Appendix A. GROUP STRUCTURES

1. IGN=2...CSEWG 240-Group Structure

This set of group bounds was proposed[1] as a "supergroup" structure to be used for fine-group libraries that could be collapsed to several other group structures in general use at the time. It was felt that such a collapse would be more economical than producing a set of group constants directly in the target group structure. A large 171-group subset of these group bounds was used for the VITAMIN-C library[2] generated a the Oak Ridge National Laboratory for shielding and fusion applications.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	4.1399E-01	5.3158E-01	6.2506E-01	6.8256E-01
6	8.3368E-01	8.7642E-01	1.1254E+00	1.4450E+00	1.8554E+00
11	2.3824E+00	3.0590E+00	3.9279E+00	5.0435E+00	6.4760E+00
16	8.3153E+00	1.0677E+01	1.3710E+01	1.7603E+01	2.2603E+01
21	2.9023E+01	3.7267E+01	4.7851E+01	6.1442E+01	7.8893E+01
26	1.0130E+02	1.3007E+02	1.6702E+02	2.1445E+02	2.7536E+02
31	3.5358E+02	4.5400E+02	5.8295E+02	7.4852E+02	9.6112E+02
36	1.2341E+03	1.3639E+03	1.5073E+03	1.5846E+03	1.6659E+03
41	1.8411E+03	2.0347E+03	2.2487E+03	2.4852E+03	2.6126E+03
46	2.7465E+03	2.8635E+03	3.0354E+03	3.3546E+03	3.7074E+03
51	4.0973E+03	4.3074E+03	4.5283E+03	5.0045E+03	5.5308E+03
56	6.2673E+03	7.1017E+03	8.0473E+03	9.1188E+03	1.0333E+04
61	1.1709E+04	1.3268E+04	1.5034E+04	1.7036E+04	1.9305E+04
66	2.1335E+04	2.1875E+04	2.3579E+04	2.4176E+04	2.4788E+04
71	2.6058E+04	2.8088E+04	3.1828E+04	3.4307E+04	3.5175E+04
76	3.6066E+04	4.0868E+04	4.6309E+04	5.2475E+04	5.6562E+04
81	5.9462E+04	6.2511E+04	6.7379E+04	7.6351E+04	8.6517E+04
86	9.8037E+04	1.1109E+05	1.1679E+05	1.2277E+05	1.2907E+05
91	1.3569E+05	1.4264E+05	1.4996E+05	1.5764E+05	1.6163E+05
96	1.6573E+05	1.6992E+05	1.7422E+05	1.8316E+05	1.9255E+05
101	2.0242E+05	2.1280E+05	2.2371E+05	2.3518E+05	2.4724E+05
106	2.5991E+05	2.7324E+05	2.8015E+05	2.8725E+05	2.9452E+05
111	3.0197E+05	3.0962E+05	3.1746E+05	3.3373E+05	3.5084E+05
116	3.6883E+05	3.8774E+05	4.0762E+05	4.2852E+05	4.5049E+05
121	4.7359E+05	4.9787E+05	5.1047E+05	5.2340E+05	5.3665E+05
126	5.5023E+05	5.7844E+05	6.0810E+05	6.3928E+05	6.7206E+05
131	7.0651E+05	7.4274E+05	7.8082E+05	8.2085E+05	8.6294E+05
136	9.0718E+05	9.5369E+05	9.6164E+05	9.7783E+05	1.0026E+06
141	1.0540E+06	1.1080E+06	1.1648E+06	1.1943E+06	1.2246E+06
146	1.2873E+06	1.3534E+06	1.4227E+06	1.4957E+06	1.5335E+06
151	1.5724E+06	1.6122E+06	1.6530E+06	1.7377E+06	1.8268E+06
156	1.8731E+06	1.9205E+06	1.9691E+06	2.0190E+06	2.1225E+06
161	2.2313E+06	2.2689E+06	2.3069E+06	2.3457E+06	2.3653E+06

166	2.3852E+06	2.4251E+06	2.4660E+06	2.5924E+06	2.7253E+06
171	2.8650E+06	3.0119E+06	3.0882E+06	3.1664E+06	3.2465E+06
176	3.3287E+06	3.4994E+06	3.6788E+06	3.8674E+06	4.0657E+06
181	4.2741E+06	4.4933E+06	4.6070E+06	4.7237E+06	4.8432E+06
186	4.9659E+06	5.2205E+06	5.4881E+06	5.7695E+06	5.9156E+06
191	6.0653E+06	6.2189E+06	6.3763E+06	6.5377E+06	6.5924E+06
196	6.6476E+06	6.7032E+06	6.8729E+06	7.0469E+06	7.2253E+06
201	7.4082E+06	7.5957E+06	7.7880E+06	7.9852E+06	8.1873E+06
206	8.3946E+06	8.6071E+06	8.8250E+06	9.0484E+06	9.2774E+06
211	9.5123E+06	9.7531E+06	1.0000E+07	1.0253E+07	1.0513E+07
216	1.0779E+07	1.1052E+07	1.1331E+07	1.1618E+07	1.1912E+07
221	1.2214E+07	1.2523E+07	1.2840E+07	1.3165E+07	1.3499E+07
226	1.3840E+07	1.4191E+07	1.4550E+07	1.4918E+07	1.5296E+07
231	1.5683E+07	1.6080E+07	1.6487E+07	1.6905E+07	1.7333E+07
236	1.7771E+07	1.8221E+07	1.8682E+07	1.9155E+07	1.9640E+07
241	1.9970E+07				

2. IGN=3...LANL 30-Group Structure

This is a small structure with complete energy coverage, and it is very economical to use. This makes it useful for survey calculations for fusion systems, fast fission systems, and radiation shields. The group size at low energies is "one lethargy". At higher energies, some one-half and one-quarter lethargy groups are used. Finally, the fusion energy range is represented by bounds close to even energy values. This structure was used in the CLAW-3 and CLAW-4 libraries[3] that are available from the Radiation Shielding Information Center at the Oak Ridge National Laboratory, and in the MATXS1 and MATXS5 libraries used with the TRANSX code[4].

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.3900E-04	1.5200E-01	4.1400E-01	1.1300E+00	3.0600E+00
6	8.3200E+00	2.2600E+01	6.1400E+01	1.6700E+02	4.5400E+02
11	1.2350E+03	3.3500E+03	9.1200E+03	2.4800E+04	6.7600E+04
16	1.8400E+05	3.0300E+05	5.0000E+05	8.2300E+05	1.3530E+06
21	1.7380E+06	2.2320E+06	2.8650E+06	3.6800E+06	6.0700E+06
26	7.7900E+06	1.0000E+07	1.2000E+07	1.3500E+07	1.5000E+07
31	1.7000E+07				

3. IGN=4...ANL 27-Group Structure

This small group structure with even one-half lethargy spacings has been used for fast breeder reactor studies. It is most appropriate for data that has been collapsed from a finer structure for use in two- or three-dimensional calculations; however, it has also been used for processing code comparison studies.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	5.0435E+00	2.2603E+01	3.7267E+01	6.1442E+01	1.0130E+02
6	1.6702E+02	2.7536E+02	4.5400E+02	7.4852E+02	1.2341E+03
11	2.0347E+03	3.3546E+03	5.5308E+03	9.1188E+03	1.5034E+04
16	2.4788E+04	4.0868E+04	6.7379E+04	1.1109E+05	1.8316E+05
21	3.0197E+05	4.9787E+05	8.2085E+05	1.3534E+06	2.2313E+06
26	3.6788E+06	6.0653E+06	1.0000E+07		

4. IGN=5...RRD 50-Group Structure

This structure was specified for a standardized library[5] of group constants based on ENDF/B-IV to be used in the U.S. Fast Breeder Reactor Program (base technology was then under the Office of Reactor Research and Development, RRD). It is still useful for this application, but comparisons with more detailed structures suggested that more groups were needed in the region where U-238 epithermal capture is important and in the region of the 27 keV iron resonance (see the 70- and 80-group structures below). The RRD structure uses quarter lethargy spacing in the middle energy range, with one-half lethargy groups above 500 keV and below 275 eV.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	6.8256E-01	1.1254E+00	1.8554E+00	3.0590E+00
6	5.0435E+00	8.3153E+00	1.3710E+01	2.2603E+01	3.7267E+01
11	6.1442E+01	1.0130E+02	1.6702E+02	2.7536E+02	3.5358E+02
16	4.5400E+02	5.8295E+02	7.4852E+02	9.6112E+02	1.2341E+03
21	1.5846E+03	2.0347E+03	2.6126E+03	3.3546E+03	4.3074E+03
26	5.5308E+03	7.1017E+03	9.1188E+03	1.1709E+04	1.5034E+04
31	1.9305E+04	2.4788E+04	3.1828E+04	4.0868E+04	5.2475E+04
36	6.7379E+04	8.6517E+04	1.1109E+05	1.4264E+05	1.8316E+05
41	2.3518E+05	3.0197E+05	3.8774E+05	4.9787E+05	8.2085E+05
46	1.3534E+06	2.2313E+06	3.6788E+06	6.0653E+06	1.0000E+07
51	1.9971E+07				

5. IGN=6...GAM-I 68-Group Structure

This group structure uses a simple uniform quarter-lethargy spacing. It is accurate for the epithermal portion of thermal reactor calculations, and it has been used extensively for both water-moderated and graphite-moderated designs. In addition to its use in the GAM-I code at General Atomic, this structure is used in libraries[6] produced for the state-of-the-art EPRI-CELL code developed by the Electric Power Research Institute for the U.S. electric utilities.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	4.1399E-01	5.3158E-01	6.8256E-01	8.7642E-01	1.1254E+00
6	1.4450E+00	1.8554E+00	2.3824E+00	3.0590E+00	3.9279E+00
11	5.0435E+00	6.4760E+00	8.3153E+00	1.0677E+01	1.3710E+01
16	1.7603E+01	2.2603E+01	2.9023E+01	3.7267E+01	4.7851E+01
21	6.1442E+01	7.8893E+01	1.0130E+02	1.3007E+02	1.6702E+02
26	2.1445E+02	2.7536E+02	3.5358E+02	4.5400E+02	5.8295E+02
31	7.4852E+02	9.6112E+02	1.2341E+03	1.5846E+03	2.0347E+03
36	2.6126E+03	3.3546E+03	4.3074E+03	5.5308E+03	7.1017E+03
41	9.1188E+03	1.1709E+04	1.5034E+04	1.9305E+04	2.4788E+04
46	3.1828E+04	4.0868E+04	5.2475E+04	6.7379E+04	8.6517E+04
51	1.1109E+05	1.4264E+05	1.8316E+05	2.3518E+05	3.0197E+05
56	3.8774E+05	4.9787E+05	6.3928E+05	8.2085E+05	1.0540E+06
61	1.3534E+06	1.7377E+06	2.2313E+06	2.8650E+06	3.6788E+06
66	4.7237E+06	6.0653E+06	7.7880E+06	1.0000E+07	

6. IGN=7...GAM-II 100-Group Structure

This structure was a successor to the GAM-I set described above. It is the same as GAM-I below 100 keV, but for groups above that point it shifts to one-tenth lethargy. It also includes several groups above 10 MeV to represent the D-T fusion source and the high-energy tail of the fission spectrum. The upper limit of the highest group was changed at Los Alamos (from 14.918 to 17.0 MeV) to permit more accurate averaging over the fusion peak.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	4.1399E-01	5.3158E-01	6.8256E-01	8.7642E-01
6	1.1254E+00	1.4450E+00	1.8554E+00	2.3824E+00	3.0590E+00
11	3.9279E+00	5.0435E+00	6.4760E+00	8.3153E+00	1.0677E+01
16	1.3710E+01	1.7603E+01	2.2603E+01	2.9023E+01	3.7267E+01
21	4.7851E+01	6.1442E+01	7.8893E+01	1.0130E+02	1.3007E+02
26	1.6702E+02	2.1445E+02	2.7536E+02	3.5358E+02	4.5400E+02
31	5.8295E+02	7.4852E+02	9.6112E+02	1.2341E+03	1.5846E+03
36	2.0347E+03	2.6126E+03	3.3546E+03	4.3074E+03	5.5308E+03
41	7.1017E+03	9.1188E+03	1.1709E+04	1.5034E+04	1.9305E+04
46	2.4788E+04	3.1828E+04	4.0868E+04	5.2475E+04	6.7379E+04
51	8.6517E+04	1.1109E+05	1.2277E+05	1.3569E+05	1.4996E+05
56	1.6573E+05	1.8316E+05	2.0242E+05	2.2371E+05	2.4724E+05
61	2.7324E+05	3.0197E+05	3.3373E+05	3.6883E+05	4.0762E+05

66	4.5049E+05	4.9787E+05	5.5023E+05	6.0810E+05	6.7206E+05
71	7.4274E+05	8.2085E+05	9.0718E+05	1.0026E+06	1.1080E+06
76	1.2246E+06	1.3534E+06	1.4957E+06	1.6530E+06	1.8268E+06
81	2.0190E+06	2.2313E+06	2.4660E+06	2.7253E+06	3.0119E+06
86	3.3287E+06	3.6788E+06	4.0657E+06	4.4933E+06	4.9659E+06
91	5.4881E+06	6.0653E+06	6.7032E+06	7.4082E+06	8.1873E+06
96	9.0484E+06	1.0000E+07	1.1052E+07	1.2214E+07	1.3499E+07
101	1.7000E+07				

7. IGN=8...LASER-THERMOS 35-Group Structure

This is a thermal group structure. It is based on the THERMOS equal-velocity structure with additional groups added in the vicinity of the Pu-240 resonance. It is used for the thermal calculation in EPRI-CELL.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	2.5300E-04	2.2770E-03	6.3250E-03	1.2397E-02	2.0493E-02
6	3.0613E-02	4.2757E-02	5.6925E-02	8.1972E-02	1.1159E-01
11	1.4573E-01	1.8444E-01	2.2770E-01	2.5104E-01	2.7053E-01
16	2.9075E-01	3.0113E-01	3.2064E-01	3.5768E-01	4.1704E-01
21	5.0326E-01	6.2493E-01	7.8211E-01	9.5070E-01	1.0137E+00
26	1.0428E+00	1.0525E+00	1.0624E+00	1.0722E+00	1.0987E+00
31	1.1664E+00	1.3079E+00	1.4575E+00	1.5950E+00	1.7262E+00
36	1.8550E+00				

8. IGN=9...EPRI-CPM 69-Group Structure

This group structure is designed for water-moderated thermal reactor data sets. It is the same as the WIMS structure, and it was used at Los Alamos to prepare libraries[6] for the EPRI-CPM code. The portion above 4 eV is basically one-half lethargy, except that the boundaries of several groups have been shifted to move important resonances close to the center of their groups. The portion below 4 eV is a detailed thermal structure including extra detail for the Pu-240 resonance.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	5.0000E-03	1.0000E-02	1.5000E-02	2.0000E-02
6	2.5000E-02	3.0000E-02	3.5000E-02	4.2000E-02	5.0000E-02
11	5.8000E-02	6.7000E-02	8.0000E-02	1.0000E-01	1.4000E-01
16	1.8000E-01	2.2000E-01	2.5000E-01	2.8000E-01	3.0000E-01
21	3.2000E-01	3.5000E-01	4.0000E-01	5.0000E-01	6.2500E-01

26	7.8000E-01	8.5000E-01	9.1000E-01	9.5000E-01	9.7200E-01
31	9.9600E-01	1.0200E+00	1.0450E+00	1.0710E+00	1.0970E+00
36	1.1230E+00	1.1500E+00	1.3000E+00	1.5000E+00	2.1000E+00
41	2.6000E+00	3.3000E+00	4.0000E+00	9.8770E+00	1.5968E+01
46	2.7700E+01	4.8052E+01	7.5501E+01	1.4873E+02	3.6726E+02
51	9.0690E+02	1.4251E+03	2.2395E+03	3.5191E+03	5.5300E+03
56	9.1180E+03	1.5030E+04	2.4780E+04	4.0850E+04	6.7340E+04
61	1.1100E+05	1.8300E+05	3.0250E+05	5.0000E+05	8.2100E+05
66	1.3530E+06	2.2310E+06	3.6790E+06	6.0655E+06	1.0000E+07

9. IGN=10...LANL 187-Group Structure

This structure is intended to be a single set of fine-lethargy bounds that can be used for thermal reactors, fast breeder reactors, fusion systems, and shielding calculations. As such, it has a thermal structure below 4 eV that is somewhat finer than either the 69-group or the 35-group structures. It is superior to all the other structures in the epithermal range (say, 4 eV to 100 keV). Finally, it has a high-energy structure that is finer than the 80-group set, but not as detailed as the 100- or 240-group structures.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	2.5399E-04	7.6022E-04	2.2769E-03	6.3247E-03
6	1.2396E-02	2.0492E-02	2.5500E-02	3.0612E-02	3.5500E-02
11	4.2755E-02	5.0000E-02	5.6922E-02	6.7000E-02	8.1968E-02
16	1.1157E-01	1.4572E-01	1.5230E-01	1.8443E-01	2.2769E-01
21	2.5103E-01	2.7052E-01	2.9074E-01	3.0112E-01	3.2063E-01
26	3.5767E-01	4.1499E-01	5.0323E-01	6.2506E-01	7.8208E-01
31	8.3368E-01	8.7642E-01	9.1000E-01	9.5065E-01	9.7100E-01
36	9.9200E-01	1.0137E+00	1.0427E+00	1.0525E+00	1.0623E+00
41	1.0722E+00	1.0987E+00	1.1254E+00	1.1664E+00	1.3079E+00
46	1.4574E+00	1.5949E+00	1.7261E+00	1.8554E+00	2.1024E+00
51	2.3824E+00	2.6996E+00	3.0590E+00	3.4663E+00	3.9279E+00
56	4.4509E+00	5.0435E+00	5.7150E+00	6.4760E+00	6.8680E+00
61	7.3382E+00	8.3153E+00	9.4225E+00	1.0677E+01	1.2099E+01
66	1.3710E+01	1.5535E+01	1.7603E+01	1.9947E+01	2.2603E+01
71	2.5613E+01	2.9023E+01	3.2888E+01	3.7267E+01	4.2229E+01
76	4.7851E+01	5.4222E+01	6.1442E+01	6.9623E+01	7.8893E+01
81	8.9398E+01	1.0130E+02	1.1479E+02	1.3007E+02	1.4739E+02
86	1.6702E+02	1.8926E+02	2.1445E+02	2.4301E+02	2.7536E+02
91	3.1203E+02	3.5358E+02	4.0065E+02	4.5400E+02	5.1445E+02
96	5.8295E+02	6.6057E+02	7.4852E+02	8.4818E+02	9.6112E+02
101	1.0891E+03	1.2341E+03	1.3984E+03	1.5846E+03	1.7956E+03
106	2.0347E+03	2.3056E+03	2.6126E+03	2.9604E+03	3.3546E+03
111	3.8013E+03	4.3074E+03	4.8810E+03	5.5308E+03	6.2673E+03
116	7.1017E+03	8.0473E+03	9.1188E+03	1.0333E+04	1.1709E+04
121	1.3268E+04	1.5034E+04	1.7036E+04	1.9305E+04	2.1875E+04

126	2.4788E+04	2.6058E+04	2.8088E+04	3.1828E+04	3.6066E+04
131	4.0868E+04	4.6309E+04	5.2475E+04	5.9462E+04	6.7379E+04
136	7.6351E+04	8.6517E+04	9.8037E+04	1.1109E+05	1.2588E+05
141	1.4264E+05	1.6163E+05	1.8316E+05	2.0754E+05	2.3518E+05
146	2.6649E+05	3.0197E+05	3.4218E+05	3.8774E+05	4.3937E+05
151	4.9787E+05	5.6416E+05	6.3928E+05	7.2440E+05	8.2085E+05
156	9.3014E+05	1.0540E+06	1.1943E+06	1.3534E+06	1.5335E+06
161	1.7377E+06	1.9691E+06	2.2313E+06	2.5284E+06	2.8650E+06
166	3.2465E+06	3.6788E+06	4.1686E+06	4.7237E+06	5.3526E+06
171	6.0653E+06	6.8729E+06	7.7880E+06	8.8250E+06	1.0000E+07
176	1.1000E+07	1.2000E+07	1.3000E+07	1.3500E+07	1.3750E+07
181	1.3940E+07	1.4200E+07	1.4420E+07	1.4640E+07	1.5000E+07
186	1.6000E+07	1.7000E+07	2.0000E+07		

10. IGN=11...LANL 70-Group Structure

This structure was designed for the ENDF/B-V follow-on to the 50-group library. More groups were added in the region between 450 eV and 3 keV where U-238 capture is important in fast breeder reactors, and a few more groups were added for important resonances in iron and oxygen. The low limit was left at a relatively high 10 eV to discourage the use of the corresponding library (which was produced with a specific fast-reactor weight function) at inappropriate energies. Later consideration showed this to be a mistake, because the library doesn't work well in the outlying blanket and shield regions of some benchmark assemblies and reactor systems. The 80-group structure is preferred.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0677E+01	6.1442E+01	1.0130E+02	1.3007E+02	1.6702E+02
6	2.1445E+02	2.7537E+02	3.5358E+02	4.5400E+02	5.8295E+02
11	7.4852E+02	9.6112E+02	1.0891E+03	1.2341E+03	1.3984E+03
16	1.5846E+03	1.7956E+03	2.0347E+03	2.3056E+03	2.6126E+03
21	2.9605E+03	3.3546E+03	3.8013E+03	4.3074E+03	4.8810E+03
26	5.5308E+03	6.2673E+03	7.1017E+03	8.0473E+03	9.1188E+03
31	1.0333E+04	1.1709E+04	1.3268E+04	1.5034E+04	1.7036E+04
36	1.9305E+04	2.1875E+04	2.4788E+04	2.8088E+04	3.1828E+04
41	4.0868E+04	5.2475E+04	6.7380E+04	8.6517E+04	1.1109E+05
46	1.4264E+05	1.8316E+05	2.3518E+05	3.0197E+05	3.8774E+05
51	4.3937E+05	4.9787E+05	5.6416E+05	6.3928E+05	7.2440E+05
56	8.2085E+05	9.3015E+05	1.0540E+06	1.1943E+06	1.3534E+06
61	1.7377E+06	2.2313E+06	2.8651E+06	3.6788E+06	4.7237E+06
66	6.0653E+06	7.7880E+06	1.0000E+07	1.2840E+07	1.6487E+07
71	2.0000E+07				

11. IGN=12...SAND-II 620-Group Structure

This very fine group structure is used in dosimetry applications for flux unfolding. It has also been used for processing code comparisons[7], where it is almost as accurate as pointwise cross sections without the complication of different grid structures for different codes. Many users now use the 640-group version of this structure (see IGN=15 below) that has 20 additional groups above 18 MeV for high-energy dosimetry.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-04	1.0500E-04	1.1000E-04	1.1500E-04	1.2000E-04
6	1.2750E-04	1.3500E-04	1.4250E-04	1.5000E-04	1.6000E-04
11	1.7000E-04	1.8000E-04	1.9000E-04	2.0000E-04	2.1000E-04
16	2.2000E-04	2.3000E-04	2.4000E-04	2.5500E-04	2.7000E-04
21	2.8000E-04	3.0000E-04	3.2000E-04	3.4000E-04	3.6000E-04
26	3.8000E-04	4.0000E-04	4.2500E-04	4.5000E-04	4.7500E-04
31	5.0000E-04	5.2500E-04	5.5000E-04	5.7500E-04	6.0000E-04
36	6.3000E-04	6.6000E-04	6.9000E-04	7.2000E-04	7.6000E-04
41	8.0000E-04	8.4000E-04	8.8000E-04	9.2000E-04	9.6000E-04
46	1.0000E-03	1.0500E-03	1.1000E-03	1.1500E-03	1.2000E-03
51	1.2750E-03	1.3500E-03	1.4250E-03	1.5000E-03	1.6000E-03
56	1.7000E-03	1.8000E-03	1.9000E-03	2.0000E-03	2.1000E-03
61	2.2000E-03	2.3000E-03	2.4000E-03	2.5500E-03	2.7000E-03
66	2.8000E-03	3.0000E-03	3.2000E-03	3.4000E-03	3.6000E-03
71	3.8000E-03	4.0000E-03	4.2500E-03	4.5000E-03	4.7500E-03
76	5.0000E-03	5.2500E-03	5.5000E-03	5.7500E-03	6.0000E-03
81	6.3000E-03	6.6000E-03	6.9000E-03	7.2000E-03	7.6000E-03
86	8.0000E-03	8.4000E-03	8.8000E-03	9.2000E-03	9.6000E-03
91	1.0000E-02	1.0500E-02	1.1000E-02	1.1500E-02	1.2000E-02
96	1.2750E-02	1.3500E-02	1.4250E-02	1.5000E-02	1.6000E-02
101	1.7000E-02	1.8000E-02	1.9000E-02	2.0000E-02	2.1000E-02
106	2.2000E-02	2.3000E-02	2.4000E-02	2.5500E-02	2.7000E-02
111	2.8000E-02	3.0000E-02	3.2000E-02	3.4000E-02	3.6000E-02
116	3.8000E-02	4.0000E-02	4.2500E-02	4.5000E-02	4.7500E-02
121	5.0000E-02	5.2500E-02	5.5000E-02	5.7500E-02	6.0000E-02
126	6.3000E-02	6.6000E-02	6.9000E-02	7.2000E-02	7.6000E-02
131	8.0000E-02	8.4000E-02	8.8000E-02	9.2000E-02	9.6000E-02
136	1.0000E-01	1.0500E-01	1.1000E-01	1.1500E-01	1.2000E-01
141	1.2750E-01	1.3500E-01	1.4250E-01	1.5000E-01	1.6000E-01
146	1.7000E-01	1.8000E-01	1.9000E-01	2.0000E-01	2.1000E-01
151	2.2000E-01	2.3000E-01	2.4000E-01	2.5500E-01	2.7000E-01
156	2.8000E-01	3.0000E-01	3.2000E-01	3.4000E-01	3.6000E-01
161	3.8000E-01	4.0000E-01	4.2500E-01	4.5000E-01	4.7500E-01
166	5.0000E-01	5.2500E-01	5.5000E-01	5.7500E-01	6.0000E-01
171	6.3000E-01	6.6000E-01	6.9000E-01	7.2000E-01	7.6000E-01
176	8.0000E-01	8.4000E-01	8.8000E-01	9.2000E-01	9.6000E-01
181	1.0000E+00	1.0500E+00	1.1000E+00	1.1500E+00	1.2000E+00

186	1.2750E+00	1.3500E+00	1.4250E+00	1.5000E+00	1.6000E+00
191	1.7000E+00	1.8000E+00	1.9000E+00	2.0000E+00	2.1000E+00
196	2.2000E+00	2.3000E+00	2.4000E+00	2.5500E+00	2.7000E+00
201	2.8000E+00	3.0000E+00	3.2000E+00	3.4000E+00	3.6000E+00
206	3.8000E+00	4.0000E+00	4.2500E+00	4.5000E+00	4.7500E+00
211	5.0000E+00	5.2500E+00	5.5000E+00	5.7500E+00	6.0000E+00
216	6.3000E+00	6.6000E+00	6.9000E+00	7.2000E+00	7.6000E+00
221	8.0000E+00	8.4000E+00	8.8000E+00	9.2000E+00	9.6000E+00
226	1.0000E+01	1.0500E+01	1.1000E+01	1.1500E+01	1.2000E+01
231	1.2750E+01	1.3500E+01	1.4250E+01	1.5000E+01	1.6000E+01
236	1.7000E+01	1.8000E+01	1.9000E+01	2.0000E+01	2.1000E+01
241	2.2000E+01	2.3000E+01	2.4000E+01	2.5500E+01	2.7000E+01
246	2.8000E+01	3.0000E+01	3.2000E+01	3.4000E+01	3.6000E+01
251	3.8000E+01	4.0000E+01	4.2500E+01	4.5000E+01	4.7500E+01
256	5.0000E+01	5.2500E+01	5.5000E+01	5.7500E+01	6.0000E+01
261	6.3000E+01	6.6000E+01	6.9000E+01	7.2000E+01	7.6000E+01
266	8.0000E+01	8.4000E+01	8.8000E+01	9.2000E+01	9.6000E+01
271	1.0000E+02	1.0500E+02	1.1000E+02	1.1500E+02	1.2000E+02
276	1.2750E+02	1.3500E+02	1.4250E+02	1.5000E+02	1.6000E+02
281	1.7000E+02	1.8000E+02	1.9000E+02	2.0000E+02	2.1000E+02
286	2.2000E+02	2.3000E+02	2.4000E+02	2.5500E+02	2.7000E+02
291	2.8000E+02	3.0000E+02	3.2000E+02	3.4000E+02	3.6000E+02
296	3.8000E+02	4.0000E+02	4.2500E+02	4.5000E+02	4.7500E+02
301	5.0000E+02	5.2500E+02	5.5000E+02	5.7500E+02	6.0000E+02
306	6.3000E+02	6.6000E+02	6.9000E+02	7.2000E+02	7.6000E+02
311	8.0000E+02	8.4000E+02	8.8000E+02	9.2000E+02	9.6000E+02
316	1.0000E+03	1.0500E+03	1.1000E+03	1.1500E+03	1.2000E+03
321	1.2750E+03	1.3500E+03	1.4250E+03	1.5000E+03	1.6000E+03
326	1.7000E+03	1.8000E+03	1.9000E+03	2.0000E+03	2.1000E+03
331	2.2000E+03	2.3000E+03	2.4000E+03	2.5500E+03	2.7000E+03
336	2.8000E+03	3.0000E+03	3.2000E+03	3.4000E+03	3.6000E+03
341	3.8000E+03	4.0000E+03	4.2500E+03	4.5000E+03	4.7500E+03
346	5.0000E+03	5.2500E+03	5.5000E+03	5.7500E+03	6.0000E+03
351	6.3000E+03	6.6000E+03	6.9000E+03	7.2000E+03	7.6000E+03
356	8.0000E+03	8.4000E+03	8.8000E+03	9.2000E+03	9.6000E+03
361	1.0000E+04	1.0500E+04	1.1000E+04	1.1500E+04	1.2000E+04
366	1.2750E+04	1.3500E+04	1.4250E+04	1.5000E+04	1.6000E+04
371	1.7000E+04	1.8000E+04	1.9000E+04	2.0000E+04	2.1000E+04
376	2.2000E+04	2.3000E+04	2.4000E+04	2.5500E+04	2.7000E+04
381	2.8000E+04	3.0000E+04	3.2000E+04	3.4000E+04	3.6000E+04
386	3.8000E+04	4.0000E+04	4.2500E+04	4.5000E+04	4.7500E+04
391	5.0000E+04	5.2500E+04	5.5000E+04	5.7500E+04	6.0000E+04
396	6.3000E+04	6.6000E+04	6.9000E+04	7.2000E+04	7.6000E+04
401	8.0000E+04	8.4000E+04	8.8000E+04	9.2000E+04	9.6000E+04
406	1.0000E+05	1.0500E+05	1.1000E+05	1.1500E+05	1.2000E+05
411	1.2750E+05	1.3500E+05	1.4250E+05	1.5000E+05	1.6000E+05
416	1.7000E+05	1.8000E+05	1.9000E+05	2.0000E+05	2.1000E+05
421	2.2000E+05	2.3000E+05	2.4000E+05	2.5500E+05	2.7000E+05
426	2.8000E+05	3.0000E+05	3.2000E+05	3.4000E+05	3.6000E+05
431	3.8000E+05	4.0000E+05	4.2500E+05	4.5000E+05	4.7500E+05
436	5.0000E+05	5.2500E+05	5.5000E+05	5.7500E+05	6.0000E+05
441	6.3000E+05	6.6000E+05	6.9000E+05	7.2000E+05	7.6000E+05
446	8.0000E+05	8.4000E+05	8.8000E+05	9.2000E+05	9.6000E+05

451	1.0000E+06	1.1000E+06	1.2000E+06	1.3000E+06	1.4000E+06
456	1.5000E+06	1.6000E+06	1.7000E+06	1.8000E+06	1.9000E+06
461	2.0000E+06	2.1000E+06	2.2000E+06	2.3000E+06	2.4000E+06
466	2.5000E+06	2.6000E+06	2.7000E+06	2.8000E+06	2.9000E+06
471	3.0000E+06	3.1000E+06	3.2000E+06	3.3000E+06	3.4000E+06
476	3.5000E+06	3.6000E+06	3.7000E+06	3.8000E+06	3.9000E+06
481	4.0000E+06	4.1000E+06	4.2000E+06	4.3000E+06	4.4000E+06
486	4.5000E+06	4.6000E+06	4.7000E+06	4.8000E+06	4.9000E+06
491	5.0000E+06	5.1000E+06	5.2000E+06	5.3000E+06	5.4000E+06
496	5.5000E+06	5.6000E+06	5.7000E+06	5.8000E+06	5.9000E+06
501	6.0000E+06	6.1000E+06	6.2000E+06	6.3000E+06	6.4000E+06
506	6.5000E+06	6.6000E+06	6.7000E+06	6.8000E+06	6.9000E+06
511	7.0000E+06	7.1000E+06	7.2000E+06	7.3000E+06	7.4000E+06
516	7.5000E+06	7.6000E+06	7.7000E+06	7.8000E+06	7.9000E+06
521	8.0000E+06	8.1000E+06	8.2000E+06	8.3000E+06	8.4000E+06
526	8.5000E+06	8.6000E+06	8.7000E+06	8.8000E+06	8.9000E+06
531	9.0000E+06	9.1000E+06	9.2000E+06	9.3000E+06	9.4000E+06
536	9.5000E+06	9.6000E+06	9.7000E+06	9.8000E+06	9.9000E+06
541	1.0000E+07	1.0100E+07	1.0200E+07	1.0300E+07	1.0400E+07
546	1.0500E+07	1.0600E+07	1.0700E+07	1.0800E+07	1.0900E+07
551	1.1000E+07	1.1100E+07	1.1200E+07	1.1300E+07	1.1400E+07
556	1.1500E+07	1.1600E+07	1.1700E+07	1.1800E+07	1.1900E+07
561	1.2000E+07	1.2100E+07	1.2200E+07	1.2300E+07	1.2400E+07
566	1.2500E+07	1.2600E+07	1.2700E+07	1.2800E+07	1.2900E+07
571	1.3000E+07	1.3100E+07	1.3200E+07	1.3300E+07	1.3400E+07
576	1.3500E+07	1.3600E+07	1.3700E+07	1.3800E+07	1.3900E+07
581	1.4000E+07	1.4100E+07	1.4200E+07	1.4300E+07	1.4400E+07
586	1.4500E+07	1.4600E+07	1.4700E+07	1.4800E+07	1.4900E+07
591	1.5000E+07	1.5100E+07	1.5200E+07	1.5300E+07	1.5400E+07
596	1.5500E+07	1.5600E+07	1.5700E+07	1.5800E+07	1.5900E+07
601	1.6000E+07	1.6100E+07	1.6200E+07	1.6300E+07	1.6400E+07
606	1.6500E+07	1.6600E+07	1.6700E+07	1.6800E+07	1.6900E+07
611	1.7000E+07	1.7100E+07	1.7200E+07	1.7300E+07	1.7400E+07
616	1.7500E+07	1.7600E+07	1.7700E+07	1.7800E+07	1.7900E+07
621	1.8000E+07				

12. IGN=13...LANL 80-Group Structure

This structure has been optimized for fast breeder reactors and fusion systems. The resonance-region treatment uses numerous one-eighth lethargy groups to give an accurate treatment of U-238 capture, and extra group bounds are provided around the important sodium resonance near 3 keV and the iron resonance near 27 keV. A fairly high level of resolution is used in the fission spectrum range to accommodate the differences between different reactor designs and fast critical assemblies such a GODIVA and JEZEBEL, and to represent the resonances and "window" in oxygen. The structure above 10 MeV is similar to that of the 30-group set, which is adequate for practical fusion blanket calculations of tritium production and radiation damage. A finer structure should only be needed for careful high-threshold dosimetry work. Finally, a few low-energy groups were provided to represent the soft flux in outlying blanket and shield regions of reactor systems. The 80-group structure is recommended over the 50- or 70-group structures for these kinds of problems.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.3888E-04	1.5230E-01	4.1399E-01	1.1254E+00	3.0590E+00
6	5.0435E+00	8.3153E+00	1.3710E+01	2.2603E+01	3.7267E+01
11	6.1442E+01	1.0130E+02	1.6702E+02	2.7536E+02	3.5358E+02
16	4.5400E+02	5.8295E+02	7.4852E+02	9.6112E+02	1.0891E+03
21	1.2341E+03	1.3984E+03	1.5846E+03	1.7956E+03	2.0347E+03
26	2.3056E+03	2.6126E+03	2.9604E+03	3.3546E+03	3.8013E+03
31	4.3074E+03	4.8810E+03	5.5308E+03	6.2673E+03	7.1017E+03
36	8.0473E+03	9.1188E+03	1.0333E+04	1.1709E+04	1.3268E+04
41	1.5034E+04	1.7036E+04	1.9305E+04	2.1875E+04	2.4788E+04
46	2.6058E+04	2.8088E+04	3.1828E+04	4.0868E+04	5.2475E+04
51	6.7379E+04	8.6517E+04	1.1109E+05	1.4264E+05	1.8316E+05
56	2.3518E+05	3.0197E+05	3.8774E+05	4.3937E+05	4.9787E+05
61	5.6416E+05	6.3928E+05	7.2440E+05	8.2085E+05	9.3014E+05
66	1.0540E+06	1.1943E+06	1.3534E+06	1.7377E+06	2.2313E+06
71	2.8650E+06	3.6788E+06	4.7237E+06	6.0653E+06	7.7880E+06
76	1.0000E+07	1.1912E+07	1.3499E+07	1.4918E+07	1.6905E+07
81	2.0000E+07				

13. IGN=14...EURLIB 100-Group Structure

This structure has been used extensively in Western Europe in the analysis of integral experiments and in NEA shielding benchmark exercises. It is very similar to the constant-lethargy-step GAM-II structure (see IGN=7 above). The only changes are the removal of 7 of the 16 group boundaries below 17 eV, the insertion of 4 new boundaries at high energy (7.0469, 6.3763, 4.7237, and 2.3457 MeV), and the addition of 3 new boundaries near the iron minimum (26.058, 23.579, and 21.875 keV).

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	4.1399E-01	6.2506E-01	1.1254E+00	1.8554E+00
6	3.0590E+00	5.0435E+00	8.3153E+00	1.0677E+01	1.7603E+01
11	2.2603E+01	2.9023E+01	3.7267E+01	4.7851E+01	6.1442E+01
16	7.8893E+01	1.0130E+02	1.3007E+02	1.6702E+02	2.1445E+02
21	2.7536E+02	3.5358E+02	4.5400E+02	5.8295E+02	7.4852E+02
26	9.6112E+02	1.2341E+03	1.5846E+03	2.0347E+03	2.6126E+03

31	3.3546E+03	4.3074E+03	5.5308E+03	7.1017E+03	9.1188E+03
36	1.1709E+04	1.5034E+04	1.9305E+04	2.1875E+04	2.3579E+04
41	2.4788E+04	2.6058E+04	3.1828E+04	4.0868E+04	5.2475E+04
46	6.7379E+04	8.6517E+04	1.1109E+05	1.2277E+05	1.3569E+05
51	1.4996E+05	1.6573E+05	1.8316E+05	2.0242E+05	2.2371E+05
56	2.4724E+05	2.7324E+05	3.0197E+05	3.3373E+05	3.6883E+05
61	4.0762E+05	4.5049E+05	4.9787E+05	5.5023E+05	6.0810E+05
66	6.7206E+05	7.4274E+05	8.2085E+05	9.0718E+05	1.0026E+06
71	1.1080E+06	1.2246E+06	1.3534E+06	1.4957E+06	1.6530E+06
76	1.8268E+06	2.0190E+06	2.2313E+06	2.3457E+06	2.4660E+06
81	2.7253E+06	3.0119E+06	3.3287E+06	3.6788E+06	4.0657E+06
86	4.4933E+06	4.7237E+06	4.9659E+06	5.4881E+06	6.0653E+06
91	6.3763E+06	6.7032E+06	7.0469E+06	7.4082E+06	8.1873E+06
96	9.0484E+06	1.0000E+07	1.1052E+07	1.2214E+07	1.3499E+07
101	1.4918E+07				

14. IGN=15...SAND-IIA 640-Group Structure

This fine-group structure is used for dosimetry work with flux unfolding codes. It is an extension of the 620-group structure (see above) that includes 20 extra groups above 18 MeV.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-04	1.0500E-04	1.1000E-04	1.1500E-04	1.2000E-04
6	1.2750E-04	1.3500E-04	1.4250E-04	1.5000E-04	1.6000E-04
11	1.7000E-04	1.8000E-04	1.9000E-04	2.0000E-04	2.1000E-04
16	2.2000E-04	2.3000E-04	2.4000E-04	2.5500E-04	2.7000E-04
21	2.8000E-04	3.0000E-04	3.2000E-04	3.4000E-04	3.6000E-04
26	3.8000E-04	4.0000E-04	4.2500E-04	4.5000E-04	4.7500E-04
31	5.0000E-04	5.2500E-04	5.5000E-04	5.7500E-04	6.0000E-04
36	6.3000E-04	6.6000E-04	6.9000E-04	7.2000E-04	7.6000E-04
41	8.0000E-04	8.4000E-04	8.8000E-04	9.2000E-04	9.6000E-04
46	1.0000E-03	1.0500E-03	1.1000E-03	1.1500E-03	1.2000E-03
51	1.2750E-03	1.3500E-03	1.4250E-03	1.5000E-03	1.6000E-03
56	1.7000E-03	1.8000E-03	1.9000E-03	2.0000E-03	2.1000E-03
61	2.2000E-03	2.3000E-03	2.4000E-03	2.5500E-03	2.7000E-03
66	2.8000E-03	3.0000E-03	3.2000E-03	3.4000E-03	3.6000E-03
71	3.8000E-03	4.0000E-03	4.2500E-03	4.5000E-03	4.7500E-03
76	5.0000E-03	5.2500E-03	5.5000E-03	5.7500E-03	6.0000E-03
81	6.3000E-03	6.6000E-03	6.9000E-03	7.2000E-03	7.6000E-03
86	8.0000E-03	8.4000E-03	8.8000E-03	9.2000E-03	9.6000E-03
91	1.0000E-02	1.0500E-02	1.1000E-02	1.1500E-02	1.2000E-02
96	1.2750E-02	1.3500E-02	1.4250E-02	1.5000E-02	1.6000E-02
101	1.7000E-02	1.8000E-02	1.9000E-02	2.0000E-02	2.1000E-02
106	2.2000E-02	2.3000E-02	2.4000E-02	2.5500E-02	2.7000E-02
111	2.8000E-02	3.0000E-02	3.2000E-02	3.4000E-02	3.6000E-02
116	3.8000E-02	4.0000E-02	4.2500E-02	4.5000E-02	4.7500E-02

121	5.0000E-02	5.2500E-02	5.5000E-02	5.7500E-02	6.0000E-02
126	6.3000E-02	6.6000E-02	6.9000E-02	7.2000E-02	7.6000E-02
131	8.0000E-02	8.4000E-02	8.8000E-02	9.2000E-02	9.6000E-02
136	1.0000E-01	1.0500E-01	1.1000E-01	1.1500E-01	1.2000E-01
141	1.2750E-01	1.3500E-01	1.4250E-01	1.5000E-01	1.6000E-01
146	1.7000E-01	1.8000E-01	1.9000E-01	2.0000E-01	2.1000E-01
151	2.2000E-01	2.3000E-01	2.4000E-01	2.5500E-01	2.7000E-01
156	2.8000E-01	3.0000E-01	3.2000E-01	3.4000E-01	3.6000E-01
161	3.8000E-01	4.0000E-01	4.2500E-01	4.5000E-01	4.7500E-01
166	5.0000E-01	5.2500E-01	5.5000E-01	5.7500E-01	6.0000E-01
171	6.3000E-01	6.6000E-01	6.9000E-01	7.2000E-01	7.6000E-01
176	8.0000E-01	8.4000E-01	8.8000E-01	9.2000E-01	9.6000E-01
181	1.0000E+00	1.0500E+00	1.1000E+00	1.1500E+00	1.2000E+00
186	1.2750E+00	1.3500E+00	1.4250E+00	1.5000E+00	1.6000E+00
191	1.7000E+00	1.8000E+00	1.9000E+00	2.0000E+00	2.1000E+00
196	2.2000E+00	2.3000E+00	2.4000E+00	2.5500E+00	2.7000E+00
201	2.8000E+00	3.0000E+00	3.2000E+00	3.4000E+00	3.6000E+00
206	3.8000E+00	4.0000E+00	4.2500E+00	4.5000E+00	4.7500E+00
211	5.0000E+00	5.2500E+00	5.5000E+00	5.7500E+00	6.0000E+00
216	6.3000E+00	6.6000E+00	6.9000E+00	7.2000E+00	7.6000E+00
221	8.0000E+00	8.4000E+00	8.8000E+00	9.2000E+00	9.6000E+00
226	1.0000E+01	1.0500E+01	1.1000E+01	1.1500E+01	1.2000E+01
231	1.2750E+01	1.3500E+01	1.4250E+01	1.5000E+01	1.6000E+01
236	1.7000E+01	1.8000E+01	1.9000E+01	2.0000E+01	2.1000E+01
241	2.2000E+01	2.3000E+01	2.4000E+01	2.5500E+01	2.7000E+01
246	2.8000E+01	3.0000E+01	3.2000E+01	3.4000E+01	3.6000E+01
251	3.8000E+01	4.0000E+01	4.2500E+01	4.5000E+01	4.7500E+01
256	5.0000E+01	5.2500E+01	5.5000E+01	5.7500E+01	6.0000E+01
261	6.3000E+01	6.6000E+01	6.9000E+01	7.2000E+01	7.6000E+01
266	8.0000E+01	8.4000E+01	8.8000E+01	9.2000E+01	9.6000E+01
271	1.0000E+02	1.0500E+02	1.1000E+02	1.1500E+02	1.2000E+02
276	1.2750E+02	1.3500E+02	1.4250E+02	1.5000E+02	1.6000E+02
281	1.7000E+02	1.8000E+02	1.9000E+02	2.0000E+02	2.1000E+02
286	2.2000E+02	2.3000E+02	2.4000E+02	2.5500E+02	2.7000E+02
291	2.8000E+02	3.0000E+02	3.2000E+02	3.4000E+02	3.6000E+02
296	3.8000E+02	4.0000E+02	4.2500E+02	4.5000E+02	4.7500E+02
301	5.0000E+02	5.2500E+02	5.5000E+02	5.7500E+02	6.0000E+02
306	6.3000E+02	6.6000E+02	6.9000E+02	7.2000E+02	7.6000E+02
311	8.0000E+02	8.4000E+02	8.8000E+02	9.2000E+02	9.6000E+02
316	1.0000E+03	1.0500E+03	1.1000E+03	1.1500E+03	1.2000E+03
321	1.2750E+03	1.3500E+03	1.4250E+03	1.5000E+03	1.6000E+03
326	1.7000E+03	1.8000E+03	1.9000E+03	2.0000E+03	2.1000E+03
331	2.2000E+03	2.3000E+03	2.4000E+03	2.5500E+03	2.7000E+03
336	2.8000E+03	3.0000E+03	3.2000E+03	3.4000E+03	3.6000E+03
341	3.8000E+03	4.0000E+03	4.2500E+03	4.5000E+03	4.7500E+03
346	5.0000E+03	5.2500E+03	5.5000E+03	5.7500E+03	6.0000E+03
351	6.3000E+03	6.6000E+03	6.9000E+03	7.2000E+03	7.6000E+03
356	8.0000E+03	8.4000E+03	8.8000E+03	9.2000E+03	9.6000E+03
361	1.0000E+04	1.0500E+04	1.1000E+04	1.1500E+04	1.2000E+04
366	1.2750E+04	1.3500E+04	1.4250E+04	1.5000E+04	1.6000E+04
371	1.7000E+04	1.8000E+04	1.9000E+04	2.0000E+04	2.1000E+04
376	2.2000E+04	2.3000E+04	2.4000E+04	2.5500E+04	2.7000E+04
381	2.8000E+04	3.0000E+04	3.2000E+04	3.4000E+04	3.6000E+04

386	3.8000E+04	4.0000E+04	4.2500E+04	4.5000E+04	4.7500E+04
391	5.0000E+04	5.2500E+04	5.5000E+04	5.7500E+04	6.0000E+04
396	6.3000E+04	6.6000E+04	6.9000E+04	7.2000E+04	7.6000E+04
401	8.0000E+04	8.4000E+04	8.8000E+04	9.2000E+04	9.6000E+04
406	1.0000E+05	1.0500E+05	1.1000E+05	1.1500E+05	1.2000E+05
411	1.2750E+05	1.3500E+05	1.4250E+05	1.5000E+05	1.6000E+05
416	1.7000E+05	1.8000E+05	1.9000E+05	2.0000E+05	2.1000E+05
421	2.2000E+05	2.3000E+05	2.4000E+05	2.5500E+05	2.7000E+05
426	2.8000E+05	3.0000E+05	3.2000E+05	3.4000E+05	3.6000E+05
431	3.8000E+05	4.0000E+05	4.2500E+05	4.5000E+05	4.7500E+05
436	5.0000E+05	5.2500E+05	5.5000E+05	5.7500E+05	6.0000E+05
441	6.3000E+05	6.6000E+05	6.9000E+05	7.2000E+05	7.6000E+05
446	8.0000E+05	8.4000E+05	8.8000E+05	9.2000E+05	9.6000E+05
451	1.0000E+06	1.1000E+06	1.2000E+06	1.3000E+06	1.4000E+06
456	1.5000E+06	1.6000E+06	1.7000E+06	1.8000E+06	1.9000E+06
461	2.0000E+06	2.1000E+06	2.2000E+06	2.3000E+06	2.4000E+06
466	2.5000E+06	2.6000E+06	2.7000E+06	2.8000E+06	2.9000E+06
471	3.0000E+06	3.1000E+06	3.2000E+06	3.3000E+06	3.4000E+06
476	3.5000E+06	3.6000E+06	3.7000E+06	3.8000E+06	3.9000E+06
481	4.0000E+06	4.1000E+06	4.2000E+06	4.3000E+06	4.4000E+06
486	4.5000E+06	4.6000E+06	4.7000E+06	4.8000E+06	4.9000E+06
491	5.0000E+06	5.1000E+06	5.2000E+06	5.3000E+06	5.4000E+06
496	5.5000E+06	5.6000E+06	5.7000E+06	5.8000E+06	5.9000E+06
501	6.0000E+06	6.1000E+06	6.2000E+06	6.3000E+06	6.4000E+06
506	6.5000E+06	6.6000E+06	6.7000E+06	6.8000E+06	6.9000E+06
511	7.0000E+06	7.1000E+06	7.2000E+06	7.3000E+06	7.4000E+06
516	7.5000E+06	7.6000E+06	7.7000E+06	7.8000E+06	7.9000E+06
521	8.0000E+06	8.1000E+06	8.2000E+06	8.3000E+06	8.4000E+06
526	8.5000E+06	8.6000E+06	8.7000E+06	8.8000E+06	8.9000E+06
531	9.0000E+06	9.1000E+06	9.2000E+06	9.3000E+06	9.4000E+06
536	9.5000E+06	9.6000E+06	9.7000E+06	9.8000E+06	9.9000E+06
541	1.0000E+07	1.0100E+07	1.0200E+07	1.0300E+07	1.0400E+07
546	1.0500E+07	1.0600E+07	1.0700E+07	1.0800E+07	1.0900E+07
551	1.1000E+07	1.1100E+07	1.1200E+07	1.1300E+07	1.1400E+07
556	1.1500E+07	1.1600E+07	1.1700E+07	1.1800E+07	1.1900E+07
561	1.2000E+07	1.2100E+07	1.2200E+07	1.2300E+07	1.2400E+07
566	1.2500E+07	1.2600E+07	1.2700E+07	1.2800E+07	1.2900E+07
571	1.3000E+07	1.3100E+07	1.3200E+07	1.3300E+07	1.3400E+07
576	1.3500E+07	1.3600E+07	1.3700E+07	1.3800E+07	1.3900E+07
581	1.4000E+07	1.4100E+07	1.4200E+07	1.4300E+07	1.4400E+07
586	1.4500E+07	1.4600E+07	1.4700E+07	1.4800E+07	1.4900E+07
591	1.5000E+07	1.5100E+07	1.5200E+07	1.5300E+07	1.5400E+07
596	1.5500E+07	1.5600E+07	1.5700E+07	1.5800E+07	1.5900E+07
601	1.6000E+07	1.6100E+07	1.6200E+07	1.6300E+07	1.6400E+07
606	1.6500E+07	1.6600E+07	1.6700E+07	1.6800E+07	1.6900E+07
611	1.7000E+07	1.7100E+07	1.7200E+07	1.7300E+07	1.7400E+07
616	1.7500E+07	1.7600E+07	1.7700E+07	1.7800E+07	1.7900E+07
621	1.8000E+07	1.8100E+07	1.8200E+07	1.8300E+07	1.8400E+07
626	1.8500E+07	1.8600E+07	1.8700E+07	1.8800E+07	1.8900E+07
631	1.9000E+07	1.9100E+07	1.9200E+07	1.9300E+07	1.9400E+07
636	1.9500E+07	1.9600E+07	1.9700E+07	1.9800E+07	1.9900E+07
641	2.0000E+07				

15. IGN=16...VITAMIN-E 174-Group Structure

This group structure was used for the VITAMIN-E library[8] generated at the Oak Ridge National Laboratory using ENDF/B-V cross sections. It is an evolution of the VITAMIN-C structure, and it shares many group bounds with the CSEWG 240-group structure (see IGG=2 above).

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E-05	1.0000E-01	4.1399E-01	5.3158E-01	6.8256E-01
6	8.7642E-01	1.1254E+00	1.4450E+00	1.8554E+00	2.3824E+00
11	3.0590E+00	3.9279E+00	5.0435E+00	6.4760E+00	8.3153E+00
16	1.0677E+01	1.3710E+01	1.7603E+01	2.2603E+01	2.9023E+01
21	3.7267E+01	4.7851E+01	6.1442E+01	7.8893E+01	1.0130E+02
26	1.3007E+02	1.6702E+02	2.1445E+02	2.7536E+02	3.5358E+02
31	4.5400E+02	5.8295E+02	7.4852E+02	9.6112E+02	1.2341E+03
36	1.5846E+03	2.0347E+03	2.2487E+03	2.4852E+03	2.6126E+03
41	2.7465E+03	3.0354E+03	3.3546E+03	3.7074E+03	4.3074E+03
46	5.5308E+03	7.1017E+03	9.1188E+03	1.0595E+04	1.1709E+04
51	1.5034E+04	1.9305E+04	2.1875E+04	2.3579E+04	2.4176E+04
56	2.4788E+04	2.6058E+04	2.7000E+04	2.8500E+04	3.1828E+04
61	3.4307E+04	4.0868E+04	4.6309E+04	5.2475E+04	5.6562E+04
66	6.7379E+04	7.2000E+04	7.9500E+04	8.2500E+04	8.6517E+04
71	9.8037E+04	1.1109E+05	1.1679E+05	1.2277E+05	1.2907E+05
76	1.3569E+05	1.4264E+05	1.4996E+05	1.5764E+05	1.6573E+05
81	1.7422E+05	1.8316E+05	1.9255E+05	2.0242E+05	2.1280E+05
86	2.2371E+05	2.3518E+05	2.4724E+05	2.7324E+05	2.8725E+05
91	2.9452E+05	2.9720E+05	2.9850E+05	3.0197E+05	3.3373E+05
96	3.6883E+05	3.8774E+05	4.0762E+05	4.5049E+05	4.9787E+05
101	5.2340E+05	5.5023E+05	5.7844E+05	6.0810E+05	6.3928E+05
106	6.7206E+05	7.0651E+05	7.4274E+05	7.8082E+05	8.2085E+05
111	8.6294E+05	9.0718E+05	9.6164E+05	1.0026E+06	1.1080E+06
116	1.1648E+06	1.2246E+06	1.2873E+06	1.3534E+06	1.4227E+06
121	1.4957E+06	1.5724E+06	1.6530E+06	1.7377E+06	1.8268E+06
126	1.9205E+06	2.0190E+06	2.1225E+06	2.2313E+06	2.3069E+06
131	2.3457E+06	2.3653E+06	2.3852E+06	2.4660E+06	2.5924E+06
136	2.7253E+06	2.8650E+06	3.0119E+06	3.1664E+06	3.3287E+06
141	3.6788E+06	4.0657E+06	4.4933E+06	4.7237E+06	4.9659E+06
146	5.2205E+06	5.4881E+06	5.7695E+06	6.0653E+06	6.3763E+06
151	6.5924E+06	6.7032E+06	7.0469E+06	7.4082E+06	7.7880E+06
156	8.1873E+06	8.6071E+06	9.0484E+06	9.5123E+06	1.0000E+07
161	1.0513E+07	1.1052E+07	1.1618E+07	1.2214E+07	1.2523E+07
166	1.3499E+07	1.3840E+07	1.4191E+07	1.4550E+07	1.4918E+07
171	1.5683E+07	1.6487E+07	1.6905E+07	1.7333E+07	1.9640E+07

16. IGN=17...VITAMIN-J 175-Group Structure

The VITAMIN-J structure is being used in Europe for processed cross section libraries based on the JEF-I and JEF-II evaluated cross section libraries (which are in ENDF format). It is identical to the VITAMIN-E structure shown above, except one additional group bound at `1.2840E+07` is inserted between entries 165 and 166. The total number of groups is thus increased by one.

17. IGG=2...CSEWG 94-Group Structure

This is a supergroup structure for photons that was developed at the same time as the 240-group neutron structure given above. As such, it was designed to contain a number of the photon group structures in use at that time as subsets. This has made it much more detailed than needed for practical calculations of the comparatively smooth photon spectra found in actual systems. It is also lacking in the detail above 10 MeV needed to represent the emission of "primary" photons from capture reactions in systems with a large flux of 14-MeV neutrons.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	5.0000E+03	1.0000E+04	1.5000E+04	2.0000E+04	3.0000E+04
6	3.5000E+04	4.0000E+04	4.5000E+04	5.5000E+04	6.0000E+04
11	6.5000E+04	7.5000E+04	8.0000E+04	9.0000E+04	1.0000E+05
16	1.2000E+05	1.4000E+05	1.5000E+05	1.6000E+05	1.9000E+05
21	2.2000E+05	2.6000E+05	3.0000E+05	3.2500E+05	3.5000E+05
26	3.7500E+05	4.0000E+05	4.2500E+05	4.5000E+05	5.0000E+05
31	5.2500E+05	5.5000E+05	5.7500E+05	6.0000E+05	6.2500E+05
36	6.5000E+05	6.7500E+05	7.0000E+05	7.5000E+05	8.0000E+05
41	8.2500E+05	8.6500E+05	9.0000E+05	1.0000E+06	1.1250E+06
46	1.2000E+06	1.2500E+06	1.3300E+06	1.4200E+06	1.5000E+06
51	1.6000E+06	1.6600E+06	1.7500E+06	1.8750E+06	2.0000E+06
56	2.1660E+06	2.3330E+06	2.5000E+06	2.6660E+06	2.8330E+06
61	3.0000E+06	3.1660E+06	3.3330E+06	3.5000E+06	3.6500E+06
66	3.8000E+06	3.9000E+06	4.0000E+06	4.2000E+06	4.4000E+06
71	4.5000E+06	4.7000E+06	5.0000E+06	5.2000E+06	5.4000E+06
76	5.5000E+06	5.7500E+06	6.0000E+06	6.2500E+06	6.5000E+06
81	6.7500E+06	7.0000E+06	7.2500E+06	7.5000E+06	7.7500E+06
86	8.0000E+06	8.5000E+06	9.0000E+06	9.5000E+06	1.0000E+07
91	1.0600E+07	1.1000E+07	1.2000E+07	1.4000E+07	2.0000E+07

18. IGG=3...LANL 12-Group Structure

This is a comparatively coarse photon structure that has been used extensively at Los Alamos. It is part of the 42-group structure used in the CLAW-3 and

CLAW-4 coupled libraries[3] available from RSIC, and also in the MATXS1 and MATXS5 libraries used with TRANSX[4]. It is most suitable for systems containing a reasonable concentration of heavy atoms; strongly hydrogenous systems have a very soft photon flux that is not well represented by the single group below 100 keV. The 24-group option (see below) is better in this low range, and it also does a better job of calculating photon energy deposition because of more detail above 9 MeV.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+04	1.0000E+05	5.0000E+05	1.0000E+06	2.0000E+06
6	3.0000E+06	4.0000E+06	5.0000E+06	6.0000E+06	7.0000E+06
11	8.0000E+06	9.0000E+06	2.0000E+07		

19. IGG=4...Steiner 21-Group Structure

This structure was used extensively in early fusion-reactor systems studies at the Oak Ridge National Laboratory and elsewhere.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+04	1.0000E+05	2.0000E+05	4.0000E+05	1.0000E+06
6	1.5000E+06	2.0000E+06	2.5000E+06	3.0000E+06	3.5000E+06
11	4.0000E+06	4.5000E+06	5.0000E+06	5.5000E+06	6.0000E+06
16	6.5000E+06	7.0000E+06	7.5000E+06	8.0000E+06	1.0000E+07
21	1.2000E+07	1.4000E+07			

20. IGG=5...Straker 22-Group Structure

This structure has been used in air-transport and weapons effects calculations.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+04	3.0000E+04	6.0000E+04	1.0000E+05	1.5000E+05
6	3.0000E+05	4.5000E+05	6.0000E+05	8.0000E+05	1.0000E+06
11	1.3300E+06	1.6600E+06	2.0000E+06	2.5000E+06	3.0000E+06
16	3.5000E+06	4.0000E+06	5.0000E+06	6.0000E+06	7.0000E+06
21	8.0000E+06	1.0000E+07	1.4000E+07		

21. IGG=6...LANL 48-Group Structure

This is intended to be a comprehensive photon structure that includes all the detail needed for practical photon-transport calculations. It includes enough detail at low energies to represent systems dominated by light elements, and enough detail at high energies to give accurate energy-deposition results, even in systems with many primary photons from 14 MeV capture events. In addition, several groups are provided for "signatures" of fissionable materials needed for nondestructive assays in safeguards work. The only applications that require more groups would be those that depend on the observation of particular discrete gamma rays, such as quantitative analyses. The 12- and 24-group structures are both subsets of this 48-group set.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+03	1.0000E+04	2.0000E+04	3.0000E+04	4.5000E+04
6	6.0000E+04	8.0000E+04	1.0000E+05	1.5000E+05	2.0000E+05
11	3.0000E+05	4.0000E+05	4.5000E+05	5.0000E+05	5.2500E+05
16	6.0000E+05	7.0000E+05	8.0000E+05	9.0000E+05	1.0000E+06
21	1.1250E+06	1.2000E+06	1.3300E+06	1.5000E+06	1.6600E+06
26	1.8750E+06	2.0000E+06	2.3330E+06	2.5000E+06	2.6660E+06
31	3.0000E+06	3.5000E+06	4.0000E+06	4.5000E+06	5.0000E+06
36	5.5000E+06	6.0000E+06	6.5000E+06	7.0000E+06	7.5000E+06
41	8.0000E+06	9.0000E+06	1.0000E+07	1.2000E+07	1.4000E+07
46	1.7000E+07	2.0000E+07	3.0000E+07	5.0000E+07	

22. IGG=7...LANL 24-Group Structure

This structure is intended for practical calculations of photon transport in fission and fusion systems. It includes enough detail at low energies for normal shield compositions, and it gives reasonably good results for photon energy deposition in fusion blanket calculations. It has been used with the 80-group neutron structure in the MATXS6 library used with the TRANSX[4] code. It should be used in preference to the 12-group structure when practical.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+04	3.0000E+04	6.0000E+04	1.0000E+05	2.0000E+05
6	3.0000E+05	5.0000E+05	5.2500E+05	7.5000E+05	1.0000E+06
11	1.3300E+06	1.6600E+06	2.0000E+06	2.5000E+06	3.0000E+06
16	4.0000E+06	5.0000E+06	6.0000E+06	7.0000E+06	8.0000E+06
21	9.0000E+06	1.0000E+07	1.2000E+07	1.7000E+07	3.0000E+07

23. IGG=8...VITAMIN-C 36-Group Structure

This structure was designed for use with the VITAMIN-C library[2], which was intended for fusion and fast-reactor shielding applications. It is a combination of the 21-group and 22-group structures described above, with an extra group added to transport the annihilation radiation at 511 keV, and an extra bound added at 70 keV. The main problem with this structure is the upper limit of 14 MeV (see IGG=9 below).

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+04	2.0000E+04	3.0000E+04	4.5000E+04	6.0000E+04
6	7.0000E+04	1.0000E+05	1.5000E+05	2.0000E+05	3.0000E+05
11	4.0000E+05	4.5000E+05	5.1000E+05	5.1200E+05	6.0000E+05
16	7.0000E+05	8.0000E+05	1.0000E+06	1.3300E+06	1.5000E+06
21	1.6600E+06	2.0000E+06	2.5000E+06	3.0000E+06	3.5000E+06
26	4.0000E+06	4.5000E+06	5.0000E+06	5.5000E+06	6.0000E+06
31	6.5000E+06	7.0000E+06	7.5000E+06	8.0000E+06	1.0000E+07
36	1.2000E+07	1.4000E+07			

24. IGG=9...VITAMIN-E 38-Group Structure

This is a slightly extended version of the previous group structure that was selected for use with the VITAMIN-E library[8]. There were only two changes made: a new group was added above 14 MeV, and a new bound was inserted at 75 keV. The structure given in the reference is not exactly correct; contact the Radiation Shielding Information Center (RSIC) at Oak Ridge for a full description of the VITAMIN-E library as issued.

GROUP INDEX N	GROUP LOWER BOUNDARIES (EV) EL(N+0)	EL(N+1)	EL(N+2)	EL(N+3)	EL(N+4)
1	1.0000E+04	2.0000E+04	3.0000E+04	4.5000E+04	6.0000E+04
6	7.0000E+04	7.5000E+04	1.0000E+05	1.5000E+05	2.0000E+05
11	3.0000E+05	4.0000E+05	4.5000E+05	5.1000E+05	5.1200E+05
16	6.0000E+05	7.0000E+05	8.0000E+05	1.0000E+06	1.3300E+06
21	1.5000E+06	1.6600E+06	2.0000E+06	2.5000E+06	3.0000E+06
26	3.5000E+06	4.0000E+06	4.5000E+06	5.0000E+06	5.5000E+06
31	6.0000E+06	6.5000E+06	7.0000E+06	7.5000E+06	8.0000E+06
36	1.0000E+07	1.2000E+07	1.4000E+07	2.0000E+07	

25. References

1. C. R. Weisbin and R. J. LaBauve, "Specifications of a Generally Useful Multigroup Structure for Neutron Transport," Los Alamos Scientfic Laboratory report LA-5277-MS (May 1973).

2. R. W. Roussin, C. R. Weisbin, J. E. White, N. M. Greene, R. Q. Wright, and J. B. Wright, "The CTR Processed Multigroup Cross Section Library for Neutronics Studies," Oak Ridge National Laboratory report ORNL/RSIC-37 (1978).

3. R. J. Barrett and R. E. MacFarlane, "Coupled Neutron and Photon Cross Sections of Transport Calculations," Los Alamos Scientfic Laboratory report LA-7808-MS (April 1979).

4. R. E. MacFarlane, "TRANSX-CTR: A Code for Interfacing MATXS Cross-Section Libraries to Nuclear Transport Codes for Fusion Systems Analysis," Los Alamos National Laboratory report LA-9863-MS (February 1984).

5. R. B. Kidman and R. E. MacFarlane, "LIB-IV, A Library of Group Constants for Nuclear Reactor Calculations," Los Alamos Scientific Laboratory report LA-6260-MS (March 1976).

6. R. E. MacFarlane, "ENDF/B-V Cross-Section Library for Reactor Cell Analysis," Electric Power Research Institute report EPRI NP-3418 (February 1984).

7. D. E. Cullen, "Report on the IAEA Cross Section Processing Code Verification Project," International Atomic Energy Agency Nuclear Data Section report INDC(NDS)-170/NI (May 1985).

8. C. R. Weisbin, R. W. Roussin, J. J. Wagschal, J. E. White, and R. Q. Wright, "VITAMIN-E: An ENDF/B-V Multigroup Cross-Section Library for LMFBR Core and Shield, LWR Shield, Dosimetry, and Fusion Blanket Technology," Oak Ridge National Laboratory report ORNL-5505 (ENDF-274) (February 1979).

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