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INTERCOMPARISON OF DERIVED INTEGRAL DATA FROM EVALUATED DATA LIBRARIES OF THE ACTINIDES

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Abstract

Resonance integrals and fission spectrum averaged cross-sections are calculated for the actinides from all recent major evaluated libraries. Whenever possible the results are compared against measurments. It is found that the experimental data are scarce and that there exist considerable differences between experimentally measured data and those derived from the evaluated libraries.

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1. Introduction

With the refinement of the calculational procedures in reactor analysis there is a growing demand for accurate Transactinium isotope (Z > 99) neutron data. The Transactinium isotopes play an important role in the nuclear fuel cycle of both thermal and fast reactors and have found increasing areas of application in science and industry.

The Actinide nuclear data are required for the calculation of core poisoning and absorption effects, decay heat and gamma source terms, delayed neutron yields and spectra, Sodium void and Doppler coefficients, breeding ratio and doubling time, neutron source terms and prompt neutron effects.

Integral data such as the Maxwellian thermal spectrum averaged cross sections, the Resonance integrals, the Cf-252 and the U-235 fission spectrum averaged cross sections and the cross sections measured in well known reference neutron fields [7] can be used to check the evaluated data in various energy ranges, provided the uncertainty in the integral measurments is smaller than that in the evaluated libraries.

The objective of this study is to check the consistency and the adequacy of the energy range given for the data in evaluated libraries by comparing the Resonance integral over the 1/E spectrum and the fission spectrum averaged cross sections against experimentally measured values. The emphasis is on the INDL/A library with the purpose of its verification.

The list of libraries considered is shown in Table 1 together with abbreviations which are used in this report. The KEDAK-4 and the JENDL-2 libraries are not considered separately because their actinides data are included in the INDL/A-83 library.

Table 1 :Evaluated libraries considered in the analysis

Library	format	abbr.	comment	ref
INDL/A-83 E	ENDF-4,5	IE	files 1,2	1
INDL/A-83 J	ENDF-5	IJ	JENDL-2 evaluations	1
INDL/A-83 U	UKNDL	IU	file3	1
INDL/A-83 K1	KEDAK	IK1	file4 Mat.No.: 1,2	1
INDL/A-83 K2	KEDAK	IK2	file4 Mat.No.: 8-58	1
UKNDL-80	UKNDL	UK		2
LENDL-84	ENDF-5	L4		3
ENDF/B-4	ENDF-4	B4		4
ENDF/B-5 Act.	ENDF-5	B5A		5
ENDF/B-5 Dos.	ENDF-5	B5D	from IRDF-85 file	6

The material accession numbers for the processed materials can be extracted from Tables A1-A10 in the Appendix.

2. Definition of Integral Quantities

The integral quantities considered in the analysis for a particular reaction (x) are defined by the equation:

$$I_x = \int_{E_2}^{E_1} \sigma_x(E)\, \chi(E)\, dE$$

The infinite dilution resonance integral (R.I.) is obtained by defining $\chi(E)$ as the 1/E spectrum. The lower integration limit is 0.5eV an the upper integration limit is 20 MeV unless stated otherwise.

Similarly the spectrum averaged cross sections are obtained when $\chi(E)$ is the Cf-252 or U-235 fission spectrum. The limits of integration are 1.0E-4 eV and 18 MeV respectively because the spectra, which are taken from the IRDF-85 [6] file only cover this range. $\chi(E)$ must be normalized such that the integral of $\chi(E)$ over the same energy range is equal to one.

3. Processing Codes

Libraries IE, IJ, E4 and E5A were processed first by direct integration with codes NJOY [8] and LINEAR-RECENT-GROUPIE [9] sequence (abbreviated L-R-G hereafter). The same quantities were calculated by generating the flat-spectrum averaged cross sections in the 620 group SAND-II structure by NJOY. These cross sections were then condensed using program AVSPECTM [10] with an appropriate group averaged spectrum given in the same group structure. The processing errors in producing the R.I. and the spectrum averaged cross sections can be seen from Tables 2 - 6 for each of the processed libraries:

- The discrepancies between the calculated integrals and published values [11] in Table 2 may be due to the use of a more recent version [13] of the source library in ref.[11].
- The discrepancies between the integrals calculated by NJOY and L-R-G in Tables 2 - 5 may be due to the use of the versions of the codes before the IAEA Cross Section Code Verification Project [12] was completed. Another source of error is the non-strict observation of ENDF format (for example the use of modified Adler-Adler parameters in Pu-241 evaluation in the INDL/A file in Table 4). It is difficult to say which of the two sets of the results is correct.
- The R.I. values obtained by condensation of group averaged cross sections are generally in good agreement with those calculated by direct integration. Differences up to 5% are observed only in Tables 2,3,5 in some fission integrals where the fission cross-section has a threshold. These differences can be traced not to the processing method but to the use of the 620 group structure which extends only up to 15 MeV as compared to the 20 MeV limit in direct integration. The group condensation approach is found to be accurate as seen from Table 4 where the evaluated data do not extend above 18 Mev (except for Th-232 and Pa-233). This observation has an implication on the KEDAK and UKNDL formatted data and on other evaluations where the energy range does not extend above 15 MeV.
- The differences in the calculated R.I. from the JENDL-2 evaluations could be due to non-strict observation of ENDF-5 format recommendation on spin assignment in the resolved resonance parameters.

Table 2 : Infinite dilution resonance integrals (barns) from ENDF/B-5

Isotope	total ref.11	total L-R-G	total NJOY	total AVSP.	fission ref.11	fission L-R-G	fission NJOY	fission AVSP.	capture ref.11	capture L-R-G	capture NJOY	capture AVSP.
Th-232	341.4				.6185			*.6181	83.96			*85.93
Pa-233	1030.	1030.	1031.	1030.	2.947	2.948	2.947	2.776	856.4	856.3	857.3	857.3
U-233	1069.				755.0				136.6			
U-234	932.8	933.3	934.6	936.9	6.539	6.544	6.542	6.316	660.2	660.5	660.5	663.1
U-235	600.6				281.7			*281.7	139.2			
U-236	646.0	646.3	648.1	650.7	7.768	7.772	7.772	6.614	347.0	347.1	347.3	350.3
U-238	627.2				2.032			*2.032	279.5			*279.3
Np-237	823.2	838.6	840.3		6.87	6.86	6.87	*6.870	640.4	640.7	641.	
Np-237				339.0				6.587				640.3
Pu-238	481.7	453.6	456.1	454.8	33.07	31.3	30.80	30.43	162.3	152.1	153.8	153.5
Pu-239	677.3				303.5			*303.9	193.3			
Pu-240	8789.				8.330				7971.			
Pu-241	973.9				539.4				196.9			
Pu-242	1668.	1669.	1670.	1635.	5.368	5.567	5.552	5.335	1273.	1273.	1274.	1288.
Am-241	1630.	1627.	1631.	1630.	13.43	13.44	13.44	13.17	1423.	1421.	1424.	1424.
Am-242g		896.4	899.6			621.4	623.5			72.51	72.03	
Am-242m	2339.	2340.	2364.	2362.	1883.	1884.	1903.	1902.	296.3	286.4	289.8	289.6
Am-243	2035.	2036.	2038.	2035.	6.151	6.154	6.152	5.339	1913.	1919.	1921.	1819.
Cm-242		330.8	321.9			6.25	6.25			111.3	111.7	
Cm-243	2385.	2386.	2403.	2401.	1952.	1952.	1966.	1965.	258.4	248.5	250.9	250.9
Cm-244	965.3	965.8	967.5	959.1	18.70	18.7	18.72	13.31	593.5	593.7	594.3	588.5
Cm-245	1106.	1112.	1112.	1111.	837.0	833.4	833.5	833.1	109.6	117.6	117.6	117.6
Cm-246	316.3	316.4	317.2	315.5	10.42	10.42	10.42	10.15	103.8	103.9	104.0	103.2
Cm-247		1410.	1411.		749.9	751.1	749.9			492.1	492.5	

* data form IRDF-85 (ENDF/B-5)

Table 3 : Infinite dilution resonance integrals (barns) from ENDF/B-4

Isotope	total			fission			capture		
	L-R-G	NJOY	AVSP.	L-R-G	NJOY	AVSP.	L-R-G	NJOY	AVSP.
Th-232	312.6	313.2	311.7	.593	.5928	.5391	35.57	85.57	35.37
Pa-233	1030.	1031.	1030.	2.948	2.947	2.776	856.8	857.3	857.3
U-233	1069.	1068.	1068.	763.1	762.4	762.2	134.7	134.7	134.7
U-234	979.1	978.1	984.5	5.595	5.580	5.362	631.6	631.7	637.6
U-235	602.5	603.4	602.1	283.4	283.5	283.0	138.8	138.9	138.5
U-236	633.5	633.4	635.5	3.427	3.425	3.247	347.1	347.1	350.0
U-238	609.3	610.6	609.4	2.056	2.057	1.915	277.7	277.8	277.1
Np-237	828.4	840.1	838.7	6.834	6.843	6.561	640.7	641.0	640.3
Pu-238	434.5	436.5	435.2	31.4	30.39	30.60	143.1	144.8	144.6
Pu-239	673.1	673.8	678.7	303.6	303.8	303.5	194.1	194.2	194.4
Pu-240	9407.	9409.	9394.	9.537	9.544	9.319	8448.	8451.	8438.
Pu-241	893.4	894.3	894.5	586.6	586.6	586.4	125.7	125.7	125.8
Pu-242	1511.	1512.	1524.	5.837	5.839	5.633	1127.	1127.	1140.
Am-241	1813.	1848.	1847.	21.01	13.87	13.60	1617.	1641.	1641.
Am-243	1569.	1560.	1550.	4.363	4.365	4.213	1362.	1363.	1362.
Cm-244	1029.	1029.	1021.	44.89	44.89	44.25	593.4	593.9	587.9

Table 4 : Infinite dilution resonance integrals (barns) from INDL/A-83 file-2

Isotope	total			fission			capture		
	L-R-G	NJOY	AVSP.	L-R-G	NJOY	AVSP.	L-R-G	NJOY	AVSP.
Th-232	335.4	336.9	335.3	.6271	.6267	.5710	80.15	80.32	80.07
Pa-233	1034.	1071.	1070.	2.974	2.965	2.755	876.3	882.1	882.3
Np-237	850.2	849.5	849.0	5.822	5.832	5.832	654.2	654.1	653.7
Pu-238	404.3	404.6	404.2	31.53	31.54	31.49	143.5	143.6	143.5
Pu-239	662.9	655.2	665.7	306.4	304.5	304.7	182.5	182.5	182.8
Pu-240	9410.	9288.	9286.	9.352	4.264	4.259	3430.	3421.	3420.
Pu-241	1887.	2683.	2691.	1215.	1219.	1220.	109.6	683.3	634.5
Pu-242	1517.	1432.	1493.	5.133	5.140	5.139	1136.	1136.	1146.
Am-241	1627.	1626.	1626.	13.76	13.77	13.77	1439.	1439.	1440.
Am-243	2029.	2032.	2030.	5.926	5.934	5.932	1813.	1815.	1813.
Cm-242	327.5	328.4	327.1	11.60	11.62	11.62	115.2	115.9	114.9
Cm-243	2322.	2334.		1873.	1876.		293.2	294.0	
Cm-245	1110.	1115.		621.1	823.5		115.5	116.7	
Cm-246	334.7	334.2	333.3	6.947	6.936	6.923	110.7	111.0	110.2
Cm-247	1337.	1343.		661.5	663.6		493.9	495.6	

Table 5 : Infinite dilution resonance integrals (barns) from INDL/A-83 (JENDL-2 files)

Isotope	total L-R-G	total NJOY	total AVSP.	fission L-R-G	fission NJOY	fission AVSP.	capture L-R-G	capture NJOY	capture AVSP.
Th-232	334.1	335.3		.6365	.6364		79.90	79.91	
Pa-233	968.5	968.1		4.673	4.682		773.6	772.2	
U-233	1089.	1090.		771.3	771.3		138.6	138.6	
U-234	949.9	949.2		6.437	6.438		609.0	609.0	
U-235	614.0	613.3	612.2	278.7	275.3	275.0	153.3	153.4	153.1
U-236	646.8	646.5		7.61	7.61		347.0	347.1	
U-238	652.4	633.3	622.4	1.262	2.053	1.915	280.2	279.0	278.5
Np-237	875.6	876.5		6.258	6.257		662.2	662.4	
Pu-238	492.0	491.5		32.44	32.43		156.3	156.3	
Pu-239	675.6	667.2	674.8	301.6	294.7	299.7	195.3	191.1	194.9
Pu-240	9410.	9410.	9396.	10.09	10.08	9.843	8449.	8449.	8427.
Pu-241	959.6	960.7	961.5	590.4	590.1	591.5	186.9	186.9	186.8
Pu-242	1479.	1473.		6.35	6.35		1117.	1117.	
Am-241	1496.	1287.		14.69	13.52		1298.	1092.	
Am-242g	1835.	1826.		1265.	1259.		392.6	391.1	
Am-242m	1907.	1907.		1529.	1529.		206.9	206.9	
Am-243	2041.	1740.		11.36	10.51		1916.	1522.	
Cm-242	351.2	350.5		11.09	11.08		116.3	116.2	
Cm-243	2293.	335.0		1813.	158.3		298.7	49.17	
Cm-244	963.7	963.2		18.39	18.38		593.4	593.5	
Cm-245	1086.	1084.		799.9	799.3		107.8	107.8	

Table 6 : Cf-252 fission spectrum averaged cross sections (barns) from INDL/A-83 file-2

Isotope	total			fission			capture		
	L-R-G	NJOY	AVSP.	L-R-G	NJOY	AVSP.	L-R-G	NJOY	AVSP.
Th-232	7.536	7.544	7.544	.07494	.07586	.07586	.09574	.09501	.09501
Pa-233	7.491	7.455	7.455	.6038	.6082	.6093	.1590	.1565	.1565
Np-237	7.561	7.548	7.548	1.298	1.308	1.308	.1381	.1844	.1844
Pu-238	7.803	7.790	7.790	1.975	1.983	1.983	.07441	.07334	.07334
Pu-239	7.704	7.717	7.717	1.795	1.795	1.795	.05420	.05335	.05335
Pu-240	.2285	6.533	6.533	.002130	.08757	.08757	.009695	.08546	.08546
Pu-241	.1342	7.962	7.962	.02669	1.607	1.607	.005460	.06644	.06644
Pu-242	7.720	7.766	7.765	1.112	1.118	1.118	.07839	.07816	.07816
Am-241	7.648	7.635	7.635	1.341	1.349	1.349	.3031	.3028	.3028
Am-243	7.676	7.653	7.653	1.116	1.124	1.124	.2386	.2350	.2350
Cm-242	8.075	8.056	8.056	1.660	1.664	1.664	.03023	.02963	.02963
Cm-243	7.976	7.955		2.170	2.167		.01728	.01696	
Cm-245	8.129	8.100		1.977	1.990		.04729	.04658	
Cm-246	8.791	8.742	8.742	1.338	1.342	1.342	.02333	.02284	.02284
Cm-247	8.592	8.556		2.269	2.265		.05111	.05013	

- The agreement between the Cf-252 fission spectrum averaged fission cross sections calculated by NJOY and L-R-G is generally very good except for the Pu isotopes in the IE library (see Table 6). Looking at the file of group averaged cross sections for Pu-240 produced by NJOY is seems that the pointwise data up to 5.5 MeV are ignored.
- No differences were observed in the fission spectrum averaged cross sections obtained by direct integration and by group condensation. This is to be expected since there is no difference in the upper integration limit in the two approaches and the cross section energy dependence around mean spectrum energy is usually rather smooth.

The integrals for the ESD library were calculated by condensation of the group averaged cross-sections from the IRDF-85 [6] file where the actinide data were generated from the availabe ENDF/B-5 files including all recent improvements [13] with latest L-R-G [14] set of codes. The cross sections are given in the extended SAND-II group structure which extends up to 20 MeV. Very good agreement of the results with the published data [11] reconfirms the adequacy of the condensation approach to calculate the integrals (see entries in Table 2 marked with an asterisk).

The remaining libraries were all processed by FEDGROUP-C84 [15] into group constants in SAND-II Extended 640-group structure and condensed into relevant integrals by AVSPECTM [10]. The verification of FEDGROUP-C84 in [12] is applicable because the processed libraries are very simple.

In some of the experimental measurments the assumed upper energy range of integration is less than 20 MeV. Such measurments are renormalized accordingly and they are marked with an asterisk in the tables.

4. Comparison with Experiment

The resonance integrals (R.I.), the U-235 and the Cf-252 fission spectra averaged cross sections are considered for all isotopes for which experimental data are available. The experimental values are extracted from an EXFOR retrieval [16]. The cross section ratio measurments and the data without quoted errors are not considered. Whenever more than one exprimental value is available the mean value is calculated using a weighted least squares technique. The correlation between errors is neglected so the mean value is equivalent to the weighted average. The inverse of the square of the experimental error is used as the weight.

For each isotope the experimental values, the calculated mean, the value from an independent compilation [17] and the calculated values from various evaluated libraries are compared. The quoted errors are the experimental errors in measurments, the standard deviation for the calculated mean value or the deviation from this mean for the values calculated from the evaluated libraries.

For consistency the R.I.s obtained by group averaged cross section condensation are used in all cases. The NBS recommended U-235 fission spectrum in group averaged form as given in [6] is used rather than the ENDF/B-5 equivalent.

To conform with the units commonly encountered in the literature the R.I.'s are given in barns and the fission spectrum averaged cross sections are given in millibarns.

4.1 90-Th-232

The capture resonance integral measurments are wildly scattered. In fact only 5 measurments out of 20 have error bars consistent with the calculated mean. This is an indication that the quoted errors are underestimated or that they do not include some systematic errors such as the uncertainty around the cadmium cut-off energy or the deviation from the 1/E spectrum. The measured R.I. of Th-232 is therefore not suitable as a criterion to judge the quality of evaluations.

Table 7: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

90-TH-232			Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			70.0	5.0	52	89.4	2.7	80	78.1	3.9	76
			85.0	8.5	25	84.7	4.9	94	77.0	4.0	76
			82.7	1.8	29						
			82.5	3.0	28						
			88.0	3.0	20						
			83.0	5.0	27						
			81.2	2.4	30						
			83.0	6.0	26						
			87.0	4.0	21						
			87.0	2.0	29						
			96.0	6.0	24						
			59.0	6.0	24						
			64.0	7.0	24						
			68.0	5.0	24						
			68.0	3.0	24						
			63.0	2.0	24						
			79.0	4.0	31						
			*59.5	4.0	90						
			*93.2	6.0	90						
			*72.5	4.5	91						
mean value (&&) and recommendations from ref.17 and ref.18											
			79.4	0.8	66	88.3	2.4	66	77.7	2.7	66
.0746	.016	17	82.3	2.4	17						
			85.	5.	18						

90-TH-232 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT			89.30	2.40	77.70	2.70
UKNDL-80	0.5153		79.93	-9.37	73.73	-3.97
LENDL-84	0.6433		81.17	-7.13	75.19	-2.52
ENDF/B-4	0.5391		74.43	-13.97	69.00	-8.70
ENDF/B-5 D	0.6161		78.07	-10.23	72.40	-5.30
INDL/A E	0.5710		75.36	-12.44	70.18	-7.52
INDL/A K2	0.5929		74.43	-13.87	69.00	-8.70

90-TH-232 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	73.40	0.75				
UKNDL-80	110.66	31.26	116.70		125.10	
LENDL-84	93.77	14.37	95.94		100.60	
ENDF/B-4	85.37	5.97	89.39		103.30	
ENDF/B-5 D	85.93	6.53	89.69		94.24	
INDL/A E	80.07	0.67	95.01		93.67	
INDL/A K2	82.63	3.43	97.47		102.30	

Only four measurments are available for the fission spectrum averaged fission cross section but they seem to be more consistent. All the evaluated libraries underestimate the fission cross section slightly. This underestimation is least pronounced in the L4 library. The two INDL/A evaluations (IE and IK2) together with E4 show largest deviation.

4.2 91-Pa-233

The measured capture R.I.'s are self-consistent. The values derived from the E4 and the E64 libraries lie within the error bars of the measured values but the values from the UK and IF libraries are considerably overestimated.

Table 8: R.I.s for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

91-Pa-233	Res. Int.				and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			930.	135.	33						
			857.	35.	69						
			*836.	35.	35						
			*921.	90.	34						
			*849.	43.	35						
			*840.	43.	35						
mean value (&&) and recommendations from ref.17 and ref.18											
			951.	13.	56						
			865.	35.	17						
3.		18	860.	35.	18						

91-PA-233 (N,GAMMA) R.I. and Spectrum aver.cross-sect.						
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	350.87	18.59				
UKNDL-80	886.00	35.13	117.70		127.00	
ENDF/B-4	857.28	6.41	178.60		188.20	
ENDF/B-5 A	857.28	6.41	178.60		188.20	
INDL/A E	882.27	31.40	156.50		168.30	

4.3 92- U-233

The R.I. measurments show good consistency except for two fission R.I. values. The UK and L4 libraries underestimate the fission R.I. and the L4, E4 and IK2 libraries underestimate the capture R.I. by an amount exceeding the uncertainty in the measurment.

Table 9: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

92- U-233	Res. Int.			and Spectrum averaged cross-sect.								
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
798.	26.	28	135.	8.	39	1893.	48.	80			
839.	40.	38	146.	8.	42	1947.	31.	87			
771.	49.	39	#148.	7.	36	1947.	31.	82			
850.	90.	41									
830.	60.	42									
#729.	36.	37									
#729.	24.	37									
#824.	30.	32									
mean value (&&) and recommendations from ref.17 and ref.18											
773.9	13.4	&&	143.4	4.4	&&	1938.	20.	&&			
783.4	7.8	17	138.1	4.6	17						
760.	17.	18	137.	6.	19						

92-U -233 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	773.92	13.43	1938.	20.		
UKNDL-80	756.52	-17.40	1891.	-47.	1899.	
LENDL-84	755.02	-18.90	1896.	-42.	1904.	
ENDF/B-4	762.19	-11.75	1833.	-105.	1841.	
INDL/A K2	764.47	-9.45	1834.	-104.	1842.	

92-U -233 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	143.36	4.39				
UKNDL-80	145.46	2.10	41.64		45.10	
LENDL-84	133.91	-9.45	60.44		64.36	
ENDF/B-4	134.66	-8.70	60.36		64.23	
INDL/A K2	134.94	-8.42	60.86		64.23	

4.4 92-U-235

92-U -235 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	280.16	3.61	1225.	9.		
UKNDL-80	274.42	-5.74	1237.	12.	1239.	
LENDL-84	283.90	3.75	1232.	7.	1232.	
ENDF/B-4	282.96	2.80	1241.	16.	1241.	
ENDF/B-5 D	281.73	1.58	1236.	11.	1236.	
INDL/A J	274.96	-5.20	1248.	23.	1248.	
INDL/A K2	269.02	-11.13	1256.	31.	1256.	

92-U -235 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	140.23	2.40				
UKNDL-80	139.91	-0.32	77.15		82.93	
LENDL-84	139.58	-0.65	91.46		97.63	
ENDF/B-4	138.55	-1.68	95.82		101.60	
INDL/A J	153.11	12.88	127.40		133.90	
INDL/A K2	142.43	2.21	90.29		96.12	

4.5 92- U-236

The capture R.I. measurments are contradictory and they can not help to select the evaluated data which also show enormous discrepancies.

Table 11: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

92- U-236			Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			450.	30.	49						
			417.	25.	50						
			419.	70.	50						
			381.	20.	22						
			259.	22.	92						
mean value (&&) and recommendations from ref.17 and ref.18											
			366.	12.	&&						
2.		17	358.	8.	17						
7.8	1.6	18	360.	15.	18						

92-U -236 (N,GAMMA) R.I. and Spectrum aver.cross-sect.						
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	366.30	11.55				
UKNDL-80	322.87	-43.43	171.10		179.30	
LENDL-84	831.49	465.20	168.20		176.30	
ENDF/B-4	350.04	-16.26	170.20		178.60	
ENDF/B-5 A	350.32	-15.98	170.20		178.50	

4.6 92- U-238

The capture R.I. measurments are reasonably consistent. A clear distinction may be observed between the "before 1972" and "after 1972" measurments, the former being higher. The R.I. values derived from the evaluated libraries are slightly overestimated except in the case of the L4 library where the value is within the experimental uncertainty an the UK library which underestimates the capture R.I.

Table 12: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

92- U-238			Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			282.	20.	52	324.	14.	75	308.	15.	83
			286.	25.	89	308.	17.	79			
			282.	8.	53	311.	14.	94			
			281.	10.	23	288.	7.	85			
			267.	5.	20	347.	6.	86			
			269.	5.	46	347.	6.	87			
			*265.	22.	91	326.	7.	78			
			*278.	10.	71						
			*269.	115.	51						
mean value (&&) and recommendations from ref.17 and ref.18											
			272.4	2.9	&&	328.	3.	&&	308.	15.	&&
.0013	.0002	17	276.3	2.7	17						
.00154	.00015	18	277.	3.	18						

92-U -238 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT			328.00	3.00	308.00	15.00
UKNDL-80	1.6008		296.80	-31.20	278.70	-29.30
LENDL-84	2.0568		321.70	-6.30	302.20	-5.80
ENDF/B-4	1.9150		315.40	-12.60	295.80	-12.20
ENDF/B-5 D	2.0323		313.60	-14.40	294.60	-13.40
INDL/A J	1.9150		323.30	-4.70	304.00	-4.00
INDL/A K2	1.6627		313.00	-15.00	294.00	-14.00

92-U -238 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	272.39	2.91				
UKNDL-80	267.45	-4.94	83.17		87.38	
LENDL-84	273.82	1.44	74.35		78.79	
ENDF/B-4	277.09	4.71	71.36		75.07	
ENDF/B-5 D	279.30	6.91	68.34		72.06	
INDL/A J	278.48	6.09	64.95		68.63	
INDL/A K2	273.49	6.11	70.92		74.91	

4.7 93-Np-237

The Cf-252 fission spectrum averaged fission cross section measurments are not sufficiently consistent to be used as a selection criterion for the evaluated data.

Table 13: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

93-Np-237			Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
						1380.	100.	79			
						1442.	23.	82			
						1366.	27.	78			
mean value (&&) and recommendations from ref.17 and ref.18											
						1409.	17.	&&			
6.5	1.2	17	822.	58.	17						
6.9	1.0	18	640.	50.	18						

93-NP-237 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT			1409.	17.		
UKNDL-80	6.9020		1371.	-38.	1338.	
LENDL-84	7.4796		1303.	-106.	1275.	
ENDF/B-4	6.5606		1351.	-58.	1320.	
ENDF/B-5 D	6.8705		1352.	-57.	1322.	
ENDF/B-5 A	6.5869		1352.	-57.	1322.	
INDL/A E	5.8325		1308.	-101.	1279.	
INDL/A K2	5.8622		1287.	-122.	1257.	

4.8 94-Pu-238

The data in all but the UK evaluated libraries agree well with the single fission R.I. measurment. It would be useful to have this value confirmed by another experiment. The capture R.I. measurment is more than an order of magnitude larger than the recommended value from ref.[17] and the values derived from the evaluated libraries. The source of the discrepancy needs to be resolved to see which value is more correct.

Table 14: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

94-Pu-238	Res. Int.					and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
32.	5.		3260.	280.	55						
			3310.	400.	55						
mean value (&&) and recommendations from ref.17 and ref.18											
32.	5.	&&	3276.	229.	&&						
24.2	2.7	17	154.	9.	17						
33.	5.	18	162.	15.	18						

94-PU-238 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	32.03	5.08				
UKNDL-80	75.95	43.92	1935.		1912.	
LENDL-84	32.21	0.18	2047.		2027.	
ENDF/B-4	30.60	-1.44	2078.		2045.	
ENDF/B-5 A	30.48	-1.56	1983.		1956.	
INDL/A E	31.49	-0.54	1983.		1959.	
INDL/A K2	31.25	-0.79	1936.		1910.	

94-PU-238 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	3276.44	229.38				
UKNDL-80	137.90	-3138.54	74.47		79.92	
LENDL-84	151.66	-3124.78	110.30		114.70	
ENDF/B-4	144.55	-3131.89	41.00		43.64	
ENDF/B-5 A	153.50	-3122.94	142.30		150.60	
INDL/A E	143.50	-3132.94	73.34		78.21	
INDL/A K2	158.50	-3117.93	122.40		129.60	

4.9 94-Pu-239

The fission R.I. measurments are often scatterred more than the quoted errors would allow and for the capture R.I. a single measurment is available. On the other hand the R.I. values for capture and fission derived from the evaluated libraries are all very close together but the evaluators seem to prefer a somewhat lower value of the capture and the fission R.I.

For the fission cross section averaged over the Cf-252 fission spectrum the same comment applies as for the R.I.

Table 15: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

94-Pu-239	Res. Int.			and Spectrum averaged cross-sect.								
R.I.f (b)	err. (b)	ref.		R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
387.	22.	44		221.	11.		1790.	41.	77			
301.	10.	45					1861.	30.	87			
327.	22.	40					1861.	30.	82			
366.	26.	56					1824.	35.	78			
330.	30.	41										
328.	22.	67										
320.	19.	72										
327.	22.	88										
434.	81.	57										
mean value (&&) and recommendations from ref.17 and ref.18												
323.8	6.5	&&		221.	11.	&&	1841.	17.	&&			
312.2	8.2	17		191.	16.	17						
301.	10.	18		200.	20.	18						

94-PU-239 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	323.80	6.49	1841.	17.		
UKNDL-80	300.15	-23.65	1783.	-58.	1775.	
LENDL-84	307.01	-16.79	1781.	-60.	1774.	
ENDF/B-4	303.63	-20.17	1789.	-52.	1781.	
ENDF/B-5 D	303.96	-19.83	1792.	-49.	1786.	
INDL/A E	304.68	-19.11	1795.	-46.	1787.	
INDL/A J	299.71	-24.09	1818.	-23.	1812.	
INDL/A K2	304.44	-19.36	1788.	-53.	1781.	

94-PU-239 (N,GAMMA) R.I. and Spectrum avar.cross-sect.						
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	221.08	11.03				
UKNDL-80	179.19	-41.89	46.61		50.29	
LENDL-84	205.68	-15.40	41.53		44.88	
ENDF/B-4	194.39	-26.69	39.76		43.45	
INDL/A E	182.95	-38.23	53.35		57.46	
INDL/A J	194.94	-26.24	59.01		63.30	
INDL/A K2	194.32	-26.76	37.66		41.08	

4.10 94-Pu-240

The capture R.I. measurments are characterised by very large quoted uncertainties but the averaged value is still outside the error bars. In the evaluated libraries the evaluators seem to prefer a considerably lower value of the capture R.I.

A single measurment for the Cf-252 fission spectrum averaged fission cross section is available. Calculations from the evaluated libraries produce values which are scattered around the measured point by more than the experimental error. The large discrepancy in the value derived from the IE library seems to be due to some processing errors described in the previous section.

Table 16: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

94-Pu-240	Res. Int.				and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			8904	550	38	1337.	32.	80			
			11000	4000	68						
			11731	1000	93						
			11459	1000	89						
			*3655	700	59						
mean value (&&) and recommendations from ref.17 and ref.18											
			9579.	367.	&&	1337.	32.	&&			
5.		17	8460.	305.	17						
8.3		13	8100.	200.	18						

94-PU-240 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT			1337.	32.		
UKNDL-80	6.4399		1255.	-82.	1227.	
LENDL-84	10.0283		1413.	76.	1381.	
ENDF/B-4	9.3176		1336.	-1.	1309.	
INDL/A E	4.2588		88.	-1249.	66.	
INDL/A J	9.8427		1367.	30.	1338.	
INDL/A K2	8.3671		1270.	-59.	1252.	

94-PU-240 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	9579.	367.				
UKNDL-80	9025.	-1555.	92.90		98.13	
LENDL-84	8328.	-1252.	88.92		92.80	
ENDF/B-4	8438.	-1142.	82.11		86.78	
INDL/A E	8420.	-1160.	85.46		91.02	
INDL/A J	8437.	-1142.	90.12		95.64	
INDL/A K2	7972.	-1607.	109.60		116.00	

4.11 94-Pu-241

The measured fission R.I are consistent but the evaluators prefer a somewhat higher value. The value derived from IF library is incorrect due to the use of modified Adler-Adler parameters.

A single measurment for the Cf-252 fission spectrum averaged fission cross section is available with a fairly large uncertainty. The data in all the evaluated libraries are consistent with this measurment.

Table 17: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

94-Pu-241	Res. Int.					and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
557.	33.	44				1616.	80.	80			
550.	40.	41									
*524.	16.	37									
mean value (&&) and recommendations from ref.17 and ref.18											
532.	14.	&&				1616.	80.	&&			
558.	18.	17	161.	13.	17						
570.	15.	18	162.	6.	18						

94-PU-241 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	532.61	13.55	1616.	80.		
UKNDL-80	563.64	31.04	1661.	45.	1662.	
LENDL-84	581.06	48.45	1593.	-23.	1597.	
ENDF/B-4	586.43	53.83	1650.	34.	1650.	
INDL/A E	1220.30	687.70	1607.	-9.	1610.	
INDL/A J	591.51	58.90	1621.	5.	1626.	
INDL/A K2	582.49	49.87	1637.	21.	1640.	

4.12 94-Pu-242

The measured capture R.I. are consistent. The values derived from the L4 and E5A libraries are in agreement with the measurment. All other evaluations underestimate the capture cross section considerably but they agree with the recommended value from ref [17].

Table 18: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

94-Pu-242	Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			1275.	30.	55						
			1275.	30.	55						
			1280.	50.	60						
mean value (&&) and recommendations from ref.17 and ref.18											
			1276.	20.	&&						
5.		17	1131.	57.	17						
5.	2.	18	1115.	40.	18						

94-PU-242 (N,GAMMA) R.I. and Spectrum aver.cross-sect.						
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	1276.	20.				
UKNDL-80	1131.	-144.	53.02		56.19	
LENDL-84	1311.	36.	81.48		85.39	
ENDF/B-4	1140.	-136.	55.41		58.51	
ENDF/B-5 A	1288.	12.	70.40		74.85	
INDL/A E	1146.	-129.	78.16		82.84	
INDL/A K2	1132.	-143.	94.73		99.53	

4.13 95-Am-241

The measured capture R.I. are completely contradictory and therefore useless for any sensible intercomparison before the discrepancies are resolved.

Table 19: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

95-Am-241			Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			2100.	200.	62						
			850.	60.	61						
			1140.	40.	54						
			1570.	110.	72						
mean value (&&) and recommendations from ref.17 and ref.18											
			1119.	32.	88						
			1330.	117.	17						
14.4	1.0	18	1230.	100.	18						

95-AM-241 (N,GAMMA) R.I. and Spectrum aver.cross-sect.						
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	1119.	31.				
UKNDL-80	1414.	295.	252.10		272.80	
LENDL-84	1507.	388.	157.40		172.50	
ENDF/B-4	1641.	522.	61.90		68.27	
ENDF/B-5 A	1424.	305.	254.20		273.50	
INDL/A E	1440.	320.	302.80		327.70	
INDL/A U	1393.	274.	252.10		272.80	
INDL/A K2	1453.	334.	214.60		234.90	

4.14 95-Am-242m

A single measurment for the fission R.I. and only three evaluations for this isotope are available. The fission R.I. derived from the evaluated data are all lower than the measurment.

Table 20: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

95-Am-242m	Res. Int.					and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
2260.	200.										
mean value (EE) and recommendations from ref.17 and ref.18											
2260.	200.	EE									
2260.	200.	17	1100.	500.	17						
1800.	65.	18									

95-AM-242m FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	2260.	200.				
LENDL-84	1542.	-718.	1825.		1833.	
ENDF/B-5 A	1902.	-359.	2214.		2222.	
INDL/A K2	1630.	-630.	1838.		1842.	

4.15 95-Am-243

The two measurments for the fission R.I. differ by nearly a factor of two although a high accuracy is claimed for each of them. The evaluated libraries produce values which are far below or equal to the lower measurment. The capture R.I. measurments are consistant but the values derived from the evaluated libraries are very underestimated.

Table 21: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

95-Am-243	Res. Int.					and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
9.0	1.0	67	2290.	50.	55						
17.1	1.3	72	2300.	200.	62						
			2200.	150.	72						
			2130.	110.	55						
mean value (&&) and recommendations from ref.17 and ref.18											
12.0	0.8	&&	2259.	43.	&&						
13.0	2.5	17	2200.	15.	17						
9.	1.	18	1820.	70.	16						

95-AM-243 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	12.0080	0.7877				
UKNDL-80	3.9332	-8.0748	1010.		979.	
LENDL-84	9.0183	-2.9897	1123.		1090.	
ENDF/B-4	4.2133	-7.7947	1023.		993.	
ENDF/B-5 A	5.8885	-6.1195	1205.		1164.	
INDL/A E	5.9322	-6.0758	1124.		1088.	
INDL/A U	5.9515	-6.0565	1124.		1088.	
INDL/A K2	5.7099	-6.2981	1253.		1214.	

95-AM-243 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	2259.	43.				
UKNDL-80	1357.	-902.	60.04		65.63	
LENDL-84	1822.	-438.	41.52		44.85	
ENDF/B-4	1362.	-897.	61.75		67.52	
ENDF/B-5 A	1819.	-441.	73.00		79.69	
INDL/A E	1813.	-446.	235.00		253.80	
INDL/A U	1845.	-415.	235.10		253.90	
INDL/A K2	1847.	-412.	123.20		135.60	

4.16 96-Cm-242

A single measurment of the capture R.I. and two evaluations are available. The R.I. values calculated from the evaluated data are within the experimental uncertainty.

Table 22: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

96-Cm-242	Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
			150.	40.							
mean value (&&) and recommendations from ref.17 and ref.18											
			150.	40.	&&						
33.		17	156.	35.	17						
			110.	20.	18						

96-CM-242 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	150.00	40.00				
LENDL-84	164.42	14.42	95.43		100.50	
INDL/A E	114.88	-35.11	29.63		32.90	

4.17 96-Cm-243

The fission R.I. measurments seem to be consistent. A single measurment for the capture R.I. is availsble. The values derived from the LENDL-84 or the ENDF/B-5 Actinides libraries which are the only ones available for this isotope bear no resemblance to each other or to the measurment.

Table 23: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

96-Cm-243	Res. Int.					and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
1360.	400.	63	216.	20.							
1480.	150.	73									
*1591.	136.	70									
mean value (&&) and recommendations from ref.17 and ref.18											
1560.	98.	&&	216.	20.	&&						
1527.	142.	17	214.	17.	17						
1570.	100.	18	215.	20.	18						

96-CM-243 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	1560.	98.				
LENDL-84	777.	-783.	1996.		1997.	
ENDF/B-5 A	1965.	405.	2073.		2075.	

96-CM-243 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	215.71	20.31				
LENDL-84	121.43	-94.28	41.00		44.30	
ENDF/B-5 A	250.86	35.15	14.77		16.24	

4.18 96-Cm-244

The capture R.I. measurments are consistent and the fission R.I. measurments are in reasonably good agreement. All evaluations overestimate the fission R.I. This overestimation is less pronounced in the ESA and IK2 libraries. On the contrary all evaluations underestimate the capture R.I. except the IK2 evaluation which produces a value within the experimental uncertainty. The values from the IK1 library are not representative because there are no data below 400 eV on the file.

Table 24: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

96-Cm-244	Res. Int.					and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
12.5	2.5	63	650.	50.	61						
13.4	1.5	67	650.	50.	63						
13.4	1.0	88	626.	53.	74						
*18.1	1.0	66									
mean value (&&) and recommendations from ref.17 and ref.18											
15.1	0.6	&&	643.	29.	&&						
13.4	1.5	17	633.	32.	17						
12.5	2.5	18	650.	30.	18						

96-CM-244 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	15.12	0.61				
UKNDL-80	43.83	28.71	1749.		1703.	
LENDL-84	34.83	19.71	1399.		1372.	
ENDF/B-4	44.25	29.13	1755.		1710.	
ENDF/B-5 A	19.31	3.19	1614.		1578.	
INDL/A K1	7.95	-7.18	1630.		1594.	
INDL/A K2	19.01	3.89	1630.		1594.	

96-CM-244 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	642.60	29.41				
UKNDL-80	587.43	-55.17	64.44		67.83	
LENDL-84	606.58	-36.02	41.38		45.29	
ENDF/B-4	587.94	-54.67	64.87		68.27	
ENDF/B-5 A	588.52	-54.09	119.30		126.40	
INDL/A K1	14.43	-628.17	96.05		102.80	
INDL/A K2	631.30	-11.31	96.16		102.90	

4.19 96-Cm-245

Except for one measurment the capture and the fission R.I. measurments are consistent. The fission R.I. calculated from the evaluated files are within the experimental uncertainty but the capture R.I. values are somewhat overestimated.

Table 25: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

96-Cm-245	Res. Int.			and Spectrum averaged cross-sect.								
R.I.f (b)	err. (b)	ref.		R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
770.	150.	63		108.	81.	74						
805.	80.	67		*104.	8.	64						
802.	80.	88										
*1161.	100.	65										
mean value (&&) and recommendations from ref.17 and ref.18												
878.	47.	&&		104.3	8.0	&&						
805.	80.	17		101.	3.	17						
840.	40.	18		101.	8.	18						

96-CM-245 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	878.41	46.77				
LENDL-84	832.95	-45.46	1723.		1724.	
ENDF/B-5 A	833.09	-45.32	1978.		1978.	

96-CM-245 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	104.33	7.96				
LENDL-84	121.43	17.10	41.00		44.30	
ENDF/B-5 A	117.56	13.23	40.74		43.97	

4.20 96-Cm-246

The fission R.I. measurments are in reasonable agreement although the errors are underestimated. The fission R.I. measurments are consistent. Except in the case of the E5A library the fission R.I. values calculated from the evaluated data are underestimated. The capture R.I. values derived from the evaluated data are much more scattered. The capture data in the IK1 and IK2 files seem to be the same and they underestimate the R.I. by an order of magnitude because the data are given between 200 eV and 15 MeV only.

Table 26: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

96-Cm-246	Res. Int.			and Spectrum averaged cross-sect.								
R.I.f (b)	err. (b)	ref.		R.I.c (b)	err. (b)	ref.		Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
13.3	1.5	88		116.	15.	74							
13.3	1.5	67		*121.	6.	64							
*10.0	0.4	66											
mean value (&&) and recommendations from ref.17 and ref.18													
10.4	0.4	&&		120.5	6.3	&&							
11.3	1.2	17		121.3	7.5	17							
10.2	0.4	18		121.	7.	18							

96-CM-246 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	10.4151	0.3676				
LENCL-84	7.6459	-2.7692	1346.		1313.	
ENDF/B-5 A	10.1455	-0.2696	1386.		1345.	
INDL/A E	6.9247	-3.4904	1342.		1313.	
INDL/A K1	6.0128	-4.4024	1375.		1333.	
INDL/A K2	6.0128	-4.4024	1375.		1333.	

96-CM-246 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	120.48	6.34				
LENCL-84	138.14	17.66	41.51		44.83	
ENDF/B-5 A	103.24	-17.24	42.19		44.83	
INDL/A E	110.16	-10.33	22.84		25.05	
INDL/A K1	10.22	-110.26	55.31		58.52	
INDL/A K2	10.22	-110.26	55.31		58.52	

4.21 96-Cm-247

Except for one measurment the fission R.I. measurments are consistent. A single capture R.I. measurment with a high uncertainty is available. Only the L4 evaluation for this isotope exists.. It somewhat overestimates the fission R.I. and slightly underestimates the capture R.I. as compared to the measurments and their uncertainties.

Table 27: Resonance integrals for Fission (R.I.f) and Capture (R.I.c) and the fission cross section averaged over the Cf-252 fission spectrum (Cf.f) and the U-235 fission spectrum (U5.f.)

96-Cm-247			Res. Int.			and Spectrum averaged cross-sect.					
R.I.f (b)	err. (b)	ref.	R.I.c (b)	err. (b)	ref.	Cf.f. (mb)	err. (mb)	ref.	U5.f. (mb)	err. (mb)	ref.
935.	190.	63	800.	400.							
730.	70.	67									
*1062.	110.	65									
*784.	50.	66									
mean value (&&) and recommendations from ref.17 and ref.18											
806.	37.	&&	800.	400.	&&						
754.	60.	17	650.	250.	17						
760.	50.	13	530.	30.	18						

96-CM-247 FISSION	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	806.36	37.41				
LENDL-84	918.96	112.61	2066.		2062.	

96-CM-247 (N,GAMMA)	R.I. and Spectrum aver.cross-sect.					
Library	R.I. (b)	err. (b)	Cf-252 f. (mb)	err. (mb)	U-235 f. (mb)	err. (mb)
EXPERIMENT	800.00	399.99				
LENDL-84	363.92	-436.09	40.95		44.23	

5. Conclusions

Looking at the tables and the comments for each of the isotopes the following observations and recommendations can be made:

- It is important to use validated programs for processing of evaluated libraries.
- Evaluations which do not obey format rules strictly should be identified. They are potentially dangerous to be included in a library and should be avoided if possible.
- The experimental data for the integral quantities considered are scarce.
- Different measurments for the same quantity often differ by more than the quoted experimental uncertainty. This indicates the fact that sometimes the quoted errors are underestimated or that they do not include systematic errors such as the uncertainty in the cadmium cut-off energy, daviation of the actual from the assumed neutron spectrum or the error in the reference cross section (this is particularly important in some older measurments).
- Whenever possible the ratio data should be used in preference to the absolute values. The best estimates of the reference cross sections obtained iteratively should be used.
- A few measurments of cross sections averaged over some fairly well known reference spectra [7] are available. They should be included in the analysis.
- Error analysis for each of the measurments included for average value determination should carefully be considered. When measurments are contradictory and their error analysis is not described sufficiently they should be discarded or their error bars incerased suitably.

The evaluations for some of the major actinides in the INDL/A library have recently been superseeded by new evaluations from the same authors [19]. Revised data for some ENDF/B-5 evaluations have also been released. In any future work care should be taken to consider the most recent data.

Within the scope of present analysis a definite conclusion about superiority of one evaluation compared to another can not be made. By a more selective error analysis and by including the measurments in other known spectra the available data base could be improved and extended. This might help to resolve the discrepancies in some of the measurments and confirm some others. Experimental measurments could then be used with greater confidence as the selection criteria for evaluated data.

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APPENDIX

In the following tables a complete list of spectrum averaged cross sections from all the evaluated libraries is given. The resonance integrals in barns can be reconstructed from the 1/E spectrum averaged cross sections by multiplying the values with (1.0E3*ln(20.E6/0.5)) which is the 1/E spectrum integral in the assumed energy interval.

The processed libraries to which the calculated averaged cross sections belong are self-evident from the table headings. Energy ranges in which the spectra are defined are also given. The isotopes with threshold reactions and without subthreshold data can also be identified. The upper energy limit up to which the individual cross section data are non-zero can be obtained from the number of groups processed starting from threshold. The SAND-II extended group structure may be assumed in all cases.

Table A1: Spectra averages (millibarns) from INDL/A-83 file-2

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-232	9090	620		TOTAL	19156.	7544.	7592.	7557.
90-TH-232	9090	169	1.1	FISSION	32.62	75.86	70.18	72.75
90-TH-232	9090	620		(N,GAMMA)	4574.	95.01	99.67	97.33
91-PA-233	9193	620		TOTAL	61143.	7455.	7522.	7482.
91-PA-233	9193	218	0.09	FISSION	157.4	608.3	587.0	603.7
91-PA-233	9193	620		(N,GAMMA)	50403.	156.5	168.8	161.8
93-NP-237	9337	600		TOTAL	48504.	7548.	7593.	7561.
93-NP-237	9337	600		FISSION	333.2	1308.	1279.	1303.
93-NP-237	9337	600		(N,GAMMA)	37344.	184.4	199.0	189.1
94-PU-238	9438	579		TOTAL	23093.	7790.	7835.	7806.
94-PU-238	9438	579		FISSION	1799.	1983.	1959.	1978.
94-PU-238	9438	579		(N,GAMMA)	8198.	73.34	78.21	75.08
94-PU-239	9421	590		TOTAL	38029.	7717.	7756.	7723.
94-PU-239	9421	590		FISSION	17406.	1795.	1787.	1794.
94-PU-239	9421	590		(N,GAMMA)	10446.	53.35	57.46	54.47
94-PU-240	9431	590		TOTAL	530479.	6538.	6595.	6539.
94-PU-240	9431	382	0.47E-05	FISSION	243.3	87.57	66.26	67.88
94-PU-240	9431	590		(N,GAMMA)	481012.	85.46	91.02	87.58
94-PU-241	9440	590		TOTAL	153751.	7962.	8007.	7972.
94-PU-241	9440	590		FISSION	69714.	1607.	1610.	1609.
94-PU-241	9440	590		(N,GAMMA)	39106.	66.44	70.48	68.71
94-PU-242	9450	590		TOTAL	85279.	7766.	7816.	7774.
94-PU-242	9450	590		FISSION	293.6	1118.	1089.	1112.
94-PU-242	9450	590		(N,GAMMA)	65475.	78.16	82.84	80.34
95-AM-241	9541	590		TOTAL	92901.	7635.	7690.	7651.
95-AM-241	9541	590		FISSION	786.8	1349.	1309.	1342.
95-AM-241	9541	590		(N,GAMMA)	82244.	302.8	327.7	309.8
95-AM-243	9530	590		TOTAL	115999.	7663.	7713.	7683.
95-AM-243	9530	590		FISSION	338.9	1124.	1088.	1116.
95-AM-243	9530	590		(N,GAMMA)	103592.	235.0	253.8	241.9
96-CM-242	9662	590		TOTAL	18689.	8056.	8098.	8067.
96-CM-242	9662	590		FISSION	663.6	1664.	1637.	1662.
96-CM-242	9662	590		(N,GAMMA)	6563.	29.63	32.90	30.85
96-CM-246	9666	590		TOTAL	19042.	8742.	8800.	8762.
96-CM-246	9666	590		FISSION	395.6	1342.	1313.	1342.
96-CM-246	9666	590		(N,GAMMA)	6293.	22.84	25.05	23.61

Table A2: Spectra averages (millibarns) from INDL/A-83 file-2 (origin JENDL-2)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
92-U -235	9235	620		TOTAL	34974.	7632.	7671.	7643.
92-U -235	9235	620		FISSION	15708.	1248.	1248.	1248.
92-U -235	9235	620		(N,GAMMA)	8747.	127.4	133.9	131.0
92-U -238	9238	620		TOTAL	36127.	7780.	7827.	7795.
92-U -238	9238	620		FISSION	109.4	323.3	304.0	314.8
92-U -238	9238	620		(N,GAMMA)	15909.	64.95	68.63	66.74
94-PU-239	9439	620		TOTAL	38552.	7699.	7740.	7710.
94-PU-239	9439	620		FISSION	17122.	1818.	1812.	1818.
94-PU-239	9439	606		(N,GAMMA)	11131.	59.01	63.30	60.76
94-PU-240	9445	620		TOTAL	536796.	7831.	7874.	7846.
94-PU-240	9445	620		FISSION	562.3	1367.	1338.	1364.
94-PU-240	9445	620		(N,GAMMA)	482007.	90.12	95.64	92.73
94-PU-241	9448	620		TOTAL	54929.	7828.	7870.	7843.
94-PU-241	9448	620		FISSION	33792.	1621.	1626.	1624.
94-PU-241	9448	620		(N,GAMMA)	10673.	145.5	152.7	149.0

Table A3: Spectra averages (millibarns) INDL/A-83 file-3 (Mat. Acc. No. 1009,1010)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
95-AM-241	9541	590		TOTAL	90757.	7767.	7801.	7777.
95-AM-241	9541	590		ELASTIC	10046.	5018.	5080.	5033.
95-AM-241	9541	590		NON-ELASTIC	80686.	2749.	2721.	2743.
95-AM-241	9541	160	0.04	INELASTIC-TOTAL	250.7	1064.	1062.	1064.
95-AM-241	9541	81	7.0	(N,2N)	17.21	5.206	3.342	3.488
95-AM-241	9541	590		FISSION	850.5	1426.	1382.	1417.
95-AM-241	9541	590		(N,GAMMA)	79567.	252.1	272.8	257.9
95-AM-243	9543	590		TOTAL	117811.	7668.	7717.	7688.
95-AM-243	9543	590		ELASTIC	11694.	4979.	5038.	4996.
95-AM-243	9543	590		NON-ELASTIC	106062.	2689.	2679.	2692.
95-AM-243	9543	165	0.04	INELASTIC-TOTAL	316.6	1321.	1331.	1328.
95-AM-243	9543	86	6.5	(N,2N)	19.75	7.332	4.854	5.058
95-AM-243	9543	590		FISSION	340.0	1124.	1088.	1116.
95-AM-243	9543	590		(N,GAMMA)	105384.	235.1	253.9	242.0

Table A4: Spectra averages (millibarns) INDL/A-83 file-4 (Mat. Acc. No. 1,2)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
96-CM-244	9664	295	0.40E-03	TOTAL	8181.	7982.	8040.	7997.
96-CM-244	9664	295	0.40E-03	ELASTIC	6642.	5259.	5351.	5277.
96-CM-244	9664	295	0.40E-03	NON-ELASTIC	1540.	2724.	2689.	2720.
96-CM-244	9664	204	0.04	INELASTIC-TOTAL	239.2	990.8	988.0	993.2
96-CM-244	9664	84	6.7	(N,2N)	21.33	6.803	4.406	4.592
96-CM-244	9664	295	0.40E-03	FISSION	454.1	1630.	1594.	1624.
96-CM-244	9664	295	0.40E-03	27	1278.	1726.	1697.	1722.
96-CM-244	9664	295	0.40E-03	(N,GAMMA)	824.4	96.05	102.8	98.45
96-CM-244	9664	295	0.40E-03	251	168.4	605.4	592.7	600.5
96-CM-246	9666	308	0.20E-03	TOTAL	8129.	8018.	8075.	8031.
96-CM-246	9666	308	0.20E-03	ELASTIC	6888.	5419.	5519.	5439.
96-CM-246	9666	308	0.20E-03	NON-ELASTIC	1241.	2600.	2556.	2591.
96-CM-246	9666	204	0.04	INELASTIC-TOTAL	282.5	1158.	1157.	1161.
96-CM-246	9666	88	6.3	(N,2N)	29.35	10.70	7.108	7.395
96-CM-246	9666	308	0.20E-03	FISSION	343.5	1375.	1333.	1366.
96-CM-246	9666	308	0.20E-03	27	927.6	1431.	1392.	1422.
96-CM-246	9666	308	0.20E-03	(N,GAMMA)	584.1	55.31	58.52	56.80
96-CM-246	9666	308	0.20E-03	251	166.4	594.9	581.7	589.6

Table A5: Spectra averages (millibarns) INDL/A-83 file-4 (Mat. Acc. No. 8 - 58)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-232	9032	595	0.10E-08	TOTAL	19437.	7417.	7461.	7427.
90-TH-232	9032	595	0.10E-08	ELASTIC	14033.	4958.	5038.	4978.
90-TH-232	9032	250	0.05	INELASTIC-TOTAL	506.0	2263.	2236.	2262.
90-TH-232	9032	137	6.3	(N,2N)	85.16	24.23	15.93	16.59
90-TH-232	9032	188	1.2	FISSION	33.87	74.43	69.00	71.55
90-TH-232	9032	595	0.10E-08	27	4765.	172.0	171.4	171.2
90-TH-232	9032	595	0.10E-08	(N,GAMMA)	4732.	97.47	102.3	99.62
90-TH-232	9032	640		251	154.9	522.9	508.7	517.2
92-U -233	9233	640		TOTAL	61349.	7347.	7384.	7354.
92-U -233	9233	640		ELASTIC	9646.	4297.	4350.	4307.
92-U -233	9233	254	0.04	INELASTIC-TOTAL	251.5	1151.	1128.	1147.
92-U -233	9233	140	6.0	(N,2N)	29.27	12.14	8.490	8.793

Table A5 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
92-U -233	9233	640		FISSION	43673.	1834.	1842.	1837.
92-U -233	9233	640		27	51383.	1896.	1907.	1900.
92-U -233	9233	640		(N,GAMMA)	7709.	60.86	64.23	61.75
92-U -233	9233	640		251	197.8	611.2	601.9	606.4
92-U -235	9235	546	0.10E-08	TOTAL	33643.	7627.	7666.	7639.
92-U -235	9235	546	0.10E-08	ELASTIC	9966.	4709.	4769.	4725.
92-U -235	9235	218	0.02	INELASTIC-TOTAL	343.6	1560.	1536.	1557.
92-U -235	9235	98	5.3	(N,2N)	23.40	13.68	9.805	10.12
92-U -235	9235	546	0.10E-08	FISSION	15369.	1256.	1256.	1256.
92-U -235	9235	546	0.10E-08	27	23509.	1347.	1354.	1350.
92-U -235	9235	546	0.10E-08	(N,GAMMA)	8137.	90.29	96.12	92.76
92-U -235	9235	640		(N,P)	0.00000	0.00000	0.00000	0.00000
92-U -235	9235	640		(N,ALPHA)	0.00000	0.00000	0.00000	0.00000
92-U -235	9235	546	0.10E-08	251	145.3	520.8	507.5	514.8
92-U -237	9237	81	0.01	TOTAL	2892.	1946.	2131.	1958.
92-U -237	9237	81	0.01	ELASTIC	2329.	1435.	1575.	1447.
92-U -237	9237	81	0.01	NON-ELASTIC	563.4	510.6	555.7	511.2
92-U -237	9237	81	0.01	INELASTIC-TOTAL	235.1	294.5	319.8	293.6
92-U -237	9237	81	0.01	FISSION	209.1	174.3	189.7	174.8
92-U -237	9237	81	0.01	27	328.2	216.1	235.9	217.6
92-U -237	9237	81	0.01	(N,GAMMA)	119.2	41.81	46.22	42.81
92-U -238	9238	546	0.10E-08	TOTAL	36073.	7800.	7847.	7813.
92-U -238	9238	546	0.10E-08	ELASTIC	19520.	5496.	5573.	5518.
92-U -238	9238	204	0.04	INELASTIC-TOTAL	441.1	1899.	1890.	1903.
92-U -238	9238	90	6.1	(N,2N)	55.35	23.74	16.25	16.86
92-U -238	9238	157	0.5	FISSION	94.99	313.0	294.0	304.6
92-U -238	9238	546	0.10E-08	27	16005.	383.8	368.7	377.4
92-U -238	9238	546	0.10E-08	(N,GAMMA)	15910.	70.92	74.81	72.93
92-U -238	9238	640		(N,P)	0.00000	0.00000	0.00000	0.00000
92-U -238	9238	640		(N,ALPHA)	0.00000	0.00000	0.00000	0.00000
92-U -238	9238	546	0.10E-08	251	148.2	543.3	530.5	538.0
93-NP-237	9337	546	0.10E-08	TOTAL	48101.	7849.	7905.	7866.
93-NP-237	9337	546	0.10E-08	ELASTIC	10662.	4961.	5033.	4978.
93-NP-237	9337	308	0.20E-03	NON-ELASTIC	3639.	2888.	2872.	2888.
93-NP-237	9337	209	0.03	INELASTIC-TOTAL	357.9	1432.	1435.	1436.
93-NP-237	9337	84	6.7	(N,2N)	20.67	5.741	3.681	3.836
93-NP-237	9337	546	0.10E-08	FISSION	334.9	1287.	1257.	1281.
93-NP-237	9337	546	0.10E-08	27	37028.	1450.	1433.	1449.
93-NP-237	9337	546	0.10E-08	(N,GAMMA)	36693.	162.7	176.3	167.4
93-NP-237	9337	308	0.20E-03	251	171.7	615.1	603.0	610.3
94-PU-238	9438	546	0.10E-08	TOTAL	23174.	7775.	7836.	7793.
94-PU-238	9438	546	0.10E-08	ELASTIC	12094.	4786.	4864.	4801.
94-PU-238	9438	175	0.04	INELASTIC-TOTAL	226.3	928.3	930.5	933.8
94-PU-238	9438	81	7.0	(N,2N)	5.858	2.344	1.537	1.605
94-PU-238	9438	546	0.10E-08	FISSION	1785.	1936.	1910.	1930.
94-PU-238	9438	546	0.10E-08	27	10841.	2057.	2037.	2055.

Table A5 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
94-PU-238	9438	546	0.10E-08	(N,GAMMA)	9055.	122.4	128.6	125.6
94-PU-238	9438	546	0.10E-08	251	169.5	616.9	604.6	612.5
94-PU-239	9439	546	0.10E-08	TOTAL	38728.	7693.	7734.	7705.
94-PU-239	9439	546	0.10E-08	ELASTIC	9937.	4762.	4831.	4781.
94-PU-239	9439	236	0.008	INELASTIC-TOTAL	266.8	1083.	1062.	1078.
94-PU-239	9439	95	5.6	(N,2N)	25.35	15.87	11.55	11.89
94-PU-239	9439	546	0.10E-08	FISSION	17392.	1788.	1781.	1787.
94-PU-239	9439	546	0.10E-08	27	28497.	1824.	1820.	1824.
94-PU-239	9439	546	0.10E-08	(N,GAMMA)	11101.	37.66	41.08	38.71
94-PU-239	9439	640		(N,P)	0.00000	0.00000	0.00000	0.00000
94-PU-239	9439	640		(N,ALPHA)	0.00000	0.00000	0.00000	0.00000
94-PU-239	9439	546	0.10E-08	251	148.9	543.2	530.4	537.9
94-PU-240	9440	546	0.10E-08	TOTAL	500760.	7595.	7633.	7600.
94-PU-240	9440	546	0.10E-08	ELASTIC	45389.	5017.	5063.	5016.
94-PU-240	9440	174	0.04	INELASTIC-TOTAL	303.0	1184.	1199.	1193.
94-PU-240	9440	87	6.4	(N,2N)	17.67	6.293	4.155	4.322
94-PU-240	9440	546	0.10E-08	FISSION	478.0	1278.	1252.	1276.
94-PU-240	9440	546	0.10E-08	27	455943.	1387.	1369.	1388.
94-PU-240	9440	546	0.10E-08	(N,GAMMA)	455449.	109.6	116.0	112.4
94-PU-240	9440	546	0.10E-08	251	152.2	557.7	544.7	552.6
94-PU-241	9441	546	0.10E-08	TOTAL	54010.	7836.	7897.	7851.
94-PU-241	9441	546	0.10E-08	ELASTIC	9369.	4617.	4675.	4625.
94-PU-241	9441	164	0.04	INELASTIC-TOTAL	312.0	1472.	1475.	1483.
94-PU-241	9441	97	5.4	(N,2N)	36.70	34.55	26.18	26.83
94-PU-241	9441	546	0.10E-08	FISSION	33276.	1637.	1640.	1639.
94-PU-241	9441	546	0.10E-08	27	44294.	1713.	1721.	1716.
94-PU-241	9441	546	0.10E-08	(N,GAMMA)	11011.	75.57	81.06	77.39
94-PU-241	9441	546	0.10E-08	251	177.7	633.9	622.9	629.8
94-PU-242	9442	546	0.10E-08	TOTAL	84367.	7625.	7664.	7633.
94-PU-242	9442	546	0.10E-08	ELASTIC	19067.	5065.	5113.	5067.
94-PU-242	9442	164	0.04	INELASTIC-TOTAL	341.3	1360.	1373.	1368.
94-PU-242	9442	89	6.2	(N,2N)	19.23	11.14	7.774	8.070
94-PU-242	9442	472	0.47E-07	FISSION	268.7	1094.	1071.	1093.
94-PU-242	9442	546	0.10E-08	27	64944.	1188.	1171.	1190.
94-PU-242	9442	546	0.10E-08	(N,GAMMA)	64676.	94.73	99.53	97.45
94-PU-242	9442	546	0.10E-08	251	153.6	560.8	548.1	555.8
95-AM-241	9541	546	0.10E-08	TOTAL	94171.	7727.	7791.	7745.
95-AM-241	9541	546	0.10E-08	ELASTIC	9866.	4359.	4411.	4351.
95-AM-241	9541	205	0.04	INELASTIC-TOTAL	372.8	1747.	1781.	1776.
95-AM-241	9541	85	6.6	(N,2N)	6.487	1.803	1.152	1.200
95-AM-241	9541	546	0.10E-08	FISSION	898.5	1402.	1359.	1393.
95-AM-241	9541	546	0.10E-08	27	83912.	1618.	1594.	1614.
95-AM-241	9541	546	0.10E-08	(N,GAMMA)	83009.	214.6	234.9	219.8
95-AM-241	9541	546	0.10E-08	251	202.3	714.8	704.3	710.7
95-AM-242	9542	546	0.10E-08	TOTAL	118728.	7747.	7814.	7764.
95-AM-242	9542	546	0.10E-08	ELASTIC	9490.	4493.	4553.	4505.

Table A5 (cont.)

SPECTRA----------	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS----------	475	620	620	620
SPECTRA ENERGY RANGE IS FROM---	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)----------	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)--	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)-------	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
95-AM-242	9542	214	0.02	INELASTIC-TOTAL	297.3	1324.	1324.	1333.
95-AM-242	9542	97	5.4	(N,2N)	27.13	16.29	11.63	12.02
95-AM-242	9542	546	0.10E-08	FISSION	9311B.	1838.	1842.	1835.
95-AM-242	9542	546	0.10E-08	27	109126.	1913.	1925.	1913.
95-AM-242	9542	546	0.10E-08	(N,GAMMA)	15979.	75.82	82.92	77.83
95-AM-242	9542	546	0.10E-08	251	202.7	715.4	704.9	711.3
95-AM-243	9543	546	0.10E-08	TOTAL	116441.	7757.	7824.	7774.
95-AM-243	9543	546	0.10E-08	ELASTIC	10071.	4655.	4747.	4680.
95-AM-243	9543	205	0.04	INELASTIC-TOTAL	499.1	1725.	1728.	1721.
95-AM-243	9543	88	6.3	(N,2N)	4.102	1.173	0.7595	0.7898
95-AM-243	9543	546	0.10E-08	FISSION	326.2	1253.	1214.	1245.
95-AM-243	9543	546	0.10E-08	27	105824.	1378.	1351.	1374.
95-AM-243	9543	546	0.10E-08	(N,GAMMA)	105512.	123.2	135.6	127.9
95-AM-243	9543	546	0.10E-08	251	146.7	524.1	510.8	518.0
96-CM-244	9644	546	0.10E-08	TOTAL	57621.	7976.	8032.	7989.
96-CM-244	9644	546	0.10E-08	ELASTIC	20191.	5251.	5343.	5269.
96-CM-244	9644	204	0.04	INELASTIC-TOTAL	240.9	991.3	988.6	993.8
96-CM-244	9644	84	6.7	(N,2N)	21.33	6.803	4.406	4.592
96-CM-244	9644	546	0.10E-08	FISSION	1086.	1630.	1594.	1623.
96-CM-244	9644	546	0.10E-08	27	37151.	1726.	1697.	1722.
96-CM-244	9644	546	0.10E-08	(N,GAMMA)	36065.	96.16	102.9	98.60
96-CM-244	9644	546	0.10E-08	251	169.4	605.4	592.7	600.5
96-CM-246	9646	308	0.20E-03	TOTAL	8129.	8018.	8075.	8031.
96-CM-246	9646	308	0.20E-03	ELASTIC	6888.	5419.	5519.	5439.
96-CM-246	9646	308	0.20E-03	NON-ELASTIC	1241.	2600.	2556.	2591.
96-CM-246	9646	204	0.04	INELASTIC-TOTAL	282.5	1158.	1157.	1161.
96-CM-246	9646	88	6.3	(N,2N)	29.35	10.70	7.108	7.395
96-CM-246	9646	308	0.20E-03	FISSION	343.5	1375.	1333.	1366.
96-CM-246	9646	308	0.20E-03	27	927.6	1431.	1392.	1422.
96-CM-246	9646	308	0.20E-03	(N,GAMMA)	584.1	55.31	58.52	56.80
96-CM-246	9646	308	0.20E-03	251	166.4	594.9	581.7	589.6
96-CM-248	9648	263	0.002	TOTAL	5837.	8044.	8106.	8060.
96-CM-248	9648	263	0.002	ELASTIC	5036.	5482.	5585.	5505.
96-CM-248	9648	263	0.002	NON-ELASTIC	800.8	2562.	2521.	2555.
96-CM-248	9648	204	0.04	INELASTIC-TOTAL	302.3	1249.	1236.	1245.
96-CM-248	9648	89	6.2	(N,2N)	30.17	11.83	7.969	8.281
96-CM-248	9648	263	0.002	FISSION	305.0	1248.	1222.	1247.
96-CM-248	9648	263	0.002	27	464.7	1301.	1277.	1301.
96-CM-248	9648	263	0.002	(N,GAMMA)	159.6	52.68	55.62	54.08
96-CM-248	9648	263	0.002	251	167.0	598.1	585.1	592.9

Table A6: Spectra averages (millibarns) from UKNDL-80

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-232	9032	590		TOTAL	16681.	7336.	7383.	7350.
90-TH-232	9032	590		ELASTIC	9658.	4709.	4787.	4729.
90-TH-232	9032	590		NON-ELASTIC	6971.	2626.	2595.	2621.
90-TH-232	9032	88	6.3	(N,2N)	60.57	20.43	13.41	13.97
90-TH-232	9032	141	1.0	FISSION	29.44	79.93	73.73	76.44
90-TH-232	9032	590		(N,GAMMA)	6322.	118.7	125.1	122.0
91-PA-233	9133	540		TOTAL	61427.	8224.	8313.	8256.
91-PA-233	9133	540		ELASTIC	9882.	4972.	5047.	4987.
91-PA-233	9133	26	7.5	(N,2N)	8.180	4.820	3.220	3.369
91-PA-233	9133	123	0.2	FISSION	195.1	977.6	952.8	973.6
91-PA-233	9133	540		(N,GAMMA)	50616.	117.7	127.0	122.0
92-U -233	9233	590		TOTAL	61253.	7467.	7490.	7476.
92-U -233	9233	590		ELASTIC	9431.	4432.	4461.	4437.
92-U -233	9233	92	5.9	(N,2N)	24.61	11.93	8.321	8.625
92-U -233	9233	590		FISSION	43219.	1891.	1899.	1895.
92-U -233	9233	464		(N,GAMMA)	8310.	41.64	45.10	42.59
92-U -234	9234	590		TOTAL	59217.	8425.	8484.	8447.
92-U -234	9234	590		ELASTIC	20118.	5273.	5367.	5298.
92-U -234	9234	204	0.04	INELASTIC-TOTAL	423.3	1816.	1798.	1815.
92-U -234	9234	83	6.8	(N,2N)	11.44	2.373	1.467	1.528
92-U -234	9234	270	0.001	FISSION	286.0	1156.	1131.	1151.
92-U -234	9234	590		(N,GAMMA)	37433.	171.0	179.3	175.0
92-U -235	9235	590		TOTAL	33863.	7501.	7537.	7512.
92-U -235	9235	590		ELASTIC	9785.	4708.	4754.	4718.
92-U -235	9235	590		NON-ELASTIC	24030.	2793.	2782.	2794:
92-U -235	9235	98	5.3	(N,2N)	27.18	13.80	9.771	10.09
92-U -235	9235	590		FISSION	15677.	1237.	1239.	1238.
92-U -235	9235	590		(N,GAMMA)	7993.	77.15	82.93	79.53
92-U -236	9236	590		TOTAL	36862.	7990.	8051.	8008.
92-U -236	9236	590		ELASTIC	17155.	5258.	5353.	5284.
92-U -236	9236	203	0.04	INELASTIC-TOTAL	447.8	1961.	1950.	1964.
92-U -236	9236	82	6.9	(N,2N)	32.43	11.61	7.649	7.971
92-U -236	9236	152	0.6	FISSION	168.5	584.2	557.2	573.7
92-U -236	9236	590		(N,GAMMA)	18445.	171.1	179.3	175.0
92-U -237	9237	276	0.001	TOTAL	6083.	7366.	7389.	7372.
92-U -237	9237	276	0.001	ELASTIC	4812.	4532.	4572.	4542.
92-U -237	9237	276	0.001	NON-ELASTIC	1271.	2834.	2816.	2829.
92-U -237	9237	97	5.4	(N,2N)	38.78	20.67	14.55	15.05
92-U -237	9237	276	0.001	FISSION	326.0	799.5	796.6	796.8
92-U -237	9237	276	0.001	(N,GAMMA)	471.3	139.2	147.4	142.8
92-U -238	9238	590		TOTAL	33203.	7797.	7840.	7810.
92-U -238	9238	590		ELASTIC	17231.	5014.	5093.	5032.
92-U -238	9238	590		NON-ELASTIC	15944.	2783.	2746.	2778.
92-U -238	9238	91	6.0	(N,2N)	57.01	25.13	17.14	17.81
92-U -238	9238	276	0.001	FISSION	91.45	296.8	278.7	288.7
92-U -238	9238	590		(N,GAMMA)	15279.	83.17	87.38	85.40

Table A6 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
92-U -239	9239	276	0.001	TOTAL	6059.	7362.	7383.	7367.
92-U -239	9239	276	0.001	ELASTIC	4244.	4157.	4185.	4164.
92-U -239	9239	276	0.001	NON-ELASTIC	1814.	3204.	3197.	3202.
92-U -239	9239	104	4.7	(N,2N)	63.32	32.38	22.90	23.68
92-U -239	9239	276	0.001	FISSION	412.6	623.2	627.2	621.2
92-U -239	9239	276	0.001	(N,GAMMA)	800.6	263.3	277.2	270.4
92-U -240	9240	276	0.001	TOTAL	6260.	7761.	7802.	7771.
92-U -240	9240	276	0.001	ELASTIC	5425.	5109.	5177.	5122.
92-U -240	9240	276	0.001	NON-ELASTIC	833.9	2651.	2625.	2650.
92-U -240	9240	93	5.8	(N,2N)	50.51	22.44	15.25	15.85
92-U -240	9240	178	0.2	FISSION	11.07	38.02	37.33	37.76
92-U -240	9240	276	0.001	(N,GAMMA)	199.8	32.45	34.85	33.08
93-NP-237	9337	590		TOTAL	49270.	8866.	8894.	8877.
93-NP-237	9337	590		ELASTIC	10875.	4789.	4849.	4800.
93-NP-237	9337	209	0.03	INELASTIC-TOTAL	628.0	2336.	2320.	2335.
93-NP-237	9337	84	6.7	(N,2N)	9.854	2.811	1.796	1.873
93-NP-237	9337	590		FISSION	394.3	1371.	1338.	1365.
93-NP-237	9337	590		(N,GAMMA)	37152.	364.4	382.2	371.5
94-PU-238	9438	590		TOTAL	26538.	7368.	7375.	7368.
94-PU-238	9438	590		ELASTIC	10083.	4684.	4731.	4689.
94-PU-238	9438	590		NON-ELASTIC	15473.	2676.	2634.	2670.
94-PU-238	9438	91	6.0	(N,2N)	16.11	9.770	6.916	7.166
94-PU-238	9438	590		FISSION	4339.	1935.	1912.	1931.
94-PU-238	9438	470		(N,GAMMA)	7878.	74.47	79.92	77.41
94-PU-239	9439	590		TOTAL	38244.	8002.	8047.	8015.
94-PU-239	9439	590		ELASTIC	10348.	4377.	4454.	4387.
94-PU-239	9439	590		NON-ELASTIC	27815.	3625.	3592.	3628.
94-PU-239	9439	93	5.8	(N,2N)	23.68	8.460	5.573	5.800
94-PU-239	9439	590		FISSION	17147.	1783.	1775.	1782.
94-PU-239	9439	590		(N,GAMMA)	10237.	46.61	50.29	47.90
94-PU-240	9440	590		TOTAL	508943.	7995.	8042.	8008.
94-PU-240	9440	590		ELASTIC	49662.	5214.	5298.	5232.
94-PU-240	9440	81	7.0	(N,2N)	23.52	8.611	5.677	5.916
94-PU-240	9440	590		FISSION	367.9	1255.	1227.	1250.
94-PU-240	9440	590		(N,GAMMA)	458431.	92.90	98.13	95.26
94-PU-241	9441	590		TOTAL	52196.	7814.	7836.	7814.
94-PU-241	9441	590		ELASTIC	9914.	4748.	4787.	4754.
94-PU-241	9441	590		NON-ELASTIC	42210.	3066.	3048.	3060.
94-PU-241	9441	96	5.5	(N,2N)	29.86	23.63	17.39	17.90
94-PU-241	9441	590		FISSION	32200.	1661.	1662.	1662.
94-PU-241	9441	521		(N,GAMMA)	9617.	38.03	41.69	39.12
94-PU-242	9442	590		TOTAL	86568.	7544.	7586.	7560.
94-PU-242	9442	590		ELASTIC	21161.	4713.	4811.	4744.
94-PU-242	9442	203	0.04	INELASTIC-TOTAL	359.5	1509.	1489.	1505.
94-PU-242	9442	89	6.2	(N,2N)	22.43	8.731	5.811	6.049
94-PU-242	9442	232	0.010	FISSION	304.1	1244.	1208.	1234.

Table A6 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
94-PU-242	9442	590		(N,GAMMA)	64629.	53.02	56.19	54.31
95-AM-241	9541	590		TOTAL	92045.	7767.	7801.	7777.
95-AM-241	9541	590		ELASTIC	10061.	5018.	5080.	5033.
95-AM-241	9541	590		NON-ELASTIC	81934.	2749.	2721.	2743.
95-AM-241	9541	160	0.04	INELASTIC-TOTAL	250.7	1064.	1062.	1064.
95-AM-241	9541	81	7.0	(N,2N)	17.18	5.206	3.342	3.488
95-AM-241	9541	590		FISSION	858.3	1426.	1382.	1417.
95-AM-241	9541	590		(N,GAMMA)	80807.	252.1	272.8	257.9
95-AM-243	9543	590		TOTAL	88834.	7989.	8004.	7999.
95-AM-243	9543	590		ELASTIC	10391.	4769.	4826.	4778.
95-AM-243	9543	190	0.08	INELASTIC-TOTAL	452.9	2130.	2111.	2133.
95-AM-243	9543	232	0.010	FISSION	224.7	1010.	979.2	1005.
95-AM-243	9543	590		(N,GAMMA)	77541.	60.04	65.63	61.96
96-CM-244	9644	590		TOTAL	58258.	7627.	7667.	7647.
96-CM-244	9644	590		ELASTIC	21818.	4623.	4715.	4655.
96-CM-244	9644	204	0.04	INELASTIC-TOTAL	293.8	1173.	1163.	1172.
96-CM-244	9644	84	6.7	(N,2N)	6.596	2.117	1.371	1.429
96-CM-244	9644	590		FISSION	2504.	1749.	1703.	1736.
96-CM-244	9644	590		(N,GAMMA)	33559.	64.44	67.83	65.91

Table A7: Spectra averages (millibarns) from LENDL-84 library

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-231	7863	640		TOTAL	67792.	7259.	7322.	7273.
90-TH-231	7863	640		ELASTIC	10454.	4449.	4534.	4462.
90-TH-231	7863	250	0.05	INELASTIC-TOTAL	481.6	2431.	2425.	2448.
90-TH-231	7863	149	5.1	(N,2N)	99.26	78.17	59.40	60.86
90-TH-231	7863	640		FISSION	8915.	203.5	202.2	203.1
90-TH-231	7863	640		(N,GAMMA)	47812.	95.84	101.0	98.58
90-TH-231	7863	640		251	190.0	638.2	627.7	633.2
90-TH-232	7864	640		TOTAL	19251.	7417.	7456.	7426.
90-TH-232	7864	640		ELASTIC	13258.	4996.	5078.	5018.
90-TH-232	7864	250	0.05	INELASTIC-TOTAL	495.8	2219.	2186.	2216.
90-TH-232	7864	135	6.5	(N,2N)	77.19	24.20	16.07	16.72

Table A7 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-232	7864	190	1.0	FISSION	36.75	81.17	75.18	77.91
90-TH-232	7864	640		(N,GAMMA)	5357.	95.94	100.6	98.20
90-TH-232	7864	640		251	142.6	517.0	500.5	511.1
90-TH-233	7865	640		TOTAL	39727.	7184.	7249.	7199.
90-TH-233	7865	640		ELASTIC	10454.	4449.	4534.	4462.
90-TH-233	7865	250	0.05	INELASTIC-TOTAL	479.2	2416.	2414.	2436.
90-TH-233	7865	152	4.8	(N,2N)	101.4	94.77	73.62	75.39
90-TH-233	7865	640		FISSION	4793.	127.3	127.2	127.1
90-TH-233	7865	640		(N,GAMMA)	23866.	95.68	100.9	98.38
90-TH-233	7865	640		251	198.6	640.0	629.9	635.2
92-U -233	7866	640		TOTAL	60525.	7214.	7235.	7219.
92-U -233	7866	640		ELASTIC	9508.	4197.	4239.	4207.
92-U -233	7866	235	0.1	INELASTIC-TOTAL	199.7	1053.	1022.	1047.
92-U -233	7866	140	6.0	(N,2N)	28.80	7.621	5.058	5.256
92-U -233	7866	640		FISSION	43133.	1896.	1904.	1899.
92-U -233	7866	640		(N,GAMMA)	7650.	60.44	64.36	61.46
92-U -233	7866	640		251	160.6	546.1	530.3	539.7
92-U -234	7867	640		TOTAL	16045.	7588.	7615.	7594.
92-U -234	7867	640		ELASTIC	10066.	5044.	5119.	5056.
92-U -234	7867	253	0.04	INELASTIC-TOTAL	222.9	1168.	1144.	1167.
92-U -234	7867	132	6.8	(N,2N)	27.42	9.320	6.143	6.403
92-U -234	7867	235	0.1	FISSION	340.4	1230.	1202.	1224.
92-U -234	7867	640		(N,GAMMA)	5379.	136.6	143.9	140.2
92-U -234	7867	640		251	155.1	523.0	508.7	517.3
92-U -235	7868	640		TOTAL	34776.	7534.	7568.	7546.
92-U -235	7868	640		ELASTIC	10183.	4613.	4661.	4624.
92-U -235	7868	267	0.02	INELASTIC-TOTAL	362.0	1582.	1566.	1584.
92-U -235	7868	148	5.2	(N,2N)	33.07	15.54	10.93	11.31
92-U -235	7868	640		FISSION	16219.	1232.	1232.	1232.
92-U -235	7868	640		(N,GAMMA)	7974.	91.46	97.63	94.00
92-U -235	7868	640		251	155.1	523.0	508.7	517.3
92-U -236	7869	640		TOTAL	58315.	7611.	7639.	7615.
92-U -236	7869	640		ELASTIC	10073.	5055.	5130.	5066.
92-U -236	7869	250	0.05	INELASTIC-TOTAL	348.3	1782.	1760.	1787.
92-U -236	7869	135	6.5	(N,2N)	43.45	19.01	12.94	13.47
92-U -236	7869	640		FISSION	331.3	586.7	560.1	576.6
92-U -236	7869	640		(N,GAMMA)	47502.	168.2	176.3	172.3
92-U -236	7869	640		251	155.0	522.9	508.7	517.3
92-U -237	7870	640		TOTAL	37746.	7524.	7570.	7524.
92-U -237	7870	640		ELASTIC	10390.	4658.	4717.	4662.
92-U -237	7870	267	0.02	INELASTIC-TOTAL	492.5	2075.	2061.	2081.
92-U -237	7870	149	5.1	(N,2N)	54.37	32.19	23.04	23.81
92-U -237	7870	640		FISSION	5453.	655.9	658.9	651.9
92-U -237	7870	640		(N,GAMMA)	21335.	103.0	110.3	106.1
92-U -237	7870	640		251	160.1	541.0	525.3	534.5
92-U -238	7871	640		TOTAL	34194.	7781.	7828.	7794.

Table A7 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
92-U -238	7871	640		ELASTIC	17779.	4834.	4919.	4853.
92-U -238	7871	252	0.04	INELASTIC-TOTAL	575.0	2527.	2512.	2535.
92-U -238	7871	140	6.0	(N,2N)	61.35	23.65	15.96	16.60
92-U -238	7871	207	0.4	FISSION	117.5	321.7	302.2	313.1
92-U -238	7871	640		(N,GAMMA)	15643.	74.85	78.79	76.92
92-U -238	7871	640		251	165.2	554.5	540.9	549.1
92-U -239	7872	640		TOTAL	35020.	7756.	7799.	7756.
92-U -239	7872	640		ELASTIC	10390.	4665.	4723.	4668.
92-U -239	7872	250	0.05	INELASTIC-TOTAL	512.6	2422.	2418.	2436.
92-U -239	7872	152	4.8	(N,2N)	86.33	84.85	65.09	66.75
92-U -239	7872	640		FISSION	15068.	527.9	532.9	527.2
92-U -239	7872	640		(N,GAMMA)	8926.	55.66	60.15	57.75
92-U -239	7872	640		251	160.0	540.7	525.1	534.3
92-U -240	7873	640		TOTAL	19430.	7690.	7720.	7700.
92-U -240	7873	640		ELASTIC	8770.	5367.	5452.	5387.
92-U -240	7873	280	0.01	INELASTIC-TOTAL	375.0	1953.	1924.	1961.
92-U -240	7873	141	5.9	(N,2N)	70.78	45.76	32.94	34.03
92-U -240	7873	190	1.0	FISSION	92.21	242.3	226.7	235.1
92-U -240	7873	640		(N,GAMMA)	10083.	80.95	84.16	82.83
92-U -240	7873	640		251	155.0	522.9	508.7	517.3
93-NP-235	8307	640		TOTAL	34173.	7653.	7688.	7663.
93-NP-235	8307	640		ELASTIC	9956.	4802.	4884.	4819.
93-NP-235	8307	257	0.03	INELASTIC-TOTAL	371.9	1518.	1502.	1518.
93-NP-235	8307	130	7.0	(N,2N)	27.45	6.339	4.018	4.189
93-NP-235	8307	640		FISSION	427.3	1303.	1275.	1299.
93-NP-235	8307	640		(N,GAMMA)	23375.	22.38	23.58	22.95
93-NP-235	8307	640		251	159.7	538.2	522.6	531.7
93-NP-236	8308	640		TOTAL	110709.	7930.	8005.	7951.
93-NP-236	8308	640		ELASTIC	10517.	4803.	4885.	4819.
93-NP-236	8308	257	0.03	INELASTIC-TOTAL	196.3	1016.	991.5	1015.
93-NP-236	8308	143	5.7	(N,2N)	30.36	16.96	12.25	12.64
93-NP-236	8308	640		FISSION	96715.	2062.	2082.	2070.
93-NP-236	8308	640		(N,GAMMA)	3244.	32.85	34.02	33.35
93-NP-236	8308	640		251	159.7	538.2	522.6	531.7
93-NP-237	7874	640		TOTAL	46319.	7798.	7846.	7812.
93-NP-237	7874	640		ELASTIC	11679.	4803.	4885.	4819.
93-NP-237	7874	257	0.03	INELASTIC-TOTAL	371.9	1518.	1502.	1518.
93-NP-237	7874	135	6.5	(N,2N)	27.47	6.364	4.037	4.209
93-NP-237	7874	640		FISSION	427.3	1303.	1275.	1299.
93-NP-237	7874	640		(N,GAMMA)	33796.	166.5	181.1	172.0
93-NP-237	7874	640		251	159.7	538.2	522.6	531.7
93-NP-238	8309	640		TOTAL	93574.	7798.	7860.	7814.
93-NP-238	8309	640		ELASTIC	10517.	4803.	4885.	4819.
93-NP-238	8309	257	0.03	INELASTIC-TOTAL	284.9	1468.	1436.	1469.
93-NP-238	8309	145	5.5	(N,2N)	50.53	20.51	14.49	14.96
93-NP-238	8309	640		FISSION	79465.	1474.	1491.	1478.
93-NP-238	8309	640		(N,GAMMA)	3244.	32.85	34.02	33.35

Table A7 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
93-NP-238	8309	640		251	159.6	538.2	522.6	531.7
94-PU-238	7875	640		TOTAL	25483.	7761.	7821.	7775.
94-PU-238	7875	640		ELASTIC	14754.	4642.	4720.	4655.
94-PU-238	7875	250	0.05	INELASTIC-TOTAL	212.8	959.7	958.8	961.7
94-PU-238	7875	130	7.0	(N,2N)	11.05	2.285	1.407	1.468
94-PU-238	7875	640		FISSION	1840.	2047.	2027.	2044.
94-PU-238	7875	640		(N,GAMMA)	8664.	110.3	114.7	112.5
94-PU-238	7875	640		251	160.1	543.0	527.3	536.7
94-PU-239	7876	640		TOTAL	41214.	7732.	7774.	7743.
94-PU-239	7876	640		ELASTIC	11667.	4710.	4777.	4721.
94-PU-239	7876	248	0.05	INELASTIC-TOTAL	236.8	1193.	1173.	1195.
94-PU-239	7876	144	5.6	(N,2N)	18.39	7.205	4.936	5.125
94-PU-239	7876	640		FISSION	17539.	1781.	1774.	1780.
94-PU-239	7876	640		(N,GAMMA)	11750.	41.53	44.88	42.65
94-PU-239	7876	640		251	155.0	522.9	508.7	517.3
94-PU-240	7877	640		TOTAL	532512.	7442.	7490.	7455.
94-PU-240	7877	640		ELASTIC	55814.	4402.	4480.	4414.
94-PU-240	7877	252	0.04	INELASTIC-TOTAL	373.2	1533.	1533.	1538.
94-PU-240	7877	134	6.6	(N,2N)	12.09	5.228	3.581	3.718
94-PU-240	7877	640		FISSION	572.9	1413.	1381.	1407.
94-PU-240	7877	640		(N,GAMMA)	475740.	88.92	92.80	91.03
94-PU-240	7877	640		251	155.0	522.9	508.7	517.3
94-PU-241	7878	640		TOTAL	55040.	8102.	8167.	8123.
94-PU-241	7878	640		ELASTIC	8585.	4826.	4891.	4839.
94-PU-241	7878	250	0.05	INELASTIC-TOTAL	296.6	1524.	1524.	1537.
94-PU-241	7878	147	5.3	(N,2N)	46.34	45.32	34.68	35.50
94-PU-241	7878	640		FISSION	33195.	1593.	1597.	1595.
94-PU-241	7878	640		(N,GAMMA)	12901.	113.5	120.8	115.8
94-PU-241	7878	640		251	154.9	522.9	508.7	517.3
94-PU-242	7880	640		TOTAL	104600.	7912.	7966.	7928.
94-PU-242	7880	640		ELASTIC	26917.	4880.	4965.	4895.
94-PU-242	7880	252	0.04	INELASTIC-TOTAL	427.3	1814.	1808.	1819.
94-PU-242	7880	137	6.3	(N,2N)	27.12	10.52	7.082	7.371
94-PU-242	7880	640		FISSION	2298.	1126.	1100.	1122.
94-PU-242	7880	640		(N,GAMMA)	74917.	81.48	85.39	83.45
94-PU-242	7880	640		251	174.0	594.9	581.5	590.0
94-PU-243	7881	640		TOTAL	57671.	7804.	7869.	7821.
94-PU-243	7881	640		ELASTIC	11998.	4585.	4672.	4597.
94-PU-243	7881	246	0.06	INELASTIC-TOTAL	397.6	2032.	2041.	2053.
94-PU-243	7881	150	5.0	(N,2N)	64.38	67.64	52.43	53.66
94-PU-243	7881	640		FISSION	29300.	1076.	1058.	1075.
94-PU-243	7881	640		(N,GAMMA)	15886.	41.48	44.79	42.56
94-PU-243	7881	640		251	173.9	594.6	581.2	589.7
95-AM-241	7882	640		TOTAL	107029.	7615.	7657.	7625.
95-AM-241	7882	640		ELASTIC	10130.	4732.	4799.	4741.
95-AM-241	7882	250	0.05	INELASTIC-TOTAL	246.4	1192.	1200.	1201.
95-AM-241	7882	141	5.9	(N,2N)	15.83	15.87	12.14	12.43

Table A7 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
95-AM-241	7882	640		FISSION	949.6	1500.	1454.	1491.
95-AM-241	7882	640		(N,GAMMA)	86115.	157.4	172.5	161.5
95-AM-241	7882	640		251	177.8	629.1	617.6	624.2
95-AM-242	7883	640		TOTAL	107508.	7547.	7624.	7552.
95-AM-242	7883	640		ELASTIC	9791.	4531.	4610.	4534.
95-AM-242	7883	235	0.1	INELASTIC-TOTAL	207.4	1068.	1060.	1073.
95-AM-242	7883	144	5.6	(N,2N)	27.29	27.56	20.97	21.50
95-AM-242	7883	640		FISSION	88081.	1825.	1833.	1826.
95-AM-242	7883	640		(N,GAMMA)	9393.	95.43	100.5	98.05
95-AM-242	7883	640		251	169.3	596.7	583.0	592.1
95-AM-243	7884	640		TOTAL	122480.	7667.	7722.	7684.
95-AM-243	7884	640		ELASTIC	17468.	4589.	4677.	4601.
95-AM-243	7884	240	0.08	INELASTIC-TOTAL	360.9	1888.	1893.	1904.
95-AM-243	7884	136	6.4	(N,2N)	46.40	25.57	17.77	18.45
95-AM-243	7884	640		FISSION	515.2	1123.	1090.	1118.
95-AM-243	7884	640		(N,GAMMA)	104069.	41.52	44.85	42.61
95-AM-243	7884	640		251	174.1	595.3	581.9	590.5
96-CM-242	7885	640		TOTAL	36383.	7707.	7766.	7735.
96-CM-242	7885	640		ELASTIC	24546.	4537.	4624.	4561.
96-CM-242	7885	252	0.04	INELASTIC-TOTAL	338.4	1627.	1625.	1634.
96-CM-242	7885	130	7.0	(N,2N)	35.02	14.64	9.765	10.18
96-CM-242	7885	640		FISSION	2064.	1433.	1407.	1432.
96-CM-242	7885	640		(N,GAMMA)	9393.	95.43	100.5	98.05
96-CM-242	7885	640		251	169.3	596.7	583.0	592.1
96-CM-243	7886	640		TOTAL	63824.	8258.	8363.	8276.
96-CM-243	7886	640		ELASTIC	11998.	4585.	4672.	4597.
96-CM-243	7886	246	0.06	INELASTIC-TOTAL	434.4	1608.	1630.	1617.
96-CM-243	7886	143	5.7	(N,2N)	40.49	26.73	19.65	20.21
96-CM-243	7886	640		FISSION	44405.	1996.	1997.	2000.
96-CM-243	7886	640		(N,GAMMA)	6937.	41.00	44.30	42.11
96-CM-243	7886	640		251	173.9	594.6	581.2	589.7
96-CM-244	7887	640		TOTAL	61576.	7654.	7710.	7680.
96-CM-244	7887	640		ELASTIC	24547.	4537.	4624.	4561.
96-CM-244	7887	252	0.04	INELASTIC-TOTAL	343.4	1661.	1658.	1669.
96-CM-244	7887	132	6.8	(N,2N)	34.71	15.06	10.09	10.51
96-CM-244	7887	640		FISSION	1990.	1399.	1372.	1397.
96-CM-244	7887	640		(N,GAMMA)	34653.	41.88	45.29	43.07
96-CM-244	7887	640		251	174.2	595.6	582.2	590.8
96-CM-245	7888	640		TOTAL	65504.	7964.	8063.	7981.
96-CM-245	7888	640		ELASTIC	10533.	4653.	4740.	4668.
96-CM-245	7888	246	0.06	INELASTIC-TOTAL	398.5	1519.	1534.	1527.
96-CM-245	7888	144	5.6	(N,2N)	40.46	27.46	20.26	20.83
96-CM-245	7888	640		FISSION	47585.	1723.	1724.	1723.
96-CM-245	7888	640		(N,GAMMA)	6937.	41.00	44.30	42.11
96-CM-245	7888	640		251	156.9	568.8	553.5	564.3
96-CM-246	7889	640		TOTAL	23798.	7622.	7669.	7641.
96-CM-246	7889	640		ELASTIC	15054.	4510.	4588.	4527.

Table A7 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
96-CM-246	7889	253	0.04	INELASTIC-TOTAL	349.8	1701.	1706.	1712.
96-CM-246	7889	136	6.4	(N,2N)	44.65	23.55	16.31	16.94
96-CM-246	7889	640		FISSION	436.8	1346.	1313.	1343.
96-CM-246	7889	640		(N,GAMMA)	7892.	41.51	44.83	42.59
96-CM-246	7889	640		251	174.1	595.0	581.6	590.1
96-CM-247	7890	640		TOTAL	85968.	7912.	7988.	7935.
96-CM-247	7890	640		ELASTIC	12387.	4541.	4622.	4559.
96-CM-247	7890	250	0.05	INELASTIC-TOTAL	237.4	1224.	1229.	1236.
96-CM-247	7890	149	5.1	(N,2N)	40.41	41.05	31.66	32.38
96-CM-247	7890	640		FISSION	52499.	2066.	2062.	2065.
96-CM-247	7890	640		(N,GAMMA)	20790.	40.85	44.23	41.97
96-CM-247	7890	640		251	174.2	595.6	582.2	590.7
96-CM-248	7891	640		TOTAL	44743.	7633.	7672.	7653.
96-CM-248	7891	640		ELASTIC	27331.	4522.	4598.	4536.
96-CM-248	7891	252	0.04	INELASTIC-TOTAL	321.1	1668.	1663.	1679.
96-CM-248	7891	138	6.2	(N,2N)	44.73	25.59	17.94	18.61
96-CM-248	7891	640		FISSION	887.7	1342.	1313.	1341.
96-CM-248	7891	640		(N,GAMMA)	16135.	74.85	78.81	76.93
96-CM-248	7891	640		251	173.9	594.4	581.0	589.5
97-BK-249	7892	640		TOTAL	244189.	7629.	7667.	7644.
97-BK-249	7892	640		ELASTIC	18588.	4521.	4598.	4536.
97-BK-249	7892	250	0.05	INELASTIC-TOTAL	420.8	2115.	2114.	2129.
97-BK-249	7892	138	6.2	(N,2N)	59.65	29.36	20.31	21.09
97-BK-249	7892	640		FISSION	280.0	888.6	856.4	881.0
97-BK-249	7892	640		(N,GAMMA)	224811.	74.90	78.86	76.99
97-BK-249	7892	640		251	174.0	594.8	581.4	589.9
98-CF-249	7893	640		TOTAL	156123.	7858.	7924.	7877.
98-CF-249	7893	640		ELASTIC	13668.	4522.	4599.	4537.
98-CF-249	7893	252	0.04	INELASTIC-TOTAL	285.3	1509.	1511.	1523.
98-CF-249	7893	144	5.6	(N,2N)	43.29	29.54	21.58	22.22
98-CF-249	7893	640		FISSION	126894.	1721.	1714.	1718.
98-CF-249	7893	640		(N,GAMMA)	15219.	74.89	78.85	76.98
98-CF-249	7893	640		251	174.0	594.8	581.4	589.9
98-CF-250	7894	640		TOTAL	896267.	8023.	8090.	8039.
98-CF-250	7894	640		ELASTIC	60279.	4522.	4599.	4537.
98-CF-250	7894	252	0.04	INELASTIC-TOTAL	293.8	1432.	1434.	1440.
98-CF-250	7894	134	6.6	(N,2N)	34.30	15.55	10.57	10.99
98-CF-250	7894	640		FISSION	667.7	1978.	1968.	1974.
98-CF-250	7894	640		(N,GAMMA)	834966.	74.93	78.90	77.03
98-CF-250	7894	640		251	174.1	595.1	581.8	590.3
98-CF-251	7895	640		TOTAL	257344.	7862.	7929.	7881.
98-CF-251	7895	640		ELASTIC	19777.	4522.	4599.	4537.

Table A7 (cont.)

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
98-CF-251	7895	263	0.02	INELASTIC-TOTAL	281.4	1495.	1500.	1511.
98-CF-251	7895	149	5.1	(N,2N)	50.67	48.38	37.07	37.96
98-CF-251	7895	640		FISSION	99643.	1721.	1715.	1718.
98-CF-251	7895	640		(N,GAMMA)	137576.	74.92	78.89	77.02
98-CF-251	7895	640		251	174.1	594.8	581.5	589.9
98-CF-252	7896	640		TOTAL	25906.	7782.	7844.	7813.
98-CF-252	7896	640		ELASTIC	16315.	4640.	4731.	4667.
98-CF-252	7896	250	0.05	INELASTIC-TOTAL	251.2	1169.	1179.	1178.
98-CF-252	7896	138	6.2	(N,2N)	22.26	11.86	8.362	8.660
98-CF-252	7896	640		FISSION	6455.	1922.	1883.	1919.
98-CF-252	7896	640		(N,GAMMA)	2854.	39.76	42.84	40.79
98-CF-252	7896	640		251	159.4	575.9	560.8	571.3

Table A8: Spectra averages (millibarns) from ENDF/B-4 library

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-232	1296	620		TOTAL	17807.	7240.	7266.	7250.
90-TH-232	1296	168	1.2	FISSION	30.80	74.43	69.00	71.54
90-TH-232	1296	620		(N,GAMMA)	4877.	98.39	103.3	100.6
91-PA-233	1297	620		TOTAL	58857.	7294.	7333.	7304.
91-PA-233	1297	186	0.5	FISSION	158.6	479.8	451.7	468.1
91-PA-233	1297	620		(N,GAMMA)	48975.	178.6	188.2	183.9
92-U -233	1260	620		TOTAL	60998.	7254.	7281.	7262.
92-U -233	1260	620		FISSION	43542.	1833.	1841.	1836.
92-U -233	1260	620		(N,GAMMA)	7693.	60.86	64.23	61.75
92-U -234	1043	620		TOTAL	56243.	8437.	8495.	8459.
92-U -234	1043	299	0.001	FISSION	306.3	1157.	1132.	1152.
92-U -234	1043	620		(N,GAMMA)	36425.	170.4	178.7	174.4
92-U -235	1261	620		TOTAL	34396.	7607.	7642.	7617.
92-U -235	1261	620		FISSION	16165.	1241.	1241.	1241.
92-U -235	1261	620		(N,GAMMA)	7915.	95.82	101.6	98.16
92-U -236	1163	620		TOTAL	36311.	8015.	8074.	8033.
92-U -236	1163	181	0.6	FISSION	185.5	587.5	560.6	577.2
92-U -236	1163	620		(N,GAMMA)	19997.	170.2	178.6	174.2
92-U -238	1262	620		TOTAL	34813.	7796.	7842.	7809.
92-U -238	1262	440	0.10E-05	FISSION	109.4	315.4	295.8	306.6
92-U -238	1262	620		(N,GAMMA)	15830.	71.36	75.07	73.34
93-NP-237	1263	620		TOTAL	47914.	7636.	7670.	7648.
93-NP-237	1263	620		FISSION	374.8	1351.	1320.	1345.
93-NP-237	1263	620		(N,GAMMA)	36579.	162.9	176.6	167.8
94-PU-238	1050	620		TOTAL	24865.	7509.	7559.	7526.
94-PU-238	1050	620		FISSION	1748.	2078.	2045.	2068.
94-PU-238	1050	620		(N,GAMMA)	8258.	41.00	43.64	42.09
94-PU-239	1264	620		TOTAL	38770.	7719.	7753.	7730.
94-PU-239	1264	620		FISSION	17346.	1789.	1781.	1787.
94-PU-239	1264	620		(N,GAMMA)	11105.	39.76	43.45	40.89
94-PU-240	1265	620		TOTAL	536677.	7580.	7623.	7595.
94-PU-240	1265	620		FISSION	532.3	1336.	1309.	1334.
94-PU-240	1265	620		(N,GAMMA)	482029.	82.11	86.78	84.23
94-PU-241	1266	620		TOTAL	51100.	8188.	8261.	8209.
94-PU-241	1266	620		FISSION	33502.	1650.	1650.	1651.
94-PU-241	1266	620		(N,GAMMA)	7188.	107.3	111.3	109.4
94-PU-242	1161	620		TOTAL	87084.	7523.	7565.	7539.
94-PU-242	1161	260	0.01	FISSION	321.8	1234.	1198.	1224.
94-PU-242	1161	620		(N,GAMMA)	65105.	55.41	58.51	56.75
95-AM-241	1056	620		TOTAL	105538.	8259.	8258.	8261.
95-AM-241	1056	620		FISSION	776.8	1277.	1230.	1263.
95-AM-241	1056	620		(N,GAMMA)	93768.	61.90	68.27	64.98
95-AM-243	1057	620		TOTAL	89043.	7988.	8002.	7998.
95-AM-243	1057	260	0.01	FISSION	240.7	1023.	992.8	1019.
95-AM-243	1057	620		(N,GAMMA)	77800.	61.75	67.52	63.65
96-CM-244	1162	620		TOTAL	58304.	7632.	7672.	7651.
96-CM-244	1162	620		FISSION	2528.	1755.	1710.	1743.
96-CM-244	1162	620		(N,GAMMA)	33588.	64.87	68.27	66.32

Table A9: Spectra averages (millibarns) Actinides from ENDF/B-V Actinides

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
91-PA-233	1391	620		TOTAL	58857.	7294.	7334.	7304.
91-PA-233	1391	186	0.5	FISSION	158.6	479.8	451.7	468.1
91-PA-233	1391	620		(N,GAMMA)	48975.	178.6	188.2	183.9
92-U -234	1394	620		TOTAL	53521.	8499.	8553.	8518.
92-U -234	1394	620		FISSION	360.8	1232.	1205.	1226.
92-U -234	1394	620		(N,GAMMA)	37882.	170.5	178.9	174.5
92-U -236	1396	620		TOTAL	37171.	8071.	8139.	8096.
92-U -236	1396	620		FISSION	435.0	599.2	573.2	590.0
92-U -236	1396	620		(N,GAMMA)	20013.	170.2	178.5	174.2
93-NP-237	1337	620		TOTAL	47929.	7765.	7807.	7782.
93-NP-237	1337	620		FISSION	376.3	1352.	1322.	1347.
93-NP-237	1337	620		(N,GAMMA)	36579.	162.7	176.5	167.7
94-PU-238	1338	620		TOTAL	25979.	7575.	7616.	7588.
94-PU-238	1338	620		FISSION	1741.	1983.	1956.	1976.
94-PU-238	1338	620		(N,GAMMA)	8769.	142.3	150.6	145.6
94-PU-242	1342	620		TOTAL	96275.	7934.	7988.	7945.
94-PU-242	1342	620		FISSION	304.8	1129.	1103.	1125.
94-PU-242	1342	620		(N,GAMMA)	73584.	70.40	74.85	72.55
95-AM-241	1361	620		TOTAL	93139.	7977.	8013.	7987.
95-AM-241	1361	620		FISSION	752.5	1474.	1429.	1465.
95-AM-241	1361	620		(N,GAMMA)	81358.	254.2	273.5	260.2
95-AM-242	1369	620		TOTAL	134932.	7040.	7074.	7029.
95-AM-242	1369	620		FISSION	108640.	2214.	2222.	2217.
95-AM-242	1369	620		(N,GAMMA)	16542.	18.68	20.40	19.62
95-AM-243	1363	620		TOTAL	116277.	7926.	7987.	7944.
95-AM-243	1363	333	0.24E-03	FISSION	336.4	1205.	1164.	1193.
95-AM-243	1363	620		(N,GAMMA)	103890.	73.00	79.69	76.20
96-CM-243	1343	620		TOTAL	137192.	8219.	8282.	8232.
96-CM-243	1343	620		FISSION	112280.	2073.	2075.	2081.
96-CM-243	1343	620		(N,GAMMA)	14331.	14.77	16.24	15.50
96-CM-244	1344	620		TOTAL	54792.	7528.	7578.	7538.
96-CM-244	1344	620		FISSION	1046.	1614.	1578.	1607.
96-CM-244	1344	620		(N,GAMMA)	33621.	119.3	128.4	122.8
96-CM-245	1345	620		TOTAL	63454.	8218.	8317.	8237.
96-CM-245	1345	620		FISSION	47593.	1978.	1978.	1980.
96-CM-245	1345	620		(N,GAMMA)	6716.	40.74	43.97	41.77
96-CM-246	1346	620		TOTAL	18025.	7768.	7828.	7778.
96-CM-246	1346	620		FISSION	579.6	1386.	1345.	1378.
96-CM-246	1346	620		(N,GAMMA)	5898.	42.19	44.83	43.28

Table A10: Spectra averages (millibarns) Actinides from ENDF/B-V Dos MOD-2

SPECTRA	1/E spect. .5 eV cut.	Cf-252 fiss (NBS)	U-235 fiss (NBS)	U-235 f (ENDF/B
NUMBER OF GROUPS	475	620	620	620
SPECTRA ENERGY RANGE IS FROM	5.0000- 7	1.0000-10	1.0000-10	1.0000-10
TO (MEV)	20.0	18.0	18.0	18.0
SPECTRA AVERAGED ENERGY (MEV)	1.1426	2.1194	1.9771	2.0313
STANDARD DEVIATION (MEV)	3.1813	1.7141	1.5931	1.5967

ISOTOPE	MAT	GROUPS	THRESHOLD (MEV)	REACTION	SPECTRA AVERAGES (MILLIBARNS)			
90-TH-232	6390	205	0.5	FISSION	35.31	78.07	72.40	75.04
90-TH-232	6390	640		(N,GAMMA)	4909.	89.69	94.24	91.97
92-U -235	6395	640		FISSION	16095.	1236.	1236.	1236.
92-U -238	6398	640		FISSION	116.1	313.6	294.6	305.2
92-U -238	6398	640		(N,GAMMA)	15956.	68.34	72.06	70.25
93-NP-237	6337	640		FISSION	392.5	1352.	1322.	1347.
94-PU-239	6399	640		FISSION	17365.	1792.	1786.	1791.