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Multigroup and Few-Group Cross Sections for ENDF/B-IV Fission Products; The TOAFEW Collapsing Code and Data File of 154-Group Fission-Product Cross Sections

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W. B. Wilson
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MULTIGROUP AND FEW-GROUP CROSS SECTIONS FOR ENDF/B-IV FISSION PRODUCTS; THE TOAFEW COLLAPSING CODE AND DATA FILE OF 154-GROUP FISSION-PRODUCT CROSS SECTIONS

by

W. B. Wilson,
T. R. England, and R. J. LaBauve

ABSTRACT

The ENDF/B-IV fission-product data file includes data describing 824 nuclides. Cross sections, given for 181 of these nuclides, have been processed into 154 neutron energy groups. The production of the data file is described. The TOAFEW code, useful in collapsing the multigroup values to few-group cross sections, is presented with instructions and examples of its use. The file of multigroup cross sections is available on request.

I. INTRODUCTION

Version four of the Evaluated Nuclear Data File (ENDF/B-IV) includes a library of data for fission-product nuclides. The fission-product library includes radioactive decay, neutron reaction, and fission yield data for 824 nuclides. Basic nuclear data parameters for all nuclides contained in the library have been succinctly presented in Ref. 1, listing half-lives, modes of decay, decay branching fractions, and average decay energies.

Of the 824 nuclides, 181 have neutron cross-section evaluations for total, elastic, total inelastic, and radiative capture reactions from 10^{-5} eV to 20 MeV. Additional cross-section evaluations are included for 36 of the 181 nuclides for other neutron absorption reactions, e.g., (n,2n), (n,p), etc. The thermal (0.0253-eV) value and resonance integral (E_{cut} = 0.5 eV; T = 0 K) of radiative capture cross sections are also tabulated in Ref. 1, along with branching fractions to radiative capture products.

The cross-section evaluations of the ENDF/B-IV fission-product data file have been processed into multigroup form, as described in Sec. II and Sec. III. The multigroup library has been collapsed to a four-group cross-section set, which was combined with ENDF/B-IV radioactive decay and fission yield data to form a fission-product data library for an updated version of the CINDER code.[2]

The TOAFEW code, used in producing few-group values from the multigroup library, is described in Sec. IV and Sec. V. Four-group (n,γ) cross sections produced by the code are given in Sec. VI. A listing of the code is given in Appendix A, and sample problems are described in Appendix B.

II. CROSS-SECTION PROCESSING

Cross sections of the 181 nuclides (MATs) of the ENDF/B-IV fission-product 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 0 K cross-section data representation of ENDF/B-IV, 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, or PENDF.[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.

Of the 181 nuclides (MATs) of the ENDF/B-IV fission-product file having evaluated cross sections, 25 also appear in the ENDF/B-IV general-purpose file. Multigroup cross sections for 20 of these MATs were processed from 900 K PENDF files retained from previous processing. The remaining 161 MATs were processed from 1000 K PENDF files produced from the fission-product data file.

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 as

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

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 integral of $\phi(E)$ over the energy range of group j.

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 defined a flux weighting function and multigroup energy structure appropriate to power reactor studies (PRS).

A. PRS Flux Weighting Function

The PRS flux description, the product of an investigation of structure found in the flux spectrum of a mid-life PWR, is applicable to the processing of neutron multigroup cross sections for power reactor studies. The flux weighting function $\phi(E)$, described by a set of 115 log-log interpolation points given in Table I and shown in Fig. 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.[5]

0.625 eV — 3.0×10^{4} eV

$\phi(E)$ approximates the spectrum from MC^2 (Ref. 6) "ultrafine" multigroup calculations with over 2000 energy groups to vividly display flux perturbations due to ^{238}U resonances at 6.67 eV, 20.9 eV, 36.7 eV, 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 MeV, 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.

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.[7]

1.557×10^{7} eV — 2.0×10^{7} eV

$\phi(E)$ varies as 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.[7]

TABLE I

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	1.0670E-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.

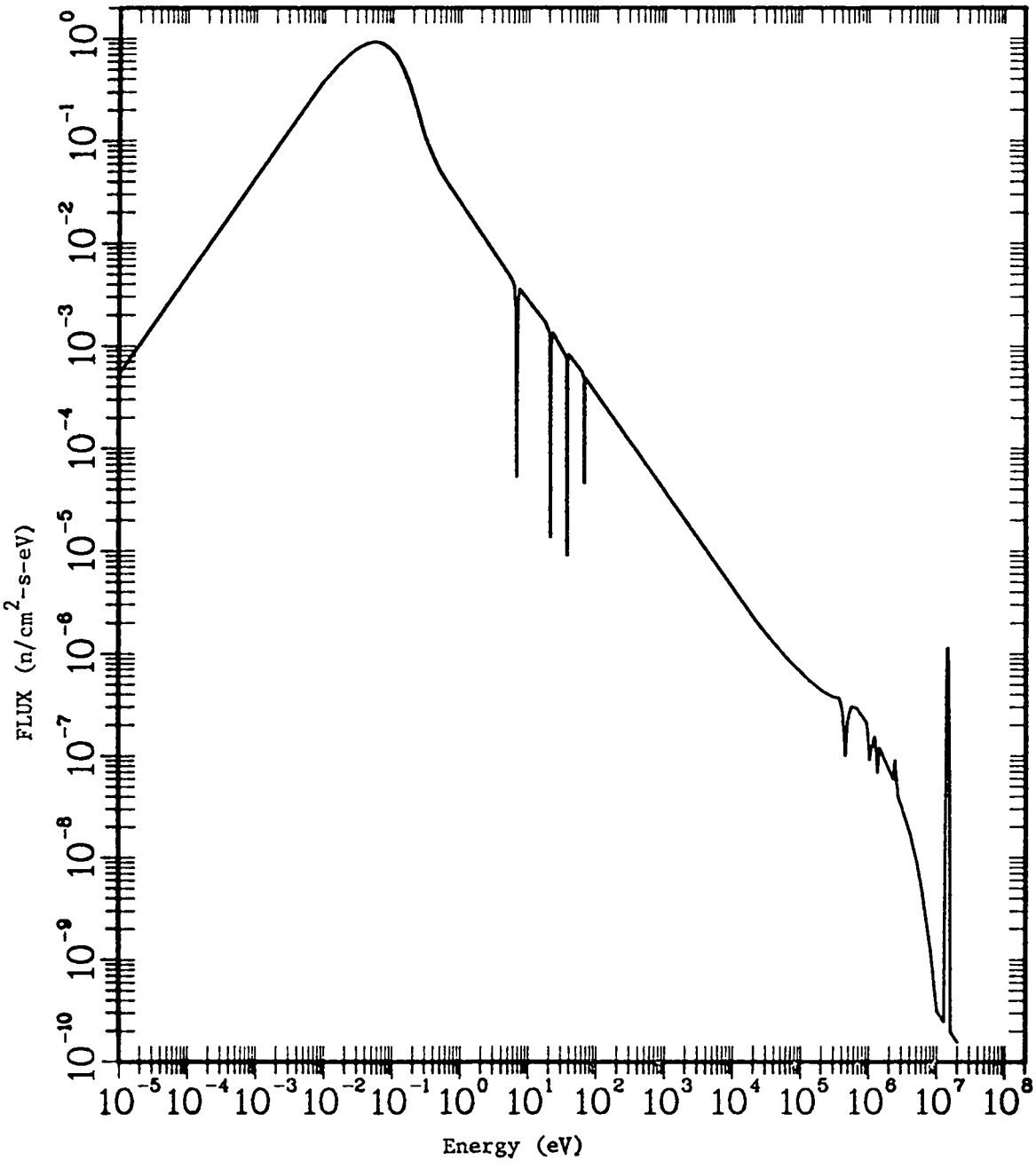

Fig. 1.
PRS flux weighting function.

B. PRS 154-Group Neutron Multigroup Structure

The PRS 154-Group Structure,[8] a subset of the LASL comprehensive 347-Group Structure,[8] 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, 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 II. The corresponding energy group boundary indices of the various subsets listed above are also identified.

III. 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 multigroup cross sections processed are infinitely dilute, with a value of $\sigma_0 = 10^{10}$ barns used in the Bondarenko resonance self-shielding scheme.[9] All cross sections of the 181 nuclides were processed, except for the redundant nonelastic cross section (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 III.

The 181 nuclides (MATs) and reactions (MTs) for which multigroup cross sections are tabulated are listed in Table IV. It should be noted that this tabulation is the same ordering as the nuclide data in the multigroup cross-section file. This ordering is, in order, on Z, A, S, and MT. Here Z and A are the nuclear charge and mass number, S is the nuclear state (0 = ground, 1 = first isomeric level), and MT is the ENDF/B-IV reaction type identification number. This ordering does not correspond to the MAT number ordering of nuclides in the ENDF/B-IV data files.

The multigroup cross-section file contains a total of 25 989 BCD card image records. The first 69 records of the data file (described in Table V) contain descriptive information and data on the data file and the group structure and weighting function used in its production. Multigroup cross-section tabulations (described in Table VI) consist of 960 sets of 27 records each, beginning 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.

TABLE II

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 II (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 II (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 II (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.

TABLE III

IDENTIFICATION OF MT REACTION TYPES

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

TABLE IV

NUCLIDES AND REACTIONS

NUCLIDE	MAT	REACTION MT VALUES												
		1	2	4	16	17	22	28	102	103	104	105	106	107
32-GE- 72	48	X	X	X					X					
32-GE- 73	49	X	X	X					X					
32-GE- 74	51	X	X	X					X					
32-GE- 76	54	X	X	X					X					
33-AS- 75	68	X	X	X					X					
34-SE- 76	85	X	X	X					X					
34-SE- 77	86	X	X	X					X					
34-SE- 78	88	X	X	X					X					
34-SE- 80	91	X	X	X					X					
34-SE- 82	94	X	X	X					X					
35-BR- 79	108	X	X	X					X					
35-BR- 81	112	X	X	X					X					
36-KR- 80	131	X	X	X	X				X	X	X	X	X	X
36-KR- 82	134	X	X	X	X				X	X	X	X	X	X
36-KR- 83	135	X	X	X	X	X			X	X	X	X	X	X
36-KR- 84	137	X	X	X	X				X	X	X	X	X	X
36-KR- 85	138	X	X	X					X					
36-KR- 86	140	X	X	X	X	X			X	X	X	X		X
37-RB- 85	153	X	X	X					X					
37-RB- 86	154	X	X	X					X					
37-RB- 87	156	X	X	X					X					
38-SR- 86	172	X	X	X					X					
38-SR- 87	173	X	X	X					X					
38-SR- 88	175	X	X	X					X					
38-SR- 89	176	X	X	X					X					
38-SR- 90	177	X	X	X					X					
39-Y - 89	192	X	X	X					X					
39-Y - 90	194	X	X	X					X					
39-Y - 91	196	X	X	X					X					
40-ZR- 90	215	X	X	X					X					
40-ZR- 91	217	X	X	X					X					
40-ZR- 92	218	X	X	X					X					
40-ZR- 93	219	X	X	X					X					
40-ZR- 94	220	X	X	X					X					
40-ZR- 95	221	X	X	X					X					
40-ZR- 96	222	X	X	X					X					
41-NB- 93	1189	X	X	X	X	X	X		X	X				X
41-NB- 94	238	X	X	X					X					
41-NB- 95	240	X	X	X					X					
42-MO- 94	264	X	X	X					X					
42-MO- 95	265	X	X	X					X					
42-MO- 96	266	X	X	X					X					
42-MO- 97	267	X	X	X					X					

TABLE IV (cont)

NUCLIDE	MAT	REACTION MT VALUES												
		1	2	4	16	17	22	28	102	103	104	105	106	107
42-MO- 98	268	X	X	X					X					
42-MO- 99	269	X	X	X					X					
42-MO-100	270	X	X	X					X					
43-TC- 99	1137	X	X	X	X				X					
44-RU- 99	308	X	X	X					X					
44-RU-100	309	X	X	X					X					
44-RU-101	310	X	X	X					X					
44-RU-102	311	X	X	X					X					
44-RU-103	312	X	X	X					X					
44-RU-104	313	X	X	X					X					
44-RU-105	314	X	X	X					X					
44-RU-106	315	X	X	X					X					
45-RH-103	1125	X	X	X	X				X					
45-RH-105	334	X	X	X					X					
46-PD-104	358	X	X	X					X					
46-PD-105	359	X	X	X					X					
46-PD-106	360	X	X	X					X					
46-PD-107	361	X	X	X					X					
46-PD-108	363	X	X	X					X					
46-PD-110	366	X	X	X					X					
47-AG-107	1138	X	X	X	X				X	X	X	X		X
47-AG-109	1139	X	X	X	X				X	X				X
47-AG-111	391	X	X	X					X					
48-CD-108	415	X	X	X					X					
48-CD-110	417	X	X	X					X					
48-CD-111	418	X	X	X					X					
48-CD-112	420	X	X	X					X					
48-CD-113	1282	X	X	X	X				X	X				X
48-CD-114	423	X	X	X					X					
48-CD-115M	425	X	X	X					X					
48-CD-116	426	X	X	X					X					
49-IN-113	445	X	X	X					X					
49-IN-115	449	X	X	X					X					
50-SN-115	482	X	X	X					X					
50-SN-116	483	X	X	X					X					
50-SN-117	484	X	X	X					X					
50-SN-118	486	X	X	X					X					
50-SN-119	487	X	X	X					X					
50-SN-120	489	X	X	X					X					
50-SN-122	492	X	X	X					X					
50-SN-123	493	X	X	X					X					
50-SN-124	495	X	X	X					X					
50-SN-125	496	X	X	X					X					
50-SN-126	498	X	X	X					X					
51-SB-121	511	X	X	X					X					
51-SB-123	514	X	X	X					X					
51-SB-124	515	X	X	X					X					
51-SB-125	518	X	X	X					X					
51-SB-126	519	X	X	X					X					

TABLE IV (cont)

NUCLIDE	MAT	REACTION MT VALUES												
		1	2	4	16	17	22	28	102	103	104	105	106	107
52-TE-122	538	X	X	X					X					
52-TE-123	539	X	X	X					X					
52-TE-124	541	X	X	X					X					
52-TE-125	542	X	X	X					X					
52-TE-126	544	X	X	X					X					
52-TE-127M	546	X	X	X					X					
52-TE-128	547	X	X	X					X					
52-TE-129M	549	X	X	X					X					
52-TE-130	550	X	X	X					X					
52-TE-132	553	X	X	X					X					
53-I -127	565	X	X	X					X					
53-I -129	567	X	X	X					X					
53-I -130	568	X	X	X					X					
53-I -131	570	X	X	X					X					
53-I -135	576	X	X	X					X					
54-XE-128	1173	X	X	X	X	X			X	X	X	X		X
54-XE-129	589	X	X	X	X	X			X	X	X	X		X
54-XE-130	1174	X	X	X	X	X			X	X	X	X		X
54-XE-131	1175	X	X	X	X	X			X	X	X	X		X
54-XE-132	1176	X	X	X	X	X			X	X	X	X		X
54-XE-133	595	X	X	X					X					
54-XE-134	1177	X	X	X	X	X			X	X	X	X		X
54-XE-135	1294	X	X	X					X					
54-XE-136	1178	X	X	X	X	X			X	X	X	X		X
55-CS-133	1141	X	X	X	X				X	X				X
55-CS-134	614	X	X	X					X					
55-CS-135	616	X	X	X					X					
55-CS-136	618	X	X	X					X					
55-CS-137	619	X	X	X					X					
56-BA-134	634	X	X	X					X					
56-BA-135	635	X	X	X					X					
56-BA-136	637	X	X	X					X					
56-BA-137	639	X	X	X					X					
56-BA-138	641	X	X	X					X					
56-BA-140	643	X	X	X					X					
57-LA-139	657	X	X	X					X					
57-LA-140	658	X	X	X					X					
58-CE-140	674	X	X	X					X					
58-CE-141	675	X	X	X					X					
58-CE-142	676	X	X	X					X					
58-CE-143	677	X	X	X					X					
58-CE-144	678	X	X	X					X					
59-PR-141	692	X	X	X	X	X	X	X	X	X	X	X	X	X
59-PR-142	693	X	X	X					X					
59-PR-143	695	X	X	X					X					
60-ND-142	713	X	X	X					X					
60-ND-143	714	X	X	X	X	X	X	X	X	X	X	X	X	X
60-ND-144	715	X	X	X					X					
60-ND-145	716	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE IV (cont)

NUCLIDE	MAT	REACTION MT VALUES												
		1	2	4	16	17	22	28	102	103	104	105	106	107
60-ND-146	717	X	X	X	X	X	X	X	X	X	X	X	X	X
60-ND-147	718	X	X	X					X					
60-ND-148	719	X	X	X	X	X	X	X	X	X	X	X	X	X
60-ND-150	721	X	X	X	X	X	X	X	X	X	X	X		X
61-PM-147	733	X	X	X	X	X	X	X	X	X	X	X	X	X
61-PM-148	734	X	X	X					X					
61-PM-148M	735	X	X	X					X					
61-PM-149	736	X	X	X					X					
61-PM-151	738	X	X	X					X					
62-SM-147	753	X	X	X	X	X	X	X	X	X	X	X	X	X
62-SM-148	754	X	X	X					X					
62-SM-149	1027	X	X	X	X	X			X	X				X
62-SM-150	756	X	X	X					X					
62-SM-151	757	X	X	X	X	X	X	X	X	X	X	X	X	X
62-SM-152	758	X	X	X	X	X	X	X	X	X	X	X	X	X
62-SM-153	759	X	X	X					X					
62-SM-154	760	X	X	X					X					
63-EU-151	1290	X	X	X	X	X	X	X	X	X	X	X	X	X
63-EU-152	1292	X	X	X	X	X	X	X	X	X	X	X	X	X
63-EU-153	1291	X	X	X	X	X	X	X	X	X	X	X	X	X
63-EU-154	1293	X	X	X	X	X	X	X	X	X	X	X	X	X
63-EU-155	778	X	X	X	X	X	X	X	X	X	X	X	X	X
63-EU-156	779	X	X	X					X					
63-EU-157	780	X	X	X					X					
64-GD-154	791	X	X	X					X					
64-GD-155	792	X	X	X					X					
64-GD-156	793	X	X	X					X					
64-GD-157	794	X	X	X					X					
64-GD-158	795	X	X	X					X					
64-GD-160	797	X	X	X					X					
65-TB-159	803	X	X	X					X					
65-TB-160	804	X	X	X					X					
66-DY-160	811	X	X	X					X					
66-DY-161	812	X	X	X					X					
66-DY-162	813	X	X	X					X					
66-DY-163	814	X	X	X					X					
66-DY-164	1031	X	X	X	X	X			X	X				X
67-HO-165	820	X	X	X					X					
68-ER-166	823	X	X	X					X					
68-ER-167	824	X	X	X					X					

*THE 181 NUCLIDES DESCRIBED ABOVE ARE CONTAINED IN THE ENDF/B-IV FISSION-PRODUCT DATA FILE. TWENTY-FIVE OF THESE ALSO APPEAR IN THE ENDF/B-IV GENERAL PURPOSE FILE UNDER DIFFERENT MAT NUMBERS. MULTIGROUP CROSS SECTIONS FOR TWENTY OF THESE, IDENTIFIED WITH MAT NUMBERS GREATER THAN 1000, WERE PRODUCED FROM 900K PENDF FILES RETAINED FROM PREVIOUS G.P. FILE PROCESSING. MULTIGROUP CROSS SECTIONS FOR THE REMAINING 161 NUCLIDES WERE PRODUCED FROM 1000K PENDF FILES PROCESSED FROM THE F.P. FILE.

TABLE V

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 VI

DESCRIPTION OF CROSS-SECTION TABULATION 27-RECORD SET

Record (s)	Column (s)	Format and Description
1		(A6,A5,2I3,I1,I4,2I2,I3,2E9.3,2A10)
	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 - 67	reaction identification
2 - 27		(6E12.5)
	(1 - 72)	multigroup cross-section values (CXF(I),I=1,154)

IV. TOAFEW COLLAPSING CODE

The TOAFEW 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.

A. Cross-Section Collapsing

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

$$\sigma_J = \frac{\int_{E_{J+1}}^{E_J} \sigma(E)\,\psi(E)\,dE}{\int_{E_{J+1}}^{E_J} \psi(E)\,dE} = \frac{\int_{E_{J+1}}^{E_J} \sigma(E)\,\psi(E)\,dE}{\psi_J} \quad . \tag{2}$$

If the energy boundaries of group J of the few-group structure, shown in Fig. 2, lie in groups m and n of the multigroup structure such that $E_{n+1} \leqslant E_{J+1} \leqslant E_n$ and $E_{m+1} \leqslant E_J \leqslant E_m$, then we may write

$$\sigma_J = \frac{\int_{E_{J+1}}^{E_n} \sigma(E)\,\psi(E)\,dE + \sum_{j=m+1}^{n-1} \int_{E_{j+1}}^{E_j} \sigma(E)\,\psi(E)\,dE + \int_{E_{m+1}}^{E_J} \sigma(E)\,\psi(E)\,dE}{\psi_J} \quad . \tag{3}$$

If we assume that the multigroup values are relatively insensitive to the flux weighting function used in processing, then

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

or

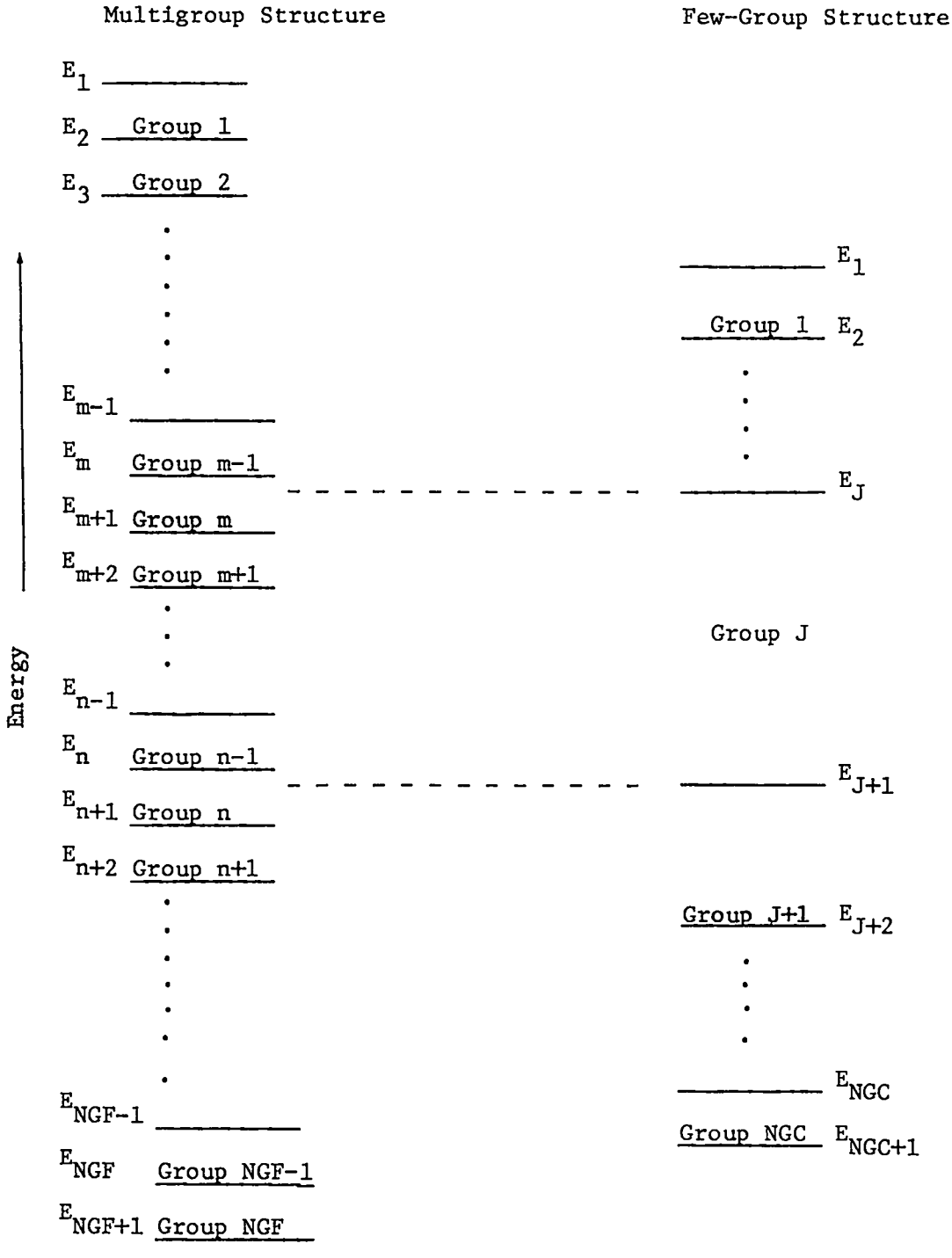

Fig. 2.

Multigroup and few-group energy structures.

$$\int_{E_{j+1}}^{E_j} \sigma(E)\ \psi(E)\ dE \simeq \sigma_j\ \psi_j \quad . \tag{5}$$

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

$$\sigma_J \simeq \frac{\int_{E_{J+1}}^{E_n} \sigma(E)\ \psi(E)\ dE + \sum_{j=m+1}^{n-1} \sigma_j\ \psi_j + \int_{E_{m+1}}^{E_J} \sigma(E)\ \psi(E)\ dE}{\psi_J} \quad . \tag{6}$$

If we also assume that $\sigma(E)$ is approximately constant in groups m and n, then

$$\sigma_J \simeq \frac{\sigma_n \int_{E_{j+1}}^{E_n} \psi(E)\ dE + \sum_{j=m+1}^{n-1} \sigma_j\ \psi_j + \sigma_m \int_{E_{m+1}}^{E_J} \psi(E)\ dE}{\psi_J} \quad . \tag{7}$$

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

$$\sigma_J \simeq \sum_{j=m}^{n} \sigma_j\ \psi_j \Big/ \sum_{j=m}^{n} \psi_j \quad . \tag{8}$$

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) is not required. The few-group cross section is then given exactly by

$$\sigma_J = \sum_{j=m}^{n} \sigma_j\ \phi_j \Big/ \sum_{j=m}^{n} \phi_j \quad . \tag{9}$$

The TOAFEW code collapses a set of multigroup (fine) cross sections {CXF(j)} to a set of few-group (coarse) values {CXC(J)} using Eq. (7). 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 lies 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. (7) is then

$$CXC(J) = \left[\sum_{j=LFG(J)}^{LFG(J+1)} CXF(j)*FLXIM(J,j) \right] \Big/ FLXI(J) \quad . \tag{10}$$

In addition to few-group cross sections, the TOAFEW 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 2200 m/s. 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.

B. User Flux Weighting Functions

1. 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[7] to higher energies, as described in Sec. II.A, 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, $EX(5) \leq E \leq EX(6)$

$$\psi(E) = C(5)\ e^{-5/TKF(\sqrt{E} - \sqrt{EP})^2}$$

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.

2. 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.

3. 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.

C. Input and Output Files

Files input to the TOAFEW code are INPUT, the card input file described in the following section, and TAPE1, the cross-section data file described in Sec. III. Files output from the code are OUTPUT, TAPE2,and FILM. The OUTPUT print file includes a summary of all input information, intermediate calculated values, and collapsed few-group values. TAPE2 is a print file tabulating only the collapsed few-group cross sections in a form useful in reporting. FILM 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 flux spectrum produced from FILM are given in Appendix B for a variety of sample problems.

D. 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 PLOTM called in subroutine PLOTX are particular to LASL. Calls to these routines must be examined and, if necessary, modified to correspond with equivalent user system routines.

V. TOAFEW 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 of 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			(6I5,4E10.3)
	1 - 5		MINZ
	6 - 10		MAXZ
	11 - 15		MINA
	16 - 20		MAXA
	21 - 25		MINMT
	26 - 30		MAXMT
	31 - 40		SZMIN
	41 - 50		SZMAX
	51 - 60		TEMIN
	61 - 70		TEMAX

limits of nuclide Z and A, reaction MT, Bondarenko σ_0 value and temperature within which TAPE1 multigroup cross sections should be collapsed.

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

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 (continued)
	1 - 12	EX(7)
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 (continued)
	1 - 12	SLPC, region 6 flux slope

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

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≥4. Values may be in increasing or decreasing energy.

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)].

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)
	5 - 10	LB(2)
	.	.
	.	.
	.	.
	.	LB(NGC+1)

VI. FOUR-GROUP (n,γ) CROSS SECTIONS

Four-group (n,γ) cross sections have been generated with the TOAFEW code and data file in the EPRI 4-group structure for use in the EPRI-CINDER Data Set.[2] The radiative capture (MT=102) cross sections of all nuclides present were collapsed using the PRS flux description. Group cross sections for all other neutron absorption reactions were found to be negligible in the computation of parasitic neutron absorption in thermal reactors.

The four-group values, tabulated in Table VII, may be adequate for many user applications. In addition to the four-group values, an effective thermal cross section for each reaction is tabulated. This quantity is defined in Sec. IV.A and in a footnote to Table VII.

REFERENCES

1. T. R. England and R. E. Schenter, "ENDF/B-IV Fission-Product Files: Summary of Major Nuclear Data," Los Alamos Scientific Laboratory report LA-6116-MS (ENDF-223) (October 1975).

2. T. R. England, W. B. Wilson, and M. G. Stamatelatos, "Fission Product Data for Thermal Reactors, Part 1: A Data Set for EPRI-CINDER Using ENDF/B-IV," Los Alamos Scientific Laboratory report LA-6745-MS (December 1976); "Fission Product Data for Thermal Reactors, Part 2: Users Manual for EPRI-CINDER Code and Data," Los Alamos Scientific Laboratory report LA-6746-MS (December 1976). (Also published as Electric Power Research Institute reports EPRI NP-356, Part 1 and Part 2 (December 1976)).

3. R. E. MacFarlane and R. M. Boicourt, "NJOY-A Neutron and Photon Cross-Section Processing System," Trans. Am. Nucl. Soc. 22, 720 (1975).

4. R. J. LaBauve, C. R. Weisbin, R. E. Seamon, M. E. Battat, D. R. Harris, P. G. Young, and M. M. Klein, "PENDF: A Library of Nuclear Data for Monte Carlo Calculations Derived from Data in the ENDF/B Format," Los Alamos Scientific Laboratory report LA-5687 (October 1974).

5. N. G. Demas, Westinghouse Electric Corporation, Nuclear Energy Systems, private communications, 1976, on calculations using methods described in Nucl. Sci. Eng. 23, 58 (1967).

6. B. J. Toppel, A. L. Rago, and D. M. O'Shea, "MC^2, A Code to Calculate Multigroup Cross Sections," Argonne National Laboratory report ANL-7318 (1967).

7. R. Roussin, Radiation Shielding Information Center, Oak Ridge National Laboratory, private communication, 1975.

8. R. J. LaBauve and W. B. Wilson, "Proposal to Extend CSEWG Neutron and Photon Multigroup Structures for Wider Applications," Los Alamos Scientific Laboratory report LA-6240-P (February 1976).

9. I. I. Bondarenko, Ed., "Group Constants for Nuclear Reactor Calculations," Consultants Bureau, New York (1964).

TABLE VII

FOUR GROUP CROSS SECTIONS

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	GROUP 3 CROSS SECTION	GROUP 4 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
GE 72	32	72	0	48	3	102	1000	1.0E+10	2.099716E-02	5.432289E-02	8.043696E-02	5.476937E-01	9.885840E-01
GE 73	32	73	0	49	3	102	1000	1.0E+10	4.379093E-02	1.769910E-01	8.051782E+00	8.381628E+00	1.512879E+01
GE 74	32	74	0	51	3	102	1000	1.0E+10	9.484258E-03	3.185640E-02	4.402824E-02	2.141804E-01	3.865945E-01
GE 76	32	76	0	54	3	102	1000	1.0E+10	2.668907E-03	9.284226E-03	1.632492E-01	7.941654E-02	1.433464E-01
AS 75	33	75	0	68	3	102	1000	1.0E+10	3.174023E-02	2.399267E-01	7.066404E+00	2.408837E+00	4.347936E+00
SE 76	34	76	0	85	3	102	1000	1.0E+10	3.043571E-02	1.025647E-01	3.876426E+00	4.754810E+01	8.582406E+01
SE 77	34	77	0	86	3	102	1000	1.0E+10	2.397912E-02	2.570206E-01	3.571884E+00	2.346095E+01	4.234688E+01
SE 78	34	78	0	88	3	102	1000	1.0E+10	1.233979E-02	4.559968E-02	5.350889E-01	2.234162E-01	4.032650E-01
SE 80	34	80	0	91	3	102	1000	1.0E+10	1.224080E-02	4.557911E-02	8.982662E-02	3.412236E-01	6.159067E-01
SE 82	34	82	0	94	3	102	1000	1.0E+10	3.747510E-03	1.079513E-02	1.686126E-03	2.513117E-02	4.536163E-02
BR 79	35	79	0	108	3	102	1000	1.0E+10	6.182080E-02	4.360678E-01	1.200472E+01	6.222752E+00	1.123203E+01
BR 81	35	81	0	112	3	102	1000	1.0E+10	4.217740E-02	2.809681E-01	5.719194E+00	1.503798E+00	2.714348E+00
KR 80	36	80	0	131	3	102	1000	1.0E+10	3.268930E-02	1.358841E-01	6.958419E+00	7.974773E+00	1.439442E+01
KR 82	36	82	0	134	3	102	1000	1.0E+10	3.209819E-02	1.243721E-01	1.984202E+01	1.685921E+01	3.043078E+01
KR 83	36	83	0	135	3	102	1000	1.0E+10	6.710060E-02	3.993954E-01	1.841473E+01	1.119001E+02	2.019790E+02
KR 84	36	84	0	137	3	102	1000	1.0E+10	4.472712E-03	1.912670E-02	4.376474E-01	4.633101E-02	8.362721E-02
KR 85	36	85	0	138	3	102	1000	1.0E+10	4.363354E-03	2.864559E-02	1.600506E-01	9.295652E-01	1.677860E+00
KR 86	36	86	0	140	3	102	1000	1.0E+10	1.108820E-03	3.162755E-03	1.545394E-02	3.441791E-02	6.212414E-02
RB 85	37	85	0	153	3	102	1000	1.0E+10	2.080914E-02	2.157803E-01	5.395468E-01	2.576161E-01	4.649955E-01
RB 86	37	86	0	154	3	102	1000	1.0E+10	4.296598E-03	9.237312E-02	2.813636E+00	2.735252E+00	4.937115E+00
RB 87	37	87	0	156	3	102	1000	1.0E+10	1.287127E-03	8.266649E-03	2.536605E-01	6.710316E-02	1.211208E-01
SR 86	38	86	0	172	3	102	1000	1.0E+10	1.688432E-02	4.158945E-02	5.748211E-01	1.588873E+00	2.867907E+00
SR 87	38	87	0	173	3	102	1000	1.0E+10	1.669480E-02	7.775602E-02	1.045327E+01	9.270864E+00	1.673386E+01
SR 88	38	88	0	175	3	102	1000	1.0E+10	1.329117E-03	1.164227E-03	2.201289E-04	3.248619E-03	5.863738E-03
SR 89	38	89	0	176	3	102	1000	1.0E+10	8.295338E-03	2.038847E-02	3.876896E-02	2.348515E-01	4.239056E-01
SR 90	38	90	0	177	3	102	1000	1.0E+10	4.920037E-03	1.560162E-02	3.315065E-02	5.026414E-01	9.072648E-01
Y 89	39	89	0	192	3	102	1000	1.0E+10	7.136131E-03	2.253723E-02	8.228018E-02	7.165644E-01	1.293395E+00
Y 90	39	90	0	194	3	102	1000	1.0E+10	1.138581E-02	1.146555E-01	4.323381E-01	1.954493E+00	3.527849E+00
Y 91	39	91	0	196	3	102	1000	1.0E+10	4.217073E-03	3.284697E-02	1.639328E-01	7.827059E-01	1.412780E+00
ZR 90	40	90	0	215	3	102	1000	1.0E+10	1.508096E-02	2.520652E-02	1.987868E-02	5.586877E-02	1.008428E-01
ZR 91	40	91	0	217	3	102	1000	1.0E+10	1.715130E-02	5.507396E-02	6.700606E-01	5.758814E-01	1.039463E+00
ZR 92	40	92	0	218	3	102	1000	1.0E+10	1.042367E-02	3.130879E-02	8.308115E-02	1.452876E-01	2.622433E-01
ZR 93	40	93	0	219	3	102	1000	1.0E+10	2.089521E-02	5.150402E-02	3.654891E+00	1.396955E+00	2.521495E+00
ZR 94	40	94	0	220	3	102	1000	1.0E+10	5.447404E-03	2.595021E-02	2.019570E-02	3.128906E-02	5.647657E-02
ZR 95	40	95	0	221	3	102	1000	1.0E+10	3.771503E-02	1.168058E-01	5.797035E-01	2.741127E-01	4.947719E-01
ZR 96	40	96	0	222	3	102	1000	1.0E+10	2.648158E-02	2.165040E-02	6.357653E-01	8.862928E-03	1.599754E-02
NB 93	41	93	0	1189	3	102	900	1.0E+10	1.604464E-02	1.581963E-01	1.036643E+00	6.392347E-01	1.153815E+00
NB 94	41	94	0	238	3	102	1000	1.0E+10	5.739899E-03	1.688129E-01	1.173435E+01	7.640611E+00	1.379126E+01
NB 95	41	95	0	240	3	102	1000	1.0E+10	5.266054E-02	2.650329E-01	2.503124E+00	8.380113E-01	1.512606E+00
MO 94	42	94	0	264	3	102	1000	1.0E+10	1.622583E-02	3.166593E-02	9.483320E-02	8.925915E-03	1.611123E-02
MO 95	42	95	0	265	3	102	1000	1.0E+10	3.417280E-02	2.320601E-01	1.257062E+01	8.099988E+00	1.462043E+01
MO 96	42	96	0	266	3	102	1000	1.0E+10	1.622694E-02	4.895069E-02	2.259064E+00	5.590317E-01	1.009049E+00

TABLE VII (cont)

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	GROUP 3 CROSS SECTION	GROUP 4 CROSS SECTION	EFFEC. THERMAL CROSS SECTION
MO 97	42	97	0	267	3	102	1000	1.0E+10	2.907559E-02	2.248807E-01	1.719731E+00	1.215824E+00	2.194556E+00
MO 98	42	98	0	268	3	102	1000	1.0E+10	2.516355E-02	7.168378E-02	7.678803E-01	7.125803E-02	1.286203E-01
MO 99	42	99	0	269	3	102	1000	1.0E+10	4.286153E-02	4.063070E-01	2.849176E+00	9.492203E-01	1.713337E+00
MO100	42	100	0	270	3	102	1000	1.0E+10	9.074271E-03	5.494819E-02	4.423330E-01	1.111105E-01	2.005538E-01
TC 99	43	99	0	1137	3	102	900	1.0E+10	3.673952E-02	3.614800E-01	3.069278E+01	1.083246E+01	1.955253E+01
RU 99	44	99	0	308	3	102	1000	1.0E+10	3.826665E-02	3.753455E-01	1.421606E+01	2.833373E+00	5.114222E+00
RU100	44	100	0	309	3	102	1000	1.0E+10	3.858774E-02	1.136596E-01	1.132016E+00	3.239899E+00	5.847999E+00
RU101	44	101	0	310	3	102	1000	1.0E+10	2.690347E-02	4.480972E-01	9.421788E+00	1.743797E+00	3.147543E+00
RU102	44	102	0	311	3	102	1000	1.0E+10	6.954545E-02	1.577507E-01	3.499625E-01	7.279318E-01	1.313913E+00
RU103	44	103	0	312	3	102	1000	1.0E+10	2.468305E-02	3.671989E-01	7.404899E+00	4.301005E+00	7.763290E+00
RU104	44	104	0	313	3	102	1000	1.0E+10	3.070218E-02	1.059028E-01	7.196752E-01	2.440178E-01	4.404508E-01
RU105	44	105	0	314	3	102	1000	1.0E+10	2.325016E-02	3.233188E-01	6.399468E-01	1.117743E-01	2.017520E-01
RU106	44	106	0	315	3	102	1000	1.0E+10	8.344953E-03	5.233637E-02	2.475373E-01	8.153410E-02	1.471686E-01
RH103	45	103	0	1125	3	102	900	1.0E+10	4.648621E-02	5.571160E-01	9.047802E+01	9.701270E+01	1.751074E+02
RH105	45	105	0	334	3	102	1000	1.0E+10	9.125643E-02	4.919683E-01	7.002262E+02	4.934551E+03	8.906837E+03
PD104	46	104	0	358	3	102	1000	1.0E+10	8.530149E-02	2.169388E-01	2.016123E+00	2.166387E-01	3.910315E-01
PD105	46	105	0	359	3	102	1000	1.0E+10	8.900761E-02	7.121473E-01	9.287985E+00	7.843382E+00	1.415726E+01
PD106	46	106	0	360	3	102	1000	1.0E+10	4.789705E-02	1.283831E-01	7.720379E-01	1.332195E-01	2.404604E-01
PD107	46	107	0	361	3	102	1000	1.0E+10	6.726203E-02	4.894277E-01	7.143654E+00	5.588543E+00	1.008729E+01
PD108	46	108	0	363	3	102	1000	1.0E+10	4.149806E-02	1.255796E-01	2.259456E+01	6.845444E+00	1.235599E+01
PD110	46	110	0	366	3	102	1000	1.0E+10	1.580939E-02	7.311286E-02	8.358860E-01	1.229825E-01	2.219828E-01
AG107	47	107	0	1138	3	102	900	1.0E+10	8.334117E-02	5.664923E-01	1.210986E+01	2.047736E+01	3.696153E+01
AG109	47	109	0	1139	3	102	900	1.0E+10	4.458553E-02	3.535820E-01	1.302363E+02	5.257063E+01	9.488969E+01
AG111	47	111	0	391	3	102	1000	1.0E+10	2.611568E-02	3.334252E-01	1.231271E+01	1.677295E+00	3.027507E+00
CD108	48	108	0	415	3	102	1000	1.0E+10	9.591343E-02	1.805074E-01	3.702015E-01	6.153806E-01	1.110758E+00
CD110	48	110	0	417	3	102	1000	1.0E+10	1.158785E-01	2.033491E-01	4.663890E+00	6.207640E+00	1.120475E+01
CD111	48	111	0	418	3	102	1000	1.0E+10	3.549300E-02	3.246907E-01	5.577368E+00	1.357310E+01	2.449936E+01
CD112	48	112	0	420	3	102	1000	1.0E+10	9.319133E-02	1.924481E-01	1.147311E+00	1.230079E+00	2.220285E+00
CD113	48	113	0	1282	3	102	900	1.0E+10	4.035980E-02	2.936839E-01	2.050547E+01	2.727591E+04	4.923287E+04
CD114	48	114	0	423	3	102	1000	1.0E+10	9.644373E-02	2.058760E-01	2.208012E+00	1.877895E-01	3.389589E-01
CD115M	48	115	1	425	3	102	1000	1.0E+10	3.428619E-02	2.347852E-01	2.226469E+01	1.732369E+01	3.126916E+01
CD116	48	116	0	426	3	102	1000	1.0E+10	4.177477E-02	9.279391E-02	2.235261E-01	4.293487E-02	7.749719E-02
IN113	49	113	0	445	3	102	1000	1.0E+10	2.409397E-01	5.236885E-01	2.162369E+01	6.590786E+00	1.189633E+01
IN115	49	115	0	449	3	102	1000	1.0E+10	1.228192E-01	3.755484E-01	2.854464E+02	1.289674E+02	2.327855E+02
SN115	50	115	0	482	3	102	1000	1.0E+10	3.729064E-03	3.183642E-02	2.008304E+00	2.796581E+01	5.047812E+01
SN116	50	116	0	483	3	102	1000	1.0E+10	3.175388E-02	4.364059E-02	1.356454E+00	6.732990E-02	1.215301E-01
SN117	50	117	0	484	3	102	1000	1.0E+10	3.274490E-02	1.661797E-01	1.984943E+00	1.455753E+00	2.627627E+00
SN118	50	118	0	486	3	102	1000	1.0E+10	7.690040E-02	8.667272E-02	6.911670E-01	4.610512E-02	8.321948E-02
SN119	50	119	0	487	3	102	1000	1.0E+10	6.371977E-03	4.040596E-02	3.974212E-01	1.284014E+00	2.317637E+00
SN120	50	120	0	489	3	102	1000	1.0E+10	1.800320E-02	2.933619E-02	1.337315E-01	7.881781E-02	1.422657E-01
SN122	50	122	0	492	3	102	1000	1.0E+10	1.337318E-02	1.827124E-02	7.595520E-02	1.010517E-01	1.823978E-01
SN123	50	123	0	493	3	102	1000	1.0E+10	3.947307E-02	8.523844E-02	2.774607E-01	1.845241E-02	3.330650E-02
SN124	50	124	0	495	3	102	1000	1.0E+10	1.849913E-02	2.415400E-02	8.102987E-01	7.272250E-02	1.312537E-01
SN125	50	125	0	496	3	102	1000	1.0E+10	9.919385E-03	4.686948E-02	1.984130E+00	3.074827E-01	5.550044E-01
SN126	50	126	0	498	3	102	1000	1.0E+10	5.678309E-03	7.303296E-03	1.098527E-02	1.677718E-01	3.028272E-01
SB121	51	121	0	511	3	102	1000	1.0E+10	1.106325E-01	4.009508E-01	1.677825E+01	3.560680E+00	6.427007E+00
SB123	51	123	0	514	3	102	1000	1.0E+10	5.059958E-02	2.100477E-01	8.328224E+00	2.434903E+00	4.394987E+00

TABLE VII (cont)

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	GROUP 3 CROSS SECTION	GROUP 4 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
SB124	51	124	0	515	3	102	1000	1.0E+10	2.543705E-02	5.863286E-01	2.475458E+00	3.630309E+00	6.552687E+00
SB125	51	125	0	518	3	102	1000	1.0E+10	7.517359E-02	2.103150E-01	2.103414E+00	5.592590E-01	1.009459E+00
SB126	51	126	0	519	3	102	1000	1.0E+10	1.848180E-02	3.033790E-01	5.136429E+00	3.247778E+00	5.862222E+00
TE122	52	122	0	538	3	102	1000	1.0E+10	1.202321E-01	2.504961E-01	8.412152E+00	1.569423E+00	2.832800E+00
TE123	52	123	0	539	3	102	1000	1.0E+10	6.157976E-02	3.666051E-01	4.865476E+02	2.468661E+02	4.455918E+02
TE124	52	124	0	541	3	102	1000	1.0E+10	1.104859E-01	1.937552E-01	7.708467E-01	3.808186E+00	6.873755E+00
TE125	52	125	0	542	3	102	1000	1.0E+10	2.613155E-02	2.557467E-01	2.647459E+00	8.658353E-01	1.562828E+00
TE126	52	126	0	544	3	102	1000	1.0E+10	3.714886E-02	8.357152E-02	1.185596E+00	5.779812E-01	1.043253E+00
TE127M	52	127	1	546	3	102	1000	1.0E+10	5.419348E-02	2.648949E-01	4.726406E+00	5.264135E+00	9.501734E+00
TE128	52	128	0	547	3	102	1000	1.0E+10	4.529906E-02	8.662364E-02	2.271824E-01	1.202259E-01	2.170070E-01
TE129M	52	129	1	549	3	102	1000	1.0E+10	9.472597E-03	8.205984E-02	6.885660E-01	6.142364E-01	1.108693E+00
TE130	52	130	0	550	3	102	1000	1.0E+10	3.760774E-03	1.329507E-02	2.826283E-02	1.621755E-01	2.927259E-01
TE132	52	132	0	553	3	102	1000	1.0E+10	5.710111E-04	4.443987E-04	7.327881E-05	1.117629E-03	2.017314E-03
I127	53	127	0	565	3	102	1000	1.0E+10	5.610752E-02	3.939301E-01	1.539254E+01	3.478504E+00	6.278681E+00
I129	53	129	0	567	3	102	1000	1.0E+10	4.800948E-02	2.804701E-01	3.709139E+00	1.510053E+01	2.725637E+01
I130	53	130	0	568	3	102	1000	1.0E+10	1.837486E-02	2.696179E-01	1.985659E+01	1.004999E+01	1.814018E+01
I131	53	131	0	570	3	102	1000	1.0E+10	9.472025E-03	7.367629E-02	9.685281E-01	3.911037E-01	7.059399E-01
I135	53	135	0	576	3	102	1000	1.0E+10	4.684394E-04	5.736313E-04	7.324264E-04	1.118905E-02	2.019617E-02
XE128	54	128	0	1173	3	102	900	1.0E+10	5.312305E-02	2.997089E-01	2.526227E+01	9.969592E+00	1.799506E+01
XE129	54	129	0	589	3	102	1000	1.0E+10	5.323277E-02	3.033197E-01	2.522329E+01	1.003302E+01	1.810954E+01
XE130	54	130	0	1174	3	102	900	1.0E+10	3.404525E-02	1.127239E-01	3.154451E-01	3.446107E+00	6.220203E+00
XE131	54	131	0	1175	3	102	900	1.0E+10	1.332154E-02	1.837029E-01	8.832394E+01	5.042924E+01	9.102450E+01
XE132	54	132	0	1176	3	102	900	1.0E+10	1.814070E-02	6.651676E-02	1.568604E-01	2.501073E-01	4.514423E-01
XE133	54	133	0	595	3	102	1000	1.0E+10	5.950709E-03	5.286344E-02	3.435562E+01	1.062848E+02	1.918434E+02
XE134	54	134	0	1177	3	102	900	1.0E+10	1.054011E-02	3.432525E-02	3.981692E-02	1.434189E-01	2.588703E-01
XE135	54	135	0	1294	3	102	900	1.0E+10	5.564618E-04	3.218521E-03	3.634285E+02	1.670657E+06	3.015526E+06
XE136	54	136	0	1178	3	102	900	1.0E+10	1.072229E-03	2.288886E-03	1.069663E-02	8.874087E-02	1.601768E-01
CS133	55	133	0	1141	3	102	900	1.0E+10	5.103384E-02	3.777516E-01	3.378401E+01	1.663776E+01	3.003107E+01
CS134	55	134	0	614	3	102	1000	1.0E+10	1.286883E-02	3.448577E-01	2.079022E+01	7.828318E+01	1.413007E+02
CS135	55	135	0	616	3	102	1000	1.0E+10	3.180215E-03	4.148685E-02	4.381765E+00	4.866696E+00	8.784359E+00
CS136	55	136	0	618	3	102	1000	1.0E+10	1.942282E-02	1.635070E-01	3.303652E+00	7.287809E-01	1.315445E+00
CS137	55	137	0	619	3	102	1000	1.0E+10	1.502562E-03	5.543158E-03	5.867613E-02	6.142019E-02	1.108631E-01
BA134	56	134	0	634	3	102	1000	1.0E+10	3.524396E-02	8.612855E-02	2.724576E+00	1.205309E+00	2.175576E+00
BA135	56	135	0	635	3	102	1000	1.0E+10	2.867491E-02	2.214519E-01	1.119982E+01	3.250888E+00	5.867834E+00
BA136	56	136	0	637	3	102	1000	1.0E+10	1.312605E-02	3.583927E-02	2.133971E-01	2.289892E-01	4.133242E-01
BA137	56	137	0	639	3	102	1000	1.0E+10	7.225130E-03	3.743974E-02	4.969716E-01	2.849852E+00	5.143966E+00
BA138	56	138	0	641	3	102	1000	1.0E+10	9.214468E-03	5.529264E-03	1.282347E-02	1.955539E-01	3.529736E-01
BA140	56	140	0	643	3	102	1000	1.0E+10	1.689069E-03	3.743996E-03	1.567531E+00	8.912482E-01	1.608698E+00
LA139	57	139	0	657	3	102	1000	1.0E+10	6.009337E-03	2.967405E-02	1.244460E+00	5.013105E+00	9.048625E+00
LA140	57	140	0	658	3	102	1000	1.0E+10	2.948971E-02	1.295762E-01	7.885135E+00	1.508462E+00	2.722765E+00
CE140	58	140	0	674	3	102	1000	1.0E+10	1.703531E-02	1.730715E-02	2.903654E-02	3.190750E-01	5.759285E-01
CE141	58	141	0	675	3	102	1000	1.0E+10	4.510816E-02	1.054578E-01	2.342997E+00	1.619745E+01	2.923631E+01
CE142	58	142	0	676	3	102	1000	1.0E+10	1.485239E-02	3.294434E-02	5.925282E-02	5.307171E-01	9.579413E-01
CE143	58	143	0	677	3	102	1000	1.0E+10	9.577707E-03	7.577132E-02	5.095466E+00	3.349870E+00	6.046496E+00
CE144	58	144	0	678	3	102	1000	1.0E+10	1.090923E-02	2.405806E-02	2.314846E-01	5.586255E-01	1.008316E+00
PR141	59	141	0	692	3	102	1000	1.0E+10	2.548600E-02	9.959114E-02	2.105239E+00	6.439460E+00	1.162319E+01
PR142	59	142	0	693	3	102	1000	1.0E+10	1.604911E-02	2.547188E-01	1.527271E+01	1.117627E+01	2.017310E+01

TABLE VII (cont)

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	GROUP 3 CROSS SECTION	GROUP 4 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
PR143	59	143	0	695	3	102	1000	1.0E+10	4.842014E-02	2.161496E-01	1.913981E+01	4.977789E+01	8.984881E+01
ND142	60	142	0	713	3	102	1000	1.0E+10	2.773231E-02	3.127668E-02	7.312854E-01	1.044265E+01	1.884892E+01
ND143	60	143	0	714	3	102	1000	1.0E+10	5.923333E-02	1.938598E-01	1.209111E+01	1.773106E+02	3.200445E+02
ND144	60	144	0	715	3	102	1000	1.0E+10	4.188978E-02	6.863372E-02	5.867006E-01	2.013982E+00	3.635226E+00
ND145	60	145	0	716	3	102	1000	1.0E+10	6.803414E-02	1.983824E-01	2.256161E+01	2.355985E+01	4.252540E+01
ND146	60	146	0	717	3	102	1000	1.0E+10	5.710881E-02	1.082823E-01	2.963151E-01	7.827704E-01	1.412896E+00
ND147	60	147	0	718	3	102	1000	1.0E+10	5.106341E-02	3.928675E-01	6.013407E+01	2.740049E+01	4.945773E+01
ND148	60	148	0	719	3	102	1000	1.0E+10	1.435365E-01	1.318842E-01	2.284639E+00	1.399507E+00	2.526102E+00
ND150	60	150	0	721	3	102	1000	1.0E+10	5.230297E-02	1.742186E-01	1.865556E+00	6.713311E-01	1.211749E+00
PM147	61	147	0	733	3	102	1000	1.0E+10	1.382808E-01	8.170927E-01	1.918335E+02	9.917021E+01	1.790017E+02
PM148	61	148	0	734	3	102	1000	1.0E+10	4.921928E-01	2.574234E+00	2.332976E+03	2.594150E+03	4.682426E+03
PM148M	61	148	1	735	3	102	1000	1.0E+10	4.921928E-01	2.574234E+00	3.182157E+02	1.909160E+04	3.446023E+04
PM149	61	149	0	736	3	102	1000	1.0E+10	5.268164E-01	2.133433E+00	7.332632E+01	7.811904E+02	1.410044E+03
PM151	61	151	0	738	3	102	1000	1.0E+10	1.012214E-03	2.037358E-02	1.742050E+02	3.910634E+02	7.058672E+02
SM147	62	147	0	753	3	102	1000	1.0E+10	1.180276E-01	5.432755E-01	7.514796E+01	3.454724E+01	6.235757E+01
SM148	62	148	0	754	3	102	1000	1.0E+10	2.023254E-01	2.596780E-01	3.134887E+00	1.509450E+00	2.724549E+00
SM149	62	149	0	1027	3	102	900	1.0E+10	5.637011E-02	9.344686E-01	2.770684E+02	4.841072E+04	8.738108E+04
SM150	62	150	0	756	3	102	1000	1.0E+10	1.313093E-01	2.862238E-01	1.160902E+01	5.471646E+01	9.876290E+01
SM151	62	151	0	757	3	102	1000	1.0E+10	2.315641E-01	1.356167E+00	2.894601E+02	4.669738E+03	8.428850E+03
SM152	62	152	0	758	3	102	1000	1.0E+10	7.520442E-02	2.877061E-01	2.755117E+02	1.173567E+02	2.118281E+02
SM153	62	153	0	759	3	102	1000	1.0E+10	2.260670E-04	1.191724E-02	2.418654E+02	1.846696E+02	3.333276E+02
SM154	62	154	0	760	3	102	1000	1.0E+10	5.706727E-02	1.425114E-01	3.851160E+00	3.076205E+00	5.552533E+00
EU151	63	151	0	1290	3	102	900	1.0E+10	4.181577E-01	2.402754E+00	2.044278E+02	4.717469E+03	8.515005E+03
EU152	63	152	0	1292	3	102	900	1.0E+10	1.744222E-01	3.245252E+00	3.252586E+02	7.677840E+02	1.385846E+03
EU153	63	153	0	1291	3	102	900	1.0E+10	2.431446E-01	1.539698E+00	1.478631E+02	2.197333E+02	3.966174E+02
EU154	63	154	0	1293	3	102	900	1.0E+10	7.241066E-02	1.875663E+00	2.228416E+02	4.972313E+02	8.974997E+02
EU155	63	155	0	778	3	102	1000	1.0E+10	9.062116E-01	1.543263E+00	1.540107E+02	2.258836E+03	4.077187E+03
EU156	63	156	0	779	3	102	1000	1.0E+10	5.008924E-04	3.539738E-02	1.016701E+02	2.696344E+02	4.866885E+02
EU157	63	157	0	780	3	102	1000	1.0E+10	3.221641E-03	2.526199E-02	8.471598E+01	1.059332E+02	1.912089E+02
GD154	64	154	0	791	3	102	1000	1.0E+10	3.041554E-01	6.280531E-01	2.531751E+01	4.755081E+01	8.582895E+01
GD155	64	155	0	792	3	102	1000	1.0E+10	1.251320E-01	1.467746E+00	1.313204E+02	1.920502E+04	3.466494E+04
GD156	64	156	0	793	3	102	1000	1.0E+10	1.177736E-01	2.925910E-01	1.328447E+01	8.292483E-01	1.496788E+00
GD157	64	157	0	794	3	102	1000	1.0E+10	1.068337E-01	7.103253E-01	8.871128E+01	8.261695E+04	1.491231E+05
GD158	64	158	0	795	3	102	1000	1.0E+10	4.647452E-02	1.882511E-01	6.519249E+00	1.403779E+00	2.533814E+00
GD160	64	160	0	797	3	102	1000	1.0E+10	8.083934E-02	1.503781E-01	9.311768E-01	4.300564E-01	7.762493E-01
TB159	65	159	0	803	3	102	1000	1.0E+10	9.138282E-02	7.922879E-01	4.634842E+01	1.437843E+01	2.595299E+01
TB160	65	160	0	804	3	102	1000	1.0E+10	1.434563E-03	7.845290E-02	8.018238E+01	2.928139E+02	5.285275E+02
DY160	66	160	0	811	3	102	1000	1.0E+10	7.939346E-01	1.200462E+00	1.508596E+02	3.609387E+01	6.514924E+01
DY161	66	161	0	812	3	102	1000	1.0E+10	5.945760E-02	1.227134E+00	1.166236E+02	3.112586E+02	5.618201E+02
DY162	66	162	0	813	3	102	1000	1.0E+10	2.803023E-01	5.297747E-01	2.471440E+02	1.147570E+02	2.071357E+02
DY163	66	163	0	814	3	102	1000	1.0E+10	5.480995E-02	5.190151E-01	1.336405E+02	7.776202E+01	1.403600E+02
DY164	66	164	0	1031	3	102	900	1.0E+10	9.006775E-02	1.905334E-01	2.300536E+01	1.300572E+03	2.347525E+03
HO165	67	165	0	820	3	102	1000	1.0E+10	8.922674E-02	8.753142E-01	7.475623E+01	3.753369E+01	6.774810E+01
ER166	68	166	0	823	3	102	1000	1.0E+10	1.431152E-01	2.983558E-01	1.481533E+01	1.954315E+01	3.527527E+01
ER167	68	167	0	824	3	102	1000	1.0E+10	6.106636E-02	8.024943E-01	1.590069E+02	1.101003E+03	1.987304E+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 2200 M/S .554018

APPENDIX A

TOAFEW CODE LISTING

LASL Identification No. LP-0886

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      PROGRAM TOAFEW (INPUT,OUTPUT,FILM,TAPE1,TAPE2)
C*********************************************************************
C*                                                                   *
C* W.B.WILSON, T.R.ENGLAND, R.J.LA BAUVE                FEBRUARY 1978 *
C*  GROUP T-2,  NUCLEAR DATA                                         *
C*  LOS ALAMOS SCIENTIFIC LABORATORY                                 *
C*                                                                   *
C*********************************************************************
C*********************************************************************
C*TOAFEW 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 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 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 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,MINMT,MAXMT,SZMIN,SZMAX,TEMIN,TEMAX
      PRINT 710,MINZ,MAXZ,MINA,MAXA,MINMT,MAXMT,SZMIN,SZMAX,TEMIN,TEMAX
      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 (35,40,140,60,60,60), IFLX
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
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,R1,R2
      IF (EOF, 1) 380,300
  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 (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
      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)SYM(IZ),IA,W,IZ,IA,IS,MAT,MF,MT,TEMP,SZ,(CXC(IGC),IGC
     1=1,NGC),EFFEC
      PRINT 560, SYM(IZ),IA,W,IZ,IA,IS,MAT,MF,MT,TEMP,SZ,
     1 (CXC(IGC),IGC=1,NGC), EFFEC
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(6I5,4E10.3)
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 2200M/S ) OVER LOWEST COARSE GROUP,/,30X,1H=,E12.5,
   2 3H / ,E12.5,3H = ,E12.5)
540 FORMAT (/,10X,21HINPUT WEIGHT FUNCTION,10X,I5,6HPOINTS,/)
560 FORMAT (1X,A2,I3,A1,1X,I3,1X,I3,1X,I1,1X,I4,1X,I2,1X,I3,F6.0,E8.1,
   15E14.6)
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,I3,2E9.3,2A10)
590 FORMAT(/,1X,58HNOTE THAT THE EFFECTIVE THERMAL CROSS SECTION IS TH
   1E GROUP,I2,36H CROSS SECTION DIVIDED BY SIGMA(1/V),/,2X,30HWHERE S
   2IGMA(1/V) IS THE GROUP ,I2,56H VALUE OF A 1/V CROSS SECTION EQUAL
   3TO UNITY AT 2200 M/S ,F9.6)
600 FORMAT (/,10X,21HINPUT WEIGHT FUNCTION,10X,I5,16HHISTOGRAM VALUES,
   110X,20HFLUX-PER-UNIT-ENERGY )
620 FORMAT (///,32X,5HTABLE,I3,//,24X,24HONE GROUP CROSS SECTIONS)
630 FORMAT (///,39X,5HTABLE,I3,//,31X,24HTWO GROUP CROSS SECTIONS)
640 FORMAT (///,46X,5HTABLE,I3,//,37X,26HTHREE GROUP CROSS SECTIONS)
580 FORMAT(///,53X,5HTABLE,I3,//,45X,25HFOUR GROUP CROSS SECTIONS )
585 FORMAT(//,56X,5HTABLE,I3,//,48X,I3,21H GROUP CROSS SECTIONS,//)
660 FORMAT (///,31X,40HTEMP  SIGMA     GROUP 1    EFFEC.THERMAL,/,43H
   1NUCLIDE  Z  A  S  MAT MF  MT DEG K  ZERO  ,2(14H CROSS SECTION),/,
   243H ------  -- --- - ---- -- --- ----- -------,2(14H -------------
   3))
670 FORMAT (///,31X,54HTEMP  SIGMA     GROUP 1       GROUP 2    EFFEC.
   1THERMAL,/,43H NUCLIDE  Z  A  S  MAT MF  MT DEG K  ZERO  ,3(14H CRO
   2SS SECTION),/,43H ------  -- --- - ---- -- --- ----- -------,3(14H
   3 -------------))
```

```
  680 FORMAT (///,31X,68HTEMP  SIGMA     GROUP 1       GROUP 2       GRO
     1UP 3    EFFEC.THERMAL,/,43H NUCLIDE  Z  A  S  MAT MF  MT DEG K  ZE
     2RO  ,/,43H ------  -- --- - ---- -- --- ----- -------,4(14H ------
     3-------))
  550 FORMAT (///,31X,82HTEMP  SIGMA     GROUP 1       GROUP 2       GRO
     1UP 3       GROUP 4    EFFEC.THERMAL,/,43H NUCLIDE  Z  A  S  MAT MF
     2  MT DEG K  ZERO  ,5(14H CROSS SECTION),/,1X,42H------  -- --- - -
     3--- -- --- ------ -------,5(14H -------------))
  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
     2MT*,4X,27H***BONDARENKO SIGMA ZERO***,4X,27H******TEMPERATURE (K)*
     3*****,/, 3(5X,I3,4H TO ,I3), 2(6X,E10.3,5H TO  ,E10.3),/)
  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)
      A7=(5.*EA)/TK
      A8=SQRT(A7)-SQRT(A5)
      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(A8)+ERF(A6))
      GO TO 260
  210 ENTEG=ENTEG+TERM+C(5)*SQRT(A3)*(ERF(A8)-ERF(A6))
      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(A8)+ERF(A6))
      GO TO 260
  240 ENTEG=ENTEG+CON*(ERF(A8)-ERF(A6))
```

```
      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
      IF (E2.LE.EFLUX(IFX).AND.E2.GT.EFLUX(IFX+1)) GO TO 330
  320 CONTINUE
  330 LFH=IFX
      DO 340 IFX=LFH,NFXM1
      IF (E1.LT.EFLUX(IFX).AND.E1.GE.EFLUX(IFX+1)) GO TO 350
  340 CONTINUE
  350 LFL=IFX
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 IF NORMALIZED TO THIS BY      *
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
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 I=1,NPRP1
      IF (I.EQ.1) GO TO 20
      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
      C=1.
      IF(IFLX.LT.4) GO TO 205
C IF HISTOGRAM USER FLUX, DRAW HISTOGRAM
      L=1
      C=-1.
  205 CALL PLOTM(EB,FB,-NB,-1,L,-39,C)
      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)
      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))
      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.

CARD INPUT FOR SAMPLE PROBLEM 1

```
SAMPLE PROBLEM 1  EPRI 4-GROUP CROSS SECTIONS/ XE-135 /ALL MT /PRS FLUX
   2    0   -4    8    1
  54   54  135  135    1  1021.0    +101.0    +109.0    +021.0    +03
   7   18   47  128  155
```

OUTPUT FILE FROM SAMPLE PROBLEM 1

```
                SAMPLE PROBLEM 1  EPRI 4-GROUP CROSS SECTIONS/ XE-135 /ALL MT /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)
   NGC =  4   ,NUMBER OF COARSE GROUPS
    NT =  8   ,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 MT*    ***BONDARENKO SIGMA ZERO***     ******TEMPERATURE (K)******
   54 TO  54     135 TO 135       1 TO 102       1.000E+10 TO   1.000E+10       9.000E+02 TO   1.000E+03

 ECHO FROM DATA FILE    LASL 154-GP FISSION PRODUCT CROSS-SECTION FILE/WILSON,ENGLAND AND LA BAUVE  6-77
```

```
 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  2200M/S ) 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 MULTIGROUP CROSS SECTIONS ORDERED ON Z, A, STATE, AND REACTION MT

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	GROUP 3 CROSS SECTION	GROUP 4 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
XE135	54	135	0	1294	3	1	900	1.0E+10	5.971888E+00	6.352873E+00	6.506110E+02	1.975492E+06	3.565752E+06
XE135	54	135	0	1294	3	2	900	1.0E+10	5.090378E+00	6.341942E+00	2.871072E+02	3.049013E+05	5.503451E+05
XE135	54	135	0	1294	3	4	900	1.0E+10	8.814840E-01	7.834933E-03	0.	0.	0.
XE135	54	135	0	1294	3	102	900	1.0E+10	5.564618E-04	3.218521E-03	3.634285E+02	1.670657E+06	3.015526E+06

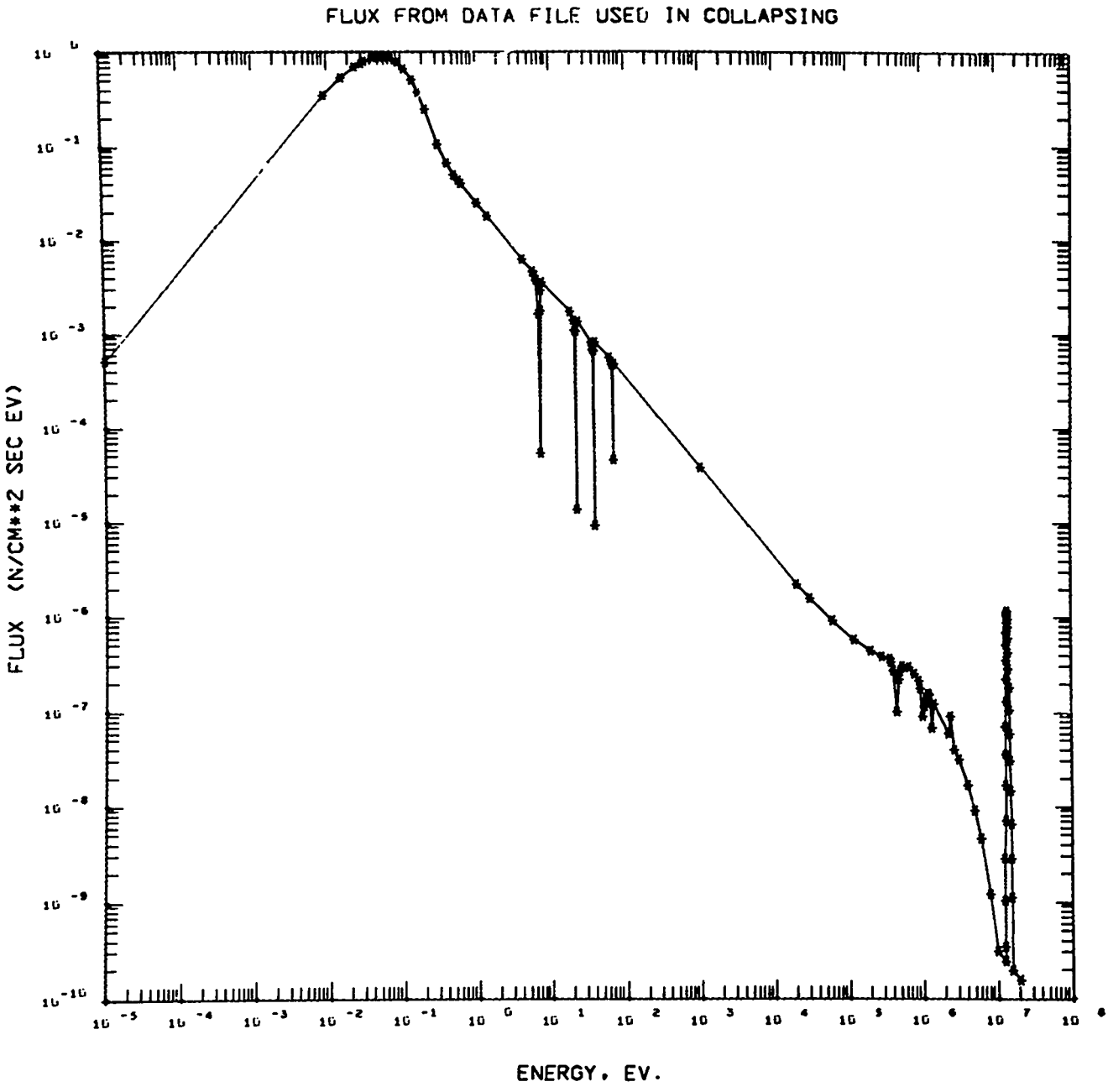
TAPE2 FILE FROM SAMPLE PROBLEM 1

TABLE 8

FOUR-GROUP CROSS SECTIONS

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	GROUP 3 CROSS SECTION	GROUP 4 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
XE135	54	135	0	1294	3	1	900	1.0E+10	5.971888E+00	6.352873E+00	6.506110E+02	1.975492E+06	3.565752E+06
XE135	54	135	0	1294	3	2	900	1.0E+10	5.090378E+00	6.341942E+00	2.871072E+02	3.049013E+05	5.503451E+05
XE135	54	135	0	1294	3	4	900	1.0E+10	8.814840E-01	7.834933E-03	0.	0.	0.
XE135	54	135	0	1294	3	102	900	1.0E+10	5.564618E-04	3.218521E-03	3.634285E+02	1.670657E+06	3.015526E+06

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 2200 M/S .554018



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.

CARD INPUT FOR SAMPLE PROBLEM 2

```
SAMPLE PROBLEM 2  B+W 2-GROUP (N,GAMMA) FOR ALL XENON/HISTOGRAM 111-GROUP FLUX
    6  111    2    9    1
   54   54  128  136  102  1021.0    +101.0    +109.0    +021.0    +03
1.0      +076.0653066+063.6787944+062.2313016+061.3533528+068.2084995+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
9.6001401-019.4001378-019.1001369-018.8001373-018.5001268-018.2001327-01
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
1.8581266-021.8794406-023.8277032-023.9196386-024.0124366-024.1080629-02
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-GROUP (N,GAMMA) FOR ALL XENON/HISTOGRAM 111-GROUP 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)
   NGC =  2    ,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 MT*     ***BONDARENKO SIGMA ZERO***     ******TEMPERATURE (K)******
   54 TO  54      128 TO 136      102 TO 102        1.000E+10 TO   1.000E+10        9.000E+02 TO   1.000E+03

 ECHO FROM DATA FILE    LASL 154-GP FISSION PRODUCT CROSS-SECTION FILE/WILSON,ENGLAND AND LA BAUVE  6-77
 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 5.39138E+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(IGC),IGC=1,  3)ARE
   6   103   154
 FLUX-WEIGHTED AVERAGE OF 1/V CROSS SECTION (UNITY AT  2200M/S ) OVER LOWEST COARSE GROUP
                        = 6.23457E+00 /  1.33865E+01 =  4.65735E-01
  INTEGRATED MULTIGROUP FLUXES, FLXI(IGC),IGC=1,  2)
7.50227E+01 1.33865E+01
```

EFFECTIVE THERMAL GROUP FLUX= 6.234570E+00
ECHO FROM DATA FILE MULTIGROUP CROSS SECTIONS ORDERED ON Z, A, STATE AND REACTION MT

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
XE128	54	128	0	1173	3	102	900	1.0E+10	7.950522E+00	8.444517E+00	1.813160E+01
XE129	54	129	0	589	3	102	1000	1.0E+10	7.939349E+00	8.496994E+00	1.824427E+01
XE130	54	130	0	1174	3	102	900	1.0E+10	1.300260E-01	2.898171E+00	6.222791E+00
XE131	54	131	0	1175	3	102	900	1.0E+10	2.578177E+01	4.271934E+01	9.172458E+01
XE132	54	132	0	1176	3	102	900	1.0E+10	8.607339E-02	2.103460E-01	4.516432E-01
XE133	54	133	0	595	3	102	1000	1.0E+10	1.124755E+01	8.934066E+01	1.918273E+02
XE134	54	134	0	1177	3	102	900	1.0E+10	2.837469E-02	1.207665E-01	2.593032E-01
XE135	54	135	0	1294	3	102	900	1.0E+10	6.854973E+00	1.287427E+06	2.764291E+06
XE136	54	136	0	1178	3	102	900	1.0E+10	3.968694E-03	7.462344E-02	1.602273E-01

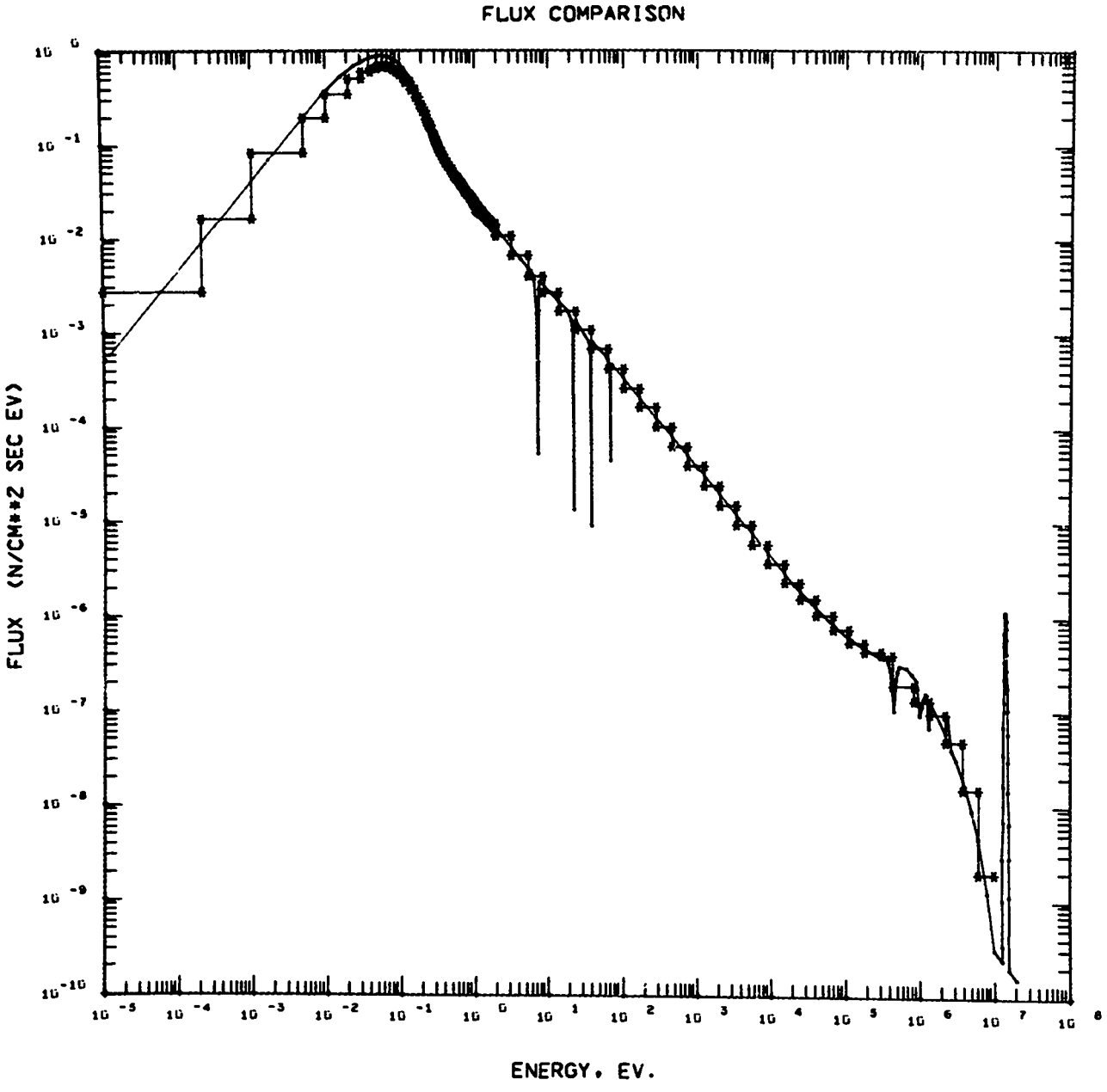
TAPE2 FILE FROM SAMPLE PROBLEM 2

TABLE 9

TWO GROUP CROSS SECTIONS

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1 CROSS SECTION	GROUP 2 CROSS SECTION	EFFEC.THERMAL CROSS SECTION
XE128	54	128	0	1173	3	102	900	1.0E+10	7.950522E+00	8.444517E+00	1.813160E+01
XE129	54	129	0	589	3	102	1000	1.0E+10	7.939349E+00	8.496994E+00	1.824427E+01
XE130	54	130	0	1174	3	102	900	1.0E+10	1.300260E-01	2.898171E+00	6.222791E+00
XE131	54	131	0	1175	3	102	900	1.0E+10	2.578177E+01	4.271934E+01	9.172458E+01
XE132	54	132	0	1176	3	102	900	1.0E+10	8.607339E-02	2.103460E-01	4.516432E-01
XE133	54	133	0	595	3	102	1000	1.0E+10	1.124755E+01	8.934066E+01	1.918273E+02
XE134	54	134	0	1177	3	102	900	1.0E+10	2.837469E-02	1.207665E-01	2.593032E-01
XE135	54	135	0	1294	3	102	900	1.0E+10	6.854973E+00	1.287427E+06	2.764291E+06
XE136	54	136	0	1178	3	102	900	1.0E+10	3.968694E-03	7.462344E-02	1.602273E-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 2200 M/S .465735



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.

CARD INPUT FOR SAMPLE PROBLEM 3

```
SAMPLE PROBLEM 3  3-GP (N,GAMMA) FOR ALL DYSPROSIUM/ FUNCTIONAL FLUX FOR MTR
    1    0    3   10    1
   66   66  160  164  102  1021.0    +101.0    +109.0    +021.0    +03
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) FOR ALL DYSPROSIUM/ 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)
    NGC =  3   ,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 MT*    ***BONDARENKO SIGMA ZERO***     ******TEMPERATURE (K)******
    66 TO  66     160 TO 164     102 TO 102       1.000E+10 TO   1.000E+10       9.000E+02 TO   1.000E+03

 ECHO FROM DATA FILE    LASL 154-GP FISSION PRODUCT CROSS-SECTION FILE/WILSON,ENGLAND AND LA BAUVE  6-77
 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
```

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 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 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.
  (LFG(IGC),IGC=1,  4)ARE
    6    47   143   154
  FLUX-WEIGHTED AVERAGE OF 1/V CROSS SECTION (UNITY AT  2200M/S ) OVER LOWEST COARSE GROUP
                          = 7.11385E-04 /  7.60340E-04 =  9.35615E-01
    INTEGRATED MULTIGROUP FLUXES, FLXI(IGC),IGC=1,  3)
2.37417E-03 3.44145E-03 7.60340E-04
    EFFECTIVE THERMAL GROUP FLUX=   7.113851E-04
```

ECHO FROM DATA FILE MULTIGROUP CROSS SECTIONS ORDERED ON Z, A, STATE AND REACTION MT

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1	GROUP 2	GROUP 3	EFFEC.THERMAL
DY160	66	160	0	811	3	102	1000	1.0E+10	1.213757E+00	1.575490E+02	5.423726E+01	5.796966E+01
DY161	66	161	0	812	3	102	1000	1.0E+10	1.248979E+00	1.361589E+02	5.115268E+02	5.467281E+02
DY162	66	162	0	813	3	102	1000	1.0E+10	5.115748E-01	2.875909E+02	1.766576E+02	1.888145E+02
DY163	66	163	0	814	3	102	1000	1.0E+10	5.194179E-01	1.420322E+02	1.186120E+02	1.267744E+02
DY164	66	164	0	1031	3	102	900	1.0E+10	1.710835E-01	1.322543E+02	2.176068E+03	2.325817E+03

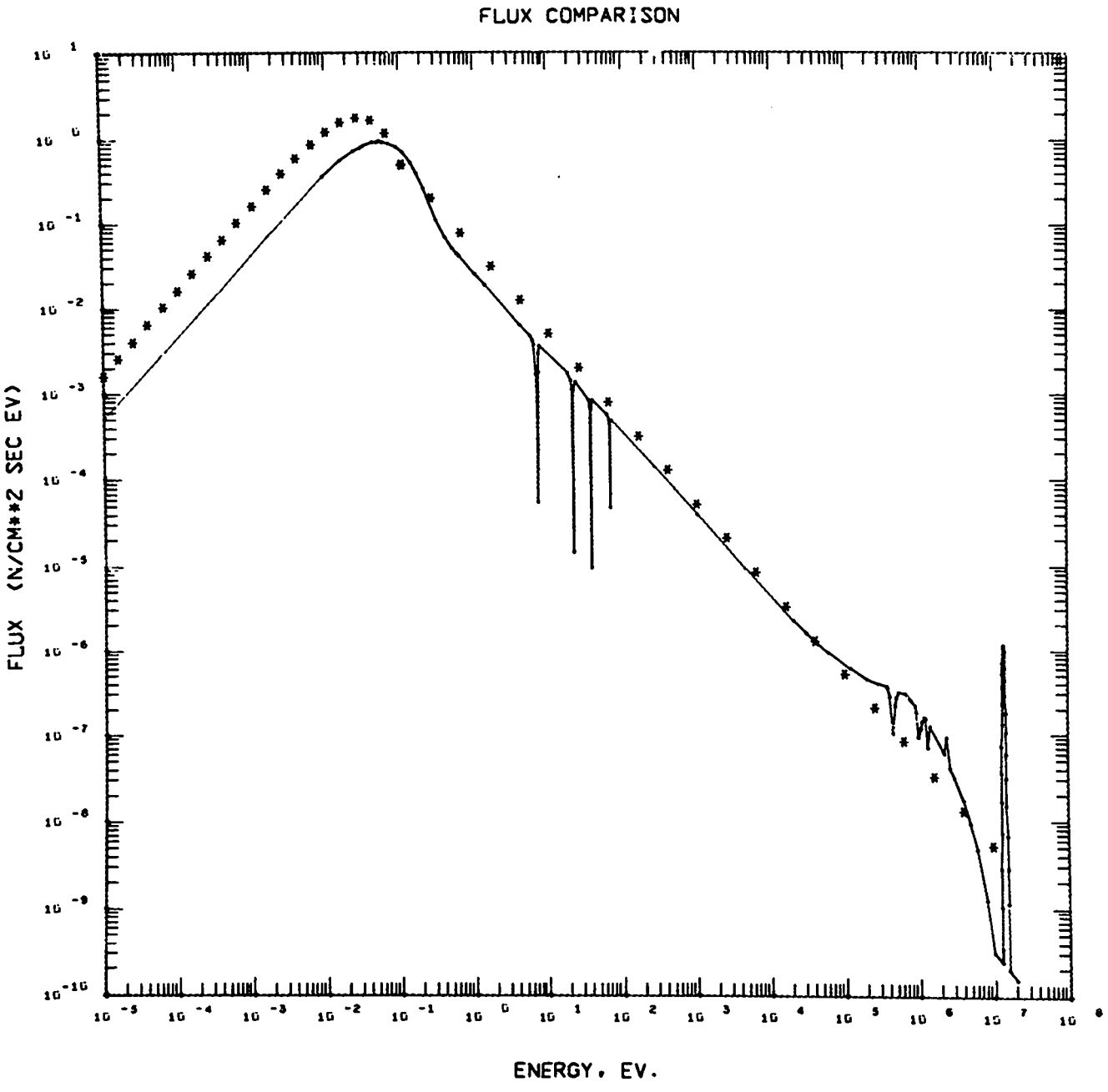
TAPE2 FILE FROM SAMPLE PROBLEM 3

TABLE 10

THREE GROUP CROSS SECTIONS

NUCLIDE	Z	A	S	MAT	MF	MT	TEMP DEG K	SIGMA ZERO	GROUP 1	GROUP 2	GROUP 3	EFFEC.THERMAL
DY160	66	160	0	811	3	102	1000	1.0E+10	1.213757E+00	1.575490E+02	5.423726E+01	5.796966E+01
DY161	66	161	0	812	3	102	1000	1.0E+10	1.248979E+00	1.361589E+02	5.115268E+02	5.467281E+02
DY162	66	162	0	813	3	102	1000	1.0E+10	5.115748E-01	2.875909E+02	1.766576E+02	1.888145E+02
DY163	66	163	0	814	3	102	1000	1.0E+10	5.194179E-01	1.420322E+02	1.186120E+02	1.267744E+02
DY164	66	164	0	1031	3	102	900	1.0E+10	1.710835E-01	1.322543E+02	2.176068E+03	2.325817E+03

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 2200 M/S .935615



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 NGC=4, IT IS NECESSARY TO INCREASE THE DIMENSIONS OF EC(NGC+1),CXC(NGC),
                   LFG(NGC+1),CXFLXI(NGC),LB(NGC+1),FLXI(NGC),AND FLXIM(NGC,NGF).  SPECIFY THE
                   GAM-I ENERGY BOUNDARIES BY TAGGING NGC NEGATIVE AND USING THE (LB(IGC),IGC=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,NGF,NGC,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

       CARD INPUT FOR SAMPLE PROBLEM 4
       -------------------------------


SAMPLE PROBLEM 4  GAM-I 68-GROUP TOTAL CROSS SECTIONS ALL IODINE/PRS FLUX
    2    0  -68   11    0
   53   53  127  135    1    11.0    +101.0    +109.0    +021.0    +03
    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-GROUP TOTAL CROSS SECTIONS ALL IODINE/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)
     NGC = 68    ,NUMBER OF COARSE GROUPS
      NT = 11    ,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 MT*     ***BONDARENKO SIGMA ZERO***      ******TEMPERATURE (K)******
     53 TO  53       127 TO 135        1 TO   1        1.000E+10 TO   1.000E+10        9.000E+02 TO   1.000E+03

  ECHO FROM DATA FILE    LASL 154-GP FISSION PRODUCT CROSS-SECTION FILE/WILSON,ENGLAND AND LA BAUVE  6-77
```

```
 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 3.99310E-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    MULTIGROUP CROSS SECTIONS ORDERED ON Z, A, STATE AND REACTION MT

I127       MAT 565     MF  3     MT  1     TEMP=  1000     SIGMA 0= 1.0E+10
4.03993E+00 3.89602E+00 4.11400E+00 4.46616E+00 4.92621E+00 5.43503E+00 5.84755E+00 6.14600E+00 6.28610E+00 6.30352E+00
6.24417E+00 6.15385E+00 6.05723E+00 5.97545E+00 5.91467E+00 5.87441E+00 5.85338E+00 5.84797E+00 5.86011E+00 5.88706E+00
5.93155E+00 5.99559E+00 6.07983E+00 6.19214E+00 6.31761E+00 6.51224E+00 6.71814E+00 6.95372E+00 7.24921E+00 7.59634E+00
8.00994E+00 8.49404E+00 9.02749E+00 9.65343E+00 1.03674E+01 1.11983E+01 1.02487E+01 1.37049E+01 1.80306E+01 1.54450E+01
3.35969E+01 7.32774E+00 1.73561E+01 6.87833E+01 3.17532E+01 4.15051E+00 4.07205E+01 4.72923E+01 6.49541E+00 3.05180E+02
1.91428E+02 3.66907E+00 1.63889E+01 3.21990E+00 3.29328E+00 3.39064E+00 3.46579E+00 3.56163E+00 3.63441E+00 3.71303E+00
3.79744E+00 3.88445E+00 3.98112E+00 4.09026E+00 4.21119E+00 4.34555E+00 4.49692E+00 4.67110E+00

I129       MAT 567     MF  3     MT  1     TEMP=  1000     SIGMA 0= 1.0E+10
4.04724E+00 3.90359E+00 4.15071E+00 4.53899E+00 5.04179E+00 5.56037E+00 5.95786E+00 6.22660E+00 6.32242E+00 6.28914E+00
6.18672E+00 6.05927E+00 5.93467E+00 5.83583E+00 5.76894E+00 5.73051E+00 5.72036E+00 5.73393E+00 5.76844E+00 5.82362E+00
5.90288E+00 6.00291E+00 6.12771E+00 6.29351E+00 6.48633E+00 6.72072E+00 7.00111E+00 7.30679E+00 7.68192E+00 8.11807E+00
8.63312E+00 9.23102E+00 9.88861E+00 1.06558E+01 1.15291E+01 1.25423E+01 1.36651E+01 1.47613E+01 1.56474E+01 1.66801E+01
1.78424E+01 1.90941E+01 2.07230E+01 1.98051E+01 3.78152E+01 6.39931E+00 6.08874E+00 2.74127E+01 4.97711E+00 5.12288E+00
5.25137E+00 5.35801E+00 5.48759E+00 5.62012E+00 5.76656E+00 5.93750E+00 6.10580E+00 6.35022E+00 6.58633E+00 6.85856E+00
7.16690E+00 7.52456E+00 7.91301E+00 8.36547E+00 8.88712E+00 9.45555E+00 1.01502E+01 1.08955E+01

I130       MAT 568     MF  3     MT  1     TEMP=  1000     SIGMA 0= 1.0E+10
4.05201E+00 3.90958E+00 4.17059E+00 4.58618E+00 5.10607E+00 5.59682E+00 6.00045E+00 6.23213E+00 6.26928E+00 6.26521E+00
6.15060E+00 5.99842E+00 5.86653E+00 5.77350E+00 5.70726E+00 5.66869E+00 5.66729E+00 5.69098E+00 5.73545E+00 5.80798E+00
5.90406E+00 6.03371E+00 6.20577E+00 6.39123E+00 6.60333E+00 6.86456E+00 7.17418E+00 7.52592E+00 7.99414E+00 8.52061E+00
9.07592E+00 9.69269E+00 1.04419E+01 1.17095E+01 1.33750E+01 1.55271E+01 1.83286E+01 2.11127E+01 2.38707E+01 2.71564E+01
3.10360E+01 3.56278E+01 4.10767E+01 4.75259E+01 5.52678E+01 6.46327E+01 7.48122E+01 8.55789E+01 9.89955E+01 1.14124E+02
1.29333E+02 8.02412E+01 1.68598E+01 5.42139E+00 5.52015E+00 5.62888E+00 5.73666E+00 5.90555E+00 6.05459E+00 6.23823E+00
6.44820E+00 6.67603E+00 6.94472E+00 7.24562E+00 7.58155E+00 7.96431E+00 8.42754E+00 8.93310E+00

I131       MAT 570     MF  3     MT  1     TEMP=  1000     SIGMA 0= 1.0E+10
4.05829E+00 3.91627E+00 4.18839E+00 4.62028E+00 5.16078E+00 5.62626E+00 6.05783E+00 6.27481E+00 6.29029E+00 6.27090E+00
6.13711E+00 5.99000E+00 5.83950E+00 5.72125E+00 5.66378E+00 5.61857E+00 5.63456E+00 5.66956E+00 5.71717E+00 5.81897E+00
5.93068E+00 6.07369E+00 6.27742E+00 6.48918E+00 6.71813E+00 7.01784E+00 7.37469E+00 7.76716E+00 8.31957E+00 8.96881E+00
9.69454E+00 1.05070E+01 1.14349E+01 1.25332E+01 1.37313E+01 1.50052E+01 1.64482E+01 1.81031E+01 1.99736E+01 2.20830E+01
2.44391E+01 2.60230E+01 1.65799E+01 6.45836E+00 4.72522E+00 4.72647E+00 4.72784E+00 4.72938E+00 4.73125E+00 4.73319E+00
4.73571E+00 4.73822E+00 4.74125E+00 4.74450E+00 4.74831E+00 4.75259E+00 4.75687E+00 4.76331E+00 4.76938E+00 4.77672E+00
4.78462E+00 4.79396E+00 4.80464E+00 4.81630E+00 4.82981E+00 4.84607E+00 4.86371E+00 4.88391E+00

I135       MAT 576     MF  3     MT  1     TEMP=  1000     SIGMA 0= 1.0E+10
4.09065E+00 3.95751E+00 4.25544E+00 4.64313E+00 5.31525E+00 5.84090E+00 6.25975E+00 6.44658E+00 6.40710E+00 6.28335E+00
6.07285E+00 5.87484E+00 5.67817E+00 5.53869E+00 5.49217E+00 5.45781E+00 5.51980E+00 5.61096E+00 5.72084E+00 5.90954E+00
6.11507E+00 6.36334E+00 6.69307E+00 7.03747E+00 7.40574E+00 7.87665E+00 7.47193E+00 5.23100E+00 4.81231E+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 4.81236E+00 4.81241E+00 4.81246E+00 4.81253E+00
4.81261E+00 4.81269E+00 4.81280E+00 4.81291E+00 4.81305E+00 4.81321E+00 4.81337E+00 4.81362E+00 4.81387E+00 4.81417E+00
4.81453E+00 4.81496E+00 4.81545E+00 4.81607E+00 4.81680E+00 4.81766E+00 4.81871E+00 4.82009E+00
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TAPE2 FILE FROM SAMPLE PROBLEM 4

TABLE 11

68 GROUP CROSS SECTIONS

I127 MAT 565 MF 3 MT 1 TEMP= 1000 SIGMA 0= 1.0E+10
4.03993E+00 3.89602E+00 4.11400E+00 4.46616E+00 4.92621E+00 5.43503E+00 5.84755E+00 6.14600E+00 6.28610E+00 6.30352E+00
6.24417E+00 6.15385E+00 6.05723E+00 5.97545E+00 5.91467E+00 5.87441E+00 5.85338E+00 5.84797E+00 5.86011E+00 5.88706E+00
5.93155E+00 5.99559E+00 6.07983E+00 6.19214E+00 6.31761E+00 6.51224E+00 6.71814E+00 6.95372E+00 7.24921E+00 7.59634E+00
8.00994E+00 8.49404E+00 9.02749E+00 9.65343E+00 1.03674E+01 1.11983E+01 1.02487E+01 1.37049E+01 1.80306E+01 1.54450E+01
3.35969E+01 7.32774E+00 1.73561E+01 6.87833E+01 3.17532E+01 4.15051E+00 4.07205E+01 4.72923E+01 6.49541E+00 3.05180E+02
1.91428E+02 3.66907E+00 1.63889E+01 3.21990E+00 3.29328E+00 3.39064E+00 3.46579E+00 3.56163E+00 3.63441E+00 3.71303E+00
3.79744E+00 3.88445E+00 3.98112E+00 4.09026E+00 4.21119E+00 4.34555E+00 4.49692E+00 4.67110E+00

I129 MAT 567 MF 3 MT 1 TEMP= 1000 SIGMA 0= 1.0E+10
4.04724E+00 3.90359E+00 4.15071E+00 4.53899E+00 5.04179E+00 5.56037E+00 5.95786E+00 6.22660E+00 6.32242E+00 6.28914E+00
6.18672E+00 6.05927E+00 5.93467E+00 5.83583E+00 5.76894E+00 5.73051E+00 5.72036E+00 5.73393E+00 5.76844E+00 5.82362E+00
5.90288E+00 6.00291E+00 6.12771E+00 6.29351E+00 6.48633E+00 6.72072E+00 7.00111E+00 7.30679E+00 7.68192E+00 8.11807E+00
8.63312E+00 9.23102E+00 9.88861E+00 1.06558E+01 1.15291E+01 1.25423E+01 1.36651E+01 1.47613E+01 1.56474E+01 1.66801E+01
1.78424E+01 1.90941E+01 2.07230E+01 1.98051E+01 3.78152E+01 6.39931E+00 6.08874E+00 2.74127E+01 4.97711E+00 5.12288E+00
5.25137E+00 5.35801E+00 5.48759E+00 5.62012E+00 5.76656E+00 5.93750E+00 6.10580E+00 6.35022E+00 6.58633E+00 6.85856E+00
7.16690E+00 7.52456E+00 7.91301E+00 8.36547E+00 8.88712E+00 9.45555E+00 1.01502E+01 1.08955E+01

I130 MAT 568 MF 3 MT 1 TEMP= 1000 SIGMA 0= 1.0E+10
4.05201E+00 3.90958E+00 4.17059E+00 4.58618E+00 5.10607E+00 5.59682E+00 6.00045E+00 6.23213E+00 6.26928E+00 6.26521E+00
6.15060E+00 5.99842E+00 5.86653E+00 5.77350E+00 5.70726E+00 5.66869E+00 5.66729E+00 5.69098E+00 5.73545E+00 5.80793E+00
5.90406E+00 6.03371E+00 6.20577E+00 6.39123E+00 6.60333E+00 6.86456E+00 7.17418E+00 7.52592E+00 7.99414E+00 8.52061E+00
9.07592E+00 9.69269E+00 1.04419E+01 1.17095E+01 1.33750E+01 1.55271E+01 1.83286E+01 2.11127E+01 2.38707E+01 2.71564E+01
3.10360E+01 3.56278E+01 4.10767E+01 4.75259E+01 5.52678E+01 6.46327E+01 7.48122E+01 8.55789E+01 9.89955E+01 1.14124E+02
1.29333E+02 8.02412E+01 1.68598E+01 5.42139E+00 5.52015E+00 5.62888E+00 5.73666E+00 5.90555E+00 6.05459E+00 6.23823E+00
6.44820E+00 6.67603E+00 6.94472E+00 7.24562E+00 7.58155E+00 7.96431E+00 8.42754E+00 8.93310E+00

I131 MAT 570 MF 3 MT 1 TEMP= 1000 SIGMA 0= 1.0E+10
4.05829E+00 3.91627E+00 4.18839E+00 4.62028E+00 5.16078E+00 5.62626E+00 6.05783E+00 6.27481E+00 6.29029E+00 6.27090E+00
6.13711E+00 5.99000E+00 5.83950E+00 5.72125E+00 5.66378E+00 5.61857E+00 5.63456E+00 5.66956E+00 5.71717E+00 5.81697E+00
5.93068E+00 6.07369E+00 6.27742E+00 6.48918E+00 6.71813E+00 7.01784E+00 7.37469E+00 7.76716E+00 8.31957E+00 8.96881E+00
9.69454E+00 1.05070E+01 1.14349E+01 1.25332E+01 1.37313E+01 1.50052E+01 1.64482E+01 1.81031E+01 1.99736E+01 2.20830E+01
2.44391E+01 2.60230E+01 1.65799E+01 6.45836E+00 4.72522E+00 4.72647E+00 4.72784E+00 4.72938E+00 4.73125E+00 4.73319E+00
4.73571E+00 4.73822E+00 4.74125E+00 4.74450E+00 4.74831E+00 4.75259E+00 4.75687E+00 4.76331E+00 4.76938E+00 4.77672E+00
4.78462E+00 4.79396E+00 4.80464E+00 4.81630E+00 4.82981E+00 4.84607E+00 4.86371E+00 4.88391E+00

I135 MAT 576 MF 3 MT 1 TEMP= 1000 SIGMA 0= 1.0E+10
4.09065E+00 3.95751E+00 4.25544E+00 4.64313E+00 5.31525E+00 5.84090E+00 6.25975E+00 6.44658E+00 6.40710E+00 6.28335E+00
6.07285E+00 5.87484E+00 5.67817E+00 5.53869E+00 5.49217E+00 5.45781E+00 5.51930E+00 5.61096E+00 5.72084E+00 5.90954E+00
6.11507E+00 6.36334E+00 6.69307E+00 7.03747E+00 7.40574E+00 7.87665E+00 7.47193E+00 5.23100E+00 4.81231E+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 4.81236E+00 4.81241E+00 4.81246E+00 4.81253E+00
4.81261E+00 4.81269E+00 4.81280E+00 4.81291E+00 4.81305E+00 4.81321E+00 4.81337E+00 4.81362E+00 4.81387E+00 4.81417E+00
4.81453E+00 4.81496E+00 4.81545E+00 4.81607E+00 4.81680E+00 4.81766E+00 4.81871E+00 4.82009E+00

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