0(I,N)=C0(I,N)+C0(I,L)*E01                                        PERT0770
      GO TO 140                                                          PERT0771
135   C0(I,N)=C0(I,N)*E01                                                PERT0772
140   CONTINUE                                                           PERT0773
145   IF(NPRT-1)  175,155,155                                            PERT0774
155   IF(IHT - 4)  161,156,161                                           PERT0775
156   WRITE (NOUT,160 )  IIG                                             PERT0776
160   FORMAT(6HOGROUP,I3,  84H   SIGF        SIGA       NUSIGF      SIGTR  PERT0777
     1     GXG        G-1XG       G-2XG       . . .)                    PERT0778
      GO TO 164                                                          PERT0779
161   WRITE(NOUT,163)  IIG                                               PERT0780
163   FORMAT(6HOGROUP,I3)                                                PERT0781
164   DO 165  N=1,MT                                                     PERT0782
165   WRITE (NOUT,170 )            N,(C0(I,N),I=1,ITL)                   PERT0783
170   FORMAT(4H MAT,I3,10E11.5/(7X,10E11.5))                             PERT0784
175   WRITE (NSCR1)    ((C0(I,J),I=1,ITL),J=1,MT)                        PERT0785
180   CONTINUE                                                           PERT0786
      REWIND NCR1                                                        PERT0787
      REWIND NSCR1                                                       PERT0788
      CALL SWITCH(NCR1,NSCR1)                                            PERT0789
      IF(BUCK)  200, 245, 200                                            PERT0790
200   TEMP = BUCK                                                        PERT0791
220   DO 240   IIG=1,IGM                                                 PERT0792
      READ(NCR1)  ((C0(I,J), I=1,ITL),J=1,MT)                            PERT0793
      DO 235  MTZ = 1,MT                                                 PERT0794
      DO 230   KZ=1,IZM                                                  PERT0795
      IF(M2(KZ) - MTZ)  230, 225, 230                                    PERT0796
225   TEMP1 = (TEMP*GAM(KZ))/(3.*C0(4,MTZ))                              PERT0797
      C0(2,MTZ) = C0(2,MTZ) + TEMP1                                      PERT0798
      C0(5,MTZ) = C0(5,MTZ) - TEMP1                                      PERT0799
      GO TO 235                                                          PERT0800
230   CONTINUE                                                           PERT0801
235   CONTINUE                                                           PERT0802
      WRITE(NSCR1)   ((C0(I,J), I=1,ITL),J=1,MT)                         PERT0803
```

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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
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```
570     CONTINUE                                                PERT0866
580     CONTINUE                                                PERT0867
        RETURN                                                  PERT0868
        END                                                     PERT0869
```

```
-IT FOR  PRT,PRT                                                    PERT0870
      SUBROUTINE PRT (JIM,JJM, N2, Z4, NOUT)                        PERT0871
      DIMENSION N2(JIM,JJM), Z4(1)                                  PERT0872
      REAL N2                                                       PERT0873
C     THIS SUBROUTINE PRINTS (IM,JM) ARRAYS                         PERT0874
      IM = JIM                                                      PERT0875
      JM = JJM                                                      PERT0876
      DO 50  I=1,IM,5                                               PERT0877
      I1=I                                                          PERT0878
      I2=I+4                                                        PERT0879
      IF(I2-IM) 20, 20, 10                                          PERT0880
10    I2=IM                                                         PERT0881
20    WRITE ( NOUT,30 ) ( JJ,JJ=I1,I2)                             PERT0882
30    FORMAT( 5I20)                                                 PERT0883
      DO 50  JJ=1,JM                                                PERT0884
      J=JJ                                                          PERT0885
40    FORMAT(I5,E15.7,5E20.7)                                       PERT0886
50    WRITE(NOUT,40 ) J,(N2(K,J),K=I1,I2),Z4(J)                     PERT0887
      RETURN                                                        PERT0888
      END                                                           PERT0889
```

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-ITC  FOR  GRAM,GRAM                                                    PERT0890
      SUBROUTINE GRAM(MASS, VOL,  ATW, HOLN,JIM,JJM, MO, M2, V0,        PERT0891
     1                  IO, I1, I2,JML, I3)                           PERT0892
      INCLUDE ABC                                                       PERT0893
      DIMENSION MASS(JML,1), VOL(1), ATW(1), HOLN(1), MO(JIM,JJM),      PERT0894
     1          M2(1), V0(JIM,JJM), IO(1), I1(1), I2(1), I3(1)         PERT0895
C     THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS      PERT0896
      EV = 1.0                                                          PERT0897
      WRITE(NOUT,10) (ID(I), I=1,11)                                    PERT0898
10    FORMAT(1H1,11A6///)                                               PERT0899
      WRITE(NOUT, 20)                                                   PERT0900
20    FORMAT(45H MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE /  )      PERT0901
      CALL CLEAR(0.0,VOL,IZM)                                           PERT0902
      ITEMP = ML*IZM                                                    PERT0903
      CALL CLEAR(0.0,MASS,ITEMP)                                        PERT0904
      DO 30  J = 1, JM                                                  PERT0905
      DO 30  I = 1, IM                                                  PERT0906
      K = MO(I,J)                                                       PERT0907
30    VOL(K) = VOL(K) + V0(I, J)*.001                                   PERT0908
      DO 39  M=1,M01                                                    PERT0909
      I3(M) = I2(M)                                                     PERT0910
      IF(IO(M) - I1(M))  39,35,39                                       PERT0911
35    IF(I2(M))  39,36,39                                               PERT0912
36    DO 38  MM=1,M                                                     PERT0913
      IF(IO(M) - IO(MM))  38,37,38                                      PERT0914
37    I3(MM) = I2(MM)*EV                                                PERT0915
38    CONTINUE                                                          PERT0916
39    CONTINUE                                                          PERT0917
      DO 190 N =1, IZM                                                  PERT0918
      NN = M2(N)                                                        PERT0919
      DO 190 M = 1,M01                                                  PERT0920
      IF(IO(M) - NN)   190, 40, 190                                     PERT0921
40    L = I1(M)                                                         PERT0922
      IF(L - ML)  170, 170, 50                                          PERT0923
50    NNAA = L                                                          PERT0924
      IF(L - IO(M))  130,190, 130                                       PERT0925
130   DO 160 MAA = 1, M01                                               PERT0926
      IF(IO(MAA) - NNAA)  160, 140, 160                                 PERT0927
140   L = I1(MAA)                                                       PERT0928
      IF(L)  160, 160, 150                                              PERT0929
150   E01 = I3(MAA)*I3(M)                                               PERT0930
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/.6023) + MASS(L,N)               PERT0931
160   CONTINUE                                                          PERT0932
      GO TO 190                                                         PERT0933
170   IF(L)  190, 190, 180                                              PERT0934
180   E01 = I3(M)                                                       PERT0935
      MASS(L,N) = ((E01*ATW(L)*VOL(N))/.6023) + MASS(L,N)               PERT0936
190   CONTINUE                                                          PERT0937
      DATA   ZONE/6H ZONE /                                             PERT0938
      DO 260 L = 1, IZM, 5                                              PERT0939
      LL = L + 4                                                        PERT0940
      IF(LL - IZM) 210, 210, 200                                        PERT0941
200   LL = IZM                                                          PERT0942
210   WRITE(NOUT,220)  ((ZONE, K), K=L, LL)                             PERT0943
220   FORMAT(//26H   MATERIAL   ATOMIC WT.  ,3X, 5(A6,I2,12X))          PERT0944
      WRITE(NOUT,230)  (VOL(K), K = L, LL)                              PERT0945
230   FORMAT(25X, 5(E8.3, 7H LITERS, 5X))                               PERT0946
      DO 240 K = 1, ML                                                  PERT0947
240   WRITE(NOUT,250)  K, HOLN(K), ATW(K), (MASS(K, I), I = L, LL)      PERT0948
250   FORMAT( I3,1X, A6, F13.3, 1X, 1PE13.3, 1P4E20.3)                  PERT0949
      IF(LL - IZM)  260, 270, 270                                       PERT0950
260   CONTINUE                                                          PERT0951
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270   RETURN
      END
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PERT0952
PERT0953

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-ITC FOR NORM,NORM                                                      PERT0954
      SUBROUTINE NORM(C0,JTL,N0,N1,JIM,SORC1,SORC2,M0,M2,V0,K6,POW,     PERT0955
     1               Z5,A0,R5,R4,A1,Z4,ZPHI,ZPOW,VOL)                   PERT0956
      DIMENSION  C0(JTL,1), N0(JIM,1), N1(JIM,1), SORC1(JIM,1),         PERT0957
     1           SORC2(JIM,1), M0(JIM,1), M2(1), V0(JIM,1), K6(1),     PERT0958
     2           POW(JIM,1), Z5(1), A0(1), R5(1), R4(1), A1(1), Z4(1), PERT0959
     3           ZPHI(1), ZPOW(1), VOL(1)                              PERT0960
      INCLUDE ABC                                                       PERT0961
C     THIS SUBROUTINE NORMALIZES THE FLUXES (REGULAR AND ADJOINT)       PERT0962
      CFX = 0.0                                                         PERT0963
      POWER = 0.0                                                       PERT0964
      DENOM = 0.0                                                       PERT0965
      RL = 0.0                                                          PERT0966
      RABS = 0.0                                                        PERT0967
      RSORS = 0.0                                                       PERT0968
      CALL CLEAR(0.0,SORC1,IMJM)                                        PERT0969
      CALL CLEAR(0.0,SORC2,IMJM)                                        PERT0970
      CALL CLEAR(0.0,POW,IMJM)                                          PERT0971
      IF (IGE - 3) 30,10,30                                             PERT0972
10    TEMP1 = Z5(1)                                                     PERT0973
      DO 15 I = 1,IM                                                    PERT0974
15    R5(I) = 2.*Z5(1)/3.                                               PERT0975
      DO 20 J = 1,JM                                                    PERT0976
20    Z5(J) = 1.0                                                       PERT0977
30    DO 700 IIG = 1,IGM                                                PERT0978
      READ(NCR1)  ((C0(II,J), II=1,ITL), J=1,MT)                        PERT0979
      READ(NFLUX1)  ((N0(I,J), I=1,IM), J=1,JM)                         PERT0980
      READ(NFLUX2)  ((N1(I,J), I=1,IM), J=1,JM)                         PERT0981
      CFX = CFX + N0(1,1)                                               PERT0982
      DO 35 J = 1,JM                                                    PERT0983
      DO 35 I = 1,IM                                                    PERT0984
      ITEMP = M0(I,J)                                                   PERT0985
      ITEMP = M2(ITEMP)                                                 PERT0986
      POWER = POWER + C0(IHF,ITEMP)*N0(I,J)*V0(I,J)                     PERT0987
      POW(I,J) = POW(I,J) + C0(IHF,ITEMP)*N0(I,J)*TSD*1000.             PERT0988
      SORC1(I,J) = SORC1(I,J) + C0(IHN,ITEMP)*N0(I,J)                   PERT0989
      SORC2(I,J) = SORC2(I,J) + K6(IIG)*N1(I,J)                         PERT0990
      RABS = RABS + C0(IHA,ITEMP)*N0(I,J)*V0(I,J)                       PERT0991
35    RSORS = RSORS + C0(IHN,ITEMP)*N0(I,J)*V0(I,J)                     PERT0992
C     CALCULATE LEAKAGE                                                 PERT0993
40    DO 100  J=1,JM                                                    PERT0994
      IF(B01)  60,50,60                                                 PERT0995
50    I = 1                                                             PERT0996
      ITEMP = M0(I,J)                                                   PERT0997
      ITEMP = M2(ITEMP)                                                 PERT0998
      RL = RL + (Z5(J)*A0(I)*N0(I,J))/(3.*((C0(IHT,ITEMP)*.5*R5(I))     PERT0999
     1     + .71))                                                      PERT1000
60    IF(B02)  100,70,100                                               PERT1001
70    I = IM                                                            PERT1002
      ITEMP = M0(I,J)                                                   PERT1003
      ITEMP = M2(ITEMP)                                                 PERT1004
      RL = RL + (Z5(J)*A0(IP)*N0(I,J))/(3.*((C0(IHT,ITEMP)*.5*R5(I))    PERT1005
     1     + .71))                                                      PERT1006
100   CONTINUE                                                          PERT1007
      IF(NDIM - 1)  105,700,105                                         PERT1008
105   DO 300  I=1,IM                                                    PERT1009
      IF(B04)  200,110,200                                              PERT1010
110   J = 1                                                             PERT1011
      ITEMP = M0(I,J)                                                   PERT1012
      ITEMP = M2(ITEMP)                                                 PERT1013
      GO TO (130,130,120,125), IGEP                                     PERT1014
120   TEMP = .5*PI2*Z5(J)*R4(I)                                         PERT1015
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      GO TO 140                                                                 PERT1016
125   TEMP = .5 * R5(I)                                                         PERT1017
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                        PERT1018
      IF (ITEMP1) 140,200,140                                                   PERT1019
130   TEMP = .5*Z5(J)                                                           PERT1020
140   RL = RL + (A1(I)*N0(I,J))/(3.*((C0(IHT,ITEMP)*TEMP) + .71))               PERT1021
200   IF(B03)  300,240,300                                                      PERT1022
240   J = JM                                                                    PERT1023
      ITEMP = M0(I,J)                                                           PERT1024
      ITEMP = M2(ITEMP)                                                         PERT1025
      GO TO (260,260,250,255), IGEP                                             PERT1026
250   TEMP = .5*PI2*Z5(J)*R4(I)                                                 PERT1027
      GO TO 270                                                                 PERT1028
255   TEMP = .5*R5(I)                                                           PERT1029
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                        PERT1030
      IF (ITEMP1) 300,270,300                                                   PERT1031
260   TEMP = .5*Z5(J)                                                           PERT1032
270   RL = RL + (A1(I)*N0(I,J))/(3.*((C0(IHT,ITEMP)*TEMP) + .71))               PERT1033
300   CONTINUE                                                                  PERT1034
700   CONTINUE                                                                  PERT1035
      IF (IGE - 3) 730,710,730                                                  PERT1036
710   DO 715 I = 1,IM                                                           PERT1037
715   R5(I) = TEMP1/1.73205                                                     PERT1038
      DO 720 J = 1,JM                                                           PERT1039
720   Z5(J) = TEMP1                                                             PERT1040
730   AK = RSORS/(RABS + RL)                                                    PERT1041
      CAD = SORC2(1,1)                                                          PERT1042
      POWER = POWER*TSD                                                         PERT1043
      REWIND NCR1                                                               PERT1044
      REWIND NFLUX1                                                             PERT1045
      REWIND NFLUX2                                                             PERT1046
      GO TO (740,780), NFP                                                      PERT1047
740   CONST = FLPO/CFX                                                          PERT1048
      GO TO 800                                                                 PERT1049
780   CONST = FLPO/POWER                                                        PERT1050
800   IF(ZKEFF)  820,810,820                                                    PERT1051
810   ZKEFF = AK                                                                PERT1052
820   DO 840  J=1,JM                                                            PERT1053
      DO 840  I=1,IM                                                            PERT1054
      POW(I,J) = POW(I,J)*CONST                                                 PERT1055
      DENOM = DENOM + (CONST*SORC1(I,J)*SORC2(I,J)*V0(I,J))/(CAD*ZKEFF)         PERT1056
840   SORC2(I,J) = SORC2(I,J)/CAD                                               PERT1057
      POWER = POWER*CONST                                                       PERT1058
      CFX = CFX*CONST                                                           PERT1059
      WRITE(NOUT,850)  (ID(I), I=1,12)                                          PERT1060
850   FORMAT(1H1,12A6//)                                                        PERT1061
      RSORS = CONST*RSORS                                                       PERT1062
      RABS = CONST*RABS                                                         PERT1063
      RL = CONST*RL                                                             PERT1064
      WRITE(NOUT,860)  CFX, POWER, DENOM, RSORS, RABS, RL, AK                   PERT1065
860   FORMAT(44H0CENTER POINT FLUX (N/CM2-SEC)   -   -   -   1PE12.5//  PERT1066
     1       44H TOTAL POWER (MWT)   -   -   -   -   -   -   1PE12.5//  PERT1067
     2       44H DENOMINATOR OF PERT. EQUATION   -   -   -   1PE12.5//  PERT1068
     3       44H SOURCE RATE -   -   -   -   -   -   -   -   1PE12.5//  PERT1069
     1       44H ABSORPTION RATE -   -   -   -   -   -   -   1PE12.5//  PERT1070
     5       44H LEAKAGE RATE    -   -   -   -   -   -   -   1PE12.5//  PERT1071
     6       44H CALCULATED KEFF -   -   -   -   -   -   -   1PE12.5)   PERT1072
      CALL CLEAR(0.0,SORC1,IMJM)                                                PERT1073
      DO 1000  IIG=1,IGM                                                        PERT1074
      READ(NFLUX1)  ((N0(I,J), I=1,IM), J=1,JM)                                 PERT1075
      READ(NFLUX2)  ((N1(I,J), I=1,IM), J=1,JM)                                 PERT1076
      DO 900  J=1,JM                                                            PERT1077
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      DO 900  I=1,IM                                                    PERT1078
      N0(I,J) = N0(I,J)*CONST                                           PERT1079
      N1(I,J) = N1(I,J)/CAD                                             PERT1080
C     TOTAL FLUX                                                        PERT1081
900   SORC1(I,J) = SORC1(I,J) + N0(I,J)                                 PERT1082
      IF(NPRT - 2)  950,910,950                                         PERT1083
910   WRITE(NOUT,850)  (ID(I), I=1,12)                                  PERT1084
      WRITE(NOUT,920)  IIG                                              PERT1085
920   FORMAT(//15H FLUX FOR GROUP,I3/)                                  PERT1086
      CALL PRT(IM,JM,N0,Z4,NOUT)                                        PERT1087
      WRITE(NOUT,850)  (ID(I), I=1,12)                                  PERT1088
      WRITE(NOUT,930)  IIG                                              PERT1089
930   FORMAT(//23H ADJOINT FLUX FOR GROUP,I3/)                          PERT1090
      CALL PRT(IM,JM,N1,Z4,NOUT)                                        PERT1091
950   WRITE(NSCR1)  ((N0(I,J), I=1,IM), J=1,JM)                         PERT1092
1000  WRITE(NSCR2)  ((N1(I,J), I=1,IM), J=1,JM)                         PERT1093
      REWIND NFLUX1                                                     PERT1094
      REWIND NFLUX2                                                     PERT1095
      REWIND NSCR1                                                      PERT1096
      REWIND NSCR2                                                      PERT1097
      CALL SWITCH(NFLUX1,NSCR1)                                         PERT1098
      CALL SWITCH(NFLUX2,NSCR2)                                         PERT1099
      IF(NPRT)  1050,1050,1010                                          PERT1100
1010  WRITE(NOUT,850)  (ID(I), I=1,12)                                  PERT1101
      WRITE(NOUT,1020)                                                  PERT1102
1020  FORMAT(//11H TOTAL FLUX/)                                         PERT1103
      CALL PRT(IM,JM,SORC1,Z4,NOUT)                                     PERT1104
      WRITE(NOUT,850)  (ID(I), I=1,12)                                  PERT1105
      WRITE(NOUT,1030)                                                  PERT1106
1030  FORMAT(//28H FISSION SOURCE*ADJOINT FLUX/)                        PERT1107
      CALL PRT(IM,JM,SORC2,Z4,NOUT)                                     PERT1108
      WRITE(NOUT,850)  (ID(I), I=1,12)                                  PERT1109
      WRITE(NOUT,1040)                                                  PERT1110
1040  FORMAT(//26H POWER DENSITY (MW/LITER) /)                          PERT1111
      CALL PRT(IM,JM,POW,Z4,NOUT)                                       PERT1112
C     CALCULATE ZONE AVERAGED FLUXES AND POWERS                         PERT1113
1050  CALL CLEAR(0.0,ZPHI,IZM)                                          PERT1114
      CALL CLEAR(0.0,ZPOW,IZM)                                          PERT1115
      DO 1100  J=1,JM                                                   PERT1116
      DO 1100  I=1,IM                                                   PERT1117
      KZ = M0(I,J)                                                      PERT1118
      ZPHI(KZ) = ZPHI(KZ) + V0(I,J)*SORC1(I,J)                          PERT1119
1100  ZPOW(KZ) = ZPOW(KZ) + V0(I,J)*POW(I,J)                            PERT1120
      DO 1120  KZ=1,IZM                                                 PERT1121
      ZPHI(KZ) = ZPHI(KZ)*.001/VOL(KZ)                                  PERT1122
1120  ZPOW(KZ) = ZPOW(KZ)*.001/VOL(KZ)                                  PERT1123
      WRITE(NOUT,850)  (ID(I), I=1,12)                                  PERT1124
      WRITE(NOUT,1160)  (KZ, VOL(KZ), ZPHI(KZ), ZPOW(KZ), KZ=1,IZM)     PERT1125
1160  FORMAT(    61H0     ZONE            ZONE          ZONE AV.       ZPERT1126
     1ONE AV.  /                                                        PERT1127
     2           61H                     VOLUME          FLUX          PERT1128
     3POWER    // (I9,E19.6,2E15.6))                                   PERT1129
      RETURN                                                            PERT1130
      END                                                               PERT1131
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-ITC FOR ABETA,ABETA                                                    PERT1132
      SUBROUTINE ABETA(POW,JIM,SORC1,N0,N1,C0,JTL,M0,V7,NBET,BETA,      PERT1133
     1                 MASS,JML,D7,SORC2,ATW,VOL,V0,JGM,JPG,AB,AL)      PERT1134
      DIMENSION     POW(JIM,1), SORC1(JIM,1), N0(JIM,1), N1(JIM,1),     PERT1135
     1              C0(JTL,1), M0(JIM,1), V7(1), NBET(1), BETA(1),      PERT1136
     1              MASS(JML,1), AL(1), SORC2(JIM,1), ATW(1), VOL(1),   PERT1137
     2              V0(JIM,1), D7(JGM,1), AB(JPG,1)                     PERT1138
      INCLUDE ABC                                                       PERT1139
C     THIS SUBROUTINE CALCULATES BETA EFFECTIVE AND THE GENERATION TIME PERT1140
      TEMP = .0                                                         PERT1141
      TEMP1 = .0                                                        PERT1142
      WRITE (NOUT,10) (ID(I), I=1,12)                                   PERT1143
10    FORMAT (1H1,12A6,////)                                            PERT1144
      DO 20  KZ=1,IZM                                                   PERT1145
      DO 20  M=1,ML                                                     PERT1146
20    MASS(M,KZ) = (MASS(M,KZ)*.6023)/(ATW(M)*VOL(KZ))                  PERT1147
      DO 250 K = 1,IPG                                                  PERT1148
      CALL CLEAR(0.0,POW,IMJM)                                          PERT1149
      CALL CLEAR(0.0,SORC1,IMJM)                                        PERT1150
      CALL CLEAR(0.0,SORC2,IMJM)                                        PERT1151
      DO 100  IIG=1,IGM                                                 PERT1152
      READ(NFLUX1)  ((N0(I,J), I=1,IM), J=1,JM)                         PERT1153
      READ(NFLUX2)  ((N1(I,J), I=1,IM), J=1,JM)                         PERT1154
      READ(NCR1)  ((C0(II,J), II=1,ITL), J=1,MT)                        PERT1155
      DO 100  J=1,JM                                                    PERT1156
      DO 100  I=1,IM                                                    PERT1157
C     FLUX*ADJOINT FLUX/VELOCITY                                        PERT1158
      SORC1(I,J) = SORC1(I,J) + (N0(I,J)*N1(I,J))/V7(IIG)               PERT1159
C     DELAYED FISSION SOURCE*ADJOINT FLUX                               PERT1160
      SORC2(I,J) = SORC2(I,J) + D7(IIG,K)*N1(I,J)                       PERT1161
C     DELAYED NEUTRON PRODUCTION RATE                                   PERT1162
      KZ = M0(I,J)                                                      PERT1163
      DO 100  L=1,NIBC                                                  PERT1164
      M = NBET(L)                                                       PERT1165
100   POW(I,J) = POW(I,J) + BETA(L)*MASS(M,KZ)*C0(IHF,M)*N0(I,J)*AB(K,L)PERT1166
      BEFF = 0.0                                                        PERT1167
      ALIFE = 0.0                                                       PERT1168
      DO 200  J=1,JM                                                    PERT1169
      DO 200  I=1,IM                                                    PERT1170
      BEFF = BEFF + SORC2(I,J)*POW(I,J)*V0(I,J)                         PERT1171
200   ALIFE = ALIFE + SORC1(I,J)*V0(I,J)                                PERT1172
      BEFF = BEFF/(DENOM*ZKEFF)                                         PERT1173
      ALIFE = ALIFE/(DENOM*ZKEFF)                                       PERT1174
      TEMP = TEMP + BEFF                                                PERT1175
      TEMP1 = TEMP1 + BEFF/(AL(K) + 1./3600.)                           PERT1176
      WRITE(NOUT,210)  K,BEFF                                           PERT1177
210   FORMAT (6HOBETA(,I3,6H)  =  ,6X,1PE14.4)                          PERT1178
      REWIND NFLUX1                                                     PERT1179
      REWIND NFLUX2                                                     PERT1180
      REWIND NCR1                                                       PERT1181
250   CONTINUE                                                          PERT1182
      TEMP1 = (ALIFE + TEMP1)/3600.                                     PERT1183
      WRITE (NOUT,300) TEMP, TEMP1, ALIFE                               PERT1184
300   FORMAT (16HOTOTAL BETA  =  ,5X,1PE14.4//                          PERT1185
     1 16H ONE INHOUR  =  ,5X,1PE14.4//                                 PERT1186
     1 21H GENERATION TIME  =  ,1PE14.4)                                PERT1187
      RETURN                                                            PERT1188
      END                                                               PERT1189
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-ITC FOR SLOPE,SLOPE                                                    PERT1190
      SUBROUTINE SLOPE(N0,N1,JIM,R5,Z5,R4,C0,JTL,M0,M2,DEL,V0,A0,A1)    PERT1191
      DIMENSION  N0(JIM,1), N1(JIM,1), R5(1), Z5(1), R4(1), C0(JTL,1),  PERT1192
     1           M0(JIM,1), M2(1), DEL(JIM,1), V0(JIM,1), A0(1), A1(1)  PERT1193
      INCLUDE ABC                                                       PERT1194
C     THIS SUBROUTINE CALCULATES (GRAD FLUX*GRAD ADJOINT)/SIGTR**2      PERT1195
      IF (IGE - 3) 10,2,10                                              PERT1196
2     DO 4 I = 1,IM                                                     PERT1197
4     R5(I) = 2.*Z5(1)/3.                                               PERT1198
      TEMP1 = Z5(1)                                                     PERT1199
      DO 6 J = 1,JM                                                     PERT1200
6     Z5(J) = 1.0                                                       PERT1201
10    DO 1400  IIG=1,IGM                                                PERT1202
      READ(NCR1)  ((C0(II,J), II=1,ITL), J=1,MT)                        PERT1203
      READ(NFLUX1)  ((N0(I,J), I=1,IM), J=1,JM)                         PERT1204
      READ(NFLUX2)  ((N1(I,J), I=1,IM), J=1,JM)                         PERT1205
      DO 1200  J=1,JM                                                   PERT1206
      DO 1200  I=1,IM                                                   PERT1207
      ITEMP = M0(I,J)                                                   PERT1208
      ITEMP = M2(ITEMP)                                                 PERT1209
      IF (I-1) 14,14,12                                                 PERT1210
12    ITEMPL = M0(I-1,J)                                                PERT1211
      ITEMPL = M2(ITEMPL)                                               PERT1212
14    ITEMPR = M0(I+1,J)                                                PERT1213
      ITEMPR = M2(ITEMPR)                                               PERT1214
      IF (J-1) 18,18,16                                                 PERT1215
16    ITEMPB = M0(I,J-1)                                                PERT1216
      ITEMPB = M2(ITEMPB)                                               PERT1217
18    ITEMPT = M0(I,J+1)                                                PERT1218
      ITEMPT = M2(ITEMPT)                                               PERT1219
      SL1 = 0.0                                                         PERT1220
      SL2 = 0.0                                                         PERT1221
      SR1 = 0.0                                                         PERT1222
      SR2 = 0.0                                                         PERT1223
      SB1 = 0.0                                                         PERT1224
      SB2 = 0.0                                                         PERT1225
      ST1 = 0.0                                                         PERT1226
      ST2 = 0.0                                                         PERT1227
      IF(I-1)  30,30,100                                                PERT1228
30    IF(B01-1)  40,110,50                                              PERT1229
C     VACUUM BOUNDARY                                                   PERT1230
40    SIGTR = C0(IHT,ITEMP)                                             PERT1231
      SL1 =(N0(I,J)/(.5*R5(I) + (.71/SIGTR)))/SIGTR                     PERT1232
      SL2 =(N1(I,J)/(.5*R5(I) + (.71/SIGTR)))/SIGTR                     PERT1233
      GO TO 110                                                         PERT1234
C     PERIODIC BOUNDARY                                                 PERT1235
50    ITEMPP = M0(IM,J)                                                 PERT1236
      ITEMPP = M2(ITEMPP)                                               PERT1237
      SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(IM)*C0(IHT,ITEMPP))/            PERT1238
     1        (R5(I) + R5(IM))                                          PERT1239
      SL1 =((N0(I,J) - N0(IM,J))/(.5*R5(I) + .5*R5(IM)))/SIGTR          PERT1240
      SL2 =((N1(I,J) - N1(IM,J))/(.5*R5(I) + .5*R5(IM)))/SIGTR          PERT1241
      GO TO 110                                                         PERT1242
C     INTERIOR INTERVAL                                                 PERT1243
100   SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(I-1)*C0(IHT,ITEMPL))/           PERT1244
     1        (R5(I) + R5(I-1))                                         PERT1245
      SL1 =((N0(I,J) - N0(I-1,J))/(.5*R5(I) + .5*R5(I-1)))/SIGTR        PERT1246
      SL2 =((N1(I,J) - N1(I-1,J))/(.5*R5(I) + .5*R5(I-1)))/SIGTR        PERT1247
110   IF(I-IM)  200,130,130                                             PERT1248
130   IF(B02-1)   140,210,150                                           PERT1249
C     VACUUM BOUNDARY                                                   PERT1250
140   SIGTR = C0(IHT,ITEMP)                                             PERT1251
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      SR1 = -(N0(I,J)/(.5*R5(I) + (.71/SIGTR)))/SIGTR                    PERT1252
      SR2 = -(N1(I,J)/(.5*R5(I) + (.71/SIGTR)))/SIGTR                    PERT1253
      GO TO 210                                                          PERT1254
C     PERIODIC BOUNDARY                                                  PERT1255
150   ITEMPP = M0(1,J)                                                   PERT1256
      ITEMPP = M2(ITEMPP)                                                PERT1257
      SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(1)*C0(IHT,ITEMPP))/              PERT1258
     1        (R5(1) + R5(I))                                            PERT1259
      SR1 =((N0(1,J) - N0(I,J))/(.5*R5(1) + .5*R5(I)))/SIGTR             PERT1260
      SR2 =((N1(1,J) - N1(I,J))/(.5*R5(1) + .5*R5(I)))/SIGTR             PERT1261
      GO TO 210                                                          PERT1262
C     INTERIOR INTERVAL                                                  PERT1263
200   SIGTR = (R5(I)*C0(IHT,ITEMP) + R5(I+1)*C0(IHT,ITEMPR))/            PERT1264
     1        (R5(I) + R5(I+1))                                          PERT1265
      SR1 =((N0(I+1,J) - N0(I,J))/(.5*R5(I+1) + .5*R5(I)))/SIGTR         PERT1266
      SR2 =((N1(I+1,J) - N1(I,J))/(.5*R5(I+1) + .5*R5(I)))/SIGTR         PERT1267
210   IF(NDIM-1)  220,1000,220                                           PERT1268
220   IF(J-1)  230,230,300                                               PERT1269
230   IF(B04-1)  240,310,280                                             PERT1270
C     VACUUM BOUNDARY                                                    PERT1271
240   SIGTR = C0(IHT,ITEMP)                                              PERT1272
      GO TO (250,250,260,255), IGEP                                      PERT1273
250   TEMP = .5*Z5(J)                                                    PERT1274
      GO TO 270                                                          PERT1275
255   TEMP = .5*R5(I)                                                    PERT1276
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                 PERT1277
      IF (ITEMP1) 270,310,270                                            PERT1278
260   TEMP = .5*PI2*Z5(J)*R4(I)                                          PERT1279
270   SB1 =(N0(I,J)/(TEMP + (.71/SIGTR)))/SIGTR                          PERT1280
      SB2 =(N1(I,J)/(TEMP + (.71/SIGTR)))/SIGTR                          PERT1281
      GO TO 310                                                          PERT1282
C     PERIODIC BOUNDARY                                                  PERT1283
280   ITEMPP = M0(I,JM)                                                  PERT1284
      ITEMPP = M2(ITEMPP)                                                PERT1285
      SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(JM)*C0(IHT,ITEMPP))/             PERT1286
     1        (Z5(J) + Z5(JM))                                           PERT1287
      GO TO (285,285,290,288), IGEP                                      PERT1288
285   TEMP = .5*Z5(J) + .5*Z5(JM)                                        PERT1289
      GO TO 295                                                          PERT1290
288   TEMP = R5(I)                                                       PERT1291
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                 PERT1292
      IF (ITEMP1) 295,310,295                                            PERT1293
290   TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(JM))                               PERT1294
295   SB1 =((N0(I,J) - N0(I,JM))/TEMP)/SIGTR                             PERT1295
      SB2 =((N1(I,J) - N1(I,JM))/TEMP)/SIGTR                             PERT1296
      GO TO 310                                                          PERT1297
C     INTERIOR INTERVAL                                                  PERT1298
300   SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(J-1)*C0(IHT,ITEMPB))/            PERT1299
     1        (Z5(J) + Z5(J-1))                                          PERT1300
      GO TO (302,302,304,303), IGEP                                      PERT1301
302   TEMP = .5*Z5(J) + .5*Z5(J-1)                                       PERT1302
      GO TO 306                                                          PERT1303
303   TEMP = R5(I)                                                       PERT1304
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                 PERT1305
      IF (ITEMP1) 306,310,306                                            PERT1306
304   TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(J-1))                              PERT1307
306   SB1 =((N0(I,J) - N0(I,J-1))/TEMP)/SIGTR                            PERT1308
      SB2 =((N1(I,J) - N1(I,J-1))/TEMP)/SIGTR                            PERT1309
310   IF(J-JM)  400,330,330                                              PERT1310
330   IF(B03-1)  340,1000,380                                            PERT1311
C     VACUUM BOUNDARY                                                    PERT1312
340   SIGTR = C0(IHT,ITEMP)                                              PERT1313
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      GO TO (350,350,360,355), IGEP                                      PERT1314
350   TEMP = .5*Z5(J)                                                    PERT1315
      GO TO 370                                                          PERT1316
355   TEMP = .5*R5(I)                                                    PERT1317
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                 PERT1318
      IF (ITEMP1) 1000,370,1000                                          PERT1319
360   TEMP = .5*PI2*Z5(J)*R4(I)                                          PERT1320
370   ST1 = -(N0(I,J)/(TEMP + (.71/SIGTR)))/SIGTR                        PERT1321
      ST2 = -(N1(I,J)/(TEMP + (.71/SIGTR)))/SIGTR                        PERT1322
      GO TO 1000                                                         PERT1323
C     PERIODIC BOUNDARY                                                  PERT1324
380   ITEMPP = M0(I,1)                                                   PERT1325
      ITEMPP = M2(ITEMPP)                                                PERT1326
      SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(1)*C0(IHT,ITEMPP))/              PERT1327
     1        (Z5(J) + Z5(1))                                            PERT1328
      GO TO (385,385,390,388), IGEP                                      PERT1329
385   TEMP = .5*Z5(J) + .5*Z5(1)                                         PERT1330
      GO TO 395                                                          PERT1331
388   TEMP = R5(I)                                                       PERT1332
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                 PERT1333
      IF (ITEMP1) 1000,395,1000                                          PERT1334
390   TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(1))                                PERT1335
395   ST1 =((N0(I,1) - N0(I,J))/TEMP)/SIGTR                              PERT1336
      ST2 =((N1(I,1) - N1(I,J))/TEMP)/SIGTR                              PERT1337
      GO TO 1000                                                         PERT1338
C     INTERIOR INTERVAL                                                  PERT1339
400   SIGTR = (Z5(J)*C0(IHT,ITEMP) + Z5(J+1)*C0(IHT,ITEMPT))/            PERT1340
     1        (Z5(J) + Z5(J+1))                                          PERT1341
      GO TO (402,402,404,403), IGEP                                      PERT1342
402   TEMP = .5*Z5(J) + .5*Z5(J+1)                                       PERT1343
      GO TO 406                                                          PERT1344
403   TEMP = R5(I)                                                       PERT1345
      ITEMP1 = I - 2*(I/2) - J + 2*(J/2)                                 PERT1346
      IF (ITEMP1) 1000,406,1000                                          PERT1347
404   TEMP = .5*PI2*R4(I)*(Z5(J) + Z5(J+1))                              PERT1348
406   ST1 =((N0(I,J+1) - N0(I,J))/TEMP)/SIGTR                            PERT1349
      ST2 =((N1(I,J+1) - N1(I,J))/TEMP)/SIGTR                            PERT1350
1000  GO TO (1010,1010,1020,1030), IGEP                                  PERT1351
1010  TEMP = Z5(J)                                                       PERT1352
      GO TO 1050                                                         PERT1353
1020  TEMP = Z5(J)*PI2*R4(I)                                             PERT1354
      GO TO 1050                                                         PERT1355
1030  TEMP = R5(I)                                                       PERT1356
1050  DEL(I,J) = .5*(SL1*SL2*Z5(J)*A0(I)*R5(I) + SR1*SR2*Z5(J)*A0(I+1)*  PERT1357
     1 R5(I) + SB1*SB2*A1(I)*TEMP + ST1*ST2*A1(I)*TEMP)/V0(I,J)          PERT1358
1200  CONTINUE                                                           PERT1359
1400  WRITE(NSCR1)  ((DEL(I,J), I=1,IM), J=1,JM)                         PERT1360
      IF (IGE - 3) 1500,1410,1500                                        PERT1361
1410  DO 1420 I = 1,IM                                                   PERT1362
1420  R5(I) = TEMP1/1.73205                                              PERT1363
      DO 1430 J = 1,JM                                                   PERT1364
1430  Z5(J) = TEMP1                                                      PERT1365
1500  CONTINUE                                                           PERT1366
      REWIND NSCR1                                                       PERT1367
      REWIND NFLUX1                                                      PERT1368
      REWIND NFLUX2                                                      PERT1369
      REWIND NCR1                                                        PERT1370
      RETURN                                                             PERT1371
      END                                                                PERT1372
```

```
-ITC FOR CALC,CALC                                                              PERT1373
      SUBROUTINE CALC(NCR,MATDK,ATW,CP,C0,JTL,N0,JIM,N1,DEL,K6,CX,              PERT1374
     1                FLUX,JGM,ADJF,HOLN,V0,R4,Z4,X,Y)                          PERT1375
      DIMENSION  NCR(1), MATDK(1), ATW(1), CP(5,1), C0(JTL,1),                  PERT1376
     1           N0(JIM,1), N1(JIM,1), DEL(JIM,1), K6(1), CX(JTL,1),           PERT1377
     2           FLUX(JGM,1), ADJF(JGM,1), HOLN(1), V0(JIM,1),                 PERT1378
     3           R4(1), Z4(1), X(1), Y(1)                                      PERT1379
      INCLUDE ABC                                                               PERT1380
C     THIS SUBROUTINE CALCULATES AND PRINTS REACTIVITY COEFFICIENTS             PERT1381
      DO 2000  III=1,NDELK                                                      PERT1382
      GO TO (100,120),  NDIM                                                    PERT1383
100   NCR(III) = 1                                                              PERT1384
120   NNCR = IABS(NCR(III))                                                     PERT1385
      MAT = MATDK(III)                                                          PERT1386
C     CONVERSION FROM ATOMS TO KG                                               PERT1387
      CT = 602.3/ATW(MAT)                                                       PERT1388
      ITEMP = 5*IJMAX                                                           PERT1389
      CALL CLEAR(0.0,CP,ITEMP)                                                  PERT1390
      WRITE(NOUT,130)  (ID(I), I=1,12)                                          PERT1391
130   FORMAT(1H1,12A6//)                                                        PERT1392
      IF (NCR(III)) 135,135,140                                                 PERT1393
135   IIJJ = JM                                                                 PERT1394
      I = NNCR                                                                  PERT1395
      GO TO 145                                                                 PERT1396
140   IIJJ = IM                                                                 PERT1397
      J = NNCR                                                                  PERT1398
145   DO 600  IIG=1,IGM                                                         PERT1399
      READ(NCR1)  ((C0(II,J), II=1,ITL), J=1,MT)                                PERT1400
      READ(NFLUX1)  ((N0(I,J), I=1,IM), J=1,JM)                                 PERT1401
      READ(NFLUX2)  ((N1(I,J), I=1,IM), J=1,JM)                                 PERT1402
      READ(NSCR1)  ((DEL(I,J), I=1,IM), J=1,JM)                                 PERT1403
      DO 150  II=1,ITL                                                          PERT1404
150   CX(II,IIG) = C0(II,MAT)                                                   PERT1405
      DO 300 K = 1,IIJJ                                                         PERT1406
      IF  (NCR(III)) 190,190,200                                                PERT1407
190   J = K                                                                     PERT1408
      GO TO 210                                                                 PERT1409
200   I = K                                                                     PERT1410
C     FISSION SOURCE*ADJOINT                                                    PERT1411
210   CP(1,K) = K6(IIG) * N1(I,J) + CP(1,K)                                     PERT1412
C     NU SIGF*FLUX                                                              PERT1413
      CP(2,K) = CX(IHN,IIG) * N0(I,J) + CP(2,K)                                 PERT1414
C     SIGA*FLUX*ADJOINT                                                         PERT1415
      CP(3,K) = CX(IHA,IIG) * N0(I,J) * N1(I,J) + CP(3,K)                       PERT1416
C     LEAKAGE COMPONENT                                                         PERT1417
      CP(4,K) = CX(IHT,IIG) * DEL(I,J)/3. + CP(4,K)                             PERT1418
      FLUX(IIG,K) = N0(I,J)                                                     PERT1419
300   ADJF(IIG,K) = N1(I,J)                                                     PERT1420
600   CONTINUE                                                                  PERT1421
C     DOWNSCATTERING COMPONENT                                                  PERT1422
      IF(IGM-1)  1010,1010,620                                                  PERT1423
620   DO 1000  IIG=1,IGM                                                        PERT1424
800   DO 890  I=1,IIJJ                                                         PERT1425
      DO 880  NN=1,IST                                                          PERT1426
      JJG = NN + IIG                                                            PERT1427
      IF(JJG - IGM)  850,850,890                                                PERT1428
850   L = IHG + NN                                                              PERT1429
      CP(5,I) = FLUX(IIG,I)*CX(L,JJG)*(ADJF(IIG,I) -ADJF(JJG,I))+CP(5,I)PERT1430
880   CONTINUE                                                                  PERT1431
890   CONTINUE                                                                  PERT1432
1000  CONTINUE                                                                  PERT1433
1010  IF(NCR(III))  1100,1100,1125                                              PERT1434
```

```
1100  WRITE(NOUT,1120)  MAT, HOLN(MAT), NNCR                                  PERT1435
1120  FORMAT(     37H0REACTIVITY COEFFICIENTS FOR MATERIAL,I3, 6X,A6,         PERT1436
     1 13H        COLUMN,I3//)                                                PERT1437
      GO TO 1135                                                             PERT1438
1125  WRITE(NOUT,1130)  MAT, HOLN(MAT), NNCR                                  PERT1439
1130  FORMAT(     37H0REACTIVITY COEFFICIENTS FOR MATERIAL,I3, 6X,A6,         PERT1440
     1 10H        ROW,I3//)                                                   PERT1441
1135  WRITE(NOUT,1140)                                                       PERT1442
1140  FORMAT(125H0         *K/K PER KG          *K              *K           PERT1443
     1    *K              *K              *K           AVG RADII       AVG APERT1444
     2XII /   99H                              (NUSIGF)        (SIGA)       PERT1445
     3 (SIGTR)         (SIGIXJ)         (INTG)       /)                     PERT1446
      SUM = 0.0                                                              PERT1447
      TOT = 0.0                                                              PERT1448
      DO 1300  I=1,IIJJ                                                      PERT1449
C     FISSIONS                                                               PERT1450
      CP(2,I) = (CP(1,I)*CP(2,I)*CT)/(ZKEFF*DENOM*VF)                        PERT1451
C     ABSORPTIONS                                                            PERT1452
      CP(3,I) = - (CP(3,I)*CT)/(DENOM*VF)                                    PERT1453
C     LEAKAGE                                                                PERT1454
      CP(4,I) = (CP(4,I)*CT)/(DENOM*VF)                                      PERT1455
C     SLOWING DOWN                                                           PERT1456
      CP(5,I) = - (CP(5,I)*CT)/(DENOM*VF)                                    PERT1457
      CP(1,I) = CP(2,I) + CP(3,I) + CP(4,I) + CP(5,I)                        PERT1458
      IF(NCR(III))  1150,1150,1250                                           PERT1459
1150  SUM = SUM + CP(1,I)*V0(NNCR,I)                                         PERT1460
      TOT = TOT + V0(NNCR,I)                                                 PERT1461
      ST = SUM/TOT                                                           PERT1462
1160  FORMAT(I4, 8E15.4)                                                     PERT1463
      WRITE(NOUT,1160)  I, (CP(KK,I), KK=1,5),  ST, R4(NNCR), Z4(I)          PERT1464
      GO TO 1300                                                             PERT1465
1250  SUM = SUM + CP(1,I)*V0(I,NNCR)                                         PERT1466
      TOT = TOT + V0(I,NNCR)                                                 PERT1467
      ST = SUM/TOT                                                           PERT1468
      WRITE(NOUT,1160)  I, (CP(KK,I), KK=1,5),  ST, R4(I), Z4(NNCR)          PERT1469
1300  CONTINUE                                                               PERT1470
      IF(NPDEL)  1400,1400,1350                                              PERT1471
1350  CALL PLOT(NCR,X,Y,R4,Z4,HOLN,CP,MAT)                                   PERT1472
1400  REWIND NCR1                                                            PERT1473
      REWIND NFLUX1                                                          PERT1474
      REWIND NFLUX2                                                          PERT1475
2000  REWIND NSCR1                                                           PERT1476
      RETURN                                                                 PERT1477
      END                                                                    PERT1478
```

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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
```

```
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,2,0.0,0.0)                                   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                                                        PERT1581
      SUBROUTINE ACT(MA,NX,NO,JIM,CO,JTL,SORC1,ZACT,MO,VO,VOL,Z4)       PERT1582
      DIMENSION     MA(1), NX(1), NO(JIM,1), CO(JTL,1), SORC1(JIM,1),   PERT1583
     1              ZACT(1), MO(JIM,1), VO(JIM,1), VOL(1), Z4(1)        PERT1584
      INCLUDE ARC                                                       PERT1585
C     THIS SUBROUTINE CALCULATES ACTIVITY TRAVERSES                     PERT1586
      DO 200  N=1,NACT                                                  PERT1587
      CALL CLEAR(0.0,SORC1,IMJM)                                        PERT1588
      KK = MA(N)                                                        PERT1589
      NN = NX(N)                                                        PERT1590
      DO 100  IIG=1,IGM                                                 PERT1591
      READ(NFLUX1)  ((NO(I,J), I=1,IM), J=1,JM)                         PERT1592
      READ(NCR1)  ((CO(II,J), II=1,ITL), J=1,MT)                        PERT1593
      DO 100  J=1,JM                                                    PERT1594
      DO 100  I=1,IM                                                    PERT1595
100   SORC1(I,J) = SORC1(I,J) + CO(NN,KK)*NO(I,J)                       PERT1596
      CALL CLEAR(0.0,ZACT,IZM)                                          PERT1597
      DO 140  J=1,JM                                                    PERT1598
      DO 140  I=1,IM                                                    PERT1599
      KZ = MO(I,J)                                                      PERT1600
140   ZACT(KZ) = ZACT(KZ) + SORC1(I,J)*VO(I,J)                          PERT1601
      DO 160  KZ=1,IZM                                                  PERT1602
160   ZACT(KZ) = ZACT(KZ)*.001/VOL(KZ)                                  PERT1603
      WRITE(NOUT,170)  N, KK, NN                                        PERT1604
170   FORMAT( 9H1ACTIVITY I3,5X, 9H MATERIAL I3,5X,23H CROSS SECTION POSPERT1605
     1ITION I3//)                                                       PERT1606
      CALL PRT(IM,JM,SORC1,Z4,NOUT)                                     PERT1607
      WRITE(NOUT,180)  (KZ, VOL(KZ), ZACT(KZ), KZ=1,IZM)                PERT1608
180   FORMAT( ///45H      ZONE           ZONE          ZONE AV.    /    PERT1609
     1           45H                    VOLUME        ACTIVITY    //   PERT1610
     2          (I9,F19.6,F15.6))                                      PERT1611
      REWIND NFLUX1                                                     PERT1612
200   REWIND NCR1                                                       PERT1613
      RETURN                                                            PERT1614
      END                                                               PERT1615
```

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