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TOAFEW-V Multigroup Cross-Section Collapsing Code and Library of 154-Group-Processed ENDF/B/V Fission-Product and Actinide Cross Sections

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Prepared by
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Los Alamos, New Mexico

ELECTRIC POWER RESEARCH INSTITUTE

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Interim Report, April 1982

Prepared by

LOS ALAMOS NATIONAL LABORATORY
Nuclear Data Group
Theoretical Division
University of California
Los Alamos, New Mexico 87545

Principal Investigators
W. B. Wilson
T. R. England
R. J. LaBauve
R. M. Boicourt

Program Manager
P. G. Young

Prepared for

Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

EPRI Project Manager
O. Ozer

Code Development and Validation Program
Nuclear Power Division

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Prepared by
Los Alamos National Laboratory
Los Alamos, New Mexico

EPRI PERSPECTIVE

PROJECT DESCRIPTION

The current version of the national reference nuclear data library (ENDF/B-V) contains a considerable amount of information relating to fission-product nuclides and heavy actinides (nuclides with Z = 90 or higher). The library contains information for some 877 fission-product nuclides and some 60 actinide nuclides. Although most of the fission products and some of the actinides are so short-lived that only decay characteristics (half-lives and beta and gamma decay energies) are given, 237 of the longer-lived nuclides have significant cross-section data. This information is needed for isotopic analyses of LWR fuel as a function of exposure and for decay heat calculations following a shutdown. In most cases, however, this extensive data base can be utilized in a considerably condensed form.

PROJECT OBJECTIVES

The objectives of this project have been (1) to evaluate the adequacy of the ENDF/B-V fission-product and actinide data files for LWR applications, (2) to correct errors, and (3) to process and reduce the data files for use in the EPRI core physics programs (ARMP).

PROJECT RESULTS

Work on the evaluation of the ENDF/B-V data files is continuing. However, during this study it was advantageous to preprocess the cross sections for the 237 fission-product and actinide nuclides into a 154 "fine-group" form using a typical PWR weight spectrum. This data can be further collapsed into any desired "few-group" form at a considerably reduced cost with the use of a special-purpose program, TOAFEW-V.

The present document describes the TOAFEW-V program and its data base. This program should be of interest in a wide range of applications in the area of LWR core physics, including burnup, fuel-cycle optimization, and decay heat calculations.

Odelli Ozer, Project Manager
Nuclear Power Division

ABSTRACT

The ENDF/B-V cross sections of 237 fission-product and actinide nuclides have been processed at infinite dilution into 154 neutron energy groups at temperatures of 300, 900, and 1200 K. Additional 154-group self-shielded actinide cross sections were calculated with Bondarenko background σ_0 values as small as 1 barn. The production and content of the multigroup data library is described. The TOAFEW-V collapsing code, a modified version of the earlier TOAFEW code, is presented with instructions and examples of its use. The multigroup cross sections were produced using a typical light-water reactor spectrum. The group structure is sufficiently fine that collapse to few groups using an appropriate spectrum (e.g., LMFBR, CTR, etc.) is also accurate for alternate applications.

ACKNOWLEDGMENT

We appreciate the coding modifications to NJOY by R. E. MacFarlane to produce thermal cross-section and resonance-integral values. R. E. Schenter and F. Mann of Hanford Engineering Development Laboratory have cooperated with us in the identification and correction of minor errors in the ENDF/B-V files. We also appreciate the assistance of N. L. Whittemore in preparing tabular data and C. I. Baxman in preparing the manuscript.

CONTENTS

SUMMARY

The aggregate fission, parasitic neutron absorption, and decay properties of the fuel of a nuclear reactor are determined by calculating the inventory of each nuclide within the fuel and summing their individual contributions. These inventory and summation calculations depend upon the existence of information describing the pertinent neutron-reaction and radioactive-decay parameters for each actinide and fission-product nuclide. The Cross Section Evaluation Working Group (CSEWG) is responsible for the development and maintenance of the national reference nuclear data base, ENDF/B. The Fission Product and Actinide Subcommittee of CSEWG has recently completed, primarily under DOE funding, massive data files describing 877 fission products and 60 actinides for ENDF/B-V, the fifth version of the data base.

The object of the present task has been the reduction of the extensive neutron reaction data of ENDF/B-V to form a more manageable data base useful to calculations with core physics, inventory (burnup), and summation codes such as those of the EPRI ARMP collection. This reduction was accomplished by processing the detailed representations of the ENDF/B-V neutron reaction cross sections with the NJOY code--producing thermal (0.0253 eV), resonance-integral, and 154-group values.

The library of processed cross sections is furnished with a flexible cross-section collapsing code TOAFEW-V. The collapsing code accepts neutron flux spectrum descriptions in a variety of formats and may be used to produce few-group cross sections for a wide range of applications.

Section 1

INTRODUCTION

Version four of the Evaluated Nuclear Data File (ENDF/B-IV) (1) included evaluated cross sections for many significant long-lived fission-product and actinide nuclides. The cross sections of the ENDF/B-IV fission products were processed into multigroup form and furnished with a flexible cross-section collapsing code TOAFEW (2). The actinide and fission-product data content of ENDF/B-V, compared with that of ENDF/B-IV in Table 1-1, represents a considerable investment in recent data evaluation as well as a great increase in data content. The cross sections of ENDF/B-V actinide and fission-product nuclides have now been processed into multigroup form and are provided with the TOAFEW-V modified version of the earlier code.

Of the 877 fission-product nuclides and 60 actinide nuclides of ENDF/B-V, 237 have neutron cross-section evaluations for total, elastic, and radiative capture reactions from 10^{-5} eV to 20 MeV. Total inelastic evaluations are present for nearly all of the 237 nuclides, and additional neutron reaction cross-section evaluations [e.g., (n,2n), (n,p), etc] are present for many of them. Thermal (0.0253 eV), resonance integral (above 0.5 eV and above 0.625 eV), and multigroup values have been produced in the processing of each cross-section evaluation as described in Sections 2 and 3. The multigroup library has been collapsed to a 4-group cross-section set for use with ENDF/B-V radioactive decay and fission yield data in a variety of reactor physics and depletion codes. The TOAFEW-V code, used in producing few-group values from the companion multigroup library, is described in Sections 4 and 5. Four-group radiative capture (n,γ) cross sections produced by the code are given in Section 6. A listing of the code is given in Appendix A and sample problems are described in Appendix B.

Much of the material presented here is simply repeated from the earlier report (2) on ENDF/B-IV to form a complete description of the code and data.

Table 1-1

COMPARISON OF FISSION-PRODUCT
AND ACTINIDE DATA CONTENT OF ENDF/B-IV and -V

Quantity	Actinides ENDF/B-IV	Actinides ENDF/B-V	Fission Products ENDF/B-IV	Fission Products ENDF/B-V
Total nuclides	16	60	824	877
Nuclides with cross sections	16	42	181	196
Stable nuclides	0	0	113	127
Unstable nuclides	16	60	711	750
First isomeric states	0	3	117	148
Second isomeric states	0	0	6	6
Delayed Neutron Precursors	0	0	57	105

Section 2

CROSS SECTION PROCESSING

Cross sections of the 237 actinide and fission-product nuclides (MATs) of the ENDF/B-IV data library having cross-section evaluations were processed into multigroup form using the NJOY cross-section processing code (3). This procedure first requires, for each reaction (MT), the formation of a set of linear-linear interpolation points from the interpretation of the zero degree kelvin cross-section data representation of ENDF/B-V, consisting of resonance parameters, tabulated cross-section values, and various interpolation schemes. Cross-section tabulations produced in this linear-linear form are combined with other linearized data and parameters to form a point energy nuclear data file, PENDF (3,4).

Cross sections described in the PENDF file are then Doppler broadened to desired temperatures and included in PENDF files corresponding to the elevated temperatures. The formation of Doppler broadened PENDF files represents the greatest computational time and expense in the processing procedure, and these files are generally recorded for future utilization. PENDF files retained from the earlier processing by Kidman (5) were used in processing 42 fission-product and 34 actinide MATs. New PENDF files were generated for the remaining 161 MATs. All PENDF files include cross-section tabulations at 300, 900, and 1200 K; multigroup cross sections were generated at each of these temperatures.

Multigroup cross-section values are computed as flux weighted energy-group averaged values of the cross section. The group j cross-section value σ_j is thus calculated

$$\sigma_j = \frac{\int_{E_{j+1}}^{E_j} \sigma(E)\ \phi(E)\ dE}{\int_{E_{j+1}}^{E_j} \phi(E)\ dE} = \frac{\int_{E_{j+1}}^{E_j} \sigma(E)\ \phi(E)\ dE}{\phi_j} \qquad (2\text{-}1)$$

where

$\sigma(E)$ is the energy-dependent cross section of the PENDF representation;

$\phi(E)$ is the energy-dependent neutron flux spectrum weighting function;

E_j and E_{j+1} are the upper and lower energy boundaries, respectively, of energy group j; and

ϕ_j is the group j flux value, the intergral of $\phi(E)$ over the energy range of group j.

CROSS-SECTION RESONANCE SELF SHIELDING

The resonance structure and high density of a nuclide may produce self-shielding effects--flux suppressions at neutron energies corresponding to cross-section maxima and flux peaking due to neighboring cross-section minima. The NJOY code (3) uses the Bondarenko (6) scheme to describe the effects of such flux perturbations on multigroup cross-section values. Here the weight function is described by

$$\psi(E,\sigma_0) = \frac{\phi(E)}{\sigma_t(E) + \sigma_0} \quad , \qquad (2\text{-}2)$$

where

$\phi(E)$ represents the broad energy behavior of the energy-dependent flux,

$\sigma_t(E)$ is the energy-dependent total cross section of the nuclide in question, and

σ_0 is the background group constant.

The flux weighting function is thus strongly perturbed by a resonance if a very small value of σ_0 (e.g., σ_0 = 1 b) is used, forcing the flux spectrum weighting function to reflect a $1/\sigma_t(E)$ behavior. Large values of σ_0 result in little perturbation of the flux spectrum weighting function.

Individual fission-product nuclides produced in reactor fuel generally reach maximum densities that are relatively small, resulting in negligible flux spectrum perturbations. Multigroup cross sections for all fission-product nuclides have been calculated with a large σ_0 value ($\sigma_0 = 1 \times 10^{10}$ b) and are referred to as "infinite dilution" cross sections, alluding to the absence of any other atoms of the same species and consequently no spectrum perturbation due to the nuclide's cross-section structure.

The resonance structure and high relative densities of some actinide nuclides initially present or produced in a reactor fuel may result in strong self-shielding effects. Consequently, all actinide cross sections have been processed at each temperature using three or more values of σ_0 ranging from 1 to 1×10^{10} b.

PRS FLUX WEIGHTING FUNCTION

The neutron flux spectrum weighting function used in processing multigroup cross sections should reflect the spectrum appropriate to the cross-section application. Because this work is directed at light water reactor (LWR) calculations, we have used a flux weighting function and multigroup energy structure appropriate to power reactor studies (PRS). The PRS flux description $\phi(E)$ represents the broad energy behavior of the energy dependent flux of a mid-life PWR. The function, described by a set of 115 log-log interpolation points given in Table 2-1 and shown in Fig. 2-1, was constructed in the following manner.

1.0×10^{-5} eV - 0.625 eV

$\phi(E)$ approximates a mid-life PWR thermal spectrum from a 172-group calculation.

0.625 - 3.0×10^{4} eV

$\phi(E)$ approximates the spectrum from MC^2 (7) "ultrafine" multigroup calculations with over 2000 energy groups to vividly display flux perturbations due to ^{238}U resonances at 6.67, 20.9, 36.7, and 66.0 eV. No attempt was made to include observed minor flux depressions due to ^{238}U resonances at higher energies.

3.0×10^{4} eV - 3.0×10^{6} eV

$\phi(E)$ approximates the spectrum from MC^2 "fine" multigroup calculations. Flux perturbations due to ^{16}O resonances at 442 keV, 1.0 and 1.3 MeV, and the ^{16}O window at 2.35 MeV are clearly present.

3.0×10^{6} eV - 1.0×10^{7} eV

$\phi(E)$ assumes the shape of a fission spectrum with the temperature of 1.3427 MeV, approximating the calculated MC^2 multigroup spectrum.

TABLE 2-1

PRS FLUX WEIGHTING FUNCTION

POINT	ENERGY, (EV)	FLUX	POINT	ENERGY, (EV)	FLUX	POINT	ENERGY, (EV)	FLUX
1	1.0000E-05	5.2500E-04	40	3.5600E+01	7.4897E-04	78	3.0000E+06	3.1142E-08
2	9.0000E-03	3.5500E-01	41	3.5900E+01	6.7872E-04	79	4.0000E+06	1.7073E-08
3	1.6000E-02	5.5200E-01	42	3.6700E+01	9.1595E-06	80	5.0000E+06	9.0679E-09
4	2.4000E-02	7.1200E-01	43	3.7400E+01	6.5453E-04	81	6.0000E+06	4.7153E-09
5	2.9000E-02	7.8500E-01	44	3.8700E+01	8.2618E-04	82	8.0000E+06	1.2276E-09
6	3.3000E-02	8.2900E-01	45	6.1200E+01	5.5873E-04	83	1.0000E+07	3.0953E-10
7	4.3000E-02	8.9800E-01	46	6.4900E+01	4.8243E-04	84	1.2570E+07	2.4619E-10
8	5.0000E-02	9.1800E-01	47	6.6000E+01	4.5797E-05	85	1.2600E+07	3.4731E-10
9	5.4000E-02	9.2100E-01	48	6.7100E+01	4.7226E-04	86	1.2700E+07	1.0357E-09
10	5.9000E-02	9.1800E-01	49	6.8200E+01	4.8362E-04	87	1.2800E+07	2.8436E-09
11	7.0000E-02	8.9200E-01	50	1.0100E+03	3.7829E-05	88	1.2900E+07	7.1910E-09
12	9.0000E-02	7.9900E-01	51	2.0000E+04	2.2257E-06	89	1.3000E+07	1.6776E-08
13	1.1200E-01	6.8600E-01	52	3.0700E+04	1.5571E-06	90	1.3100E+07	3.6122E-08
14	1.4000E-01	5.2000E-01	53	6.0700E+04	9.1595E-07	91	1.3200E+07	7.1864E-08
15	1.7000E-01	3.8300E-01	54	1.2000E+05	5.7934E-07	92	1.3300E+07	1.3222E-07
16	2.1000E-01	2.5200E-01	55	2.0100E+05	4.3645E-07	93	1.3400E+07	2.2511E-07
17	3.0000E-01	1.0800E-01	56	2.8300E+05	3.8309E-07	94	1.3500E+07	3.5512E-07
18	4.0000E-01	6.8700E-02	57	3.5600E+05	3.6926E-07	95	1.3600E+07	5.1946E-07
19	4.9000E-01	5.1000E-02	58	3.7700E+05	3.4027E-07	96	1.3700E+07	7.0478E-07
20	5.7000E-01	4.3700E-02	59	3.9900E+05	2.7387E-07	97	1.3800E+07	8.8825E-07
21	6.0000E-01	4.1300E-02	60	4.4200E+05	1.0075E-07	98	1.3900E+07	1.0408E-06
22	1.0000E+00	2.4914E-02	61	4.7400E+05	2.1754E-07	99	1.4070E+07	1.1540E-06
23	1.3518E+00	1.8502E-02	62	5.0200E+05	2.6333E-07	100	1.4200E+07	1.0870E-06
24	4.0100E+00	6.3200E-03	63	5.4000E+05	3.0501E-07	101	1.4300E+07	9.5757E-07
25	5.5047E+00	4.6164E-03	64	6.5000E+05	2.9493E-07	102	1.4400E+07	7.8704E-07
26	5.8842E+00	4.1950E-03	65	7.7000E+05	2.5005E-07	103	1.4500E+07	6.0403E-07
27	6.1350E+00	3.7279E-03	66	9.0000E+05	2.1479E-07	104	1.4600E+07	4.3317E-07
28	6.4490E+00	1.6524E-03	67	9.4100E+05	1.7861E-07	105	1.4700E+07	2.9041E-07
29	6.6700E+00	5.3125E-05	68	1.0000E+06	9.1595E-08	106	1.4800E+07	1.8213E-07
30	6.8940E+00	1.7632E-03	69	1.0500E+06	1.1518E-07	107	1.4900E+07	1.0699E-07
31	7.0100E+00	2.9219E-03	70	1.1200E+06	1.3648E-07	108	1.5000E+07	5.8832E-08
32	7.3080E+00	3.6042E-03	71	1.1900E+06	1.5479E-07	109	1.5100E+07	3.0354E-08
33	1.7530E+01	1.7156E-03	72	1.2100E+06	1.5022E-07	110	1.5200E+07	1.4687E-08
34	1.9860E+01	1.3858E-03	73	1.3100E+06	6.8696E-08	111	1.5300E+07	6.6688E-09
35	2.0370E+01	1.0973E-03	74	1.4000E+06	1.2182E-07	112	1.5400E+07	2.8450E-09
36	2.0900E+01	1.3739E-05	75	2.2200E+06	5.9033E-08	113	1.5500E+07	1.1406E-09
37	2.1400E+01	1.0588E-03	76	2.3500E+06	9.1595E-08	114	1.5676E+07	1.9780E-10
38	2.2500E+01	1.3565E-03	77	2.6300E+06	3.9981E-08	115	2.0000E+07	1.5477E-10
39	3.4400E+01	8.1519E-04						

FLUX VALUES ARE GIVEN IN UNITS OF NEUTRONS/ CM**2 SEC. EV.

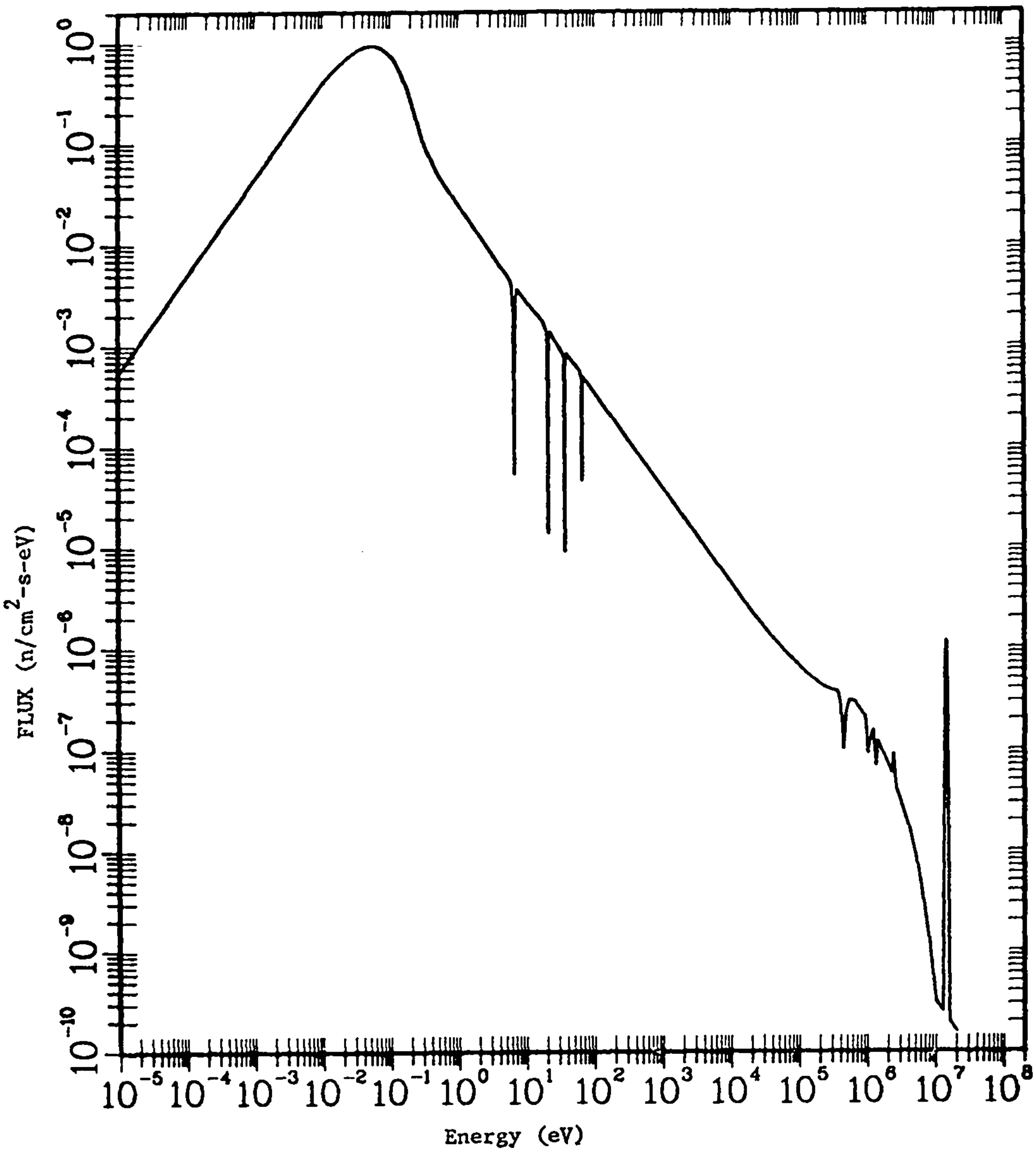

Figure 2-1. PRS flux weighting function.

1.0×10^7 eV - 1.257×10^7 eV

$\phi(E)$ varies as 1/E.

1.257×10^7 eV - 1.557×10^7 eV

$\phi(E)$ is a velocity exponential fusion peak (8).

1.557×10^7 eV - 2.0×10^7 eV

$\phi(E)$ varies at 1/E.

In the energy range of typical LWR calculations below 10 MeV, the weighting function accurately describes the appropriate spectrum. Above this energy the spectrum applies to fusion systems and approximates a functional form suggested by D. W. Muir and R. Roussin (8).

PRS 154-GROUP NEUTRON MULTIGROUP STRUCTURE

The PRS 154-group structure (9), a subset of the Los Alamos comprehensive 347-group structure (9), is primarily intended for use in power reactor studies. The structure extends from 10^{-5} eV to 20 MeV and includes all of the energy bounds of GAM-1, GRANIT, LASER, LASL 30-group, EPRI-CELL (GAM-1 + LASER), and EPRI 4-group structures. Additional groups were added to extend the upper and lower energy limits; to better treat the resonances of a number of fuel, fission-product, and structural nuclides; and to provide detail of the fission spectrum region. These additional energy boundaries were selected from the CSEWG 239-group structure, where practical.

The energy and lethargy values of the group boundaries are given in Table 2-2. The corresponding energy group boundary indices of the various subsets listed above are also identified.

TABLE 2-2

THE 154-GROUP PRS NEUTRON MULTIGROUP STRUCTURE

GROUP NO.	UPPER ENERGY BOUND,(EV)	GROUP ENERGY WIDTH,(EV)	LETHARGY	LETHARGY DIFFERENCE	CORRESPONDS WITH UPPER BOUND OF GROUPS IN THE FOLLOWING GAMI 68	GRANIT 48	LASER 35	LASL 30	EPRI 4
1	2.000000000E+07	1.7788120E+06	-6.931472E-01	9.314718E-02					
2	1.822118800E+07	1.3165995E+06	-6.000000E-01	7.500000E-02					
3	1.690458848E+07	1.9863415E+06	-5.250000E-01	1.250000E-01				1	
4	1.491824698E+07	1.4196589E+06	-4.000000E-01	1.000000E-01				2	
5	1.349858808E+07	1.5861259E+06	-3.000000E-01	1.250000E-01				3	
6	1.191246217E+07	1.9124622E+06	-1.750000E-01	1.750000E-01				4	
7	1.000000000E+07	2.2119922E+06	0.	2.500000E-01	1			5	1
8	7.788007831E+06	1.7227012E+06	2.500000E-01	2.500000E-01	2			6	
9	6.065306597E+06	1.3416411E+06	5.000000E-01	2.500000E-01	3			7	
10	4.723665527E+06	1.0448711E+06	7.500000E-01	2.500000E-01	4				
11	3.678794412E+06	8.1374644E+05	1.000000E+00	2.500000E-01	5			8	
12	2.865047969E+06	6.3374637E+05	1.250000E+00	2.500000E-01	6			9	
13	2.231301601E+06	4.9356217E+05	1.500000E+00	2.500000E-01	7			10	
14	1.737739435E+06	3.8438660E+05	1.750000E+00	2.500000E-01	8			11	
15	1.353352832E+06	2.9936059E+05	2.000000E+00	2.500000E-01	9			12	
16	1.053992246E+06	1.0030062E+05	2.250000E+00	1.000000E-01	10				
17	9.536916222E+05	1.3284164E+05	2.350000E+00	1.500000E-01					
18	8.208499862E+05	7.8114204E+04	2.500000E+00	1.000000E-01	11			13	2
19	7.427357821E+05	1.0345717E+05	2.600000E+00	1.500000E-01					
20	6.392786121E+05	6.0835403E+04	2.750000E+00	1.000000E-01	12				
21	5.784432087E+05	8.0572525E+04	2.850000E+00	1.500000E-01					
22	4.978706837E+05	4.7378660E+04	3.000000E+00	1.000000E-01	13			14	
23	4.504920239E+05	6.2749946E+04	3.100000E+00	1.500000E-01					
24	3.877420783E+05	3.6898537E+04	3.250000E+00	1.000000E-01	14				
25	3.508435410E+05	4.8869707E+04	3.350000E+00	1.500000E-01					
26	3.019738342E+05	2.8736610E+04	3.500000E+00	1.000000E-01	15			15	
27	2.732372245E+05	3.8059766E+04	3.600000E+00	1.500000E-01					
28	2.351774586E+05	2.2380094E+04	3.750000E+00	1.000000E-01	16				
29	2.127973644E+05	2.9640976E+04	3.850000E+00	1.500000E-01					
30	1.831563889E+05	4.0514050E+04	4.000000E+00	2.500000E-01	17			16	
31	1.426423391E+05	3.1552374E+04	4.250000E+00	2.500000E-01	18				
32	1.110899654E+05	2.4573013E+04	4.500000E+00	2.500000E-01	19				
33	8.651695203E+04	1.9137482E+04	4.750000E+00	2.500000E-01	20				
34	6.737946999E+04	1.4904286E+04	5.000000E+00	2.500000E-01	21			17	
35	5.247518399E+04	1.1607470E+04	5.250000E+00	2.500000E-01	22				
36	4.086771438E+04	9.0399064E+03	5.500000E+00	2.500000E-01	23				
37	3.182780797E+04	3.7398660E+03	5.750000E+00	1.250000E-01	24				
38	2.808794195E+04	2.0295368E+03	5.875000E+00	7.500000E-02					

TABLE 2-2 (cont.)

GROUP NO.	UPPER ENERGY BOUND,(EV)	GROUP ENERGY WIDTH,(EV)	LETHARGY	LETHARGY DIFFERENCE	CORRESPONDS WITH UPPER BOUND OF GROUPS IN THE FOLLOWING GAMI 68	GRANIT 48	LASER 35	LASL 30	EPRI 4
39	2.605840518E+04	1.2708834E+03	5.950000E+00	5.000000E-02					
40	2.478752177E+04	1.2089017E+03	6.000000E+00	5.000000E-02	25			18	
41	2.357862006E+04	4.2740787E+03	6.050000E+00	2.000000E-01					
42	1.930454136E+04	4.2701494E+03	6.250000E+00	2.500000E-01	26				
43	1.503439193E+04	3.3255957E+03	6.500000E+00	2.500000E-01	27				
44	1.170879621E+04	2.5899766E+03	6.750000E+00	2.500000E-01	28				
45	9.118819656E+03	2.0170758E+03	7.000000E+00	2.500000E-01	29			19	
46	7.101743888E+03	1.5709002E+03	7.250000E+00	2.500000E-01	30				
47	5.530843701E+03	1.2234183E+03	7.500000E+00	2.500000E-01	31				3
48	4.307425406E+03	9.5279913E+02	7.750000E+00	2.500000E-01	32				
49	3.354626279E+03	7.4204071E+02	8.000000E+00	2.500000E-01	33			20	
50	2.612585573E+03	5.7790188E+02	8.250000E+00	2.500000E-01	34				
51	2.034683690E+03	4.5007044E+02	8.500000E+00	2.500000E-01	35				
52	1.584613251E+03	3.5051521E+02	8.750000E+00	2.500000E-01	36				
53	1.234098041E+03	2.7298152E+02	9.000000E+00	2.500000E-01	37			21	
54	9.611165206E+02	2.1259822E+02	9.250000E+00	2.500000E-01	38				
55	7.485182989E+02	1.6557166E+02	9.500000E+00	2.500000E-01	39				
56	5.829466373E+02	1.2894734E+02	9.750000E+00	2.500000E-01	40				
57	4.539992976E+02	1.0042429E+02	1.000000E+01	2.500000E-01	41			22	
58	3.535750085E+02	7.8210515E+01	1.025000E+01	2.500000E-01	42				
59	2.753644935E+02	6.0910410E+01	1.050000E+01	2.500000E-01	43				
60	2.144540832E+02	4.7437075E+01	1.075000E+01	2.500000E-01	44				
61	1.670170079E+02	3.6944031E+01	1.100000E+01	2.500000E-01	45			23	
62	1.300729765E+02	2.8772040E+01	1.125000E+01	2.500000E-01	46				
63	1.013009360E+02	2.2407688E+01	1.150000E+01	2.500000E-01	47				
64	7.889324827E+01	5.2932483E+00	1.175000E+01	6.945063E-02	48				
65	7.360000000E+01	3.8500000E+00	1.181945E+01	5.372761E-02					
66	6.975000000E+01	1.2000000E+00	1.187318E+01	1.735401E-02					
67	6.855000000E+01	1.5500000E+00	1.189053E+01	2.287079E-02					
68	6.700000000E+01	5.5578765E+00	1.191340E+01	8.659697E-02					
69	6.144212353E+01	1.5421235E+00	1.200000E+01	2.541915E-02	49			24	
70	5.990000000E+01	8.5000000E-01	1.202542E+01	1.429196E-02					
71	5.905000000E+01	6.5000000E-01	1.203971E+01	1.106865E-02					
72	5.840000000E+01	1.0548826E+01	1.205078E+01	1.992202E-01					
73	4.785117392E+01	7.8511739E+00	1.225000E+01	1.792162E-01	50				
74	4.000000000E+01	2.7334683E+00	1.242922E+01	7.078380E-02					
75	3.726653172E+01	1.2165317E+00	1.250000E+01	3.318879E-02	51				
76	3.605000000E+01	1.0500000E+00	1.253319E+01	2.955880E-02					
77	3.500000000E+01	5.9767959E+00	1.256275E+01	1.872524E-01					
78	2.902320409E+01	5.3132041E+00	1.275000E+01	2.021988E-01	52				
79	2.371000000E+01	5.1000000E-01	1.295220E+01	2.174462E-02					
80	2.320000000E+01	5.9670593E-01	1.297394E+01	2.605663E-02					
81	2.260329407E+01	5.0329407E-01	1.300000E+01	2.251804E-02	53			25	

TABLE 2-2 (cont.)

GROUP NO.	UPPER ENERGY BOUND, (EV)	GROUP ENERGY WIDTH, (EV)	LETHARGY	LETHARGY DIFFERENCE	CORRESPONDS WITH UPPER BOUND OF GROUPS IN THE FOLLOWING				
					GAMI 68	GRANIT 48	LASER 35	LASL 30	EPRI 4
82	2.210000000E+01	6.0000000E-01	1.302252E+01	2.752467E-02					
83	2.150000000E+01	1.2000000E+00	1.305004E+01	5.743205E-02					
84	2.030000000E+01	2.6965369E+00	1.310747E+01	1.425252E-01					
85	1.760346312E+01	3.8938723E+00	1.325000E+01	2.500000E-01	54				
86	1.370959086E+01	3.0325508E+00	1.350000E+01	2.500000E-01	55				
87	1.067704010E+01	2.3617529E+00	1.375000E+01	2.500000E-01	56				
88	8.315287191E+00	1.3152872E+00	1.400000E+01	1.721855E-01	57			26	
89	7.000000000E+00	5.2404782E-01	1.417219E+01	7.781450E-02					
90	6.475952176E+00	1.4324755E+00	1.425000E+01	2.500000E-01	58				
91	5.043476626E+00	1.1156131E+00	1.450000E+01	2.500000E-01	59				
92	3.927863545E+00	8.6884034E-01	1.475000E+01	2.500000E-01	60				
93	3.059023205E+00	4.9817846E-01	1.500000E+01	1.777585E-01	61	48		27	
94	2.560844746E+00	1.7847508E-01	1.517776E+01	7.224153E-02		47			
95	2.382369668E+00	6.6344444E-02	1.525000E+01	2.824320E-02	62	46			
96	2.316025224E+00	2.1734124E-02	1.527824E+01	9.428544E-03		45			
97	2.294291100E+00	2.1631664E-02	1.528767E+01	9.473203E-03		44			
98	2.272659436E+00	2.1529203E-02	1.529714E+01	9.518288E-03		43			
99	2.251130233E+00	7.9001585E-02	1.530666E+01	3.572479E-02		42			
100	2.172128648E+00	7.8050829E-02	1.534239E+01	3.659436E-02		41			
101	2.094077819E+00	7.6170895E-02	1.537898E+01	3.705248E-02		40			
102	2.017906924E+00	8.2290918E-02	1.541603E+01	4.163517E-02		39			
103	1.935616006E+00	8.0224643E-02	1.545767E+01	4.232997E-02		38			
*104	1.855391363E+00	4.6423297E-02	1.550000E+01	2.533910E-02	63	37	35		
105	1.808968066E+00	4.5913180E-02	1.552534E+01	2.570852E-02		36			
106	1.763054886E+00	3.6974385E-02	1.555105E+01	2.119480E-02		35			
107	1.726080501E+00	8.3486240E-03	1.557224E+01	4.848487E-03			34		
108	1.717731877E+00	7.0146149E-02	1.557709E+01	4.169372E-02		34			
109	1.647585728E+00	5.2654518E-02	1.561878E+01	3.248041E-02		33			
110	1.594931210E+00	1.6429054E-02	1.565127E+01	1.035421E-02			33		
111	1.578502156E+00	1.2108290E-01	1.566162E+01	7.980916E-02		32			
112	1.457419257E+00	1.2439011E-02	1.574143E+01	8.571589E-03			32		
113	1.444980246E+00	1.3712785E-01	1.575000E+01	9.970925E-02	64	31			
114	1.307852396E+00	9.9180537E-02	1.584971E+01	7.886428E-02			31		
115	1.208671859E+00	4.2290688E-02	1.592857E+01	3.561618E-02		30			
116	1.166381171E+00	4.1029424E-02	1.596419E+01	3.581029E-02			30		
117	1.125351747E+00	2.6670325E-02	1.600000E+01	2.398490E-02	65			28	
118	1.098681422E+00	2.6513205E-02	1.602398E+01	2.442778E-02		29	29		
119	1.072168217E+00	9.8589660E-03	1.604841E+01	9.237892E-03		28	28		
120	1.062309251E+00	9.8134280E-03	1.605765E+01	9.280759E-03		27	27		
121	1.052495823E+00	9.7678900E-03	1.606693E+01	9.324026E-03		26	26		
122	1.042727933E+00	2.9030442E-02	1.607626E+01	2.823576E-02		25	25		
123	1.013697491E+00	6.3044759E-02	1.610449E+01	6.421097E-02		24	24		
124	9.506527323E-01	7.4227910E-02	1.616870E+01	8.129791E-02		23	23		

TABLE 2-2 (cont.)

GROUP NO.	UPPER ENERGY BOUND,(EV)	GROUP ENERGY WIDTH,(EV)	LETHARGY	LETHARGY DIFFERENCE	CORRESPONDS WITH UPPER BOUND OF GROUPS IN THE FOLLOWING GAMI 68	GRANIT 48	LASER 35	LASL 30	EPRI 4
125	8.764248219E-01	9.4345983E-02	1.625000E+01	1.138954E-01	66				
126	7.820788385E-01	9.9518501E-02	1.636390E+01	1.361046E-01		22	22		
127	6.825603376E-01	5.7500338E-02	1.650000E+01	8.800328E-02	67				
*128	6.250600000E-01	9.3481475E-02	1.658800E+01	1.619967E-01		21	21		4
129	5.315785254E-01	2.8343722E-02	1.675000E+01	5.479406E-02	68				
130	5.032348036E-01	8.6218515E-02	1.680479E+01	1.879316E-01		20	20		
131	4.170162887E-01	3.0225168E-03	1.699273E+01	7.274353E-03		19	19		
*132	4.139937719E-01	5.6328609E-02	1.700000E+01	1.462537E-01	BOT			29	
133	3.576651631E-01	3.7037531E-02	1.714625E+01	1.093168E-01		18	18		
134	3.206276321E-01	1.9507951E-02	1.725557E+01	6.277263E-02		17	17		
135	3.011196812E-01	1.0382652E-02	1.731834E+01	3.508862E-02		16	16		
136	2.907370290E-01	2.0218849E-02	1.735343E+01	7.207987E-02		15	15		
137	2.705181801E-01	1.9490242E-02	1.742551E+01	7.477506E-02		14	14		
138	2.510279384E-01	2.3338198E-02	1.750029E+01	9.758033E-02		13	13		
139	2.276897400E-01	4.3261051E-02	1.759787E+01	2.107210E-01		12	12		
140	1.844286894E-01	3.2128892E-02	1.780859E+01	1.914120E-01		11	11		
141	1.522997974E-01	6.5783638E-03	1.800000E+01	4.415412E-02				30	
142	1.457214336E-01	3.4153461E-02	1.804415E+01	2.670628E-01		10	10		
143	1.115679726E-01	2.9599666E-02	1.831122E+01	3.083014E-01		9	9		
144	8.196830640E-02	2.5045871E-02	1.861952E+01	3.646431E-01		8	8		
145	5.692243500E-02	1.4167362E-02	1.898416E+01	2.862017E-01		7	7		
146	4.275507340E-02	1.2143453E-02	1.927036E+01	3.341082E-01		6	6		
147	3.061162060E-02	1.0119544E-02	1.960447E+01	4.013414E-01		5	5		
148	2.049207660E-02	8.0956352E-03	2.000581E+01	5.026289E-01		4	4		
149	1.239644140E-02	6.0717264E-03	2.050844E+01	6.729445E-01		3	3		
150	6.324715000E-03	4.0478176E-03	2.118139E+01	1.021651E+00		2	2		
151	2.276897400E-03	1.5166787E-03	2.220304E+01	1.096963E+00		1	1		
152	7.602187410E-04	5.0723014E-04	2.330000E+01	1.100262E+00					
153	2.529886000E-04	1.1410916E-04	2.440026E+01	5.997382E-01		BOT	BOT		
154	1.388794386E-04	1.2887944E-04	2.500000E+01	2.631021E+00				BOT	
LOWER BOUND	1.000000000E-05		2.763102E+01						BOT

*THE UPPER ENERGY BOUNDRIES OF GROUPS 104,128 AND 132 CORRESPOND TO LETHARGY VALUES OF 15.5,16.588 AND 17.0 OF THE CSEWG 239-GROUP STRUCTURE. THESE ENERGIES DIFFER SLIGHTLY FROM THE VELOCITY-SPECIFIED BOUNDRIES OF GROUP STRUCTURES USED WITH GRANIT AND LASER.

Section 3

MULTIGROUP CROSS-SECTION FILE

Multigroup cross sections were processed with the NJOY code (3), using the PRS 154-group structure and neutron flux spectrum weighting function previously described. All reaction cross-section tabulations (identified in ENDF/B by MT values) were processed, except for the redundant nonelastic cross sections (MT=3) and cross sections for inelastic scattering to isolated levels (MT=51, 52, ..., 90) and to the continuum (MT=91). The reaction types corresponding to MT values encountered here are identified in Table 3-1.

Cross-section evaluations of ENDF/B are given in File 3 (MF=3) of the data collection for each nuclide (identified in ENDF/B by MAT value). A variety of data types are included in other files (MFs). Of particular interest are energy-dependent branching fractions for reactions in which the residual nucleus may be the ground or isomeric state. These reaction (MT) branching fractions, given in File 9 (MF=9) have been processed with associated cross sections of File 3 (MF=3), producing partial cross sections leading to the ground state of the residual nucleus. These are identified with MF=9 in the multigroup file. The complimentary partial cross sections leading to the isomeric state of the residual nucleus, not included in the multigroup file to prevent confusion, may be computed as the difference between MF=3 and MF=9 values.

The reactions (MTs), temperatures, and Bondarenko background cross section σ_0 values for each reaction processed are given for each nuclide (MAT) in Table 3-2. The ordering of the information of Table 3-2 is similar to that of the multigroup cross-section library, where tabulations are ordered on increasing Z, A, S, temperature, MF, and MT, and finally on decreasing σ_0. Here Z and A are the nuclear charge and mass number, and S is the nuclear state (0 = ground, 1 = first isomeric, etc.)

The multigroup cross-section file contains a total of 226,059 BCD card-image records. The first 69 records of the data files (described in Table 3-3) contain descriptive information and parameters on the data file and the group structure and weighting function used in its production. Multigroup cross-section tabulations consist of 8370 sets of 27 records each, as described in Table 3-4, begining with record 70. The first record of each cross-section tabulation 27-record set contains alphanumeric information, identifying the nuclide and reaction, for examination of a data file listing.

Versions of ENDF/B are released on intervals of five to six years. Modifications, corrections, or additions to the data file for a particular nuclide of an ENDF/B version are formally released in a "MOD" to the version, giving the nuclide a new MAT identification. We have identified some errors in the MF3 tabulations of 11 fission-product nuclides. The (n,γ) cross section (MF=3 MT=102) of $^{105}_{45}$Rh (MAT=9355) at 0.5 eV was changed from 360 to 3600 b as required for agreement with other values in the 1/v behavior. The interpolation scheme (INT) used in describing the 1/v behavior of 10 fission-product nuclides has been changed from linear-linear (INT=2) to log-log (INT=5); the nuclides affected are $^{74}_{34}$Se (MAT=9089), $^{84}_{38}$Sr (MAT=9179), $^{96}_{44}$Ru (MAT=9325), $^{98}_{44}$Ru (MAT=9327), $^{102}_{46}$Pd (MAT=9379), $^{106}_{48}$Cd (MAT=9440), $^{112}_{50}$Sn (MAT=9513), $^{114}_{50}$Sn (MAT=9516), $^{120}_{52}$Te (MAT=9576), and $^{144}_{62}$Sm (MAT=9803). Total (MT=1) and (n,γ) (MT=102) multigroup values for these nuclides in the file and collapsed values given in Section 6 reflect these correctons. These corrections have been made with the help and concurrence of the pertinent data evaluators (10,11), although they are not incorporated in MODs to ENDF/B-V and do not reflect official ENDF/B changes.

Table 3-1

IDENTIFICATION OF ENDF/B MT REACTION TYPES

MT	Description
1	Total
2	Elastic
4	Total Inelastic
16	(n,2n)
17	(n,3n)
18	Total fission
22	(n,n'α)
28	(n,n'p)
37	(n,4n)
102	(n,γ)
103	(n,p)
104	(n,d)
105	(n,t)
106	(n,^{3}He)
107	(n,α)

TABLE 3-2

MULTIGROUP FILE SUMMARY

NUCLIDE	MAT	1	2	4	16	17	18	22	28	37	102	103	104	105	106	107	300K	900K	1200K	1E0	1E1	5E1	1E2	3E2	1E3	1E4	1E5	1E10
		REACTION MT VALUES															TEMPERATURES			BONDORINKO SELF-SHIELDING SIGMA ZERO								
ENDF/B-V	FISSION PRODUCTS																											
32GE 72	9050	X	X	X							X						X	X	X									X
32GE 73	9051	X	X	X							X						X	X	X									X
32GE 74	9053	X	X	X							X						X	X	X									X
32GE 76	9056	X	X	X							X						X	X	X									X
33AS 75	9071	X	X	X							X						X	X	X									X
+34SE 74	9089	X	X	X							X						X	X	X									X
34SE 76	9091	X	X	X							X						X	X	X									X
34SE 77	9092	X	X	X							X						X	X	X									X
34SE 78	9094	X	X	X							X						X	X	X									X
34SE 80	9097	X	X	X							X						X	X	X									X
34SE 82	9100	X	X	X							X						X	X	X									X
35BR 79	9113	X	X	X							X						X	X	X									X
35BR 81	9117	X	X	X							X						X	X	X									X
36KR 78	1330	X	X	X	X						X	X	X	X	X	X	X	X	X									X
36KR 80	1331	X	X	X	X						X	X	X	X	X	X	X	X	X									X
36KR 82	1332	X	X	X	X						X	X	X	X	X	X	X	X	X									X
36KR 83	1333	X	X	X	X	X					X	X	X	X	X	X	X	X	X									X
36KR 84	1334	X	X	X	X						X	X	X	X	X	X	X	X	X									X
36KR 85	9145	X	X	X							X						X	X	X									X
36KR 86	1336	X	X	X	X	X					X	X	X	X			X	X	X									X
37RB 85	9160	X	X	X							X						X	X	X									X
37RB 86	9161	X	X	X							X						X	X	X									X
37RB 87	9163	X	X	X							X						X	X	X									X
+38SR 84	9179	X	X	X							X						X	X	X									X
38SR 86	9182	X	X	X							X						X	X	X									X
38SR 87	9183	X	X	X							X						X	X	X									X
38SR 88	9185	X	X	X							X						X	X	X									X
38SR 89	9186	X	X	X							X						X	X	X									X
38SR 90	9187	X	X	X							X						X	X	X									X
39Y 89	9202	X	X	X							X						X	X	X									X
39Y 90	9204	X	X	X							X						X	X	X									X
39Y 91	9206	X	X	X							X						X	X	X									X
40ZR 90	1385	X	X	X	X						X	X				X	X	X	X									X
40ZR 91	1386	X	X	X	X						X	X				X	X	X	X									X
40ZR 92	1387	X	X	X	X						X	X				X	X	X	X									X
40ZR 93	9232	X	X	X							X						X	X	X									X
40ZR 94	1388	X	X	X	X						X	X				X	X	X	X									X
40ZR 95	9234	X	X	X							X						X	X	X									X
40ZR 96	1389	X	X	X	X						X					X	X	X	X									X
41NB 93	1189	X	X	X	X	X		X			X	X				X	X	X	X									X
41NB 94	9251	X	X	X							X						X	X	X									X
41NB 95	9253	X	X	X							X						X	X	X									X
42MO 92	9278	X	X	X							X	X				X	X	X	X									X
42MO 94	9281	X	X	X							X						X	X	X									X
42MO 95	9282	X	X	X							X						X	X	X									X

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TABLE 3-2 (cont.)

			REACTION MT VALUES															TEMPERATURES			BONDORINKO SELF-SHIELDING SIGMA								ZERO
	NUCLIDE	MAT	1	2	4	16	17	18	22	28	37	102	103	104	105	106	107	300K	900K	1200K	1E0	1E1	5E1	1E2	3E2	1E3	1E4	1E5	1E10
	42MO 96	9283	X	X	X							X						X	X	X									X
	42MO 97	9284	X	X	X							X						X	X	X									X
	42MO 98	9285	X	X	X							X						X	X	X									X
	42MO 99	9286	X	X	X							X						X	X	X									X
	42MO100	9287	X	X	X							X						X	X	X									X
	43TC 99	1308	X	X	X	X						X						X	X	X									X
+	44RU 96	9325	X	X	X							X						X	X	X									X
+	44RU 98	9327	X	X	X							X						X	X	X									X
	44RU 99	9328	X	X	X							X						X	X	X									X
	44RU100	9329	X	X	X							X						X	X	X									X
	44RU101	9330	X	X	X							X						X	X	X									X
	44RU102	9331	X	X	X							X						X	X	X									X
	44RU103	9332	X	X	X							X						X	X	X									X
	44RU104	9333	X	X	X							X						X	X	X									X
	44RU105	9334	X	X	X							X						X	X	X									X
	44RU106	9335	X	X	X							X						X	X	X									X
	45RH103	1310	X	X	X	X						X						X	X	X									X
+	45RH105	9355	X	X	X							X						X	X	X									X
+	46PD102	9379	X	X	X							X						X	X	X									X
	46PD104	9381	X	X	X							X						X	X	X									X
	46PD105	9382	X	X	X							X						X	X	X									X
	46PD106	9383	X	X	X							X						X	X	X									X
	46PD107	9384	X	X	X							X						X	X	X									X
	46PD108	9386	X	X	X							X						X	X	X									X
	46PD110	9389	X	X	X							X						X	X	X									X
	47AG107	1371	X	X	X	X						X	X	X	X		X	X	X	X									X
	47AG109	1373	X	X	X	X						X	X				X	X	X	X									X
	47AG111	9415	X	X	X							X						X	X	X									X
+	48CD106	9440	X	X	X							X						X	X	X									X
	48CD108	9442	X	X	X							X						X	X	X									X
	48CD110	9444	X	X	X							X						X	X	X									X
	48CD111	9445	X	X	X							X						X	X	X									X
	48CD112	9447	X	X	X							X						X	X	X									X
	48CD113	1318	X	X	X	X						X	X				X	X	X	X									X
	48CD114	9450	X	X	X							X						X	X	X									X
	48CD115M	9452	X	X	X							X						X	X	X									X
	48CD116	9453	X	X	X							X						X	X	X									X
	49IN113	9473	X	X	X							X						X	X	X									X
	49IN115	9477	X	X	X							X						X	X	X									X
+	50SN112	9513	X	X	X							X						X	X	X									X
+	50SN114	9516	X	X	X							X						X	X	X									X
	50SN115	9517	X	X	X							X						X	X	X									X
	50SN116	9518	X	X	X							X						X	X	X									X
	50SN117	9519	X	X	X							X						X	X	X									X
	50SN118	9521	X	X	X							X						X	X	X									X
	50SN119	9522	X	X	X							X						X	X	X									X
	50SN120	9524	X	X	X							X						X	X	X									X
	50SN122	9527	X	X	X							X						X	X	X									X
	50SN123	9528	X	X	X							X						X	X	X									X
	50SN124	9530	X	X	X							X						X	X	X									X

TABLE 3-2 (cont.)

NUCLIDE	MAT	1	2	4	16	17	18	22	28	37	102	103	104	105	106	107	300K	900K	1200K	1E0	1E1	5E1	1E2	3E2	1E3	1E4	1E5	1E10
		REACTION MT VALUES															TEMPERATURES			BONDORINKO SELF-SHIELDING SIGMA								ZERO
50SN125	9531	X	X	X							X						X	X	X									X
50SN126	9533	X	X	X							X						X	X	X									X
51SB121	9548	X	X	X							X						X	X	X									X
51SB123	9551	X	X	X							X						X	X	X									X
51SB124	9552	X	X	X							X						X	X	X									X
51SB125	9555	X	X	X							X						X	X	X									X
51SB126	9556	X	X	X							X						X	X	X									X
+52TE120	9576	X	X	X							X						X	X	X									X
52TE122	9579	X	X	X							X						X	X	X									X
52TE123	9580	X	X	X							X						X	X	X									X
52TE124	9582	X	X	X							X						X	X	X									X
52TE125	9583	X	X	X							X						X	X	X									X
52TE126	9585	X	X	X							X						X	X	X									X
52TE127M	9587	X	X	X							X						X	X	X									X
52TE128	9588	X	X	X							X						X	X	X									X
52TE129M	9590	X	X	X							X						X	X	X									X
52TE130	9591	X	X	X							X						X	X	X									X
52TE132	9594	X	X	X							X						X	X	X									X
53I 127	9606	X	X	X							X						X	X	X									X
53I 129	9608	X	X	X							X						X	X	X									X
53I 130	9609	X	X	X							X						X	X	X									X
53I 131	9611	X	X	X							X						X	X	X									X
53I 135	9618	X	X	X							X						X	X	X									X
54XE124	1335	X	X	X	X	X					X	X	X	X	X	X	X	X	X									X
54XE126	1339	X	X	X	X	X					X	X	X	X	X	X	X	X	X									X
54XE128	1348	X	X	X	X	X					X	X	X	X	X	X	X	X	X									X
54XE129	1349	X	X	X	X	X					X	X	X	X		X	X	X	X									X
54XE130	1350	X	X	X	X	X					X	X	X	X		X	X	X	X									X
54XE131	1351	X	X	X	X	X					X	X	X	X		X	X	X	X									X
54XE132	1352	X	X	X	X	X					X	X	X	X		X	X	X	X									X
54XE133	9643	X	X	X							X						X	X	X									X
54XE134	1354	X	X	X	X	X					X	X	X	X		X	X	X	X									X
54XE135	1294	X	X	X							X						X	X	X									X
54XE136	1356	X	X	X	X	X					X	X	X	X		X	X	X	X									X
55CS133	1355	X	X	X	X						X	X				X	X	X	X									X
55CS134	9663	X	X	X							X						X	X	X									X
55CS135	9665	X	X	X							X						X	X	X									X
55CS136	9667	X	X	X							X						X	X	X									X
55CS137	9669	X	X	X							X						X	X	X									X
56BA134	9684	X	X	X							X						X	X	X									X
56BA135	9685	X	X	X							X						X	X	X									X
56BA136	9687	X	X	X							X						X	X	X									X
56BA137	9689	X	X	X							X						X	X	X									X
56BA138	1353	X	X	X	X	X					X	X				X	X	X	X									X
56BA140	9693	X	X	X							X						X	X	X									X
57LA139	9707	X	X	X							X						X	X	X									X
57LA140	9708	X	X	X							X						X	X	X									X
58CE140	9724	X	X	X							X						X	X	X									X
58CE141	9725	X	X	X							X						X	X	X									X
58CE142	9726	X	X	X							X						X	X	X									X

TABLE 3-2 (cont.)

NUCLIDE	MAT	REACTION MT VALUES 1	2	4	16	17	18	22	28	37	102	103	104	105	106	107	TEMPERATURES 300K	900K	1200K	BONDORINKO SELF-SHIELDING SIGMA ZERO 1E0	1E1	5E1	1E2	3E2	1E3	1E4	1E5	1E10
58CE143	9727	X	X	X							X						X	X	X									X
58CE144	9728	X	X	X							X						X	X	X									X
59PR141	9742	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
59PR142	9743	X	X	X							X						X	X	X									X
59PR143	9745	X	X	X							X						X	X	X									X
60ND142	9763	X	X	X							X						X	X	X									X
60ND143	9764	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
60ND144	9765	X	X	X							X						X	X	X									X
60ND145	9766	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
60ND146	9767	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
60ND147	9768	X	X	X							X						X	X	X									X
60ND148	9769	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
60ND150	9771	X	X	X	X	X		X	X		X	X	X	X		X	X	X	X									X
61PM147	9783	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
61PM148	9784	X	X	X							X						X	X	X									X
61PM148M	9785	X	X	X							X						X	X	X									X
61PM149	9786	X	X	X							X						X	X	X									X
61PM151	9788	X	X	X							X						X	X	X									X
+62SM144	9803	X	X	X							X						X	X	X									X
62SM147	9806	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
62SM148	9807	X	X	X							X						X	X	X									X
62SM149	1319	X	X	X	X	X					X	X				X	X	X	X									X
62SM150	9809	X	X	X							X						X	X	X									X
62SM151	9810	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
62SM152	9811	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
62SM153	9812	X	X	X							X						X	X	X									X
62SM154	9813	X	X	X							X						X	X	X									X
63EU151	1357	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
63EU152	1292	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
63EU153	1359	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
63EU154	1293	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
63EU155	9832	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X									X
63EU156	9833	X	X	X							X						X	X	X									X
63EU157	9834	X	X	X							X						X	X	X									X
64GD152	1362	X	X	X	X			X	X		X	X				X	X	X	X									X
64GD154	1364	X	X	X	X			X	X		X	X				X	X	X	X									X
64GD155	1365	X	X	X	X			X	X		X	X				X	X	X	X									X
64GD156	1366	X	X	X	X			X	X		X	X				X	X	X	X									X
64GD157	1367	X	X	X	X			X	X		X	X				X	X	X	X									X
64GD158	1368	X	X	X	X			X	X		X	X				X	X	X	X									X
64GD160	1370	X	X	X	X			X	X		X	X				X	X	X	X									X
65TB159	9857	X	X	X							X						X	X	X									X
65TB160	9858	X	X	X							X						X	X	X									X
66DY160	9864	X	X	X							X						X	X	X									X
66DY161	9865	X	X	X							X						X	X	X									X
66DY162	9866	X	X	X							X						X	X	X									X
66DY163	9867	X	X	X							X						X	X	X									X
66DY164	1031	X	X	X	X	X					X	X				X	X	X	X									X
67HO165	9872	X	X	X							X						X	X	X									X
68ER166	9875	X	X	X							X						X	X	X									X

TABLE 3-2 (cont.)

NUCLIDE	MAT	REACTION MT VALUES															TEMPERATURES			BONDORINKO SELF-SHIELDING SIGMA ZERO								
		1	2	4	16	17	18	22	28	37	102	103	104	105	106	107	300K	900K	1200K	1E0	1E1	5E1	1E2	3E2	1E3	1E4	1E5	1E10
68ER167	9876	X	X	X							X						X	X	X									X
ENDF/B-V	ACTINIDES																											
90TH230	8030	X	X	X	X	X	X				X						X	X	X		X		X		X	X		X
90TH232	1390	X	X	X	X	X	X				X						X	X	X		X	X	X	X	X	X		X
91PA231	8131	X	X	X	X	X	X				X						X	X	X		X		X		X	X	X	X
91PA233	1391	X	X	X	X	X	X				X						X	X	X		X		X		X	X	X	X
92U 232	8232	X	X	X	X	X	X				X						X	X	X		X		X	X	X	X	X	X
92U 233	1393	X	X	X	X	X	X				X						X	X	X		X		X	X	X	X	X	X
92U 234	1394	X	X	X	X	X	X				X						X	X	X		X		X		X	X	X	X
92U 235	1395	X	X	X	X	X	X				X						X	X	X		X		X	X	X	X		X
92U 236	1396	X	X	X	X	X	X				X						X	X	X		X		X		X	X	X	X
92U 237	8237	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X		X
92U 238	1398	X	X	X	X	X	X				X						X	X	X		X	X	X	X	X	X		X
93NP237	1337	X	X	X	X*	X	X				X						X	X	X		X		X		X	X	X	X
93NP238	8338	X	X				X				X						X	X	X		X		X		X	X		X
94PU236	8436	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X		X
94PU237	8437	X	X	X	X	X	X				X						X	X	X		X		X		X	X		X
94PU238	1338	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X		X
94PU239	1399	X	X	X	X	X	X			X	X						X	X	X		X		X	X	X	X		X
94PU240	1380	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X	X	X
94PU241	1381	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X	X	X
94PU242	1342	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X	X	X
94PU243	8443	X	X	X	X	X	X			X	X						X	X	X		X		X		X	X		X
94PU244	8444	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
95AM241	1361	X	X	X	X	X	X				X*						X	X	X	X	X		X		X	X		X
95AM242	8542	X	X				X				X						X	X	X		X		X		X	X		X
95AM242M	1369	X	X	X*	X	X	X			X	X						X	X	X						X	X		X
95AM243	1363	X	X	X	X	X	X			X	X*						X	X	X		X		X		X	X		X
96CM241	8641	X	X	X	X	X	X				X						X	X	X		X		X		X	X		X
96CM242	8642	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X		X
96CM243	1343	X	X	X	X	X	X			X	X						X	X	X		X		X		X	X		X
96CM244	1344	X	X	X	X	X	X				X						X	X	X	X	X		X		X	X		X
96CM245	1345	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
96CM246	1346	X	X	X	X	X	X			X	X						X	X	X		X		X		X	X		X
96CM247	8647	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
96CM248	8648	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
97BK249	8749	X	X	X	X	X	X			X	X						X	X	X		X		X		X	X		X
98CF249	8849	X	X	X	X	X	X			X	X						X	X	X		X		X		X	X		X
98CF250	8850	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
98CF251	8851	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
98CF252	8852	X	X	X	X	X	X			X	X						X	X	X	X	X		X		X	X		X
98CF253	8853	X	X				X				X						X	X	X		X		X		X	X		X
99ES253	8953	X	X								X						X	X	X		X		X		X	X		X

+MINOR CORRECTIONS HAVE BEEN MADE TO MF3 MT102 DATA REPRESENTATIONS OF ENDF/B-V FOR SOME NUCLIDES AS DESCRIBED IN SECTION 3.

*PARTIAL CROSS SECTIONS FOR GROUND STATE FORMATION BY THIS REACTION MT GIVEN IN MF=9

Table 3-3

DESCRIPTION OF DATA FILE RECORDS 1-69

Record(s)	Format	Description
1	(20A4)	File heading
2	(17A4,I4)	Group structure heading, NGF
3-28	(6E12.5)	Group structure energy boundaries [EF(I),I=1,155]
29	(17A4,I4)	Flux weighting function heading, NFXP
30-68	(6E12.5)	Flux weighting function points [EFLUXP(I),FLUXP(I),I=1,115]
69	(20A4)	Cross-section tabulations heading

Table 3-4

DESCRIPTION OF CROSS-SECTION TABULATION 27-RECORD SET

Record(s)	Column(s)	Format and Description
1		(A6,A5,2I3,I1,I4,2I2,I3,2E9.3,3E11.4)
	1-11	Nuclide identification
	12-14	IZ, nuclide Z value
	15-17	IA, nuclide A value
	18	IS, nuclide state I.D.
	19-22	MAT, ENDF/B nuclide I.D.
	23-24	IVER, ENDF/B version
	25-26	MF, ENDF/B file number
	27-29	MT, ENDF/B reaction I.D.
	30-38	TEMP, temperature (K)
	39-47	SZ, σ_0 value
	48-58	Cross-section value at 0.0253 eV
	59-69	Resonance integral above 0.5 eV
	70-80	Resonance integral above 0.625 eV
2-27		(6E12.5)
	1-72	Multigroup cross-section values [CXF(I),I=1,154]

Section 4

TOAFEW-V COLLAPSING CODE

The TOAFEW-V code produces few-group flux weighted average cross sections by collapsing multigroup values, using either a flux weighting function provided by the user or a log-log flux weighting function read from the data file. Fine-group cross sections processed and collapsed to a few-group subset with a common flux weighting function yield few-group values identical to those processed directly into the few-group structure with that flux description. Few-group cross sections for use in calculations with a spectrum different from that used in processing may be closely approximated by collapsing with the appropriate flux spectrum. Few-group values so produced are generally far more sensitive to the flux description used in collapsing than to that used in processing the multigroup values; the multigroup values can therefore be used to produce few-group cross sections for fast-reactor or CTR applications.

CROSS-SECTION COLLAPSING

Few-group cross-section values appropriate for a flux spectrum $\Psi(E)$ are defined by

$$\sigma_J = \frac{\int_{E_{J+1}}^{E_J} \sigma(E)\ \Psi(E)\ dE}{\int_{E_{J+1}}^{E_J} \Psi(E)\ dE} = \frac{\int_{E_{J+1}}^{E_J} \sigma(E)\ \Psi(E)\ dE}{\Psi_J} \quad . \tag{4-1}$$

If the energy boundaries of group J of the few-group structure shown in Fig. 4-1, lie in groups m and n of the multigroup structure such that $E_{n+1} \leq E_{J+1} \leq E_n$ and $E_{m+1} \leq E_J \leq E_m$, then we may write

$$\sigma_J = \frac{\int_{E_{J+1}}^{E_n} \sigma(E)\ \Psi(E)\ dE + \sum_{j=m+1}^{n-1} \int_{E_{j+1}}^{E_j} \sigma(E)\ \Psi(E)\ dE + \int_{E_{m+1}}^{E_J} \sigma(E)\ \Psi(E)\ dE}{\Psi_J} \quad . \tag{4-2}$$

If it is assumed that the multigroup values are relatively insensitive to the flux weighting function $\phi(E)$ used in processing, then

$$\sigma_j = \frac{\int_{E_{j+1}}^{E_j} \sigma(E)\ \phi(E)\ dE}{\phi_j} \simeq \frac{\int_{E_{j+1}}^{E_j} \sigma(E)\ \Psi(E)\ dE}{\Psi_j} \quad , \tag{4-3}$$

or

$$\int_{E_{j+1}}^{E_j} \sigma(E)\ \Psi(E)\ dE \simeq \sigma_j\ \Psi_j \quad . \tag{4-4}$$

The few-group cross-section expression may now be written as

$$\sigma_J \simeq \frac{\int_{E_{J+1}}^{E_n} \sigma(E)\ \Psi(E)\ dE + \sum_{j=m+1}^{n-1} \sigma_j\ \Psi_j + \int_{E_{m+1}}^{E_J} \sigma(E)\ \Psi(E)\ dE}{\Psi_J} \quad . \tag{4-5}$$

If it is assumed that $\sigma(E)$ is approximately constant in groups m and n, then

$$\sigma_J \simeq \frac{\sigma_n \int_{E_{j=m+1}}^{E_n} \Psi(E)\ dE + \sum_{j=m+1}^{n-1} \sigma_j\ \Psi_j + \sigma_m \int_{E_{m+1}}^{E_J} \Psi(E)\ dE}{\Psi_J} \quad . \tag{4-6}$$

If the few-group structure is a subset of the multigroup structure such that $E_{J+1} = E_{n+1}$ and $E_J = E_m$, then the second assumption above is not required, and

$$\sigma_J \simeq \sum_{j=m}^{n} \sigma_j\ \Psi_j \Big/ \sum_{j=m}^{n} \Psi_j \quad . \tag{4-7}$$

If, in addition, the user flux $\Psi(E)$ is chosen to be the flux description $\phi(E)$ used in processing, then the approximation of Eq. (4-3) is not required. The few-group cross section is then given by

$$\sigma_J = \sum_{j=m}^{n} \sigma_j \phi_j \Big/ \sum_{j=m}^{n} \phi_j \quad . \tag{4-8}$$

The TOAFEW-V code collapses a set of multigroup (fine) cross sections $\{CXF(j)\}$ to a set of few-group (coarse) values $\{CXC(J)\}$ using Eq. (4-6). The locations of fine groups m and n containing the few-group energy boundaries E_J and E_{J+1} are determined as LFG(J) and LFG(J+1), respectively. All integrals of the user flux $\Psi(E)$ over that part of fine group j that lie within coarse group J are computed by the code as FLXIM(J,j). Integrals of the user flux over each coarse group are computed by the code as FLXI(J). The algorithm corresponding to Eq. (4-6) is then

$$CXC(J) = \left[\sum_{j=LFG(J)}^{LFG(J+1)} CXF(j)*FLXIM(J,j) \right] \Bigg/ FLXI(J) \quad . \tag{4-9}$$

In addition to few-group cross sections, the TOAFEW-V code generates, for each reaction, an effective thermal cross-section value σ_{NGC}^{eff}. This quantity is calculated as the thermal group value σ_{NGC} divided by $\langle\sigma_{1/v}\rangle$, where $\langle\sigma_{1/v}\rangle$ is the thermal group value of a cross section that varies as 1/v and is equal to unity at 0.0253 eV. The value of $\langle\sigma_{1/v}\rangle$ is calculated by the code, using the user flux description.

A glossary of terms used in the code is included in the code listing of Appendix A. Modifications to the original code are clearly noted.

USER FLUX WEIGHTING FUNCTIONS

Functional Flux (IFLX=1).

A functional expression for neutron flux spectra often used in neutron cross-section processing consists of a fission spectrum, 1/E "slowing down" region, and a thermal Maxwellian distribution. This scheme has been extended by Roussin (8) to higher energies, as described in Section 2, by adding a fusion peak bounded on each flank by a 1/E region. These six regions have been incorporated into a flexible, generalized flux function that is built into the code as a user flux option. The regions, ordered in increasing energy, are as follows.

Region 1, Maxwellian Distribution, $EX(1) \leq E \leq EX(2)$, $\Psi(E) = C(1)\, E\, e^{-E/TKM}$

Region 2, Log-Log Slope, $EX(2) \leq E \leq EX(3)$, $\Psi(E) = C(2)\, E^{SLPA}$

Region 3, Fission Spectrum, $EX(3) \leq E \leq EX(4)$, $\Psi(E) = C(3)\sqrt{E}\, e^{-E/THETA}$

Region 4, Log-Log Slope, $EX(4) \leq E \leq EX(5)$, $\Psi(E) = C(4)\, E^{SLPB}$

Region 5, Fusion Peak, $EX(5) \leq E \leq EX(6)$, $\Psi(E) = C(5)\, e^{-5(\sqrt{E}-\sqrt{E_p})^2/TKF}$

Region 6, Log-Log Slope, $EX(6) \leq E \leq EX(7)$ $\Psi(E) = C(6)\, E^{SLPC}$

Use of the functional flux description requires user input of region boundary values [EX(I),I=1,2,...], distribution parameters (TKM,THETA,TKF,EP), and log-log slopes (SLPA,SLPB,SLPC). Coefficients C(I) are calculated in the routine COEFS by equating flux expressions at the common boundaries. Regions I-1 and I+1 may be joined and Region I omitted by defining identical values for EX(I) and EX(I+1). Low-lying regions not required must be specified with appropriate parameters, yet may be negated by equating nonzero energy boundaries. Parameters of higher energy regions not desired must be specified, although coefficients of regions above the few-group energy structure are not calculated.

Log-Log Interpolation (IFLX=2,3)

The description of neutron flux spectra as a series of log-log segments is commonly used to provide a detailed accounting of energy structure. The user may specify such a flux description by setting IFLX=3 and supplying a set of NFX energy and flux values. Alternatively, the log-log flux description given in the data file may be selected by setting IFLX=2. Flux values specified under this option must be in units of flux-per-unit-energy, i.e., n/cm^2-s-eV.

Histogram Values (IFLX>4)

Group flux values may be determined in external multigroup transport or diffusion calculations and supplied to the code. NFX group fluxes may be specified in units of flux-per-unit-energy (IFLX=4), flux-per-unit-lethargy (IFLX=5), or as integrated group fluxes (IFLX=6). Group flux values are transformed to (if not furnished in) a histogram representation to $\Psi(E)$; accuracy is obviously increased with the use of a large number of groups. The user must also supply NFX+1 histogram energy boundary values.

INPUT AND OUTPUT FILES

Files input to the TOAFEW-V code are INPUT, the card input file described in the following section; and TAPE1, the cross-section data file described in Section 3. Files output from the code are OUTPUT, TAPE2, and PLOT. The OUTPUT print file includes a summary of all input information, intermediate calculated values, and collapsed few-group cross sections in a form useful in reporting. PLOT is a graphics plot file useful in comparing the neutron flux spectra used in processing and collapsing the multigroup cross sections.

Examples of the files INPUT, OUTPUT, and TAPE2 and the flux spectrum produced from PLOT are given in Appendix B for a variety of sample problems.

LOCAL SYSTEM ROUTINE LIMITATIONS

The error function routine ERF called in function subprogram ENTEG and the min/max vector value routines MINV and MAXV and plotting package calls to GPLOT, LIB4020, PLOTM, and GDONE in subroutine PLOTX are particular to Los Alamos. Calls to these routines must be examined and, if necessary, modified to correspond with equivalent user system routines.

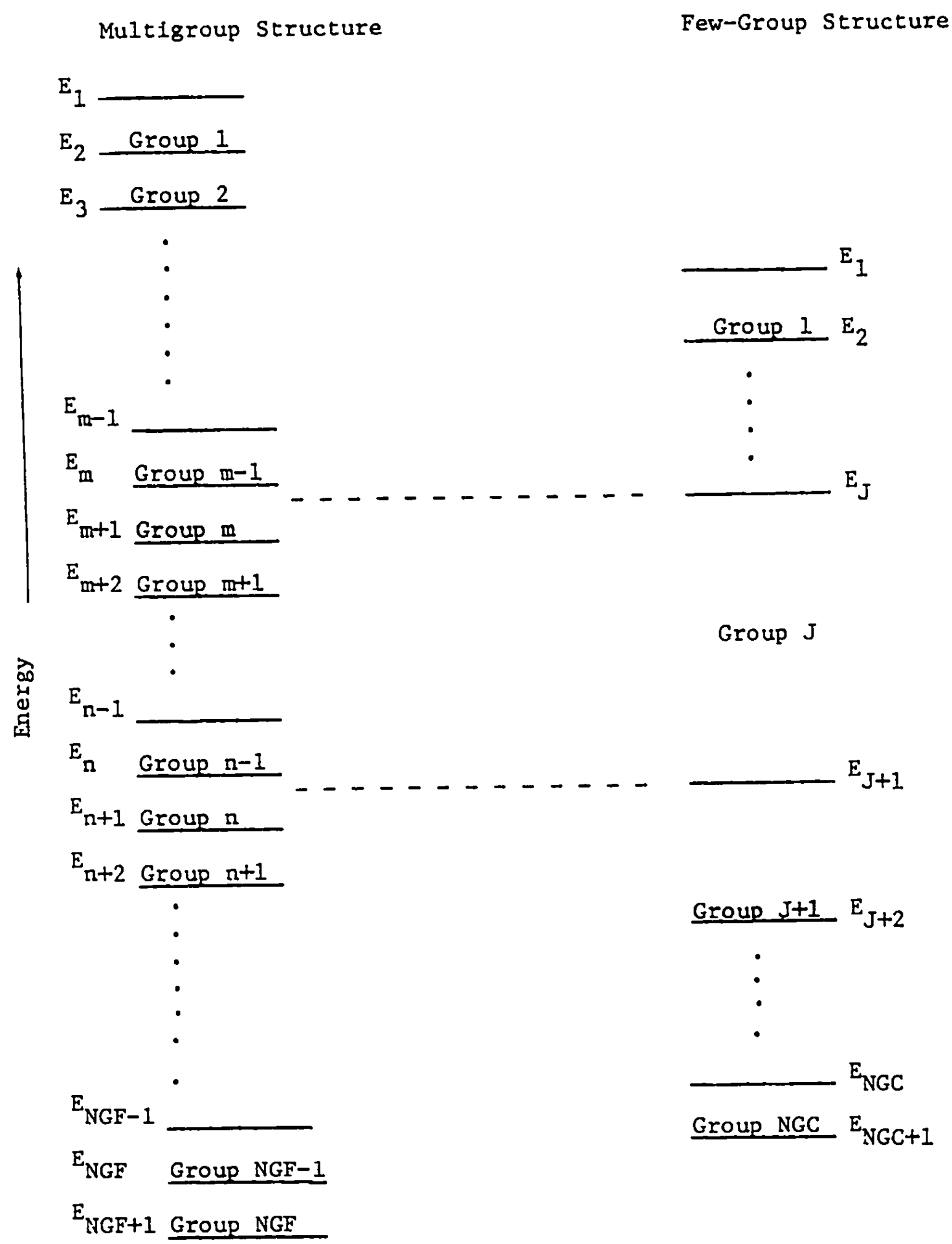

Figure 4-1. Multigroup and few-group energy structures.

Section 5

TOAFEW-V CARD INPUT (INPUT FILE)

Card input is supplied by the user to the code in the sequence below. All energy values supplied to and generated by the code are in units of electron volts. Integer values must be right adjusted. All variables are clearly described in the code listing in Appendix A.

Card	Column(s)		Format and Card Content	
Title			(20A4)	
	1-80		Problem description (alphanumeric)	
Control			(16I5)	
	1-5		IFLX, collapsing flux control	
	6-10		NFX, number of user-supplied flux values	
	11-15	±	NGC, number of coarse groups; sign controls input of EC values, cards E and F below	
	16-20		NT, table number for TAPE2 heading	
	21-25		IPLTFX, flux plot control	
Limits			(8I5,4E10.3)	
	1-5		MINZ	limits of nuclide Z and A, file MF, reaction MT, Bondarenko σ_0 value, and temperature within which TAPE1 multigroup cross sections should be collapsed.
	6-10		MAXZ	
	11-15		MINA	
	16-20		MAXA	
	21-25		MINMF	
	26-30		MAXMF	
	31-35		MINMT	
	36-40		MAXMT	
	41-50		SZMIN	
	51-60		SZMAX	
	61-70		TEMIN	
	71-80		TEMAX	

Cards A1, A2, B1, and B2 are supplied only if IFLX=1 (see Section 4 for functional flux description).

Card	Column(s)	Format and Card Content
A1		(6E12.5) Region boundaries
	1-12	EX(1)
	13-24	EX(2)
	25-36	EX(3)
	37-48	EX(4)
	49-60	EX(5)
	61-72	EX(6)
A2		(6E12.5) Region boundaries (cont)
	1-12	EX(7)

Card	Column(s)	Format and Card Content
B1		(6E12.5) Flux parameters
	1-12	TKM, Maxwellian temperature
	13-24	SLPA, region 2 flux slope
	25-36	THETA, fission spectrum temperature
	37-48	SLPB, region 4 flux slope
	49-60	TKF, fusion peak temperature
	61-72	EP, fusion peak energy
B2		(6E12.5) Flux parameters (cont)
	1-12	SLPC, region 6 flux slope

Cards C are supplied only if FLX=3. Values may be increasing or decreasing energy.

Card	Column(s)	Format and Card Content
C		(6E12.5) Log-log flux points
	1-12	EFLUX(1)
	13-24	FLUX(1)
	25-36	EFLUX(2)
	⋮	⋮
		EFLUX(NFX)
		FLUX(NFX)

Cards D1 and D2 are supplied only if IFLX $\geq$ 4. Values may be increasing or decreasing energy.

Card	Column(s)	Format and Card Content
D1		(6E12.5) Histogram flux boundaries
	1-12	EFLUX(1)
	13-24	EFLUX(2)
	25-36	EFLUX(3)
	⋮	⋮
		EFLUX(NFX+1)
D2		(6E12.5) Histogram flux values
	1-12	FLUX(1)
	13-24	FLUX(2)
	25-36	FLUX(3)
	⋮	⋮
		FLUX(NFX)

A positive sign on NGC of the CONTROL card requires that coarse-group structure boundaries [EC(I), I=1, NGC+1] be read from card(s) E. A negative sign on NGC requires that fine-group structure boundary indices [LB(I), I=1, NGC=1] be read from card(s) F; coarse-group structure boundaries are selected from fine-group structure boundaries according to EC(IGC) = EF[LB(IGC)].

Card	Column(s)	Format and Card Content
E		(6E12.5) Coarse-group structure
	1-12	EC(1)
	13-24	EC(2)
	⋮	⋮
	⋮	EC(NGC+1)
F		(16I5) Coarse-group structure
	1-5	LB(1)
	6-10	LB(2)
	⋮	⋮
	⋮	LB(NGC+1)

Section 6

FOUR-GROUP RADIATIVE CAPTURE (n,γ) CROSS SECTIONS

Four-group (n,γ) cross sections have been generated with the TOAFEW-V code and library in the EPRI 4-group structure for use in reactor physics and fuel depletion calculations. The energy bounds of the group structure are given in Table 6-1. The infinite dilution ($\sigma_0 = 10^{10}$ b) 900 K radiative capture (MT=102) cross sections of all 237 nuclides present were collapsed using the PRS flux description. These 4-group values and effective thermal value defined in Section 4 of this report are listed in Table 6-2, along with thermal and resonance integral values read from the data library.

TABLE 6-1

EPRI FOUR-GROUP STRUCTURE

Group	Energy, eV
	1.0×10^{7} eV
1	
	$8.208499862 \times 10^{5}$ eV
2	
	$5.530843701 \times 10^{3}$ eV
3	
	$6.250600000 \times 10^{-1}$ eV
4	
	$1.000000000 \times 10^{-5}$ eV

TABLE 6-2

FOUR GROUP CROSS SECTIONS

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION	THERMAL X-SECTION EFFECTIVE*	THERMAL X-SECTION (0.0253 EV)	RESONANCE INTEG. ABOVE 0.500 EV	RESONANCE INTEG. ABOVE 0.625 EV
ENDF/B-V	FISSION PRODUCTS											
32GE 72	9050	3102	900	1E+10	2.09929E-02	5.49443E-02	8.04255E-02	5.45659E-01	9.84911E-01	9.83060E-01	1.12180E+00	1.07640E+00
32GE 73	9051	3102	900	1E+10	4.38309E-02	1.77096E-01	8.05845E+00	8.36568E+00	1.51000E+01	1.50650E+01	6.96250E+01	6.89270E+01
32GE 74	9053	3102	900	1E+10	9.48673E-03	3.22018E-02	4.40517E-02	2.13400E-01	3.85186E-01	3.84380E-01	6.03710E-01	5.85860E-01
32GE 76	9056	3102	900	1E+10	2.66745E-03	9.19389E-03	1.63564E-01	7.90956E-02	1.42767E-01	1.42480E-01	1.34350E+00	1.33690E+00
33AS 75	9071	3102	900	1E+10	3.17458E-02	2.40147E-01	7.08094E+00	2.39953E+00	4.33115E+00	4.31700E+00	6.14970E+01	6.12940E+01
+34SE 74	9089	3102	900	1E+10	2.02958E-02	1.03365E-01	5.91773E+01	2.88983E+01	5.21613E+01	5.18320E+01	5.79510E+02	5.77040E+02
34SE 76	9091	3102	900	1E+10	3.03909E-02	1.03039E-01	3.87552E+00	4.73640E+01	8.54917E+01	8.53240E+01	4.38660E+01	3.98800E+01
34SE 77	9092	3102	900	1E+10	2.40018E-02	2.57120E-01	3.57072E+00	2.33770E+01	4.21954E+01	4.21200E+01	3.61540E+01	3.41820E+01
34SE 78	9094	3102	900	1E+10	1.23472E-02	4.56151E-02	5.36059E-01	2.22929E-01	4.02386E-01	4.01580E-01	4.55130E+00	4.53250E+00
34SE 80	9097	3102	900	1E+10	1.22365E-02	4.55578E-02	8.98803E-02	3.39942E-01	6.13594E-01	6.12330E-01	1.06800E+00	1.03940E+00
34SE 82	9100	3102	900	1E+10	3.75449E-03	1.07395E-02	1.68444E-03	2.50838E-02	4.52761E-02	4.51950E-02	9.25850E-02	9.05010E-02
35BR 79	9113	3102	900	1E+10	6.18398E-02	4.36177E-01	1.20570E+01	6.19395E+00	1.11800E+01	1.11330E+01	1.35880E+02	1.35350E+02
35BR 81	9117	3102	900	1E+10	4.21821E-02	2.81024E-01	5.73807E+00	1.50094E+00	2.70919E+00	2.70160E+00	4.99700E+01	4.98440E+01
36KR 78	1330	3102	900	1E+10	6.27707E-02	2.02410E-01	2.62458E+00	2.69433E+00	4.86325E+00	4.85930E+00	2.36820E+01	2.34570E+01
36KR 80	1331	3102	900	1E+10	3.17745E-02	1.40200E-01	7.84161E+00	6.53644E+00	1.17982E+01	1.17780E+01	6.85890E+01	6.80430E+01
36KR 82	1332	3102	900	1E+10	1.42546E-02	6.74546E-02	1.99069E+01	1.67796E+01	3.02870E+01	3.02630E+01	1.83340E+02	1.81940E+02
36KR 83	1333	3102	900	1E+10	3.40022E-02	2.10555E-01	1.79991E+01	1.11567E+02	2.01377E+02	2.08130E+02	1.88000E+02	1.80400E+02
36KR 84	1334	3102	900	1E+10	5.95885E-03	2.26531E-02	4.30425E-01	4.61659E-02	8.33292E-02	8.31350E-02	3.47650E+00	3.47260E+00
36KR 85	9145	3102	900	1E+10	4.36750E-03	2.86425E-02	1.58712E-01	9.24867E-01	1.66938E+00	1.66590E+00	1.66500E+00	1.58770E+00
36KR 86	1336	3102	900	1E+10	1.23752E-03	2.87790E-03	1.54601E-02	3.42168E-02	6.17612E-02	6.16390E-02	1.41240E-01	1.38380E-01
37RB 85	9160	3102	900	1E+10	1.83425E-02	2.15137E-01	5.40000E-01	2.56305E-01	4.62629E-01	4.61490E-01	5.85530E+00	5.83390E+00
37RB 86	9161	3102	900	1E+10	4.28466E-03	9.23147E-02	2.81096E+00	2.73008E+00	4.92777E+00	4.92000E+00	2.36410E+01	2.34120E+01
37RB 87	9163	3102	900	1E+10	2.10695E-03	1.04549E-02	2.53980E-01	6.68367E-02	1.20640E-01	1.20360E-01	2.10740E+00	2.10180E+00
+38SR 84	9179	3102	900	1E+10	5.79140E-02	1.67385E-01	1.18242E+00	4.52595E-01	8.16932E-01	8.14810E-01	1.04730E+01	1.04350E+01
38SR 86	9182	3102	900	1E+10	1.68572E-02	4.22368E-02	5.74684E-01	1.58134E+00	2.85430E+00	2.84840E+00	5.17720E+00	5.04440E+00
38SR 87	9183	3102	900	1E+10	1.66897E-02	7.76876E-02	1.04537E+01	9.23529E+00	1.66696E+01	1.60570E+01	1.18960E+02	1.17980E+02
38SR 88	9185	3102	900	1E+10	1.32789E-03	2.21425E-03	2.20216E-04	3.23125E-03	5.83238E-03	5.82020E-03	1.98870E-02	1.96170E-02
38SR 89	9186	3102	900	1E+10	8.31346E-03	2.03699E-02	3.94254E-02	2.33912E-01	4.22210E-01	4.21330E-01	5.24810E-01	5.05140E-01
38SR 90	9187	3102	900	1E+10	4.91790E-03	1.56772E-02	3.29447E-02	5.01561E-01	9.05314E-01	9.03630E-01	5.05190E-01	4.63150E-01
39 Y 89	9202	3102	900	1E+10	7.13167E-03	2.24638E-02	8.23312E-02	7.12990E-01	1.28694E+00	1.28410E+00	9.72970E-01	9.13020E-01
39 Y 90	9204	3102	900	1E+10	1.13651E-02	1.14577E-01	4.37880E-01	1.94788E+00	3.51592E+00	3.50930E+00	4.73280E+00	4.57080E+00
39 Y 91	9206	3102	900	1E+10	4.21694E-03	3.28378E-02	1.60662E-01	7.79680E-01	1.40732E+00	1.40430E+00	1.65840E+00	1.59320E+00
40ZR 90	1385	3102	900	1E+10	9.16233E-03	2.04209E-02	1.79307E-02	3.38864E-02	6.11647E-02	6.10490E-02	2.86320E-01	2.83490E-01
40ZR 91	1386	3102	900	1E+10	9.16215E-03	6.34989E-02	6.45422E-01	5.56133E-01	1.00382E+00	1.00220E+00	5.69670E+00	5.65010E+00
40ZR 92	1387	3102	900	1E+10	9.16221E-03	2.65094E-02	6.63950E-02	8.88599E-02	1.60392E-01	1.60080E-01	6.92820E-01	6.85410E-01
40ZR 93	9232	3102	900	1E+10	2.08866E-02	5.14749E-02	3.45908E+00	1.39432E+00	2.51674E+00	2.51050E+00	3.05550E+01	3.04390E+01
40ZR 94	1388	3102	900	1E+10	9.16216E-03	3.24799E-02	1.90589E-02	3.11088E-02	5.61512E-02	5.60350E-02	3.92380E-01	3.89760E-01
40ZR 95	9234	3102	900	1E+10	3.76649E-02	1.16684E-01	5.79721E-01	2.73066E-01	4.92883E-01	4.91870E-01	5.20580E+00	5.18280E+00
40ZR 96	1389	3102	900	1E+10	9.16221E-03	2.35376E-02	6.46505E-01	1.33652E-02	2.41241E-02	2.40440E-02	5.29070E+00	5.28960E+00
41NB 93	1189	3102	900	1E+10	1.60594E-02	1.59109E-01	1.03757E+00	6.41854E-01	1.15854E+00	1.15560E+00	9.43770E+00	9.38370E+00
41NB 94	9251	3102	900	1E+10	5.73148E-03	1.68644E-01	1.17404E+01	7.61188E+00	1.37394E+01	1.36530E+01	1.16480E+02	1.15820E+02
41NB 95	9253	3102	900	1E+10	5.26057E-02	2.64773E-01	2.49320E+00	8.35015E-01	1.50720E+00	1.50430E+00	2.20080E+01	2.19380E+01
42MO 92	9278	3102	900	1E+10	2.23524E-02	5.83061E-02	7.10790E-02	2.06918E-02	3.73486E-02	4.38730E-02	9.48280E-01	9.47020E-01
42MO 94	9281	3102	900	1E+10	3.04507E-02	6.13672E-02	9.50285E-02	8.89489E-03	1.60552E-02	1.60240E-02	1.09750E+00	1.09680E+00
42MO 95	9282	3102	900	1E+10	3.55339E-02	2.34593E-01	1.25945E+01	8.06935E+00	1.45651E+01	1.45230E+01	1.13410E+02	1.12730E+02

TABLE 6-2 (cont.)

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION	THERMAL EFFECTIVE*	X-SECTION (0.0253 EV)	RESONANCE 0.500 EV	INTEG. ABOVE 0.625 EV
42MO 96	9283	3102	900	1E+10	2.61959E-02	7.93164E-02	2.27590E+00	5.57017E-01	1.00541E+00	1.00260E+00	1.96520E+01	1.96040E+01
42MO 97	9284	3102	900	1E+10	3.12284E-02	2.37576E-01	1.80911E+00	1.21012E+00	2.18426E+00	2.18000E+00	1.65560E+01	1.64540E+01
42MO 98	9285	3102	900	1E+10	1.48589E-02	7.75051E-02	7.71592E-01	7.11041E-02	1.28342E-01	1.27680E-01	6.89400E+00	6.88790E+00
42MO 99	9286	3102	900	1E+10	4.27950E-02	4.05511E-01	2.84516E+00	9.47432E-01	1.71011E+00	1.70700E+00	2.72690E+01	2.71890E+01
42MO100	9287	3102	900	1E+10	9.68723E-03	6.04586E-02	4.42180E-01	1.10872E-01	2.00123E-01	1.99710E-01	3.88240E+00	3.87300E+00
43TC 99	1308	3102	900	1E+10	4.71331E-02	4.87907E-01	2.88552E+01	1.11555E+01	2.01356E+01	1.95780E+01	3.50850E+02	3.49760E+02
+ 44RU 96	9325	3102	900	1E+10	1.34126E-01	3.02138E-01	1.24257E+00	1.38836E-01	2.50599E-01	2.49340E-01	1.18890E+01	1.18770E+01
+ 44RU 98	9327	3102	900	1E+10	2.01210E-02	8.65149E-02	9.58421E-01	4.45282E+00	8.03732E+00	7.98060E+00	9.48040E+00	9.10520E+00
44RU 99	9328	3102	900	1E+10	3.82655E-02	3.74955E-01	1.42050E+01	2.82015E+00	5.09035E+00	5.01770E+00	1.36410E+02	1.36160E+02
44RU100	9329	3102	900	1E+10	5.32264E-02	1.47718E-01	8.00659E-01	3.22798E+00	5.82649E+00	5.81680E+00	8.10820E+00	7.83630E+00
44RU101	9330	3102	900	1E+10	3.68424E-02	5.92171E-01	9.99165E+00	1.73678E+00	3.13487E+00	3.10840E+00	1.00200E+02	1.00040E+02
44RU102	9331	3102	900	1E+10	5.76720E-02	1.34429E-01	3.21353E-01	7.24175E-01	1.30713E+00	1.30440E+00	3.58310E+00	3.52220E+00
44RU103	9332	3102	900	1E+10	2.46152E-02	3.66416E-01	7.46211E+00	4.28578E+00	7.73580E+00	7.72110E+00	7.18750E+01	7.15140E+01
44RU104	9333	3102	900	1E+10	2.80225E-02	1.08068E-01	7.29072E-01	2.43141E-01	4.38867E-01	4.37900E-01	6.51160E+00	6.49110E+00
44RU105	9334	3102	900	1E+10	2.32603E-02	3.22879E-01	6.38469E-01	1.11368E-01	2.01019E-01	2.00590E-01	7.38500E+00	7.37570E+00
44RU106	9335	3102	900	1E+10	8.34152E-03	5.23641E-02	2.34258E-01	8.13597E-02	1.46854E-01	1.46590E-01	2.17000E+00	2.16320E+00
45RH103	1310	3102	900	1E+10	4.61392E-02	5.56270E-01	8.91497E+01	9.60417E+01	1.73355E+02	1.47370E+02	1.03860E+03	1.01600E+03
+ 45RH105	9355	3102	900	1E+10	9.12895E-02	4.91229E-01	1.14388E+03	9.15819E+03	1.65305E+04	1.60460E+04	1.52750E+04	1.29670E+04
+.46PD102	9379	3102	900	1E+10	4.14199E-02	1.30515E-01	1.03625E+00	2.65652E+00	4.79501E+00	4.78540E+00	9.93380E+00	9.71240E+00
46PD104	9381	3102	900	1E+10	9.76349E-02	2.52785E-01	2.07601E+00	2.15824E-01	3.89562E-01	3.88480E-01	1.84740E+01	1.84560E+01
46PD105	9382	3102	900	1E+10	8.79848E-02	7.21569E-01	9.41208E+00	7.81224E+00	1.41011E+01	1.40560E+01	9.16860E+01	9.10220E+01
46PD106	9383	3102	900	1E+10	7.74378E-02	2.09756E-01	9.12550E-01	1.32619E-01	2.39376E-01	2.38790E-01	8.63910E+00	8.62790E+00
46PD107	9384	3102	900	1E+10	9.18013E-02	6.56232E-01	7.71044E+00	5.56819E+00	1.00506E+01	1.00290E+01	7.66670E+01	7.62030E+01
46PD108	9386	3102	900	1E+10	6.08255E-02	1.91431E-01	2.27729E+01	6.81843E+00	1.23072E+01	1.22500E+01	2.25140E+02	2.24550E+02
46PD110	9389	3102	900	1E+10	2.32766E-02	1.13845E-01	8.66353E-01	1.22752E-01	2.21566E-01	2.20930E-01	7.46980E+00	7.45950E+00
47AG107	1371	3102	900	1E+10	6.88439E-02	5.31984E-01	1.20385E+01	2.05309E+01	3.70581E+01	3.69900E+01	1.14980E+02	1.13250E+02
47AG109	1373	3102	900	1E+10	7.40717E-02	5.82079E-01	1.30812E+02	5.27492E+01	9.52120E+01	9.24190E+01	1.46640E+03	1.46110E+03
47AG111	9415	3102	900	1E+10	2.60671E-02	3.33167E-01	1.20358E+01	1.67159E+00	3.01720E+00	3.01160E+00	1.04730E+02	1.04590E+02
+ 48CD106	9440	3102	900	1E+10	7.20725E-02	1.85065E-01	1.19797E+00	6.08847E-01	1.09896E+00	1.09660E+00	1.10580E+01	1.10070E+01
48CD108	9442	3102	900	1E+10	9.60246E-02	1.80421E-01	3.62264E-01	6.12460E-01	1.10549E+00	1.10330E+00	4.26400E+00	4.21260E+00
48CD110	9444	3102	900	1E+10	1.16113E-01	2.09569E-01	4.69751E+00	6.18518E+00	1.11642E+01	1.11400E+01	4.25750E+01	4.20570E+01
48CD111	9445	3102	900	1E+10	3.55117E-02	3.24283E-01	5.61827E+00	1.35257E+01	2.44138E+01	2.43650E+01	5.43930E+01	5.32530E+01
48CD112	9447	3102	900	1E+10	9.32298E-02	1.95166E-01	1.15009E+00	1.22528E+00	2.21162E+00	2.20660E+00	1.37670E+01	1.36640E+01
48CD113	1318	3102	900	1E+10	4.03813E-02	2.93993E-01	1.90434E+01	2.74457E+04	4.95393E+04	2.02480E+04	3.67590E+02	1.99950E+02
48CD114	9450	3102	900	1E+10	9.62790E-02	2.05335E-01	2.21267E+00	1.87128E-01	3.37764E-01	3.36920E-01	1.92250E+01	1.92090E+01
48CD115M	9452	3102	900	1E+10	3.42993E-02	2.34424E-01	2.17848E+01	1.72606E+01	3.11552E+01	3.10890E+01	1.94130E+02	1.92700E+02
48CD116	9453	3102	900	1E+10	4.16811E-02	9.27579E-02	2.27616E-01	4.27836E-02	7.72242E-02	7.70560E-02	2.42070E+00	2.41710E+00
49IN113	9473	3102	900	1E+10	2.40440E-01	5.23453E-01	2.16476E+01	6.56913E+00	1.18572E+01	1.14360E+01	2.26260E+02	2.25530E+02
49IN115	9477	3102	900	1E+10	1.22805E-01	3.74931E-01	2.85715E+02	1.28248E+02	2.31488E+02	2.03050E+02	3.28250E+03	3.25760E+03
+ 50SN112	9513	3102	900	1E+10	1.88239E-01	2.31271E-01	3.37574E+00	6.36914E-01	1.14963E+00	1.14580E+00	3.02510E+01	3.01980E+01
+ 50SN114	9516	3102	900	1E+10	1.72743E-01	2.23813E-01	2.82930E-01	6.12782E-01	1.10607E+00	1.10370E+00	3.95150E+00	3.90040E+00
50SN115	9517	3102	900	1E+10	3.72535E-03	3.18134E-02	2.00424E+00	2.78348E+01	5.02416E+01	5.01430E+01	2.34980E+01	2.11580E+01
50SN116	9518	3102	900	1E+10	3.17029E-02	4.35930E-02	1.36124E+00	6.70938E-02	1.21104E-01	1.20710E-01	1.17300E+01	1.17240E+01
50SN117	9519	3102	900	1E+10	3.27456E-02	1.65914E-01	1.99372E+00	1.44842E+00	2.61438E+00	2.60660E+00	1.85210E+01	1.83960E+01
50SN118	9521	3102	900	1E+10	7.68228E-02	8.66297E-02	6.94482E-01	4.59346E-02	8.29117E-02	8.26820E-02	6.20980E+00	6.20590E+00
50SN119	9522	3102	900	1E+10	6.36312E-03	4.03655E-02	3.95753E-01	1.28161E+00	2.31330E+00	2.30910E+00	3.83490E+00	3.72750E+00
50SN120	9524	3102	900	1E+10	1.79755E-02	3.45365E-02	1.34925E-01	7.85082E-02	1.41707E-01	1.41390E-01	1.29250E+00	1.28590E+00
50SN122	9527	3102	900	1E+10	1.33390E-02	1.82358E-02	7.60660E-02	1.00706E-01	1.81774E-01	1.81420E-01	7.63990E-01	7.55540E-01
50SN123	9528	3102	900	1E+10	3.95123E-02	8.51870E-02	2.69231E-01	1.83710E-02	3.31595E-02	3.30900E-02	2.67920E+00	2.67770E+00
50SN124	9530	3102	900	1E+10	1.84819E-02	2.44166E-02	8.12352E-01	7.24584E-02	1.30787E-01	1.30260E-01	7.14100E+00	7.13490E+00

TABLE 6-2 (cont.)

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION	THERMAL X-SECTION EFFECTIVE*	THERMAL X-SECTION (0.0253 EV)	RESONANCE INTEG. ABOVE 0.500 EV	RESONANCE INTEG. ABOVE 0.625 EV
50SN125	9531	3102	900	1E+10	9.91051E-03	4.67810E-02	1.95465E+00	3.06288E-01	5.52848E-01	5.51610E-01	1.52140E+01	1.51890E+01
50SN126	9533	3102	900	1E+10	5.66485E-03	7.21642E-03	1.09788E-02	1.67147E-01	3.01700E-01	3.01120E-01	1.83150E-01	1.69100E-01
51SB121	9548	3102	900	1E+10	9.53319E-02	3.55580E-01	1.68596E+01	3.55292E+00	6.41300E+00	6.28110E+00	2.06100E+02	2.05770E+02
51SB123	9551	3102	900	1E+10	4.17338E-02	1.76270E-01	8.36212E+00	2.42205E+00	4.37179E+00	4.34020E+00	1.27060E+02	1.26850E+02
51SB124	9552	3102	900	1E+10	2.53934E-02	5.85894E-01	2.53943E+00	3.61756E+00	6.52968E+00	6.51700E+00	2.64420E+01	2.61370E+01
51SB125	9555	3102	900	1E+10	7.51678E-02	2.10473E-01	2.10823E+00	5.57166E-01	1.00568E+00	1.00380E+00	1.85560E+01	1.85090E+01
51SB126	9556	3102	900	1E+10	1.84509E-02	3.03242E-01	5.14698E+00	3.23083E+00	5.83163E+00	5.81970E+00	4.57300E+01	4.54600E+01
+ 52TE120	9576	3102	900	1E+10	1.33965E-01	3.01990E-01	2.19116E+00	1.27320E+00	2.29812E+00	2.29280E+00	2.00580E+01	1.99510E+01
52TE122	9579	3102	900	1E+10	1.19998E-01	2.50413E-01	8.42302E+00	1.56212E+00	2.81962E+00	2.80860E+00	7.39200E+01	7.37870E+01
52TE123	9580	3102	900	1E+10	6.15282E-02	3.66714E-01	4.86847E+02	2.45702E+02	4.43491E+02	4.11310E+02	5.53610E+03	5.50310E+03
52TE124	9582	3102	900	1E+10	1.10426E-01	1.95542E-01	7.72352E-01	3.78806E+00	6.83743E+00	6.82350E+00	8.34290E+00	8.02730E+00
52TE125	9583	3102	900	1E+10	2.60916E-02	2.55687E-01	2.65671E+00	8.62912E-01	1.55755E+00	1.55400E+00	2.35270E+01	2.34540E+01
52TE126	9585	3102	900	1E+10	3.71648E-02	8.44469E-02	1.18705E+00	5.76899E-01	1.04130E+00	1.03930E+00	1.03270E+01	1.02780E+01
52TE127M	9587	3102	900	1E+10	5.41796E-02	2.64856E-01	4.72893E+00	5.23639E+00	9.45165E+00	9.43240E+00	4.24180E+01	4.19810E+01
52TE128	9588	3102	900	1E+10	4.53504E-02	8.65904E-02	2.29655E-01	1.19590E-01	2.15859E-01	2.15420E-01	2.39740E+00	2.38750E+00
52TE129M	9590	3102	900	1E+10	9.47771E-03	8.19557E-02	6.83135E-01	6.12154E-01	1.10493E+00	1.10280E+00	6.11440E+00	6.06320E+00
52TE130	9591	3102	900	1E+10	3.75896E-03	1.40090E-02	2.85228E-02	1.61438E-01	2.91395E-01	2.90810E-01	3.59770E-01	3.46160E-01
52TE132	9594	3102	900	1E+10	5.70362E-04	4.48797E-04	7.31968E-05	1.11359E-03	2.01002E-03	2.00560E-03	5.74280E-03	5.65000E-03
53 I127	9606	3102	900	1E+10	4.97887E-02	4.08591E-01	1.54588E+01	3.46076E+00	6.24665E+00	6.22210E+00	1.54870E+02	1.54570E+02
53 I129	9608	3102	900	1E+10	3.81510E-02	2.27988E-01	3.69723E+00	1.50312E+01	2.71311E+01	2.71010E+01	3.52330E+01	3.39680E+01
53 I130	9609	3102	900	1E+10	1.83588E-02	2.69265E-01	1.97811E+01	1.00311E+01	1.81062E+01	1.80760E+01	1.80650E+02	1.79810E+02
53 I131	9611	3102	900	1E+10	9.46357E-03	7.35971E-02	9.58907E-01	3.89687E-01	7.03382E-01	7.01920E-01	8.10170E+00	8.06930E+00
53 I135	9618	3102	900	1E+10	4.68210E-04	5.73641E-04	7.32055E-04	1.11371E-02	2.01024E-02	2.00610E-02	1.52180E-02	1.42830E-02
54XE124	1335	3102	900	1E+10	9.49315E-02	2.99731E-01	2.78826E+02	9.37473E+01	1.69213E+02	1.65070E+02	3.06570E+03	3.05660E+03
54XE126	1339	3102	900	1E+10	6.55492E-02	1.88845E-01	5.05107E+00	1.22466E+00	2.21050E+00	2.20760E+00	4.40160E+01	4.39140E+01
54XE128	1348	3102	900	1E+10	4.22094E-02	1.39635E-01	1.21201E+00	2.94197E+00	5.31024E+00	5.37380E+00	1.11730E+01	1.09470E+01
54XE129	1349	3102	900	1E+10	5.30938E-02	3.00179E-01	2.52808E+01	1.00619E+01	1.81617E+01	1.80540E+01	2.55050E+02	2.54180E+02
54XE130	1350	3102	900	1E+10	3.39895E-02	1.12854E-01	3.92665E-01	3.39975E+00	6.13652E+00	6.21490E+00	4.43470E+00	4.17450E+00
54XE131	1351	3102	900	1E+10	1.33102E-02	1.84060E-01	1.02592E+02	5.06670E+01	9.14537E+01	9.03780E+01	1.01630E+03	1.01180E+03
54XE132	1352	3102	900	1E+10	1.81277E-02	6.66074E-02	1.58019E-01	2.44765E-01	4.41799E-01	4.41360E-01	1.71320E+00	1.69270E+00
54XE133	9643	3102	900	1E+10	5.95691E-03	5.28233E-02	3.40758E+01	1.05791E+02	1.90953E+02	1.90590E+02	3.65740E+02	3.56850E+02
54XE134	1354	3102	900	1E+10	1.05611E-02	3.43687E-02	6.65973E-02	1.38313E-01	2.49654E-01	2.50650E-01	7.64470E-01	7.53240E-01
54XE135	1294	3102	900	1E+10	5.55362E-04	3.22388E-03	3.63971E+02	1.66836E+06	3.01139E+06	2.68940E+06	7.41880E+03	4.04580E+03
54XE136	1356	3102	900	1E+10	1.07182E-03	2.29148E-03	1.06944E-02	8.90751E-02	1.60780E-01	1.60440E-01	1.21030E-01	1.13610E-01
55CS133	1355	3102	900	1E+10	4.51478E-02	3.42774E-01	3.41196E+01	1.67104E+01	3.01622E+01	2.96970E+01	3.82200E+02	3.80660E+02
55CS134	9663	3102	900	1E+10	1.28780E-02	3.44643E-01	2.04544E+01	7.79358E+01	1.40674E+02	1.40380E+02	2.10920E+02	2.04360E+02
55CS135	9665	3102	900	1E+10	3.18449E-03	4.14892E-02	6.30838E+00	4.84412E+00	8.74361E+00	8.72710E+00	6.11210E+01	6.07140E+01
55CS136	9667	3102	900	1E+10	1.94151E-02	1.63524E-01	3.31416E+00	7.25024E-01	1.30866E+00	1.30460E+00	3.95370E+01	3.94760E+01
55CS137	9669	3102	900	1E+10	1.50365E-03	5.54138E-03	5.85594E-02	6.12890E-02	1.10626E-01	1.10430E-01	4.99030E-01	4.93870E-01
56BA134	9684	3102	900	1E+10	3.51966E-02	8.61060E-02	2.72913E+00	1.20305E+00	2.17150E+00	2.16710E+00	2.39720E+01	2.38710E+01
56BA135	9685	3102	900	1E+10	2.86421E-02	2.21467E-01	1.12271E+01	3.24398E+00	5.85536E+00	5.83760E+00	1.00440E+02	1.00170E+02
56BA136	9687	3102	900	1E+10	1.31286E-02	3.58320E-02	2.13005E-01	2.28188E-01	4.11878E-01	4.11060E-01	1.95020E+00	1.93090E+00
56BA137	9689	3102	900	1E+10	7.22114E-03	3.73458E-02	4.98298E-01	2.83952E+00	5.12532E+00	5.11420E+00	4.89440E+00	4.65770E+00
56BA138	1353	3102	900	1E+10	2.61066E-03	4.88691E-03	2.72552E-02	1.94596E-01	3.51245E-01	3.51030E-01	3.15400E-01	2.99020E-01
56BA140	9693	3102	900	1E+10	1.68909E-03	3.74652E-03	1.56515E+00	8.89579E-01	1.60568E+00	1.60630E+00	1.27690E+01	1.26950E+01
57LA139	9707	3102	900	1E+10	6.06355E-03	2.65476E-02	1.24915E+00	4.99615E+00	9.01802E+00	9.02500E+00	1.19980E+01	1.15670E+01
57LA140	9708	3102	900	1E+10	2.94966E-02	1.29606E-01	7.65361E+00	1.50303E+00	2.71295E+00	2.70730E+00	6.45010E+01	6.43760E+01
58CE140	9724	3102	900	1E+10	1.70385E-02	1.73210E-02	2.85401E-02	3.17499E-01	5.73085E-01	5.71840E-01	4.43120E-01	4.16430E-01
58CE141	9725	3102	900	1E+10	4.50432E-02	1.05438E-01	2.29761E+00	1.61408E+01	2.91340E+01	2.90750E+01	2.38970E+01	2.25380E+01
58CE142	9726	3102	900	1E+10	1.48611E-02	3.29180E-02	5.92087E-02	5.28822E-01	9.54520E-01	9.52540E-01	8.17800E-01	7.73630E-01

TABLE 6-2 (cont.)

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION	THERMAL X-SECTION EFFECTIVE*	THERMAL X-SECTION (0.0253 EV)	RESONANCE INTEG. ABOVE 0.500 EV	RESONANCE INTEG. ABOVE 0.625 EV
58CE143	9727	3102	900	1E+10	9.58177E-03	7.57476E-02	5.03452E+00	3.34360E+00	6.03517E+00	6.02510E+00	4.22420E+01	4.19640E+01
58CE144	9728	3102	900	1E+10	1.08995E-02	2.40524E-02	2.30946E-01	5.56600E-01	1.00466E+00	1.00270E+00	2.03000E+00	1.98370E+00
59PR141	9742	3102	900	1E+10	1.56633E-02	7.09218E-02	2.08793E+00	6.40060E+00	1.15530E+01	1.15400E+01	1.89170E+01	1.83780E+01
59PR142	9743	3102	900	1E+10	1.60795E-02	2.54632E-01	1.48426E+01	1.11362E+01	2.01007E+01	2.00560E+01	1.46180E+02	1.45250E+02
59PR143	9745	3102	900	1E+10	4.83503E-02	2.16246E-01	1.84212E+01	4.95455E+01	8.94293E+01	8.92570E+01	1.89330E+02	1.85180E+02
60ND142	9763	3102	900	1E+10	2.77271E-02	3.12292E-02	7.30840E-01	1.04068E+01	1.87842E+01	1.87470E+01	8.77540E+00	7.89950E+00
60ND143	9764	3102	900	1E+10	6.02296E-02	1.98509E-01	1.21494E+01	1.76721E+02	3.18981E+02	3.25810E+02	1.29480E+02	1.16590E+02
60ND144	9765	3102	900	1E+10	2.96981E-02	5.03102E-02	5.86897E-01	2.00658E+00	3.62187E+00	3.61730E+00	5.47390E+00	5.30490E+00
60ND145	9766	3102	900	1E+10	9.52507E-02	2.83260E-01	2.26892E+01	2.34496E+01	4.23265E+01	4.21450E+01	2.32270E+02	2.30270E+02
60ND146	9767	3102	900	1E+10	4.51084E-02	8.33473E-02	2.95620E-01	7.79893E-01	1.40770E+00	1.40460E+00	3.07060E+00	3.00520E+00
60ND147	9768	3102	900	1E+10	5.10845E-02	3.93064E-01	6.00286E+01	2.72783E+01	4.92371E+01	4.91350E+01	6.36170E+02	6.33870E+02
60ND148	9769	3102	900	1E+10	6.19424E-02	1.02378E-01	2.25854E+00	1.39407E+00	2.51628E+00	2.50930E+00	1.94950E+01	1.93780E+01
60ND150	9771	3102	900	1E+10	2.63589E-02	1.04617E-01	1.83030E+00	6.68333E-01	1.20634E+00	1.20340E+00	1.59640E+01	1.59080E+01
61PM147	9783	3102	900	1E+10	1.28866E-01	7.74256E-01	1.91914E+02	9.88601E+01	1.78442E+02	1.82510E+02	2.28440E+03	2.27690E+03
61PM148	9784	3102	900	1E+10	4.92718E-01	2.57395E+00	2.83250E+03	2.64914E+03	4.78168E+03	2.00580E+03	3.83850E+04	3.22310E+04
61PM148M	9785	3102	900	1E+10	4.92718E-01	2.57395E+00	3.18088E+02	1.90624E+04	3.44075E+04	1.07880E+04	3.52640E+03	3.45490E+03
61PM149	9786	3102	900	1E+10	5.26487E-01	2.13418E+00	7.37983E+01	7.78544E+02	1.40527E+03	1.40350E+03	7.90700E+02	7.28850E+02
61PM151	9788	3102	900	1E+10	1.01026E-03	2.03785E-02	1.73205E+02	3.89649E+02	7.03314E+02	7.01880E+02	2.04850E+03	2.01600E+03
62SM144	9803	3102	900	1E+10	2.44760E-01	2.18841E-01	2.21331E+00	3.86689E-01	6.97971E-01	6.97630E-01	1.97150E+01	1.96830E+01
62SM147	9806	3102	900	1E+10	1.82583E-01	8.60702E-01	7.64223E+01	3.44189E+01	6.21260E+01	6.42070E+01	7.59500E+02	7.57040E+02
62SM148	9807	3102	900	1E+10	2.02160E-01	2.59660E-01	3.11052E+00	1.50356E+00	2.71391E+00	2.70770E+00	2.74550E+01	2.73290E+01
62SM149	1319	3102	900	1E+10	9.06789E-02	1.48915E+00	2.86959E+02	4.97816E+04	8.98555E+04	4.05250E+04	3.25460E+03	3.14110E+03
62SM150	9809	3102	900	1E+10	1.31309E-01	2.86248E-01	1.15206E+01	5.45535E+01	9.84687E+01	1.02300E+02	3.20930E+02	3.17340E+02
62SM151	9810	3102	900	1E+10	2.67965E-01	1.60536E+00	2.89559E+02	4.66263E+03	8.41602E+03	1.49240E+04	3.38800E+03	3.28840E+03
62SM152	9811	3102	900	1E+10	8.90128E-02	3.65346E-01	2.76045E+02	1.16950E+02	2.11094E+02	2.06840E+02	3.00240E+03	2.99140E+03
62SM153	9812	3102	900	1E+10	2.25689E-04	1.19034E-02	2.39097E+02	1.83819E+02	3.31792E+02	3.31040E+02	2.84220E+03	2.82670E+03
62SM154	9813	3102	900	1E+10	5.70837E-02	1.42599E-01	3.85946E+00	3.06481E+00	5.53196E+00	5.52080E+00	3.37360E+01	3.34780E+01
63EU151	1357	3102	900	1E+10	3.15428E-01	2.70801E+00	2.05399E+02	4.67901E+03	8.44558E+03	9.16060E+03	3.35700E+03	2.16600E+03
63EU152	1292	3102	900	1E+10	1.74624E-01	3.24995E+00	3.25449E+02	7.66810E+02	1.38409E+03	2.30400E+03	3.67810E+03	3.54880E+03
63EU153	1359	3102	900	1E+10	1.62826E-01	1.71669E+00	1.37439E+02	1.39787E+02	2.52315E+02	3.00330E+02	1.44720E+03	1.44090E+03
63EU154	1293	3102	900	1E+10	7.25178E-02	1.87909E+00	2.20970E+02	4.96457E+02	8.96102E+02	1.49320E+03	2.55250E+03	2.47850E+03
63EU155	9832	3102	900	1E+10	9.04481E-01	1.54313E+00	1.53588E+02	2.24920E+03	4.05980E+03	4.05190E+03	1.82500E+03	1.63610E+03
63EU156	9833	3102	900	1E+10	5.00353E-04	3.54005E-02	1.29522E+02	2.68663E+02	4.84935E+02	4.83340E+02	1.47000E+03	1.44760E+03
63EU157	9834	3102	900	1E+10	3.22379E-03	2.52811E-02	1.13710E+02	1.05549E+02	1.90516E+02	1.90480E+02	1.28030E+03	1.27150E+03
64GD152	1362	3102	900	1E+10	3.14777E-01	5.54281E-01	3.29325E+01	8.01885E+00	1.44740E+01	1.44680E+01	4.03860E+02	4.03200E+02
64GD154	1364	3102	900	1E+10	3.14240E-01	8.56674E-01	2.38970E+01	4.69328E+01	8.47134E+01	8.62450E+01	2.29380E+02	2.25910E+02
64GD155	1365	3102	900	1E+10	1.62974E-01	1.62543E+00	1.32213E+02	1.91317E+04	3.45326E+04	6.04830E+04	1.55080E+03	1.51660E+03
64GD156	1366	3102	900	1E+10	9.61730E-02	3.90195E-01	1.14368E+01	9.55792E-01	1.72520E+00	1.71610E+00	1.04820E+02	1.04740E+02
64GD157	1367	3102	900	1E+10	5.43024E-02	8.15579E-01	5.91069E+01	8.24669E+04	1.48852E+05	2.54020E+05	7.45360E+02	6.23920E+02
64GD158	1368	3102	900	1E+10	6.55924E-02	1.91531E-01	6.51629E+00	1.12046E+00	2.02242E+00	2.01130E+00	6.26030E+01	6.25060E+01
64GD160	1370	3102	900	1E+10	5.43195E-02	1.11351E-01	9.02069E-01	4.25296E-01	7.67657E-01	7.68060E-01	7.85860E+00	7.82320E+00
65TB159	9857	3102	900	1E+10	9.12003E-02	1.09536E+00	4.68098E+01	1.43285E+01	2.58628E+01	2.55720E+01	4.56100E+02	4.54810E+02
65TB160	9858	3102	900	1E+10	1.43074E-03	7.84143E-02	9.86094E+01	2.91755E+02	5.26615E+02	5.26330E+02	1.12290E+03	1.09870E+03
66DY160	9864	3102	900	1E+10	7.93981E-01	1.20071E+00	1.51606E+02	3.59658E+01	6.49181E+01	6.11970E+01	1.67010E+03	1.66550E+03
66DY161	9865	3102	900	1E+10	5.94233E-02	1.22732E+00	1.17057E+02	3.10247E+02	5.59995E+02	5.86870E+02	1.20560E+03	1.18610E+03
66DY162	9866	3102	900	1E+10	2.79945E-01	5.30115E-01	2.46923E+02	1.14177E+02	2.06088E+02	1.99870E+02	2.78440E+03	2.77290E+03
66DY163	9867	3102	900	1E+10	5.48633E-02	5.19304E-01	1.33671E+02	7.74903E+01	1.39870E+02	1.34730E+02	1.46800E+03	1.45740E+03
66DY164	1031	3102	900	1E+10	9.00514E-02	1.90647E-01	2.30257E+01	1.30122E+03	2.34869E+03	2.52160E+03	3.20780E+02	2.49310E+02
67HO165	9872	3102	900	1E+10	8.92770E-02	8.75484E-01	7.47406E+01	3.73998E+01	6.75064E+01	6.66860E+01	7.57340E+02	7.53980E+02
68ER166	9875	3102	900	1E+10	1.43092E-01	2.98597E-01	1.48463E+01	1.94729E+01	3.51485E+01	3.50590E+01	1.40260E+02	1.38630E+02

TABLE 6-2 (cont.)

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION+	THERMAL X-SECTION EFFECTIVE*	THERMAL X-SECTION (0.0253 EV)	RESONANCE INTEG. ABOVE 0.500 EV	RESONANCE INTEG. ABOVE 0.625 EV
68ER167	9876	3102	900	1E+10	6.09090E-02	8.02473E-01	1.58766E+02	1.07057E+03	1.93238E+03	6.73660E+02	3.00780E+03	1.75140E+03
ENDF/B-V ACTINIDES												
90TH230	8030	3102	900	1E+10	1.34054E-02	1.21432E-01	7.93247E+01	1.35326E+01	2.44262E+01	2.31590E+01	8.53720E+02	8.51740E+02
90TH232	1390	3102	900	1E+10	7.87452E-02	2.94364E-01	8.88511E+00	4.04262E+00	7.29691E+00	7.41450E+00	8.37150E+01	8.34050E+01
91PA231	8131	3102	900	1E+10	1.90229E-01	2.61241E+00	5.36287E+01	2.57268E+02	4.64367E+02	2.27760E+02	6.04930E+02	5.56340E+02
91PA233	1391	3102	900	1E+10	1.66012E-01	8.03290E-01	7.66653E+01	2.13067E+01	3.84584E+01	4.16680E+01	8.56440E+02	8.53870E+02
92 U232	8232	3102	900	1E+10	6.66569E-02	5.71778E-01	2.77986E+01	3.46792E+01	6.25957E+01	7.28480E+01	3.16920E+02	3.15550E+02
92 U233	1393	3102	900	1E+10	2.99052E-02	2.41806E-01	1.16439E+01	2.84525E+01	5.13567E+01	4.58520E+01	1.37140E+02	1.35010E+02
92 U234	1394	3102	900	1E+10	1.61264E-01	4.71970E-01	6.02696E+01	5.42976E+01	9.80069E+01	1.03760E+02	6.57470E+02	6.54150E+02
92 U235	1395	3102	900	1E+10	6.67153E-02	4.62601E-01	1.28001E+01	5.28373E+01	9.53710E+01	9.84550E+01	1.39190E+02	1.37230E+02
92 U236	1396	3102	900	1E+10	1.61336E-01	4.62993E-01	3.23377E+01	2.91516E+00	5.26185E+00	5.17580E+00	3.45670E+02	3.45410E+02
92 U237	8237	3102	900	1E+10	7.01050E-02	2.89437E-01	2.98826E+01	2.48625E+02	4.48766E+02	4.77280E+02	3.09230E+02	2.95120E+02
92 U238	1398	3102	900	1E+10	6.04449E-02	2.61710E-01	4.92352E+00	1.52635E+00	2.75506E+00	2.71990E+00	2.78810E+02	2.78670E+02
93NP237	1337	3102	900	1E+10	7.30444E-02	1.34102E+00	5.34404E+01	1.24073E+02	2.23950E+02	1.69190E+02	6.48650E+02	5.63830E+02
93NP238	8338	3102	900	1E+10	0.	3.53939E-02	8.55610E+00	1.07255E+02	1.93594E+02	2.03550E+02	9.96840E+01	9.26400E+01
94PU236	8436	3102	900	1E+10	2.68486E-02	2.67201E-01	2.90215E+01	8.56043E+01	1.54515E+02	1.63710E+02	3.12830E+02	3.07690E+02
94PU237	8437	3102	900	1E+10	1.96310E-02	1.56401E-01	1.47774E+01	3.00583E+02	5.42550E+02	5.41360E+02	1.86440E+02	1.61410E+02
94PU238	1338	3102	900	1E+10	1.05851E-01	5.88564E-01	1.50153E+01	2.45914E+02	4.43873E+02	5.63500E+02	1.52430E+02	1.46950E+02
94PU239	1399	3102	900	1E+10	1.27012E-02	3.51432E-01	1.85560E+01	4.18757E+02	7.55854E+02	2.71180E+02	1.92850E+02	1.78850E+02
94PU240	1380	3102	900	1E+10	6.29961E-02	4.18758E-01	6.90839E+02	1.98643E+02	3.58549E+02	2.91640E+02	8.00190E+03	7.94170E+03
94PU241	1381	3102	900	1E+10	9.29891E-02	3.62644E-01	1.78824E+01	2.95720E+02	5.33772E+02	3.62980E+02	1.96510E+02	1.89790E+02
94PU242	1342	3102	900	1E+10	5.48887E-02	3.60508E-01	1.13360E+02	1.13720E+01	2.05264E+01	1.93380E+01	1.27350E+03	1.27210E+03
94PU243	8443	3102	900	1E+10	2.10830E-02	2.96712E-01	2.38554E+01	4.68049E+01	8.44826E+01	8.82760E+01	2.75330E+02	2.72070E+02
94PU244	8444	3102	900	1E+10	1.01208E-02	1.19462E-01	8.52064E+00	1.00500E+00	1.81401E+00	1.84560E+00	1.05680E+02	1.05610E+02
95AM241	1361	3102	900	1E+10	1.29760E-01	1.41934E+00	9.04746E+01	6.15186E+02	1.11041E+03	5.81420E+02	1.41990E+03	9.87750E+02
95AM242	8542	3102	900	1E+10	0.	3.21375E-02	6.05919E+00	1.32252E+02	2.38714E+02	2.53900E+02	7.12730E+01	6.35990E+01
95AM242M	1369	3102	900	1E+10	7.95070E-03	2.73958E-01	2.19603E+01	1.01588E+03	1.83366E+03	1.35190E+03	2.83810E+02	2.32420E+02
95AM243	1363	3102	900	1E+10	3.24622E-02	7.39139E-01	1.59108E+02	4.76273E+01	8.59670E+01	7.52910E+01	1.81900E+03	1.81060E+03
96CM241	8641	3102	900	1E+10	9.41339E-03	1.61041E-01	9.10652E+00	1.39334E+02	2.51496E+02	2.50940E+02	1.10140E+02	9.85380E+01
96CM242	8642	3102	900	1E+10	1.52638E-02	1.88425E-01	1.64668E+01	9.15596E+00	1.65265E+01	1.72380E+01	1.55920E+02	1.55330E+02
96CM243	1343	3102	900	1E+10	5.52518E-03	1.67362E-01	2.26844E+01	3.35473E+01	6.05527E+01	5.86280E+01	2.50870E+02	2.46930E+02
96CM244	1344	3102	900	1E+10	7.03873E-02	6.98271E-01	5.59825E+01	5.77517E+00	1.04242E+01	1.04340E+01	5.91790E+02	5.91290E+02
96CM245	1345	3102	900	1E+10	2.03011E-02	2.95067E-01	9.86390E+00	1.83819E+02	3.31793E+02	3.85140E+02	1.16700E+02	1.07940E+02
96CM246	1346	3102	900	1E+10	3.13102E-02	1.74211E-01	1.00068E+01	7.48178E-01	1.35046E+00	1.30440E+00	1.03780E+02	1.03700E+02
96CM247	8647	3102	900	1E+10	2.03506E-02	2.88469E-01	4.21752E+01	4.09566E+01	7.39264E+01	5.86140E+01	4.93490E+02	4.75280E+02
96CM248	8648	3102	900	1E+10	4.15738E-02	1.96567E-01	2.37239E+01	1.38148E+00	2.49356E+00	2.45870E+00	2.48250E+02	2.48120E+02
97BK249	8749	3102	900	1E+10	6.74352E-02	3.47211E-01	3.40080E+02	9.02850E+02	1.62964E+03	1.59330E+03	4.07770E+03	3.77590E+03
98CF249	8849	3102	900	1E+10	6.73831E-02	2.75876E-01	5.80420E+01	2.77500E+02	5.00886E+02	4.82930E+02	8.10390E+02	6.50600E+02
98CF250	8850	3102	900	1E+10	6.73837E-02	2.73687E-01	7.84129E+02	1.33738E+03	2.41396E+03	1.61870E+03	1.12070E+04	8.86710E+03
98CF251	8851	3102	900	1E+10	6.73820E-02	2.63679E-01	1.17655E+02	1.57284E+03	2.83897E+03	2.87400E+03	1.62200E+03	1.32490E+03
98CF252	8852	3102	900	1E+10	1.96142E-02	2.64105E-01	4.91563E+00	1.08079E+01	1.95082E+01	2.06110E+01	4.71890E+01	4.65440E+01
98CF253	8853	3102	900	1E+10	0.	3.39466E-02	2.80902E+01	2.38468E+02	4.30434E+02	3.42120E+02	3.76980E+02	3.02990E+02
99ES253	8953	3102	900	1E+10	0.	2.72784E-02	1.11177E+02	9.78694E+02	1.76654E+03	2.02000E+02	6.36290E+03	1.16380E+03

*NOTE THAT THE EFFECTIVE THERMAL CROSS SECTION IS THE GROUP 4 CROSS SECTION DIVIDED BY SIGMA(1/V) WHERE SIGMA(1/V) IS THE GROUP 4 VALUE OF A 1/V CROSS SECTION EQUAL TO UNITY AT .0253EV (=.554018)

+MINOR CORRECTIONS HAVE BEEN MADE TO MF3 MT102 DATA REPRESENTATIONS OF ENDF/B-V FOR SOME NUCLIDES AS DESCRIBED IN SECTION 3.

Section 7

REFERENCES

1. The Evaluated Nuclear Data File, Versions IV and V (ENDF/B-IV and -V), Available from and maintained by the National Nuclear Data Center at Brookhaven National Laboratory).

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3. R. E. MacFarlane, R. J. Barrett, D. W. Muir, and R. M. Boicourt, "The NJOY Nuclear Data Processing System: User's Manual," Los Alamos Scientific Laboratory report LA-7584-M (ENDF-272 (1978).

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Appendix A

TOAFEW CODE LISTING

```
      PROGRAM TOAFEW (INPUT,OUTPUT,PLOT,TAPE1,TAPE2)                   MOD
C*********************************************************************
C*                                                                   *
C* W.B.WILSON, T.R.ENGLAND, R.J.LA BAUVE             FEBRUARY 1978 *
C*                                       TOAFEW-V MODS    APRIL 1981 * ADD
C*  GROUP T-2,  NUCLEAR DATA                                         *
C*  LOS ALAMOS NATIONAL LABORATORY                                   * MOD
C*                                                                   *
C*********************************************************************
C**** ADDITIONS (ADD) AND MODIFICATIONS (MOD) TO THE ORIGINAL TOAFEW  * ADD
C*     COLLAPSING CODE ARE INDICATED IN COLUMNS 74-76.  THESE CHANGES * ADD
C*     HAVE BEEN REQUIRED AS FOLLOWS.                                 * ADD
C*       * CORRECT ORDER OF STATEMENT NUMBERS IN  30 GO TO            * ADD
C*       * READ AND OUTPUT THERMAL CROSS SECTIONS AND RESONANCE INTEGRALS* ADD
C*       * READ AND USE MF RANGE OF USER INPUT                        * ADD
C*       * CHANGE ERF ARGUMENTS TO ABS. VALUE IN ENTEG FOR RGN.5,IFLX=1 * ADD
C*       * CORRECT SIGN OF EXP ARGUMENT IN C(5) EXPRESSION OF COEFS   * ADD
C*       * CHANGE PLOTTING ROUTINE CALLS AS REQUIRED BY PROGRESS      * ADD
C*       * OTHER MISCELLANEOUS IMPROVEMENTS                           * ADD
C********************************************************************* ADD
C*********************************************************************
C*TOAFEW-V COLLAPSES MULTIGROUP CROSS SECTIONS READ FROM A COMPATIBLE *
C*DATA FILE, USING EITHER A LOG-LOG FLUX DESCRIPTION GIVEN IN THE DATA *
C*FILE OR A FLUX DESCRIPTION PROVIDED BY THE USER.                    *
C*********************************************************************
C
C TAPE 1 IS THE INPUT DATA FILE
C TAPE 2 IS AN OUTPUT PRINT FILE OF COLLAPSED CROSS SECTIONS
C
C DESCRIPTION OF VARIABLES
C**************************
C C(I)        =COEFFICIENT OF FUNCTIONAL FLUX,REGION I, CALC. IN COEFS
C CX2200      =VALUE OF CROSS SECTION AT 0.0253 EV. READ FROM TAPE1      ADD
C CXC(IGC)    =COARSE GROUP IGC CROSS SECTION CALCULATED
C CXF(IGF)    =FINE GROUP IGF CROSS SECTION INPUT
C CXFLXI(IGC)=INTEGRAL OVER COARSE GROUP IGC, FROM EC(IGC+1) TO EC(IGC),
C                   OF THE PRODUCT OF WEIGHTING FLUX AND FINE GROUP
C                   CROSS SECTIONS
C EC(IGC)     =COARSE-GROUP IGC UPPER ENERGY BOUND
C EF(IGF)     =FINE-GROUP IGF UPPER ENERGY BOUND
C EFLUX(IFX)  =ENERGY AT FLUX DISCONTINUITY OR HISTOGRAM BOUNDARY IFX
C EFLUXP(I)   =ENERGY VALUE I AT DATA FILE FLUX VALUE FLUXP(I)
C EP          =ENERGY OF FUSION PEAK IN FUNCTIONAL FLUX DESCRIPTION
C EX(I)       =ENERGY BOUNDRY I OF FUNCTIONAL FLUX DESCRIPTION
C FLUX(IFX)   =FLUX AT DISCONTINUITY OR HISTOGRAM GROUP IFX
C FLXI(IGC)   =INTEGRAL OVER COARSE GROUP IGC, FROM EC(IGC+1) TO EC(IGC),
C                   OF THE WEIGHTING FLUX
C FLXIM(IGC,
C         IGF)=INTEGRAL OF FLUX OVER THAT PART OF FINE GROUP IGF
C                  WITHIN COARSE GROUP IGC
C FLUXP(I)    =DATA FILE FLUX VALUE I AT ENERGY VALUE EFLUXP(I)
C IFLX        =1, COLLAPSE TO FLUX FUNCTION BUILT INTO COEFS,ENTEG,PLOTX
C             =2, COLLAPSE TO LOG-LOG FLUX READ FROM DATA FILE
C             =3, COLLAPSE TO LOG-LOG FLUX READ FROM CARD INPUT
C             =4, COLLAPSE TO HISTOGRAM FLUX,  N/CM**2-SEC-UNIT ENERGY
C             =5, COLLAPSE TO HISTOGRAM FLUX,  N/CM**2-SEC-UNIT LETHARGY
C             =6, COLLAPSE TO HISTOGRAM FLUX,  N/CM**2-SEC (INTEGRAL)
C IA          =A VALUE OF NUCLIDE
C IS          =0, GROUND STATE
C             =1, ISOMERIC STATE
C IVER        =ENDF/B VERSION FROM WHICH MULTIGROUP VALUES PROCESSED
C IZ          =Z VALUE OF NUCLIDE
C LB(IGC)     =FINE GROUP BOUND CORRESPONDING TO COARSE GROUP BOUND IGC
C LFG(IGC)    =FINE GROUP WITHIN WHICH COARSE GROUP BOUNDRY IGC LIES
C MAT         =ENDF/B-IVER NUCLIDE IDENTIFICATION NUMBER
C MINA,MAXA   =LIMITS OF IA WITHIN WHICH CROSS SECTIONS TO BE COLLAPSED
C MINZ,MAXZ   =LIMITS OF IZ WITHIN WHICH CROSS SECTIONS TO BE COLLAPSED
C MINMF,MAXMF=LIMITS OF MF WITHIN WHICH CROSS SECTIONS TO BE COLLAPSED   ADD
C MINMT,MAXMT=LIMITS OF MT WITHIN WHICH CROSS SECTIONS TO BE COLLAPSED
C MT          =ENDF/B REACTION IDENTIFICATION NUMBER
C NGC         =NUMBER OF COARSE GROUPS
C NGF         =NUMBER OF FINE GROUPS
```

```
C NFX         =NUMBER OF FLUX DISCONTINUITY POINTS, IF IFLX=2 OR 3
C             =NUMBER OF FLUX HISTOGRAM VALUES, IF IFLX=4,5 OR 6
C NFXP        =NUMBER OF DATA FILE FLUX LOG-LOG POINTS
C RI500       =VALUE OF RESONANCE INTEGRAL ABOVE .500 EV READ FROM TAPE1  ADD
C RI625       =VALUE OF RESONANCE INTEGRAL ABOVE .625 EV READ FROM TAPE1  ADD
C SLPA        =LOG-LOG FLUX SLOPE, REGION 2, FUNCTIONAL FLUX
C SLPB        =LOG-LOG FLUX SLOPE, REGION 4, FUNCTIONAL FLUX
C SLPC        =LOG-LOG FLUX SLOPE, REGION 6, FUNCTIONAL FLUX
C SYM(IZ)     =CHEMICAL SYMBOL OF ELEMENT WITH Z=IZ
C SZ          =SIGMA-0 USED IN PROCESSING WITH BONDORINKO SELF SHIELDING
C THERM       =THERMAL GROUP VALUE OF 1/V CROSS SECTION= UNITY AT 2200M/S
C THETA       =FISSION SPECTRUM TEMP.(MEV),FUNCTIONAL FLUX
C TKM         =NEUTRON TEMP.(MEV) OF MAXWELLIAN, FUNCTIONAL FLUX
C TKF         =NEUTRON TEMP.(MEV) OF FUSION PEAK, FUNCTIONAL FLUX
C ******************************************************************
C
C  ***************************************************************
C  *THIS VERSION OF TOAFEW IS DIMENSIONED FOR THE FOLLOWING VALUES *
C  * NGC=4  NGF=154  NFX=200  NFXP=115                             *
C  *ARRAYS ARE DIMENSIONED AS FOLLOWS                              *
C  * EFLUX(NFX+1)  EF(NGF+1)  EC(NGC+1)  CXF(NGF)  CXC(NGC)        *
C  * LB(NGC+1)  LFG(NGC+1)  CXFLXI(NGC)  FLXI(NGC)                 *
C  * FLUX(NFX)  FLXIM(NGC,NGF)  EFLUXP(NFXP)  FLUXP(NFXP)          *
C  ***************************************************************
C STORAGE
C **********
      COMMON /A/ EFLUX(201),FLUX(200),EF(155),EC(5),CXF(154),CXC(4)
      COMMON /B/ LB(5), LFG(5),CXFLXI(4),FLXI(4)
      COMMON /C/ IFLX,NFX,NFXP,NGF,NGC,TITLE(20),TITL(17)
      COMMON /D/ FLXIM(4,154),SYM(103)
      COMMON /E/ EFLUXP(115),FLUXP(115)
      COMMON /F/ C(6),EX(7),TKM,SLPA,THETA,SLPB,TKF,EP,SLPC
C
      DATA SYM/2H H,2HHE,2HLI,2HBE,2H B,2H C,2H N,2H O,2H F,2HNE,2HNA,2H
     1MG,2HAL,2HSI,2H P,2H S,2HCL,2HAR,2H K,2HCA,2HSC,2HTI,2H V,2HCR,2HM
     2N,2HFE,2HCO,2HNI,2HCU,2HZN,2HGA,2HGE,2HAS,2HSE,2HBR,2HKR,2HRB,2HSR
     3,2H Y,2HZR,2HNB,2HMO,2HTC,2HRU,2HRH,2HPD,2HAG,2HCD,2HIN,2HSN,2HSB,
     42HTE,2H I,2HXE,2HCS,2HBA,2HLA,2HCE,2HPR,2HND,2HPM,2HSM,2HEU,2HGD,2
     5HTB,2HDY,2HHO,2HER,2HTM,2HYB,2HLU,2HHF,2HTA,2H W,2HRE,2HOS,2HIR,2H
     6PT,2HAU,2HHG,2HTL,2HPB,2HBI,2HPO,2HAT,2HRN,2HFR,2HRA,2HAC,2HTH,2HP
     7A,2H U,2HNP,2HPU,2HAM,2HCM,2HBK,2HCF,2HES,2HFM,2HMD,2HNO,2HLR/
C
C ******************************************************************
C
C READ JOB DESCRIPTIVE PARAMETERS
C********************************
      READ 390, TITLE
      PRINT 420
      READ 400, IFLX,NFX,NGC,NT,IPLTFX
      PRINT 430, TITLE
      IGCFLG=0
      IF(NGC.LT.0) IGCFLG=1
      NGC=IABS(NGC)
      PRINT 470, IFLX,NFX,NGC,NT,IPLTFX
      READ 405,MINZ,MAXZ,MINA,MAXA,MINMF,MAXMF,MINMT,MAXMT,SZMIN,SZMAX,   MOD
     1 TEMIN,TEMAX                                                        MOD
      PRINT 710,MINZ,MAXZ,MINA,MAXA,MINMF,MAXMF,MINMT,MAXMT,SZMIN,SZMAX,  MOD
     1 TEMIN,TEMAX                                                        MOD
      NGCP1=NGC+1
C READ DATA FILE HEADING
C**********************
      READ ( 1,390)TITLE
      PRINT 440, TITLE
C READ MULTIGROUP STRUCTURE
C*************************
      READ ( 1,395)TITL, NGF
      PRINT 440, TITL
      NGFP1= NGF + 1
      READ ( 1,410)(EF(IGF),IGF=1,NGFP1)
      PRINT 450, (EF(IGF),IGF=1,NGFP1)
C READ DATA SET FLUX WEIGHTING FUNCTION
C*************************************
      READ ( 1,395)TITL, NFXP
      PRINT 440, TITL
      READ ( 1,410)(EFLUXP(I),FLUXP(I),I=1,NFXP)
      PRINT 450, (EFLUXP(I),FLUXP(I),I=1,NFXP)
C READ COLLAPSING FLUX DESCRIPTION
C**********************************
```

```
      IF(IFLX.NE.2) GO TO 30
C COLLAPSE TO DATA SET LOG-LOG FLUX
C*****
      NFX=NFXP
      DO 20 I=1,NFXP
      EFLUX(I)=EFLUXP(I)
   20 FLUX(I)=FLUXP(I)
      GO TO 140
C COLLAPSE TO WT.FUNCTION OTHER THAN THAT READ FROM DATA FILESET
C***************
C BRANCH ON INPUT FLUX DESCRIPTION
C*****
   30 GO TO (35,140,40,60,60,60), IFLX                                  MOD
C READ PARAMETERS OF FUNCTIONAL FLUX
C*****
   35 READ 410,  (EX(I),I=1,7)
      READ 410,  TKM,SLPA,THETA,SLPB,TKF,EP,SLPC
      GO TO 140
C READ LOG-LOG ENERGY-FLUX INTERPOLATION POINTS FROM CARDS
C*****
   40 READ 410,  (EFLUX(I),FLUX(I),I=1,NFX)
      IF  (EFLUX(1).GT.EFLUX(NFX))  GO TO 140
C ORDER IN DECREASING ENERGY
C***************************
      NP=NFX/2
      DO 50 IP=1,NP
      STOWE=EFLUX(NFX+1-IP)
      STOWF=FLUX(NFX+1-IP)
      EFLUX(NFX+1-IP)=EFLUX(IP)
      FLUX(NFX+1-IP)=FLUX(IP)
      EFLUX(IP)=STOWE
   50 FLUX(IP)=STOWF
      GO TO 140
C READ HISTOGRAM FLUXES FROM CARDS
C*****
   60 NFXP1=NFX+1
      READ 410,  (EFLUX(I),I=1,NFXP1)
      READ 410,  (FLUX(I),I=1,NFX)
      IF  (EFLUX(1).GT.EFLUX(NFXP1))  GO TO 90
C ORDER IN DECREASING ENERGY
C***************************
      NP=NFXP1/2
      DO 70 IP=1,NP
      STOWE=EFLUX(NFXP1+1-IP)
      EFLUX(NFXP1+1-IP)=EFLUX(IP)
   70 EFLUX(IP)=STOWE
      NP=NFX/2
      DO 80 IP=1,NP
      STOWF=FLUX(NFX+1-IP)
      FLUX(NFX+1-IP)=FLUX(IP)
   80 FLUX(IP)=STOWF
C CONVERT HISTOGRAM FLUXES TO UNITS OF N/CM**2 SEC EV
C**************************************************
   90 GO TO (140,140,140,140,100,120), IFLX
C GROUP FLUXES INPUT AS PER-UNIT-LETHARGY
C*****
  100 DO 110 I=1,NFX
  110 FLUX(I)=FLUX(I)*ALOG(EFLUX(I)/EFLUX(I+1))/(EFLUX(I)-EFLUX(I+1))
      GO TO 140
C GROUP FLUXES INPUT AS INTEGRAL GROUP FLUXES
C*****
  120 DO 130 I=1,NFX
  130 FLUX(I)=FLUX(I)/(EFLUX(I)-EFLUX(I+1))
  140 CONTINUE
      DO 150 IGC=1,NGC
      DO 150 IGF=1,NGF
  150 FLXIM(IGC,IGF)=0.0
C
C READ COARSE-GROUP STRUCTURE FROM CARDS
C****************************************
      IF(IGCFLG.EQ.0)  GO TO 155
      READ 400,  (LB(IGC),IGC=1,NGCP1)
      DO 153  IGC=1,NGCP1
      IJ=LB(IGC)
  153 EC(IGC)=EF(IJ)
      GO TO 157
  155 READ 410,  (EC(IGC),IGC=1,NGCP1)
  157 IF  (EC(1).GT.EC(NGCP1))  GO TO 170
```


41

```
C ORDER IN DECREASING ENERGY
C****************************
      NP=NGCP1/2
      DO 160 IP=1,NP
      STOWE=EC(NGC+2-IP)
      EC(NGC+2-IP)=EC(IP)
  160 EC(IP)=STOWE
  170 PRINT 700
      PRINT 450, (EC(I),I=1,NGCP1)
C
C PRINT USER FLUX
C****************
      GO TO (190,200,175,180,180,180), IFLX
  175 PRINT 540, NFX
      PRINT 450, (EFLUX(I),FLUX(I),I=1,NFX)
      GO TO 200
  180 PRINT 600, NFX
      PRINT 450, (EFLUX(I),FLUX(I),I=1,NFX),EFLUX(NFXP1)
      GO TO 200
  190 CALL COEFS
      PRINT 690, EX(1),C(1),TKM,EX(2),C(2),SLPA,EX(3),C(3),THETA,EX(4),
     1C(4),SLPB,EX(5),C(5),TKF,EX(6),EP,C(6),EX(7),SLPC
C
C DETERMINE LFG VALUES
C**********************
  200 N=1
      IF (EF(1).GT.EC(1)) GO TO 220
      IF (EF(1).EQ.EC(1)) GO TO 210
      PRINT 490, EF(1),EC(1)
      STOP
  210 LFG(1)=1
      N=2
  220 IF (EC(NGCP1).GE.EF(NGFP1)) GO TO 230
      PRINT 510, EF(NGFP1),EC(NGCP1)
      STOP
  230 DO 250 IGF=1,NGF
  240 IF (EC(N).LT.EF(IGF+1)) GO TO 250
      LFG(N)=IGF
      N=N+1
      IF (N.GT.NGCP1) GO TO 255
      GO TO 240
  250 CONTINUE
  255 PRINT 520, NGCP1
      PRINT 460, (LFG(I),I=1,NGCP1)
C CALCULATE FINE-AND COARSE-GROUP FLUX INTEGRALS
C***********************************************
  260 DO 280 IGC=1,NGC
      IGCP1=IGC+1
      FLXI(IGC)=ENTEG(EC(IGCP1),EC(IGC),2)
      L=LFG(IGCP1)-1
      M=LFG(IGC)+1
      MM1=M-1
      LP1=L+1
      FLXIM(IGC,MM1)=ENTEG(EF(M),EC(IGC),2) .
      FLXIM(IGC,LP1)=ENTEG(EC(IGCP1),EF(LP1),2)
      DO 270 IGF=M,L
      IGFP1=IGF+1
  270 FLXIM(IGC,IGF)=ENTEG(EF(IGFP1),EF(IGF),2)
  280 CONTINUE
C CALCULATE FLUX-WEIGHTED-AVERAGE OF 1/V CROSS SECTION =UNITY AT 2200M/S
C***********************************************************************
      TOP=ENTEG(EC(NGCP1),EC(NGC),1)
      BOT=ENTEG(EC(NGCP1),EC(NGC),2)
      THERM=TOP/BOT
      IF(NGC.LE.4) PRINT 530, TOP,BOT,THERM
C PRINT COARSE GROUP FLUXES FOR USERS FLUX
C*****************************************
      TFX=THERM*FLXI(NGC)
      PRINT 720, NGC
      PRINT 450, (FLXI(IGC), IGC=1,NGC)
      IF(NGC.LE.4) PRINT 730, TFX
      READ ( 1,390)TITLE
      PRINT 440, TITLE
      IF(NGC.GT.4)  WRITE(2,585)  NT,NGC
      INUM=0
      IPAGE=0
C READ FINE-GROUP CROSS SECTIONS AND TEST EOF AND Z,A, AND MT LIMITS
C*******************************************************************
```

```
 290 READ ( 1,570)TAG1,TAG2,IZ,IA,IS,MAT,IVER,MF,MT,TEMP,SZ,CX2200,        MOD
    1 RI500,RI625                                                        MOD
     IF (EOF( 1)) 380,300                                                MOD
 300 READ ( 1,410)(CXF(I),I=1,NGF)
     IF (IZ.LT.MINZ) GO TO 290
     IF (IZ.GT.MAXZ) GO TO 380
     IF (IA.LT.MINA.OR.IA.GT.MAXA) GO TO 290
     IF (MF.LT.MINMF.OR.MF.GT.MAXMF) GO TO 290                           ADD
     IF (MT.LT.MINMT.OR.MT.GT.MAXMT) GO TO 290
     IF(SZ.LT.SZMIN.OR.SZ.GT.SZMAX) GO TO 290
     IF(TEMP.LT.TEMIN.OR.TEMP.GT.TEMAX) GO TO 290
     INUM=INUM+1
     IF(INUM.EQ.48)  INUM=1
C*********************************
C*COLLAPSE FINE GROUP CROSS SECTIONS*
C*********************************
     DO 320 IGC=1,NGC
     CXFLXI(IGC)=0.0
     L1=LFG(IGC)
     L3=LFG(IGC+1)
     DO 310 IGF=L1,L3
 310 CXFLXI(IGC)=CXFLXI(IGC)+FLXIM(IGC,IGF)*CXF(IGF)
 320 CXC(IGC)=CXFLXI(IGC)/FLXI(IGC)
C OUTPUT COLLAPSED CROSS SECTIONS
C******************************
     W=1H
     IF(IS.NE.0)  W=1HM
     KTEMP=TEMP
     IF(NGC.LE.4) GO TO 325
     WRITE(2,565)  SYM(IZ),IA,W,MAT,MF,MT,TEMP,SZ
     PRINT 565,    SYM(IZ),IA,W,MAT,MF,MT,TEMP,SZ
     WRITE(2,450)  (CXC(IGC),IGC=1,NGC)
     PRINT 450,    (CXC(IGC),IGC=1,NGC)
     GO TO 290
 325 EFFEC=CXC(NGC)/THERM
     IF (INUM.NE.1) GO TO 370
     IPAGE=IPAGE+1
     IF (IPAGE.EQ.1) INUM=6
     WRITE (2,420)
     GO TO (330,340,350,360), NGC
 330 IF (IPAGE.EQ.1) WRITE (2,620)NT
     IF(IPAGE.EQ.1)  PRINT 660
     WRITE (2,660)
     GO TO 370
 340 IF (IPAGE.EQ.1) WRITE (2,630)NT
     IF(IPAGE.EQ.1)  PRINT 670
     WRITE (2,670)
     GO TO 370
 350 IF (IPAGE.EQ.1) WRITE (2,640)NT
     IF(IPAGE.EQ.1)  PRINT 680
     WRITE (2,680)
     GO TO 370
 360 IF (IPAGE.EQ.1) WRITE (2,580)NT
     IF(IPAGE.EQ.1)  PRINT 550
     WRITE (2,550)
 370 CONTINUE
     WRITE (2,560)IZ,SYM(IZ),IA,W,MAT,MF,MT,KTEMP,SZ,(CXC(IGC),IGC       MOD
    1=1,NGC),EFFEC,CX2200,RI500,RI625                                    MOD
     PRINT 560,IZ,SYM(IZ),IA,W,MAT,MF,MT,KTEMP,SZ,(CXC(IGC),IGC          MOD
    1=1,NGC),EFFEC,CX2200,RI500,RI625                                    MOD
C RETURN TO READ NEXT FINE-GROUP CROSS SECTIONS ABOVE
C**************************************************
     GO TO 290
 380 IF(NGC.LE.4) WRITE (2,590)NGC,NGC,THERM
     WRITE (2,420)
     END FILE 2
C GO PLOT FLUX, IF DESIRED
C*************************
     IF (IPLTFX.NE.0) CALL PLOTX
C*
C  THIS IS THE END***THIS IS THE END***THIS IS THE END***
C*********************************************************************
C*
C FORMATS
C********
 390 FORMAT (20A4)
 395 FORMAT(17A4,I4)
 400 FORMAT (16I5)
```

```
405 FORMAT(8I5,4E10.3)                                                  MOD
410 FORMAT (6E12.5)
420 FORMAT (1H1)
430 FORMAT(20X,20A4)
440 FORMAT (3X,23HECHO FROM DATA FILE      ,20A4)
450 FORMAT (1X,10E12.5)
460 FORMAT (1X,16I6)
470 FORMAT(10X,40H**SUMMARY OF PROBLEM CONTROL INPUT******,/,5X,6HIFLX
   1 =,I3,3X,83H,WHERE 1=COLLAPSE TO BUILT-IN FUNCTIONAL FLUX, WITH PA
   2RAMETERS READ FROM CARD INPUT,/,24X,87H2=COLLAPSE TO FLUX DESCRIBE
   3D BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM DATA FILE,/,24X
   4,88H3=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION P
   5OINTS READ FROM CARD INPUT,/,24X,74H4=COLLAPSE TO HISTOGRAM FLUX R
   6EAD FROM CARD INPUT IN UNITS  N/CM**2-SEC-EV,/,24X,85H5=COLLAPSE T
   7O HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-UNIT L
   8ETHARGY,/,24X,95H6=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT
   9 IN UNITS  N/CM**2-SEC (GROUP INTEGRAL FLUXES),/,6X,5HNFX =,I3,3X,
   158H,NUMBER OF FLUX VALUES IN USER COLLAPSING FLUX DESCRIPTION,
   2 3X,31H(SET TO NFXP BY CODE IF IFLX=2) ,/,
   36X,5HNGC =,I3,3X,24H,NUMBER OF COARSE GROUPS,/,7X,4HNT =,I3,3X,
   431H,TABLE NUMBER FOR TAPE2 HEADING,/,3X,8HIPLTFX =,I3,3X,24H,WHERE
   5 0=NO PLOT OF FLUX,/,24X,87H1=MAKE PLOT OF LOG-LOG FLUX READ FROM
   6DATA FILE AND, IF DIFFERENT, USER COLLAPSING FLUX)
490 FORMAT(1X,46HFINE GROUP CROSS SECTIONS WITH UPPER BOUND OF ,E12.5,
   13X,20HCAN NOT BE COLLAPSED ,/,5X,46HTO COARSE GROUP STRUCTURE WITH
   2 UPPER BOUND OF ,E12.5,/,20X,9HI GIVE UP )
510 FORMAT (//,1X,45HFINE GROUP CROSS SECTIONS WITH LOWER BOUND OF,1PE
   112.5,3X,20HCAN NOT BE COLLAPSED,/,5X,45HTO COARSE GROUP STRUCTURE
   2WITH LOWER BOUND OF,1PE12.5,//,20X,9HI GIVE UP,//)
520 FORMAT(3X,16H(LFG(IGC),IGC=1,,I3,1H),3HARE,8I5)
530 FORMAT(3X,88HFLUX-WEIGHTED AVERAGE OF 1/V CROSS SECTION (UNITY AT
   1 .0253EV ) OVER LOWEST COARSE GROUP,/,30X,1H=,E12.5,               MOD
   2 3H / ,E12.5,3H = ,E12.5)
540 FORMAT (/,10X,21HINPUT WEIGHT FUNCTION,10X,I5,6HPOINTS,/)
560 FORMAT(I3,A2,I3,A1,I5,I2,I3,I5,E6.0,8E12.5)
565 FORMAT(/,1X,A2,I3,A1,5X,3HMAT,I4,5X,2HMF,I3,5X,2HMT,I3,5X,
   1 5HTEMP=,F6.0,5X,8HSIGMA 0=,E8.1)
570 FORMAT (A6,A5,2I3,I1,I4,2I2,I3,2E9.3,3E11.4)                       MOD
590 FORMAT(/, 60H *NOTE THAT THE EFFECTIVE THERMAL CROSS SECTION IS TH MOD
   1E GROUP,I2,36H CROSS SECTION DIVIDED BY SIGMA(1/V),/,2X,30HWHERE S
   2IGMA(1/V) IS THE GROUP ,I2,58H VALUE OF A 1/V CROSS SECTION EQUAL  MOD
   3TO UNITY AT .0253EV (=,F7.6,1H))                                   MOD
600 FORMAT (/,10X,21HINPUT WEIGHT FUNCTION,10X,I5,16HHISTOGRAM VALUES,
   110X,20HFLUX-PER-UNIT-ENERGY )
620 FORMAT (42X,5HTABLE,I3,//,33X,24HONE GROUP CROSS SECTIONS,//)      MOD
630 FORMAT (48X,5HTABLE,I3,//,39X,24HTWO GROUP CROSS SECTIONS,//)      MOD
640 FORMAT (54X,5HTABLE,I3,//,45X,26HTHREE GROUP CROSS SECTIONS,//)    MOD
580 FORMAT(60X,5HTABLE,I3,//,51X,25HFOUR GROUP CROSS SECTIONS ,//)     MOD
585 FORMAT(56X,5HTABLE,I3,//,48X,I3,21H GROUP CROSS SECTIONS,//)       MOD
550 FORMAT(20X,10HTEMP SIGMA,3X,                                       MOD
   1 43HGROUP 1      GROUP 2      GROUP 3      GROUP 4 ,               MOD
   2 6X,43HTHERMAL X-SECTION    RESONANCE INTEG. ABOVE,/,9H  NUCLIDE,  MOD
   3 20H MAT  MFMT  (K) ZERO ,4(12H   X-SECTION),2X,10HEFFECTIVE*,     MOD
   4 35H  (0.0253 EV)  0.500 EV     0.625 EV,/,9H ---------,4(5H ----), MOD
   5  1H-,8(12H ------------))                                          MOD
680 FORMAT(20X,10HTEMP SIGMA,3X,                                       MOD
   1 31HGROUP 1      GROUP 2      GROUP 3 ,                            MOD
   2 6X,43HTHERMAL X-SECTION    RESONANCE INTEG. ABOVE,/,9H  NUCLIDE,  MOD
   3 20H MAT  MFMT  (K) ZERO ,3(12H   X-SECTION),2X,10HEFFECTIVE*,     MOD
   4 35H  (0.0253 EV)  0.500 EV     0.625 EV,/,9H ---------,4(5H ----), MOD
   5  1H-,7(12H ------------))                                          MOD
670 FORMAT(20X,10HTEMP SIGMA,3X,                                       MOD
   1 19HGROUP 1      GROUP 2 ,                                         MOD
   2 6X,43HTHERMAL X-SECTION    RESONANCE INTEG. ABOVE,/,9H  NUCLIDE,  MOD
   3 20H MAT  MFMT  (K) ZERO ,2(12H   X-SECTION),2X,10HEFFECTIVE*,     MOD
   4 35H  (0.0253 EV)  0.500 EV     0.625 EV,/,9H ---------,4(5H ----), MOD
   5  1H-,6(12H ------------))                                          MOD
660 FORMAT(20X,10HTEMP SIGMA,2X,                                       MOD
   1  9HONE GROUP ,                                                    MOD
   2 6X,43HTHERMAL X-SECTION    RESONANCE INTEG. ABOVE,/,9H  NUCLIDE,  MOD
   3 20H MAT  MFMT  (K) ZERO ,12H   X-SECTION   ,2X,10HEFFECTIVE*,     MOD
   4 35H  (0.0253 EV)  0.500 EV     0.625 EV,/,9H ---------,4(5H ----), MOD
   5  1H-,5(12H ------------))                                          MOD
690 FORMAT(//,10X,46HFUNCTIONAL FLUX DESCRIPTION USED IN COLLAPSING,//
   1,5X,13HENERGY LIMITS,25X,13HFLUX FUNCTION,21X,31HINPUT AND CALCULA
   2TED PARAMETERS,/,1X,21(1H-),3X,49(1H-),3X,38(1H-),/,7H EX(1)=,E13.
   36,3H EV,54X,6HC(1) =E13.6,/,25X,23HF(E)=C(1)*E*EXP(-E/TKM),29X,6HT
   4KM  =,E13.6,3H EV,/,7H EX(2)=,E13.6,3H EV,54X,6HC(2) =,E13.6,/,25X
```

```
     5,17HF(E)=C(2)*E**SLPA,35X,6HSLPA =,E13.6,/,7H EX(3)=,E13.6,3H EV,5
     64X,6HC(3)  =,E13.6,/,25X,31HF(E)=C(3)*SQRT(E)*EXP(-E/THETA),21X,6HT
     7HETA=,E13.6,3H EV,/,7H EX(4)=,E13.6,3H EV,54X,6HC(4)  =,E13.6,/,25X
     8,17HF(E)=C(4)*E**SLPB,35X,6HSLPB =,E13.6,/,7H EX(5)=,E13.6,3H EV,5
     94X,6HC(5)  =,E13.6,/,25X,49HF(E)=C(5)*EXP(-5.*(SQRT(E/TKF)-SQRT(EP/
     1TKF))**2.),3X,6HTKF   =,E13.6,3H EV,/,7H EX(6)=,E13.6,3H EV,54X,6HE
     2P     =,E13.6,3H EV,/,25X,17HF(E)=C(6)*E**SLPC,35X,6HC(6)  =,E13.6,/,
     37H EX(7)=,E13.6,3H EV,54X,6HSLPC =,E13.6)
 700 FORMAT (1H1,/,10X,22HCOARSE GROUP STRUCTURE ,)
 710 FORMAT(/,5X,62HCOLLAPSE CROSS-SECTION TABULATIONS WITHIN THE FOLLO
     1WING LIMITS,/,5X,11H*****Z*****,4X,11H*****A*****,3X,13H*REACTION
     2MF*,2X,13H*REACTION MT*,4X,27H***BONDARENKO SIGMA ZERO***,4X,27H**  MOD
     3****TEMPERATURE (K)******,/,4(5X,I3,4H TO ,I3),2(6X,E10.3,5H TO  ,  MOD
     4E10.3),/)                                                           MOD
 720 FORMAT(5X,46HINTEGRATED MULTIGROUP FLUXES, FLXI(IGC),IGC=1,I3,
     11H))
 730 FORMAT(5X,29HEFFECTIVE THERMAL GROUP FLUX=,E15.6)
     END
     FUNCTION ENTEG (E1,E2,ITS)
C
C**********************************************************************
C*                                                                    *
C*ENTEG INTEGRATES FROM E1 TO E2 THE FOLLOWING-                       *
C*FOR ITS=1, THE PRODUCT OF FLUX AND 1/V CROSS SECTION=UNITY AT 2200M/S*
C*FOR ITS=2, THE FLUX                                                 *
C**********************************************************************
C
     COMMON /A/ EFLUX(201),FLUX(200),EF(155),EC(5),CXF(154),CXC(4)
     COMMON /B/ LB(5), LFG(5),CXFLXI(4),FLXI(4)
     COMMON /C/ IFLX,NFX,NFXP,NGF,NGC,TITLE(20),TITL(17)
     COMMON /F/ C(6),EX(7),TKM,SLPA,THETA,SLPB,TKF,EP,SLPC
C
     NFXP1=NFX+1
     ENTEG=0.0
     IF (E1.EQ.E2) RETURN
     IF (E2.LT.E1) GO TO 520
C BRANCH ON FLUX DESCRIPTION
C***************************
     GO TO (10,310,310,420,420,420), IFLX
C
C FUNCTIONAL CALCULATION OF FLUX INTEGRAL HERE FOR IFLX=1
C******************************************************
  10 PI=3.141592654
     NX=6
     NXP1=NX+1
     EPS=0.000001
C DETERMINE REGIONS OF E1 AND E2
C*****
     DO 20 IX=1,NX
     IF (E1.GE.EX(IX).AND.E1.LT.EX(IX+1)) GO TO 30
  20 CONTINUE
     PRINT 570, E1,(EX(I),I=1,NXP1)
     PRINT 550, E2
     STOP
  30 LE1=IX
     DO 40 IX=LE1,NX
     IF (E2.GT.EX(IX).AND.E2.LE.EX(IX+1)) GO TO 50
  40 CONTINUE
     PRINT 560, E1
     PRINT 580, E2,(EX(I),I=1,NXP1)
     STOP
  50 LE2=IX
     GO TO (60,90,130,160,200,270), LE1
C REGION 1
C*****
  60 TK=TKM
     EA=EX(1)
     EB=EX(2)
     IF (E1.GT.EA) EA=E1
     IF (E2.LT.EB) EB=E2
     RA=EA/TK
     RB=EB/TK
     IF (ITS.EQ.1) GO TO 70
     ENTEG=ENTEG+C(1)*(TK**2.)*((1.+RA)*EXP(-1.*RA)-(1.+RB)*EXP(-1.*RB)
    1)
     GO TO 80
  70 SRA=SQRT(RA)
     SRB=SQRT(RB)
```

```
      XA=EXP(-1.*RA*RA)
      XB=EXP(-1.*RB*RB)
      ENTEG=ENTEG+C(1)*(TK**1.5)*SQRT(0.0253)*(SRA*XA-SRB*XB+(SQRT(PI)/2
     1.)*(ERF(SRB)-ERF(SRA)))
   80 IF (LE2.EQ.1) RETURN
C REGION 2
C*****
   90 EA=EX(2)
      EB=EX(3)
      IF (E1.GT.EA) EA=E1
      IF (E2.LT.EB) EB=E2
      R=EB/EA
      CON=C(2)
      SLOPE=SLPA
      IF (ITS.EQ.2) GO TO 100
      CON=CON*SQRT(.0253)
      SLOPE=SLPA-0.5
  100 TEST=ABS(SLOPE+1.0)
      IF (TEST.LT.EPS) GO TO 110
      ENTEG=ENTEG+CON*(EB**(SLOPE+1.)-EA**(SLOPE+1.))/(SLOPE+1.)
      GO TO 120
  110 ENTEG=ENTEG+CON*ALOG(R)
  120 IF (LE2.EQ.2) RETURN
C REGION 3
C*****
  130 EA=EX(3)
      EB=EX(4)
      IF (E1.GT.EA) EA=E1
      IF (E2.LT.EB) EB=E2
      RA=EA/THETA
      SRA=SQRT(RA)
      RB=EB/THETA
      SRB=SQRT(RB)
      TP=THETA*PI
      SA=SQRT(EA)
      SB=SQRT(EB)
      XA=EXP(-1.*RA)
      XB=EXP(-1.*RB)
      STP=SQRT(TP)
      IF (ITS.EQ.2) GO TO 140
      ENTEG=ENTEG+C(3)*SQRT(.0253)*THETA*(XA-XB)
      GO TO 150
  140 ENTEG=ENTEG+C(3)*THETA*(SA*XA-SB*XB+(STP/2.)*(ERF(SRB)-ERF(SRA)))
  150 IF (LE2.EQ.3) RETURN
C REGION 4
C*****
  160 EA=EX(4)
      EB=EX(5)
      IF (E1.GT.EA) EA=E1
      IF (E2.LT.EB) EB=E2
      R=EB/EA
      CON=C(4)
      SLOPE=SLPB
      IF (ITS.EQ.2) GO TO 170
      CON=CON*SQRT(.0253)
      SLOPE=SLPB-0.5
  170 TEST=ABS(SLOPE+1.0)
      IF (TEST.LT.EPS) GO TO 180
      ENTEG=ENTEG+CON*(EB**(SLOPE+1.)-EA**(SLOPE+1.))/(SLOPE+1.)
      GO TO 190
  180 ENTEG=ENTEG+CON*ALOG(R)
  190 IF (LE2.EQ.4) RETURN
C REGION 5
C*****
  200 TK=TKF
      EA=EX(5)
      EB=EX(6)
      IF (E1.GT.EA) EA=E1
      IF (E2.LT.EB) EB=E2
      A1=(-5./TK)*(SQRT(EA)-SQRT(EP))*(SQRT(EA)-SQRT(EP))
      A2=(-5./TK)*(SQRT(EB)-SQRT(EP))*(SQRT(EB)-SQRT(EP))
      A3=(TK*EP*PI)/5.
      A4=(5.*EB)/TK
      A5=(5.*EP)/TK
      A6=SQRT(A4)-SQRT(A5)
      ABA6=ABS(A6)                                                  ADD
      A7=(5.*EA)/TK
      A8=SQRT(A7)-SQRT(A5)
```

```
      ABA8=ABS(A8)
      IF (ITS.EQ.1) GO TO 230
      TERM=C(5)*(TK/5.)*(EXP(A1)-EXP(A2))
      IF (A6.LT.0.) GO TO 210
      IF (A8.GT.0.) GO TO 220
      ENTEG=ENTEG+TERM+C(5)*SQRT(A3)*(ERF(ABA8)+ERF(A6))                MOD
      GO TO 260
  210 ENTEG=ENTEG+TERM+C(5)*SQRT(A3)*(ERF(ABA8)-ERF(ABA6))              MOD
      GO TO 260
  220 ENTEG=ENTEG+TERM+C(5)*SQRT(A3)*(ERF(A6)-ERF(A8))
      GO TO 260
  230 CON=C(5)*SQRT(.0253*PI*TK/5.)
      IF (A6.LT.0.) GO TO 240
      IF (A8.GT.0.) GO TO 250
      ENTEG=ENTEG+CON*(ERF(ABA8)+ERF(A6))                               MOD
      GO TO 260
  240 ENTEG=ENTEG+CON*(ERF(ABA8)-ERF(ABA6))                             MOD
      GO TO 260
  250 ENTEG=ENTEG+CON*(ERF(A6)-ERF(A8))
  260 IF (LE2.EQ.5) RETURN
C REGION 6
C*****
  270 EA=EX(6)
      EB=EX(7)
      IF (E1.GT.EA) EA=E1
      IF (E2.LT.EB) EB=E2
      R=EB/EA
      CON=C(6)
      SLOPE=SLPC
      IF (ITS.EQ.2) GO TO 280
      CON=CON*SQRT(.0253)
      SLOPE=SLPC-0.5
  280 TEST=ABS(SLOPE+1.)
      IF (TEST.LT.EPS) GO TO 290
      ENTEG=ENTEG+CON*(EB**(SLOPE+1.)-EA**(SLOPE+1.))/(SLOPE+1.)
      GO TO 300
  290 ENTEG=ENTEG+CON*ALOG(R)
  300 RETURN
C
C IFLX=2 OR 3, LOG-LOG INTERPOLATION
C***********************************
C FIND CORRECT FLUX SEGMENT FOR E1 AND E2
C*****
  310 NFXM1=NFX-1
      DO 320 IFX=1,NFXM1
      JFX=IFX                                                           ADD
      IF (E2.LE.EFLUX(IFX).AND.E2.GT.EFLUX(IFX+1)) GO TO 330
  320 CONTINUE
  330 LFH=JFX                                                           MOD
      DO 340 IFX=LFH,NFXM1
      JFX=IFX                                                           ADD
      IF (E1.LT.EFLUX(IFX).AND.E1.GE.EFLUX(IFX+1)) GO TO 350
  340 CONTINUE
  350 LFL=JFX                                                           MOD
C INTEGRATE LOG-LOG FLUX
C***********************
      DO 410 IFX=LFH,LFL
      EH=EFLUX(IFX)
      EL=EFLUX(IFX+1)
      IF (E2.LT.EFLUX(IFX)) EH=E2
      IF (E1.GT.EFLUX(IFX+1)) EL=E1
      R1=FLUX(IFX)/FLUX(IFX+1)
      R2=EFLUX(IFX)/EFLUX(IFX+1)
      S=ALOG(R1)/ALOG(R2)
      IF (ITS.EQ.1) GO TO 380
      IF (R1.EQ.1.) GO TO 370
      IF (ABS(S+1.).LT.1.0E-05) GO TO 360
      R1=EH*(EH/EFLUX(IFX+1))**S
      R2=EL*(EL/EFLUX(IFX+1))**S
      ENTEG=ENTEG+FLUX(IFX+1)*(R1-R2)/(S+1.)
      GO TO 410
  360 R3=EH/EL
      R4=ALOG(R3)
      ENTEG=ENTEG+EFLUX(IFX)*FLUX(IFX)*ABS(R4)
      GO TO 410
  370 ENTEG=ENTEG+FLUX(IFX)*(EH-EL)
      GO TO 410
  380 IF (ABS(S+.5).LT.1.0E-05) GO TO 390
```

```
      IF (ABS(S-.5).LT.1.0E-05) GO TO 400
      R1=SQRT(EH)*(EH/EFLUX(IFX+1))**S
      R2=SQRT(EL)*(EL/EFLUX(IFX+1))**S
      ENTEG=ENTEG+(FLUX(IFX+1)*SQRT(.0253)/(S+0.5))*(R1-R2)
      GO TO 410
  390 R3=EH/EL
      R4=ALOG(R3)
      CO=FLUX(IFX+1)/EFLUX(IFX+1)**S
      ENTEG=ENTEG+CO*SQRT(0.0253)*ABS(R4)
      GO TO 410
  400 CO=FLUX(IFX+1)/EFLUX(IFX+1)**S
      ENTEG=ENTEG+CO*SQRT(0.0253)*(EH-EL)
  410 CONTINUE
      RETURN
C
C IFLX=4,5 OR 6, ARBITRARY HISTOGRAM FLUX TREATMENT
C**************************************************
  420 IF (E1.GE.EFLUX(1)) RETURN
      IF (E2.LE.EFLUX(NFXP1)) RETURN
C
C LOCATE FLUX HISTOGRAM GROUP LOCATIONS OF E1 AND E2
C*****
      DO 430 IH=1,NFX
      IF (E2.LE.EFLUX(IH).AND.E2.GE.EFLUX(IH+1)) GO TO 440
  430 CONTINUE
      STOP
  440 LH=IH
      DO 450 IH=LH,NFX
      IF (E1.LE.EFLUX(IH).AND.E1.GE.EFLUX(IH+1)) GO TO 460
  450 CONTINUE
      STOP
  460 LL=IH
C INTEGRATE FLUX HISTOGRAM
C*****
      IF (ITS.EQ.1) GO TO 490
      ENTEG=(E2-EFLUX(LH+1))*FLUX(LH)
      IF (LH.EQ.LL) GO TO 480
      L=LH+1
      DO 470 IH=L,LL
  470 ENTEG=ENTEG+(EFLUX(IH)-EFLUX(IH+1))*FLUX(IH)
  480 ENTEG=ENTEG-(E1-EFLUX(LL+1))*FLUX(LL)
      RETURN
  490 L=LH+1
      ENTEG=2.*SQRT(.0253)*FLUX(LH)*(SQRT(E2)-SQRT(EFLUX(L)))
      IF (LH.EQ.LL) GO TO 510
      DO 500 IH=L,LL
      IHP1=IH+1
  500 ENTEG=ENTEG+2.*SQRT(.0253)*FLUX(IH)*(SQRT(EFLUX(IH))-SQRT(EFLUX
     1(IHP1)))
  510 LLP1=LL+1
      ENTEG=ENTEG-2.*SQRT(.0253)*FLUX(LL)*(SQRT(E1)-SQRT(EFLUX(LLP1)))
      RETURN
  520 PRINT 590, E1,E2
      STOP
C*********
C FORMATS
C*********
  550 FORMAT (/,10X,4HE2= ,  E12.5,/)
  560 FORMAT (/,10X,4HE1= ,  E12.5,/)
  570 FORMAT(/,10X,3HE1=, E12.5,3X,48HCANNOT BE FOUND IN THE FOLLOWING E
     1NERGY SEGMENTS,/,3X,10E12.5,/)
  580 FORMAT (/,10X,3HE2=,E12.5,3X,48HCANNOT BE FOUND IN THE FOLLOWING E
     1NERGY SEGMENTS,/,3X,10E12.5,/)
  590 FORMAT(/,10X,21HENTEG CALLED WITH E1=,E12.5,3X,16HGREATER THAN E2=
     1 ,  E12.5,3X,6H  STOP,/)
      END
      SUBROUTINE PLOTX
C
C*********************************************************************
C*PLOTX PLOTS THE LOG-LOG FLUX WEIGHTING FUNCTION READ FROM THE DATA  *
C*FILE.  A USER-SUPPLIED FLUX DESCRIPTION IS NORMALIZED TO THIS BY    * MOD
C*EQUATING FLUX INTEGRALS OVER THE ENERGY RANGE OF THE COARSE GROUP   *
C*STRUCTURE AND SUPERIMPOSED ON THE FLUX PLOT.                        *
C*********************************************************************
      COMMON /A/ EFLUX(201),FLUX(200),EF(155),EC(5),CXF(154),CXC(4)
      COMMON /C/ IFLX,NFX,NFXP,NGF,NGC,TITLE(20),TITL(17)
      COMMON /E/ EFLUXP(115),FLUXP(115)
      COMMON /F/ C(6),EX(7),TKM,SLPA,THETA,SLPB,TKF,EP,SLPC
```

```
      DIMENSION EB(400), FB(400),V(2),H(2)
C
      CALL GPLOT(1HU,20HTOAFEW-Y PLOT OUTPUT,20)                          ADD
      CALL LIB4020                                                        ADD
C
C BRANCH ON FLUX DESCRIPTION
C***************************
      GO TO (10,210,140,160,160,160), IFLX
C
C BUILT IN FUNCTIONAL FLUX---CALCULATE FLUXES FOR PLOTTING
C*******************************************************
   10 NPR=20
      FN=NPR
      NPRP1=NPR+1
      I=0
      NGFP1=NGF+1
      NGCP1=NGC+1
C REGION 1
C*****
      IF (EX(2).LE.EF(NGFP1).OR.EX(1).EQ.EX(2))  GO TO 30
      I=1
      EB(1)=EX(1)
      IF (EX(1).LT.EF(NGFP1)) EB(1)=EF(NGFP1)
      TK=TKM
      ET=EX(2)
      IF (EX(2).GT.EF(1)) ET=EF(1)
      DO 20 J=1,NPRP1                                                     MOD
      IF (J.EQ.1) GO TO 20                                                MOD
      I=I+1                                                               ADD
      FIM1=I-1
      EB(I)=EB(1)*((ET/EB(1))**(FIM1/FN))
   20 FB(I)=C(1)*EB(I)*EXP(-1.*EB(I)/TK)
      IF (ET.GT.EC(1)) GO TO 130
C REGION 2
C*****
   30 IF (EX(3).LE.EF(NGFP1).OR.EX(2).EQ.EX(3)) GO TO 50
      IF(C(2).LE.0.)  GO TO 130
      I=I+1
      EB(I)=EX(2)
      IF (EX(2).LT.EF(NGFP1)) EB(I)=EF(NGFP1)
      K=I
      ET=EX(3)
      IF (EX(3).GT.EF(1)) ET=EF(1)
      DO 40 J=1,NPRP1
      IF (J.EQ.1) GO TO 40
      I=I+1
      FJM1=J-1
      EB(I)=EB(K)*((ET/EB(K))**(FJM1/FN))
   40 FB(I)=C(2)*EB(I)**SLPA
      IF (ET.GE.EC(1)) GO TO 130
C REGION 3
C*****
   50 IF (EX(4).LE.EF(NGFP1).OR.EX(3).EQ.EX(4)) GO TO 70
      IF(C(3).LE.0.)  GO TO 130
      I=I+1
      EB(I)=EX(3)
      IF (EX(3).LT.EF(NGFP1)) EB(I)=EF(NGFP1)
      K=I
      ET=EX(4)
      IF (EX(4).GT.EF(1)) ET=EF(1)
      DO 60 J=1,NPRP1
      IF (J.EQ.1) GO TO 60
      I=I+1
      FJM1=J-1
      EB(I)=EB(K)*((ET/EB(K))**(FJM1/FN))
   60 FB(I)=C(3)*SQRT(EB(I))*EXP(-1.*EB(I)/THETA)
      IF (ET.GE.EC(1)) GO TO 130
C REGION 4
C*****
   70 IF (EX(5).LE.EF(NGFP1).OR.EX(4).EQ.EX(5)) GO TO 90
      IF(C(4).LE.0.)  GO TO 130
      I=I+1
      EB(I)=EX(4)
      IF (EX(4).LT.EF(NGFP1)) EB(I)=EF(NGFP1)
      K=I
      ET=EX(5)
      IF (EX(5).GT.EF(1)) ET=EF(1)
      DO 80 J=1,NPRP1
```

```
      IF (J.EQ.1) GO TO 80
      I=I+1
      FJM1=J-1
      EB(I)=EB(K)*((ET/EB(K))**(FJM1/FN))
   80 FB(I)=C(4)*EB(I)**SLPC
      IF (ET.GE.EC(1)) GO TO 130
C REGION 5
C*****
   90 IF (EX(6).LE.EF(NGFP1).OR.EX(5).EQ.EX(6)) GO TO 110
      IF(C(5).LE.0.)  GO TO 130
      I=I+1
      TK=TKF
      EB(I)=EX(5)
      IF (EX(5).LT.EF(NGFP1)) EB(I)=EF(NGFP1)
      K=I
      ET=EX(6)
      IF (EX(6).GT.EF(1)) ET=EF(1)
      DO 100 J=1,NPRP1
      IF (J.EQ.1) GO TO 100
      I=I+1
      FJM1=J-1
      EB(I)=EB(K)*((ET/EB(K))**(FJM1/FN))
  100 FB(I)=C(5)*EXP((-5./TK)*(SQRT(EB(I))-SQRT(EP))*(SQRT(EB(I))-SQRT
     1(EP)))
      IF (ET.GE.EC(1)) GO TO 130
C REGION 6
C*****
  110 IF(C(6).LE.0.)  GO TO 130
      I=I+1
      EB(I)=EX(6)
      IF (EX(6).LT.EF(NGFP1)) EB(I)=EF(NGFP1)
      ET=EX(7)
      IF (ET.GT.EF(1)) ET=EF(1)
      K=I
      DO 120 J=1,NPRP1
      IF (J.EQ.1) GO TO 120
      I=I+1
      FJM1=J-1
      EB(I)=EB(K)*((ET/EB(K))**(FJM1/FN))
  120 FB(I)=C(6)*EB(I)**SLPC
  130 NB=I
      EL=EC(NGC+1)
      EH=EC(1)
      FN=ENTEG(EL,EH,2)
      GO TO 180
C FLUX IS SET OF LOG-LOG INTERPOLATION POINTS
C*******************************************
  140 EH=EC(1)
      EL=EC(NGC+1)
      FN=ENTEG(EL,EH,2)
      DO 150 I=1,NFX
      EB(I)=EFLUX(I)
  150 FB(I)=FLUX(I)
      NB=NFX
      GO TO 180
C FLUX HISTOGRAM, ARBITRARY STRUCTURE
C*********************************
  160 EL=EC(NGC+1)
      EH=EC(1)
      FN=ENTEG(EL,EH,2)
      IB=0
      DO 170 IH=1,NFX
      IB=IB+1
      EB(IB)=EFLUX(IH)
      FB(IB)=FLUX(IH)
      IB=IB+1
      EB(IB)=EFLUX(IH+1)
  170 FB(IB)=FLUX(IH)
      NB=IB
C NOW INTEGRATE THE LOG-LOG FLUX READ FROM THE DATA FILE OVER THE LIMITS
C OF THE USER COARSE GROUP STRUCTURE. NORMALIZE THE USER FLUX FOR PLOT.
C**********
  180 DO 190 I=1,NFXP
      EFLUX(I)=EFLUXP(I)
  190 FLUX(I)=FLUXP(I)
      LFLX=IFLX

      IFLX=2
```

```
      NFX=NFXP
      FN=ENTEG(EL,EH,2)/FN
      DO 200 I=1,NB
  200 FB(I)=FB(I)*FN
C PLOT DATA FILE FLUX AND DIFFERENT USER FLUX
C*******************************************
C DETERMINE MIN VALUE V1L AND MAX VALUE V1H OF DATA FILE FLUX
      CALL MINV(FLUX,1,NFX,L1,V1L)
      CALL MAXV(FLUX,1,NFX,L2,V1H)
C DETERMINE MIN VALUE V2L AND MAX VALUE V2H OF USERS FLUX
      CALL MINV(FB,1,NB,L3,V2L)
      CALL MAXV(FB,1,NB,L4,V2H)
C SET LIMITS OF ORDINATE FOR PLOTTING
      V(1)= AMIN1(V1L,V2L)
      V(2)= AMAX1(V1H,V2H)
C SET LIMITS OF ABSCISSA FOR PLOTTING
      H(1)= EF(NGF+1)
      H(2)= EF(1)
C PLOT BLANK LOG-LOG FRAME WITH CAPTIONS
      CALL PLOTM(H,V,-2,-1,-1,45,1.,1.,1.,15HFLUX COMPARISON,15,
     1 11HENERGY, EV.,11,22HFLUX   (N/CM**2 SEC EV) ,22)
C PLOT DATA FILE FLUX ON FRAME
      CALL PLOTM(EFLUX,FLUX,-NFX,-1, 1,-48,-1.)
C PLOT USER FLUX ON FRAME
      IFLX=LFLX
      L=-1
      CC=1.                                                             MOD
      IF(IFLX.LT.4) GO TO 205
C IF HISTOGRAM USER FLUX, DRAW HISTOGRAM
      L=1
      CC=-1.                                                            MOD
  205 CALL PLOTM(EB,FB,-NB,-1,L,-39,CC)                                 MOD
      CALL GDONE                                                        ADD
      RETURN
C PLOT DATA FILE FLUX, USED IN COLLAPSING
C*************************************************
  210 CALL PLOTM(EFLUX,FLUX,-NFX,-1,1,39,-1.,1.,1.,38HFLUX FROM DATA FIL
     1E USED IN COLLAPSING,38,11HENERGY, EV.,11,22HFLUX   (N/CM**2 SEC EV
     2),22)
      CALL GDONE                                                        ADD
      RETURN
      END
      SUBROUTINE COEFS
C
C*****************************************************************
C*                                                               *
C*COEFS CALCULATES THE COEFFICIENTS OF THE FUNCTIONAL FLUX EXPRESSION *
C*                                                               *
C*****************************************************************
C
      COMMON /A/ EFLUX(201),FLUX(200),EF(155),EC(5),CXF(154),CXC(4)
      COMMON /C/ IFLX,NFX,NFXP,NGF,NGC,TITLE(20),TITL(17)
      COMMON /F/ C(6),EX(7),TKM,SLPA,THETA,SLPB,TKF,EP,SLPC
C
      IF (EX(1).GT.EC(NGC+1)) EX(1)=EC(NGC+1)
      IF (EX(7).LT.EC(1)) EX(7)=EC(1)
      C(1)=1.0
      C(2)=C(3)=C(4)=C(5)=C(6)=0.0
      IF(EX(2).GE.EC(1)) GO TO 200
      C(2)=C(1)*EX(2)*EXP(-1.*EX(2)/TKM)/EX(2)**SLPA
      IF(EX(3).GE.EC(1)) GO TO 200
      C(3)=C(2)*EX(3)**(SLPA-0.5)*EXP(EX(3)/THETA)
      IF(EX(4).GE.EC(1))  GO TO 200
      C(4)=C(3)*EX(4)**(0.5-SLPB)*EXP(-1.*EX(4)/THETA)
      IF(EX(5).GE.EC(1)) GO TO 200
      RP=EP/TKF
      RX5=EX(5)/TKF
      SRP=SQRT(RP)
      SRX5=SQRT(RX5)
      C(5)=C(4)*(EX(5)**SLPB)*EXP( 5.*(SRX5-SRP)*(SRX5-SRP))            MOD
      IF(EX(6).GE.EC(1))  GO TO 200
      RX6=EX(6)/TKF
      SRX6=SQRT(RX6)
      C(6)=(C(5)/EX(6)**SLPC)*EXP(-5.*(SRX6-SRP)*(SRX6-SRP))
  200 CONTINUE
      RETURN
      END
```

Appendix B

SAMPLE PROBLEMS

SAMPLE CALCULATIONS WERE PERFORMED FOR FOUR DIFFERENT, TYPICAL PROBLEMS. THE PROBLEMS ARE EACH PRESENTED WITH A SHORT DESCRIPTION, LISTINGS OF THE INPUT, OUTPUT, AND TAPE2 FILES, AND THE FLUX PLOT GENERATED FROM THE FILM FILE.

```
SAMPLE PROBLEM 1.  CALCULATE 4-GROUP CROSS SECTIONS FOR ALL REACTIONS OF XE-135 TABULATED
================   IN THE DATA FILE IN THE EPRI 4-GROUP STRUCTURE.  COLLAPSE WITH THE
================   PRS FLUX WEIGHTING FUNCTION.  INPUT THE  COARSE GROUP STRUCTURE BY TAGGING NGC
                   NEGATIVE AND SPECIFYING THE (LB(IGC),IGC=1,5) VALUES.
```

INPUT FILE FOR SAMPLE PROBLEM 1.

```
SAMPLE PROBLEM 1,EPRI 4-GP XE-135 ALL MT 900K PRS FLUX
   2     0   -4    9     1
  54    54  135  135     3     3     1  1021.0     +101.0     +109.0     +029.0     +02
   7    18   47  128   155
```

OUTPUT FILE FROM SAMPLE PROBLEM 1.

```
                   SAMPLE PROBLEM 1,EPRI 4-GP XE-135 ALL MT 900K PRS FLUX
          **SUMMARY OF PROBLEM CONTROL INPUT******
    IFLX =  2    ,WHERE 1=COLLAPSE TO BUILT-IN FUNCTIONAL FLUX, WITH PARAMETERS READ FROM CARD INPUT
                        2=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM DATA FILE
                        3=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM CARD INPUT
                        4=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-EV
                        5=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-UNIT LETHARGY
                        6=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC (GROUP INTEGRAL FLUXES)
     NFX =  0    ,NUMBER OF FLUX VALUES IN USER COLLAPSING FLUX DESCRIPTION   (SET TO NFXP BY CODE IF IFLX=2)
     NCC =  4    ,NUMBER OF COARSE GROUPS
      NT =  9    ,TABLE NUMBER FOR TAPE2 HEADING
  IPLTFX =  1    ,WHERE 0=NO PLOT OF FLUX
                        1=MAKE PLOT OF LOG-LOG FLUX READ FROM DATA FILE AND, IF DIFFERENT, USER COLLAPSING FLUX

    COLLAPSE CROSS-SECTION TABULATIONS WITHIN THE FOLLOWING LIMITS
    *****Z*****    *****A*****   *REACTION MF*  *REACTION MT*   ***BONDARENKO SIGMA ZERO***    ******TEMPERATURE (K)******
     54 TO  54     135 TO 135       3 TO   3       1 TO 102      1.000E+10 TO  1.000E+10        9.000E+02 TO   9.000E+02

    ECHO FROM DATA FILE    TOAFEW-V 154-GP ENDF/B-V FISSION-PRODUCT AND ACTINIDE CROSS SECTIONS 2-9-81


ECHO FROM DATA FILE     PRS 154-GROUP NEUTRON MULTIGROUP STRUCTURE
2.00000E+07 1.82212E+07 1.69046E+07 1.49182E+07 1.34986E+07 1.19125E+07 1.00000E+07 7.78801E+06 6.06531E+06 4.72367E+06
3.67879E+06 2.86505E+06 2.23130E+06 1.73774E+06 1.35335E+06 1.05399E+06 9.53692E+05 8.20850E+05 7.42736E+05 6.39279E+05
5.78443E+05 4.97871E+05 4.50492E+05 3.87742E+05 3.50844E+05 3.01974E+05 2.73237E+05 2.35177E+05 2.12797E+05 1.83156E+05
1.42642E+05 1.11090E+05 8.65170E+04 6.73795E+04 5.24752E+04 4.08677E+04 3.18278E+04 2.80879E+04 2.60584E+04 2.47875E+04
2.35786E+04 1.93045E+04 1.50344E+04 1.17088E+04 9.11882E+03 7.10174E+03 5.53084E+03 4.30743E+03 3.35463E+03 2.61259E+03
2.03468E+03 1.58461E+03 1.23410E+03 9.61117E+02 7.48518E+02 5.82947E+02 4.53999E+02 3.53575E+02 2.75364E+02 2.14454E+02
1.67017E+02 1.30073E+02 1.01301E+02 7.88932E+01 7.36000E+01 6.97500E+01 6.85500E+01 6.70000E+01 6.14421E+01 5.99000E+01
5.90500E+01 5.84000E+01 4.78512E+01 4.00000E+01 3.72665E+01 3.60500E+01 3.50000E+01 2.90232E+01 2.37100E+01 2.32000E+01
2.26033E+01 2.21000E+01 2.15000E+01 2.03000E+01 1.76035E+01 1.37096E+01 1.06770E+01 8.31529E+00 7.00000E+00 6.47595E+00
5.04348E+00 3.92786E+00 3.05902E+00 2.56084E+00 2.38237E+00 2.31603E+00 2.29429E+00 2.27266E+00 2.25113E+00 2.17213E+00
2.09408E+00 2.01791E+00 1.93562E+00 1.85539E+00 1.80897E+00 1.76305E+00 1.72608E+00 1.71773E+00 1.64759E+00 1.59493E+00
1.57850E+00 1.45742E+00 1.44498E+00 1.30785E+00 1.20867E+00 1.16638E+00 1.12535E+00 1.09868E+00 1.07217E+00 1.06231E+00
1.05250E+00 1.04273E+00 1.01370E+00 9.50653E-01 8.76425E-01 7.82079E-01 6.82560E-01 6.25060E-01 5.31579E-01 5.03235E-01
4.17016E-01 4.13994E-01 3.57665E-01 3.20628E-01 3.01120E-01 2.90737E-01 2.70518E-01 2.51028E-01 2.27690E-01 1.84429E-01
1.52300E-01 1.45721E-01 1.11568E-01 8.19683E-02 5.69224E-02 4.27551E-02 3.06116E-02 2.04921E-02 1.23964E-02 6.32472E-03
2.27690E-03 7.60219E-04 2.52989E-04 1.38879E-04 1.00000E-05
```

```
 ECHO FROM DATA FILE     PRS NEUTRON FLUX WEIGHTING FUNCTION  115 LOG-LOG INTERPOLATION PTS
2.00000E+07 1.54770E-10 1.56760E+07 1.97800E-10 1.55000E+07 1.14060E-09 1.54000E+07 2.84500E-09 1.53000E+07 6.66880E-09
1.52000E+07 1.46870E-08 1.51000E+07 3.03540E-08 1.50000E+07 5.88320E-08 1.49000E+07 1.06990E-07 1.48000E+07 1.82130E-07
1.47000E+07 2.90410E-07 1.46000E+07 4.33170E-07 1.45000E+07 6.04030E-07 1.44000E+07 7.87040E-07 1.43000E+07 9.57570E-07
1.42000E+07 1.08700E-06 1.40700E+07 1.15400E-06 1.39000E+07 1.04080E-06 1.38000E+07 8.88250E-07 1.37000E+07 7.04780E-07
1.36000E+07 5.19460E-07 1.35000E+07 3.55120E-07 1.34000E+07 2.25110E-07 1.33000E+07 1.32220E-07 1.32000E+07 7.18640E-08
1.31000E+07 3.61220E-08 1.30000E+07 1.67760E-08 1.29000E+07 7.19100E-09 1.28000E+07 2.84360E-09 1.27000E+07 1.03570E-09
1.26000E+07 3.47310E-10 1.25700E+07 2.46190E-10 1.00000E+07 3.09530E-10 8.00000E+06 1.22760E-09 6.00000E+06 4.71530E-09
5.00000E+06 9.06790E-09 4.00000E+06 1.70730E-08 3.00000E+06 3.11420E-08 2.63000E+06 3.99810E-08 2.35000E+06 9.15950E-08
2.22000E+06 5.90330E-08 1.40000E+06 1.21820E-07 1.31000E+06 6.86960E-08 1.21000E+06 1.50220E-07 1.19000E+06 1.54790E-07
1.12000E+06 1.36480E-07 1.05000E+06 1.15180E-07 1.00000E+06 9.15950E-08 9.41000E+05 1.78610E-07 9.00000E+05 2.14790E-07
7.70000E+05 2.50050E-07 6.50000E+05 2.94930E-07 5.40000E+05 3.05010E-07 5.02000E+05 2.63330E-07 4.74000E+05 2.17540E-07
4.42000E+05 1.00750E-07 3.99000E+05 2.73870E-07 3.77000E+05 3.40270E-07 3.56000E+05 3.69260E-07 2.83000E+05 3.83090E-07
2.01000E+05 4.36450E-07 1.20000E+05 5.79340E-07 6.07000E+04 9.15950E-07 3.07000E+04 1.55710E-06 2.00000E+04 2.22570E-06
1.01000E+03 3.78290E-05 6.82000E+01 4.83620E-04 6.71000E+01 4.72260E-04 6.60000E+01 4.57970E-05 6.49000E+01 4.82430E-04
6.12000E+01 5.58730E-04 3.87000E+01 8.26180E-04 3.74000E+01 6.54530E-04 3.67000E+01 9.15950E-06 3.59000E+01 6.78720E-04
3.56000E+01 7.48970E-04 3.44000E+01 8.15190E-04 2.25000E+01 1.35650E-03 2.14000E+01 1.05880E-03 2.09000E+01 1.37390E-05
2.03700E+01 1.09730E-03 1.98600E+01 1.38580E-03 1.75300E+01 1.71560E-03 7.30800E+00 3.60420E-03 7.01000E+00 2.92190E-03
6.89400E+00 1.76320E-03 6.67000E+00 5.31250E-05 6.44900E+00 1.65240E-03 6.13500E+00 3.72790E-03 5.88420E+00 4.19500E-03
5.50470E+00 4.61640E-03 4.01000E+00 6.32000E-03 1.35180E+00 1.85020E-02 1.00000E+00 2.49140E-02 6.00000E-01 4.13000E-02
5.70000E-01 4.37000E-02 4.90000E-01 5.10000E-02 4.00000E-01 6.87000E-02 3.00000E-01 1.08000E-01 2.10000E-01 2.52000E-01
1.70000E-01 3.83000E-01 1.40000E-01 5.20000E-01 1.12000E-01 6.86000E-01 9.00000E-02 7.99000E-01 7.00000E-02 8.92000E-01
5.90000E-02 9.18000E-01 5.40000E-02 9.21000E-01 5.00000E-02 9.18000E-01 4.30000E-02 8.98000E-01 3.30000E-02 8.29000E-01
2.90000E-02 7.85000E-01 2.40000E-02 7.12000E-01 1.60000E-02 5.52000E-01 9.00000E-03 3.55000E-01 1.00000E-05 5.25000E-04

        COARSE GROUP STRUCTURE
1.00000E+07 8.20850E+05 5.53084E+03 6.25060E-01 1.00000E-05
 (LFG(IGC),IGC=1,   5)ARE
    6     17     46     127     154
 FLUX-WEIGHTED AVERAGE OF 1/V CROSS SECTION (UNITY AT  .0253EV ) OVER LOWEST COARSE GROUP
                         = 8.89715E-02 /  1.60593E-01 =   5.54018E-01
   INTEGRATED MULTIGROUP FLUXES, FLXI(IGC),IGC=1,   4)
2.37019E-01 3.75805E-01 2.86382E-01 1.60593E-01
   EFFECTIVE THERMAL GROUP FLUX=   8.897151E-02
```

ECHO FROM DATA FILE   TABULATIONS ORDERED ON INCREASING Z,A,STATE,TEMP,MF,MT AND DECREASING SIGMA-0

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION	THERMAL EFFECTIVE*	X-SECTION (0.0253 EV)	RESONANCE 0.500 EV	INTEG. ABOVE 0.625 EV
54XE135	1294	3 1	900	1E+10	5.97286E+00	6.35420E+00	6.51127E+02	1.97377E+06	3.56265E+06	2.99730E+06	1.25290E+04	7.28680E+03
54XE135	1294	3 2	900	1E+10	5.09127E+00	6.34314E+00	2.87155E+02	3.05409E+05	5.51261E+05	3.07880E+05	5.10650E+03	3.23720E+03
54XE135	1294	3 4	900	1E+10	8.81044E-01	7.83121E-03	0.	0.	0.	0.	3.84720E+00	3.84720E+00
54XE135	1294	3102	900	1E+10	5.55362E-04	3.22388E-03	3.63971E+02	1.66836E+06	3.01139E+06	2.68940E+06	7.41880E+03	4.04580E+03

TAPE2 FILE FROM SAMPLE PROBLEM 1.

TABLE 9

FOUR GROUP CROSS SECTIONS

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	GROUP 4 X-SECTION	THERMAL EFFECTIVE*	X-SECTION (0.0253 EV)	RESONANCE 0.500 EV	INTEG. ABOVE 0.625 EV
54XE135	1294	3 1	900	1E+10	5.97286E+00	6.35420E+00	6.51127E+02	1.97377E+06	3.56265E+06	2.99730E+06	1.25290E+04	7.28680E+03
54XE135	1294	3 2	900	1E+10	5.09127E+00	6.34314E+00	2.87155E+02	3.05409E+05	5.51261E+05	3.07880E+05	5.10650E+03	3.23720E+03
54XE135	1294	3 4	900	1E+10	8.81044E-01	7.83121E-03	0.	0.	0.	0.	3.84720E+00	3.84720E+00
54XE135	1294	3102	900	1E+10	5.55362E-04	3.22388E-03	3.63971E+02	1.66836E+06	3.01139E+06	2.68940E+06	7.41880E+03	4.04580E+03

*NOTE THAT THE EFFECTIVE THERMAL CROSS SECTION IS THE GROUP 4 CROSS SECTION DIVIDED BY SIGMA(1/V)
WHERE SIGMA(1/V) IS THE GROUP 4 VALUE OF A 1/V CROSS SECTION EQUAL TO UNITY AT .0253EV (=.554018)

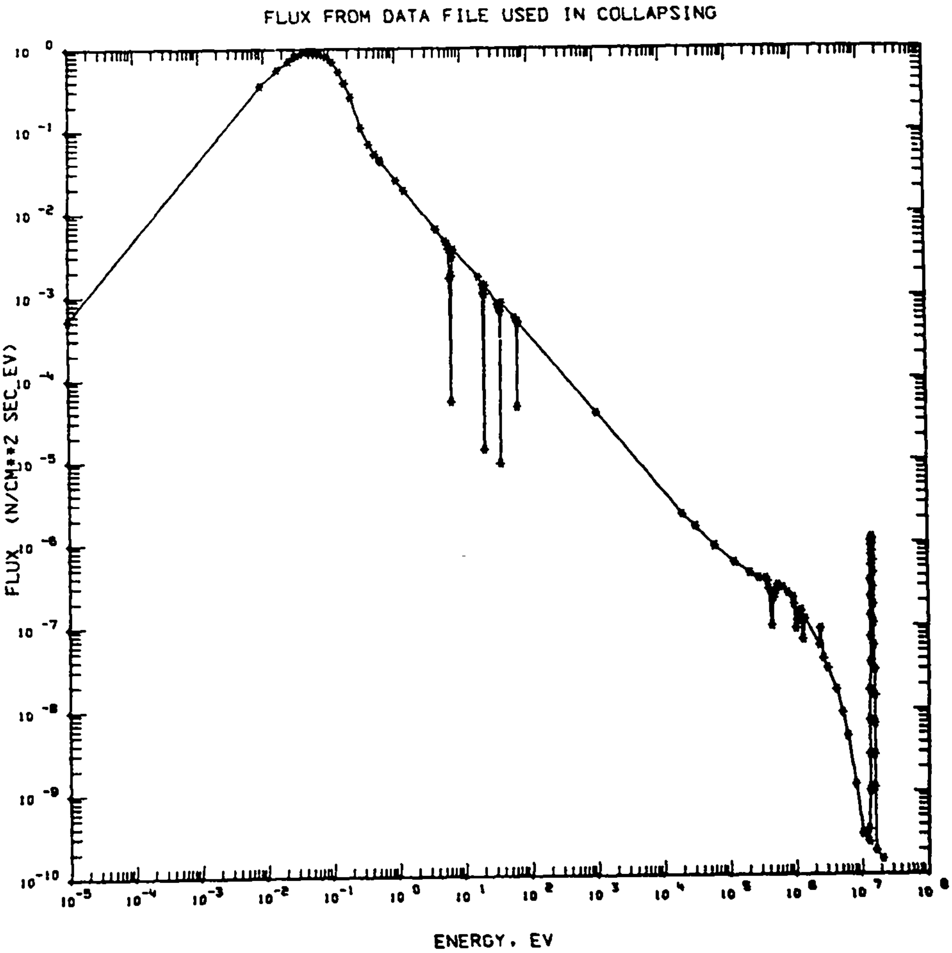

Figure B-1. Flux plot from sample problem 1.

SAMPLE PROBLEM 2. CALCULATE 2-GROUP RADIATIVE CAPTURE CROSS SECTIONS IN B+W 2-GROUP STRUCTURE, USING HISTOGRAM FLUX DESCRIPTION. HISTOGRAM FLUX VALUES WERE CALCULATED EXTERNALLY IN 111 ENERGY GROUPS AND SUPPLIED AS GROUP INTEGRATED VALUES. DEFINE 2-GROUP STRUCTURE WITH ENERGY BOUNDARIES 1.E-05EV.,1,8554031EV., AND 10MEV.

INPUT FILE FOR SAMPLE PROBLEM 2.

```
SAMPLE PROBLEM 2,B+W 2-GP (N,GAMMA) FOR ALL XENON,900K,HISTOGRAM 111-GP FLUX
    6  111    2   10    1
   54   54  124  136    3     3  102  1021.0     +101.0     +109.0     +029.0     +02
1.0        +076.0653066+063.6787944+062.2313016+061.3533528+068.2084999+05
4.2787068+053.0197383+051.8315639+051.1108997+056.7379470+044.0867714+04
2.4787522+041.5034392+049.1188197+035.5308437+033.3546263+032.0346837+03
1.2340980+037.4851830+024.5399930+022.7536449+021.6701701+021.0130094+02
6.1442124+013.7266532+012.2603294+011.3709591+018.3152872+005.0434766+00
3.0590232+001.8554031+001.8000125+001.7500138+001.7000140+001.6500151+00
1.6000140+001.5500133+001.5100150+001.4700147+001.4300148+001.3900155+00
1.3500139+001.3100135+001.2800135+001.2500132+001.2200133+001.1900134+00
1.1600132+001.1400132+001.1200131+001.1000131+001.0800130+001.0700132+00
1.0600133+001.0500134+001.0400136+001.0200135+001.0000137+009.8001385-01
9.6001401-019.4001378-019.1001369-018.8001371-018.5001268-018.2001327-01
7.9001230-017.6001273-017.3001202-017.0001104-016.7001155-016.4001197-01
6.1001087-015.8001014-015.5001009-015.2001013-014.9001122-014.6001127-01
4.3001095-014.0001051-013.8001083-013.6001020-013.4001001-013.2001019-01
3.1001022-013.0001022-012.9001019-012.8001016-012.7001011-012.6001016-01
2.4000982-012.2001019-012.0001083-011.8001128-011.6001120-011.4001118-01
1.2001092-011.1001095-011.0001094-019.0010544-028.0010806-027.0010819-02
6.0010358-025.0010352-024.0010392-023.0009966-022.0010035-021.0010178-02
5.0100957-031.0100428-032.0999706-041.0000000-05
6.3797412-013.0545294+005.7326530+006.8270876+005.7268298+006.1698076+00
4.1969518+004.2217538+003.2296350+002.6639372+002.2947076+002.0600194+00
1.9103046+001.8109646+001.7329866+001.6756761+001.6590423+001.6346861+00
1.6224981+001.5947158+001.5563242+001.5265884+001.4748602+001.4328803+00
1.4111223+001.3429236+001.2693679+001.2308217+001.1196303+001.1083371+00
1.0930927+006.5690565-025.7310591-025.8656948-026.0397776-026.2250226-02
6.4040971-025.2465487-025.3510686-025.4542564-025.6153833-025.8041453-02
5.9956789-024.6231372-024.7280934-024.8248750-024.9081108-024.9823077-02
3.3722899-023.4227617-023.4889884-023.5655920-021.8143502-021.8358117-02
1.8581266-021.8794406-023.8277[illegible]2-023.9196386-024.0124366-024.1080629-02
4.2065769-026.5047679-026.7529228-027.0168727-027.3000119-027.6048136-02
7.9341940-028.2922523-028.6836709-029.1116366-029.5836685-021.0106149-01
1.0691100-011.1348682-011.2097225-011.2965127-011.3985723-011.5213629-01
1.6715710-011.2174504-011.3167949-011.4367729-011.5831497-018.5479504-02
9.0881930-029.6803483-021.0354914-011.1123203-011.1994419-012.7052950-01
3.2086830-013.8366197-014.6114170-015.5512158-016.6587522-017.9129752-01
4.4562606-014.7891385-015.1083429-015.3952399-015.6248709-015.7624009-01
5.7625342-015.5673205-015.1049635-014.2874370-013.0067370-018.3454729-02
2.7726338-021.0842853-034.5729249-05
1.0        +071.8554031+001.0         -05
```

OUTPUT FILE FROM SAMPLE PROBLEM 2

```
                SAMPLE PROBLEM 2,B+W 2-GP (N,GAMMA) FOR ALL XENON,900K,HISTOGRAM 111-GP FLUX
          **SUMMARY OF PROBLEM CONTROL INPUT******
  IFLX =  6     ,WHERE 1=COLLAPSE TO BUILT-IN FUNCTIONAL FLUX, WITH PARAMETERS READ FROM CARD INPUT
                       2=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM DATA FILE
                       3=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM CARD INPUT
                       4=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-EV
                       5=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-UNIT LETHARGY
                       6=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC (GROUP INTEGRAL FLUXES)
   NFX =111     ,NUMBER OF FLUX VALUES IN USER COLLAPSING FLUX DESCRIPTION   (SET TO NFXP BY CODE IF IFLX=2)
   NCC =  2     ,NUMBER OF COARSE GROUPS
    NT = 10     ,TABLE NUMBER FOR TAPE2 HEADING
IPLTFX =  1     ,WHERE 0=NO PLOT OF FLUX
                       1=MAKE PLOT OF LOG-LOG FLUX READ FROM DATA FILE AND, IF DIFFERENT, USER COLLAPSING FLUX

  COLLAPSE CROSS-SECTION TABULATIONS WITHIN THE FOLLOWING LIMITS
  *****Z*****     *****A*****    *REACTION MF*  *REACTION MT*    ***BONDARENKO SIGMA ZERO***     ******TEMPERATURE (K)******
   54 TO  54       124 TO 136        3 TO   3     102 TO 102       1.000E+10 TO   1.000E+10        9.000E+02 TO    9.000E+02
```

ECHO FROM DATA FILE TOAFEW-V 154-GP ENDF/B-V FISSION-PRODUCT AND ACTINIDE CROSS SECTIONS 2-9-81
ECHO FROM DATA FILE PRS 154-GROUP NEUTRON MULTIGROUP STRUCTURE

2.00000E+07	1.82212E+07	1.69046E+07	1.49182E+07	1.34986E+07	1.19125E+07	1.00000E+07	7.78801E+06	6.06531E+06	4.72367E+06
3.67879E+06	2.86505E+06	2.23130E+06	1.73774E+06	1.35335E+06	1.05399E+06	9.53692E+05	8.20850E+05	7.42736E+05	6.39279E+05
5.78443E+05	4.97871E+05	4.50492E+05	3.87742E+05	3.50844E+05	3.01974E+05	2.73237E+05	2.35177E+05	2.12797E+05	1.83156E+05
1.42642E+05	1.11090E+05	8.65170E+04	6.73795E+04	5.24752E+04	4.08677E+04	3.18278E+04	2.80879E+04	2.60584E+04	2.47875E+04
2.35786E+04	1.93045E+04	1.50344E+04	1.17088E+04	9.11882E+03	7.10174E+03	5.53084E+03	4.30743E+03	3.35463E+03	2.61259E+03
2.03468E+03	1.58461E+03	1.23410E+03	9.61117E+02	7.48518E+02	5.82947E+02	4.53999E+02	3.53575E+02	2.75364E+02	2.14454E+02
1.67017E+02	1.30073E+02	1.01301E+02	7.88932E+01	7.36000E+01	6.97500E+01	6.85500E+01	6.70000E+01	6.14421E+01	5.99000E+01
5.90500E+01	5.84000E+01	4.78512E+01	4.00000E+01	3.72665E+01	3.60500E+01	3.50000E+01	2.90232E+01	2.37100E+01	2.32000E+01
2.26033E+01	2.21000E+01	2.15000E+01	2.03000E+01	1.76035E+01	1.37096E+01	1.06770E+01	8.31529E+00	7.00000E+00	6.47595E+00
5.04348E+00	3.92786E+00	3.05902E+00	2.56084E+00	2.38237E+00	2.31603E+00	2.29429E+00	2.27266E+00	2.25113E+00	2.17213E+00
2.09408E+00	2.01791E+00	1.93562E+00	1.85539E+00	1.80897E+00	1.76305E+00	1.72608E+00	1.71773E+00	1.64759E+00	1.59493E+00
1.57850E+00	1.45742E+00	1.44498E+00	1.30785E+00	1.20867E+00	1.16638E+00	1.12535E+00	1.09868E+00	1.07217E+00	1.06231E+00
1.05250E+00	1.04273E+00	1.01370E+00	9.50653E-01	8.76425E-01	7.82079E-01	6.82560E-01	6.25060E-01	5.31579E-01	5.03235E-01
4.17016E-01	4.13994E-01	3.57665E-01	3.20628E-01	3.01120E-01	2.90737E-01	2.70518E-01	2.51028E-01	2.27690E-01	1.84429E-01
1.52300E-01	1.45721E-01	1.11568E-01	8.19683E-02	5.69224E-02	4.27551E-02	3.06116E-02	2.04921E-02	1.23964E-02	6.32472E-03
2.27690E-03	7.60219E-04	2.52989E-04	1.38879E-04	1.00000E-05					

ECHO FROM DATA FILE PRS NEUTRON FLUX WEIGHTING FUNCTION 115 LOG-LOG INTERPOLATION PTS

2.00000E+07	1.54770E-10	1.56760E+07	1.97800E-10	1.55000E+07	1.14060E-09	1.54000E+07	2.84500E-09	1.53000E+07	6.66880E-09
1.52000E+07	1.46870E-08	1.51000E+07	3.03540E-08	1.50000E+07	5.88320E-08	1.49000E+07	1.06990E-07	1.48000E+07	1.82130E-07
1.47000E+07	2.90410E-07	1.46000E+07	4.33170E-07	1.45000E+07	6.04030E-07	1.44000E+07	7.87040E-07	1.43000E+07	9.57570E-07
1.42000E+07	1.08700E-06	1.40700E+07	1.15400E-06	1.39000E+07	1.04080E-06	1.38000E+07	8.88250E-07	1.37000E+07	7.04780E-07
1.36000E+07	5.19460E-07	1.35000E+07	3.55120E-07	1.34000E+07	2.25110E-07	1.33000E+07	1.32220E-07	1.32000E+07	7.18640E-08
1.31000E+07	3.61220E-08	1.30000E+07	1.67760E-08	1.29000E+07	7.19100E-09	1.28000E+07	2.84360E-09	1.27000E+07	1.03570E-09
1.26000E+07	3.47310E-10	1.25700E+07	2.46190E-10	1.00000E+07	3.09530E-10	8.00000E+06	1.22760E-09	6.00000E+06	4.71530E-09
5.00000E+06	9.06790E-09	4.00000E+06	1.70730E-08	3.00000E+06	3.11420E-08	2.63000E+06	3.99810E-08	2.35000E+06	9.15950E-08
2.22000E+06	5.90330E-08	1.40000E+06	1.21820E-07	1.31000E+06	6.86960E-08	1.21000E+06	1.50220E-07	1.19000E+06	1.54790E-07
1.12000E+06	1.36480E-07	1.05000E+06	1.15180E-07	1.00000E+06	9.15950E-08	9.41000E+05	1.78610E-07	9.00000E+05	2.14790E-07
7.70000E+05	2.50050E-07	6.50000E+05	2.94930E-07	5.40000E+05	3.05010E-07	5.02000E+05	2.63330E-07	4.74000E+05	2.17540E-07
4.42000E+05	1.00750E-07	3.99000E+05	2.73870E-07	3.77000E+05	3.40270E-07	3.56000E+05	3.69260E-07	2.83000E+05	3.83090E-07
2.01000E+05	4.36450E-07	1.20000E+05	5.79340E-07	6.07000E+04	9.15950E-07	3.07000E+04	1.55710E-06	2.00000E+04	2.22570E-06
1.01000E+03	3.78290E-05	6.82000E+01	4.83620E-04	6.71000E+01	4.72260E-04	6.60000E+01	4.57970E-05	6.49000E+01	4.82430E-04
6.12000E+01	5.58730E-04	3.87000E+01	8.26180E-04	3.74000E+01	6.54530E-04	3.67000E+01	9.15950E-06	3.59000E+01	6.78720E-04
3.56000E+01	7.48970E-04	3.44000E+01	8.15190E-04	2.25000E+01	1.35650E-03	2.14000E+01	1.05880E-03	2.09000E+01	1.37390E-05
2.03700E+01	1.09730E-03	1.98600E+01	1.38580E-03	1.75300E+01	1.71560E-03	7.30800E+00	3.60420E-03	7.01000E+00	2.92190E-03
6.89400E+00	1.76320E-03	6.67000E+00	5.31250E-05	6.44900E+00	1.65240E-03	6.13500E+00	3.72790E-03	5.88420E+00	4.19500E-03
5.50470E+00	4.61640E-03	4.01000E+00	6.32000E-03	1.35180E+00	1.85020E-02	1.00000E+00	2.49140E-02	6.00000E-01	4.13000E-02
5.70000E-01	4.37000E-02	4.90000E-01	5.10000E-02	4.00000E-01	6.87000E-02	3.00000E-01	1.08000E-01	2.10000E-01	2.52000E-01
1.70000E-01	3.83000E-01	1.40000E-01	5.20000E-01	1.12000E-01	6.86000E-01	9.00000E-02	7.99000E-01	7.00000E-02	8.92000E-01
5.90000E-02	9.18000E-01	5.40000E-02	9.21000E-01	5.00000E-02	9.18000E-01	4.30000E-02	8.98000E-01	3.30000E-02	8.29000E-01
2.90000E-02	7.85000E-01	2.40000E-02	7.12000E-01	1.60000E-02	5.52000E-01	9.00000E-03	3.55000E-01	1.00000E-05	5.25000E-04

```
          COARSE GROUP STRUCTURE
1.00000E+07 1.85540E+00 1.00000E-05

          INPUT WEIGHT FUNCTION                 111HISTOGRAM VALUES               FLUX-PER-UNIT-ENERGY
1.00000E+07 1.62141E-07 6.06531E+06 1.27991E-06 3.67879E+06 3.96040E-06 2.23130E+06 7.77618E-06 1.35335E+06 1.07546E-05
8.20850E+05 1.57001E-05 4.27871E+05 3.33364E-05 3.01974E+05 3.55314E-05 1.83156E+05 4.48147E-05 1.11090E+05 6.09450E-05
6.73795E+04 8.65543E-05 4.08677E+04 1.28109E-04 2.47875E+04 1.95866E-04 1.50344E+04 3.06135E-04 9.11882E+03 4.82998E-04
5.53084E+03 7.69995E-04 3.35463E+03 1.25690E-03 2.03468E+03 2.04186E-03 1.23410E+03 3.34136E-03 7.48518E+02 5.41464E-03
4.53999E+02 8.71232E-03 2.75364E+02 1.40897E-02 1.67017E+02 2.24429E-02 1.01301E+02 3.59489E-02 6.14421E+01 5.83697E-02
3.72665E+01 9.15844E-02 2.26033E+01 1.42727E-01 1.37096E+01 2.28171E-01 8.31529E+00 3.42205E-01 5.04348E+00 5.58510E-01
3.05902E+00 9.08171E-01 1.85540E+00 1.18595E+00 1.80001E+00 1.14624E+00 1.75001E+00 1.17314E+00 1.70001E+00 1.20798E+00
1.65002E+00 1.24498E+00 1.60001E+00 1.28080E+00 1.55001E+00 1.31169E+00 1.51002E+00 1.33776E+00 1.47001E+00 1.36357E+00
1.43001E+00 1.40387E+00 1.39002E+00 1.45098E+00 1.35001E+00 1.49890E+00 1.31001E+00 1.54105E+00 1.28001E+00 1.57602E+00
1.25001E+00 1.60830E+00 1.22001E+00 1.63604E+00 1.19001E+00 1.66076E+00 1.16001E+00 1.68614E+00 1.14001E+00 1.71137E+00
1.12001E+00 1.74449E+00 1.10001E+00 1.78279E+00 1.08001E+00 1.81439E+00 1.07001E+00 1.83583E+00 1.06001E+00 1.85815E+00
1.05001E+00 1.87948E+00 1.04001E+00 1.91384E+00 1.02001E+00 1.95984E+00 1.00001E+00 2.00623E+00 9.80014E-01 2.05405E+00
9.60014E-01 2.10326E+00 9.40014E-01 2.16825E+00 9.10014E-01 2.25098E+00 8.80014E-01 2.33888E+00 8.50013E-01 2.43339E+00
8.20013E-01 2.53486E+00 7.90012E-01 2.64477E+00 7.60013E-01 2.76402E+00 7.30012E-01 2.89446E+00 7.00011E-01 3.03726E+00
6.70012E-01 3.19460E+00 6.40012E-01 3.36859E+00 6.10011E-01 3.56361E+00 5.80010E-01 3.78289E+00 5.50010E-01 4.03241E+00
5.20010E-01 4.32187E+00 4.90011E-01 4.66192E+00 4.60011E-01 5.07116E+00 4.30011E-01 5.57182E+00 4.00011E-01 6.08735E+00
3.80011E-01 6.58377E+00 3.60010E-01 7.18380E+00 3.40010E-01 7.91582E+00 3.20010E-01 8.54798E+00 3.10010E-01 9.08819E+00
3.00010E-01 9.68032E+00 2.90010E-01 1.03549E+01 2.80010E-01 1.11231E+01 2.70010E-01 1.19945E+01 2.60010E-01 1.35262E+01
2.40010E-01 1.60437E+01 2.20010E-01 1.91837E+01 2.00011E-01 2.30576E+01 1.80011E-01 2.77560E+01 1.60011E-01 3.32937E+01
1.40011E-01 3.95644E+01 1.20011E-01 4.45627E+01 1.10011E-01 4.78913E+01 1.00011E-01 5.10814E+01 9.00105E-02 5.39538E+01
8.00108E-02 5.62488E+01 7.00108E-02 5.76214E+01 6.00104E-02 5.76253E+01 5.00104E-02 5.56734E+01 4.00104E-02 5.10475E+01
3.00100E-02 4.28747E+01 2.00100E-02 3.00678E+01 1.00102E-02 1.66907E+01 5.01010E-03 6.93149E+00 1.01004E-03 1.35528E+00
2.09997E-04 2.28650E-01 1.00000E-05
 (LFG(ICC),ICC=1,  3)ARE
    6   103   154
 FLUX-WEIGHTED AVERAGE OF 1/V CROSS SECTION (UNITY AT  .0253EV ) OVER LOWEST COARSE GROUP
                              = 6.23457E+00 /  1.33865E+01 =  4.65735E-01
   INTEGRATED MULTIGROUP FLUXES, FLXI(ICC),ICC=1,  2)
7.50227E+01 1.33865E+01
```

EFFECTIVE THERMAL GROUP FLUX= 6.234570E+00
ECHO FROM DATA FILE TABULATIONS ORDERED ON INCREASING Z,A,STATE,TEMP,MF,MT AND DECREASING SIGMA-0

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	THERMAL X-SECTION EFFECTIVE*	(0.0253 EV)	RESONANCE INTEG. ABOVE 0.500 EV	0.625 EV
54XE124	1335	3102	900	1E+10	8.91435E+01	8.07968E+01	1.73482E+02	1.65070E+02	3.06570E+03	3.05660E+03
54XE126	1339	3102	900	1E+10	1.89780E+00	1.02914E+00	2.20970E+00	2.20760E+00	4.40160E+01	4.39140E+01
54XE128	1348	3102	900	1E+10	4.78776E-01	2.44801E+00	5.25624E+00	5.37380E+00	1.11730E+01	1.09470E+01
54XE129	1349	3102	900	1E+10	7.95063E+00	8.49873E+00	1.82480E+01	1.80540E+01	2.55050E+02	2.54180E+02
54XE130	1350	3102	900	1E+10	1.64933E-01	2.82740E+00	6.07084E+00	6.21490E+00	4.43470E+00	4.17450E+00
54XE131	1351	3102	900	1E+10	3.00222E+01	4.29763E+01	9.22764E+01	9.03780E+01	1.01630E+03	1.01180E+03
54XE132	1352	3102	900	1E+10	8.66639E-02	2.05622E-01	4.41500E-01	4.41360E-01	1.71320E+00	1.69270E+00
54XE133	9643	3102	900	1E+10	1.11507E+01	8.89524E+01	1.90994E+02	1.90590E+02	3.65740E+02	3.56850E+02
54XE134	1354	3102	900	1E+10	3.83968E-02	1.15751E-01	2.48535E-01	2.50650E-01	7.64470E-01	7.53240E-01
54XE135	1294	3102	900	1E+10	6.87852E+00	1.28503E+06	2.75915E+06	2.68940E+06	7.41880E+03	4.04580E+03
54XE136	1356	3102	900	1E+10	3.96618E-03	7.48984E-02	1.60818E-01	1.60440E-01	1.21030E-01	1.13610E-01

TAPE2 FILE FROM SAMPLE PROBLEM 2.

TABLE 10

TWO GROUP CROSS SECTIONS

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	THERMAL X-SECTION EFFECTIVE*	(0.0253 EV)	RESONANCE INTEG. ABOVE 0.500 EV	0.625 EV
54XE124	1335	3102	900	1E+10	8.91435E+01	8.07968E+01	1.73482E+02	1.65070E+02	3.06570E+03	3.05660E+03
54XE126	1339	3102	900	1E+10	1.89780E+00	1.02914E+00	2.20970E+00	2.20760E+00	4.40160E+01	4.39140E+01
54XE128	1348	3102	900	1E+10	4.78776E-01	2.44801E+00	5.25624E+00	5.37380E+00	1.11730E+01	1.09470E+01
54XE129	1349	3102	900	1E+10	7.95063E+00	8.49873E+00	1.82480E+01	1.80540E+01	2.55050E+02	2.54180E+02
54XE130	1350	3102	900	1E+10	1.64933E-01	2.82740E+00	6.07084E+00	6.21490E+00	4.43470E+00	4.17450E+00
54XE131	1351	3102	900	1E+10	3.00222E+01	4.29763E+01	9.22764E+01	9.03780E+01	1.01630E+03	1.01180E+03
54XE132	1352	3102	900	1E+10	8.66639E-02	2.05622E-01	4.41500E-01	4.41360E-01	1.71320E+00	1.69270E+00
54XE133	9643	3102	900	1E+10	1.11507E+01	8.89524E+01	1.90994E+02	1.90590E+02	3.65740E+02	3.56850E+02
54XE134	1354	3102	900	1E+10	3.83968E-02	1.15751E-01	2.48535E-01	2.50650E-01	7.64470E-01	7.53240E-01
54XE135	1294	3102	900	1E+10	6.87852E+00	1.28503E+06	2.75915E+06	2.68940E+06	7.41880E+03	4.04580E+03
54XE136	1356	3102	900	1E+10	3.96618E-03	7.48984E-02	1.60818E-01	1.60440E-01	1.21030E-01	1.13610E-01

*NOTE THAT THE EFFECTIVE THERMAL CROSS SECTION IS THE GROUP 2 CROSS SECTION DIVIDED BY SIGMA(1/V)
WHERE SIGMA(1/V) IS THE GROUP 2 VALUE OF A 1/V CROSS SECTION EQUAL TO UNITY AT .0253EV (=.465735)

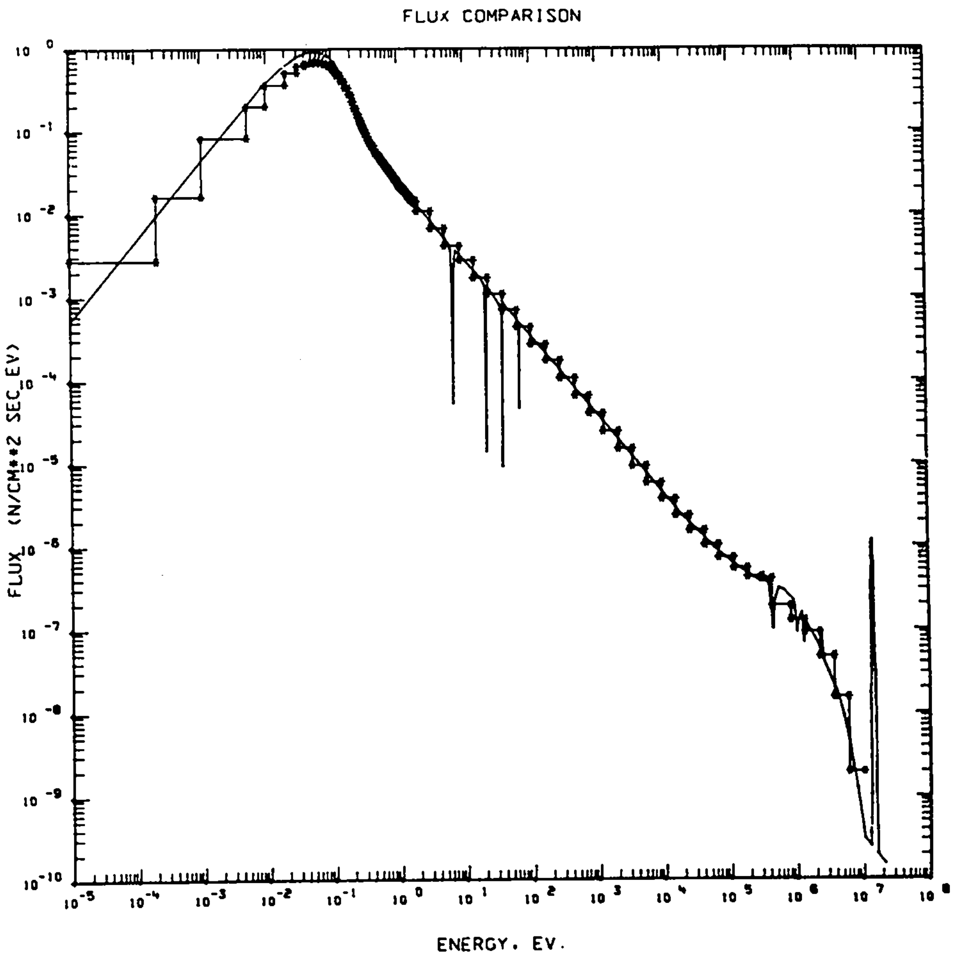

Figure B-2. Flux plot from sample problem 2.

```
SAMPLE PROBLEM 3.  CALCULATE 3-GROUP RADIATIVE CAPTURE CROSS SECTIONS FOR ALL DYSPROSIUM
=================  NUCLIDES USING MTR FLUX SPECTRUM.  USE FUNCTIONAL FLUX DESCRIPTION FOR
=================  THERMAL MAXWELLIAN AT 343.2K (.0295738EV.) BELOW 0.105 EV. AND 1/E
                   ABOVE THIS ENERGY.  DEFINE 3-GROUP STRUCTURE WITH BOUNDARIES 1.E-05EV.,
                   0.105EV.,5.53KEV., AND 10 MEV.

INPUT FILE FOR SAMPLE PROBLEM 3.
--------------------------------

SAMPLE PROBLEM 3, 3-GP (N,GAMMA), ALL DYSPROSIUM 300K,FUNCTIONAL FLUX FOR MTR
   1    0    3   11    1
  66   66  160  164    3    3  102  1021.0    +101.0    +103.0    +023.0    +02
1.0       -051.05     -011.0     +071.0     +071.0     +071.0     +07
1.0       +07
2.95738   -02-1.0      0.         0.         0.         0.
0.
1.0       -051.05     -015.53    +031.0     +07

OUTPUT FILE FROM SAMPLE PROBLEM 3.
----------------------------------

                   SAMPLE PROBLEM 3, 3-GP (N,GAMMA), ALL DYSPROSIUM 300K,FUNCTIONAL FLUX FOR MTR
        **SUMMARY OF PROBLEM CONTROL INPUT******
    IFLX =  1    ,WHERE 1=COLLAPSE TO BUILT-IN FUNCTIONAL FLUX, WITH PARAMETERS READ FROM CARD INPUT
                        2=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM DATA FILE
                        3=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM CARD INPUT
                        4=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-EV
                        5=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-UNIT LETHARGY
                        6=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC (GROUP INTEGRAL FLUXES)
     NFX =  0    ,NUMBER OF FLUX VALUES IN USER COLLAPSING FLUX DESCRIPTION   (SET TO NFXP BY CODE IF IFLX=2)
     NCC =  3    ,NUMBER OF COARSE GROUPS
      NT = 11    ,TABLE NUMBER FOR TAPE2 HEADING
  IPLTFX =  1    ,WHERE 0=NO PLOT OF FLUX
                        1=MAKE PLOT OF LOG-LOG FLUX READ FROM DATA FILE AND, IF DIFFERENT, USER COLLAPSING FLUX

    COLLAPSE CROSS-SECTION TABULATIONS WITHIN THE FOLLOWING LIMITS
    *****Z*****     *****A*****   *REACTION MF*  *REACTION MT*    ***BONDARENKO SIGMA ZERO***     ******TEMPERATURE (K)******
     66 TO  66      160 TO 164       3 TO   3     102 TO 102       1.000E+10 TO   1.000E+10        3.000E+02 TO   3.000E+02

   ECHO FROM DATA FILE     TOAFEW-V 154-GP ENDF/B-V FISSION-PRODUCT AND ACTINIDE CROSS SECTIONS 2-9-81
   ECHO FROM DATA FILE     PRS 154-GROUP NEUTRON MULTIGROUP STRUCTURE
  2.00000E+07 1.82212E+07 1.69046E+07 1.49182E+07 1.34986E+07 1.19125E+07 1.00000E+07 7.78801E+06 6.06531E+06 4.72367E+06
  3.67879E+06 2.86505E+06 2.23130E+06 1.73774E+06 1.35335E+06 1.05399E+06 9.53692E+05 8.20850E+05 7.42736E+05 6.39279E+05
  5.78443E+05 4.97871E+05 4.50492E+05 3.87742E+05 3.50844E+05 3.01974E+05 2.73237E+05 2.35177E+05 2.12797E+05 1.83156E+05
  1.42642E+05 1.11090E+05 8.65170E+04 6.73795E+04 5.24752E+04 4.08677E+04 3.18278E+04 2.80879E+04 2.60584E+04 2.47875E+04
  2.35786E+04 1.93045E+04 1.50344E+04 1.17088E+04 9.11882E+03 7.10174E+03 5.53084E+03 4.30743E+03 3.35463E+03 2.61259E+03
  2.03468E+03 1.58461E+03 1.23410E+03 9.61117E+02 7.48518E+02 5.82947E+02 4.53999E+02 3.53575E+02 2.75364E+02 2.14454E+02
  1.67017E+02 1.30073E+02 1.01301E+02 7.88932E+01 7.36000E+01 6.97500E+01 6.85500E+01 6.70000E+01 6.14421E+01 5.99000E+01
  5.90500E+01 5.84000E+01 4.78512E+01 4.00000E+01 3.72665E+01 3.60500E+01 3.50000E+01 2.90232E+01 2.37100E+01 2.32000E+01
  2.26033E+01 2.21000E+01 2.15000E+01 2.03000E+01 1.76035E+01 1.37096E+01 1.06770E+01 8.31529E+00 7.00000E+00 6.47595E+00
  5.04348E+00 3.92786E+00 3.05902E+00 2.56084E+00 2.38237E+00 2.31603E+00 2.29429E+00 2.27266E+00 2.25113E+00 2.17213E+00
  2.09408E+00 2.01791E+00 1.93562E+00 1.85539E+00 1.80897E+00 1.76305E+00 1.72608E+00 1.71773E+00 1.64759E+00 1.59493E+00
  1.57850E+00 1.45742E+00 1.44498E+00 1.30785E+00 1.20867E+00 1.16638E+00 1.12535E+00 1.09868E+00 1.07217E+00 1.06231E+00
  1.05250E+00 1.04273E+00 1.01370E+00 9.50653E-01 8.76425E-01 7.82079E-01 6.82560E-01 6.25060E-01 5.31579E-01 5.03235E-01
  4.17016E-01 4.13994E-01 3.57665E-01 3.20628E-01 3.01120E-01 2.90737E-01 2.70518E-01 2.51028E-01 2.27690E-01 1.84429E-01
  1.52300E-01 1.45721E-01 1.11568E-01 8.19683E-02 5.69224E-02 4.27551E-02 3.06116E-02 2.04921E-02 1.23964E-02 6.32472E-03
  2.27690E-03 7.60219E-04 2.52989E-04 1.38879E-04 1.00000E-05
```

```
 ECHO FROM DATA FILE       PRS NEUTRON FLUX WEIGHTING FUNCTION     15 LOG-LOG INTERPOLATION PTS
2.00000E+07 1.54770E-10 1.56760E+07 1.97800E-10 1.55000E+07 1.14060E-09 1.54000E+07 2.84500E-09 1.53000E+07 6.66880E-09
1.52000E+07 1.46870E-08 1.51000E+07 3.03540E-08 1.50000E+07 5.88320E-08 1.49000E+07 1.06990E-07 1.48000E+07 1.82130E-07
1.47000E+07 2.90410E-07 1.46000E+07 4.33170E-07 1.45000E+07 6.04030E-07 1.44000E+07 7.87040E-07 1.43000E+07 9.57570E-07
1.42000E+07 1.08700E-06 1.40700E+07 1.15400E-06 1.39000E+07 1.04080E-06 1.38000E+07 8.88250E-07 1.37000E+07 7.04780E-07
1.36000E+07 5.19460E-07 1.35000E+07 3.55120E-07 1.34000E+07 2.25110E-07 1.33000E+07 1.32220E-07 1.32000E+07 7.18640E-08
1.31000E+07 3.61220E-08 1.30000E+07 1.67760E-08 1.29000E+07 7.19100E-09 1.28000E+07 2.84360E-09 1.27000E+07 1.03570E-09
1.26000E+07 3.47310E-10 1.25700E+07 2.46190E-10 1.00000E+07 3.09530E-10 8.00000E+06 1.22760E-09 6.00000E+06 4.71530E-09
5.00000E+06 9.06790E-09 4.00000E+06 1.70730E-08 3.00000E+06 3.11420E-08 2.63000E+06 3.99810E-08 2.35000E+06 9.15950E-08
2.22000E+06 5.90330E-08 1.40000E+06 1.21820E-07 1.31000E+06 6.86960E-08 1.21000E+06 1.50220E-07 1.19000E+06 1.54790E-07
1.12000E+06 1.36480E-07 1.05000E+06 1.15180E-07 1.00000E+06 9.15950E-08 9.41000E+05 1.78610E-07 9.00000E+05 2.14790E-07
7.70000E+05 2.50050E-07 6.50000E+05 2.94930E-07 5.40000E+05 3.05010E-07 5.02000E+05 2.63330E-07 4.74000E+05 2.17540E-07
4.42000E+05 1.00750E-07 3.99000E+05 2.73870E-07 3.77000E+05 3.40270E-07 3.56000E+05 3.69260E-07 2.83000E+05 3.83090E-07
2.01000E+05 4.36450E-07 1.20000E+05 5.79340E-07 6.07000E+04 9.15950E-07 3.07000E+04 1.55710E-06 2.00000E+04 2.22570E-06
1.01000E+03 3.78290E-05 6.82000E+01 4.83620E-04 6.71000E+01 4.72260E-04 6.60000E+01 4.57970E-05 6.49000E+01 4.82430E-04
6.12000E+01 5.58730E-04 3.87000E+01 8.26180E-04 3.74000E+01 6.54530E-04 3.67000E+01 9.15950E-06 3.59000E+01 6.78720E-04
3.56000E+01 7.48970E-04 3.44000E+01 8.15190E-04 2.25000E+01 1.35650E-03 2.14000E+01 1.05880E-03 2.09000E+01 1.37390E-05
2.03700E+01 1.09730E-03 1.98600E+01 1.38580E-03 1.75300E+01 1.71560E-03 7.30800E+00 3.60420E-03 7.01000E+00 2.92190E-03
6.89400E+00 1.76320E-03 6.67000E+00 5.31250E-05 6.44900E+00 1.65240E-03 6.13500E+00 3.72790E-03 5.88420E+00 4.19500E-03
5.50470E+00 4.61640E-03 4.01000E+00 6.32000E-03 1.35180E+00 1.85020E-02 1.00000E+00 2.49140E-02 6.00000E-01 4.13000E-02
5.70000E-01 4.37000E-02 4.90000E-01 5.10000E-02 4.00000E-01 6.87000E-02 3.00000E-01 1.08000E-01 2.10000E-01 2.52000E-01
1.70000E-01 3.83000E-01 1.40000E-01 5.20000E-01 1.12000E-01 6.86000E-01 9.00000E-02 7.99000E-01 7.00000E-02 8.92000E-01
5.90000E-02 9.18000E-01 5.40000E-02 9.21000E-01 5.00000E-02 9.18000E-01 4.30000E-02 8.98000E-01 3.30000E-02 8.29000E-01
2.90000E-02 7.85000E-01 2.40000E-02 7.12000E-01 1.60000E-02 5.52000E-01 9.00000E-03 3.55000E-01 1.00000E-05 5.25000E-04

       COARSE GROUP STRUCTURE
1.00000E+07 5.53000E+03 1.05000E-01 1.00000E-05

       FUNCTIONAL FLUX DESCRIPTION USED IN COLLAPSING
   ENERGY LIMITS                     FLUX FUNCTION                                INPUT AND CALCULATED PARAMETERS
-------------------  ----------------------------------------------------------  -----------------------------------
EX(1)= 1.000000E-05 EV                                                             C(1)  = 1.000000E+00
                     F(E)=C(1)*E*EXP(-E/TKM)                                       TKM   = 2.957380E-02 EV
EX(2)= 1.050000E-01 EV                                                             C(2)  = 3.165499E-04
                     F(E)=C(2)*E**SLPA                                             SLPA  =-1.000000E+00
EX(3)= 1.000000E+07 EV                                                             C(3)  = 0.
                     F(E)=C(3)*SQRT(E)*EXP(-E/THETA)                               THETA= 0.           EV
EX(4)= 1.000000E+07 EV                                                             C(4)  = 0.
                     F(E)=C(4)*E**SLPB                                             SLPB  = 0.
EX(5)= 1.000000E+07 EV                                                             C(5)  = 0.
                     F(E)=C(5)*EXP(-5.*(SQRT(E/TKF)-SQRT(EP/TKF))**2.)             TKF   = 0.          EV
EX(6)= 1.000000E+07 EV                                                             EP    = 0.          EV
                     F(E)=C(6)*E**SLPC                                             C(6)  = 0.
EX(7)= 1.000000E+07 EV                                                             SLPC  = 0.
   (LFC(ICC),ICC=1,  4)ARE
     6     47    143    154
 FLUX-WEIGHTED AVERAGE OF 1/V CROSS SECTION (UNITY AT  .0253EV ) OVER LOWEST COARSE GROUP
                              = 7.11385E-04 /  7.60340E-04 =  9.35615E-01
    INTEGRATED MULTIGROUP FLUXES, FLXI(ICC),ICC=1,  3)
 2.37417E-03 3.44145E-03 7.60340E-04
    EFFECTIVE THERMAL GROUP FLUX=   7.113851E-04
```

ECHO FROM DATA FILE TABULATIONS ORDERED ON INCREASING Z,A,STATE,TEMP,MF,MT AND DECREASING SIGMA-0

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	THERMAL EFFECTIVE*	X-SECTION (0.0253 EV)	RESONANCE 0.500 EV	INTEG. ABOVE 0.625 EV
66DY160	9864	3102	300	1E+10	1.21410E+00	1.59449E+02	5.39279E+01	5.76390E+01	6.10910E+01	1.66540E+03	1.66090E+03
66DY161	9865	3102	300	1E+10	1.24925E+00	1.36436E+02	5.08429E+02	5.43417E+02	5.86050E+02	1.20450E+03	1.18500E+03
66DY162	9866	3102	300	1E+10	5.11843E-01	2.87430E+02	1.75380E+02	1.87449E+02	1.99500E+02	2.76960E+03	2.75820E+03
66DY163	9867	3102	300	1E+10	5.19738E-01	1.41861E+02	1.17983E+02	1.26102E+02	1.34540E+02	1.46670E+03	1.45610E+03
66DY164	1031	3102	300	1E+10	1.71146E-01	1.32340E+02	2.17599E+03	2.32574E+03	2.52150E+03	3.20580E+02	2.49140E+02

TAPE2 FILE FROM SAMPLE PROBLEM 3.

TABLE 11

THREE GROUP CROSS SECTIONS

NUCLIDE	MAT	MFMT	TEMP (K)	SIGMA ZERO	GROUP 1 X-SECTION	GROUP 2 X-SECTION	GROUP 3 X-SECTION	THERMAL EFFECTIVE*	X-SECTION (0.0253 EV)	RESONANCE 0.500 EV	INTEG. ABOVE 0.625 EV
66DY160	9864	3102	300	1E+10	1.21410E+00	1.59449E+02	5.39279E+01	5.76390E+01	6.10910E+01	1.66540E+03	1.66090E+03
66DY161	9865	3102	300	1E+10	1.24925E+00	1.36436E+02	5.08429E+02	5.43417E+02	5.86050E+02	1.20450E+03	1.18500E+03
66DY162	9866	3102	300	1E+10	5.11843E-01	2.87430E+02	1.75380E+02	1.87449E+02	1.99500E+02	2.76960E+03	2.75820E+03
66DY163	9867	3102	300	1E+10	5.19738E-01	1.41861E+02	1.17983E+02	1.26102E+02	1.34540E+02	1.46670E+03	1.45610E+03
66DY164	1031	3102	300	1E+10	1.71146E-01	1.32340E+02	2.17599E+03	2.32574E+03	2.52150E+03	3.20580E+02	2.49140E+02

*NOTE THAT THE EFFECTIVE THERMAL CROSS SECTION IS THE GROUP 3 CROSS SECTION DIVIDED BY SIGMA(1/V)
WHERE SIGMA(1/V) IS THE GROUP 3 VALUE OF A 1/V CROSS SECTION EQUAL TO UNITY AT .0253EV (=.935615)

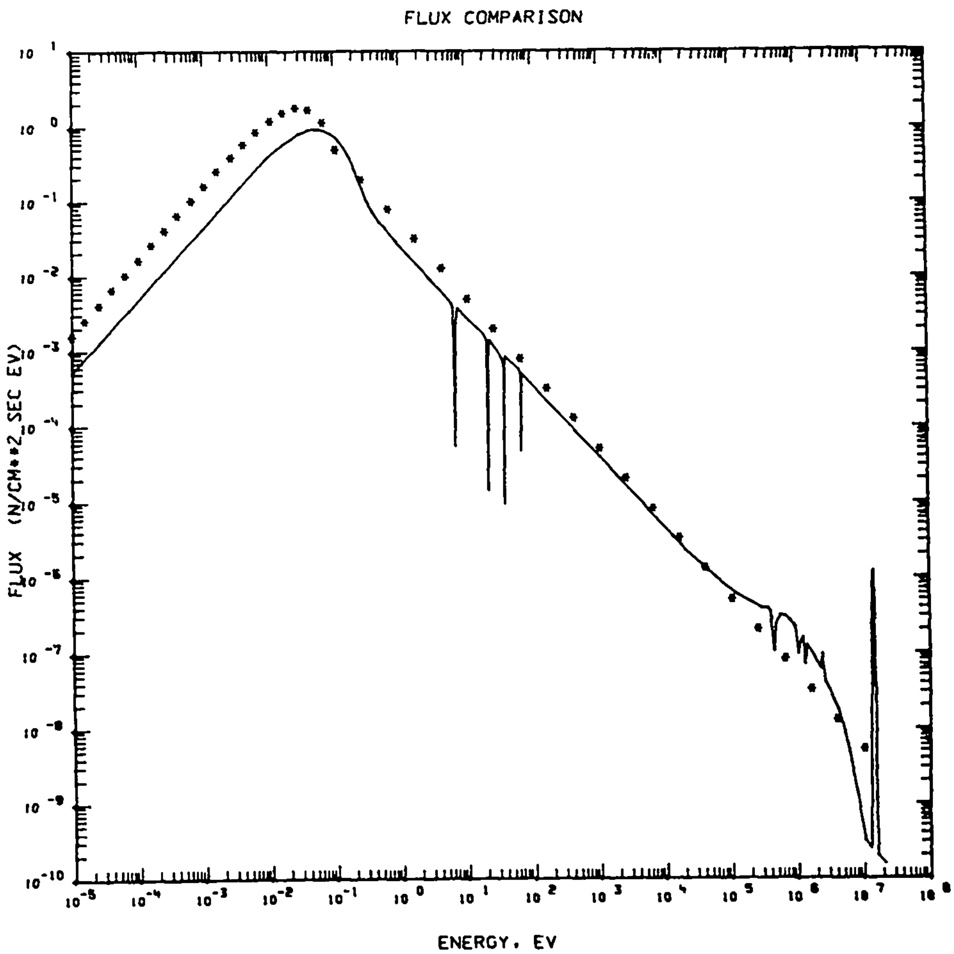

Figure B-3. Flux plot from sample problem 3.

SAMPLE PROBLEM 4. CALCULATE 68-GROUP TOTAL CROSS SECTIONS IN THE GAM-I STRUCTURE FOR ALL IODINE NUCLIDES USING THE PRS FLUX WEIGHTING FUNCTION. SINCE THE CODE IS DIMENSIONED FOR NCC=4, IT IS NECESSARY TO INCREASE THE DIMENSIONS OF EC(NCC+1),CXC(NCC), LFG(NCC+1),CXFLXI(NCC)LB(NCC+1),FLXI(NCC), AND FLXIM(NCC,NCF). SPECIFY THE GAM-I ENERGY BOUNDARIES BY TAGGING NCC NEGATIVE AND USING THE (LB(ICC),ICC=1,69) INPUT. DO NOT MAKE FLUX PLOT.

STORAGE ADJUSTMENTS FOR SAMPLE PROBLEM 4.

```
     COMMON /A/ EFLUX(201),FLUX(200),EF(155),EC(69),CXF(154),CXC(68)
     COMMON /B/ LB(69),LFG(69),CXFLXI(68),FLXI(68)
     COMMON /C/ IFLX,NFX,NFXP,NCF,NCC,TITLE(20),TITL(17)
     COMMON /D/ FLXIM(68,154),SYM(103)
     COMMON /E/ EFLUXP(115),FLUXP(115)
     COMMON /F/ C(6),EX(7),TKM,SLPA,THETA,SLPB,TKF,EP,SLPC
```

INPUT FILE FOR SAMPLE PROBLEM 4.

```
SAMPLE PROBLEM 4, GAM-I 68-GP TOTAL, ALL IODINE,PRS FLUX, 900K
    2     0   -68    12     0
   53    53   127   135     3     3     1    11.0    +101.0    +109.0    +029.0    +02
    7     8     9    10    11    12    13    14    15    16    18    20    22    24    26    28
   30    31    32    33    34    35    36    37    40    42    43    44    45    46    47    48
   49    50    51    52    53    54    55    56    57    58    59    60    61    62    63    64
   69    73    75    78    81    85    86    87    88    90    91    92    93    95   104   113
  117   125   127   129   132
```

OUTPUT FILE FROM SAMPLE PROBLEM 4.

```
                      SAMPLE PROBLEM 4, GAM-I 68-GP TOTAL, ALL IODINE,PRS FLUX, 900K
         **SUMMARY OF PROBLEM CONTROL INPUT******
   IFLX =  2    ,WHERE 1=COLLAPSE TO BUILT-IN FUNCTIONAL FLUX, WITH PARAMETERS READ FROM CARD INPUT
                       2=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM DATA FILE
                       3=COLLAPSE TO FLUX DESCRIBED BY SET OF LOG-LOG INTERPOLATION POINTS READ FROM CARD INPUT
                       4=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-EV
                       5=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC-UNIT LETHARGY
                       6=COLLAPSE TO HISTOGRAM FLUX READ FROM CARD INPUT IN UNITS  N/CM**2-SEC (GROUP INTEGRAL FLUXES)
    NFX =  0    ,NUMBER OF FLUX VALUES IN USER COLLAPSING FLUX DESCRIPTION   (SET TO NFXP BY CODE IF IFLX=2)
    NCC = 68    ,NUMBER OF COARSE GROUPS
     NT = 12    ,TABLE NUMBER FOR TAPE2 HEADING
 IPLTFX =  0    ,WHERE 0=NO PLOT OF FLUX
                       1=MAKE PLOT OF LOG-LOG FLUX READ FROM DATA FILE AND, IF DIFFERENT, USER COLLAPSING FLUX

  COLLAPSE CROSS-SECTION TABULATIONS WITHIN THE FOLLOWING LIMITS
  *****Z*****     *****A*****   *REACTION MF*  *REACTION MT*    ***BONDARENKO SIGMA ZERO***     ******TEMPERATURE (K)******
   53 TO  53      127 TO 135        3 TO   3        1 TO   1      1.000E+10 TO   1.000E+10        9.000E+02 TO   9.000E+02

 ECHO FROM DATA FILE     TOAFEW-V 154-GP ENDF/B-V FISSION-PRODUCT AND ACTINIDE CROSS SECTIONS 2-9-81
```

```
 ECHO FROM DATA FILE       PRS 154-GROUP NEUTRON MULTIGROUP STRUCTURE     1.00000E+07 7.78801E+06 6.06531E+06 4.72367E+06
2.00000E+07 1.82212E+07 1.69046E+07 1.49182E+07 1.34986E+07 1.19125E+07 1.05399E+06 9.53692E+05 8.20850E+05 7.42736E+05 6.39279E+05
3.67879E+06 2.86505E+06 2.23130E+06 1.73774E+06 1.35335E+06 1.05399E+06 9.53692E+05 8.20850E+05 7.42736E+05 6.39279E+05
5.78443E+05 4.97871E+05 4.50492E+05 3.87742E+05 3.50844E+05 3.01974E+05 2.73237E+05 2.35177E+05 2.12797E+05 1.83156E+05
1.42642E+05 1.11090E+05 8.65170E+04 6.73795E+04 5.24752E+04 4.08677E+04 3.18278E+04 2.80879E+04 2.60584E+04 2.47875E+04
2.35786E+04 1.93045E+04 1.50344E+04 1.17088E+04 9.11882E+03 7.10174E+03 5.53084E+03 4.30743E+03 3.35463E+03 2.61259E+03
2.03468E+03 1.58461E+03 1.23410E+03 9.61117E+02 7.48518E+02 5.82947E+02 4.53999E+02 3.53575E+02 2.75364E+02 2.14454E+02
1.67017E+02 1.30073E+02 1.01301E+02 7.88932E+01 7.36000E+01 6.97500E+01 6.85500E+01 6.70000E+01 6.14421E+01 5.99000E+01
5.90500E+01 5.84000E+01 4.78512E+01 4.00000E+01 3.72665E+01 3.60500E+01 3.50000E+01 2.90232E+01 2.37100E+01 2.32000E+01
2.26033E+01 2.21000E+01 2.15000E+01 2.03000E+01 1.76035E+01 1.37096E+01 1.06770E+01 8.31529E+00 7.00000E+00 6.47595E+00
5.04348E+00 3.92786E+00 3.05902E+00 2.56084E+00 2.38237E+00 2.31603E+00 2.29429E+00 2.27266E+00 2.25113E+00 2.17213E+00
2.09408E+00 2.01791E+00 1.93562E+00 1.85539E+00 1.80897E+00 1.76305E+00 1.72608E+00 1.71773E+00 1.64759E+00 1.59493E+00
1.57850E+00 1.45742E+00 1.44498E+00 1.30785E+00 1.20867E+00 1.16638E+00 1.12535E+00 1.09868E+00 1.07217E+00 1.06231E+00
1.05250E+00 1.04273E+00 1.01370E+00 9.50653E-01 8.76425E-01 7.82079E-01 6.82560E-01 6.25060E-01 5.31579E-01 5.03235E-01
4.17016E-01 4.13994E-01 3.57665E-01 3.20628E-01 3.01120E-01 2.90737E-01 2.70518E-01 2.51028E-01 2.27690E-01 1.84429E-01
1.52300E-01 1.45721E-01 1.11568E-01 8.19683E-02 5.69224E-02 4.27551E-02 3.06116E-02 2.04921E-02 1.23964E-02 6.32472E-03
2.27690E-03 7.60219E-04 2.52989E-04 1.38879E-04 1.00000E-05
 ECHO FROM DATA FILE       PRS NEUTRON FLUX WEIGHTING FUNCTION    115 LOG-LOG INTERPOLATION PTS
2.00000E+07 1.54770E-10 1.56760E+07 1.97800E-10 1.55000E+07 1.14060E-09 1.54000E+07 2.84500E-09 1.53000E+07 6.66880E-09
1.52000E+07 1.46870E-08 1.51000E+07 3.03540E-08 1.50000E+07 5.88320E-08 1.49000E+07 1.06990E-07 1.48000E+07 1.82130E-07
1.47000E+07 2.90410E-07 1.46000E+07 4.33170E-07 1.45000E+07 6.04030E-07 1.44000E+07 7.87040E-07 1.43000E+07 9.57570E-07
1.42000E+07 1.08700E-06 1.40700E+07 1.15400E-06 1.39000E+07 1.04080E-06 1.38000E+07 8.88250E-07 1.37000E+07 7.04780E-07
1.36000E+07 5.19460E-07 1.35000E+07 3.55120E-07 1.34000E+07 2.25110E-07 1.33000E+07 1.32220E-07 1.32000E+07 7.18640E-08
1.31000E+07 3.61220E-08 1.30000E+07 1.67760E-08 1.29000E+07 7.19100E-09 1.28000E+07 2.84360E-09 1.27000E+07 1.03570E-09
1.26000E+07 3.47310E-10 1.25700E+07 2.46190E-10 1.00000E+07 3.09530E-10 8.00000E+06 1.22760E-09 6.00000E+06 4.71530E-09
5.00000E+06 9.06790E-09 4.00000E+06 1.70730E-08 3.00000E+06 3.11420E-08 2.63000E+06 3.99810E-08 2.35000E+06 9.15950E-08
2.22000E+06 5.90330E-08 1.40000E+06 1.21820E-07 1.31000E+06 6.86960E-08 1.21000E+06 1.50220E-07 1.19000E+06 1.54790E-07
1.12000E+06 1.36480E-07 1.05000E+06 1.15180E-07 1.00000E+06 9.15950E-08 9.41000E+05 1.78610E-07 9.00000E+05 2.14790E-07
7.70000E+05 2.50050E-07 6.50000E+05 2.94930E-07 5.40000E+05 3.05010E-07 5.02000E+05 2.63330E-07 4.74000E+05 2.17540E-07
4.42000E+05 1.00750E-07 3.99000E+05 2.73870E-07 3.77000E+05 3.40270E-07 3.56000E+05 3.69260E-07 2.83000E+05 3.83090E-07
2.01000E+05 4.36450E-07 1.20000E+05 5.79340E-07 6.07000E+04 9.15950E-07 3.07000E+04 1.55710E-06 2.00000E+04 2.22570E-06
1.01000E+03 3.78290E-05 6.82000E+01 4.83620E-04 6.71000E+01 4.72260E-04 6.60000E+01 4.57970E-05 6.49000E+01 4.82430E-04
6.12000E+01 5.58730E-04 3.87000E+01 8.26180E-04 3.74000E+01 6.54530E-04 3.67000E+01 9.15950E-06 3.59000E+01 6.78720E-04
3.56000E+01 7.48970E-04 3.44000E+01 8.15190E-04 2.25000E+01 1.35650E-03 2.14000E+01 1.05880E-03 2.09000E+01 1.37390E-05
2.03700E+01 1.09730E-03 1.98600E+01 1.38580E-03 1.75300E+01 1.71560E-03 7.30800E+00 3.60420E-03 7.01000E+00 2.92190E-03
6.89400E+00 1.76320E-03 6.67000E+00 5.31250E-05 6.44900E+00 1.65240E-03 6.13500E+00 3.72790E-03 5.88420E+00 4.19500E-03
5.50470E+00 4.61640E-03 4.01000E+00 6.32000E-03 1.35180E+00 1.85020E-02 1.00000E+00 2.49140E-02 6.00000E-01 4.13000E-02
5.70000E-01 4.37000E-02 4.90000E-01 5.10000E-02 4.00000E-01 6.87000E-02 3.00000E-01 1.08000E-01 2.10000E-01 2.52000E-01
1.70000E-01 3.83000E-01 1.40000E-01 5.20000E-01 1.12000E-01 6.86000E-01 9.00000E-02 7.99000E-01 7.00000E-02 8.92000E-01
5.90000E-02 9.18000E-01 5.40000E-02 9.21000E-01 5.00000E-02 9.18000E-01 4.30000E-02 8.98000E-01 3.30000E-02 8.29000E-01
2.90000E-02 7.85000E-01 2.40000E-02 7.12000E-01 1.60000E-02 5.52000E-01 9.00000E-03 3.55000E-01 1.00000E-05 5.25000E-04

        COARSE GROUP STRUCTURE
1.00000E+07 7.78801E+06 6.06531E+06 4.72367E+06 3.67879E+06 2.86505E+06 2.23130E+06 1.73774E+06 1.35335E+06 1.05399E+06
8.20850E+05 6.39279E+05 4.97871E+05 3.87742E+05 3.01974E+05 2.35177E+05 1.83156E+05 1.42642E+05 1.11090E+05 8.65170E+04
6.73795E+04 5.24752E+04 4.08677E+04 3.18278E+04 2.47875E+04 1.93045E+04 1.50344E+04 1.17088E+04 9.11882E+03 7.10174E+03
5.53084E+03 4.30743E+03 3.35463E+03 2.61259E+03 2.03468E+03 1.58461E+03 1.23410E+03 9.61117E+02 7.48518E+02 5.82947E+02
4.53999E+02 3.53575E+02 2.75364E+02 2.14454E+02 1.67017E+02 1.30073E+02 1.01301E+02 7.88932E+01 6.14421E+01 4.78512E+01
3.72665E+01 2.90232E+01 2.26033E+01 1.76035E+01 1.37096E+01 1.06770E+01 8.31529E+00 6.47595E+00 5.04348E+00 3.92786E+00
3.05902E+00 2.38237E+00 1.85539E+00 1.44498E+00 1.12535E+00 8.76425E-01 6.82560E-01 5.31579E-01 4.13994E-01
 (LFG(IGC),IGC=1, 69)ARE
   6     7     8     9    10    11    12    13    14    15    17    19    21    23    25    27
  29    30    31    32    33    34    35    36    39    41    42    43    44    45    46    47
  48    49    50    51    52    53    54    55    56    57    58    59    60    61    62    63
  68    72    74    77    80    84    85    86    87    89    90    91    92    94   103   112
 116   124   126   128   131
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 INTEGRATED MULTIGROUP FLUXES, FLXI(IGC),IGC=1, 68)
1.57700E-03 4.44467E-03 9.60783E-03 1.57722E-02 2.14780E-02 3.49394E-02 3.51326E-02 3.96047E-02 3.53772E-02 3.90860E-02
4.80386E-02 4.16709E-02 2.11615E-02 3.11154E-02 2.61921E-02 2.24547E-02 1.98891E-02 1.77936E-02 1.62701E-02 1.49896E-02
1.38708E-02 1.30922E-02 1.23866E-02 1.17778E-02 1.12996E-02 1.10376E-02 1.08973E-02 1.07588E-02 1.06221E-02 1.04870E-02
1.03538E-02 1.02221E-02 1.00922E-02 9.96394E-03 9.83729E-03 9.71226E-03 9.58865E-03 9.46134E-03 9.33318E-03 9.20675E-03
9.08204E-03 8.95901E-03 8.83765E-03 8.71794E-03 8.59985E-03 8.48335E-03 8.36844E-03 7.54056E-03 8.39829E-03 7.91186E-03
6.16962E-03 7.43635E-03 5.80991E-03 7.38241E-03 7.10814E-03 6.84385E-03 4.84642E-03 5.71924E-03 6.34143E-03 6.32461E-03
6.30545E-03 6.28635E-03 6.26731E-03 6.24801E-03 6.22845E-03 6.21163E-03 6.21079E-03 6.41633E-03
 ECHO FROM DATA FILE    TABULATIONS ORDERED ON INCREASING Z,A,STATE,TEMP,MF,MT AND DECREASING SIGMA-0

I127       MAT9606      MF  3      MT  1      TEMP=    900      SIGMA 0= 1.0E+10
4.03750E+00 3.89574E+00 4.11443E+00 4.46666E+00 4.92649E+00 5.42705E+00 5.84260E+00 6.14286E+00 6.28578E+00 6.30246E+00
6.24402E+00 6.15331E+00 6.05698E+00 5.97519E+00 5.91336E+00 5.87420E+00 5.85297E+00 5.84805E+00 5.85929E+00 5.88639E+00
5.92855E+00 5.99074E+00 6.07628E+00 6.18134E+00 6.31859E+00 6.50603E+00 6.72195E+00 6.95662E+00 7.25383E+00 7.60061E+00
8.00542E+00 8.48566E+00 9.02894E+00 9.64723E+00 1.03756E+01 1.12074E+01 1.14126E+01 1.37255E+01 1.80576E+01 1.54625E+01
3.36654E+01 7.33305E+00 1.73836E+01 6.89580E+01 3.17673E+01 4.14961E+00 4.03619E+01 4.79026E+01 6.48973E+00 3.06604E+02
1.91617E+02 3.66316E+00 1.63630E+01 3.21880E+00 3.29344E+00 3.39017E+00 3.46412E+00 3.57011E+00 3.63277E+00 3.71165E+00
3.79372E+00 3.88008E+00 3.97804E+00 4.08423E+00 4.20387E+00 4.34038E+00 4.48901E+00 4.66453E+00

I129       MAT9608      MF  3      MT  1      TEMP=    900      SIGMA 0= 1.0E+10
4.04529E+00 3.90375E+00 4.15120E+00 4.53900E+00 5.04244E+00 5.56156E+00 5.94786E+00 6.21948E+00 6.32044E+00 6.28761E+00
6.18677E+00 6.05971E+00 5.93285E+00 5.83546E+00 5.76884E+00 5.73049E+00 5.72037E+00 5.73413E+00 5.76873E+00 5.82433E+00
5.90159E+00 6.00171E+00 6.12500E+00 6.28226E+00 6.47506E+00 6.72382E+00 7.00590E+00 7.31027E+00 7.68708E+00 8.10732E+00
8.62309E+00 9.22074E+00 9.87939E+00 1.06471E+01 1.15392E+01 1.25532E+01 1.36799E+01 1.46514E+01 1.55799E+01 1.66402E+01
1.78092E+01 1.90793E+01 2.06819E+01 1.92182E+01 3.76752E+01 6.40669E+00 6.08328E+00 2.74528E+01 4.97968E+00 5.12130E+00
5.24967E+00 5.35880E+00 5.48704E+00 5.61688E+00 5.76877E+00 5.93753E+00 6.07845E+00 6.36247E+00 6.58241E+00 6.85732E+00
7.16892E+00 7.51229E+00 7.91234E+00 8.36694E+00 8.86918E+00 9.45490E+00 1.01104E+01 1.08529E+01

I130       MAT9609      MF  3      MT  1      TEMP=    900      SIGMA 0= 1.0E+10
4.03454E+00 3.90781E+00 4.16967E+00 4.58424E+00 5.10424E+00 5.58784E+00 6.00347E+00 6.23245E+00 6.26922E+00 6.26340E+00
6.14941E+00 5.99844E+00 5.86544E+00 5.77324E+00 5.70711E+00 5.66839E+00 5.66685E+00 5.69015E+00 5.73536E+00 5.80867E+00
5.90323E+00 6.03226E+00 6.20418E+00 6.38870E+00 6.58891E+00 6.86021E+00 7.17849E+00 7.52640E+00 7.98575E+00 8.51030E+00
9.08117E+00 9.69981E+00 1.04394E+01 1.16992E+01 1.33581E+01 1.55020E+01 1.83027E+01 2.10736E+01 2.38798E+01 2.71767E+01
3.10633E+01 3.56727E+01 4.11344E+01 4.75974E+01 5.51578E+01 6.43404E+01 7.47314E+01 8.54952E+01 9.90859E+01 1.13990E+02
1.33239E+02 8.26728E+01 5.98486E+00 5.42266E+00 5.51777E+00 5.62888E+00 5.73281E+00 5.90738E+00 6.05705E+00 6.24144E+00
6.44152E+00 6.67660E+00 6.94102E+00 7.23914E+00 7.58387E+00 7.96329E+00 8.40780E+00 8.91101E+00

I131       MAT9611      MF  3      MT  1      TEMP=    900      SIGMA 0= 1.0E+10
4.04066E+00 3.91628E+00 4.19032E+00 4.61822E+00 5.15762E+00 5.60492E+00 6.04706E+00 6.27251E+00 6.29035E+00 6.26934E+00
6.13706E+00 5.99086E+00 5.83956E+00 5.72079E+00 5.66365E+00 5.61855E+00 5.63480E+00 5.66920E+00 5.71758E+00 5.81989E+00
5.93152E+00 6.07228E+00 6.27576E+00 6.48937E+00 6.71492E+00 7.02088E+00 7.37932E+00 7.76351E+00 8.31652E+00 8.96517E+00
9.68802E+00 1.05011E+01 1.14347E+01 1.25152E+01 1.37068E+01 1.50164E+01 1.64611E+01 1.81190E+01 1.99898E+01 2.20595E+01
2.44197E+01 2.70687E+01 1.60383E+01 4.74176E+00 4.72523E+00 4.72643E+00 4.72784E+00 4.72937E+00 4.73118E+00 4.73320E+00
4.73569E+00 4.73814E+00 4.74124E+00 4.74447E+00 4.74825E+00 4.75262E+00 4.75642E+00 4.76352E+00 4.76952E+00 4.77647E+00
4.78461E+00 4.79386E+00 4.80419E+00 4.81626E+00 4.82971E+00 4.84508E+00 4.86298E+00 4.88255E+00

I135       MAT9618      MF  3      MT  1      TEMP=    900      SIGMA 0= 1.0E+10
4.07308E+00 3.96910E+00 4.26727E+00 4.63886E+00 5.32341E+00 5.81718E+00 6.25453E+00 6.44651E+00 6.40721E+00 6.27598E+00
6.07234E+00 5.87518E+00 5.67500E+00 5.53839E+00 5.49204E+00 5.45784E+00 5.52040E+00 5.61164E+00 5.72193E+00 5.91124E+00
6.11660E+00 6.36868E+00 6.69024E+00 7.03819E+00 7.40697E+00 7.87219E+00 7.47129E+00 5.23000E+00 4.81207E+00 4.81204E+00
4.81205E+00 4.81205E+00 4.81206E+00 4.81207E+00 4.81208E+00 4.81209E+00 4.81210E+00 4.81211E+00 4.81213E+00 4.81214E+00
4.81216E+00 4.81219E+00 4.81221E+00 4.81224E+00 4.81227E+00 4.81231E+00 4.81235E+00 4.81240E+00 4.81246E+00 4.81253E+00
4.81260E+00 4.81269E+00 4.81279E+00 4.81290E+00 4.81304E+00 4.81319E+00 4.81335E+00 4.81359E+00 4.81383E+00 4.81413E+00
4.81447E+00 4.81487E+00 4.81536E+00 4.81594E+00 4.81662E+00 4.81747E+00 4.81845E+00 4.81969E+00
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TAPE2 FILE FROM SAMPLE PROBLEM 4.

TABLE 12

68 GROUP CROSS SECTIONS

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I127       MAT9606     MF  3     MT  1     TEMP=   900    SIGMA 0= 1.0E+10 4.92649E+00 5.42705E+00 5.84260E+00 6.14286E+00 6.28578E+00 6.30246E+00
4.03750E+00 3.89574E+00 4.11443E+00 4.46666E+00 4.92649E+00 5.42705E+00 5.84260E+00 6.14286E+00 6.28578E+00 6.30246E+00
6.24402E+00 6.15331E+00 6.05698E+00 5.97519E+00 5.91336E+00 5.87420E+00 5.85297E+00 5.84805E+00 5.85929E+00 5.88639E+00
5.92855E+00 5.99074E+00 6.07628E+00 6.18134E+00 6.31859E+00 6.50603E+00 6.72195E+00 6.95662E+00 7.25383E+00 7.60061E+00
8.00542E+00 8.48566E+00 9.02894E+00 9.64723E+00 1.03756E+01 1.12074E+01 1.14126E+01 1.37255E+01 1.80576E+01 1.54625E+01
3.36654E+01 7.33305E+00 1.73836E+01 6.89580E+01 3.17673E+01 4.14961E+00 4.03619E+01 4.79026E+01 6.48973E+00 3.06604E+02
1.91617E+02 3.66316E+00 1.63630E+01 3.21880E+00 3.29344E+00 3.39017E+00 3.46412E+00 3.57011E+00 3.63277E+00 3.71165E+00
3.79372E+00 3.88008E+00 3.97804E+00 4.08423E+00 4.20387E+00 4.34038E+00 4.48901E+00 4.66453E+00

I129       MAT9608     MF  3     MT  1     TEMP=   900    SIGMA 0= 1.0E+10 5.04244E+00 5.56156E+00 5.94786E+00 6.21948E+00 6.32044E+00 6.28761E+00
4.04529E+00 3.90375E+00 4.15120E+00 4.53900E+00 5.04244E+00 5.56156E+00 5.94786E+00 6.21948E+00 6.32044E+00 6.28761E+00
6.18677E+00 6.05971E+00 5.93285E+00 5.83546E+00 5.76884E+00 5.73049E+00 5.72037E+00 5.73413E+00 5.76873E+00 5.82433E+00
5.90159E+00 6.00171E+00 6.12500E+00 6.28226E+00 6.47506E+00 6.72382E+00 7.00590E+00 7.31027E+00 7.68708E+00 8.10732E+00
8.62309E+00 9.22074E+00 9.87939E+00 1.06471E+01 1.15392E+01 1.25532E+01 1.36799E+01 1.46514E+01 1.55799E+01 1.66402E+01
1.78092E+01 1.90793E+01 2.06819E+01 1.92182E+01 3.76752E+01 6.40669E+00 6.08328E+00 2.74528E+01 4.97968E+00 5.12130E+00
5.24967E+00 5.35880E+00 5.48704E+00 5.61688E+00 5.76877E+00 5.93753E+00 6.07845E+00 6.36247E+00 6.58241E+00 6.85732E+00
7.16892E+00 7.51229E+00 7.91234E+00 8.36694E+00 8.86918E+00 9.45490E+00 1.01104E+01 1.08529E+01

I130       MAT9609     MF  3     MT  1     TEMP=   900    SIGMA 0= 1.0E+10 5.10424E+00 5.58784E+00 6.00347E+00 6.23245E+00 6.26922E+00 6.26340E+00
4.03454E+00 3.90781E+00 4.16967E+00 4.58424E+00 5.10424E+00 5.58784E+00 6.00347E+00 6.23245E+00 6.26922E+00 6.26340E+00
6.14941E+00 5.99844E+00 5.86544E+00 5.77324E+00 5.70711E+00 5.66839E+00 5.66685E+00 5.69015E+00 5.73536E+00 5.80867E+00
5.90323E+00 6.03226E+00 6.20418E+00 6.38870E+00 6.58891E+00 6.86021E+00 7.17849E+00 7.52640E+00 7.98575E+00 8.51030E+00
9.08117E+00 9.69981E+00 1.04394E+01 1.16992E+01 1.33581E+01 1.55020E+01 1.83027E+01 2.10736E+01 2.38798E+01 2.71767E+01
3.10633E+01 3.56727E+01 4.11344E+01 4.75974E+01 5.51578E+01 6.43404E+01 7.47314E+01 8.54952E+01 9.90859E+01 1.13990E+02
1.33239E+02 8.26728E+01 5.98486E+00 5.42266E+00 5.51777E+00 5.62888E+00 5.73281E+00 5.90738E+00 6.05705E+00 6.24144E+00
6.44152E+00 6.67660E+00 6.94102E+00 7.23914E+00 7.58387E+00 7.96329E+00 8.40780E+00 8.91101E+00

I131       MAT9611     MF  3     MT  1     TEMP=   900    SIGMA 0= 1.0E+10 5.15762E+00 5.60492E+00 6.04706E+00 6.27251E+00 6.29035E+00 6.26934E+00
4.04066E+00 3.91628E+00 4.19032E+00 4.61822E+00 5.15762E+00 5.60492E+00 6.04706E+00 6.27251E+00 6.29035E+00 6.26934E+00
6.13706E+00 5.99086E+00 5.83956E+00 5.72079E+00 5.66365E+00 5.61855E+00 5.63480E+00 5.66920E+00 5.71758E+00 5.81989E+00
5.93152E+00 6.07228E+00 6.27576E+00 6.48937E+00 6.71492E+00 7.02088E+00 7.37932E+00 7.76351E+00 8.31652E+00 8.96517E+00
9.68802E+00 1.05011E+01 1.14347E+01 1.25152E+01 1.37068E+01 1.50164E+01 1.64611E+01 1.81190E+01 1.99898E+01 2.20595E+01
2.44197E+01 2.70687E+01 1.60383E+01 4.74176E+00 4.72523E+00 4.72643E+00 4.72784E+00 4.72937E+00 4.73118E+00 4.73320E+00
4.73569E+00 4.73814E+00 4.74124E+00 4.74447E+00 4.74825E+00 4.75262E+00 4.75642E+00 4.76352E+00 4.76952E+00 4.77647E+00
4.78461E+00 4.79386E+00 4.80419E+00 4.81626E+00 4.82971E+00 4.84508E+00 4.86298E+00 4.88255E+00

I135       MAT9618     MF  3     MT  1     TEMP=   900    SIGMA 0= 1.0E+10 5.32341E+00 5.81718E+00 6.25453E+00 6.44651E+00 6.40721E+00 6.27598E+00
4.07308E+00 3.96910E+00 4.26727E+00 4.63886E+00 5.32341E+00 5.81718E+00 6.25453E+00 6.44651E+00 6.40721E+00 6.27598E+00
6.07234E+00 5.87518E+00 5.67500E+00 5.53839E+00 5.49204E+00 5.45784E+00 5.52040E+00 5.61164E+00 5.72193E+00 5.91124E+00
6.11660E+00 6.36868E+00 6.69024E+00 7.03819E+00 7.40697E+00 7.87219E+00 7.47129E+00 5.23000E+00 4.81207E+00 4.81204E+00
4.81205E+00 4.81205E+00 4.81206E+00 4.81207E+00 4.81208E+00 4.81209E+00 4.81210E+00 4.81211E+00 4.81213E+00 4.81214E+00
4.81216E+00 4.81219E+00 4.81221E+00 4.81224E+00 4.81227E+00 4.81231E+00 4.81235E+00 4.81240E+00 4.81246E+00 4.81253E+00
4.81260E+00 4.81269E+00 4.81279E+00 4.81290E+00 4.81304E+00 4.81319E+00 4.81335E+00 4.81359E+00 4.81383E+00 4.81413E+00
4.81447E+00 4.81487E+00 4.81536E+00 4.81594E+00 4.81662E+00 4.81747E+00 4.81845E+00 4.81969E+00
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