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DEVELOPMENT
REPORT

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**PERT-IV, A TWO-DIMENSIONAL
PERTURBATION CODE IN FORTRAN-IV**

**R. W. HARDIE
W. W. LITTLE, JR.**

APRIL 1967

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PERT-IV, A TWO-DIMENSIONAL
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By

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

FFTF Reactor Physics Section
Reactor Physics Department

April 1967

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PERT-IV, A TWO-DIMENSIONAL
PERTURBATION CODE IN FORTRAN-IV

ABSTRACT

PERT-IV is a two-dimensional (R-Z, X-Y, R- θ), first-order perturbation theory code for computing reactivity coefficient traverses, activity traverses, the neutron generation time, and the effective delayed neutron fraction. The input flux and adjoint flux can be taken directly from 2-D calculations or synthesized (by the code) from 1-D calculations.

In a 65 K memory (and 4 tapes), the code can handle 35 materials, 26 energy groups, and a 50 x 50 spatial mesh. Running time on a UNIVAC 1107 is about 3 minutes.

Input instructions, a sample case, and a FORTRAN-IV source deck listing are given in the appendices.

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PERT-IV, A TWO-DIMENSIONAL
PERTURBATION CODE IN FORTRAN-IV

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

I. INTRODUCTION

This report describes a two-dimensional perturbation code for use in fast reactor analysis. The code can be used to:

- Compute reactivity coefficient traverses using first order perturbation theory
- Compute activity traverses for any cross section of any material
- Compute the neutron generation time and the effective delayed neutron fraction.

The code is compatible with the one-dimensional DTF-IV⁽¹⁾ and two-dimensional 2DF⁽²⁾ transport theory codes from Los Alamos. In fact, the generalized input portions of these programs were incorporated into the PERT-IV code.

II. DISCUSSION OF PRINCIPAL OPTIONS

Format of Input Fluxes and Adjoint Fluxes

The input flux and adjoint flux options are:

- Flux and adjoint from DTF-IV
- Flux and adjoint from 2DF
- Flux from DTF-IV, adjoint from 2DF
- Flux from 2DF, adjoint from DTF-IV
- Flux from DTF-IV, no adjoint
- Flux from 2DF, no adjoint

When 1-D flux dumps are used, PERT-IV synthesizes these into 2-D arrays. For the last two options, the code assumes a flat adjoint distribution.

Flux Normalization Options

Four options are available for normalizing the flux. These are:

- Center point flux
- Center point power density
- Total reactor power
- Denominator of perturbation equation [see Equation (1)].

The adjoint flux is always normalized such that the fission source times the adjoint, summed over all groups, is unity at the center mesh point.

Reactivity Coefficient Calculation

Using first-order perturbation theory, PERT-IV will calculate reactivity coefficient (in units of $\delta k/kg$) traverses for any specified row or column. The contribution of each component of the reactivity coefficient (e.g., moderation, capture) is also given.

Activity Traverses

For any material and cross section (e.g., σ_f , σ_a), the code will calculate and print a complete activity map. A full print gives the activity at each mesh point for each group; a partial print gives the total over all groups at each mesh point. Zone averaged activities are also given.

III. MATHEMATICAL MODELS

- Let:
- N = number of energy groups,
 - ϕ_i = flux in group i ($\text{n-cm}^{-2}\text{-sec}^{-1}$),
 - $\phi_i^\dagger$ = adjoint flux in group i ,
 - v_i = neutron velocity in group i (cm-sec^{-1}),
 - χ_i = fission source in group i ,
 - $\nu\Sigma_f^i$ = macroscopic fission source cross section in group i (cm^{-1}),
 - Σ_a^i = macroscopic absorption cross section in group i (cm^{-1}),
 - Σ_{tr}^i = macroscopic transport cross section in group i (cm^{-1}),
 - $\Sigma(i \rightarrow j)$ = macroscopic transfer cross section from group i to j (cm^{-1}),
 - k = effective multiplication factor,

where, for simplicity, the spatial variables are not explicitly shown.

The reactivity coefficients at each mesh point are computed using the equation

$$\frac{\delta k}{k} = \frac{A + B + C + D}{I}, \quad (1)$$

where:

$$I = \frac{1}{k} \int_{\text{Reactor}} dV \left\{ \sum_{j=1}^N \left(\chi_j \phi_j^\dagger \right) \sum_{i=1}^N \left(\nu \Sigma_f^i \phi_i \right) \right\}, \quad (2)$$

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

$$B = \frac{1}{K} \int dV \left\{ \sum_{j=1}^N \left(\chi_j \phi_j^+ \right) \sum_{i=1}^N \left(\delta [\nu \Sigma_f^i] \phi_i \right) \right\}, \quad (4)$$

$$C = - \int dV \left\{ \sum_{i=1}^N \left(\delta [\Sigma_a^i] \phi_i \phi_i^+ \right) \right\}, \quad (5)$$

and

$$D = \int dV \left\{ \sum_{i=1}^N \left(\sum_{j=i+1}^N \delta [\Sigma(i \rightarrow j)] \phi_i (\phi_j^+ - \phi_i^+) \right) \right\}. \quad (6)$$

The gradient terms in Equation (3) are evaluated by using first order difference approximations; the gradients at $r = 0$ (left boundary) are assumed zero.

The neutron generation time is calculated from the expression

$$\Lambda = \frac{1}{K} \int dV \left\{ \sum_{i=1}^N \phi_i \phi_i^+ / v_i \right\} / I \quad (7)$$

The effective delayed neutron fraction is computed using the algorithm

$$\beta_{\text{eff}} = \frac{1}{K} \int dV \left\{ \sum_{i=1}^N \left(\sum_{\ell=1}^L f_{\ell} \Sigma_{f,\ell}^i \right) \phi_i \sum_{j=1}^N \chi_j^D \phi_j^+ \right\} / I, \quad (8)$$

where:

L = number of fissionable isotopes for β_{eff} calculation,

f_{ℓ} = absolute delayed neutron yield per fission of isotope ℓ ,

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

χ_j^D = delayed fission source in group j .

IV. LIMITS ON PROBLEM COMPLEXITY

<u>Variable</u>	<u>Definition</u>	<u>Maximum Value</u>
IGM	No. of Energy Groups	26
IST	No. of Downscattering Terms	10
IM	No. of Radial Intervals	50
JM	No. of Axial Intervals	50
MCR	No. of Cross Sections from Cards	25
MTP	No. of Cross Sections from Tape	25
IZM	No. of Material Zones	35
MT	No. of Materials Including Mixes	35
M01	No. of Mixture Specifications	45
NDELK	No. of Reactivity Traverses	20
NIBC	No. of Isotopes in β_{eff} Calculation	20
NACT	No. of Activity Traverses	3

REFERENCES

1. K. D. Lathrop. DTF-IV, a FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, Los Alamos, New Mexico. 1965.
2. 2DF, A Two-Dimensional S_n Code. Unpublished Data. Los Alamos Scientific Laboratory.

APPENDIX A
INPUT INSTRUCTIONS

The following two pages describe the input data for PERT-IV.

For DTF fluxes and all subsequent data, the cards consist of six data fields of 12 columns each. The last nine columns contain the data associated with the particular field; columns 2-3 contain an integer, N, from 0 (or blank) to 99. The first column of each field must contain:

- 0 - no effect ($N = 0$),
- 1 - repeat associated data 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.

PERT – IV

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80										
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<table border="1"> <tr> <td> <u>ND</u> • 1, Fluxes from 1-D • 2, Fluxes from 2-D • 3, Flux from 1-D, Adjoint from 2-D • 4, Flux from 2-D, Adjoint from 1-D • 5, Flux from 1-D, No Adjoint • 6, Flux from 2-D, No Adjoint </td> <td> <u>IGM</u> No. of Energy Groups </td> <td> <u>IST</u> No. of Downscattering Terms </td> <td> <u>IFP</u> • 0, No Effect • 1, Punch Fluxes • 2, Punch Adjoint Fluxes </td> <td> <u>IM</u> No. of Radial Intervals </td> <td> <u>JM</u> No. of Axial Intervals </td> <td> <u>MCR</u> No. of Materials From Cards </td> <td> <u>MTP</u> No. of Materials From Tape </td> <td> <u>IZM</u> No. of Material Zones </td> <td> <u>MT</u> Total No. of Materials, Including Mixes </td> <td> <u>MOI</u> No. of Mixture Specifications </td> <td> <u>NPRT</u> • 0, Partial Print • 1, Full Print </td> </tr> </table>																																																																														<u>ND</u> • 1, Fluxes from 1-D • 2, Fluxes from 2-D • 3, Flux from 1-D, Adjoint from 2-D • 4, Flux from 2-D, Adjoint from 1-D • 5, Flux from 1-D, No Adjoint • 6, Flux from 2-D, No Adjoint	<u>IGM</u> No. of Energy Groups	<u>IST</u> No. of Downscattering Terms	<u>IFP</u> • 0, No Effect • 1, Punch Fluxes • 2, Punch Adjoint Fluxes	<u>IM</u> No. of Radial Intervals	<u>JM</u> No. of Axial Intervals	<u>MCR</u> No. of Materials From Cards	<u>MTP</u> No. of Materials From Tape	<u>IZM</u> No. of Material Zones	<u>MT</u> Total No. of Materials, Including Mixes	<u>MOI</u> No. of Mixture Specifications	<u>NPRT</u> • 0, Partial Print • 1, Full Print
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IF(N1BC) ≠ 0

IF(INDELK) ≠ 0

IF(1ACT) ≠ 0

APPENDIX B

SAMPLE PROBLEM

The following pages show the input data (omitting input fluxes) and computer output for a 2-group, 3-region test problem in R-Z geometry.

PERT-IV TEST CASE		(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)									
2	2	1	0	21	20	16	0	3	19	31	0
3	6	1	1	0							
1.0		2.0		206.							
M2PU49239.05		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	
PU240 240.05		2 GROUPS									
.697066-00		.973045-00		.210364+01		.654004+01		.549212+01		.000000	
.205185-01		.158456+01		.577565-01		.139455+02		.123609+02		.748743-01	
M2U235235.04		2 GROUPS									
.132033+01		.150965+01		.332484+01		.622874+01		.457201+01		.000000	
.336017+01		.486972+01		.814961+01		.147169+02		.984715+01		.147083-00	
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	
NA 22.990		2 GROUPS									
.000000		.713006-03		.000000		.309019+01		.300053+01		.000000	
.000000		.423424-02		.000000		.498455+01		.498031+01		.889546-01	
M2 FE 55.847		2 GROUPS									
.000000		.591775-02		.000000		.255761+01		.251745+01		.000000	
.000000		.215431-01		.000000		.482144+01		.479990+01		.342399-01	
CR 51.996		2 GROUPS									
.000000		.454490-02		.000000		.267339+01		.260924+01		.000000	
.000000		.149873-01		.000000		.472111+01		.470613+01		.596010-01	
NI 58.71		2 GROUPS									
.000000		.305271-01		.000000		.307692+01		.300395+01		.000000	
.000000		.203676-01		.000000		.945337+01		.943300+01		.424393-01	
MO 95.94		2 GROUPS									
.000000		.430943-01		.000000		.527468+01		.516105+01		.000000	
.000000		.303487-00		.000000		.788962+01		.758613+01		.705369-01	
AL 26.981		2 GROUPS									
.000000		.205447-02		.000000		.282519+01		.272632+01		.000000	
.000000		.829689-02		.000000		.217056+01		.216227+01		.968106-01	
M2U235235.04		2 GROUPS									
.134241+01		.156915+01		.333434+01		.679391+01		.505674+01		.000000	
.211779+01		.283935+01		.515408+01		.123173+02		.947794+01		.168022-00	
U238 238.05		2 GROUPS									
.372181-01		.189516-00		.105378+00		.694904+01		.664718+01		.000000	
.000000		.404503-00		.000000		.122090+02		.118045+02		.112345+00	
M2 FE 55.847		2 GROUPS									
.000000		.670574-02		.000000		.265143+01		.259971+01		.000000	
.000000		.120269-01		.000000		.449904+01		.448701+01		.450092-01	
CR 51.996		2 GROUPS									
.000000		.483021-02		.000000		.275887+01		.267499+01		.000000	

.000000	.923842-02	.000000	.441195+01	.440272+01	.790527-01
NI 58.71	2 GROUPS				
.000000	.182360-01	.000000	.338277+01	.330993+01	.000000
.000000	.169131-01	.000000	.750107+01	.748416+01	.546002-01

INPUT FLUXES

2 3 0.0	2 8 2.54	2 7 41.71	72.19	3		
2 3 0.0	2 7 2.54	2 7 38.175	68.655	3		
1 4	11 9	21 8	31 4	11 9	21 8	3
1 4	11 9	21 8	31 4	11 9	21 8	3
113	21 8	3113	2108	3113	21 8	3
113	21 8	3113	2108	3113	21 8	3
113	21 8	3113	2108	3184	3184	3
3						
	19	17	183			
.987	.013	3				
112	17106	18113	193			
	0	1	2	3	4	5
	6	7	8	9	10	11
	0	12	13	14	15	16
	0	1	2	3	4	5
	6	7	8	9	10	11
173						
0	.001654	.000106	.000016	.007406	.020765	
.006230	.009899	.002658	.001308	.000206	.000110	
0	.000084	.039976	.004453	.001196	.000588	
0	.001654	.000106	.000016	.007406	.020765	
.006230	.009899	.002658	.001308	.000206	.000110	
1.0 -103						
1	2	3	4	12	13	
3						
.0063	.0088	.0165	.0412	.0165	.0412	
3						
1.0	0.03					
7.63085+8	1.16360+83					
1	1	63				
1	0	13				
0	5	03				
13						
13						

***** PERT - IV *****

PERT-IV TEST CASE (2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

ND	1/2/3/4/5/6=FLUXES FROM TWO 1-D RUNS/FLUXES FROM 2-D RUN/FLUX FROM 1-D,ADJOINT FROM 2-D/FLUX FROM 2-D,ADJOINT FROM 1-D/FLUX FROM 1-D, NO ADJOINT/FLUX FROM 2-D,NO ADJOINT	2
IGM	NUMBER OF ENERGY GROUPS	2
IST	NUMBER OF DOWNSCATTERING TERMS	1
IFP	0/1/2=NO EFFECT/PUNCH FLUXES/PUNCH ADJOINT FLUXES	0
IM	NUMBER OF RADIAL INTERVALS	21
JM	NUMBER OF AXIAL INTERVALS	20
MCR	NUMBER OF MATERIALS FROM CARDS	16
MTP	NUMBER OF MATERIALS FROM TAPE	0
IZM	NUMBER OF MATERIAL ZONES	3
MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES	19
M01	NUMBER OF MIXTURE SPECIFICATIONS	31
NPRT	PRINT OPTION(0/1=PARTIAL PRINT/FULL PRINT)	0
NDLK	0/N=NO EFFECT/DO N REACTIVITY COEFFICIENT CALCULATIONS	3
NIBC	0/N=NO EFFECT/USE N MATERIALS FOR BETA EFFECTIVE CALCULATION	6
NACT	0/N=NO EFFECT/DO N ACTIVITY TRAVERSES	1
NFP	FLUX OR POWER NORMALIZATION (1/2/3/4=CENTER PT. FLUX/CENTER PT. POWER/TOTAL POWER/DENOMINATOR OF PERT FORMULA)	1
IGE	GEOMETRY (0/1/2=R-Z/X-Y/R-THETA)	0
FLPO	FLUX(N/CM2-SEC) OR POWER(MWT)	1.00000+00
VF	VOLUME FACTOR (VOLUME = VF*PI*R2*Z)	2.00000+00
FEF	ENERGY(MEV) RELEASED PER FISSION	2.06000+02

B-4

BNWL-409

PERT-IV TEST CASE

(20F FLUX INPUT, 2 GROUPS, 3 ZONES)

THE FOLLOWING NUCLIDES ARE FROM CARDS

1	M2PU49	2 GROUPS
2	PU240	2 GROUPS
3	M2U235	2 GROUPS
4	U238	2 GROUPS
5	C	2 GROUPS
6	NA	2 GROUPS
7	M2 FE	2 GROUPS
8	CR	2 GROUPS
9	NI	2 GROUPS
10	MO	2 GROUPS
11	AL	2 GROUPS
12	M2U235	2 GROUPS
13	U238	2 GROUPS
14	M2 FE	2 GROUPS
15	CR	2 GROUPS
16	NI	2 GROUPS

B-5

BNWL-409

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

INPUT FLUXES (PHR/PHZ/ADJR/ADJZ/PHI/ADJERADIAL FLUX/AXIAL FLUX/RADIAL ADJOINT FLUX/AXIAL ADJOINT FLUX/2-D FLUX/2-D ADJOINT FLUX)

PHI	840									
.48222-03	.48215-03	.48181-03	.48131-03	.47674-03	.46453-03	.44519-03	.41920-03	.38712-03	.34971-03	
.30787-03	.26261-03	.21373-03	.15665-03	.10533-03	.71757-04	.48494-04	.32370-04	.20945-04	.12615-04	
.58700-05	.48207-03	.49261-03	.48171-03	.48118-03	.47657-03	.46437-03	.44505-03	.41905-03	.38699-03	
.34959-03	.30777-03	.26253-03	.21366-03	.15660-03	.10529-03	.71732-04	.48477-04	.32363-04	.20934-04	
.12608-04	.58744-05	.48181-03	.48172-03	.48138-03	.48086-03	.47625-03	.46405-03	.44477-03	.41876-03	
.38672-03	.34937-03	.30756-03	.26235-03	.21351-03	.15649-03	.10522-03	.71680-04	.48449-04	.32341-04	
.20915-04	.12604-04	.58682-05	.48131-03	.48123-03	.48089-03	.48037-03	.47577-03	.46358-03	.44431-03	
.41836-03	.38632-03	.34901-03	.30726-03	.26208-03	.21330-03	.15634-03	.10511-03	.71611-04	.48404-04	
.32300-04	.20899-04	.12592-04	.58607-05	.47677-03	.47670-03	.47639-03	.47588-03	.47133-03	.45925-03	
.44014-03	.41444-03	.38271-03	.34572-03	.30436-03	.25962-03	.21129-03	.15486-03	.10412-03	.70937-04	
.47937-04	.32000-04	.20703-04	.12471-04	.58056-05	.46447-03	.46440-03	.46408-03	.46359-03	.45916-03	
.44739-03	.42877-03	.40371-03	.37279-03	.33676-03	.29645-03	.25285-03	.20578-03	.15082-03	.10140-03	
.69080-04	.46690-04	.31168-04	.20163-04	.12147-04	.56565-05	.44456-03	.44450-03	.44420-03	.44371-03	
.43948-03	.42821-03	.41037-03	.38639-03	.35677-03	.32224-03	.28366-03	.24193-03	.19687-03	.14428-03	
.97006-04	.66093-04	.44664-04	.29615-04	.19293-04	.11626-04	.54122-05	.41742-03	.41735-03	.41708-03	
.41663-03	.41263-03	.40204-03	.38528-03	.36273-03	.33493-03	.30247-03	.26617-03	.22698-03	.18470-03	
.13536-03	.90998-04	.61984-04	.41898-04	.27979-04	.18113-04	.10915-04	.50827-05	.38350-03	.38344-03	
.38318-03	.38277-03	.37910-03	.36935-03	.35394-03	.33317-03	.30759-03	.27777-03	.24437-03	.20829-03	
.16943-03	.12415-03	.83445-04	.56859-04	.38443-04	.25691-04	.16641-04	.10033-04	.46798-05	.34342-03	
.34337-03	.34314-03	.34276-03	.33948-03	.33074-03	.31690-03	.29829-03	.27529-03	.24852-03	.21854-03	
.18615-03	.15135-03	.11085-03	.74501-04	.50742-04	.34350-04	.23001-04	.14918-04	.90183-05	.42050-05	
.29787-03	.29782-03	.29762-03	.29730-03	.29444-03	.28686-03	.27484-03	.25866-03	.23867-03	.21533-03	
.18921-03	.16083-03	.13049-03	.95448-04	.64023-04	.43721-04	.29758-04	.19995-04	.13027-04	.78938-05	
.36874-05	.24605-03	.24600-03	.24584-03	.24557-03	.24322-03	.23694-03	.22701-03	.21362-03	.19709-03	
.17775-03	.15667-03	.13236-03	.10658-03	.77480-04	.52313-04	.36196-04	.24860-04	.16836-04	.11040-04	
.67154-05	.31495-05	.18350-03	.18346-03	.18334-03	.18314-03	.18138-03	.17670-03	.16928-03	.15928-03	
.14694-03	.13248-03	.11627-03	.98450-04	.78724-04	.58583-04	.41387-04	.29071-04	.20342-04	.13882-04	
.92031-05	.56163-05	.26504-05	.12639-03	.12636-03	.12627-03	.12614-03	.12493-03	.12171-03	.11660-03	
.10970-03	.10118-03	.91201-04	.80011-04	.67591-04	.54317-04	.42197-04	.31706-04	.22880-04	.16345-04	
.11320-04	.75492-05	.46643-05	.21899-05	.88025-04	.87964-04	.87964-04	.87864-04	.87027-04	.84790-04	
.81221-04	.76423-04	.70470-04	.63529-04	.55706-04	.47163-04	.38375-04	.30262-04	.23341-04	.17407-04	
.12667-04	.69861-05	.60253-05	.37616-05	.17789-05	.60744-04	.60727-04	.60681-04	.60613-04	.60042-04	
.58492-04	.56038-04	.52721-04	.48621-04	.43845-04	.38495-04	.32767-04	.26904-04	.21610-04	.17021-04	
.12923-04	.95296-05	.68654-05	.46995-05	.29230-05	.14119-05	.41347-04	.41334-04	.41305-04	.41266-04	
.40867-04	.39816-04	.38146-04	.35888-04	.33111-04	.29884-04	.26283-04	.22459-04	.18584-04	.15047-04	
.12033-04	.93601-05	.76041-05	.50583-05	.35128-05	.22122-05	.10564-05	.27270-04	.27263-04	.27247-04	
.27213-04	.26953-04	.26262-04	.25160-04	.23677-04	.21858-04	.19740-04	.17391-04	.14924-04	.12432-04	
.10177-04	.81899-05	.64100-05	.48988-05	.35656-05	.24835-05	.15853-05	.75639-06	.16746-04	.16741-04	
.16724-04	.16707-04	.16551-04	.16125-04	.15449-04	.14545-04	.13427-04	.12134-04	.10719-04	.92226-05	
.77128-05	.63370-05	.51624-05	.40823-05	.31106-05	.23068-05	.16179-05	.10283-05	.49905-06	.79327-05	

.79295-05	.79277-05	.79202-05	.78430-05	.76412-05	.73235-05	.68920-05	.63651-05	.57613-05	.50895-05
.43866-05	.36835-05	.30449-05	.24703-05	.19678-05	.15297-05	.11218-05	.78747-06	.50871-06	.24848-06
.23534-03	.23527-03	.23509-03	.23484-03	.23262-03	.22665-03	.21714-03	.20429-03	.18836-03	.16969-03
.14863-03	.12564-03	.10066-03	.72208-04	.47385-04	.31527-04	.20897-04	.13742-04	.87248-05	.50956-05
.21372-05	.23526-03	.23519-03	.23503-03	.23477-03	.23254-03	.22658-03	.21707-03	.20422-03	.18830-03
.16964-03	.14857-03	.12559-03	.10063-03	.72184-04	.47369-04	.31517-04	.20889-04	.13738-04	.87216-05
.50930-05	.21378-05	.23512-03	.23504-03	.23486-03	.23460-03	.23238-03	.22642-03	.21693-03	.20408-03
.18817-03	.16952-03	.14847-03	.12551-03	.10056-03	.72135-04	.47337-04	.31494-04	.20876-04	.13729-04
.87144-05	.50918-05	.21353-05	.23487-03	.23480-03	.23462-03	.23436-03	.23215-03	.22619-03	.21671-03
.20388-03	.18797-03	.16935-03	.14833-03	.12538-03	.10046-03	.72063-04	.47286-04	.31462-04	.20857-04
.13713-04	.87070-05	.50853-05	.21332-05	.23265-03	.23257-03	.23241-03	.23215-03	.22995-03	.22406-03
.21465-03	.20195-03	.18620-03	.16774-03	.14691-03	.12419-03	.99498-04	.71374-04	.46838-04	.31164-04
.20655-04	.13584-04	.86242-05	.50371-05	.21130-05	.22658-03	.22650-03	.22634-03	.22609-03	.22395-03
.21820-03	.20905-03	.19666-03	.18132-03	.16335-03	.14306-03	.12092-03	.96883-04	.69498-04	.45606-04
.30343-04	.20114-04	.13228-04	.83983-05	.49054-05	.20582-05	.21673-03	.21667-03	.21651-03	.21627-03
.21422-03	.20872-03	.19996-03	.18811-03	.17342-03	.15622-03	.13681-03	.11563-03	.92636-04	.66450-04
.43606-04	.29017-04	.19234-04	.12651-04	.80335-05	.46933-05	.19691-05	.20326-03	.20319-03	.20305-03
.20283-03	.20096-03	.19574-03	.18751-03	.17639-03	.16261-03	.14646-03	.12824-03	.10838-03	.86823-04
.62278-04	.40871-04	.27194-04	.18031-04	.11864-04	.76369-05	.44047-05	.18483-05	.18633-03	.18627-03
.18613-03	.18593-03	.18416-03	.17443-03	.17188-03	.16167-03	.14902-03	.13420-03	.11748-03	.99254-04
.79493-04	.57016-04	.37416-04	.24910-04	.16524-04	.10881-04	.69196-05	.40466-05	.17003-05	.16611-03
.16605-03	.16593-03	.16575-03	.16417-03	.15995-03	.15320-03	.14409-03	.13279-03	.11956-03	.10462-03
.88347-04	.70728-04	.50720-04	.33305-04	.22179-04	.14738-04	.97296-05	.61978-05	.36332-05	.15262-05
.14289-03	.14285-03	.14274-03	.14259-03	.14123-03	.13759-03	.13178-03	.12393-03	.11420-03	.10278-03
.89083-04	.75786-04	.60587-04	.43427-04	.28496-04	.19049-04	.12736-04	.84429-05	.54043-05	.31754-05
.13372-05	.11630-03	.11626-03	.11617-03	.11604-03	.11494-03	.11198-03	.10725-03	.10085-03	.92918-04
.83599-04	.73073-04	.61512-04	.48843-04	.34838-04	.23097-04	.15689-04	.10597-04	.70914-05	.45601-05
.26969-05	.11403-05	.84931-04	.84903-04	.84841-04	.84747-04	.83943-04	.81777-04	.78322-04	.73644-04
.67848-04	.61036-04	.53334-04	.44863-04	.35421-04	.25880-04	.18044-04	.12512-04	.86238-05	.58281-05
.37988-05	.22500-05	.95819-06	.57102-04	.57081-04	.57039-04	.56979-04	.56438-04	.54984-04	.52659-04
.49513-04	.45617-04	.41033-04	.35871-04	.30147-04	.24015-04	.18414-04	.13685-04	.97851-05	.68947-05
.47298-05	.31111-05	.18614-05	.79001-06	.38822-04	.38809-04	.38781-04	.38739-04	.38371-04	.37385-04
.35803-04	.33668-04	.31016-04	.27913-04	.24409-04	.20589-04	.16657-04	.13038-04	.99889-05	.74099-05
.53339-05	.37336-05	.24764-05	.14980-05	.63786-06	.26250-04	.26240-04	.26221-04	.26191-04	.25945-04
.25277-04	.24210-04	.22766-04	.20979-04	.18890-04	.16549-04	.14045-04	.11480-04	.91683-05	.71842-05
.54446-05	.40045-05	.28482-05	.19187-05	.11632-05	.50311-06	.17590-04	.17583-04	.17570-04	.17553-04
.17386-04	.16939-04	.16225-04	.15260-04	.14067-04	.12679-04	.11137-04	.94929-05	.78335-05	.63208-05
.50292-05	.38906-05	.29074-05	.20933-05	.14272-05	.87425-06	.37593-06	.11379-04	.11375-04	.11368-04
.11354-04	.11247-04	.10959-04	.10497-04	.98750-05	.91082-05	.82183-05	.72327-05	.61963-05	.51486-05
.42028-05	.33762-05	.26348-05	.20005-05	.14575-05	.99908-06	.61773-06	.26689-06	.67761-05	.67741-05
.67678-05	.67610-05	.66975-05	.65258-05	.62516-05	.58826-05	.54281-05	.49016-05	.43248-05	.37148-05
.31010-05	.25414-05	.20625-05	.16274-05	.12388-05	.91226-06	.63099-06	.38974-06	.17041-06	.28918-05
.28901-05	.28891-05	.28860-05	.28585-05	.27851-05	.26687-05	.25111-05	.23177-05	.20957-05	.18491-05
.15920-05	.13346-05	.11014-05	.89156-06	.70602-06	.54555-06	.39947-06	.27783-06	.17355-06	.74801-07
ADJ	840								
.30709-03	.30699-03	.30676-03	.30642-03	.30344-03	.29543-03	.28261-03	.26518-03	.24337-03	.21744-03
.18750-03	.15386-03	.11499-03	.70220-04	.35814-04	.18943-04	.99324-05	.53091-05	.27942-05	.14115-05
.53776-06	.30698-03	.30688-03	.30666-03	.30632-03	.30333-03	.29533-03	.28252-03	.26509-03	.24328-03
.21736-03	.18743-03	.15380-03	.11495-03	.70195-04	.35801-04	.18937-04	.99275-05	.53088-05	.27927-05

•14097-05	•53969-06	•30678-03	•30668-03	•30644-03	•30610-03	•30312-03	•29512-03	•28232-03	•26490-03
•24311-03	•21721-03	•18730-03	•15369-03	•11487-03	•70146-04	•35777-04	•18921-04	•99222-05	•53053-05
•27888-05	•14109-05	•53759-06	•30646-03	•30636-03	•30612-03	•30578-03	•30281-03	•29481-03	•28203-03
•26463-03	•24266-03	•21699-03	•18711-03	•15353-03	•11475-03	•70076-04	•35735-04	•18901-04	•99146-05
•52956-05	•27883-05	•14084-05	•53713-06	•30347-03	•30338-03	•30315-03	•30281-03	•29986-03	•29195-03
•27928-03	•26205-03	•24050-03	•21487-03	•18528-03	•15203-03	•11362-03	•69380-04	•35383-04	•18715-04
•98096-05	•52443-05	•27592-05	•13937-05	•53166-06	•29530-03	•29520-03	•29498-03	•29465-03	•29178-03
•28408-03	•27175-03	•25408-03	•23400-03	•20906-03	•18026-03	•14791-03	•11054-03	•67487-04	•34406-04
•18191-04	•95357-05	•50959-05	•26604-05	•13539-05	•51681-06	•28197-03	•28188-03	•28167-03	•28135-03
•27861-03	•27126-03	•25948-03	•24346-03	•22342-03	•19959-03	•17209-03	•14119-03	•10550-03	•64386-04
•32808-04	•17342-04	•90829-05	•48528-05	•25523-05	•12895-05	•49168-06	•26354-03	•26345-03	•26326-03
•26296-03	•26039-03	•25352-03	•24250-03	•22752-03	•20878-03	•18650-03	•16078-03	•13189-03	•98525-04
•60098-04	•30594-04	•16151-04	•84561-05	•45166-05	•23755-05	•12001-05	•45798-06	•24000-03	•23993-03
•23975-03	•23948-03	•23714-03	•23087-03	•22083-03	•20717-03	•19009-03	•16978-03	•14634-03	•12001-03
•89599-04	•54581-04	•27733-04	•14633-04	•76521-05	•40884-05	•21518-05	•10883-05	•41641-06	•21117-03
•21110-03	•21094-03	•21070-03	•20864-03	•20312-03	•19427-03	•18224-03	•16719-03	•14929-03	•12862-03
•10543-03	•78635-04	•47815-04	•24241-04	•12757-04	•66751-05	•35772-05	•18867-05	•95906-06	•36580-06
•17689-03	•17683-03	•17670-03	•17650-03	•17477-03	•17014-03	•16272-03	•15263-03	•13999-03	•12496-03
•10760-03	•88061-04	•65534-04	•39661-04	•19970-04	•10547-04	•55629-05	•29988-05	•15960-05	•81374-06
•31265-06	•13470-03	•13466-03	•13455-03	•13440-03	•13309-03	•12955-03	•12389-03	•11617-03	•10652-03
•95022-04	•31724-04	•66718-04	•49244-04	•29563-04	•15074-04	•81656-05	•43711-05	•23979-05	•12901-05
•66486-06	•25789-06	•84091-04	•84063-04	•84000-04	•83903-04	•83082-04	•80861-04	•77306-04	•72454-04
•66383-04	•59123-04	•50736-04	•41207-04	•30144-04	•18975-04	•10649-04	•59261-05	•33191-05	•18350-05
•10238-05	•52310-06	•21141-06	•44358-04	•44341-04	•44307-04	•44261-04	•43821-04	•42642-04	•40748-04
•38162-04	•34920-04	•31029-04	•26555-04	•21415-04	•15833-04	•10928-04	•70218-05	•41373-05	•24267-05
•13831-05	•78312-06	•41549-06	•16029-06	•24161-04	•24153-04	•24136-04	•24107-04	•23867-04	•23222-04
•22178-04	•20761-04	•18970-04	•16841-04	•14374-04	•11629-04	•88106-05	•62500-05	•42492-05	•27330-05
•16716-05	•10076-05	•57308-06	•31701-06	•12240-06	•13018-04	•13014-04	•13002-04	•12985-04	•12859-04
•12506-04	•11942-04	•11167-04	•10197-04	•90412-05	•77209-05	•62958-05	•48415-05	•35891-05	•25577-05
•17154-05	•11063-05	•69200-06	•41526-06	•22405-06	•96053-07	•71149-05	•71117-05	•71059-05	•71011-05
•70267-05	•68337-05	•65224-05	•60971-05	•55653-05	•49360-05	•42283-05	•34689-05	•27142-05	•20319-05
•14938-05	•10605-05	•70924-06	•45441-06	•28359-06	•15971-06	•63433-07	•38252-05	•38240-05	•38227-05
•38156-05	•37777-05	•36734-05	•35049-05	•32757-05	•29901-05	•26541-05	•22789-05	•18869-05	•14936-05
•11575-05	•86468-06	•61786-06	•43655-06	•29038-06	•18080-06	•10629-06	•43104-07	•19708-05	•19704-05
•19666-05	•19657-05	•19459-05	•18916-05	•18047-05	•16871-05	•15400-05	•13687-05	•11813-05	•98178-06
•78529-06	•60552-06	•46906-06	•34895-06	•24110-06	•16781-06	•10872-06	•61522-07	•27396-07	•76526-06
•76404-06	•76530-06	•76411-06	•75586-06	•73474-06	•70132-06	•65498-06	•59840-06	•53324-06	•45915-06
•38415-06	•31042-06	•24822-06	•18486-06	•13795-06	•10504-06	•67868-07	•45217-07	•27882-07	•10280-07
•36080-03	•36075-03	•36050-03	•36013-03	•35674-03	•34765-03	•33328-03	•31399-03	•29023-03	•26262-03
•23191-03	•19897-03	•16420-03	•12384-03	•86060-04	•59774-04	•40995-04	•27645-04	•18014-04	•10899-04
•50838-05	•36070-03	•36065-03	•36043-03	•36003-03	•35661-03	•34754-03	•33318-03	•31388-03	•29014-03
•26254-03	•23183-03	•19890-03	•16415-03	•12380-03	•86030-04	•59754-04	•40980-04	•27639-04	•18006-04
•10894-04	•50864-05	•36051-03	•36045-03	•36019-03	•35980-03	•35637-03	•34730-03	•33297-03	•31367-03
•28994-03	•26237-03	•23167-03	•19877-03	•16404-03	•12372-03	•85972-04	•59712-04	•40955-04	•27620-04
•17990-04	•10890-04	•50813-05	•36014-03	•36008-03	•35982-03	•35944-03	•35601-03	•34695-03	•33263-03
•31337-03	•28964-03	•26210-03	•23145-03	•19866-03	•16387-03	•12359-03	•85882-04	•59653-04	•40917-04
•27587-04	•17975-04	•10879-04	•50751-05	•35676-03	•35670-03	•35648-03	•35609-03	•35271-03	•34372-03
•32952-03	•31045-03	•28695-03	•25664-03	•22927-03	•19671-03	•16233-03	•12243-03	•85077-04	•59093-04
•40524-04	•27330-04	•17807-04	•10775-04	•50276-05	•34762-03	•34756-03	•34732-03	•34696-03	•34366-03

.33490-03	.32106-03	.30246-03	.27956-03	.25296-03	.22335-03	.19161-03	.15813-03	.11925-03	.82865-04
.57551-04	.39472-04	.26620-04	.17343-04	.10495-04	.48984-05	.33283-03	.33278-03	.33256-03	.33220-03
.32905-03	.32066-03	.30740-03	.28959-03	.26764-03	.24213-03	.21379-03	.18339-03	.15132-03	.11411-03
.79287-04	.55069-04	.37764-04	.25467-04	.16596-04	.10046-04	.46872-05	.31272-03	.31267-03	.31247-03
.31214-03	.30915-03	.30127-03	.28880-03	.27204-03	.25143-03	.22743-03	.20073-03	.17216-03	.14205-03
.10710-03	.74405-04	.51663-04	.35433-04	.23903-04	.15583-04	.94332-05	.44023-05	.28768-03	.28764-03
.28745-03	.28714-03	.28440-03	.27713-03	.26565-03	.25019-03	.23119-03	.20913-03	.18452-03	.15817-03
.13044-03	.98327-04	.68280-04	.47416-04	.32527-04	.21957-04	.14322-04	.86733-05	.40544-05	.25827-03
.25823-03	.25806-03	.25778-03	.25532-03	.24878-03	.23845-03	.22456-03	.20742-03	.18755-03	.16542-03
.14169-03	.11677-03	.87957-04	.61050-04	.42370-04	.29094-04	.19675-04	.12847-04	.77992-05	.36446-05
.22522-03	.22519-03	.22504-03	.22480-03	.22264-03	.21694-03	.20791-03	.19577-03	.18079-03	.16335-03
.14394-03	.12299-03	.10112-03	.76041-04	.52640-04	.36597-04	.25250-04	.17124-04	.11228-04	.68315-05
.31975-05	.18859-03	.18856-03	.18843-03	.18823-03	.18643-03	.18165-03	.17408-03	.16389-03	.15132-03
.13666-03	.12031-03	.10253-03	.83533-04	.62269-04	.43255-04	.30410-04	.21148-04	.14443-04	.95272-05
.58166-05	.27331-05	.14472-03	.14469-03	.14459-03	.14444-03	.14306-03	.13939-03	.13356-03	.12572-03
.11606-03	.10477-03	.92152-04	.78375-04	.63246-04	.47811-04	.34447-04	.24555-04	.17349-04	.11938-04
.79508-05	.48715-05	.23012-05	.10303-03	.10300-03	.10292-03	.10282-03	.10184-03	.99224-04	.95071-04
.89477-04	.82575-04	.74502-04	.65475-04	.55513-04	.44877-04	.35109-04	.26636-04	.19441-04	.13990-04
.97551-05	.65360-05	.40476-05	.19055-05	.73181-04	.73162-04	.73029-04	.72335-04	.70482-04	.70482-04
.67526-04	.63552-04	.58629-04	.52694-04	.46449-04	.39432-04	.32212-04	.25545-04	.19829-04	.14891-04
.10898-04	.77594-05	.52285-05	.32686-05	.15486-05	.51236-04	.51221-04	.51183-04	.51125-04	.50644-04
.49341-04	.47276-04	.44488-04	.41043-04	.37034-04	.32555-04	.27766-04	.22861-04	.18416-04	.14563-04
.11117-04	.82392-05	.59505-05	.40820-05	.25472-05	.12282-05	.35241-04	.35231-04	.35205-04	.35171-04
.34833-04	.33939-04	.32519-04	.30600-04	.28240-04	.25500-04	.22458-04	.19211-04	.15925-04	.12929-04
.10363-04	.80800-05	.60707-05	.43999-05	.30579-05	.19290-05	.92250-06	.23413-04	.23407-04	.23393-04
.23365-04	.23142-04	.22550-04	.21605-04	.20335-04	.18776-04	.16965-04	.14957-04	.12848-04	.10718-04
.87854-05	.70864-05	.55599-05	.42543-05	.31213-05	.21672-05	.13834-05	.66152-06	.14445-04	.14441-04
.14427-04	.14412-04	.14277-04	.13910-04	.13328-04	.12550-04	.11588-04	.10475-04	.92590-05	.79730-05
.66745-05	.54922-05	.44774-05	.35460-05	.27098-05	.20112-05	.14119-05	.89863-06	.43591-06	.68594-05
.68567-05	.68544-05	.68479-05	.67814-05	.66073-05	.63329-05	.59605-05	.55057-05	.49852-05	.44061-05
.38000-05	.31937-05	.26419-05	.21481-05	.17122-05	.13305-05	.97951-06	.68853-06	.44430-06	.21692-06

MESH BOUNDARIES (R1/Z1=RADIAL POINTS/AXIAL POINTS)

R1		22							
- .00000	.63500-00	.12700+01	.19050+01	.25400+01	.68922+01	.11244+02	.15597+02	.19949+02	.24301+02
.28653+02	.33036+02	.37358+02	.41710+02	.45520+02	.49330+02	.53140+02	.56950+02	.60760+02	.64570+02
.68380+02	.72190+02								
Z1		21							
- .00000	.63500-00	.12700+01	.19050+01	.25400+01	.69944+01	.11449+02	.15903+02	.20357+02	.24812+02
.29266+02	.33721+02	.38175+02	.41985+02	.45795+02	.49605+02	.53415+02	.57225+02	.61035+02	.64845+02
.68655+02									

ZONE NUMBERS BY MESH INTERVAL

M0		420							
1		1	1	1	2	2	2	2	2
2		2	2	3	3	3	3	3	3
3		1	1	1	1	2	2	2	2
2		2	2	2	3	3	3	3	3
3		3	1	1	1	2	2	2	2

17	17	18	18	18	18	18	18	19	19
19	19	19	19	19	19	19	19	19	19
19									
I1	31								
0	1	2	3	4	5	6	7	8	9
10	11	0	12	13	14	15	16	0	1
2	3	4	5	6	7	8	9	10	11
17									
I2	31								
.00000	.16540-02	.10600-03	.16000-04	.74060-02	.20765-01	.62300-02	.98990-02	.26580-02	.13080-02
.20600-03	.11000-03	.00000	.84000-04	.39976-01	.44530-02	.11960-02	.58800-03	.00000	.16540-02
.10600-03	.16000-04	.74060-02	.20765-01	.62300-02	.98990-02	.26580-02	.13080-02	.20600-03	.11000-03
.10000-09									

MATERIAL NUMBERS FOR BETA CALCULATION

NBET	6					
1	2	3	4	12	13	
BETA	6					
.63000-02	.88000-02	.16500-01	.41200-01	.16500-01	.41200-01	

DELAYED FISSION SPECTRUM

CHIP	2
.10000+01	.00000

NEUTRON VELOCITY

VEL	2
.76309+09	.11636+09

PERTURBATION CALCULATION INFORMATION (MATDK/NROW/NCOL=MATERIAL NUMBER/ROW/COLUMN TO BE PERTURBED)

MATDK	3		
1	1	6	
NROW	3		
1	0	1	
NCOL	3		
0	5	0	

ACTIVITY TRAVERSE INFORMATION (MA/NX=MATERIAL NUMBER/CROSS SECTION POSITION)

MA	1
1	
NX	1
1	

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3

RADIAL

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

A
X
I
A
L

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BNWL-409

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

CROSS-SECTION EDIT

GROUP 1 CROSS-SECTIONS

MAT 1	.172+01	.185+01	.512+01	.669+01	.477+01	.000
MAT 2	.697-00	.973-00	.210+01	.654+01	.549+01	.000
MAT 3	.132+01	.151+01	.332+01	.623+01	.457+01	.000
MAT 4	.100+00	.233-00	.281-00	.634+01	.601+01	.000
MAT 5	.000	.834-05	.000	.264+01	.245+01	.000
MAT 6	.000	.713-03	.000	.309+01	.300+01	.000
MAT 7	.000	.592-02	.000	.256+01	.252+01	.000
MAT 8	.000	.454-02	.000	.267+01	.261+01	.000
MAT 9	.000	.305-01	.000	.308+01	.300+01	.000
MAT 10	.000	.431-01	.000	.527+01	.516+01	.000
MAT 11	.000	.205-02	.000	.283+01	.273+01	.000
MAT 12	.134+01	.157+01	.333+01	.679+01	.506+01	.000
MAT 13	.372-01	.190-00	.105+00	.695+01	.665+01	.000
MAT 14	.000	.671-02	.000	.265+01	.260+01	.000
MAT 15	.000	.483-02	.000	.276+01	.267+01	.000
MAT 16	.000	.182-01	.000	.338+01	.331+01	.000
MAT 17	.369-02	.503-02	.108-01	.171-00	.160-00	.000
MAT 18	.160-02	.775-02	.449-02	.295-00	.283-00	.000
MAT 19	.369-02	.503-02	.108-01	.171-00	.160-00	.000

GROUP 2 CROSS-SECTIONS

MAT 1	.228+01	.324+01	.650+01	.139+02	.107+02	.790-01
MAT 2	.205-01	.158+01	.578-01	.139+02	.124+02	.749-01
MAT 3	.336+01	.487+01	.815+01	.147+02	.985+01	.147-00
MAT 4	.000	.532-00	.000	.132+02	.126+02	.976-01
MAT 5	.000	.457-10	.000	.449+01	.449+01	.188-00
MAT 6	.000	.423-02	.000	.498+01	.498+01	.890-01
MAT 7	.000	.215-01	.000	.482+01	.480+01	.342-01
MAT 8	.000	.150-01	.000	.472+01	.471+01	.596-01
MAT 9	.000	.204-01	.000	.945+01	.943+01	.424-01
MAT 10	.000	.303-00	.000	.789+01	.759+01	.705-01
MAT 11	.000	.830-02	.000	.217+01	.216+01	.968-01
MAT 12	.212+01	.284+01	.515+01	.123+02	.948+01	.168-00
MAT 13	.000	.405-00	.000	.122+02	.118+02	.112+00
MAT 14	.000	.120-01	.000	.450+01	.449+01	.450-01
MAT 15	.000	.924-02	.000	.441+01	.440+01	.791-01

MAT 16	.000	.169-01	.000	.750+01	.748+01	.546-01
MAT 17	.383-02	.992-02	.109-01	.321-00	.311-00	.591-02
MAT 18	.178-03	.165-01	.433-03	.519-00	.502-00	.483-02
MAT 19	.383-02	.992-02	.109-01	.321-00	.311-00	.591-02

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

MIXTURE NUMBER	MIX COMMAND	MATERIAL ATOMIC DENSITY
1	17	0
2	17	1
3	17	2
4	17	3
5	17	4
6	17	5
7	17	6
8	17	7
9	17	8
10	17	9
11	17	10
12	17	11
13	18	0
14	18	12
15	18	13
16	18	14
17	18	15
18	18	16
19	19	0
20	19	1
21	19	2
22	19	3
23	19	4
24	19	5
25	19	6
26	19	7
27	19	8
28	19	9
29	19	10
30	19	11
31	19	17

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PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

	RADII	AVG RADII	AXII	AVG AXII
1	-.0000	.3175	-.0000	.3175
2	.6350	.9525	.6350	.9525
3	1.2700	1.5875	1.2700	1.5875
4	1.9050	2.2225	1.9050	2.2225
5	2.5400	4.7161	2.5400	4.7672
6	6.8922	9.0683	6.9944	9.2216
7	11.2444	13.4206	11.4487	13.6759
8	15.5967	17.7728	15.9031	18.1303
9	19.9489	22.1250	20.3575	22.5847
10	24.3011	26.4772	24.8119	27.0391
11	28.6533	30.8294	29.2662	31.4934
12	33.0056	35.1817	33.7206	35.9478
13	37.3578	39.5339	38.1750	40.0800
14	41.7100	43.6150	41.9850	43.8900
15	45.5200	47.4250	45.7950	47.7000
16	49.3300	51.2350	49.6050	51.5100
17	53.1400	55.0450	53.4150	55.3200
18	56.9500	58.8550	57.2250	59.1300
19	60.7600	62.6650	61.0350	62.9400
20	64.5700	66.4750	64.8450	66.7500
21	68.3800	70.2850	68.6550	.0000
22	72.1900	.0000	.0000	.0000

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE

MATERIAL	ATOMIC WT.	ZONE 1 .10 LITERS	ZONE 2 417.19 LITERS	ZONE 3 1830.76 LITERS
1 M2PU49	239.050	.068	273.869	.000
2 PU240	240.050	.004	17.625	.000
3 M2U235	235.040	.001	2.605	.000
4 U238	238.050	.301	1221.155	.000
5 C	12.011	.043	172.755	.000
6 NA	22.990	.024	99.208	.000
7 M2 FE	55.847	.095	382.922	.000
8 CR	51.996	.024	95.729	.000
9 NI	58.710	.013	53.191	.000
10 MO	95.940	.003	13.689	.000
11 AL	26.981	.001	2.056	.000
12 M2U235	235.040	.000	.000	60.012
13 U238	238.050	.000	.000	28925.792
14 M2 FE	55.847	.000	.000	755.910
15 CR	51.996	.000	.000	189.025
16 NI	58.710	.000	.000	104.932

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BNWL-409

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

CENTER POINT FLUX (N/CM2-SEC)	-	-	-	1.00000+00
CENTER POINT POWER (MWT/LITER)	-	-	-	1.23298-16
TOTAL POWER (MWT)	-	-	-	3.22585-14
DENOMINATOR OF PERT. FORMULA	-	-	-	1.56242+03
SOURCE RATE	-	-	-	2.82202+03
ABSORPTION RATE	-	-	-	2.64820+03
LEAKAGE RATE (TOTAL)	-	-	-	1.60694+02
RADIAL LEAKAGE	-	-	-	1.18695+02
AXIAL LEAKAGE	-	-	-	4.19992+01
KEFF	-	-	-	1.00467

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

TOTAL FLUX

	1	2	3	4	5
1	.1000000+01	.9997979-00	.9990830-00	.9980266-00	.9885766-00
2	.9996795-00	.9994885-00	.9988517-00	.9977479-00	.9882198-00
3	.9991206-00	.9988865-00	.9981660-00	.9970762-00	.9875564-00
4	.9980810-00	.9978705-00	.9971487-00	.9960616-00	.9865670-00
5	.9886532-00	.9884525-00	.9877933-00	.9867203-00	.9773106-00
6	.9630553-00	.9628477-00	.9621774-00	.9611461-00	.9519887-00
7	.9215870-00	.9214073-00	.9207746-00	.9197572-00	.9110012-00
8	.8649799-00	.8647932-00	.8642093-00	.8632811-00	.8550156-00
9	.7941176-00	.7939573-00	.7934054-00	.7925511-00	.7849783-00
10	.7100870-00	.7099364-00	.7094487-00	.7086613-00	.7018953-00
11	.6142483-00	.6141215-00	.6136992-00	.6130372-00	.6071506-00
12	.5049654-00	.5048498-00	.5045000-00	.5039495-00	.4991318-00
13	.3740842-00	.3739965-00	.3737378-00	.3733268-00	.3697648-00
14	.2557237-00	.2556457-00	.2554643-00	.2551989-00	.2527595-00
15	.1768079-00	.1767568-00	.1766346-00	.1764353-00	.1747561-00
16	.1212360+00	.1211996+00	.1211076+00	.1209706+00	.1198328+00
17	.8213459-01	.8210798-01	.8204861-01	.8197043-01	.8118136-01
18	.5386170-01	.5384623-01	.5381417-01	.5374742-01	.5323652-01
19	.3278025-01	.3277143-01	.3273916-01	.3270521-01	.3239885-01
20	.1508522-01	.1507836-01	.1507447-01	.1505970-01	.1491372-01
	6	7	8	9	10
1	.9632435-00	.9230350-00	.8689002-00	.8019929-00	.7238461-00
2	.9629202-00	.9227451-00	.8685908-00	.8017239-00	.7236064-00
3	.9622554-00	.9221473-00	.8680069-00	.8011665-00	.7231326-00
4	.9612813-00	.9212066-00	.8671595-00	.8003386-00	.7223925-00
5	.9522604-00	.9125327-00	.8589985-00	.7928382-00	.7155625-00
6	.9275754-00	.8888636-00	.8366854-00	.7722239-00	.6969577-00
7	.8876345-00	.8505630-00	.8006229-00	.7388776-00	.6667833-00
8	.8330732-00	.7982482-00	.7513225-00	.6933776-00	.6256313-00
9	.7647834-00	.7327875-00	.6896176-00	.6363356-00	.5741373-00
10	.6838216-00	.6551480-00	.6165115-00	.5687023-00	.5129564-00
11	.5915143-00	.5666732-00	.5331930-00	.4917610-00	.4433232-00
12	.4862562-00	.4658231-00	.4382421-00	.4041525-00	.3642139-00
13	.3602213-00	.3450672-00	.3246087-00	.2993286-00	.2696928-00
14	.2462481-00	.2358777-00	.2218843-00	.2045823-00	.1842821-00
15	.1702648-00	.1630863-00	.1534238-00	.1414311-00	.1274341-00
16	.1167406+00	.1118352+00	.1052000+00	.9699593-01	.8742753-01
17	.7909443-01	.7577150-01	.7128031-01	.6574823-01	.5931518-01

18	.5187190-01	.4969257-01	.4675886-01	.4315451-01	.3896344-01
19	.3156643-01	.3024271-01	.2846849-01	.2627719-01	.2374065-01
20	.1453031-01	.1392529-01	.1310426-01	.1210034-01	.1094963-01
	11	12	13	14	15
1	.6361837-00	.5410697-00	.4381390-00	.3189418-00	.2128196-00
2	.6359663-00	.5408872-00	.4379912-00	.3188355-00	.2127468-00
3	.6355343-00	.5405206-00	.4376958-00	.3186210-00	.2126040-00
4	.6349128-00	.5399576-00	.4372568-00	.3183022-00	.2123760-00
5	.6289021-00	.5348737-00	.4331125-00	.3152794-00	.2103767-00
6	.6124993-00	.5208972-00	.4218000-00	.3070444-00	.2048719-00
7	.5859691-00	.4982944-00	.4034588-00	.2936808-00	.1959591-00
8	.5496544-00	.4673644-00	.3784029-00	.2754323-00	.1837746-00
9	.5042881-00	.4285924-00	.3469087-00	.2524737-00	.1684333-00
10	.4503637-00	.3825471-00	.3094855-00	.2251717-00	.1502390-00
11	.3889489-00	.3297401-00	.2662880-00	.1935384-00	.1289354-00
12	.3193412-00	.2701874-00	.2165982-00	.1565285-00	.1050921+00
13	.2363606-00	.1997223-00	.1590731-00	.1177081+00	.8282429-01
14	.1614953-00	.1362102-00	.1091641+00	.8446820-01	.6325743-01
15	.1116493+00	.9442040-01	.7669421-01	.6034269-01	.4644917-01
16	.7670968-01	.6523789-01	.5349239-01	.4289293-01	.3373243-01
17	.5216205-01	.4452837-01	.3681526-01	.2977864-01	.2377770-01
18	.3431639-01	.2943309-01	.2450025-01	.2003979-01	.1611872-01
19	.2096513-01	.1802974-01	.1507018-01	.1237310-01	.1006868-01
20	.9669658-02	.8331944-02	.6993311-02	.5778430-02	.4685162-02
	16	17	18	19	20
1	.1439374-00	.9670494-01	.6426194-01	.4134772-01	.2468115-01
2	.1438886-00	.9666885-01	.6424759-01	.4132899-01	.2466865-01
3	.1437843-00	.9661129-01	.6420466-01	.4129239-01	.2466053-01
4	.1436436-00	.9652322-01	.6412411-01	.4125875-01	.2463484-01
5	.1422893-00	.9559075-01	.6352681-01	.4087116-01	.2439971-01
6	.1385570-00	.9309911-01	.6187023-01	.3980315-01	.2376388-01
7	.1325453-00	.8904872-01	.5918125-01	.3808221-01	.2274352-01
8	.1242794+00	.8351636-01	.5552525-01	.3574597-01	.2135013-01
9	.1139538+00	.7660265-01	.5096772-01	.3283479-01	.1962216-01
10	.1016233+00	.6841017-01	.4561415-01	.2942777-01	.1763128-01
11	.8747756-01	.5921972-01	.3963178-01	.2568666-01	.1542624-01
12	.7230852-01	.4941349-01	.3334600-01	.2175316-01	.1311704-01
13	.5795153-01	.4036715-01	.2746870-01	.1811952-01	.1096255-01
14	.4552272-01	.3238660-01	.2236776-01	.1485646-01	.9094264-02
15	.3458529-01	.2508672-01	.1772631-01	.1184803-01	.7329826-02
16	.2559708-01	.1886048-01	.1353697-01	.9223159-02	.5694604-02
17	.1846630-01	.1381287-01	.9966567-02	.6884469-02	.4301264-02
18	.1260488-01	.9615001-02	.7028025-02	.4853389-02	.3070191-02
19	.7957160-02	.6061430-02	.4486154-02	.3134061-02	.1976217-02
20	.3726299-02	.2892055-02	.2120094-02	.1484617-02	.9507971-03
	21				
1	.1115890-01				
2	.1116591-01				
3	.1115376-01				

4	.1114041-01
5	.1103550-01
6	.1075131-01
7	.1026664-01
8	.9659150-02
9	.8891368-02
10	.7987053-02
11	.7002327-02
12	.5978204-02
13	.5028931-02
14	.4152796-02
15	.3368065-02
16	.2668762-02
17	.1996130-02
18	.1426049-02
19	.9329756-03
20	.4505314-03

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

FISSION SOURCE*ADJOINT FLUX

	1	2	3	4	5
1	.1000000+01	.9998566-00	.9991575-00	.9981228-00	.9887265-00
2	.9997082-00	.9995758-00	.9989677-00	.9978643-00	.9883608-00
3	.9991967-00	.9990066-00	.9982992-00	.9972069-00	.9876982-00
4	.9981490-00	.9979892-00	.9972818-00	.9962031-00	.9867193-00
5	.9887744-00	.9886256-00	.9879953-00	.9869360-00	.9775462-00
6	.9634279-00	.9632681-00	.9626160-00	.9615955-00	.9524663-00
7	.9224203-00	.9222937-00	.9216832-00	.9206657-00	.9119304-00
8	.8666416-00	.8664959-00	.8659325-00	.8650147-00	.8567460-00
9	.7971608-00	.7970429-00	.7965046-00	.7956617-00	.7880757-00
10	.7155165-00	.7154016-00	.7149272-00	.7141347-00	.7073398-00
11	.6236798-00	.6235873-00	.6231714-00	.6225064-00	.6165375-00
12	.5217756-00	.5216807-00	.5213290-00	.5207644-00	.5157970-00
13	.3996932-00	.3996127-00	.3993418-00	.3989080-00	.3951069-00
14	.2839814-00	.2839013-00	.2836999-00	.2834050-00	.2807031-00
15	.2014523-00	.2013986-00	.2012590-00	.2010318-00	.1991213-00
16	.1408999-00	.1408600-00	.1407549-00	.1405964-00	.1392727-00
17	.9684837-01	.9681921-01	.9674938-01	.9665492-01	.9572610-01
18	.6431098-01	.6429367-01	.6425497-01	.6417743-01	.6356540-01
19	.3966207-01	.3965219-01	.3961450-01	.3957171-01	.3920098-01
20	.1882821-01	.1882077-01	.1881459-01	.1879684-01	.1861417-01
	6	7	8	9	10
1	.9635367-00	.9236741-00	.8701791-00	.8042797-00	.7276684-00
2	.9632151-00	.9233965-00	.8698687-00	.8040108-00	.7274299-00
3	.9625498-00	.9228139-00	.8692865-00	.8034510-00	.7269614-00
4	.9615794-00	.9218796-00	.8684544-00	.8026194-00	.7262159-00
5	.9526340-00	.9132619-00	.8603525-00	.7951750-00	.7194023-00
6	.9281810-00	.8897997-00	.8382088-00	.7746911-00	.7008756-00
7	.8886799-00	.8519054-00	.8025043-00	.7416187-00	.6708557-00
8	.8348914-00	.8003097-00	.7538403-00	.6966636-00	.6300840-00
9	.7679067-00	.7360738-00	.6932179-00	.6405302-00	.5793174-00
10	.6892152-00	.6605636-00	.6220560-00	.5745450-00	.5194518-00
11	.6007419-00	.5757158-00	.5420802-00	.5005631-00	.4522364-00
12	.5025571-00	.4816016-00	.4533828-00	.4186036-00	.3780020-00
13	.3849568-00	.3688740-00	.3472105-00	.3205036-00	.2893081-00
14	.2735000-00	.2620483-00	.2466231-00	.2275867-00	.2053196-00
15	.1940197-00	.1858806-00	.1749370-00	.1613799-00	.1455844-00
16	.1356880-00	.1300092-00	.1223389-00	.1128624-00	.1018320-00
17	.9326935-01	.8936444-01	.8409075-01	.7760174-01	.7007153-01

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BNWL-409

18	.6193794-01	.5934339-01	.5585258-01	.5157118-01	.4659590-01
19	.3819477-01	.3659673-01	.3445790-01	.3181697-01	.2876048-01
20	.1813611-01	.1738289-01	.1636055-01	.1511202-01	.1368294-01
	11	12	13	14	15
1	.6423965-00	.5509008-00	.4542062-00	.3419633-00	.2371703-00
2	.6421776-00	.5507179-00	.4540512-00	.3418500-00	.2370899-00
3	.6417480-00	.5503440-00	.4537468-00	.3416208-00	.2369303-00
4	.6411326-00	.5497735-00	.4532957-00	.3412811-00	.2366796-00
5	.6350998-00	.5446406-00	.4490314-00	.3380629-00	.2344624-00
6	.6186818-00	.5305244-00	.4373947-00	.3292923-00	.2283628-00
7	.5921705-00	.5077493-00	.4185585-00	.3150896-00	.2184994-00
8	.5559800-00	.4766391-00	.3928962-00	.2957295-00	.2050385-00
9	.5110376-00	.4378435-00	.3607635-00	.2714719-00	.1881486-00
10	.4580285-00	.3921477-00	.3228864-00	.2428047-00	.1682050-00
11	.3984012-00	.3402803-00	.2795162-00	.2098494-00	.1449993-00
12	.3327061-00	.2834236-00	.2307304-00	.1717388-00	.1190996+00
13	.2544077-00	.2163040-00	.1744356-00	.1317286-00	.9479888-01
14	.1804157-00	.1529257-00	.1235730+00	.9662477-01	.7325826-01
15	.1278303-00	.1084975+00	.8860752-01	.7024148-01	.5450085-01
16	.8950693-01	.7633114-01	.6283389-01	.5060665-01	.4000640-01
17	.6170773-01	.5277882-01	.4374758-01	.3551077-01	.2845693-01
18	.4107843-01	.3528243-01	.2942965-01	.2412146-01	.1945406-01
19	.2542017-01	.2188833-01	.1832217-01	.1507516-01	.1228887-01
20	.1209317-01	.1042903-01	.8764614-02	.7250180-02	.5894209-02
	16	17	18	19	20
1	.1645175-00	.1127196+00	.7596333-01	.4947530-01	.2992415-01
2	.1644616-00	.1126786+00	.7594550-01	.4945305-01	.2990956-01
3	.1643443-00	.1126110+00	.7589521-01	.4940987-01	.2989837-01
4	.1641841-00	.1125071+00	.7580222-01	.4936819-01	.2986840-01
5	.1626413-00	.1114259+00	.7509625-01	.4890640-01	.2958365-01
6	.1583963-00	.1085321+00	.7314515-01	.4763207-01	.2881449-01
7	.1515628-00	.1038346+00	.6997808-01	.4557920-01	.2758152-01
8	.1421856-00	.9742277-01	.6567759-01	.4279742-01	.2589831-01
9	.1304953-00	.8942962-01	.6032924-01	.3933367-01	.2381155-01
10	.1165911+00	.7998497-01	.5405531-01	.3528023-01	.2141107-01
11	.1006870+00	.6940648-01	.4704387-01	.3083228-01	.1875368-01
12	.8364575-01	.5812072-01	.3967228-01	.2615945-01	.1596663-01
13	.6751579-01	.4767075-01	.3278747-01	.2182905-01	.1337088-01
14	.5343499-01	.3843198-01	.2678723-01	.1794243-01	.1110899-01
15	.4091229-01	.2993135-01	.2130376-01	.1435142-01	.8970361-02
16	.3053263-01	.2262247-01	.1633442-01	.1120330-01	.6989556-02
17	.2218455-01	.1666458-01	.1207609-01	.8391491-02	.5292970-02
18	.1526119-01	.1167612-01	.8565616-02	.5946467-02	.3795627-02
19	.9731747-02	.7435973-02	.5518396-02	.3873665-02	.2465255-02
20	.4697828-02	.3650536-02	.2687149-02	.1888795-02	.1218774-02
	21				
1	.1395338-01				
2	.1396063-01				
3	.1394663-01				

4 .1392956-01
5 .1379907-01
6 .1344455-01
7 .1286480-01
8 .1208266-01
9 .1112755-01
10 .1000244-01
11 .8775192-02
12 .7500386-02
13 .6314985-02
14 .5228608-02
15 .4248862-02
16 .3369931-02
17 .2530729-02
18 .1814705-02
19 .1195761-02
20 .5949106-03

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

POWER DENSITY (MWT/LITER)

	1	2	3	4	5
1	.1232984-15	.1232733-15	.1231851-15	.1230548-15	.1218897-15
2	.1232589-15	.1232351-15	.1231565-15	.1230204-15	.1218457-15
3	.1231899-15	.1231608-15	.1230720-15	.1229376-15	.1217639-15
4	.1230617-15	.1230356-15	.1229465-15	.1228125-15	.1216419-15
5	.1218992-15	.1218743-15	.1217930-15	.1216606-15	.1205005-15
6	.1187427-15	.1187170-15	.1186343-15	.1185071-15	.1173781-15
7	.1136292-15	.1136069-15	.1135288-15	.1134034-15	.1123238-15
8	.1066486-15	.1066254-15	.1065534-15	.1064389-15	.1054199-15
9	.9790969-16	.9788979-16	.9782170-16	.9771635-16	.9678274-16
10	.8754587-16	.8752719-16	.8746701-16	.8736993-16	.8653581-16
11	.7572469-16	.7570896-16	.7565686-16	.7557525-16	.7484960-16
12	.6224442-16	.6223008-16	.6218693-16	.6211907-16	.6152526-16
13	.1420256-16	.1419976-16	.1419013-16	.1417456-16	.1403901-16
14	.9771452-17	.9768704-17	.9761882-17	.9751752-17	.9658325-17
15	.6799078-17	.6797260-17	.6792591-17	.6784838-17	.6720208-17
16	.4686312-17	.4684999-17	.4681436-17	.4676144-17	.4632109-17
17	.3187558-17	.3186571-17	.3184292-17	.3181281-17	.3150555-17
18	.2100514-17	.2099966-17	.2098737-17	.2096107-17	.2076116-17
19	.1288134-17	.1287801-17	.1286506-17	.1285155-17	.1273129-17
20	.6076100-18	.6073578-18	.6072192-18	.6066417-18	.6007301-18
	6	7	8	9	10
1	.1187662-15	.1138082-15	.1071327-15	.9888191-16	.8924468-16
2	.1187263-15	.1137724-15	.1070946-15	.9884875-16	.8921513-16
3	.1186443-15	.1136987-15	.1070226-15	.9878003-16	.8915670-16
4	.1185242-15	.1135827-15	.1069181-15	.9867796-16	.8906547-16
5	.1174119-15	.1125132-15	.1059118-15	.9775310-16	.8822330-16
6	.1143680-15	.1095945-15	.1031604-15	.9521122-16	.8592927-16
7	.1094428-15	.1048716-15	.9871346-16	.9109932-16	.8220861-16
8	.1027145-15	.9842040-16	.9263401-16	.8548854-16	.7713414-16
9	.9429286-16	.9034769-16	.8502456-16	.7845425-16	.7078410-16
10	.8430753-16	.8077217-16	.7600823-16	.7011308-16	.6323895-16
11	.7292195-16	.6985934-16	.6573149-16	.6062308-16	.5465064-16
12	.5993816-16	.5741933-16	.5401924-16	.4981667-16	.4489284-16
13	.1367664-16	.1310224-16	.1232769-16	.1137160-16	.1025194-16
14	.9409541-17	.9013848-17	.8480549-17	.7821566-17	.7049236-17
15	.6547517-17	.6271844-17	.5901166-17	.5441209-17	.4904905-17
16	.4512524-17	.4323204-17	.4067202-17	.3750757-17	.3382078-17
17	.3069548-17	.2940757-17	.2766679-17	.2552480-17	.2303541-17

18	.2022911-17	.1937979-17	.1823741-17	.1683522-17	.1520374-17
19	.1240395-17	.1188418-17	.1118840-17	.1032836-17	.9332967-18
20	.5852792-18	.5609372-18	.5278842-18	.4875109-18	.4412514-18
	11	12	13	14	15
1	.7843313-16	.6670167-16	.5400543-16	.1212234-16	.8141006-17
2	.7840632-16	.6667916-16	.5398722-16	.1211831-16	.8138223-17
3	.7835305-16	.6663397-16	.5395080-16	.1211018-16	.8132738-17
4	.7827641-16	.6656456-16	.5389669-16	.1209804-16	.8124006-17
5	.7753533-16	.6593778-16	.5338581-16	.1198345-16	.8047754-17
6	.7551290-16	.6421465-16	.5199132-16	.1167123-16	.7837595-17
7	.7224175-16	.6142844-16	.4973034-16	.1116479-16	.7497635-17
8	.6776403-16	.5761451-16	.4664155-16	.1047381-16	.7033013-17
9	.6216992-16	.5283399-16	.4275891-16	.9605414-17	.6448714-17
10	.5551997-16	.4715620-16	.3814497-16	.8575225-17	.5756678-17
11	.4794573-16	.4064424-16	.3281895-16	.7381502-17	.4946016-17
12	.3936034-16	.3329980-16	.2669195-16	.5988554-17	.4039860-17
13	.8995221-17	.7614191-17	.6084869-17	.4524165-17	.3194231-17
14	.6183332-17	.5222242-17	.4194896-17	.3256913-17	.2445907-17
15	.4300383-17	.3640271-17	.2961184-17	.2334306-17	.1799932-17
16	.2969120-17	.2526996-17	.2074372-17	.1665773-17	.1311724-17
17	.2026597-17	.1730925-17	.1432085-17	.1159378-17	.9269056-18
18	.1339401-17	.1149268-17	.9572611-18	.7835343-18	.6305037-18
19	.8244304-18	.7092929-18	.5931295-18	.4872755-18	.3968928-18
20	.3897777-18	.3359361-18	.2820708-18	.2331581-18	.1891411-18
	16	17	18	19	20
1	.5540133-17	.3740779-17	.2495257-17	.1613177-17	.9702839-18
2	.5538244-17	.3739395-17	.2494741-17	.1612393-17	.9697918-18
3	.5534236-17	.3737226-17	.2493056-17	.1610935-17	.9694954-18
4	.5528901-17	.3733823-17	.2489881-17	.1609638-17	.9685137-18
5	.5476824-17	.3697740-17	.2466751-17	.1594584-17	.9592488-18
6	.5333433-17	.3601572-17	.2402561-17	.1552948-17	.9342771-18
7	.5102651-17	.3445197-17	.2298266-17	.1485920-17	.8942561-18
8	.4785300-17	.3231637-17	.2156652-17	.1395009-17	.8395413-18
9	.4389347-17	.2965082-17	.1980202-17	.1281623-17	.7716997-18
10	.3916703-17	.2649197-17	.1772789-17	.1148890-17	.6935834-18
11	.3374265-17	.2294749-17	.1540983-17	.1003197-17	.6070648-18
12	.2792875-17	.1916747-17	.1297390-17	.8500732-18	.5164021-18
13	.2242392-17	.1567985-17	.1069596-17	.7085421-18	.4318410-18
14	.1764329-17	.1259579-17	.8720217-18	.5811742-18	.3585791-18
15	.1342007-17	.9761131-18	.6920364-18	.4637994-18	.2891591-18
16	.9958270-18	.7342181-18	.5286848-18	.3616403-18	.2246880-18
17	.7208500-18	.5393811-18	.3894813-18	.2702633-18	.1699957-18
18	.4934121-18	.3769844-18	.2758675-18	.1909925-18	.1217535-18
19	.3138265-18	.2391171-18	.1772748-18	.1242596-18	.7888532-19
20	.1506328-18	.1170665-18	.8584845-19	.6024071-19	.3886715-19
	21				
1	.4495929-18				
2	.4499207-18				
3	.4494437-18				

4	.4488739-18
5	.4446553-18
6	.4332292-18
7	.4145158-18
8	.3892744-18
9	.3584034-18
10	.3220258-18
11	.2823815-18
12	.2411692-18
13	.2029402-18
14	.1676656-18
15	.1361704-18
16	.1080491-18
17	.8084084-19
18	.5786321-19
19	.3813085-19
20	.1890341-19

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

ACTIVITY 1	ISOTOPE 1	CROSS SECTION POSITION 1			
	1	2	3	4	5
1	.1907972+01	.1907564+01	.1906193+01	.1904174+01	.1886147+01
2	.1907354+01	.1906968+01	.1905745+01	.1903638+01	.1885468+01
3	.1906278+01	.1905812+01	.1904432+01	.1902354+01	.1884203+01
4	.1904295+01	.1903875+01	.1902490+01	.1900416+01	.1882314+01
5	.1886302+01	.1885899+01	.1884633+01	.1882583+01	.1864640+01
6	.1837425+01	.1837010+01	.1835725+01	.1833756+01	.1816291+01
7	.1758240+01	.1757877+01	.1756663+01	.1754722+01	.1738025+01
8	.1650116+01	.1649742+01	.1648621+01	.1646849+01	.1631091+01
9	.1514715+01	.1514393+01	.1513335+01	.1511703+01	.1497267+01
10	.1354039+01	.1353738+01	.1352803+01	.1351301+01	.1338405+01
11	.1170667+01	.1170414+01	.1169604+01	.1168342+01	.1157129+01
12	.9614747-00	.9612448-00	.9605753-00	.9595262-00	.9503582-00
13	.7113178-00	.7111445-00	.7106505-00	.7098685-00	.7030990-00
14	.4855099-00	.4853590-00	.4850135-00	.4845093-00	.4798805-00
15	.3351690-00	.3350703-00	.3348383-00	.3344615-00	.3312791-00
16	.2295342-00	.2294642-00	.2292902-00	.2290308-00	.2268770-00
17	.1553528-00	.1553019-00	.1551894-00	.1550412-00	.1535500-00
18	.1017547+00	.1017248+00	.1016640+00	.1015382+00	.1005738+00
19	.6181158-01	.6179478-01	.6173424-01	.6167043-01	.6109259-01
20	.2826849-01	.2825535-01	.2824785-01	.2821996-01	.2794678-01
	6	7	8	9	10
1	.1837811+01	.1761057+01	.1657682+01	.1529882+01	.1380564+01
2	.1837195+01	.1760502+01	.1657093+01	.1529369+01	.1380106+01
3	.1835927+01	.1759359+01	.1655978+01	.1528306+01	.1379202+01
4	.1834068+01	.1757563+01	.1654359+01	.1526727+01	.1377791+01
5	.1816846+01	.1741006+01	.1638779+01	.1512408+01	.1364756+01
6	.1769713+01	.1695816+01	.1596181+01	.1473057+01	.1329247+01
7	.1693443+01	.1622680+01	.1527321+01	.1409392+01	.1271653+01
8	.1589230+01	.1522760+01	.1433165+01	.1322498+01	.1193078+01
9	.1458748+01	.1397687+01	.1315280+01	.1213534+01	.1094723+01
10	.1303943+01	.1249239+01	.1175509+01	.1084250+01	.9777997-00
11	.1127329+01	.1079964+01	.1016107+01	.9370678-00	.8446331-00
12	.9258428-00	.8869208-00	.8343673-00	.7693975-00	.6932588-00
13	.6849527-00	.6561260-00	.6171983-00	.5690844-00	.5126668-00
14	.4675180-00	.4478222-00	.4212380-00	.3883634-00	.3497820-00
15	.3227648-00	.3091523-00	.2908249-00	.2680761-00	.2415192-00
16	.2210234-00	.2117327-00	.1991645-00	.1836238-00	.1654940-00
17	.1496028-00	.1433157-00	.1348182-00	.1243487+00	.1121724+00

18	.9799564-01	.9387780-01	.8833344-01	.8152003-01	.7359881-01
19	.5952324-01	.5702670-01	.5367948-01	.4954623-01	.4476161-01
20	.2722840-01	.2609431-01	.2455555-01	.2267355-01	.2051615-01
	11	12	13	14	15
1	.1212966+01	.1031018+01	.8340428-00	.6063061-00	.4039465-00
2	.1212551+01	.1030670+01	.8337615-00	.6061038-00	.4038084-00
3	.1211726+01	.1029972+01	.8331990-00	.6056958-00	.4035375-00
4	.1210540+01	.1028898+01	.8323633-00	.6050899-00	.4031049-00
5	.1199075+01	.1019205+01	.8244689-00	.5993401-00	.3993074-00
6	.1167780+01	.9925559-00	.8029216-00	.5836763-00	.3888540-00
7	.1117158+01	.9494602-00	.7679814-00	.5582545-00	.3719251-00
8	.1047851+01	.6904602-00	.7202407-00	.5235330-00	.3487805-00
9	.9612321-00	.8164840-00	.6602146-00	.4798385-00	.3196312-00
10	.8582114-00	.7285764-00	.5888456-00	.4278482-00	.2850500-00
11	.7408136-00	.6277133-00	.5064451-00	.3676110-00	.2445635-00
12	.6076701-00	.5138909-00	.4116000-00	.2970919-00	.1992366-00
13	.4491811-00	.3793945-00	.3019339-00	.2231622-00	.1568969-00
14	.3064623-00	.2583961-00	.2069742-00	.1600196-00	.1197556+00
15	.2115671-00	.1788779-00	.1452444-00	.1142245+00	.8788827-01
16	.1451862-00	.1234512+00	.1011970+00	.8111586-01	.6377189-01
17	.9863476-01	.8418915-01	.6959432-01	.5628046-01	.4492505-01
18	.6481664-01	.5558752-01	.4626411-01	.3783481-01	.3042857-01
19	.3952561-01	.3398801-01	.2840575-01	.2331848-01	.1897113-01
20	.1811660-01	.1560937-01	.1310024-01	.1082340-01	.8774492-02
	16	17	18	19	20
1	.2727968-00	.1830577-00	.1215320+00	.7810529-01	.4653472-01
2	.2727045-00	.1829893-00	.1215044+00	.7807055-01	.4651116-01
3	.2725069-00	.1828796-00	.1214234+00	.7800178-01	.4649556-01
4	.2722392-00	.1827129-00	.1212717+00	.7793804-01	.4644680-01
5	.2696718-00	.1809479-00	.1201413+00	.7720508-01	.4600373-01
6	.2625952-00	.1762288-00	.1170068+00	.7518723-01	.4480461-01
7	.2511941-00	.1685580-00	.1119200+00	.7193503-01	.4287969-01
8	.2355186-00	.1580802-00	.1050016+00	.6751909-01	.4025179-01
9	.2159315-00	.1449823-00	.9637629-01	.6201759-01	.3699276-01
10	.1925388-00	.1294622-00	.8624610-01	.5557949-01	.3323727-01
11	.1657050-00	.1120525+00	.7492647-01	.4850942-01	.2907781-01
12	.1369265-00	.9347513-01	.6303309-01	.4107503-01	.2472255-01
13	.1096912+00	.7633570-01	.5191296-01	.3420831-01	.2065877-01
14	.8613173-01	.6122533-01	.4226020-01	.2804516-01	.1713402-01
15	.6541860-01	.4742000-01	.3347944-01	.2236228-01	.1380795-01
16	.4838641-01	.3564654-01	.2556471-01	.1740096-01	.1072706-01
17	.3487796-01	.2608667-01	.1881912-01	.1298480-01	.8099008-02
18	.2379097-01	.1814048-01	.1325594-01	.9148456-02	.5776055-02
19	.1499068-01	.1141859-01	.8447481-02	.5896537-02	.3711781-02
20	.6976309-02	.5412576-02	.3967471-02	.2776777-02	.1774915-02
	21				
1	.2090934-01				
2	.2092194-01				
3	.2089901-01				

4 .2087438-01
5 .2067770-01
6 .2014491-01
7 .1927412-01
8 .1809787-01
9 .1665846-01
10 .1496329-01
11 .1311777-01
12 .1119819-01
13 .9419254-02
14 .7777269-02
15 .6305405-02
16 .4994423-02
17 .3735344-02
18 .2667245-02
19 .1741740-02
20 .8352372-03

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

ZONE	AV FLUX	AV POWER	ACT 1
1	.9980257-00	.1230547-15	.1904171+01
2	.5448032-00	.6716426-16	.1038406+01
3	.5995134-01	.2308208-17	.1136144+00

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PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

BETA EFFECTIVE - - - - - 4.20647-03

NEUTRON GENERATION TIME - - - - - 3.02887-07

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

REACTIVITY COEFFICIENTS FOR MATERIAL 1

M2PU49

ROW 1

	(DELTA K)/K PER KG	DEL K (NUSIGF)	DEL K (SIGA)	DEL K (SIGTR)	DEL K (SIGJXK)	DEL K (INTG)	AVG RADII	AVG AXII
1	.5455-02	.8937-02	-.3469-02	.2461-07	-.1278-04	.5455-02	.3175-00	.3175-00
2	.5454-02	.8933-02	-.3467-02	.7413-07	-.1279-04	.5454-02	.9525-00	.3175-00
3	.5446-02	.8921-02	-.3462-02	.2113-06	-.1277-04	.5450-02	.1587+01	.3175-00
4	.5435-02	.8902-02	-.3455-02	.7864-06	-.1275-04	.5443-02	.2222+01	.3175-00
5	.5335-02	.8735-02	-.3389-02	.2424-05	-.1253-04	.5350-02	.4716+01	.3175-00
6	.5071-02	.8294-02	-.3217-02	.5893-05	-.1197-04	.5176-02	.9068+01	.3175-00
7	.4667-02	.7619-02	-.2953-02	.1216-04	-.1113-04	.4932-02	.1342+02	.3175-00
8	.4152-02	.6756-02	-.2614-02	.1998-04	-.1009-04	.4629-02	.1777+02	.3175-00
9	.3560-02	.5763-02	-.2223-02	.2866-04	-.8949-05	.4280-02	.2212+02	.3175-00
10	.2930-02	.4706-02	-.1806-02	.3741-04	-.7795-05	.3901-02	.2648+02	.3175-00
11	.2301-02	.3650-02	-.1387-02	.4538-04	-.6744-05	.3507-02	.3083+02	.3175-00
12	.1714-02	.2661-02	-.9937-03	.5312-04	-.5844-05	.3114-02	.3518+02	.3175-00
13	.1203-02	.1775-02	-.6390-03	.7166-04	-.5188-05	.2736-02	.3953+02	.3175-00
14	.6701-03	.9717-03	-.3263-03	.2894-04	-.4143-05	.2404-02	.4361+02	.3175-00
15	.3264-03	.4491-03	-.1389-03	.1881-04	-.2610-05	.2096-02	.4742+02	.3175-00
16	.1557-03	.2104-03	-.6156-04	.8306-05	-.1445-05	.1828-02	.5123+02	.3175-00
17	.7281-04	.9677-04	-.2713-04	.3926-05	-.7430-06	.1601-02	.5504+02	.3175-00
18	.3304-04	.4330-04	-.1180-04	.1900-05	-.3566-06	.1410-02	.5885+02	.3175-00
19	.1410-04	.1813-04	-.4846-05	.9712-06	-.1572-06	.1250-02	.6266+02	.3175-00
20	.5307-05	.6534-05	-.1732-05	.5630-06	-.5904-07	.1115-02	.6647+02	.3175-00
21	.1440-05	.1370-05	-.3675-06	.4501-06	-.1316-07	.1001-02	.7028+02	.3175-00

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BNWL-409

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

REACTIVITY COEFFICIENTS FOR MATERIAL 1 M2PU49 COLUMN 5

	(DELTA K)/K PER KG	DEL K (NUSIGF)	DEL K (SIGA)	DEL K (SIGTR)	DEL K (SIGJXX)	DEL K (INTG)	AVG RADII	AVG AXII
1	.5335-02	.8735-02	-.3389-02	.2424-05	-.1253-04	.5335-02	.4716+01	.3175-00
2	.5331-02	.8728-02	-.3387-02	.2472-05	-.1252-04	.5333-02	.4716+01	.9525-00
3	.5324-02	.8717-02	-.3382-02	.2579-05	-.1251-04	.5330-02	.4716+01	.1587+01
4	.5314-02	.8699-02	-.3376-02	.3094-05	-.1249-04	.5326-02	.4716+01	.2222+01
5	.5218-02	.8538-02	-.3312-02	.4597-05	-.1229-04	.5257-02	.4716+01	.4767+01
6	.4957-02	.8103-02	-.3142-02	.7954-05	-.1175-04	.5140-02	.4716+01	.9222+01
7	.4552-02	.7424-02	-.2875-02	.1428-04	-.1093-04	.4976-02	.4716+01	.1368+02
8	.4028-02	.6545-02	-.2530-02	.2246-04	-.9924-05	.4768-02	.4716+01	.1813+02
9	.3423-02	.5527-02	-.2127-02	.3197-04	-.8838-05	.4527-02	.4716+01	.2258+02
10	.2776-02	.4435-02	-.1693-02	.4220-04	-.7817-05	.4260-02	.4716+01	.2704+02
11	.2134-02	.3342-02	-.1255-02	.5403-04	-.6953-05	.3979-02	.4716+01	.3149+02
12	.1538-02	.2297-02	-.8325-03	.7973-04	-.6400-05	.3695-02	.4716+01	.3595+02
13	.8904-03	.1302-02	-.4404-03	.3430-04	-.5366-05	.3440-02	.4716+01	.4008+02
14	.4544-03	.6314-03	-.1968-03	.2339-04	-.3575-05	.3192-02	.4716+01	.4389+02
15	.2270-03	.3093-03	-.9115-04	.1090-04	-.2081-05	.2964-02	.4716+01	.4770+02
16	.1107-03	.1482-03	-.4183-04	.5422-05	-.1119-05	.2760-02	.4716+01	.5151+02
17	.5224-04	.6894-04	-.1889-04	.2753-05	-.5605-06	.2580-02	.4716+01	.5532+02
18	.2315-04	.2999-04	-.8056-05	.1476-05	-.2575-06	.2421-02	.4716+01	.5913+02
19	.9054-05	.1124-04	-.2990-05	.9068-06	-.1007-06	.2279-02	.4716+01	.6294+02
20	.2514-05	.2443-05	-.6573-06	.7512-06	-.2331-07	.2153-02	.4716+01	.6675+02

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BNWL-409

PERT-IV TEST CASE

(2DF FLUX INPUT, 2 GROUPS, 3 ZONES)

REACTIVITY COEFFICIENTS FOR MATERIAL 6

NA

ROW 1

	(DELTA K)/K PER KG	DEL K (NUSIGF)	DEL K (SIGA)	DEL K (SIGTR)	DEL K (SIGJXK)	DEL K (INTG)	AVG RADII	AVG AXII
1	-.1773-03	.0000	-.2791-04	.1112-06	-.1495-03	-.1773-03	.3175-00	.3175-00
2	-.1772-03	.0000	-.2789-04	.3334-06	-.1496-03	-.1772-03	.9525-00	.3175-00
3	-.1764-03	.0000	-.2785-04	.9636-06	-.1495-03	-.1767-03	.1587+01	.3175-00
4	-.1734-03	.0000	-.2779-04	.3601-05	-.1492-03	-.1753-03	.2222+01	.3175-00
5	-.1628-03	.0000	-.2726-04	.1111-04	-.1467-03	-.1645-03	.4716+01	.3175-00
6	-.1389-03	.0000	-.2587-04	.2699-04	-.1400-03	-.1485-03	.9068+01	.3175-00
7	-.9827-04	.0000	-.2373-04	.5565-04	-.1302-03	-.1244-03	.1342+02	.3175-00
8	-.4767-04	.0000	-.2098-04	.9142-04	-.1181-03	-.9457-04	.1777+02	.3175-00
9	.8471-05	.0000	-.1779-04	.1310-03	-.1047-03	-.6097-04	.2212+02	.3175-00
10	.6510-04	.0000	-.1439-04	.1707-03	-.9122-04	-.2558-04	.2648+02	.3175-00
11	.1168-03	.0000	-.1096-04	.2066-03	-.7892-04	.9486-05	.3083+02	.3175-00
12	.1650-03	.0000	-.7729-05	.2411-03	-.6839-04	.4361-04	.3518+02	.3175-00
13	.2593-03	.0000	-.4804-05	.3248-03	-.6071-04	.8628-04	.3953+02	.3175-00
14	.8034-04	.0000	-.2291-05	.1311-03	-.4849-04	.8532-04	.4361+02	.3175-00
15	.5468-04	.0000	-.8857-06	.8611-04	-.3055-04	.8077-04	.4742+02	.3175-00
16	.2123-04	.0000	-.3626-06	.3850-04	-.1691-04	.7254-04	.5123+02	.3175-00
17	.9517-05	.0000	-.1490-06	.1836-04	-.8695-05	.6439-04	.5504+02	.3175-00
18	.4713-05	.0000	-.6145-07	.8948-05	-.4174-05	.5714-04	.5885+02	.3175-00
19	.2731-05	.0000	-.2416-07	.4595-05	-.1840-05	.5091-04	.6266+02	.3175-00
20	.1974-05	.0000	-.8338-08	.2673-05	-.6909-06	.4561-04	.6647+02	.3175-00
21	.1984-05	.0000	-.1697-08	.2140-05	-.1540-06	.4112-04	.7028+02	.3175-00

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BNWL-409

APPENDIX C

FORTRAN-IV SOURCE DECK LISTING

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-IL PDP INCL
ABC* FCOPY
  REAL I2
  DIMENSION A(25,10), A0(50), A1(50), A2(50), ADJ(50,50), ATW(25)
1  , BETA(20), C(15,26,35), C0(15,35), CHI(26), CHIP(26), DUM(2500),
2  HOLN(25), PHC(26), PHI(50,50), PHR(50,50), PHZ(50,50), R1(51),
3  R4(50), R5(50), SLOPR(50), SLOPZ(50), SORC1(50,50), SORC2(50,50),
4  V0(50,50), VEL(26), VOL(40), Z1(51), Z4(50), Z5(50), ZACT(40,3),
5  ZPHI(40), ZPOW(40)
  DIMENSION I0(45), I1(45), I2(45), ID(12), L2(40), LDUM(2500),
1  M0(50,50), M2(40), MA(15), MATDK(20), NBET(20), NCOL(20),
2  NROW(20), NX(15)
  COMMON NINP, NOUT, NCR1, NFLUX1, NSCRAT, NFLUX2,
1  IFP, IGM, IGE, IGEp, IM, IMJM, IP, IST, ITL, IZM, JM, JP, M01,
2  MCR, MT, MTP, NACT, ND, NDELK, NFP, NIBC, NPRT
  COMMON AK, DENOM, FEF, FLPO, VF
  COMMON A, A0, A1, A2, ADJ, ATW, BETA, C, C0, CHI, CHIP, DUM,
1  HOLN, PHC, PHI, PHR, PHZ, R1, R4, R5, SLOPR, SLOPZ, SORC1, SORC2,
2  V0, VEL, VOL, Z1, Z4, Z5, ZACT, ZPHI, ZPOW
  COMMON I0, I1, I2, ID, L2, LDUM, M0, M2, MA, MATDK, NBET, NCOL,
1  NROW, NX
  END

```

-ITC FOR MAIN,MAIN
INCLUDE ABC

C
C MAIN MAIN PROGRAM SETS UP TAPE UNITS AND CALLS INP1, MAPR,
C SETUP, GRAM, NORM, ABETA, AND CALC.
C
C INP1 SUBROUTINE TO CONTROL THE READING AND PRINTING OF ALL
C INPUT DATA. INP1 IS CALLED BY MAIN AND CALLS XSINP,
C FXINP, REAG2, AND REA12.
C
C XSINP XSINP READS, CHECKS, PRINTS, AND WRITES THE CROSS
C SECTIONS TO TAPE. THE SUBROUTINE IS CALLED BY INP1.
C
C FXINP SUBROUTINE TO READ AND PRINT THE INPUT FLUXES. IF FLUXES
C ARE IN 1-D FORM, THEY ARE COMBINED RESULTING IN THE 2-D
C FORM. INP1 CALLS FXINP, REAG2, AND REA12 AND IS CALLED
C BY MAIN.
C
C REA12 REA12 READS ALL INTEGER DATA AFTER CARD 4. IT IS CALLED
C BY FXINP AND INP1.
C
C REAG2 REAG2 READS ALL REAL DATA AFTER THE CROSS SECTIONS EXCEPT
C FOR THE 2-D FLUXES. IT IS CALLED BY FXINP AND INP1.
C
C MAPR SUBROUTINE TO PRODUCE A PICTURE PRINT BY ZONE AND BY
C MATERIAL. MAPR IS CALLED BY MAIN.
C
C PRT SUBROUTINE PRINTS OUT TWO-DIMENSIONAL ARRAYS. IT IS
C CALLED BY NORM.
C
C ERRO2 SUBROUTINE TO PRINT AN ERROR MESSAGE. ERRO2 IS CALLED
C BY REA12 AND REAG2.
C
C SETUP SETUP MIXES THE CROSS SECTIONS AND CALCULATES THE AREAS
C AND VOLUMES. IT IS CALLED BY MAIN.
C
C GRAM THIS SUBROUTINE CALCULATES THE MASS OF EACH MATERIAL IN
C EACH ZONE AND ALSO THE ZONE VOLUME. IT IS CALLED BY
C MAIN.
C
C NORM NORM NORMALIZES THE FLUX AND ADJOINT FLUX AND CALCULATES
C K EFFECTIVE. IT CALLS PRT AND IS CALLED BY MAIN.
C
C AVG THIS SUBROUTINE CALCULATES ZONE AVERAGED FLUXES, POWERS,
C AND ACTIVITIES. IT IS CALLED BY NORM.
C
C ABETA ABETA PERFORMS THE NEUTRON LIFETIME AND BETA EFFECTIVE
C CALCULATION. IT IS CALLED BY MAIN.

C		
C	CALC	SUBROUTINE TO CALCULATE AND PRINT REACTIVITY
C		COEFFICIENTS. IT IS CALLED BY MAIN.
C		
C	AK	CALCULATED VALUE OF K EFFECTIVE
C	CAD	TOTAL CHI*ADJOINT AT CENTER
C	CFX	TOTAL CENTER POINT FLUX
C	CPW	TOTAL CENTER POINT POWER
C	DENOM	DENOMINATOR OF PERTURBATION FORMULA
C	FEF	AVERAGE ENERGY RELEASED PER FISSION (MEV/FISSION)
C	FLPO	FLUX OR POWER (SEE NFP)
C	IFP	FLUX PUNCH OPTION
C	IGE	TYPE OF GEOMETRY (0/1/2=R-Z/X-Y/R-THETA)
C	IGEP	IGE + 1
C	IGM	NUMBER OF GROUPS (L/E 26)
C	IGP	NUMBER OF GROUPS PLUS 1
C	IM	NUMBER OF RADIAL INTERVALS (L/E 50)
C	IMJM	IM*JM
C	IP	IM + 1
C	IST	NUMBER OF DOWNSCATTERING TERMS (L/E 10)
C	ITL	CROSS SECTION TABLE LENGTH (L/E 15)
C	IZM	NUMBER OF MATERIAL ZONES (L/E 40)
C	JM	NUMBER OF AXIAL INTERVALS (L/E 50)
C	JP	JM + 1
C	M01	LENGTH OF MIX VECTORS (I0,I1,I2) (L/E 45)
C	MCR	NUMBER OF MATERIALS FROM CARDS (L/E 25)
C	MT	TOTAL NUMBER OF MATERIALS INCLUDING MIXES (L/E 35)
C	MTP	NUMBER OF MATERIALS FROM TAPE
C	NACT	NUMBER OF ACTIVITY TRAVERSES (L/E 3)
C	NCR1	CROSS SECTION TAPE
C	ND	FLUX INPUT OPTION
C	NDELK	NUMBER OF REACTIVITY COEFFICIENT CALCULATIONS (L/E 20)
C	NFLUX1	FLUX TAPE
C	NFLUX2	ADJOINT FLUX TAPE
C	NFP	FLUX NORMALIZATION OPTION
C	NIBC	NUMBER OF ISOTOPES FOR BETA CALCULATION (L/E 20)
C	NINP	LOGICAL INPUT TAPE
C	NOUT	LOGICAL OUTPUT TAPE
C	NPRT	PRINT OPTION
C	NSCRAT	SCRATCH TAPE
C	POWER	TOTAL REACTOR POWER
C	RABS	ABSORPTION RATE
C	RL	RADIAL LEAKAGE
C	RLEAK	LEAKAGE RATE
C	RSORS	SOURCE RATE
C	TSD	(MW-SEC)/(FISSIONS)
C	VF	VOLUME FACTOR(USUALLY=2.0)
C	ZL	AXIAL LEAKAGE

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C  A(MCR,10)  ID CARD FOR EACH MATERIAL CROSS SECTION SET
C  A0(IM)      RADIAL AREA ELEMENT
C  A1(JM)      AXIAL AREA ELEMENT
C  A2(JM)      AREA AT I=IP BETWEEN J-1 AND J
C  ACT(IM,JM,NACT)  ACTIVITY TRAVERSE
C  ADJ(IM,JM)  ADJOINT FLUX
C  ADJR(IGM,IM)  1-D RADIAL ADJOINT FLUX
C  ADJZ(IGM,JM)  1-D AXIAL ADJOINT FLUX
C  ATW(MCR)    MATERIAL ATOMIC WEIGHT
C  BETA(NIBC)   ABSOLUTE NEUTRON YIELD PER DELAYED FISSION
C  C(ITL,IGM,MT)  CROSS SECTION ARRAY
C  CO(ITL,MT)   CROSS-SECTION ARRAY FOR CURRENT GROUP
C  CHI(IGM)     FISSION SPECTRUM
C  CHIP(IGM)    DELAYED NEUTRON FISSION SPECTRUM
C  CX(ITL,IGM)  CROSS SECTION ARRAY FOR MATDK (EQUIVALENCED)
C  DUM(IMJM)    DUMMY VARIABLE
C  HOLN(MCR)    MATERIAL NAME
C  IO(M01)      MIX NUMBERS
C  I1(M01)      MATERIAL NUMBERS FOR MIX
C  I2(M01)      MATERIAL DENSITIES FOR MIX
C  ID(12)       IDENTIFICATION CARD ARRAY
C  L2(MT)        ZONE NUMBER BY MATERIAL
C  LDUM(IMJM)   DUMMY VARIABLE
C  MO(IM,JM)    ZONE NUMBERS
C  M2(IZM)      MATERIAL NUMBERS BY ZONE
C  MA(N1CT)     MATERIAL NUMBER FOR ACTIVITY TRAVERSE
C  MASS(IZM,MT)  MASS OF MATERIAL IN ZONE
C  MATDK(NDELK) MATERIAL NUMBER FOR REACTIVITY COEFFICIENT CALCULATION
C  NBET(NIBC)   MATERIAL NUMBER FOR BETA CALCULATION
C  NCOL(NDELK)  COLUMN NUMBER FOR REACTIVITY COEFFICIENT CALCULATION
C  NROW(NDELK)  ROW NUMBER FOR REACTIVITY COEFFICIENT CALCULATION
C  NX(NACT)     CROSS SECTION POSITION FOR ACTIVITY TRAVERSE
C  PHC(IGM)     CENTER POINT FLUX
C  PHI(IM,JM)   FLUX
C  PHR(IGM,IM)  1-D RADIAL FLUX
C  PHZ(IGM,JM)  1-D AXIAL FLUX
C  R1(IP)       RADII VALUES
C  R4(IM)       AVERAGE RADII
C  R5(IM)       DELTA-R
C  SLOAR(IM)    D(ADJOINT)/DR (EQUIVALENCED)
C  SLOAZ(JM)    D(ADJOINT)/DZ (EQUIVALENCED)
C  SLOPR(IM)    D(FLUX)/DR
C  SLOPZ(JM)    D(FLUX)/DZ
C  SORC1(IM,JM) NU*SIGF*FLUX (IN NORM)
C  SORC2(IM,JM) =CAJJ(I,J) CHI*ADJOINT (IN NORM)
C  TPhi(IM,JM)  TOTAL FLUX (EQUIVALENCED)
C  VO(IM,JM)    VOLUME ELEMENTS
C  VEL(IGM)     NEUTRON VELOCITY

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C VOL(IZM)      ZONE VOLUME
C Z1(JP)       AXII VALUES
C Z4(JM)       AVERAGE AXII
C Z5(JM)       DELTA-Z
C ZACT(IZM,NACT) ZONE AVERAGED ACTIVITIES
C ZPHI(IZM)     ZONE AVERAGED FLUX
C ZPOW(IZM)     ZONE AVERAGED POWER
      DIMENSION JLPTAB(28)
      CALL SETIO(9,2)
      CALL SETIO(10,1)
      CALL SETDR(3,525000,50000,JLPTAB)
      CALL SETDR(4,575000,200000,JLPTAB(8))
      CALL SETDR(6,775000,200000,JLPTAB(15))
      CALL SETDR(7,975000,200000,JLPTAB(22))
      REWIND 3
      REWIND 4
      REWIND 6
      REWIND 7
      NCR1 = 3
      NSCRAT = 4
      NFLUX1 = 6
      NFLUX2 = 7
      NOUT = 9
      NINP = 10
      CALL INP1
      CALL MAPR(DUM)
      CALL SETUP
      CALL GRAM
      CALL NORM
      IF(NIBC) 8, 8, 6
6      CALL ABETA
8      CONTINUE
      IF(NDELK) 20, 20, 10
10     CALL CALC
20     CONTINUE
      END

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-ITC FOR INP1,INP1
  SUBROUTINE INP1
    INCLUDE ABC
  C THIS SUBROUTINE CONTROLS THE READING OF ALL INPUT DATA
    WRITE(NOUT, 3)
    FORMAT(42X,35H * * * * P E R T - I V * * * * //)
    READ(NINP, 5) (ID(I), I = 1, 12)
    FORMAT(12A6)
    WRITE(NOUT, 5) (ID(I), I = 1, 12)
    WRITE(NOUT, 6)
    FORMAT(1H /)
    READ(NINP,10) ND, IGM, IST, IFP, IM, JM, MCR, MTP, IZM, MT,
1 M01, NPRT, NDELK, NIBC, NACT,NFP, IGE
    FORMAT(12I6)
    READ(NINP,15) FLPO,VF,FEF
    FORMAT(6E12.6)
    WRITE(NOUT, 20) ND, IGM, IST, IFP,IM, JM
    FORMAT (78H ND 1/2/3/4/5/6=FLUXES FROM TWO 1-D RUNS/FLUXES
1 FROM 2-D RUN/FLUX FROM/,12X,66H1-D,ADJOINT FROM 2-D/FLUX FROM 2-D
2,ADJOINT FROM 1-D/FLUX FROM 1-D,/,12X,35HNO ADJOINT/FLUX FROM 2-D,N
30 ADJOINT,34X,I9/
4 35H IGM NUMBER OF ENERGY GROUPS,46X,I9/,42H
51ST NUMBER OF DOWNSCATTERING TERMS,39X,I9/,
661H IFP 0/1/2=NO EFFECT/PUNCH FLUXES/PUNCH ADJOINT FLUXES,
720X,I9/, 38H IM NUMBER OF RADIAL
8INTERVALS,43X,I9/,37H JM NUMBER OF AXIAL INTERVALS,44X,I9)
    WRITE(NOUT, 30) MCR, MTP, IZM, MT, M01, NPRT
30 FORMAT (42H MCR NUMBER OF MATERIALS FROM CARDS,39X,I9/,41H
1 MTP NUMBER OF MATERIALS FROM TAPE,40X,I9/,36H IZM NU
2MBER OF MATERIAL ZONES,45X,I9/,53H MT TOTAL NUMBER OF MATE
3RIALS INCLUDING MIXES,28X,I9/,44H M01 NUMBER OF MIXTURE SPE
4CIFICATIONS,37X,I9/,54H NPRT PRINT OPTION(0/1=PARTIAL PRINT/
5FULL PRINT)27X,I9/)
    WRITE(NOUT, 40) NDELK, NIBC, NACT
40 FORMAT (66H NDELK 0/N=NO EFFECT/DO N REACTIVITY COEFFICIENT C
1ALCULATIONS,15X,I9/
272H NIBC 0/N=NO EFFECT/USE N MATERIALS FOR BETA EFFECTIVE CA
3LCULATION, 9X,I9/
449H NACT 0/N=NO EFFECT/DO N ACTIVITY TRAVERSES,32X,I9)
    WRITE(NOUT, 50) NFP
50 FORMAT (78H NFP FLUX OR POWER NORMALIZATION (1/2/3/4=CENT
1ER PT. FLUX/CENTER PT. /,12X,46HPOWER/TOTAL POWER/DENOMINATOR OF P
2ERT FORMULA),23X,I9 )
    WRITE(NOUT,55) IGE
55 FORMAT( 46H IGE GEOMETRY (0/1/2=R-Z/X-Y/R-THETA),35X,I9/)
    WRITE(NOUT, 60) FLPO,VF,FEF
60 FORMAT (41H FLPO FLUX(N/CM2-SEC) OR POWER(MWT),39X,1PE10.5/4
17H VF VOLUME FACTOR (VOLUME = VF*P1*R2*Z),33X,1PE10.5/

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244H FEF ENERGY(MEV) RELEASED PER FISSION,36X,1PE10.5)
64 FORMAT(1H1, 12A6///)
ITL = IST + 5
C READ, CHECK, PRINT, AND WRITE CROSS SECTIONS TO TAPE
WRITE(NOUT, 64) (ID(I), I = 1, 12)
CALL XSINP
C READ FLUXES
WRITE(NOUT, 64) (ID(I), I = 1, 12)
WRITE(NOUT, 82)
82 FORMAT(98H INPUT FLUXES (PHR/PHZ/ADJR/ADJZ/PHI/ADJ=RADIAL FLUX/AXI
1AL FLUX/RADIAL ADJOINT FLUX/AXIAL ADJOINT /
232H FLUX/2-D FLUX/2-D ADJOINT FLUX)/)
CALL FXINP
IP=IM + 1
JP=JM + 1
C READ RADIIR
WRITE(NOUT, 84)
84 FORMAT(51HOMESH BOUNDARIES (R1/Z1=RADIAL POINTS/AXIAL POINTS))
CALL REAG2(6H R1,R1,IP)
C READ AXII
CALL REAG2(6H Z1,Z1,JP)
C READ ZONE NUMBERS
WRITE(NOUT,86)
86 FORMAT(30HZONE NUMBERS BY MESH INTERVAL)
CALL REAI2 (6H M0,LDUM,IMJM)
L = 0
DO 87 J = 1, JM
DO 87 I = 1, IM
L = L + 1
87 MO(I,J) = LDUM(L)
C READ MATERIAL NUMBERS
WRITE(NOUT, 88)
88 FORMAT(25HOMATERIAL NUMBERS BY ZONE)
CALL REAI2 (6H M2,M2,IZM)
C READ FISSION FRACTIONS
WRITE(NOUT, 90)
90 FORMAT(17HOFISSION SPECTRUM)
CALL REAG2 (6H CHI,CHI,IGM)
C READ MIXTURE SPECIFICATIONS
WRITE(NOUT,92)
92 FORMAT(82HUMIXTURE SPECIFICATIONS (I0/I1/I2=MIX NUMBER/MAT. NUMBER
1 FOR MIX/MATERIAL DENSITY))
CALL REAI2 (6H I0,I0,M01)
CALL REAI2 (6H I1,I1,M01)
CALL REAG2 (6H I2,I2,M01)
C CHECK FOR LIFETIME AND BETA CALCULATIONS
IF(NIBC ) 120,120, 100
C READ MATERIAL NUMBERS FOR BETAS

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100  WRITE(NOUT,94)
94   FORMAT(38HOMATERIAL NUMBERS FOR BETA CALCULATION)
      CALL REAI2(6H  NBET,NBET,NIBC)
C   READ BETAS
      CALL REAG2(6H  BETA,BETA,NIBC)
C   READ DELAYED FISSION SPECTRUM
      WRITE(NOUT, 102)
102  FORMAT(25HODELAYED FISSION SPECTRUM)
      CALL REAG2(6H  CHIP,CHIP,IGM)
C   READ VELOCITIES
      WRITE(NOUT,104)
104  FORMAT(17HONEUTRON VELOCITY)
      CALL REAG2(6H  VEL,VEL,IGM)
C   CHECK FOR DELTA K CALCULATION
120  IF(NDELK) 160, 160, 140
C   READ MATERIAL NUMBERS, ROW NUMBERS, AND COLUMN NUMBERS FOR
C   PERTURBATION CALCULATION
140  WRITE(NOUT, 138)
138  FORMAT(98HOPERTURBATION CALCULATION INFORMATION (MATDK/NROW/NCOL=M
      IATERIAL NUMBER/ROW/COLUMN TO BE PERTURBED))
      CALL REAI2(6H MATDK, MATDK,NDELK)
      CALL REAI2(6H NROW,  NROW, NDELK)
      CALL REAI2(6H NCOL,  NCOL, NDELK)
C   CHECK FOR ACTIVITIES
160  IF(NACT) 1000, 1000, 180
C   READ MATERIAL NUMBERS AND XS POSITION FOR ACTIVITIES
180  WRITE(NOUT, 178)
178  FORMAT(77H0ACTIVITY TRAVERSE INFORMATION (MA/NX=MATERIAL NUMBER/CR
      I0SS SECTION POSITION))
      CALL REAI2(6H  MA,MA,NACT)
      CALL REAI2(6H  NX,NX, NACT)
1000 CONTINUE
      RETURN
      END

```

```

-ITC FOR XSINP,XSINP
  SUBROUTINE XSINP
    INCLUDE ABC
  C THIS SUBROUTINE READS, CHECKS, PRINTS, AND WRITES THE CROSS SECTIONS TO TAPE
    IF(MCR) 500,500,10
  C  READ CROSS SECTIONS FROM CARDS
10   DO 50 I=1,MCR
      READ(NINP, 20) HOLN(I), ATW(I), (A(I,J), J=1, 10)
20   FORMAT(A6, E6.2, 10A6)
      DO 40 IIG=1,IGM
40    READ(NINP,30) (C(L,IIG,I), L=1,ITL)
30    FORMAT(6E12.5)
50    CONTINUE
  C  CHECK ON CROSS SECTION CONSISTENCY AND ORDER
      DO 200 J=1,MCR
      DO 200 I=1,IGM
        G = C(2,I,J) + C(5,I,J)
      DO 80 K=1,IST
        KK = I + K
        M = 5 + K
        IF(KK - IGM) 70, 70, 80
70      G = G + C(M,KK,J)
      0  CONTINUE
        IFUABS((G - C(4,I,J))/C(4,I,J)) - .01) 200, 90, 90
90      WRITE(NOUT,110) J,I
110     FORMAT(1H/,16H CHECK MATERIAL 12,5X, 7H GROUP 12)
200     CONTINUE
  C  PRINT CROSS SECTIONS
      IF(NPRT) 210,210, 250
210     WRITE(NOUT, 220)
220     FORMAT(38H THE FOLLOWING NUCLIDES ARE FROM CARDS//)
      DO 240 K=1,MCR
240     WRITE(NOUT, 245) K, HOLN(K), (A(K,J), J=1,10)
245     FORMAT(19,6X,11A6/)
      GO TO 510
250     D6 480 K=1,MCR
255     FORMAT(1H1)
        WRITE(NOUT, 245) K, HOLN(K), (A(K,J), J=1,10)
        WRITE(NOUT,260)
260     FORMAT( 1H0,
2113H GROUP   SIGF      SIGA      NUSIGF      SIGTR      SIGXG      G-1X
3G      G-2XG      G-3XG      G-4XG      G-5XG      G-6XG/ )
        IF(IST - 6) 290, 290, 265
265     DO 270 I=1,IGM
268     FORMAT(13,11F10.3)
270     WRITE(NOUT, 268) I,(C(J,I,K),J=1,11)
        WRITE(NOUT,275)
275     FORMAT (44H1GROUP G-7XG      G-8XG      G-9XG      G-10XG/ )

```

```

      DO 279 I=1,IGM
279  WRITE(NOUT,268) I,(C(J,I,K), J=12,ITL)
      GO TO 350
290  CONTINUE
      DO 300 I=1,IGM
300  WRITE(NOUT,268) I, (C(J,I,K), J=1,ITL )
350  IF(K - MCR) 460,480,480
460  WRITE(NOUT,255)
480  CONTINUE
      GO TO 510
C  FUTURE PLANS--STATEMENT 500 WILL READ CROSS SECTIONS FROM TAPE
500  CONTINUE
510  CONTINUE
C  WRITE CROSS SECTIONS TO TAPE
      DO 1160 IIG=1,IGM
      DO 1060 M=1,MT
      DO 1060 L=1,ITL
1060  CO (L,M) = C(L,IIG,M)
1160  WRITE (NCR1) ((CO (L,M), L=1,ITL),M=1,MT)
      REWIND NCR1
      RETURN
      END

```

```

-ITC FOR FXINP,FXINP
      SUBROUTINE FXINP
      INCLUDE ABC
      INTEGER TEMP
C THIS SUBROUTINE READS FLUXES(REGULAR FLUX AND ADJOINT FLUX) IF
C FLUXES ARE IN 1-D FORM, THEY ARE COMBINED IN SUCH A WAY TO PUT
C THEM IN 2-D FORM
      IMJM = IM*JM
      JJR = IGM*IM
      JJZ = IGM*JM
      LLH = 1
      NND = ND
      ND = IABS(ND)
C LLH=1/2=REGULAR FLUX/ADJOINT FLUX
      GO TO (100, 800, 100, 800, 100, 800), ND
C FLUX IS IN 1-D FORM
100  CONTINUE
      ZFX = 0.0
      RFX = 0.0
      GO TO (110, 120), LLH
110  CALL REAG2(6H PHR,DUM,JJR)
      GO TO 130
120  CALL REAG2(6H ADJR,DUM,JJR)
C IF NND IS POSITIVE, ADJOINT FLUXES ARE REVERSED BY GROUP
      IF(NND) 130, 130, 121
121  CONTINUE
      L = 0
      DO 126 K = 1, IGM
      DO 124 I = 1, IM
      L = L + 1
      KK = IGM + 1 - K
124  PHR(KK, I) = DUM(L)
126  RFX = RFX + PHR(KK, I)
      GO TO 165
130  L = 0
      DO 160 K=1,IGM
      DO 158 I=1,IM
      L = L + 1
158  PHR(K,I) = DUM(L)
160  RFX = RFX + PHR(K,I)
165  CONTINUE
      GO TO (170, 180), LLH
170  CALL REAG2(6H PHZ,DUM,JJZ)
      GO TO 190
180  CALL REAG2(6H ADJZ,DUM,JJZ)
      IF(NND) 190, 190, 182
C SWITCH GROUPS
182  CONTINUE

```

```

      L = 0
      DO 186 K = 1, IGM
      DO 184 I = 1, JM
      L = L + 1
      KK = IGM + 1 - K
184   PHZ(KK, I) = DUM(L)
186   ZFX = ZFX + PHZ(KK, I)
      GO TO 262
190   L = 0
      DO 260 K=1,IGM
      DO 258 I=1,JM
      L = L + 1
258   PHZ(K,I) = DUM(L)
260   ZFX = ZFX + PHZ(K,I)
262   CONTINUE
      DO 300 K=1,IGM
      DO 280 I=1,IM
280   PHR(K,I) = PHR(K,I)/RFX
      DO 300 I=1,JM
300   PHZ(K,I) = PHZ(K,I)/ZFX
      DO 400 K=1,IGM
      PHC(K) = (PHZ(K,1) + PHR(K,1))*(.5)
      DO 320 I=2,IM
320   PHR(K,I) = PHR(K,I)/PHR(K,1)
      DO 360 I=2,JM
360   PHZ(K,I) = PHZ(K,I)/PHZ(K,1)
      PHR(K,1) = 1.0
      PHZ(K,1) = 1.0
      DO 380 I=1,IM
      DO 380 J=1,JM
      PHI(I,J) = PHR(K,I)*PHZ(K,J)*PHC(K)
380   CONTINUE
      WRITE(NFLUX1) ((PHI(I,J), I = 1, IM), J = 1, JM)
400   CONTINUE
      GO TO 1000
C   FLUX IS IN 2-D FORM
800   CONTINUE
      LWH = IGM*IM*JM
      GO TO (810, 815), LLH
810   WRITE(NOUT, 812) LWH
812   FORMAT(6X, 6H PHI, I6)
      GO TO 817
815   WRITE(NOUT, 816) LWH
816   FORMAT(6X, 6H ADJ, I6)
818   FORMAT(10E12.5)
817   DO 840 K = 1, IGM
      READ(NINP, 820) ((PHI(I, J), I = 1, IM), J = 1, JM)
820   FORMAT(6E12.6)

```



```

      WRITE(NOUT,818) ((PHI(I, J), I = 1, IM), J = 1, JM)
      WRITE(NFLUX1)((PHI(I, J), I=1, IM), J=1, JM)
840   CONTINUE
      GO TO (910, 850), LLH
850   CONTINUE
C     IF NND IS POSITIVE, ADJOINT FLUXES ARE REVERSED BY GROUP
      IF(NND) 910, 910, 860
860   CONTINUE
      REWIND NFLUX1
      DO 880 K = 1, IGM
      READ(NFLUX1)
880   CONTINUE
      DO 900 K = 1, IGM
      BACKSPACE NFLUX1
      READ(NFLUX1) ((PHI(I, J), I = 1, IM), J = 1, JM)
      WRITE(NSCRAT) ((PHI(I, J), I = 1, IM), J = 1, JM)
      BACKSPACE NFLUX1
900   CONTINUE
      REWIND NSCRAT
      REWIND NFLUX1
      TEMP = NSCRAT
      NSCRAT = NFLUX1
      NFLUX1 = TEMP
910   CONTINUE
1000  GO TO (1100, 2200), LLH
1100  LLH=2
C     SWITCH TAPE DESIGNATIONS
      TEMP = NFLUX1
      NFLUX1 = NFLUX2
      NFLUX2 = TEMP
C     RE D ADJOINT FLUX
      GO TO (100, 800, 800, 100, 2000, 2000), ND
C     THERE IS NO ADJOINT FLUX INPUT
2000  CONTINUE
      AAA = 1.0
      DO 2100 K = 1, IGM
      WRITE(NFLUX1) ((AAA, I = 1, IM), J = 1, JM)
2100  CONTINUE
2200  REWIND NFLUX1
      REWIND NFLUX2
C     SWITCH TAPE DESIGNATIONS
      TEMP = NFLUX2
      NFLUX2 = NFLUX1
      NFLUX1 = TEMP
      RETURN
      END

```

```

-IT FOR REAI2,REAI2
  SUBROUTINE REAI2(HOLL,IARRAY,NCOUNT)
CCCCCCC
  DIMENSION IARRAY(10),IV(6),K(6),IN(6)
  COMMON  NINP, NOUT, NCR1, NFLUX1, NSCRAT, NFLUX2
  J=1
  10 READ(NINP,20)      (K(I),IN(I),IV(I),I=1,6)
  20 FORMAT(6(I1,I2,I9))
  DO 70I=1,6
  L=K(I)+1
  GO TO (30,40,60,80 ),L
CNO MODIFICATION
  30 IARRAY(J)=IV(I)
  J=J+1
  GO TO 70
C
CREPEAT
  40 L=IN(I)
  DO50M=1,L
  IARRAY(J)=IV(I)
  J=J+1
  50 CONTINUE
  GO TO70
C
CINTERPOLATE
  60 CALL ERRO2(6H REAI,60,1)
C
C
  70 CONTINUE
  GO TO 10
C
C
CTERMINATE
  80 J=J-1
  WRITE (NOUT,90)      HOLL,J      ,(IARRAY(I),I=1,J)
  IF(J -NCOUNT)100,110,100
  90 FORMAT(6X,A6,I6/(10I12))
  100 CALL ERRO2( 6H**REAI,100,1)
  110 RETURN
  END

```

```

-IT FOR REAG2,REAG2
  SUBROUTINE REAG2(HOLL,ARRAY,NCOUNT)
CCCCC
  DIMENSION ARRAY(10),V(12),K(12),IN(12)
  COMMON NINP, NOUT, NCR1, NFLUX1, NSCRAT, NFLUX2
  JFLAG=0
  J=1
10 IF(JFLAG)20,40,20
20 DO 30 JJ=1,6
  K(JJ)=K(JJ+6)
  IN(JJ)=IN(JJ+6)
30 V(JJ)=V(JJ+6)
  JFLAG=0
  GO TO 60
40 READ (NINP,50) (K(I),IN(I),V(I),I=1,6)
50 FORMAT(6(I1,I2,E9.4))
60 DO 140 I=1,6
  L=K(I)+1
  GO TO (70,80,100,150),L
CNO MODIFICATION
70 ARRAY(J)=V(I)
  J=J+1
  GO TO 140
C
CREPEAT
80 L=IN(I)
  DO90M=1,L
  ARRAY(J)=V(I)
  J=J+1
90 CONTINUE
  GO TO140
C
CINTERPOLATE
100 IF(I-6) 120,110,110
110 READ (NINP,50) (K(JJ),IN(JJ),V(JJ),JJ=7,12)
  JFLAG=1
120 L=IN(I)+1
  DEL=(V(I+1)-V(I))/FLOAT (L)
  DO 130 M=1,L
  ARRAY(J)=V(I)+DEL*FLOAT (M-1)
  J=J+1
130 CONTINUE
C
C
140 CONTINUE
  GO TO 10
C
C

```

```
CTERMINATE
150 J=J-1
    WRITE (NOUT,160)      HOLL,J      ,( ARRAY(I),I=1,J)
    IF(J -NCOUNT)170,180,170
160 FORMAT(6X,A6,16/(10E12.5))
170 CALL ERRO2( 6H**REAG,170,1)
180 RETURN
    END
```

```

-ITC FOR MAPR,MAPR
  SUBROUTINE MAPR(K)
    INCLUDE ABC
    DIMENSION K(9)
1  IX=IM
   IY=JM
   WRITE (NOUT,6) (ID(I), I = 1, 12)
6  FORMAT(1H1,12A6///)
3  DO 5 JJ=1,IY
   J=IY-JJ+1
5  WRITE (NOUT,4) (MO(I,J),I=1,IX)
4  FORMAT( 5H ,55I2)
   WRITE(NOUT,15)
15 FORMAT(2H A/2H X/2H I/2H A/2H L//8H RADIAL)
   WRITE (NOUT,6) (ID(I), I = 1, 12)
   DO 10 JJ=1,IY
   J=IY-JJ+1
   DO 11 L=1,IX
   N=MO(L,J)
11 K(L)=IABS (M2(N))
10 WRITE (NOUT,4) (K(L),L=1,IX)
   WRITE(NOUT,15)
   RETURN
   END

```

```

-IT  FOR PRT,PRT
      SUBROUTINE PRT(IM, JM, PHI)
      COMMON  NINP, NOUT, NCR1, NFLUX1, NSCRAT, NFLUX2
      DIMENSION PHI(50, 50)
      DO 60 I=1,IM,5
        I1=I
        I2=I+4
        IF(I2-IM) 20,20,10
10      I2=IM
20      WRITE ( NOUT,30 ) ( JJ,JJ=I1,I2)
30      FORMAT( 5X, 5I20)
        DO 50 JJ=1,JM
          J=JJ
          WRITE(NOUT,40 ) J,(PHI(K,J),K=I1,I2)
40      FORMAT(5X,I5,E15.7,4E20.7)
50      CONTINUE
60      CONTINUE
      RETURN
      END

```

```
-IT  FOR ERRO2,ERRO2
      SUBROUTINE ERRO2( HOL,JSUBR,I)
      COMMON  NINP, NOUT, NCR1, NFLUX1, NSCRAT, NFLUX2
      WRITE (NOUT,1)          HOL,JSUBR
1  FORMAT(2H */9H ERROR IN,A6,3H AT,I6/2H */2H *)
      GO TO (3,4),I
3  STOP
4  RETURN
      END
```

```

-ITC FOR SETUP, SETUP
  SUBROUTINE SETUP
    INCLUDE ABC
C   MIX CROSS SECTIONS
    ITL = IST + 5
    WRITE(NOUT, 65) (ID(I), I = 1, 12)
65  FORMAT(1H1,12A6///)
    WRITE (NOUT,70)
    70  FORMAT(/19H CROSS-SECTION EDIT)
    REWINDNCR1
    DO 100 IIG=1,IGM
    READ (NCR1) ((CO(I,J),I=1,ITL),J=1,MT)
    DO 92 M=1,M01
    IF(I0(M)-MT)74 ,74 ,72
72  CALL ERRO2(6H**S807,72 ,1)
74  IF(I1(M)-MT)80 ,72 ,72
80  N=I0(M)
    L=I1(M)
    E01=I2(M)
    DO 90 I=1,ITL
    IF(L)86 ,88 ,86
86  CO(I,N)=CO(I,N)+CO(I,L)*E01
    70T090
88  CO(I,N)=CO(I,N)*E01
90  CONTINUE
92  CONTINUE
    WRITE (NOUT,94 ) IIG
94  FORMAT( //7H GROUP I3,15H CROSS-SECTIONS/)
    DO 96 N=1,MT
96  WRITE (NOUT,98 ) N,(CO(I,N),I=1,ITL)
98  FORMAT(4H MAT,I3,10E11.3,/7X,10E11.3)
    WRITE (NSCRAT) ((CO(I,J),I=1,ITL),J=1,MT)
100 CONTINUE
    REWINDNCR1
    REWIND NSCRAT
C   SWITCH TAPE DESIGNATIONS
    ITEMP=NSCRAT
    NSCRAT=NCR1
    NCR1=ITEMP
101 FORMAT(1H1)
C   CALCULATE AREAS AND VOLUMES
C*****
C*****
    PI2=6.28318
    IGEP = IGE + 1
    DO 170 I=1,IM
    R4(I)=(R1(I+1)+R1(I))*0.5
    R5(I)=R1(I+1)-R1(I)

```



```

130 IF( R5(I) ) 130, 130, 140
140 CALL ERRO2 (6H*R5(I),130 ,1)
140 CONTINUE
140 GO TO (160, 150, 150), IGEP
150 CONTINUE
150 A1(I)=R5(I)
150 GO TO 170
160 CONTINUE
160 A1(I)=PI2*R5(I)*R4(I)
170 CONTINUE
170 DO 200 J=1, JM
170 Z4(J)=(Z1(J+1)+Z1(J))*0.5
170 Z5(J)=Z1(J+1)-Z1(J)
170 IF(Z5(J)) 175, 175, 180
175 CALL ERRO2 (6H*Z5(J),175 ,1)
180 CONTINUE
180 GO TO (183, 182, 183), IGEP
182 A2(J) = Z5(J)
182 GO TO 184
183 A2(J) = PI2*R1(IP)*Z5(J)
184 DO 195 I = 1, IM
184 GO TO (190, 185, 190), IGEP
185 V0(I,J)=R5(I)*Z5(J)*VF
185 GO TO 195
190 V0(I,J)=PI2*R5(I)*Z5(J)*R4(I)*VF
195 CONTINUE
200 CONTINUE
C PRINT MIX INFORMATION AND RADII AND AXII INFORMATION
WRITE(NOUT,204) (ID(I), I = 1, 12)
204 FORMAT(1H1, 12A6///)
WRITE(NOUT, 208) (J, I0(J), I1(J), I2(J), J = 1, M01)
208 FORMAT(3X, 16H MIXTURE NUMBER ,18H MIX COMMAND ,
124H MATERIAL ATOMIC DENSITY//(13,1X,18,8X,18,8X,E20.8))
ZZ = 0.0
IP = IM + 1
JP = JM + 1
WRITE(NOUT, 65) (ID(I), I = 1, 12)
WRITE(NOUT, 210)
210 FORMAT(84H RADII AVG RADII
1 AXII AVG AXII //)
IF(IM - JM) 240, 240, 280
240 WRITE(NOUT, 220) ((I, R1(I), R4(I), Z1(I), Z4(I)), I = 1, IP)
220 FORMAT(14,4F20.4)
IF(IM - JM) 241, 500, 241
241 III = IP + 1
WRITE(NOUT, 220) ((I, ZZ, ZZ, Z1(I), Z4(I)), I = III, JP)
GO TO 500
280 WRITE(NOUT, 220) ((I, R1(I), R4(I), Z1(I), Z4(I)), I = 1, JP)

```

```
      JJJ = JP + 1  
500  WRITE(NOUT, 220) ((I, R1(I), R4(I), ZZ, ZZ), I = JJJ, IP)  
      CONTINUE  
      RETURN  
      END
```

C-22

BNWL-409

```

-I TC FOR GRAM,GRAM
  SUBROUTINE GRAM
  INCLUDE ABC
  REAL MASS
  DIMENSION MASS(50, 50)
  EQUIVALENCE (C(1,1,1), MASS(1,1))
C  THIS SUBROUTINE CALCULATES THE MASS OF THE VARIOUS MATERIALS
  WRITE(NOUT, 1) (ID(I), I = 1, 12)
1  FORMAT(1H1,12A6///)
  WRITE(NOUT, 5)
5  FORMAT(45H MATERIAL INVENTORY (KILOGRAMS) FOR EACH ZONE ///)
  DO 10 K=1,IZM
  VOL(K) = 0.0
10 CONTINUE
  DO 15 J = 1, 50
  DO 15 I = 1, 50
15  MASS(I, J) = 0.0
  DO 20 J = 1, JM
  DO 20 I = 1, IM
  K = M0(I,J)
  KK = M2(K)
  L2(KK) = K
  VOL(K) = VOL(K) + V0(I, J)*.001
20 CONTINUE
  DO 40 M = 1, M01
  N = I0(M)
  N = L2(N)
  L = I1(M)
  IF(L) 40, 40, 30
30  E01 = I2(M)
  MASS(N,L) = ((E01*ATW(L)*VOL(N))/.6023)
40 CONTINUE
  DATA ZONE/6H ZONE /
  DO 90 L = 1, IZM, 5
  LL = L + 4
  IF(LL - IZM) 62, 62, 61
61  LL = IZM
62  WRITE(NOUT, 72) ((ZONE, K), K=L, LL)
72  FORMAT(26H MATERIAL ATOMIC WT. ,3X, 5(A6,I2,12X))
  WRITE(NOUT, 73) (VOL(K), K = L, LL)
73  FORMAT(25X, 5(F8.2, 7H LITERS, 5X))
  KK = MCR + MTP
  DO 75 K = 1, KK
75  WRITE(NOUT, 76) K, HOLN(K), ATW(K), (MASS(I, K), I = L, LL)
76  FORMAT(/I3,1X, A6, F13.3, F14.3, 4F20.3)
  IF(LL - IZM) 90, 94, 94
90 CONTINUE
94 CONTINUE

```

RETURN
END

C-24

BNWL-409

```

-ITC FOR NORM,NORM
  SUBROUTINE NORM
  INCLUDE ABC
  DIMENSION TPhi(50, 50), CADJ(50, 50), ACT(50, 50, 3), POW(50, 50)
  EQUIVALENCE (SORC1(1,1),TPhi(1,1)), (SORC2(1,1),CADJ(1,1)),
1(C(1,1,1),ACT(1,1,1)),(LDUM(1),POW(1,1))
C  THIS SUBROUTINE NORMALIZES THE FLUXES (REGULAR AND ADJOINT)
  CFX = 0.0
  CPW = 0.0
  POWER = 0.0
  DENOM = 0.0
  RL = 0.0
  ZL = 0.0
  RABS = 0.0
  RSORS = 0.0
  DO 10 J = 1, JM
  DO 10 I = 1, IM
  SORC1(I, J) = 0.0
  SORC2(I, J) = 0.0
10  CONTINUE
  REWIND NFLUX1
  REWIND NFLUX2
  REWIND NSCRAT
  REWIND NCR1
  DO 100 KK = 1, IGM
  READ(NCR1) ((C0(II, J), II = 1, ITL), J = 1, MT)
  READ(NFLUX1) ((PHI(I, J), I = 1, IM), J = 1, JM)
  READ(NFLUX2) ((ADJ(I, J), I = 1, IM), J = 1, JM)
  CFX = CFX + PHI(1, 1)
  K = M0(1, 1)
  K = M2(K)
  CPW = CPW + C0(1,K)*PHI(1,1)
  DO 20 J = 1, JM
  DO 20 I = 1, IM
  K = M0(I, J)
  K = M2(K)
  POWER = POWER + C0(1, K)*PHI(I, J)*V0(I, J)
  SORC1(I, J) = SORC1(I, J) + C0(3, K)*PHI(I, J)
  SORC2(I, J) = SORC2(I, J) + CHI(KK)*ADJ(I, J)
  RABS = RABS + C0(2, K)*PHI(I, J)*V0(I, J)
  RSORS = RSORS + C0(3, K)*PHI(I, J)*V0(I, J)
20  CONTINUE
  PI2 = 6.28318
  DO 50 I = 1, IM
  GO TO (35, 35, 25), IGEP
25  SLOPZ(I) = (PHI(I,JM) - PHI(I,JM - 1))/(Z4(JM) - Z4(JM - 1))
1 *PI2*R4(I))
  GO TO 40

```

```

35  SLOPZ(I) = (PHI(I,JM) - PHI(I,JM - 1))/(Z4(JM) - Z4(JM - 1))
40  CONTINUE
    K = M0(I, JM)
    K = M2(K)
    ZL = ZL + (SLOPZ(I)*A1(I))/(3.*C0(4,K))
50  CONTINUE
    DO 60 I = 1, IM
    GO TO (55, 55, 52), IGEP
52  SLOPZ(I) = -(PHI(I,2) - PHI(I,1))/(Z4(2) - Z4(1))*P12*R4(I)
    GO TO 56
55  SLOPZ(I) = -(PHI(I,2) - PHI(I,1))/(Z4(2) - Z4(1))
56  CONTINUE
    K = M0(I,1)
    K = M2(K)
    ZL = ZL + (SLOPZ(I)*A1(I))/(3.*C0(4,K))
60  CONTINUE
    DO 80 J=1, JM
    SLOPR(J) = (PHI(IM,J) - PHI(IM - 1,J))/(R4(IM) - R4(IM - 1))
    K = M0(IM,J)
    K = M2(K)
    RL = RL + (SLOPR(J)*A2(J))/(3.*C0(4,K))
80  CONTINUE
100 CONTINUE
    RLEAK = -ZL - RL
    RSORS = RSORS/VF
    RABS = RABS/VF
    AK = (RSORS)/(RABS + RLEAK)
C   TSD = (MW-SEC)/(FISSIONS)
    TSD = FEF*1.602*10.**(-19)
    CAD = SORC2(1, 1)
    CPW = CPW*TSD*1000.
    POWER = POWER*TSD
    REWIND NCR1
    REWIND NFLUX1
    REWIND NFLUX2
    DO 200 J = 1, JM
    DO 200 I = 1, IM
    DENOM = DENOM + (SORC1(I, J) * SORC2(I, J)*V0(I, J))/(SORC2(1,1)*AK)
200 CONTINUE
    GO TO (240, 260, 280, 300), NFP
240 CONST = FLPO/CFX
    GO TO 320
260 CONST = FLPO/CPW
    GO TO 320
280 CONST = FLPO/POWER
    GO TO 320
300 CONST = FLPO/DENOM
320 CONTINUE

```

```

CFX = CONST*CFX
CPW = CONST*CPW
POWER = CONST*POWER
DENOM = CONST*DENOM
328 WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
FORMAT(1H1, 12A6////////)
RSORS = RSORS*VF*CONST
RABS = RABS*VF*CONST
RLEAK = RLEAK*VF*CONST
RL = -RL*VF*CONST
ZL = -ZL*VF*CONST
AAK = .1*AK
WRITE(NOUT, 330) CFX, CPW, POWER, DENOM, RSORS, RABS, RLEAK
1 , RL, ZL, AAK
330 FORMAT(44H CENTER POINT FLUX (N/CM2-SEC) - - - 1PE12.5//
1 44H CENTER POINT POWER (MWT/LITER) - - - 1PE12.5//
2 44H TOTAL POWER (MWT) - - - 1PE12.5//
3 44H DENOMINATOR OF PERT. FORMULA - - - 1PE12.5//
4 44H SOURCE RATE - - - 1PE12.5//
5 44H ABSORPTION RATE - - - 1PE12.5//
6 44H LEAKAGE RATE (TOTAL) - - - 1PE12.5//
7 44H RADIAL LEAKAGE - - - 1PE12.5//
8 44H AXIAL LEAKAGE - - - 1PE12.5//
9 44H KEFF - - - F12.5)
DO 350 J = 1, JM
DO 350 I = 1, IM
DO 344 N = 1, 3
344 ACT(I, J, N) = 0.0
TPHI(I, J) = 0.0
CADJ(I, J) = 0.0
POW(I, J) = 0.0
350 CONTINUE
DO 400 K = 1, IGM
READ(NFLUX1) ((PHI(I, J), I = 1, IM), J = 1, JM)
READ(NFLUX2) ((ADJ(I, J), I = 1, IM), J = 1, JM)
READ(NCR1) ((CO(I, J), II = 1, ITL), J = 1, MT)
DO 360 J = 1, JM
DO 360 I = 1, IM
KK = M0(I, J)
KK = M2(KK)
PHI(I, J) = PHI(I, J)*CONST
ADJ(I, J) = ADJ(I, J)/CAD
TPHI(I, J) = TPHI(I, J) + PHI(I, J)
CADJ(I, J) = CADJ(I, J) + CHI(K) * ADJ(I, J)
POW(I, J) = POW(I, J) + CO(1, KK)*PHI(I, J)*TSD*1000.
IF(NACT) 360, 360, 352
352 CONTINUE
DO 356 N = 1, NACT

```

```

      KK = MA(N)
      NN = NX(N)
356  ACT(I, J, N) = ACT(I, J, N) + CO(NN, KK)*PHI(I, J)
360  CONTINUE
      WRITE(NSCRAT) ((PHI(I, J), I = 1, IM), J = 1, JM)
      WRITE(NSCRAT) ((ADJ(I, J), I = 1, IM), J = 1, JM)
      LMN = IFP + 1
      GO TO (368, 362, 364), LMN
362  PUNCH 363, ((PHI(I, J), I = 1, IM), J = 1, JM)
363  6FORMAT(6E12.6)
      GO TO 368
364  PUNCH 363, ((ADJ(I, J), I = 1, IM), J = 1, JM)
368  IF(NPRT) 376, 376, 370
370  CONTINUE
      WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
      WRITE(NOUT, 372) K
372  FORMAT(/15H FLUX FOR GROUP,I3/)
      CALL PRT(IM, JM, PHI)
      WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
      WRITE(NOUT, 374) K
374  FORMAT(/23H ADJOINT FLUX FOR GROUP,I3/)
      CALL PRT(IM, JM, ADJ)
376  CONTINUE
400  CONTINUE
      WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
      WRITE(NOUT, 478)
478  FORMAT(11H TOTAL FLUX/)
      CALL PRT(IM, JM, TPHI)
      WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
      WRITE(NOUT, 480)
480  FORMAT(28H FISSION SOURCE*ADJOINT FLUX/)
      CALL PRT(IM, JM, CADJ)
      WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
      WRITE(NOUT, 482)
482  FORMAT(26H POWER DENSITY (MWT/LITER) /)
      CALL PRT(IM, JM, POW)
      IF(NACT) 490, 490, 484
484  DO 488 N = 1, NACT
      DO 486 J = 1, JM
      DO 486 I = 1, IM
486  SORC2(I, J) = ACT(I, J, N)
      WRITE(NOUT, 328) (ID(IK), IK = 1, 12)
      KK = MA(N)
      NN = NX(N)
      WRITE(NOUT, 487) N, KK, NN
487  FORMAT(9H ACTIVITY, I3, I3H      ISOTOPE,I3, 28H      CROSS SECTI
ION POSITION,I3/)
      CALL PRT(IM, JM, SORC2)

```



```
488  CONTINUE
490  CONTINUE
      CALL AVG(TPHI,POW,ACT)
C    SWITCH TAPE DESIGNATIONS
      ITEMP = NSCRAT
      NSCRAT = NFLUX1
      NFLUX1 = ITEMP
      REWIND NSCRAT
      REWIND NFLUX1
      REWIND NFLUX2
      REWIND NCR1
      RETURN
      END
```

```

-I TC FOR AVG,AVG
  SUBROUTINE AVG(TPHI,POW,ACT)
    INCLUDE ABC
  C   THIS SUBROUTINE CALCULATES ZONE AVERAGED FLUXES, POWERS,
  C   AND ACTIVITIES
    DIMENSION ACT(50, 50, 3), TPHI(50,50), POW(50,50)
    DATA CAT/6H ACT /
    WRITE(NOUT,328) (ID(IK),IK=1,12)
328  FORMAT(1H1,12A6////////)
    DO 340 KKK=1,IZM
      ZPHI(KKK) = 0.0
      ZPOW(KKK) = 0.0
    DO 340 N=1,3
340  ZACT(KKK,N) = 0.0
    DO 525 J=1,JM
    DO 525 I=1,IM
      KKK = M0(I,J)
      ZPHI(KKK) = ZPHI(KKK) + V0(I,J)*.001*TPHI(I,J)
      ZPOW(KKK) = ZPOW(KKK) + V0(I,J)*.001*POW(I,J)
      IF(NACT) 525,525,505
505  DO 508 N=1,NACT
508  ZACT(KKK,N) = ZACT(KKK,N) + V0(I,J)*.001*ACT(I,J,N)
525  CONTINUE
    DO 540 KKK=1,IZM
      ZPHI(KKK) = ZPHI(KKK)/VOL(KKK)
      ZPOW(KKK) = ZPOW(KKK)/VOL(KKK)
      IF(NACT) 540,540,535
535  DO 538 N=1, NACT
538  ZACT(KKK,N) = ZACT(KKK,N)/VOL(KKK)
540  CONTINUE
      IF(NACT) 560,560,580
560  WRITE(NOUT,565)
565  FORMAT( 48H ZONE AV FLUX AV POWER //)
    DO 570 KKK=1,IZM
570  WRITE(NOUT,575) KKK,ZPHI(KKK),ZPOW(KKK)
575  FORMAT(/I6,5E20.7)
    GO TO 600
580  WRITE(NOUT,585) ((CAT,N), N=1,NACT)
585  FORMAT( 48H ZONE AV FLUX AV POWER 6X,
1 3(A6,I1,13X))
    DO 590 KKK=1,IZM
590  WRITE(NOUT,575) KKK, ZPHI(KKK),ZPOW(KKK), (ZACT(KKK,N),N=1,NACT)
600  CONTINUE
    RETURN
    END

```

```

-ITC FOR ABETA,ABETA
  SUBROUTINE ABETA
    INCLUDE ABC
    DIMENSION BSIGF(50,50)
    EQUIVALENCE (PHR(1,1), BSIGF(1,1))
  C  THIS SUBROUTINE CALCULATES BETA EFFECTIVE AND NEUTRON LIFETIME
    WRITE(NOUT,5) (ID(I), I=1,12)
  5  FORMAT(1H1,12A6////)
    DO 10 J=1,50
    DO 10 I=1,50
    SORC1(I,J)=0.0
    SORC2(I,J)=0.0
    PHZ(I,J) = 0.0
    BSIGF(I,J) = 0.0
  10  CONTINUE
    DO 1000 KK=1,IGM
    READ(NFLUX1) ((PHI(I,J), I=1,IM), J=1,JM)
    READ(NFLUX1) ((ADJ(I,J), I=1,IM), J=1,JM)
    READ(NCR1) ((CU(I,J), I=1,ITL),J=1,MT)
    DO 500 J = 1, JM
    DO 500 I = 1, IM
    PHZ(I,J) = (PHI(I,J)*ADJ(I,J))/(VEL(KK)) + PHZ(I,J)
    KKK= MO(I,J)
    KKK = M2(KKK)
    DO 300 L = 1, NIBC
    DEN = 0.0
    DO 120 M=1, M01
    IF(I0(M) -KKK) 120, 110, 120
  110 IF(I1(M) - NBET(L)) 120, 115, 120
  115 DEN = DEN + I2(M)
  120 CONTINUE
    NN = NBET(L)
    BSIGF(I,J) = BSIGF(I,J) + BETA(L)*DEN*CO(1,NN)*PHI(I,J)
  300 CONTINUE
  C  DELAYED NEUTRON SOURCE*ADJOINT FLUX (SUMMED OVER ENERGY GROUPS)
    SORC2(I,J) = CHIP(KK)*ADJ(I,J) + SORC2(I,J)
  500 CONTINUE
  1000 CONTINUE
    BE = 0.0
    ALIFE = 0.0
    DO 2000 J = 1, JM
    DO 2000 I = 1, IM
    BE = BE + SORC2(I,J)* BSIGF(I,J)*V0(I,J)
    ALIFE = ALIFE + (PHZ(I,J)*V0(I,J))
  2000 CONTINUE
    ALIFE = ALIFE/(DENOM*AK)

```

```
      BEFF = BE/(DENOM*AK)
      WRITE(NOUT,2050) BEFF, ALIFE
2050  FORMAT( 43H BETA EFFECTIVE - - - - - 1PE11.5//
1      43H NEUTRON GENERATION TIME - - - - - 1PE11.5)
      RETURN
      END
```

```

-ITC FOR CALC,CALC
  SUBROUTINE CALC
    INCLUDE ABC
    DIMENSION CX(15,26), FLUX(2,26,50,3), SLOAR(50),
1      SLOAZ(50)
    EQUIVALENCE (CX(1,1), PHR(1,1)), (FLUX(1,1,1,1),C(1,1,1)),
1      (SLOAR(1), DUM(51)),
2      (SLOAZ(1), DUM(151))
C  THIS SUBROUTINE USES PERTURBATION THEORY TO CALCULATE REACTIVITY
C  COEFFICIENTS
    DO 9999 III = 1, NDELK
      REWIND NCR1
      REWIND NFLUX1
      REWIND NFLUX2
      REWIND NSCRAT
      NR = NROW(III)
      NC = NCOL(III)
      MAT = MATDK(III)
C  CONVERSION FROM ATOMS TO KG
      CT= 602.3/ATW(MAT)
      PI2 = 6.28318
      DO 1 J = 1, 50
      DO 1 I = 1, 50
        SORC1(I, J) = 0.0
1      SORC2(I, J) = 0.0
        WRITE(NOUT, 2) (ID(I), I = 1, 12)
2      FORMAT(1H1,12A6/// )
        DO 1000 K = 1, IGM
          READ(NFLUX1) ((PHI(I, J), I = 1, IM), J = 1, JM)
          READ(NFLUX1) ((ADJ(I, J), I = 1, IM), J = 1, JM)
          READ(NCR1) ((CO(II, J), II = 1, ITL), J = 1, MT)
          DO 3 II = 1, ITL
            CX(II, K) = CO(II, MAT)
3          IF(NR) 400, 400, 10
C  DELTA K CALCULATION FOR ROW = NROW
10      CONTINUE
          DO 60 I = 1, IM
            IF(NR - JM) 20, 40, 40
20          NN = NR + 1
            FLUX(1, K, I, 3) = PHI(I, NN)
            FLUX(2, K, I, 3) = ADJ(I, NN)
30          IF(NR - 1) 50, 50, 40
40          NN = NR - 1
            FLUX(1, K, I, 1) = PHI(I, NN)
            FLUX(2, K, I, 1) = ADJ(I, NN)
50          NN = NR
            FLUX(1, K, I, 2) = PHI(I, NN)
            FLUX(2, K, I, 2) = ADJ(I, NN)

```

```

        SORC2(I, 1) = CHI(K)*FLUX(2, K, I, 2) + SORC2(I, 1)
        SORC1(I, 1) = CU(3, MAT)*FLUX(1, K, I, 2) + SORC1(I, 1)
        SORC1(I, 2) = CU(2, MAT)*FLUX(1, K, I, 2)*FLUX(2, K, I, 2)
        1 + SORC1(I, 2)
60      CONTINUE
        DO 150 I=1,IM
        IF(I-1) 82,82,72
72      PSR1 = (FLUX(1,K,I,2) - FLUX(1,K,I-1,2))/(R4(I) - R4(I-1))
        ASR1 = (FLUX(2,K,I,2) - FLUX(2,K,I-1,2))/(R4(I) - R4(I-1))
76      IF(I-IM) 78,86,86
78      PSR2 = (FLUX(1,K,I+1,2) - FLUX(1,K,I,2))/(R4(I+1) - R4(I))
        ASR2 = (FLUX(2,K,I+1,2) - FLUX(2,K,I,2))/(R4(I+1) - R4(I))
        GO TO 90
82      SLOPR(I) = 0.0
        SLOAR(I) = 0.0
        GO TO 92
86      SLOPR(I) = PSR1
        SLOAR(I) = ASR1
        GO TO 92
90      SLOPR(I) = (PSR1 + PSR2)/2.0
        SLOAR(I) = (ASR1 + ASR2)/2.0
92      CONTINUE
        IF(NR - 1) 100, 100, 93
93      GO TO (96, 96, 94), IGEP
94      PSZ1 = (FLUX(1,K,I,2) - FLUX(1,K,I,1))/(Z4(NR) - Z4(NR-1))
        1 *PI2*R4(I))
        ASZ1 = (FLUX(2,K,I,2) - FLUX(2,K,I,1))/(Z4(NR) - Z4(NR-1))
        1 *PI2*R4(I))
        GO TO 97
96      PSZ1 = (FLUX(1,K,I,2) - FLUX(1,K,I,1))/(Z4(NR) - Z4(NR-1))
        ASZ1 = (FLUX(2,K,I,2) - FLUX(2,K,I,1))/(Z4(NR) - Z4(NR-1))
97      IF(NR -IM) 100, 115, 115
100     GO TO (105, 105, 102), IGEP
102     PSZ2 = (FLUX(1,K,I,3) - FLUX(1,K,I,2))/(Z4(NR+1) - Z4(NR))
        1 *PI2*R4(I))
        ASZ2 = (FLUX(2,K,I,3) - FLUX(2,K,I,2))/(Z4(NR+1) - Z4(NR))
        1 *PI2*R4(I))
        GO TO 106
105     PSZ2 = (FLUX(1,K,I,3) - FLUX(1,K,I,2))/(Z4(NR+1) - Z4(NR))
        ASZ2 = (FLUX(2,K,I,3) - FLUX(2,K,I,2))/(Z4(NR+1) - Z4(NR))
106     IF(NR-1) 108, 108, 120
108     SLOPZ(I) = PSZ2
        SLOAZ(I) = ASZ2
        GO TO 130
112     CONTINUE
        IF(NR -IM) 120,115,115
115     SLOPZ(I) = PSZ1
        SLOAZ(I) = ASZ1

```

```

      GO TO 1200
1100 DO 1175 J = 1, JM
      DO 1170 NN = 1, 1ST
      N = NN + K
      L = 5 + NN
      SORC2(J, 2) = SORC2(J, 2) + FLUX(1, K, J, 2)*CX(L, N)*
1      (FLUX(2, K, J, 2) - FLUX(2, N, J, 2))
      IF(N- IGM) 1170, 1175, 1175
1170 CONTINUE
1175 CONTINUE
1200 CONTINUE
1210 CONTINUE
      IF(NR) 3000, 3000, 2000
2000 WRITE(NOUT, 2050) MAT, HOLN(MAT), NR
      WRITE(NOUT, 2060)
      WRITE(NOUT, 2062)
      SUM = 0.0
      TOT = 0.0
      DO 2200 I = 1, IM
C      FISSIONS
        SORC2(I, 3) = (SORC2(I, 1)*SORC1(I, 1)*CT)/(AK*DENOM)
C      ABSORPTIONS
        SORC1(I, 2) = (SORC1(I, 2)*CT)/DENOM
C      SLOWING DOWN
        SORC2(I, 2) = (SORC2(I, 2)*CT)/DENOM
C      LEAKAGE
        SORC1(I, 3) = (SORC1(I, 3)*CT)/DENOM
C      DELTA K
        SORC2(I, 4) = SORC2(I, 3) - SORC1(I, 2) - SORC1(I, 3) - SORC2(I, 2)
        SUM = SUM + SORC2(I, 4)*V0(I, NR)
        TOT = TOT + V0(I, NR)
        ST = SUM/TOT
2050 FORMAT( 38HOREACTIVITY COEFFICIENTS FOR MATERIAL 12,6X,A6,
1 11H      ROW 12//)
2060 FORMAT(131H      (DELTA K)/K PER KG      DEL K      DEL K
1      DEL K      DEL K      DEL K      AVG RADII
2      AVG AXII )
2062 FORMAT( 99H      (NUSIGF)      (SIGA)
1      (SIGTR)      (SIGJXK)      (INTG) / )
        SORC1(I, 2) = -SORC1(I, 2)
        SORC1(I, 3) = -SORC1(I, 3)
        SORC2(I, 2) = -SORC2(I, 2)
        WRITE(NOUT, 2080) I, SORC2(I, 4), SORC2(I, 3), SORC1(I, 2),
1      SORC1(I, 3), SORC2(I, 2), ST, R4(I), Z4(NR)
2080 FORMAT(13, 8E16.4)
2200 CONTINUE
      GO TO 3400
3000 WRITE(NOUT, 3050) MAT, HOLN(MAT), NC

```

```

        WRITE(NOUT, 2060)
        WRITE(NOUT, 2062)
        SUM = 0.0
        TOT = 0.0
        DO 3200 I = 1, JM
C   FISSIONS
        SORC2(I, 3) = (SORC2(I,1)*SORC1(I,1)*CT)/(AK*DENOM)
C   ABSORPTIONS
        SORC1(I, 2) = (SORC1(I, 2)*CT)/DENOM
C   SLOWING DOWN
        SORC2(I, 2) = (SORC2(I, 2)*CT)/DENOM
C   LEAKAGE
        SORC1(I, 3) = (SORC1(I, 3)*CT)/DENOM
C   DELTA K
        SORC2(I, 4) = SORC2(I,3) - SORC1(I,2) - SORC1(I,3) - SORC2(I,2)
        SUM = SUM + SORC2(I,4)*V0(NC,I)
        TOT = TOT + V0(NC,I)
        ST = SUM/TOT
3050  FORMAT(      38HOREACTIVITY COEFFICIENTS FOR MATERIAL I2, 6X,A6,
1 14H      COLUMN I2//)
        SORC1(9,2) = -SORC1(I,2)
        SORC1(I,3) = - SORC1(I,3)
        SORC2(I,2) = -SORC2(I,2)
        WRITE(NOUT, 2080) I, SORC2(I,4), SORC2(I,3), SORC1(I,2),
1  SORC1(I,3), SORC2(I,2),ST, R4(NC), Z4(I)
3200  CONTINUE
3400  CONTINUE
9999  CONTINUE
        REWIND NCR1
        REWIND NFLUX1
        REWIND NFLUX2
        REWIND NSCRAT
        RETURN
        END

```


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