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STATUS OF PSEUDO-FISSION-PRODUCT CROSS-SECTIONS FOR FAST REACTORS

A report by the Working Party
on International Evaluation Co-operation
of the NEA Nuclear Science Committee

CO-ORDINATOR AND MONITOR

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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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FOREWORD

A Working Party on International Evaluation Co-operation was established under the sponsorship of the OECD/NEA Nuclear Science Committee (NSC) to promote the exchange of information on nuclear data evaluations, validation, and related topics. Its aim is also to provide a framework for co-operative activities between members of the major nuclear data evaluation projects. This includes the possible exchange of scientists in order to encourage co-operation. Requirements for experimental data resulting from this activity are compiled. The working party determines common criteria for evaluated nuclear data files with a view to assessing and improving the quality and completeness of evaluated data.

The parties to the project are: ENDF (United States), JEF/EFF (NEA Data Bank Member countries) and JENDL (Japan). Co-operation with evaluation projects of non-OECD countries, specifically the Russian BROND and Chinese CENDL projects, are organised through the Nuclear Data Section of the International Atomic Energy Agency (IAEA).

Subgroup 17 of the working party was initiated with the objective to assess the status and uncertainties of fission-product cross-section data files for fast reactor calculations. In addition it would pursue the analysis of the relevant integral experiments and take into account indications from these experiments. The possibility to recommend a unique evaluated fission-product data file would be examined.

The opinions expressed in this report are those of the authors only and do not necessarily represent the position of any Member country or international organisation. This report is published on the responsibility of the Secretary-General of the OECD.

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SUMMARY

Within the framework of the SG17 benchmark organised by a Working Party of the Nuclear Science Committee of the Nuclear Energy Agency, a comparison of lumped or pseudo-fission-product cross-sections for fast reactors has been made. Four institutions participated with data libraries based on the JEF-2.2, EAF-4.2, BROND-2, FONDL-2.1, ADL-3 and JENDL-3.2 evaluated nuclear data files.

Several parameters have been compared with each other: the one group cross-sections and reactivity worths of the lumped nuclide for several partial absorption and scattering cross-sections, and the one group cross-sections of the individual fission-products. Graphs of the multi-group cross-sections of the lumped nuclide have also been compared, as well as graphs of capture cross-sections for 27 nuclides.

From two contributions based on JEF-2.2, it can be concluded that the data processing influences the capture cross-section by about 1% and the inelastic scattering cross-section by 2%. The differences between the lumped cross-sections of the different data libraries are surprisingly small: maximum 6% for capture and 9% for the inelastic scattering. Similar results are obtained for the reactivity effects. Since the reactivity worth of the lumped nuclide is dominated by the capture reaction, the maximum spread in the total reactivity worth is still only 5.3%.

There is a systematic difference between total, elastic and capture cross-sections of JENDL-3.2 and JEF-2.2 of the same order of magnitude. Possible reasons for this discrepancy have been indicated.

The one group capture and inelastic scattering cross-sections of most of the important individual fission-products differ by less than 10% (root mean square values). Larger differences are observed for unstable nuclides where there is a lack of experimental data. For the (n,2n) group cross-sections, which are rather sensitive to the weighting spectrum in the fast energy range, these differences are several tens of per cents.

The final conclusion is that the present status of lumped nuclide cross-sections for fast reactors is satisfactory, although improvements are possible as indicated in this report.

STATUS OF PSEUDO-FISSION-PRODUCT CROSS-SECTIONS FOR FAST REACTORS

1. Introduction

This report summarises the results of the Subgroup 17 (SG17) of the Working Party on Evaluation Co-ordination (WPEC) of the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) in Paris. The objective of SG17 was to investigate the status of fission-product cross-section evaluations for fast reactor applications by means of comparison of the lumped fission-product effects in fast power reactors. The definition of the activities of the subgroup was established at the May 1995 meeting of the WPEC in Paris. The background was that for future development of fast power reactors with extended burn-up the reactivity effect of fission-products need to be known preferably with an uncertainty of about 5% (1 σ).

An uncertainty of 5% in the reactivity effect is a rather small uncertainty compared to the actual uncertainty in the cross-sections (averaged over a fast-reactor flux spectrum) of the individual fission-products. However, since the reactivity effect is composed of a very large number of contributions of individual fission-products, cancellation of errors may occur, leading to a reduced uncertainty in the lumped effect. This could be true for statistical errors, but not for errors of systematic nature. Since for the bulk of the fission-products there are only few experimental data available in the fast energy range, most evaluated data rely heavily on calculations, with adjustments to available differential or in some cases integral data. For the radiative capture cross-sections the Hauser-Feshbach theory with width-fluctuation correction is used in all evaluations; a small systematic error could result from different formalisms used for the width fluctuation correction and global (optical model) parametrisations. However, in general local systematics were used for the parametrisation, reducing the effects of systematic errors. Also from experimental data adjustment a small systematic error could result. A rather small contribution results for (n,p) and (n,α) reactions. It is believed that altogether the systematic uncertainty in the lumped capture effect is below 5%.

Another component of the reactivity effect of fast power reactors is due to elastic and particularly inelastic scattering. In this case the non-negligible contributions (about 10%) to the total reactivity effect result from inelastic scattering mainly from excitation of the lowest levels. Here only few measurements exist and the evaluations are in general based upon Hauser-Feshbach theory with width fluctuation correction. There has been some concern that in the evaluations for most nuclides a spherical optical model was used and that direct excitation was neglected (exceptions for JENDL-3.2). Since it is known that for many nuclides in the fission-product mass range direct excitation cannot be neglected at high energies, it was also expected that at lower energies some effect could be seen. Early γ-ray measurements of (n,n') reactions and integral reactivity measurements also indicated that the current evaluations were in general too low at low energies. Another subgroup (SG10) deals with these questions and new measurements were made, e.g. for Pd and Mo isotopes. Meanwhile, it is clear that in the early evaluations of some fission-products the cross-sections for the excitation of low-lying states were too low. However the neglect of direct-collective effects was not the reason for the too low values at low energies; this was merely due to the optical-model parametrisation. A coupled channels optical model generally showed the best results. At higher energies these effects however are important. The expectation was that altogether the *uncertainty* in the lumped inelastic scattering reactivity effect could be larger than the corresponding capture effect. A figure of 30% would not be surprising.

A comparison of lumped fission-product capture cross-sections based upon different nuclear data libraries should reveal a spread in the data from which perhaps some conclusions could be drawn about the uncertainty and about the possible need to enhance evaluation efforts. An important condition is that the different libraries are independent. This is not completely true, since the same basic methodology and often the same experimental data were used. Also in some cases data for one library were adopted in another library. However there are some notable differences between the evaluations. First of all, different evaluators have used different parametrisations and in some evaluations more recent data have been used than in others. As an example, the JEF-2.2 fission-product file has been adjusted to integral data, the JENDL-3 data file has undergone extensive re-evaluation with recent data. The BROND-2 file is another source of independent data. Furthermore, new activation files like EAF-4.2 and ADL-3 have been issued recently with emphasis on radiative capture and other charged-particle emission reaction cross-sections. These new activation files are very complete, since they contain virtually all fission-product cross-sections. Altogether it is believed that the outcome of an comparison could yield valuable indications with regard to the status of and uncertainty of the lumped fission-product effect in fast reactors.

Therefore, a computational benchmark was defined where participants were asked to calculate pseudo-fission-product cross-sections, using their own multi-group structure and given concentrations for the fissile nuclide ^{239}Pu. A micro flux weighting spectrum, typical for a fast power reactor has been supplied pointwise, but it was not strictly necessary to use it for the generation of multi-group constants, to avoid large amounts of work. The participant could also use its own library with a probably different weighting spectrum. However, the weighting spectrum was obligatory for the condensation to one group cross-sections. In a later phase also a pointwise adjoint flux spectrum was specified to allow for reactivity worth calculations. The results requested were: multi-group pseudo-cross-sections, one group pseudo-cross-sections and reactivity worths, mainly for capture and inelastic scattering. For further interpretation also the one group cross-sections of the individual fission-products were requested. All data necessary to perform the benchmark are included in this report. Almost all results are reproduced.

2. Benchmark description

The lumped or pseudo-fission-product nuclide accounts for the neutron absorption and scattering of all the individual fission-products present in the spent fuel due to the fissioning of one actinide atom. The effective yields of the individual fission-products are given in Appendix A for five different actinide atoms. In the benchmark, the yields of ^{239}Pu were used to calculate the cross-sections of the lumped nuclide according to:

$$\sigma^x = \sum_{n=1}^{N} \gamma_n \sigma_n^x \qquad (2.1)$$

where γ_n is the effective yield or concentration of fission-product n and σ_x^n is the one group microscopic cross-section of that fission-product for reaction type x. The yields of all the fission-products specified in Appendix A sum to 2. If the contributions of some fission-products are omitted from the sum in Eq. 2.1, e.g. due to lack of cross-sections, the participant should specify the resulting sum of yields in his calculations. The cross-section of the individual fission-product n in Eq 2.1 is weighted over the total energy range by:

$$\sigma_n^x = \frac{\sum_{g=1}^{G} \Phi_g \sigma_{n,g}^x}{\sum_{g=1}^{G} \Phi_g} \tag{2.2}$$

with Φ_g the fine-group neutron spectrum. This function had to be derived by linear interpolation (lin-lin) from the pointwise neutron spectrum provided in the benchmark description (see Figure 2.1 and Appendix A). For scattering cross-sections, Eq. 2.2 reads:

$$\sigma_n^x = \frac{\sum_{g=1}^{G} \Phi_g \sum_{g'=1}^{G} \sigma_{n,g\to g'}^x}{\sum_{g=1}^{G} \Phi_g} \tag{2.3}$$

To be able to solve discrepancies, the participant also had to specify the energy group structure and weighting spectra used to calculate the fine-group microscopic cross-sections of the individual fission-products ($\sigma_{n,g}^x$ in Eq. 2.2 and $\sigma_{n,g\to g'}^x$ in Eq. 2.3). The preferred micro-flux weighting spectrum is the one specified in Appendix B.

The participants had to calculate the contribution of the lumped nuclide to the reactivity effect according to:

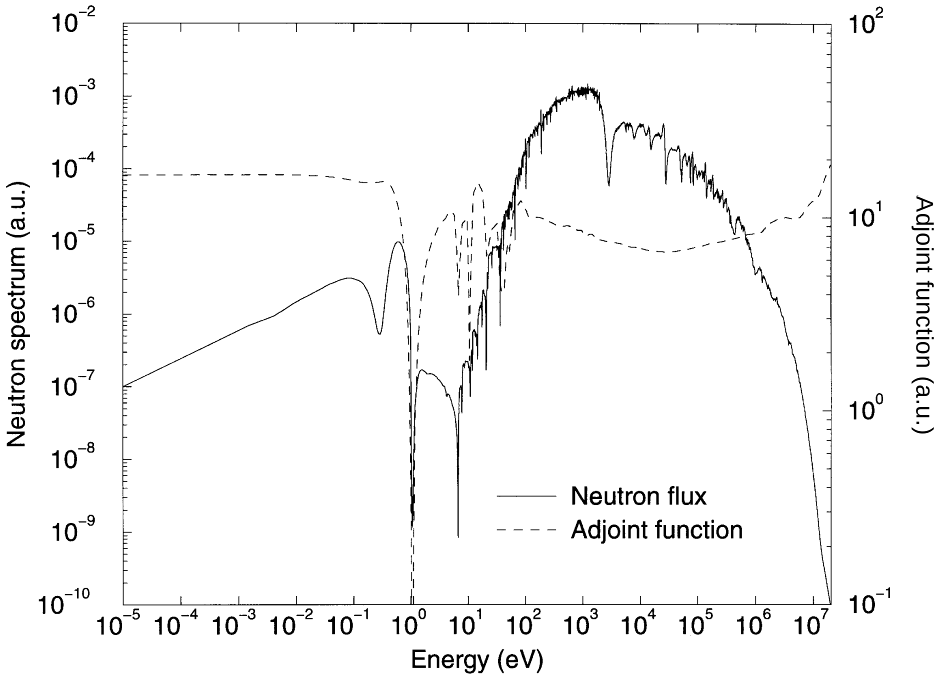
$$\rho^x = \frac{\sum_{g=1}^{G} \sigma_g^x \Phi_g^* \Phi_g}{\sum_{g=1}^{G} \Phi_g^* \Phi_g} \tag{2.4}$$

where Φ_g^* is the adjoint function. For a scattering cross-section, the reactivity effect is given by:

$$\rho^x = \frac{\sum_{g=1}^{G} \sigma_{g\to g'}^x \left(\Phi_g^* - \Phi_{g'}^*\right) \Phi_g}{\sum_{g=1}^{G} \Phi_g^* \Phi_g} \tag{2.5}$$

Also the denominator in Eq. 2.4 and 2.5 had to be specified by the participants. The adjoint function was given pointwise with a linear interpolation scheme (lin-lin), cf. 2.1 and Appendix B.

Figure 2.1. The pointwise neutron spectrum and adjoint function used in the benchmark



3. Participants

Contributions to the benchmark were received from CEA (France), ECN (the Netherlands), IPPE (Russia) and JNDC (Japan).

3.1 CEA

The contribution of the Commissariat à l'Énergie Atomique (CEA) is based on a fine-group version of the JEF-2.2 evaluated nuclear data file. The one group cross-sections and the corresponding reactivity worths of

80 individual fission-products have been calculated as well as the one group cross-sections and reactivity worths of the lumped nuclide. The sum of yields of all the 80 fission-products equals 1.90933.

3.2 ECN

The Netherlands Energy Research Foundation (ECN) contributed results based on the JEF-2.2 evaluated nuclear data file and the EAF-4.2 activation file. The first-mentioned file contains data for elastic and inelastic scattering and partial activation cross-sections, the second one contains only partial activation and transmutation cross-sections. The radiative capture cross-sections in EAF-4.2 for the important fission-product nuclides have been adopted from the JEF-2.2 file. It is noted that the JEF-2.2 fission-product file has been adjusted to available integral data (activation data and reactivity worths).

A fine-group library in XMAS structure (172 groups) is used, weighted with a thermal reactor spectrum and based on the JEF-2.2 evaluated nuclear data file. It contains the cross-sections of 155 individual fission-products with a sum of yields of 1.99936. From this library, one group cross-sections of all individual fission-products were calculated as well as the fine-group cross-sections and scattering matrices of the lumped nuclide. These were subsequently used to calculate the one group cross-sections and the reactivity worths of the lumped nuclide.

The extensive EAF-4.2 file was used for comparison and to calculate the influence of the weighting spectrum used in the preparation of the fine-group data library. Therefore, two fine-group libraries were made with different weighting spectra: one based on a thermal reactor spectrum (Maxwellian, 1/E and fission spectrum) and one based on the fast reactor spectrum specified in the benchmark. The fine-group cross-sections of all individual fission-products were used to calculate the fine-group cross-sections of the lumped nuclide, which were subsequently condensed into one group.

3.3 IPPE

Three different contributions of the Institute of Physics Power Engineering (IPPE) were received based on libraries from the BROND-2, FOND-2.1, and ADL-3 evaluated nuclear data files. The BROND-2 file contains original evaluations made in Russia. In some cases, results of integral data have been taken into account. The general purpose FOND-2.1 file contains BROND-2, but has been extended with other evaluations. The ADL-3 file is an extended activation/transmutation library. The BROND-2 library contains only 49 of the 162 requested fission-products with a total cumulative yield of 1.3689; the extensive FOND-2.1 and ADL-3 libraries contain all 162 nuclides. For this reason, not all the BROND-2 results are reported here.

Two versions of the BROND-2 and FOND-2.1 libraries were used. First, existing fine-group versions with 299 energy groups were used to calculate the one group (n,γ) cross-sections of the individual fission-products and the fine-group and one group (n,γ) cross-section and the corresponding reactivity worth of the lumped nuclide. Secondly, broad-group libraries with 28 energy groups condensed with a standard weighting spectrum (not the one specified in this benchmark) were used to calculate the (n,γ) cross-section and the corresponding reactivity worth of the lumped nuclide, and the reactivity worth due to inelastic scattering (the inelastic scattering matrix in this FOND-2.1 library contains the contributions of 125 individual fission-products with a sum of yields of 1.9340). The broad-group FOND-2.1 library was also used to calculate the one group radiative capture cross-section of the lumped nuclide. This cross-section differs about 1% from the one group cross-section calculated by the fine-group version of the FOND-2.1 library and is omitted from the comparison in this report.

A fine-group version of the ADL-3 activation library with 299 energy groups was used to calculate for various reactions the one group cross-sections of the individual fission-products and the one group cross-sections and the reactivity worths of the lumped nuclide.

3.4 JNDC

JNDC is a joint contribution of Toshiba Corporation, the Japan Atomic Energy Research Institute, Kawasaki Heavy Industry, Hitachi, RIST and Data Engineering. Two contributions were received: one based on a 70-group library processed from the JENDL-3.2 evaluated nuclear data file and one based on a 73-group library. In both cases, a typical FBR spectrum was used for the micro flux weighting by the TIMS code. The JENDL-3.2 file contains 140 fission-products of the 162 requested ones (see Appendix A) with a sum of yields of 1.99714.

First, a 70-group data library was made containing elastic and inelastic scattering matrices, and absorption cross-sections in the energy range up to 10 MeV. This library contains the total absorption cross-sections, but no partial capture cross-sections. From this library, one group cross-sections for absorption, elastic and inelastic scattering and the (n,2n) reaction of the individual fission-products were calculated as well as the one group cross-sections and the corresponding reactivity worths of the lumped nuclide. The results of this library have preference from the view point of reactor calculations.

Secondly, a 73-group data library was made based on the 70 group data library with three energy groups added in the range between 10 and 19.64 MeV. From this library, one group cross-sections were made for all reactions except the partial inelastic scattering ones. Also the fine-group cross-sections, the one group cross-sections and the corresponding reactivity worths of the lumped nuclide were calculated. From the view point of nuclear data evaluation, this library has preference.

4. Results for the lumped nuclide

4.1 One group cross-sections

The one group cross-sections of the pseudo-fission-products are given in Table 4.1 for the elastic scattering (MT=2), inelastic scattering (MT=4), (n,2n) reaction (MT=16), radiative capture (MT=102), (n,p) reaction (MT=103) and (n,α) reaction (MT=107). The last column of the table contains the maximum spread. First we discuss the important capture and inelastic scattering cross-sections. The maximum spread is about 6% for capture and about 9% for inelastic scattering. The highest values are for JEF-2.2 and rather low values for JENDL-3.2. Also the total and elastic scattering cross-sections are relatively low in JENDL-3.2. This suggests that the optical model parametrisations were quite different. A more detailed analysis is given in Section 5. For (n,2n), (n,α) and (n,p) there are large discrepancies. This has probably to do with the fact that these threshold cross-sections show a steep rise where the fission spectrum declines steeply. Since the shape of the cross-section is rather uncertain, this is reflected in the one group cross-section. It is noted that weighting spectrum differences as well as group structure differences may play a role, cf. Section 4.4. The contributions of the (n,p) and (n,α) reactions to the total absorption cross-section can be neglected in fast power reactors. This could change in systems with harder neutron spectra such as accelerator driven systems. The conclusion is that the 6% maximum spread in the capture cross seems reasonable, whereas the 9% spread in the inelastic cross-section is smaller than expected.

4.2 Reactivity worths

The corresponding table for the reactivity effects is given in Table 4.2. It is noted that the reactivity effects are given here with a normalisation that is different from common practice. Thus absolute values have no meaning. On average the total reactivity effect consists mainly of the radiative capture effect with a 10% contribution of inelastic scattering and very small contributions from the other components (less than 1%). Due to the fact that inelastic scattering cannot be calculated from the activation files a full comparison is only available for JEF-2.2, JENDL-3.2 and FOND-2.1 (after correction for missing nuclides). The maximum differences in the total reactivity is 5.5% and in the capture and inelastic scattering components 5.8% and 4.8%, respectively.

Table 4.1. One group cross-sections of the pseudo-nuclide

Lab	File	Flux [a]	2 (b)	4 (b)	16 (mb)	102 (b)	103 (μb)	107 (μb)	Total (b)
CEA	JEF-2.2 [b]		*15.2*	*0.590*		*0.571*			*16.4*
ECN	JEF-2.2	T	15.2	0.577	1.23	0.577	12.0	4.4	16.4
ECN	EAF-4.2 [c]	T			*1.44*	*0.570*	*11.8*	*11.3*	*16.4*
ECN	EAF-4.2 [d]	F			1.57	*0.565*	12.1	11.5	
JNDC	JENDL-3.2	F	14.4	0.531	1.12	0.546	5.4	21.4	15.5
IPPE	BROND-2 [e]			*0.425*	*0.64*	*0.499*			
IPPE	FOND-2.1			0.527	0.78	0.578	12.8	5.32	
IPPE	ADL-3				0.92	0.544	7.5	6.73	
Average [f]			14.8	0.545	1.12	0.561	10.0	9.9	15.9
Maxdiff (%)			5.4	9.0	70	5.9	74	172	5.7

[a] Micro flux weighting spectrum (T is thermal, F is fast reactor weighting).
[b] Not used for average to avoid double counting of JEF-2.2 values.
[c] Not used for average; used to inspect the effect of the micro flux weighting.
[d] (n,γ) cross-section not used for average because of relation with JEF-2.2.
[e] Not used for average because of missing nuclides.
[f] Numbers in *italics* are not included in the average.

Table 4.2. One group cross-sections of the pseudo-nuclide

Lab	File	Flux [a]	2 (au) [j]	4 (au)	16 (au) [j]	102 (au)	Total (au)	Total Corr [h]
CEA	JEF-2.2 [b]		*-4.25*	*-0.0708*		*-0.580*	*-0.655*	*-0.656*
ECN	JEF-2.2	T	-3.92	-0.0684	-0.694	-0.583	-0.656	-0.656
ECN	EAF-4.2 [c]	T				*-0.576*		
ECN	EAF-4.2 [d]	F				*-0.571*		-0.642
JNDC	JENDL-3.2	F	-4.67	-0.0652	-0.644	-0.546	-0.622	-0.622
IPPE	BROND-2 [e]			*-0.0477*		*-0.504*		
IPPE	FOND-2.1 [f]			*-0.0632*		*-0.584*		
IPPE	FOND-2.1 [g]			-0.0654		-0.584	-0.649	-0.654
IPPE	ADL-3			-0.0654		-0.550		-0.621
Average [i]			-4.30	-0.0663	-0.669	-0.566	-0.642	-0.639
Maxdiff (%)			17	4.8	7.5	5.8	5.3	5.5

[a] Micro flux weighting spectrum (T is thermal, F is fast reactor weighting).
[b] Not used for average to avoid double counting of JEF-2.2 values.
[c] Not used for average; used to inspect the effect of the micro flux weighting (see also Table 4.3).
[d] (n,γ) cross-section not used for average because of relation with JEF-2.2.
[e] Not used for average because of missing nuclides.
[f] Not used for average because of missing nuclides.
[g] Corrected for missing nuclides (factor 2/1.934 for MT=4).
[h] Missing data supplemented with average value of missing components.
[i] Numbers in *italics* are not included in the average.
[j] Numbers have been multiplied with 10^3.

4.3 Cross-section plots

In Appendix C all data have been plotted for capture, inelastic scattering and (n,2n) cross-sections. In this chapter, a detailed analysis is made mainly based on JEF-2.2, FOND-2.1 and JENDL-3.2.

First the plots of group cross-sections for the radiative capture cross-section are compared (see Figures 4.1 and 4.2). Because the cross-sections of the lumped nuclide show a 1/v behaviour above 100 keV, the same curves multiplied with the square root of the energy are shown in Figures 4.3 and 4.4, respectively. In the energy range above 100 keV, the various evaluations only differ by a small factor. At lower energies, the resonance structure is visible and

Figure 4.1. The radiative capture cross-section of the lumped nuclide as a function of the energy

Above 1 keV, the pseudo-fission-product behaves as a 1/v nuclide. The EAF-4.2 results are not shown because they are very close to JEF-2.2. The BROND-2 results are shown in Appendix C where a full comparison is given. The ADL-3 results are not available.

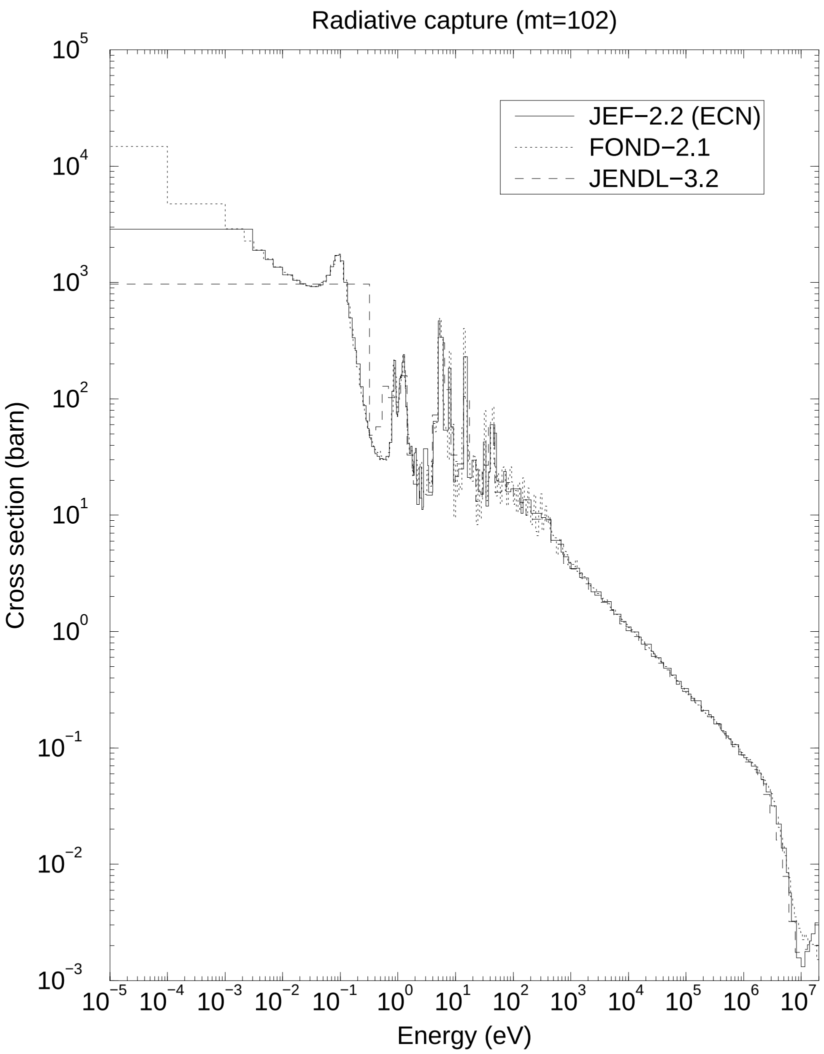


Figure 4.2. The radiative capture cross-section of the lumped nuclide as a function of the energy in the range between 0.1 eV and 10 keV

The main differences are due to the different energy group structures used by the participants. The EAF-4.2 results are very close to JEF-2.2, the BROND-2 results are shown in Appendix C and the ADL-3 results are not available. Note that the 0.6 eV resonance seen in JENDL-3.2 originates from ^{155}Eu.

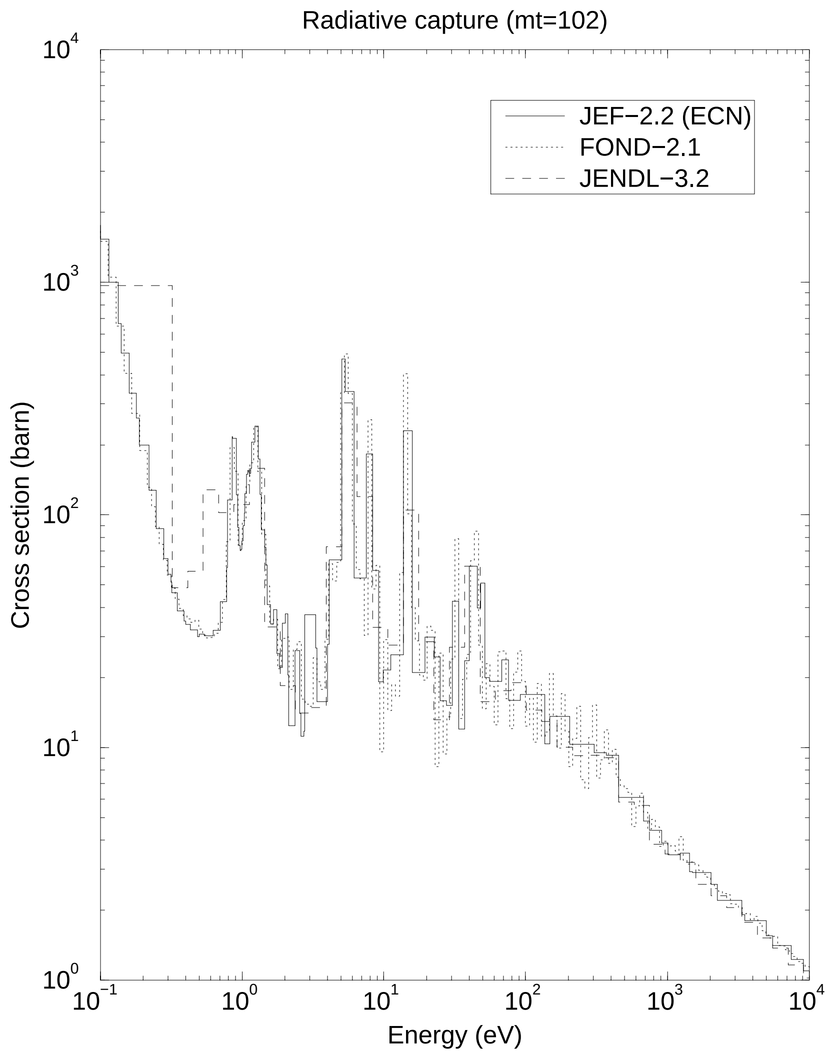


Figure 4.3. The radiative capture cross-section of the lumped nuclide multiplied with the square root of the energy as a function of the energy

The differences in the unresolved energy range are evident from this figure. Again, the EAF-4.2 results are very close to JEF-2.2, the BROND-2 results are shown in Appendix C and the ADL-3 results are not available.

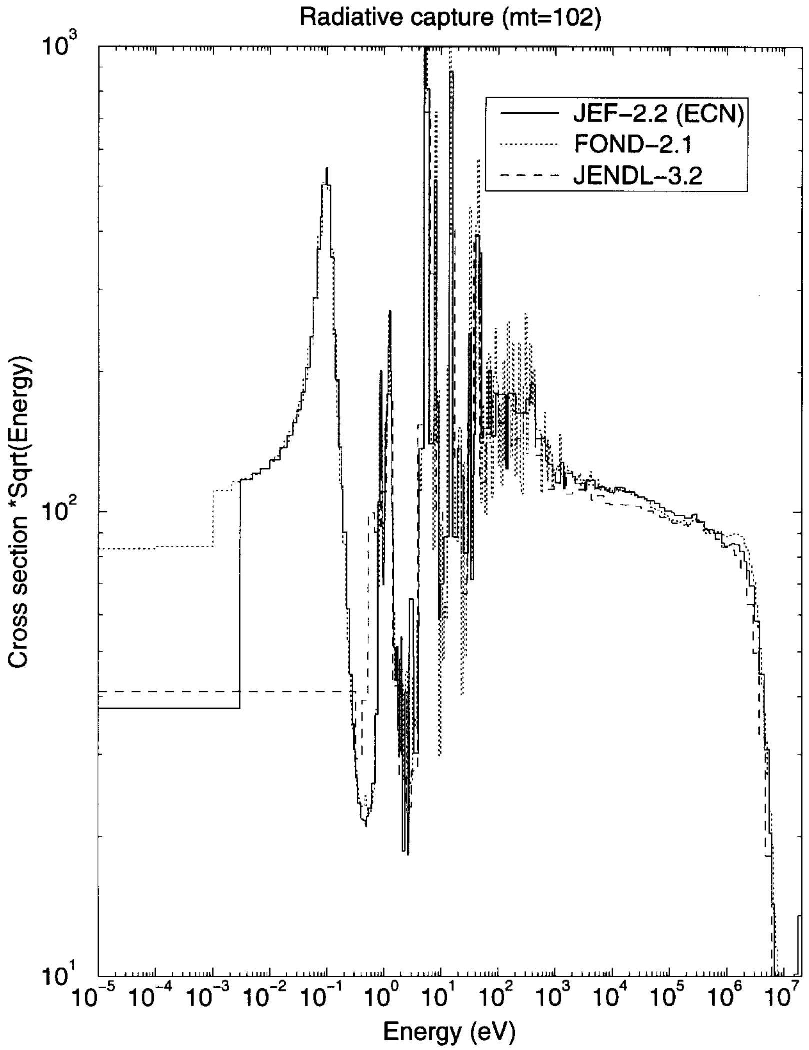
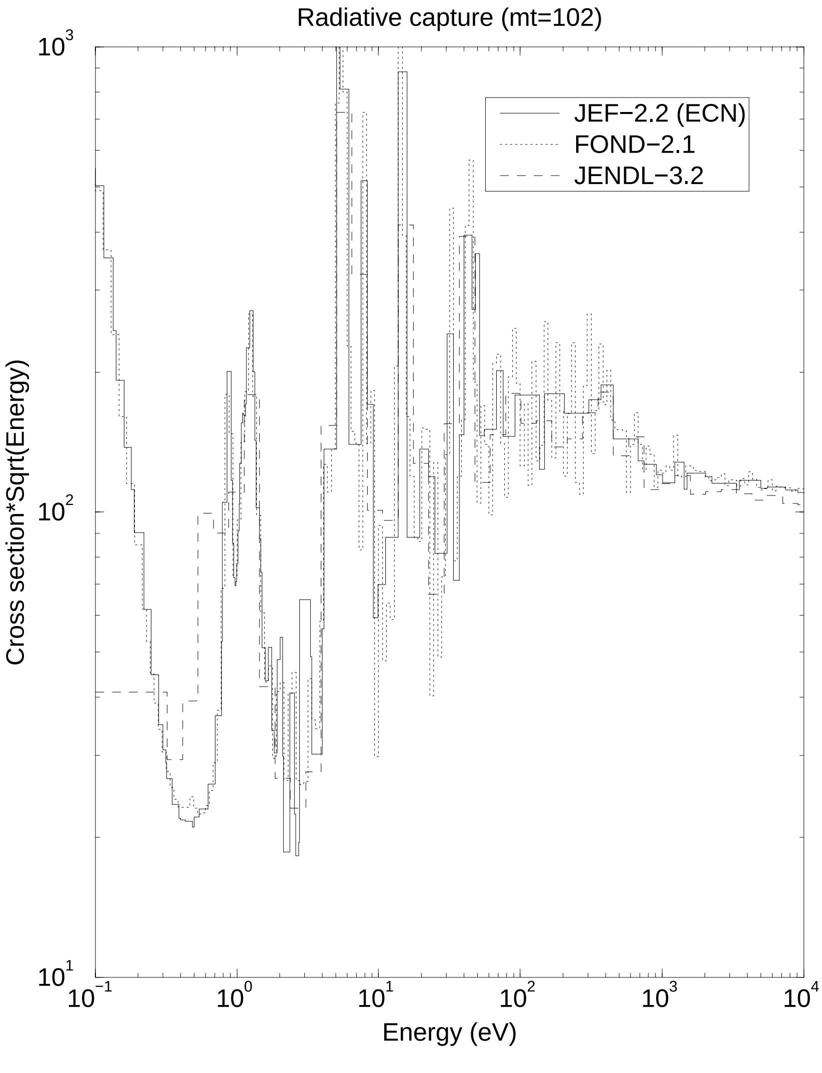


Figure 4.4. The radiative capture cross-section of the lumped nuclide multiplied with the square root of the energy as a function of the energy in the range between 0.1 eV and 10 keV

Again, the EAF-4.2 results are very close to JEF-2.2, the BROND-2 results are shown in Appendix C and the ADL-3 results are not available. Note that the 0.6 eV resonance seen in JENDL-3.2 originates from ^{155}*Eu.*



some differences between the evaluations is seen from the graphs. At the thermal groups the differences merely reflect the differences in the group structures. This also holds to a certain extent at the highest energies; above 10 MeV there are some differences in the direct-collective capture contributions. Altogether, since in the important energy range above 100 eV, most of the resonance structure has averaged out, there is good reason to believe that the hypothesis of cancellation of errors is correct for fast reactors and that in fact only systematic errors determine the uncertainty in fast capture effect. From the curves in Figures 4.3 and 4.4, it is seen that JENDL-3.2 is generally lower than JEF-2.2 and FOND-2.1 above 100 eV. In particular there are differences in the "unresolved range" from 1 to 100 keV. The resonance at 0.6 eV visible in Figure 4.2 for JENDL-3.2 originates from ^{155}Eu. This resonance has been measured but was not adopted in JEF-2.2 and FOND-2.1, where artificial resonances have been adopted (see further Appendix D).

Secondly, the plots of inelastic scattering cross-sections are inspected (see Figure 4.5). Here there is remarkable agreement between 200 keV and 10 MeV, but there are some differences below 200 keV. Apparently, cancellation of errors works well above 100 keV, but since there are many less nuclides with levels below 200 keV and since these have different threshold energies, the cross-section below 200 keV shows a large spread. As the region up to 200 keV is quite important in fast reactors it could be worthwhile to concentrate on these nuclides. Further analysis shows that the cross-section at 10 keV is mainly due to ^{151}Sm and to a lesser extent due to ^{103}Ru. Other important nuclides with thresholds below 200 keV are ^{101}Ru, ^{133}Cs, ^{103}Rh, ^{145}Nd, ^{107}Pd and ^{149}Sm.

The plots for the (n,2n) cross-section show a large spread (see Figure 4.6), which is partly due to the different group structures and flux weighting spectra used, see further the discussion in Section 4.4. Still it is curious that at 14 MeV, for which many (n,2n) measurement data are available, the FOND-2.1 library is too low. This needs further investigation. The EAF-4.2 evaluation was adjusted to 14 MeV data or systematics. Similar actions were made for JENDL-3.2.

4.4 Influence of the weighting spectrum

As mentioned in Section 3.2, the basic EAF-4.2 file has been collapsed to a 172-group cross-section data library in the XMAS group structure by use of two different weighting spectra: a light-water reactor spectrum (Maxwellian, 1/E and fission spectrum) and the fast reactor spectrum shown in Figure 2.1. Subsequently the two fine-group libraries were collapsed to one group by the neutron spectrum provided in the benchmark.

Figure 4.5. The inelastic scattering cross-section of the lumped nuclide as a function of the energy

In the MeV range, the deviations are smallest. At the lower energies (10 keV), the nuclides ^{151}Sm and ^{103}Ru dominate the cross-section. Other important nuclides with thresholds below 200 keV are ^{101}Ru, ^{133}Cs, ^{103}Rh, ^{145}Nd, ^{107}Pd and ^{149}Sm.

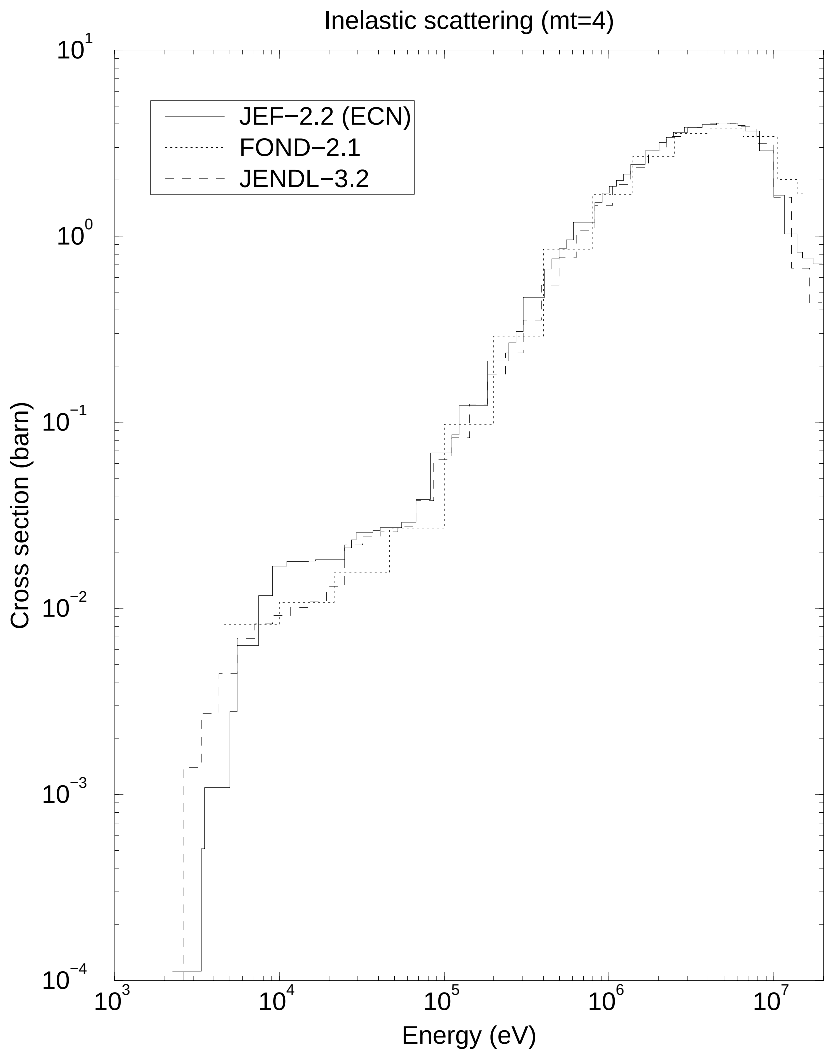


Figure 4.6. The (n,2n) cross-section of the lumped nuclide as a function of the energy

Note that some of the discrepancies result from the use of different group structures and different weighting spectra.

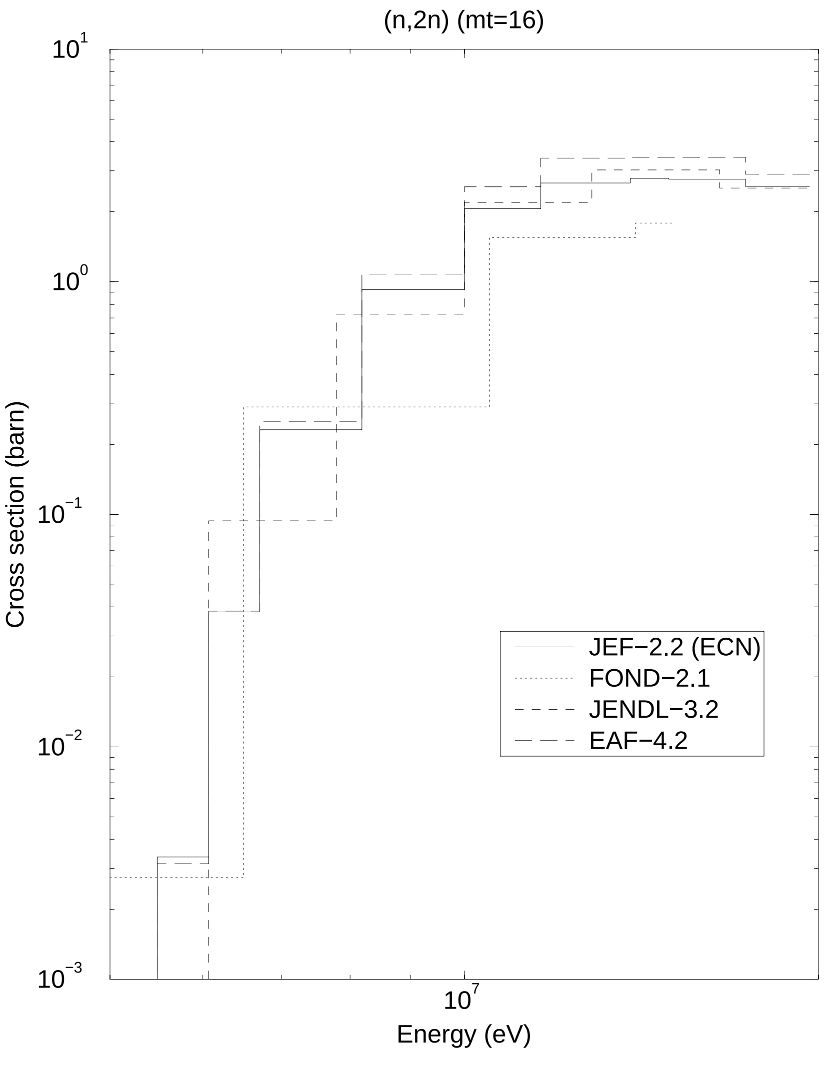


Table 4.3 shows the two results. When the thermal weighting spectrum is used, the threshold reactions have up to 8% smaller cross-sections and less negative reactivity worths then in case the fast weighting spectrum is used. This effect is quite large. Apparently, the threshold reactions are very sensitive to the weighting spectrum used. The difference for the radiative capture cross-section is, however, less than 1%. For the inelastic cross-sections as far as available on EAF-4.2 (for production of metastable states only) the differences are below 2% (not shown in Table 4.3). Therefore, the use of a pseudo-fission-product based on individual nuclide cross-sections weighted with a thermal reactor spectrum is justified, provided the number of fine energy groups is sufficiently large.

Table 4.3. One group cross-sections and reactivity worths calculated with the EAF-4.2 activation file processed by thermal and fast weighting spectrums

MT	Thermal	Fast	Ratio	MT	Thermal	Fast	Ratio
One group cross-sections				Reactivity worths			
16	1.443e-03	1.572e-03	0.918	102	-5.760e-01	-5.709e-01	1.009
17	3.220e-05	3.478e-05	0.926	103	-1.746e-05	-1.792e-05	0.974
102	5.703e-01	5.653e-01	1.009	104	-1.764e-06	-1.851e-06	0.953
103	1.179e-05	1.212e-05	0.973	105	-1.694e-07	-1.817e-07	0.932
104	8.235e-07	8.613e-07	0.956	106	-5.168e-09	-5.476e-09	0.944
105	7.417e-08	7.950e-08	0.933	107	-1.482e-05	-1.506e-05	0.984
106	2.298e-09	2.430e-09	0.946	111	-3.073e-08	-3.268e-08	0.940
107	1.129e-05	1.147e-05	0.984				
111	1.348e-08	1.430e-08	0.942				

The results of Table 4.3 should also be compared with those of Tables 4.1 and 4.2. For the (n,2n) reaction, the EAF-4.2 file gives higher cross-sections than JEF-2.2, which is probably due to the missing data in JEF-2.2 (see Section 5). There is a good agreement for the (n,γ) and (n,p) cross-sections. For the (n,α) reaction the EAF-4.2 data seem quite high.

5. Individual fission-product cross-sections

5.1 One group cross-sections

Table 5.1 gives the one group radiative capture cross-sections for 130 nuclides in order of descending importance (according to the product of concentration and cross-section). In the French data set some nuclides are lacking in the lumped fission-product (values set to zero). The differences between the CEA and ECN results reflect the processing differences.

Intercomparison of the data for the various nuclides reveals that there are still rather large differences between the values of the cross-sections of different nuclides. The strong resonance absorbers ^{149}Sm, ^{151}Sm, ^{153}Eu, ^{155}Eu have high cross-sections also in fast power reactors. The last columns of Table 5.1 contain the averages and root mean square values. Note that in this table, JEF-2.2 is counted twice, which may give too optimistic results. Furthermore, there are other dependencies between the libraries, as some evaluations have been adopted in one or more different libraries. Therefore, the RMS values are only indicative. From the top-20 nuclides the RMS values are less than 10%, except for the nuclides ^{151}Sm, ^{103}Ru, ^{135}Cs. These are unstable nuclides, for which there are almost no measurements. Integral data are available for these nuclides and have been used in the JEF-2.2 evaluation. From the next 20 nuclides the one with RMS larger than 20% are ^{155}Eu, ^{96}Zr, and ^{95}Zr. It is recommended to have a closer look at these nuclides. More generally, the largest uncertainties come from unstable nuclides. Still, the average RMS value for the top 40 nuclides is below 10%. The systematic difference in the pseudo-cross-sections of JENDL-3.2 and JEF-2.2 could partly be attributed to the following nuclides belonging to the "top 20": ^{149}Sm, ^{99}Tc, ^{147}Pm, ^{151}Sm, ^{103}Ru, ^{97}Mo, ^{153}Eu and ^{109}Ag.

Table 5.2 gives the one group inelastic scattering cross-sections for JEF-2.2 and JENDL-3.2 for the most important nuclides in order of descending importance. The activation libraries EAF-4.2 and ADL-3 do not contain total inelastic scattering cross-sections. The differences between the values of the cross-sections for different nuclides are smaller than in the case of radiative capture. The largest values are obtained for ^{151}Sm and ^{103}Ru, which are nuclides with rather low excitation levels (below 100 keV). In the top 20 nuclides, JENDL-3.2 shows a trend of larger values for even-mass nuclides and smaller ones for odd-mass nuclides, compared to JEF-2.2. This trend could come from the contributions of direct inelastic scattering for even-mass nuclides. The RMS values for the top 40 nuclides are less than 15%, except for the nuclides ^{104}Ru, ^{131}Xe, ^{139}La, ^{151}Sm, ^{144}Ce (but only two different evaluations were considered). These nuclides should be inspected in more detail. The average RMS value for the top 40 nuclides is less than 8%, which is surprisingly small.

From Table 5.3 where the (n,2n) one group cross-sections are compared, it becomes evident that the JEF-2.2 data file does not contain data for all nuclides. The RMS values are in general below 35%, however the cross-section difference is rather systematic, with relatively low values for ADL-3. This needs further investigation.

Table 5.1. One group cross-sections for radiative capture (MT=102) of the nuclides in order of descending importance determined by the product of the cross-section (FOND-2.1) and yield of the nuclide

Institute Library	CEA JEF-2.2	ECN JEF-2.2	IPPE FOND-2.1	IPPE ADL-3	JNDC JENDL-3.2	Average	RMS [a] (%)
^{101}Ru	0.7143	0.7243	0.7616	0.7141	0.7523	0.7333	2.71
^{105}Pd	0.9369	0.9490	0.9161	0.8568	0.9594	0.9236	3.94
^{149}Sm	2.5398	2.5437	2.8700	2.6540	2.2990	2.5813	7.17
^{99}Tc	0.6301	0.6479	0.6561	0.6152	0.5923	0.6283	3.65
^{133}Cs	0.5072	0.5167	0.5184	0.4715	0.4874	0.5003	3.62
^{107}Pd	1.0569	1.0700	1.0399	0.9840	1.0520	1.0406	2.87
^{103}Rh	0.6751	0.6832	0.6526	0.6124	0.6774	0.6601	3.94
^{147}Pm	1.5064	1.5167	1.4309	1.3335	1.2753	1.4126	6.72
^{151}Sm	3.3618	3.3998	2.9413	2.6922	2.1080	2.9006	16.43
^{103}Ru	1.1828	1.1992	1.2140	1.1416	0.5047	1.0485	26.03
^{97}Mo	0.3351	0.3406	0.3568	0.3159	0.3484	0.3394	4.08
^{145}Nd	0.5657	0.5700	0.5124	0.4755	0.5648	0.5377	6.99
^{131}Xe	0.2917	0.2937	0.3323	0.3018	0.3461	0.3131	7.03
^{153}Eu	2.7363	2.7655	2.9288	2.4251	2.5958	2.6903	6.31
^{143}Nd	0.3592	0.3550	0.3370	0.3080	0.3589	0.3437	5.70
^{102}Ru	0.1558	0.1581	0.1796	0.1732	0.1642	0.1662	5.41
^{109}Ag	0.7846	0.7927	0.7203	0.6705	0.6916	0.7319	6.69
^{104}Ru	0.1517	0.1546	0.1658	0.1572	0.1685	0.1596	4.06
^{135}Cs	0.2379	0.2445	0.1361	0.2269	0.2284	0.2148	18.56
^{141}Pr	0.1553	0.1582	0.1540	0.1360	0.1564	0.1520	5.34
^{95}Mo	0.3180	0.3204	0.3351	0.3096	0.3360	0.3238	3.16
^{98}Mo	0.1233	0.1280	0.1179	0.1067	0.1194	0.1191	5.97
^{100}Mo	0.0933	0.0938	0.1011	0.0862	0.1000	0.0949	5.64
^{155}Eu	2.8163	2.8428	2.9559	2.6783	1.3368	2.5260	23.80
^{108}Pd	0.1778	0.1770	0.2507	0.2352	0.2358	0.2153	14.60
^{132}Xe	0.0689	0.0708	0.0755	0.0804	0.0980	0.0787	13.27
^{93}Zr	0.1349	0.1335	0.1042	0.0924	0.1057	0.1141	14.94
^{152}Sm	0.4951	0.4956	0.5077	0.4768	0.4799	0.4910	2.31
^{141}Ce	0.2970	0.2963	0.2960	0.2754	0.2977	0.2925	2.93
^{129}I	0.3644	0.3700	0.3804	0.3566	0.3840	0.3711	2.72
^{106}Ru	0.0922	0.0871	0.0946	0.0887	0.0916	0.0909	2.91
^{96}Zr	0.0343	0.0358	0.0590	0.0550	0.0391	0.0447	22.98
^{106}Pd	0.1994	0.2027	0.2553	0.1959	0.2772	0.2261	14.85
^{127}I	0.6168	0.6199	0.6307	0.5806	0.6028	0.6102	2.83
^{146}Nd	0.0947	0.0956	0.1100	0.0911	0.1076	0.0998	7.57
^{148}Nd	0.1703	0.1681	0.1636	0.1609	0.1469	0.1620	5.08
^{134}Xe	0.0361	0.0360	0.0374	0.0292	0.0272	0.0332	12.53
^{139}La	0.0339	0.0333	0.0390	0.0320	0.0343	0.0345	6.86
^{95}Nb	0.3469	0.3496	0.2705	0.3311	0.3669	0.3330	9.99
^{95}Zr	0.0651	0.0643	0.1229	0.0586	0.1489	0.0919	40.13

[a] As the columns are not all independent, the RMS value is only indicative and might be too small.

Table 5.1. *Continued*

Institute Library	CEA JEF-2.2	ECN JEF-2.2	IPPE FOND-2.1	IPPE ADL-3	JNDC JENDL-3.2	Average	RMS (%)
^{110}Pd	0.0970	0.0985	0.2189	0.0920	0.1291	0.1271	37.53
^{111}Cd	0.4605	0.4665	0.4683	0.4350	0.7475	0.5155	22.62
^{147}Sm	1.4571	1.4660	1.4183	1.3243	1.2719	1.3875	5.52
^{150}Nd	0.1728	0.1748	0.1729	0.1668	0.1626	0.1700	2.68
^{154}Eu	3.0951	3.1233	3.1720	2.9430	3.4503	3.1567	5.24
^{143}Pr	0.4094	0.4095	0.4206	0.3847	0.1263	0.3501	32.13
^{157}Gd	1.8214	1.8389	1.6372	1.4989	1.3578	1.6308	11.36
^{92}Zr	0.0365	0.0368	0.0433	0.0425	0.0418	0.0402	7.26
^{91}Zr	0.0796	0.0789	0.0790	0.0720	0.0913	0.0801	7.77
^{156}Gd	0.6203	0.6156	0.7077	0.6631	0.7059	0.6625	6.00
^{94}Zr	0.0229	0.0237	0.0271	0.0262	0.0258	0.0251	6.22
^{147}Nd	1.0075	1.0173	0.7995	0.9482	1.2315	1.0008	13.90
^{137}Cs	0.0274	0.0280	0.0160	0.0264	0.0160	0.0228	24.34
^{142}Ce	0.0436	0.0442	0.0186	0.0196	0.0252	0.0302	37.57
^{144}Ce	0.0493	0.0490	0.0337	0.0470	0.0241	0.0406	24.85
^{159}Tb	0.0000	1.7482	2.0672	1.6488	1.8546	1.8297	8.48
^{154}Sm	0.2479	0.2507	0.2729	0.2514	0.2471	0.2540	3.77
^{83}Kr	0.0000	0.2465	0.2422	0.2232	0.2806	0.2481	8.34
^{144}Nd	0.0800	0.0807	0.0936	0.0758	0.0829	0.0826	7.23
^{128}Te	0.0418	0.0416	0.1029	0.0387	0.0408	0.0531	46.81
^{148}Pm	4.1510	4.1781	4.2530	5.8795	3.2167	4.3357	19.84
^{149}Pm	3.5314	3.5548	3.6200	3.3688	1.2367	3.0623	29.93
^{140}Ce	0.0138	0.0135	0.0123	0.0142	0.0061	0.0120	24.95
^{116}Cd	0.0000	0.1182	0.8856	0.1139	0.0823	0.3000	112.80
^{81}Br	0.0000	0.4293	0.3892	0.4048	0.2777	0.3752	15.48
^{125}Sb	0.3184	0.3217	0.3216	0.0000	0.4493	0.3527	15.82
^{161}Dy	0.0000	2.5911	2.5856	2.4223	0.0000	2.5330	3.09
^{99}Mo	0.5052	0.5132	0.5176	0.4907	0.3780	0.4810	10.87
^{115}In	0.4711	0.4772	0.4755	0.4540	0.6084	0.4972	11.30
^{104}Pd	0.0000	0.2016	0.3311	0.1921	0.2993	0.2560	23.57
^{91}Y	0.0461	0.0467	0.0472	0.0445	0.0891	0.0547	31.47
^{131}I	0.1686	0.1706	0.1743	0.1613	0.2808	0.1911	23.56
^{113}Cd	0.4092	0.4134	0.4128	0.3865	0.5273	0.4299	11.57
^{84}Kr	0.0000	0.0699	0.0664	0.0629	0.0519	0.0628	10.77
^{112}Cd	0.2421	0.2443	0.2535	0.2399	0.2084	0.2377	6.45
^{129}Te	0.0000	0.1387	0.1387	2.7649	0.7658	0.9520	113.18
^{150}Sm	0.4543	0.4583	0.3408	0.3237	0.4341	0.4022	14.41
^{121}Sb	0.4657	0.4707	0.4663	0.4467	0.4414	0.4582	2.57
^{100}Ru	0.0000	0.1996	0.1991	0.1886	0.2067	0.1985	3.26
^{158}Gd	0.0000	0.3337	0.3356	0.3126	0.3417	0.3309	3.32
^{130}Te	0.0143	0.0147	0.0149	0.0137	0.0129	0.0141	5.11
^{105}Rh	0.5905	0.5988	0.6036	0.0000	0.6544	0.6119	4.09
^{140}Ba	0.0000	0.0188	0.0691	0.0185	0.0024	0.0272	92.16
^{87}Rb	0.0247	0.0248	0.0248	0.0213	0.0292	0.0249	10.11
^{133}Xe	0.1351	0.1287	0.1275	0.1184	0.1380	0.1295	5.26

Table 5.1. *Continued*

Institute Library	CEA JEF-2.2	ECN JEF-2.2	IPPE FOND-2.1	IPPE ADL-3	JNDC JENDL-3.2	Average	RMS [a] (%)
^{114}Cd	0.0000	0.2785	0.2818	0.2611	0.1882	0.2524	15.00
^{155}Gd	0.0000	2.9068	2.9057	2.6694	2.6347	2.7792	4.59
^{148}Sm	0.0000	0.3686	0.3110	0.2907	0.2885	0.3147	10.27
^{90}Sr	0.0131	0.0134	0.0134	0.0126	0.0100	0.0125	10.25
^{140}La	0.3773	0.3788	0.3919	0.3507	0.0000	0.3747	3.99
^{136}Xe	0.0031	0.0031	0.0031	0.0029	0.0011	0.0026	28.79
^{89}Y	0.0000	0.0174	0.0145	0.0225	0.0178	0.0180	16.00
^{127}Te	0.0000	0.4100	0.4100	3.1977	0.8786	1.2241	94.39
^{138}Ba	0.0033	0.0034	0.0036	0.0034	0.0052	0.0038	18.71
^{111}Ag	0.0000	0.7936	0.8141	0.7389	0.0000	0.7822	4.06
^{148}Pm	0.0000	3.9372	4.2530	3.9542	1.9922	3.5342	25.44
^{117}Sn	0.0000	0.2228	0.2243	0.2129	0.2377	0.2244	3.93
^{143}Ce	0.0000	0.3364	0.3512	0.3144	0.0000	0.3340	4.53
^{89}Sr	0.0000	0.0225	0.0226	0.0214	0.0126	0.0198	21.01
^{110}Cd	0.0000	0.2714	0.2658	0.2640	0.2200	0.2553	8.06
^{118}Sn	0.0000	0.1255	0.1264	0.1204	0.0890	0.1153	13.34
^{123}Sb	0.0000	0.2560	0.2558	0.2471	0.2849	0.2610	5.46
^{160}Gd	0.0000	0.2236	0.1696	0.1726	0.2248	0.1977	13.44
^{77}Se	0.0000	0.4126	0.3864	0.3936	0.3970	0.3974	2.41
^{123}Sn	0.0000	0.1232	0.1239	0.1179	0.3672	0.1831	58.09
^{125}Te	0.0000	0.4001	0.4019	0.3696	0.3783	0.3875	3.59
^{80}Se	0.0000	0.0582	0.0493	0.0545	0.0422	0.0510	11.75
^{85}Kr	0.0000	0.0436	0.0066	0.0413	0.0597	0.0378	51.29
^{125}Sn	0.0000	0.3681	0.3791	0.3539	0.0000	0.3670	2.81
^{119}Sn	0.0000	0.0643	0.0630	0.0587	0.1847	0.0927	57.35
^{136}Ba	0.0000	0.0531	0.0505	0.0453	0.0700	0.0547	16.90
^{137}Ba	0.0000	0.0649	0.0680	0.0642	0.0822	0.0698	10.42
^{124}Sn	0.0000	0.0265	0.0281	0.0288	0.0150	0.0246	22.89
^{120}Sn	0.0000	0.0454	0.0454	0.0585	0.0456	0.0487	11.63
^{86}Kr	0.0000	0.0039	0.0034	0.0040	0.0028	0.0036	13.46
^{136}Cs	0.0000	0.3023	0.3187	0.2888	0.2535	0.2908	8.26
^{85}Rb	0.2193	0.2245	0.1979	0.2063	0.2767	0.2250	12.24
^{78}Se	0.0000	0.0806	0.0682	0.0706	0.0917	0.0778	11.95
^{130}Xe	0.0000	0.1265	0.1267	0.1461	0.2729	0.1680	36.33
^{128}Xe	0.0000	0.1905	0.1886	0.2026	0.2600	0.2104	13.82
^{96}Mo	0.0000	0.0859	0.0901	0.0873	0.0893	0.0882	1.88
^{160}Dy	0.0000	2.2301	2.2255	2.1165	0.0000	2.1907	2.40
^{82}Se	0.0000	0.0093	0.0094	0.0092	0.0288	0.0142	59.66
^{126}Sn	0.0000	0.0070	0.0070	0.0071	0.0085	0.0074	8.26
^{162}Dy	0.0000	0.9439	0.9456	0.8971	0.0000	0.9289	2.42
^{122}Sn	0.0000	0.0234	0.0238	0.0231	0.0276	0.0245	7.56
^{88}Sr	0.0000	0.0010	0.0010	0.0011	0.0041	0.0018	73.81
^{156}Eu	0.0000	0.0696	0.0713	0.0650	0.7202	0.2315	121.87
^{154}Gd	0.0000	1.1355	1.3159	1.2452	0.9733	1.1675	11.07
^{134}Ba	0.0000	0.1164	0.1120	0.1038	0.2081	0.1351	31.40

Table 5.2. One group cross-sections for inelastic scattering (MT=4) of the nuclides in order of descending importance determined by the product of the cross-section (JENDL-3.2) and yield of the nuclide

Institute Library	CEA JEF-2.2	ECN JEF-2.2	JNDC JENDL-3.2	Average	RMS [a] (%)
^{101}Ru	0.6176	0.6012	0.4748	0.5646	11.30
^{133}Cs	0.4675	0.4576	0.4411	0.4554	2.39
^{99}Tc	0.4633	0.4487	0.3599	0.4239	10.78
^{103}Rh	0.4129	0.4028	0.4041	0.4066	1.11
^{135}Cs	0.3057	0.2998	0.2615	0.2890	6.78
^{104}Ru	0.2127	0.2072	0.2919	0.2373	16.30
^{105}Pd	0.5106	0.4970	0.3870	0.4649	11.90
^{100}Mo	0.2716	0.2641	0.2852	0.2736	3.19
^{102}Ru	0.1940	0.1884	0.2426	0.2083	11.68
^{141}Pr	0.3522	0.3448	0.3577	0.3516	1.50
^{145}Nd	0.5086	0.4985	0.5236	0.5103	2.02
^{103}Ru	1.0791	1.0630	0.9858	1.0426	3.91
^{97}Mo	0.2611	0.2549	0.2947	0.2703	6.47
^{131}Xe	0.5059	0.4955	0.3559	0.4524	15.12
^{107}Pd	0.5094	0.4961	0.4284	0.4780	7.42
^{149}Sm	0.9357	0.9174	0.9073	0.9202	1.28
^{139}La	0.2745	0.2693	0.1850	0.2429	16.90
^{98}Mo	0.1898	0.1880	0.1956	0.1911	1.68
^{106}Ru	0.2860	0.2792	0.3048	0.2900	3.74
^{137}Cs	0.1718	0.1685	0.1565	0.1656	3.96
^{134}Xe	0.1670	0.1656	0.1268	0.1532	12.17
^{151}Sm	1.9461	1.9303	1.1939	1.6901	20.76
^{142}Ce	0.2104	0.2064	0.1706	0.1958	9.13
^{132}Xe	0.2088	0.2054	0.1559	0.1900	12.71
^{147}Pm	0.5153	0.5027	0.4834	0.5005	2.62
^{93}Zr	0.2349	0.2301	0.2062	0.2237	5.61
^{146}Nd	0.3134	0.3060	0.3054	0.3082	1.18
^{95}Mo	0.3383	0.3319	0.3328	0.3343	0.85
^{148}Nd	0.3780	0.3695	0.3943	0.3806	2.71
^{109}Ag	0.4323	0.4218	0.4105	0.4215	2.11
^{94}Zr	0.1380	0.1368	0.1543	0.1431	5.57
^{136}Xe	0.1156	0.1144	0.0924	0.1075	9.91
^{108}Pd	0.2604	0.2547	0.2531	0.2561	1.23
^{150}Nd	0.6038	0.5902	0.5478	0.5806	4.11
^{144}Ce	0.4548	0.4433	0.2091	0.3691	30.67
^{143}Nd	0.1570	0.1554	0.1380	0.1501	5.74
^{152}Sm	0.7550	0.7364	0.6112	0.7009	9.11
^{92}Zr	0.1322	0.1310	0.1510	0.1381	6.63
^{138}Ba	0.1087	0.1076	0.0849	0.1004	10.91
^{96}Zr	0.0883	0.0874	0.0838	0.0865	2.26

[a] As the columns are not all independent, the RMS value is only indicative and might be too small.

Table 5.2. *Continued*

Institute Library	CEA JEF-2.2	ECN JEF-2.2	JNDC JENDL-3.2	Average	RMS (%)
^{96}Zr	0.0883	0.0874	0.0838	0.0865	2.26
^{129}I	0.4695	0.4605	0.4174	0.4491	5.06
^{140}Ce	0.0684	0.0676	0.0780	0.0713	6.61
^{153}Eu	1.0290	1.0051	0.7759	0.9367	12.18
^{110}Pd	0.2897	0.2838	0.2884	0.2873	0.88
^{130}Te	0.1155	0.1145	0.1292	0.1198	5.60
^{90}Sr	0.1056	0.1047	0.1303	0.1135	10.47
^{106}Pd	0.2263	0.2208	0.2036	0.2169	4.46
^{154}Sm	0.5118	0.4997	0.6552	0.5556	12.71
^{127}I	0.5195	0.5089	0.4693	0.4992	4.33
^{87}Rb	0.1884	0.1840	0.1813	0.1846	1.58
^{144}Nd	0.2105	0.2071	0.2132	0.2103	1.18
^{83}Kr	0.0000	0.6619	0.5107	0.5863	12.90
^{143}Pr	0.3973	0.3895	0.4662	0.4177	8.26
^{95}Zr	0.1093	0.1083	0.0956	0.1044	5.97
^{91}Y	0.1741	0.1713	0.1875	0.1776	3.99
^{91}Zr	0.0851	0.0845	0.0913	0.0870	3.51
^{155}Eu	0.7267	0.7078	0.6595	0.6980	4.05
^{111}Cd	0.4115	0.4014	0.3348	0.3826	8.90
^{134}Cs	0.7659	0.7546	0.8764	0.7990	6.87
^{141}Ce	0.1437	0.1421	0.1078	0.1312	12.62
^{147}Nd	0.6425	0.6295	0.8092	0.6938	11.79
^{128}Te	0.1524	0.1506	0.1433	0.1488	2.65
^{95}Nb	0.1814	0.1794	0.1316	0.1641	14.03
^{89}Y	0.0000	0.1013	0.0827	0.0920	10.13
^{156}Gd	0.5917	0.5773	0.5054	0.5581	6.76
^{157}Gd	0.8340	0.8158	0.8253	0.8251	0.90
^{88}Sr	0.0000	0.0404	0.0505	0.0455	11.16
^{147}Sm	0.5573	0.5452	0.5243	0.5423	2.51
^{99}Mo	0.5006	0.4874	0.6881	0.5587	16.41
^{84}Kr	0.0000	0.1638	0.1147	0.1392	17.62
^{140}Ba	0.0000	0.1311	0.1522	0.1416	7.44
^{131}I	0.2701	0.2646	0.2820	0.2722	2.66
^{86}Kr	0.0000	0.1114	0.0655	0.0885	25.98
^{133}Xe	0.1951	0.1925	0.2571	0.2149	13.88
^{158}Gd	0.0000	0.5067	0.5507	0.5287	4.16
^{81}Br	0.0000	0.2173	0.3164	0.2669	18.56
^{89}Sr	0.0000	0.0366	0.0790	0.0578	36.74
^{129}Te	0.0000	0.1390	0.1850	0.1620	14.20
^{119}Sn	0.0000	0.5773	0.6247	0.6010	3.94
^{85}Kr	0.0000	0.0537	0.0620	0.0579	7.16
^{150}Sm	0.3317	0.3243	0.3734	0.3431	6.30
^{82}Se	0.0000	0.1211	0.1439	0.1325	8.59
^{121}Sb	0.4425	0.4348	0.4908	0.4560	5.44
^{100}Ru	0.0000	0.1609	0.2071	0.1840	12.55

Table 5.2. ***Continued***

Institute Library	CEA JEF-2.2	ECN JEF-2.2	JNDC JENDL-3.2	Average	RMS (%)
^{126}Sn	0.0000	0.0667	0.1018	0.0842	20.81
^{113}Cd	0.3898	0.3776	0.3305	0.3659	6.99
^{125}Sb	0.1746	0.1714	0.1819	0.1759	2.50
^{159}Tb	0.0000	0.9638	0.6133	0.7885	22.23
^{112}Cd	0.1488	0.1457	0.1849	0.1598	11.15
^{104}Pd	0.0000	0.2035	0.1922	0.1979	2.86
^{154}Eu	0.9158	0.8918	0.4550	0.7542	28.08
^{156}Eu	0.0000	1.3320	1.1121	1.2221	9.00
^{117}Sn	0.0000	0.3214	0.3463	0.3339	3.73
^{148}Sm	0.0000	0.1982	0.2462	0.2222	10.81
^{105}Rh	0.2872	0.2806	0.4240	0.3306	20.00
^{114}Cd	0.0000	0.1390	0.2030	0.1710	18.72
^{160}Gd	0.0000	0.5105	0.5664	0.5385	5.19
^{80}Se	0.0000	0.1235	0.1525	0.1380	10.51
^{116}Cd	0.0000	0.1597	0.2119	0.1858	14.04
^{149}Pm	0.5045	0.4923	0.6892	0.5620	16.03
^{124}Sn	0.0000	0.0645	0.1035	0.0840	23.23
^{115}In	0.1190	0.1177	0.1393	0.1253	7.89
^{136}Ba	0.0000	0.1298	0.1353	0.1326	2.07
^{127}Te	0.0000	0.1215	0.2295	0.1755	30.78
^{153}Sm	0.0000	1.4055	1.3639	1.3847	1.50
^{148}Pm	0.6098	0.5942	0.4980	0.5673	8.71
^{137}Ba	0.0000	0.1851	0.1415	0.1633	13.37
^{123}Sb	0.0000	0.2208	0.2576	0.2392	7.70
^{110}Cd	0.0000	0.1255	0.1674	0.1464	14.30
^{155}Gd	0.0000	0.7726	0.7637	0.7681	0.57
^{122}Sn	0.0000	0.0727	0.0983	0.0855	14.99
^{120}Sn	0.0000	0.0670	0.1002	0.0836	19.87
^{125}Te	0.0000	0.5385	0.5546	0.5466	1.46
^{118}Sn	0.0000	0.0608	0.0959	0.0784	22.36
^{123}Sn	0.0000	0.0907	0.1487	0.1197	24.24
^{78}Se	0.0000	0.1294	0.1652	0.1473	12.15
^{77}Se	0.0000	0.3267	0.4345	0.3806	14.16
^{96}Mo	0.0000	0.1160	0.1833	0.1496	22.48
^{85}Rb	0.2460	0.2403	0.3057	0.2640	11.20
^{130}Xe	0.0000	0.2370	0.1742	0.2056	15.27
^{148}Pm	0.0000	0.5942	0.7662	0.6802	12.64
^{136}Cs	0.0000	0.1827	0.3319	0.2573	29.00
^{142}Nd	0.0000	0.0744	0.0974	0.0859	13.37
^{128}Xe	0.0000	0.2641	0.2022	0.2331	13.27
^{134}Ba	0.0000	0.1694	0.1688	0.1691	0.18
^{126}Te	0.0000	0.1412	0.1532	0.1472	4.09
^{90}Zr	0.0000	0.0501	0.0590	0.0545	8.14
^{82}Kr	0.0000	0.1753	0.1342	0.1548	13.29
^{115}Sn	0.0000	0.1916	0.2001	0.1958	2.16

Table 5.3. One group cross-sections for (n,2n) reactions (MT=16) of the nuclides in order of descending importance determined by the product of the cross-section (ADL-3) and yield of the nuclide

Institute Library	CEA JEF-2.2	ECN JEF-2.2	IPPE ADL-3	JNDC JENDL-3.2	Average	RMS [a] (%)
^{142}Ce	1.1818	1.0179	1.0874	0.9124	1.0499	9.37
^{145}Nd	3.9818	3.8276	1.5629	3.2449	3.1543	30.40
^{143}Nd	2.6339	2.5023	1.0868	1.8441	2.0168	30.48
^{101}Ru	1.0978	0.9987	0.6108	1.0233	0.9326	20.31
^{131}Xe	2.0694	1.9330	0.9326	1.1105	1.5114	32.83
^{144}Ce	1.6126	1.4160	1.2582	1.2309	1.3794	11.02
^{97}Mo	0.0000	0.0000	0.5574	0.5398	0.5486	1.61
^{137}Cs	0.4922	0.3927	0.4355	0.3799	0.4251	10.32
^{136}Xe	0.7068	0.5802	0.3998	0.5135	0.5501	20.20
^{93}Zr	0.8254	0.7369	0.6553	1.0138	0.8078	16.50
^{107}Pd	2.2136	2.0801	0.8043	1.2667	1.5912	36.52
^{141}Ce	2.0727	1.9468	2.0871	3.2376	2.3361	22.40
^{96}Zr	0.6988	0.6158	0.4580	0.5241	0.5742	15.88
^{105}Pd	1.1214	1.0192	0.4507	0.7754	0.8417	30.70
^{134}Xe	0.6174	0.4972	0.2839	0.2728	0.4178	34.91
^{135}Cs	0.3927	0.2867	0.2716	0.2671	0.3045	16.89
^{100}Mo	0.5894	0.5017	0.3109	0.3065	0.4271	28.67
^{149}Sm	4.1049	3.9494	1.5415	2.6303	3.0565	34.21
^{151}Sm	2.9146	2.7685	2.4655	2.4093	2.6395	7.94
^{146}Nd	1.1233	1.0230	0.6855	0.6612	0.8733	23.27
^{103}Ru	2.2548	2.1410	1.0694	1.6210	1.7716	26.56
^{139}La	0.5170	0.4278	0.2676	0.2497	0.3655	30.54
^{104}Ru	0.0000	0.0000	0.2434	0.2903	0.2669	8.78
^{148}Nd	1.4448	1.3391	0.8781	0.8036	1.1164	25.02
^{133}Cs	0.4921	0.4005	0.2254	0.2128	0.3327	35.53
^{98}Mo	0.4841	0.3964	0.2514	0.2423	0.3435	29.58
^{94}Zr	0.0000	0.0000	0.3308	0.3609	0.3458	4.35
^{138}Ba	0.4936	0.3937	0.2701	0.2665	0.3560	26.55
^{95}Zr	1.0420	0.9499	0.7379	1.2580	0.9969	18.73
^{132}Xe	0.4985	0.3889	0.2375	0.2064	0.3328	35.45
^{147}Pm	1.0495	0.9402	0.7492	0.5796	0.8296	21.69
^{102}Ru	0.0000	0.0000	0.1723	0.2058	0.1890	8.86
^{99}Tc	0.4543	0.3697	0.1973	0.2010	0.3056	36.18
^{106}Ru	0.0000	0.0000	0.2971	0.3716	0.3344	11.15
^{140}Ce	0.0000	0.0000	0.2043	0.1914	0.1978	3.27
^{150}Nd	1.3084	1.1096	0.8256	0.6928	0.9841	24.41
^{90}Sr	0.0000	0.0000	0.4331	0.4335	0.4333	0.04
^{103}Rh	0.3539	0.2761	0.1669	0.1389	0.2340	36.82
^{141}Pr	0.3735	0.2902	0.1736	0.1826	0.2550	32.30
^{95}Mo	0.0000	0.0000	0.3382	0.3408	0.3395	0.38

[a] As the columns are not all independent, the RMS value is only indicative and might be too small.

Table 5.3. One group cross-sections for (n,2n) reactions (MT=16)

Institute Library	CEA JEF-2.2	ECN JEF-2.2	IPPE ADL-3	JNDC JENDL-3.2	Average	RMS (%)
^{140}Ba	0.0000	2.4793	1.7190	1.5348	1.9110	21.39
^{92}Zr	0.0000	0.0000	0.2253	0.2366	0.2309	2.44
^{130}Te	0.0000	0.0000	0.3499	0.3008	0.3254	7.54
^{91}Zr	0.4528	0.4000	0.3370	0.3101	0.3750	14.81
^{144}Nd	0.9323	0.8359	0.5527	0.4850	0.7015	26.70
^{147}Nd	0.0000	0.0000	3.1135	4.9516	4.0325	22.79
^{108}Pd	0.4641	0.3716	0.1749	0.2133	0.3060	38.36
^{89}Sr	0.0000	0.0000	0.7110	1.2691	0.9901	28.18
^{152}Sm	0.8242	0.7408	0.4670	0.3803	0.6031	30.57
^{91}Y	0.0000	0.0000	0.4003	0.3647	0.3825	4.66
^{143}Pr	0.0000	0.0000	0.8734	0.7758	0.8246	5.92
^{109}Ag	0.3879	0.3136	0.1785	0.1790	0.2648	33.96
^{95}Nb	0.4757	0.3922	0.2893	0.2776	0.3587	22.56
^{111}Cd	0.8347	0.7483	0.5800	0.7638	0.7317	12.77
^{128}Te	0.0000	0.0000	0.2773	0.2267	0.2520	10.02
^{140}La	0.0000	0.0000	3.9566	0.0000	3.9566	0.00
^{110}Pd	0.5779	0.4859	0.2284	0.3032	0.3988	34.98
^{133}Xe	0.0000	0.0000	0.9399	1.2794	1.1096	15.30
^{129}I	0.3965	0.3107	0.2297	0.2434	0.2950	22.41
^{129}Te	0.0000	0.0000	0.8330	1.5979	1.2155	31.46
^{85}Kr	0.0000	0.0000	0.2869	0.6447	0.4658	38.40
^{154}Sm	0.0000	0.0000	0.5825	0.4901	0.5363	8.61
^{153}Eu	0.7206	0.6040	0.3774	0.2563	0.4896	37.31
^{99}Mo	0.0000	0.0000	1.5544	2.1806	1.8675	16.77
^{106}Pd	0.3844	0.2929	0.1378	0.1692	0.2461	40.11
^{157}Gd	0.0000	0.0000	1.5178	1.2578	1.3878	9.37
^{143}Ce	0.0000	0.0000	3.4956	0.0000	3.4956	0.00
^{134}Cs	0.0000	0.0000	0.8867	0.9711	0.9289	4.54
^{147}Sm	2.6939	2.5681	0.9539	0.8208	1.7592	49.70
^{126}Sn	0.0000	0.0000	0.3984	0.4161	0.4073	2.17
^{87}Rb	0.0000	0.0000	0.0959	0.1044	0.1002	4.25
^{155}Eu	0.6982	0.5957	0.5030	0.3643	0.5403	22.74
^{86}Kr	0.0000	0.1518	0.1141	0.0885	0.1181	22.03
^{127}I	0.3880	0.3255	0.2162	0.2331	0.2907	24.05
^{154}Eu	1.0676	0.9558	1.6655	1.2818	1.2427	21.79
^{113}Cd	0.6090	0.5296	0.9032	1.1662	0.8020	31.44
^{88}Sr	0.0000	0.0000	0.0553	0.0483	0.0518	6.80
^{83}Kr	0.0000	0.6797	0.2187	0.3625	0.4203	45.82
^{89}Y	0.0000	0.0720	0.0490	0.0433	0.0548	22.62
^{156}Gd	0.6199	0.5188	0.3587	0.3074	0.4512	27.65
^{150}Sm	0.0000	0.0000	0.5997	0.3996	0.4997	20.02
^{119}Sn	0.0000	0.0000	0.8365	1.3121	1.0743	22.14
^{158}Gd	0.0000	0.0000	0.5982	0.5008	0.5495	8.87
^{131}I	0.0000	0.0000	0.2435	0.3070	0.2752	11.54
^{125}Sb	0.0000	0.0000	0.2931	0.2520	0.2726	7.52

Table 5.3. One group cross-sections for (n,2n) reactions (MT=16)

Institute Library	CEA JEF-2.2	ECN JEF-2.2	IPPE ADL-3	JNDC JENDL-3.2	Average	RMS (%)
^{132}Te	0.0000	0.0000	0.3962	0.0000	0.3962	0.00
^{124}Sn	0.0000	0.0000	0.3355	0.3282	0.3318	1.11
^{84}Kr	0.0000	0.1263	0.0705	0.0628	0.0865	32.69
^{156}Eu	0.0000	0.0000	1.9911	1.3876	1.6894	17.86
^{148}Pm	0.0000	0.0000	2.0836	2.1593	2.1214	1.78
^{148}Sm	0.0000	0.0000	0.4725	0.4138	0.4431	6.62
^{137}Ba	0.0000	0.0000	0.6610	0.8709	0.7660	13.70
^{117}Sn	0.0000	0.0000	0.5407	0.8909	0.7158	24.46
^{127}Te	0.0000	0.0000	0.7215	1.1535	0.9375	23.04
^{161}Dy	0.0000	0.0000	1.4646	0.0000	1.4646	0.00
^{82}Se	0.0000	0.0000	0.1208	0.1422	0.1315	8.16
^{123}Sn	0.0000	0.0000	0.7066	2.2047	1.4556	51.46
^{160}Gd	0.0000	0.0000	0.7977	0.7502	0.7740	3.07
^{159}Tb	0.0000	0.6496	0.4991	0.4648	0.5378	14.92
^{112}Cd	0.0000	0.0000	0.1476	0.1672	0.1574	6.22
^{114}Cd	0.0000	0.0000	0.1915	0.2356	0.2135	10.32
^{122}Sn	0.0000	0.0000	0.2762	0.2667	0.2714	1.75
^{136}Ba	0.0000	0.0000	0.2321	0.1867	0.2094	10.85
^{100}Ru	0.0000	0.0000	0.1242	0.1511	0.1376	9.75
^{153}Sm	0.0000	0.0000	2.5744	1.7546	2.1645	18.94
^{116}Cd	0.0000	0.0000	0.2617	0.2859	0.2738	4.42
^{115}In	0.0000	0.0000	0.1825	0.1617	0.1721	6.05
^{149}Pm	0.0000	0.0000	0.7706	0.7371	0.7539	2.22
^{120}Sn	0.0000	0.0000	0.2113	0.2052	0.2082	1.46
^{121}Sb	0.0000	0.0000	0.2142	0.1598	0.1870	14.55
^{104}Pd	0.0000	0.2287	0.1014	0.1155	0.1485	38.36
^{155}Gd	0.0000	0.0000	1.3381	0.9688	1.1534	16.01
^{148}Pm	0.0000	0.0000	2.8793	2.1593	2.5193	14.29
^{136}Cs	0.0000	0.0000	1.2428	1.1047	1.1737	5.88
^{125}Te	0.0000	0.0000	0.9264	1.0398	0.9831	5.77
^{118}Sn	0.0000	0.0000	0.1708	0.1529	0.1618	5.54
^{81}Br	0.0000	0.0000	0.0754	0.0808	0.0781	3.44
^{125}Sn	0.0000	0.0000	0.9031	0.0000	0.9031	0.00
^{80}Se	0.0000	0.0000	0.0954	0.1055	0.1004	5.00
^{105}Rh	0.0000	0.0000	0.1620	0.2340	0.1979	18.19
^{123}Sb	0.0000	0.0000	0.2339	0.2306	0.2322	0.70
^{115}Cd	0.0000	0.0000	0.8746	0.0000	0.8746	0.00
^{111}Ag	0.0000	0.0000	0.2272	0.0000	0.2272	0.00
^{110}Cd	0.0000	0.0000	0.1120	0.0957	0.1038	7.88
^{96}Mo	0.0000	0.0000	0.1709	0.1648	0.1678	1.81
^{77}Se	0.0000	0.0000	0.2817	0.5030	0.3923	28.20
^{160}Tb	0.0000	0.0000	1.7044	0.0000	1.7044	0.00
^{130}Xe	0.0000	0.2918	0.1753	0.1914	0.2195	23.49
^{142}Nd	0.0000	0.0000	0.1202	0.1387	0.1295	7.14
^{78}Se	0.0000	0.0000	0.0655	0.0669	0.0662	1.05

5.2 Energy dependence of capture cross-sections

A detailed analysis of the energy dependence of the most important fission-product capture cross-sections has been provided by JNDC. The 20 most important nuclides and seven discrepant nuclides have been inspected by means of a comparison of JEF-2.2, JENDL-3.2, ENDF/B-VI, and BROND-2 evaluations together with experimental data. The graphs and detailed comments are given in Appendix A and in Appendix D.

The main observations with respect to the differences between JEF-2.2 and JENDL-3.2 are:

- JENDL-3.2 cross-sections are smaller than those of JEF-2.2 for important unstable nuclides like ^{151}Sm, ^{103}Ru and ^{155}Eu for which experimental data are lacking in the unresolved energy range. In these cases the evaluation methodology plays an important role. In a number of cases JEF-2.2 data had been adjusted to integral data.

- For a number of nuclides, there are more recent experimental data which have the tendency to be smaller than previous data. This holds in particular for ^{109}Ag and ^{149}Sm. Since JENDL-3.2 is based upon these more recent data, the JENDL-3.2 cross-sections have the tendency to be smaller than the JEF-2.2 ones. In the low energy region below 10 eV, the lumped fission-product capture cross-section is mainly determined by ^{155}Eu. JENDL-3.2 was evaluated on the basis of experimental data of thermal values and resonance parameters. Note that in BROND, the new data have been considered, but in the case of ^{149}Sm these data were not adopted. In general new data do not always imply improvements.

- Finally, it is noted that the JNDC analysis of STEK integral reactivity data shows an underestimation of JENDL-3.2 for nuclides with masses larger than A=130, whereas most JEF-2.2 evaluations have been adjusted to these measurements (former RCN evaluations). The JNDC and ECN analyses of STEK are not exactly the same and may reflect differences due to self-shielding treatment or other computational differences. The experimental error of STEK data is less than 5% (1 σ), while the estimated systematic error was of the order of 5%, due to systematic uncertainties in the flux and adjoint function. However, it is not excluded that this value is higher.

- Following the above observations, it seems difficult to indicate one possible cause of the differences between JENDL-3.2 and JEF-2.2 capture cross-section evaluations. There are three aspects:

  1. Evaluation methodology, mostly relevant to unstable nuclides without experimental data, but also important in the difficult unresolved resonance range;
  2. Use of recent differential data;
  3. Use of integral data.

Detailed analysis with the help of the graphs and discussion as given in Appendix D is required to further resolve this discrepancy.

Finally, we add some suggestions here to inspect the evaluation methodology. A common reason could be the optical-model parametrisation or the systematics used for the (p-wave) strength functions. More generally, it is suggested to compare the yield-averaged values of S_0, S_1, $\Gamma\gamma$ and D_0 of the various evaluations, to assess possible reasons for systematic differences. These parameters determine the unresolved resonance range and are difficult to extract from resolved resonance parameters if there is a significant fraction of missed (p-wave) resonances. The optical model should match the s- and p-wave strength functions. In the high-energy part of the resolved-resonance range, a correction for missed resonances should be made. All these points are well known to the evaluators, but in order to make progress it is necessary to re-investigate such possible sources of differences.

5.3 Inelastic scattering cross-sections

There is no detailed analysis of the energy dependence of inelastic scattering cross-sections. However, a lot of work on fission-product inelastic scattering cross-sections has been performed in the framework of another working group (SG10). In this working group, emphasis is given to the evaluation methods used for inelastic scattering that are traditionally based upon the spherical optical model in most of the older evaluations. Direct effects should be accounted for by means of DWBA or coupled channels optical models. However, this is of marginal interest to the reactivity effect of fission-products in fast reactors. More important could be the observed underprediction in inelastic scattering cross-sections near A=100 in most of the older evaluations, related to the adopted optical-model parametrisation. In general in JENDL-3.2 the most recent data have been used and direct effects were accounted for by the DWBA model.

6. Conclusions

The major results are summarised in Tables 6.1 and 6.2, which have been extracted from Sections 4.1 and 4.2.

Table 6.1. One group cross-sections of the pseudo-nuclide

File	2 (n,n) (b)	4 (n,n′) (b)	16 (n,2n) (mb)	102 (n,γ) (b)	103 (n,p) (μb)	107 (n,α) (μb)	Total (b)
JEF-2.2	15.2	0.577	1.23	0.577	12.0	4.4	16.4
EAF-4.2[a]			1.57		12.1	11.5	
JENDL-3.2	14.4	0.531	1.12	0.546	5.4	21.4	15.5
FOND-2.1		0.527	0.78	0.578	12.8	5.32	
ADL-3			0.92	0.544	7.5	6.73	
Average	14.8	0.545	1.12	0.561	10.0	9.9	15.9
Maxdiff (%)	5.4	9.0	70	5.9	74	172	5.7

Table 6.2. Reactivity effects of the pseudo-nuclide (arbitrary units)

File	2 (n,n) (au)[b]	4 (n,n') (au)	16 (n,2n) (au)[b]	102 (n,γ) (au)	Total (au)
JEF-2.2	-3.92	-0.0684	-0.694	-0.583	-0.656
JENDL-3.2	-4.67	-0.0652	-0.644	-0.546	-0.622
FOND-2.1[a]		-0.0654		-0.584	-0.649
ADL-3		-0.0654		-0.550	
Average	-4.30	-0.0663	-0.669	-0.566	-0.642
Maxdiff (%)	17	4.8	7.5	5.8	5.3

[a] Corrected for missing nuclides (factor 2/1.934 for MT=4).

[b] Numbers have been multiplied with 10^3.

From the previous sections we may conclude that the considered data evaluations give a maximum spread in lumped one group cross-sections averaged over the spectrum of a large fast power reactor of about 6% for capture and 9% for inelastic scattering. On average the reactivity effect consists mainly of the radiative capture effect with a 10% contribution of inelastic scattering. The total reactivity effect has a maximum spread of 5.3%. Data processing errors are small for these cross-sections, in contrast to those for (n,2n), (n,p) and (n,α) cross-sections.

Inspection of the differences did not reveal large problems in the libraries for capture and inelastic scattering cross-sections. However, there is a 5 to 6% systematic difference in the lumped one group cross-sections between

JENDL-3.2 and JEF-2.2. This is partly ascribed to different evaluations of important absorbers like ^{149}Sm, ^{99}Tc, ^{147}Pm, ^{151}Sm, ^{103}Ru, ^{97}Mo, ^{153}Eu and ^{109}Ag. Re-investigation of these evaluations is recommended, in particular for the unstable nuclides. For the inelastic scattering cross-sections some improvements could be obtained by re-investigating the data for nuclides with low-lying levels, below 200 keV (e.g. ^{101}Ru, ^{133}Cs, ^{103}Rh, ^{145}Nd, ^{103}Ru, ^{107}Pd and ^{149}Sm).

However, improvements for a few individual fission-products will not easily solve the remaining discrepancies, since there are also systematic differences. These are probably caused by the evaluation method and/or the adjustment to integral data (JEF-2.2). For capture the unresolved resonance treatment with the difficulties in parametrisation of strength functions, level spacing and radiation widths due to missed resonances, and the treatment of width fluctuations could be important. Also the background correction in the resolved energy range can play a role. Adjusted data could have a systematic uncertainty, which is typically of the order of 5%. It is noted that there are also for some nuclides discrepancies between integral data (e.g. between STEK reactivity worth measurements and CFRMF activation measurements). New integral experiments could be considered for a number of fission-products.

For inelastic cross-sections, the optical model choice and parametrisation as well as width-fluctuation factor treatment could be different in various evaluations. It is not easy to assess such differences in the evaluation methods.

The main point to be further investigated is the systematic difference of 5-6% in the total, elastic and capture cross-sections between JENDL-3.2 and JEF-2.2. There is probably no single cause of this discrepancy. Three aspects of relevance are:

1. The evaluation methodology for unstable nuclides and possibly the unresolved resonance treatment;

2. Use of more recent experimental data in JENDL-3.2;

3. Use of integral data in JEF-2.2. Detailed analysis with the help of graphs as given in Appendix D is required to further resolve this discrepancy, in particular for the top 20 nuclides.

Finally, in spite of the above mentioned problems, the status of lumped fission-product cross-sections is satisfactory for fast reactor applications, although some improvements are possible as indicated in this report.

APPENDIX A

Nuclide Concentrations

Table A.1. Nuclides and concentrations in the lumped fission-product. For the benchmark, the yields of ^{239}Pu were used.

Nuclide	Identification	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
^{76}Ge	320760	.00015	.00001	.00011	.00001	.00000
^{75}As	330750	.00007	.00000	.00000	.00000	.00000
^{77}Se	340770	.00029	.00004	.00013	.00014	.00010
^{78}Se	340780	.00056	.00014	.00035	.00029	.00019
^{79}Se	340790	.00091	.00040	.00053	.00053	.00037
^{80}Se	340800	.00151	.00087	.00090	.00091	.00068
^{82}Se	340820	.00390	.00250	.00235	.00209	.00171
^{81}Br	350810	.00246	.00157	.00137	.00148	.00109
^{82}Br	350820	.00000	.00000	.00000	.00000	.00000
^{82}Kr	360820	.00006	.00003	.00006	.00003	.00002
^{83}Kr	360830	.00601	.00390	.00348	.00312	.00245
^{84}Kr	360840	.01084	.00559	.00565	.00458	.00377
^{85}Kr	360850	.01380	.00715	.00655	.00589	.00501
^{86}Kr	360860	.01928	.01382	.00878	.00793	.00674
^{85}Rb	370850	.00029	.00015	.00014	.00012	.00010
^{86}Rb	370860	.00001	.00000	.00000	.00000	.00000
^{87}Rb	370870	.02548	.01700	.01150	.01019	.00884
^{86}Sr	380860	.00004	.00000	.00001	.00000	.00000
^{88}Sr	380880	.03641	.02102	.01421	.01281	.01135
^{89}Sr	380890	.01278	.00956	.00543	.00499	.00424
^{90}Sr	380900	.05075	.03115	.01875	.01964	.01752
^{89}Y	390890	.03156	.02202	.01285	.01110	.00960
^{90}Y	390900	.00001	.00001	.00001	.00001	.00000
^{91}Y	390910	.01763	.01332	.00864	.00847	.00746
^{90}Zr	400900	.00043	.00026	.00016	.00016	.00014
^{91}Zr	400910	.03532	.02499	.01660	.01537	.01376
^{92}Zr	400920	.05639	.04312	.03061	.02930	.02579
^{93}Zr	400930	.05964	.04700	.03791	.03531	.03153
^{94}Zr	400940	.06449	.05107	.04274	.04232	.03773
^{95}Zr	400950	.02315	.02063	.01757	.01773	.01701
^{96}Zr	400960	.06553	.05744	.04939	.05027	.04737
^{95}Nb	410950	.01146	.00991	.00854	.00839	.00811
^{95}Mo	420950	.02925	.02417	.02118	.01998	.01955
^{96}Mo	420960	.00060	.00025	.00025	.00023	.00020
^{97}Mo	420970	.05848	.05804	.05200	.05280	.05080
^{98}Mo	420980	.06136	.06127	.05650	.05568	.05495
^{99}Mo	420990	.00091	.00112	.00099	.00108	.00101
^{100}Mo	421000	.06355	.06151	.06439	.06041	.05951

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Table A.1. *Continued*

Nuclide	Identification	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
^{99}Tc	430990	.05349	.06007	.05500	.05552	.05294
^{100}Ru	441000	.00152	.00165	.00153	.00149	.00144
^{101}Ru	441010	.05327	.05944	.06387	.05848	.05876
^{102}Ru	441020	.04816	.06361	.06834	.06165	.06099
^{103}Ru	441030	.00796	.01479	.01592	.01549	.01526
^{104}Ru	441040	.02366	.05702	.06499	.05791	.05900
^{106}Ru	441060	.00365	.02337	.03378	.04131	.04267
^{103}Rh	451030	.02509	.04346	.04810	.04391	.04404
^{105}Rh	451050	.00013	.00034	.00048	.00055	.00056
^{104}Pd	461040	.00067	.00112	.00126	.00112	.00113
^{105}Pd	461050	.01426	.03348	.04837	.05230	.05430
^{106}Pd	461060	.00149	.00679	.01105	.01148	.01200
^{107}Pd	461070	.00172	.01234	.03083	.04078	.04110
^{108}Pd	461080	.00078	.00684	.02415	.03321	.03912
^{110}Pd	461100	.00045	.00139	.00923	.01200	.01691
^{109}Ag	471090	.00054	.00201	.01632	.02139	.02758
^{111}Ag	471110	.00001	.00004	.00021	.00030	.00045
^{110}Cd	481100	.00001	.00005	.00042	.00052	.00067
^{111}Cd	481110	.00027	.00073	.00410	.00558	.00854
^{112}Cd	481120	.00039	.00071	.00135	.00288	.00433
^{113}Cd	481130	.00034	.00055	.00091	.00150	.00222
^{114}Cd	481140	.00034	.00046	.00100	.00102	.00103
^{115}Cd	481150	.00000	.00001	.00001	.00001	.00001
^{115m}Cd	481151	.00001	.00001	.00008	.00008	.00007
^{116}Cd	481160	.00036	.00035	.00064	.00085	.00100
^{115}In	491150	.00020	.00037	.00089	.00086	.00097
^{115}Sn	501150	.00001	.00002	.00004	.00004	.00005
^{116}Sn	501160	.00000	.00001	.00002	.00002	.00002
^{117}Sn	501170	.00037	.00034	.00064	.00085	.00090
^{118}Sn	501180	.00039	.00034	.00065	.00080	.00087
^{119}Sn	501190	.00042	.00034	.00066	.00080	.00086
^{120}Sn	501200	.00044	.00034	.00067	.00085	.00085
^{122}Sn	501220	.00048	.00037	.00069	.00095	.00093
^{123}Sn	501230	.00030	.00022	.00039	.00063	.00057
^{124}Sn	501240	.00060	.00042	.00120	.00120	.00111
^{125}Sn	501250	.00004	.00005	.00011	.00010	.00007
^{126}Sn	501260	.00104	.00100	.00303	.00316	.00240
^{121}Sb	511210	.00045	.00035	.00066	.00083	.00088
^{122}Sb	511220	.00000	.00000	.00000	.00000	.00000
^{123}Sb	511230	.00024	.00017	.00030	.00046	.00043
^{124}Sb	511240	.00000	.00000	.00000	.00000	.00000
^{125}Sb	511250	.00063	.00066	.00163	.00138	.00095

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Table A.1. *Continued*

Nuclide	Identification	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
^{126}Sb	511260	.00001	.00000	.00001	.00001	.00000
^{127}Sb	511270	.00005	.00004	.00012	.00010	.00008
^{122}Te	521220	.00001	.00001	.00002	.00002	.00002
^{123}Te	521230	.00000	.00000	.00000	.00000	.00000
^{124}Te	521240	.00000	.00000	.00000	.00000	.00000
^{125}Te	521250	.00005	.00005	.00012	.00009	.00007
^{125m}Te	521251	.00001	.00001	.00001	.00001	.00001
^{126}Te	521260	.00006	.00001	.00008	.00005	.00002
^{127m}Te	521271	.00017	.00013	.00045	.00033	.00028
^{128}Te	521280	.00321	.00506	.00790	.00618	.00520
^{129m}Te	521291	.00108	.00189	.00230	.00215	.00179
^{130}Te	521300	.01439	.01959	.01956	.01889	.01534
^{132}Te	521320	.00089	.00095	.00104	.00104	.00094
^{127}I	531270	.00174	.00132	.00446	.00318	.00277
^{129}I	531290	.00442	.00713	.00897	.00783	.00664
^{131}I	531310	.00153	.00185	.00218	.00184	.00150
^{128}Xe	541280	.00005	.00003	.00012	.00008	.00007
^{129}Xe	541290	.00000	.00000	.00000	.00000	.00000
^{130}Xe	541300	.00008	.00012	.00018	.00013	.00011
^{131}Xe	541310	.03063	.03391	.04139	.03224	.02683
^{132}Xe	541320	.04761	.04546	.05273	.04823	.04405
^{133}Xe	541330	.00206	.00184	.00223	.00199	.00191
^{134}Xe	541340	.07155	.06172	.07229	.06270	.06102
^{136}Xe	541360	.05993	.06292	.06776	.07121	.07112
^{133}Cs	551330	.06293	.05152	.06441	.05353	.05231
^{134}Cs	551340	.00169	.00120	.00153	.00123	.00121
^{135}Cs	551350	.06393	.05627	.07424	.06772	.06705
^{136}Cs	551360	.00004	.00003	.00009	.00007	.00005
^{137}Cs	551370	.06228	.06949	.06342	.06948	.07181
^{134}Ba	561340	.00014	.00008	.00011	.00008	.00008
^{135}Ba	561350	.00000	.00000	.00000	.00000	.00000
^{136}Ba	561360	.00024	.00016	.00082	.00056	.00031
^{137}Ba	561370	.00047	.00051	.00057	.00050	.00052
^{138}Ba	561380	.06692	.06477	.04936	.06465	.06738
^{140}Ba	561400	.00433	.00493	.00414	.00456	.00461
^{139}La	571390	.07087	.06083	.06053	.05802	.06093
^{140}La	571400	.00057	.00065	.00054	.00060	.00061
^{140}Ce	581400	.05322	.05506	.04787	.04868	.05031
^{141}Ce	581410	.01178	.01124	.01176	.01027	.01074
^{142}Ce	581420	.05878	.05054	.04924	.05302	.04990
^{143}Ce	581430	.00048	.00042	.00039	.00047	.00050
^{144}Ce	581440	.03849	.03424	.02642	.03057	.03336

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Table A.1. ***Continued***

Nuclide	Identification	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
^{141}Pr	591410	.04854	.04277	.04611	.03757	.04006
^{143}Pr	591430	.00467	.00403	.00372	.00452	.00481
^{142}Nd	601420	.00028	.00024	.00026	.00021	.00022
^{143}Nd	601430	.05270	.04163	.03970	.04464	.04854
^{144}Nd	601440	.01301	.01104	.00876	.00975	.01075
^{145}Nd	601450	.03778	.04086	.03010	.03268	.03477
^{146}Nd	601460	.03016	.03897	.02557	.02847	.03051
^{147}Nd	601470	.00133	.00186	.00141	.00161	.00176
^{148}Nd	601480	.01691	.02359	.01715	.01814	.01929
^{150}Nd	601500	.00715	.01464	.01039	.01157	.01290
^{147}Pm	611470	.01651	.02131	.01664	.01768	.01979
^{148}Pm	611480	.00004	.00005	.00004	.00004	.00005
^{148m}Pm	611481	.00020	.00025	.00019	.00020	.00023
^{149}Pm	611490	.00015	.00025	.00019	.00023	.00024
^{147}Sm	621470	.00135	.00168	.00133	.00137	.00155
^{148}Sm	621480	.00086	.00104	.00083	.00084	.00096
^{149}Sm	621490	.01017	.01620	.01265	.01404	.01520
^{150}Sm	621500	.00076	.00117	.00093	.00099	.00109
^{151}Sm	621510	.00400	.00928	.00761	.00851	.00911
^{152}Sm	621520	.00350	.00751	.00759	.00850	.00930
^{153}Sm	621530	.00002	.00006	.00007	.00008	.00009
^{154}Sm	621540	.00097	.00213	.00321	.00405	.00447
^{153}Eu	631530	.00182	.00390	.00463	.00508	.00574
^{154}Eu	631540	.00020	.00042	.00051	.00054	.00061
^{155}Eu	631550	.00034	.00105	.00214	.00267	.00295
^{156}Eu	631560	.00002	.00009	.00020	.00027	.00030
^{154}Gd	641540	.00000	.00001	.00001	.00001	.00001
^{155}Gd	641550	.00001	.00004	.00009	.00011	.00012
^{156}Gd	641560	.00017	.00071	.00166	.00215	.00246
^{157}Gd	641570	.00007	.00027	.00093	.00122	.00139
^{158}Gd	641580	.00006	.00021	.00089	.00111	.00135
^{160}Gd	641600	.00001	.00003	.00033	.00033	.00039
^{159}Tb	651590	.00003	.00008	.00043	.00053	.00062
^{160}Tb	651600	.00000	.00000	.00002	.00002	.00002
^{161}Tb	651610	.00000	.00000	.00001	.00002	.00001
^{160}Dy	661600	.00000	.00000	.00001	.00002	.00002
^{161}Dy	661610	.00000	.00001	.00020	.00029	.00020
^{162}Dy	661620	.00000	.00000	.00002	.00003	.00002
^{163}Dy	661630	.00000	.00000	.00000	.00000	.00000
^{164}Dy	661640	.00000	.00000	.00000	.00000	.00000

APPENDIX B

Flux Weighting Spectra

Table B.1. Energy, adjoint function and neutron spectrum used in the benchmark. A plot of these functions is shown in Figure 2.1.

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.0000e-05	1.6514e+01	1.0000e-07	1.5050e-03	1.6551e+01	6.9514e-07
4.0000e-03	1.6596e+01	9.4092e-07	5.9500e-03	1.6594e+01	1.1309e-06
8.4500e-03	1.6565e+01	1.3589e-06	1.2500e-02	1.6514e+01	1.6199e-06
1.7500e-02	1.6452e+01	1.8611e-06	2.2500e-02	1.6389e+01	2.0656e-06
2.7500e-02	1.6324e+01	2.2432e-06	3.2500e-02	1.6259e+01	2.4110e-06
3.8500e-02	1.6180e+01	2.5839e-06	4.6000e-02	1.6084e+01	2.7486e-06
5.4000e-02	1.5982e+01	2.8882e-06	6.2500e-02	1.5876e+01	3.0004e-06
7.2000e-02	1.5761e+01	3.0750e-06	7.8500e-02	1.5684e+01	3.1074e-06
8.7500e-02	1.5588e+01	3.1115e-06	9.7500e-02	1.5484e+01	3.0934e-06
1.0750e-01	1.5396e+01	3.0129e-06	1.2450e-01	1.5263e+01	2.8713e-06
1.3700e-01	1.5175e+01	2.7523e-06	1.4319e-01	1.5142e+01	2.6593e-06
1.4970e-01	1.5113e+01	2.5525e-06	1.5652e-01	1.5089e+01	2.4231e-06
1.6486e-01	1.5063e+01	2.2548e-06	1.7485e-01	1.5041e+01	2.0661e-06
1.8450e-01	1.5033e+01	1.8784e-06	1.9390e-01	1.5035e+01	1.6835e-06
2.0397e-01	1.5045e+01	1.4781e-06	2.1457e-01	1.5061e+01	1.2613e-06
2.2679e-01	1.5082e+01	1.0341e-06	2.4079e-01	1.5108e+01	8.1646e-07
2.5576e-01	1.5140e+01	6.4440e-07	2.7176e-01	1.5177e+01	5.3851e-07
2.9000e-01	1.5221e+01	5.2560e-07	3.0725e-01	1.5262e+01	5.8324e-07
3.1725e-01	1.5283e+01	6.7412e-07	3.2733e-01	1.5294e+01	8.5925e-07
3.4233e-01	1.5284e+01	1.2297e-06	3.5996e-01	1.5245e+01	1.8211e-06
3.8046e-01	1.5162e+01	2.4875e-06	3.9550e-01	1.5065e+01	3.0619e-06
4.0699e-01	1.4963e+01	3.7117e-06	4.2350e-01	1.4777e+01	4.5382e-06
4.4134e-01	1.4552e+01	5.3877e-06	4.5835e-01	1.4321e+01	6.2143e-06
4.7601e-01	1.4051e+01	6.9883e-06	4.9250e-01	1.3768e+01	7.6897e-06
5.0981e-01	1.3426e+01	8.3004e-06	5.2560e-01	1.3086e+01	8.7289e-06
5.3579e-01	1.2854e+01	9.0820e-06	5.5348e-01	1.2452e+01	9.5000e-06
5.8112e-01	1.1803e+01	9.8217e-06	6.1014e-01	1.1079e+01	9.8890e-06
6.3908e-01	1.0333e+01	9.7074e-06	6.6785e-01	9.5567e+00	9.3455e-06
6.9378e-01	8.8102e+00	8.8032e-06	7.2328e-01	7.9345e+00	7.9788e-06
7.6077e-01	6.7906e+00	7.1261e-06	7.8500e-01	6.0270e+00	6.4566e-06
8.0472e-01	5.3699e+00	5.6599e-06	8.3472e-01	4.3828e+00	4.8409e-06
8.5500e-01	3.7321e+00	4.2874e-06	8.6821e-01	3.3180e+00	3.6697e-06
8.9321e-01	2.5786e+00	2.8576e-06	9.2000e-01	1.8303e+00	2.1522e-06
9.4000e-01	1.3347e+00	1.5781e-06	9.6100e-01	8.9101e-01	1.0782e-06
9.7900e-01	5.6678e-01	7.3174e-07	9.9100e-01	3.9286e-01	3.3494e-07
1.0080e+00	2.2987e-01	3.4927e-08	1.0275e+00	9.7176e-02	2.3584e-09
1.0400e+00	5.7082e-02	1.2664e-09	1.0580e+00	5.2392e-02	1.2091e-09
1.0755e+00	6.0544e-02	1.9075e-09	1.0885e+00	9.2845e-02	3.6846e-09
1.1035e+00	1.5213e-01	6.6656e-09	1.1165e+00	2.2861e-01	1.2104e-08
1.1365e+00	3.9172e-01	2.1390e-08	1.1600e+00	6.0618e-01	3.4296e-08
1.1861e+00	8.5567e-01	5.1846e-08	1.2186e+00	1.1638e+00	7.2413e-08

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.2510e+00	1.4690e+00	9.2571e-08	1.2835e+00	1.7713e+00	1.1165e-07
1.3188e+00	2.0987e+00	1.2861e-07	1.3538e+00	2.4208e+00	1.4211e-07
1.3873e+00	2.7136e+00	1.5268e-07	1.4223e+00	3.0044e+00	1.6055e-07
1.4575e+00	3.2994e+00	1.6547e-07	1.4875e+00	3.5555e+00	1.6841e-07
1.5221e+00	3.8287e+00	1.6968e-07	1.5672e+00	4.1464e+00	1.6960e-07
1.6098e+00	4.4254e+00	1.6835e-07	1.6498e+00	4.6736e+00	1.6611e-07
1.6910e+00	4.9160e+00	1.6402e-07	1.7335e+00	5.1514e+00	1.6158e-07
1.7760e+00	5.3729e+00	1.5896e-07	1.8185e+00	5.5821e+00	1.5800e-07
1.8477e+00	5.7177e+00	1.5557e-07	1.8700e+00	5.8209e+00	1.5227e-07
1.9072e+00	5.9810e+00	1.5031e-07	1.9523e+00	6.1641e+00	1.4932e-07
1.9972e+00	6.3366e+00	1.4943e-07	2.0398e+00	6.4900e+00	1.5018e-07
2.0798e+00	6.6408e+00	1.5112e-07	2.1150e+00	6.7756e+00	1.5136e-07
2.1577e+00	6.9253e+00	1.5141e-07	2.2137e+00	7.1166e+00	1.5096e-07
2.2712e+00	7.2834e+00	1.5024e-07	2.3301e+00	7.4235e+00	1.4971e-07
2.3712e+00	7.5198e+00	1.4918e-07	2.4021e+00	7.5922e+00	1.4819e-07
2.4533e+00	7.7063e+00	1.4659e-07	2.5175e+00	7.8368e+00	1.4503e-07
2.5750e+00	7.9481e+00	1.4338e-07	2.6296e+00	8.0553e+00	1.4142e-07
2.6896e+00	8.1795e+00	1.3963e-07	2.7439e+00	8.2953e+00	1.3761e-07
2.8030e+00	8.4155e+00	1.3514e-07	2.8739e+00	8.5576e+00	1.3230e-07
2.9466e+00	8.7034e+00	1.2926e-07	3.0212e+00	8.8380e+00	1.2618e-07
3.0981e+00	8.9309e+00	1.2349e-07	3.1775e+00	8.9959e+00	1.2135e-07
3.2588e+00	9.0625e+00	1.1873e-07	3.3404e+00	9.1401e+00	1.1571e-07
3.4236e+00	9.2415e+00	1.1244e-07	3.5102e+00	9.3582e+00	1.0830e-07
3.5991e+00	9.4779e+00	1.0350e-07	3.6902e+00	9.5849e+00	1.0179e-07
3.7836e+00	9.6623e+00	1.0214e-07	3.8794e+00	9.7253e+00	1.0014e-07
3.9640e+00	9.7810e+00	9.3918e-08	4.0647e+00	9.8805e+00	8.4453e-08
4.1815e+00	1.0045e+01	7.3368e-08	4.2874e+00	1.0223e+01	7.3422e-08
4.3959e+00	1.0406e+01	7.9826e-08	4.5072e+00	1.0594e+01	7.8787e-08
4.6213e+00	1.0702e+01	7.7633e-08	4.7383e+00	1.0707e+01	7.4761e-08
4.8582e+00	1.0690e+01	6.9518e-08	4.9812e+00	1.0674e+01	6.5579e-08
5.0646e+00	1.0662e+01	6.3262e-08	5.1070e+00	1.0656e+01	6.1636e-08
5.1497e+00	1.0650e+01	6.0102e-08	5.1928e+00	1.0639e+01	5.8606e-08
5.2363e+00	1.0615e+01	5.7080e-08	5.2801e+00	1.0584e+01	5.5791e-08
5.3242e+00	1.0553e+01	5.4481e-08	5.3688e+00	1.0521e+01	5.3260e-08
5.4138e+00	1.0490e+01	5.2199e-08	5.4590e+00	1.0458e+01	5.1183e-08
5.5047e+00	1.0425e+01	5.0119e-08	5.5508e+00	1.0393e+01	4.9076e-08
5.5972e+00	1.0360e+01	4.8003e-08	5.6441e+00	1.0327e+01	4.6841e-08
5.6913e+00	1.0294e+01	4.5672e-08	5.7389e+00	1.0235e+01	4.4394e-08
5.7870e+00	1.0049e+01	4.3167e-08	5.8354e+00	9.7600e+00	4.1942e-08
5.8842e+00	9.4689e+00	4.0528e-08	5.9334e+00	9.1751e+00	3.9016e-08
5.9831e+00	8.8789e+00	3.7290e-08	6.0332e+00	8.5803e+00	3.5212e-08
6.0837e+00	8.2791e+00	3.2934e-08	6.1345e+00	7.9754e+00	3.0540e-08
6.1859e+00	7.6691e+00	2.8253e-08	6.2377e+00	7.3604e+00	2.5967e-08
6.2898e+00	7.0490e+00	2.3519e-08	6.3425e+00	6.7349e+00	2.1035e-08
6.3956e+00	6.4185e+00	1.8395e-08	6.4491e+00	6.0990e+00	1.4832e-08

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
6.5030e+00	5.7772e+00	9.3627e-09	6.5575e+00	5.4527e+00	3.6889e-09
6.6124e+00	5.1252e+00	9.2182e-10	6.6677e+00	4.7950e+00	8.7657e-10
6.7235e+00	4.4621e+00	4.3045e-09	6.7797e+00	4.1266e+00	1.5391e-08
6.8365e+00	3.9154e+00	3.1664e-08	6.8937e+00	4.0199e+00	4.7359e-08
6.9513e+00	4.3156e+00	6.1788e-08	7.0095e+00	4.6139e+00	7.4658e-08
7.0682e+00	4.9148e+00	8.4983e-08	7.1273e+00	5.2182e+00	9.2292e-08
7.1869e+00	5.5242e+00	9.6419e-08	7.2471e+00	5.8328e+00	9.8035e-08
7.3078e+00	6.1439e+00	9.8901e-08	7.3689e+00	6.4576e+00	1.0068e-07
7.4306e+00	6.7738e+00	1.0309e-07	7.4928e+00	7.0929e+00	1.0421e-07
7.5555e+00	7.4146e+00	1.0079e-07	7.6187e+00	7.7388e+00	8.8309e-08
7.6825e+00	8.0660e+00	6.4581e-08	7.7468e+00	8.3959e+00	4.3556e-08
7.8116e+00	8.7283e+00	4.8161e-08	7.8769e+00	9.0635e+00	8.7718e-08
7.9428e+00	9.2657e+00	1.3917e-07	8.0093e+00	9.3096e+00	1.7303e-07
8.0763e+00	9.3296e+00	1.8948e-07	8.1439e+00	9.3499e+00	1.9783e-07
8.2120e+00	9.3702e+00	2.0265e-07	8.2808e+00	9.3908e+00	2.0548e-07
8.3501e+00	9.4116e+00	2.0617e-07	8.4200e+00	9.4325e+00	2.0356e-07
8.4904e+00	9.4535e+00	1.9584e-07	8.5615e+00	9.4748e+00	1.8816e-07
8.6331e+00	9.4962e+00	1.9054e-07	8.7053e+00	9.5179e+00	1.9842e-07
8.7782e+00	9.5506e+00	2.0670e-07	8.8516e+00	9.5964e+00	2.1598e-07
8.9257e+00	9.6446e+00	2.2189e-07	9.0004e+00	9.6931e+00	2.2418e-07
9.0757e+00	9.7421e+00	2.2478e-07	9.1517e+00	9.7915e+00	2.2363e-07
9.2282e+00	9.8413e+00	2.2161e-07	9.3055e+00	9.8915e+00	2.2141e-07
9.3834e+00	9.9422e+00	2.2227e-07	9.4619e+00	9.9932e+00	2.2220e-07
9.5411e+00	9.8944e+00	2.2205e-07	9.6209e+00	9.4322e+00	2.2320e-07
9.7014e+00	8.7540e+00	2.2357e-07	9.7826e+00	8.0699e+00	2.2212e-07
9.8645e+00	7.3800e+00	2.1949e-07	9.9470e+00	6.6849e+00	2.1456e-07
1.0030e+01	5.9840e+00	2.0764e-07	1.0114e+01	5.2780e+00	1.9458e-07
1.0199e+01	4.5662e+00	1.8601e-07	1.0284e+01	3.8459e+00	1.8880e-07
1.0370e+01	3.1214e+00	1.8844e-07	1.0457e+01	2.3884e+00	1.8402e-07
1.0544e+01	1.8197e+00	1.7400e-07	1.0633e+01	1.8985e+00	1.5203e-07
1.0721e+01	2.4523e+00	1.1655e-07	1.0811e+01	3.0092e+00	8.0801e-08
1.0902e+01	3.5723e+00	7.2241e-08	1.0993e+01	4.1417e+00	1.0387e-07
1.1085e+01	4.7141e+00	1.6102e-07	1.1178e+01	5.2897e+00	2.1781e-07
1.1271e+01	5.8715e+00	2.6401e-07	1.1366e+01	6.4595e+00	2.9961e-07
1.1461e+01	7.0538e+00	3.2157e-07	1.1557e+01	7.6511e+00	3.2101e-07
1.1654e+01	8.2516e+00	2.8792e-07	1.1751e+01	8.8583e+00	2.0385e-07
1.1850e+01	9.4712e+00	1.6548e-07	1.1948e+01	1.0087e+01	3.1094e-07
1.2049e+01	1.0709e+01	4.9879e-07	1.2149e+01	1.1338e+01	5.7007e-07
1.2251e+01	1.1969e+01	5.7046e-07	1.2354e+01	1.2607e+01	5.6690e-07
1.2457e+01	1.3137e+01	5.8629e-07	1.2561e+01	1.3388e+01	5.9828e-07
1.2666e+01	1.3472e+01	5.9680e-07	1.2772e+01	1.3556e+01	5.9747e-07
1.2879e+01	1.3641e+01	6.0412e-07	1.2987e+01	1.3727e+01	6.1079e-07
1.3095e+01	1.3814e+01	6.0338e-07	1.3205e+01	1.3901e+01	5.7158e-07
1.3316e+01	1.3989e+01	5.0821e-07	1.3427e+01	1.4077e+01	5.0631e-07
1.3540e+01	1.4167e+01	5.5624e-07	1.3653e+01	1.4257e+01	5.6205e-07

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.3767e+01	1.4348e+01	5.4761e-07	1.3882e+01	1.4439e+01	5.3804e-07
1.3998e+01	1.4532e+01	5.2148e-07	1.4115e+01	1.4625e+01	4.4287e-07
1.4233e+01	1.4719e+01	3.6021e-07	1.4353e+01	1.4813e+01	4.2313e-07
1.4473e+01	1.4909e+01	3.9102e-07	1.4594e+01	1.5005e+01	2.3880e-07
1.4716e+01	1.5103e+01	3.4321e-07	1.4839e+01	1.5147e+01	6.4532e-07
1.4963e+01	1.5110e+01	8.6620e-07	1.5088e+01	1.5046e+01	9.4219e-07
1.5214e+01	1.4981e+01	9.5924e-07	1.5342e+01	1.4915e+01	9.7369e-07
1.5471e+01	1.4849e+01	1.0128e-06	1.5600e+01	1.4783e+01	1.0781e-06
1.5730e+01	1.4716e+01	1.1497e-06	1.5862e+01	1.4648e+01	1.2040e-06
1.5995e+01	1.4580e+01	1.2502e-06	1.6129e+01	1.4511e+01	1.2908e-06
1.6264e+01	1.4441e+01	1.2992e-06	1.6400e+01	1.4372e+01	1.2661e-06
1.6537e+01	1.4301e+01	1.2369e-06	1.6675e+01	1.4230e+01	1.2797e-06
1.6815e+01	1.4158e+01	1.3693e-06	1.6956e+01	1.4086e+01	1.4335e-06
1.7098e+01	1.4013e+01	1.4480e-06	1.7241e+01	1.3939e+01	1.3918e-06
1.7385e+01	1.3865e+01	1.0864e-06	1.7530e+01	1.3791e+01	6.6340e-07
1.7677e+01	1.3663e+01	8.1886e-07	1.7825e+01	1.3408e+01	1.4523e-06
1.7974e+01	1.3073e+01	1.9006e-06	1.8124e+01	1.2735e+01	2.0757e-06
1.8276e+01	1.2394e+01	2.1279e-06	1.8429e+01	1.2050e+01	2.1517e-06
1.8584e+01	1.1703e+01	2.1581e-06	1.8739e+01	1.1354e+01	2.1468e-06
1.8895e+01	1.1002e+01	2.1007e-06	1.9053e+01	1.0647e+01	1.9823e-06
1.9213e+01	1.0288e+01	1.8516e-06	1.9374e+01	9.9264e+00	1.7955e-06
1.9537e+01	9.5612e+00	1.7570e-06	1.9700e+01	9.1938e+00	1.7482e-06
1.9864e+01	8.8241e+00	1.7753e-06	2.0030e+01	8.4510e+00	1.7684e-06
2.0198e+01	8.0735e+00	1.4557e-06	2.0367e+01	7.6937e+00	1.0691e-06
2.0538e+01	7.3116e+00	6.4305e-07	2.0709e+01	6.9251e+00	1.6794e-07
2.0883e+01	6.5352e+00	2.2232e-07	2.1058e+01	6.3042e+00	1.0720e-06
2.1234e+01	6.3151e+00	2.2675e-06	2.1412e+01	6.4089e+00	3.1625e-06
2.1591e+01	6.5037e+00	3.6864e-06	2.1771e+01	6.5990e+00	3.7866e-06
2.1953e+01	6.6952e+00	3.0957e-06	2.2137e+01	6.7924e+00	2.2269e-06
2.2323e+01	6.8903e+00	3.2851e-06	2.2510e+01	6.9889e+00	5.2178e-06
2.2698e+01	7.0882e+00	6.0024e-06	2.2888e+01	7.1885e+00	6.2557e-06
2.3079e+01	7.2899e+00	6.4671e-06	2.3273e+01	7.3919e+00	6.5531e-06
2.3467e+01	7.4946e+00	6.5790e-06	2.3663e+01	7.5984e+00	6.5044e-06
2.3861e+01	7.6930e+00	6.4641e-06	2.4061e+01	7.7769e+00	6.7286e-06
2.4263e+01	7.8596e+00	6.9128e-06	2.4466e+01	7.9430e+00	6.8930e-06
2.4671e+01	8.0270e+00	6.8769e-06	2.4877e+01	8.1117e+00	6.9358e-06
2.5086e+01	8.1973e+00	7.0188e-06	2.5295e+01	8.2834e+00	7.0147e-06
2.5507e+01	8.3702e+00	6.9200e-06	2.5720e+01	8.4579e+00	6.6769e-06
2.5935e+01	8.5461e+00	5.4097e-06	2.6152e+01	8.6352e+00	4.3311e-06
2.6371e+01	8.6953e+00	5.8508e-06	2.6592e+01	8.7206e+00	7.7371e-06
2.6815e+01	8.7408e+00	8.1427e-06	2.7038e+01	8.7611e+00	7.8086e-06
2.7265e+01	8.7817e+00	7.8442e-06	2.7494e+01	8.8024e+00	8.3201e-06
2.7724e+01	8.8233e+00	8.4111e-06	2.7956e+01	8.8444e+00	8.4259e-06
2.8190e+01	8.8656e+00	8.3776e-06	2.8425e+01	8.8870e+00	8.2324e-06
2.8663e+01	8.9085e+00	8.0792e-06	2.8902e+01	8.9303e+00	8.0746e-06

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
2.9145e+01	8.9545e+00	8.1703e-06	2.9389e+01	8.9815e+00	8.2649e-06
2.9634e+01	9.0092e+00	8.3745e-06	2.9883e+01	9.0371e+00	8.4368e-06
3.0133e+01	9.0652e+00	8.4312e-06	3.0384e+01	9.0935e+00	8.3916e-06
3.0639e+01	9.1221e+00	8.2921e-06	3.0895e+01	9.1510e+00	8.2680e-06
3.1154e+01	9.1800e+00	8.4515e-06	3.1414e+01	9.2093e+00	8.6013e-06
3.1677e+01	9.2389e+00	8.4787e-06	3.1943e+01	9.2687e+00	8.0557e-06
3.2210e+01	9.1326e+00	7.8038e-06	3.2480e+01	8.7994e+00	8.1690e-06
3.2752e+01	8.4340e+00	8.5363e-06	3.3026e+01	8.0658e+00	8.5790e-06
3.3302e+01	7.6950e+00	8.5402e-06	3.3580e+01	7.3208e+00	8.5576e-06
3.3861e+01	6.9433e+00	8.3616e-06	3.4144e+01	6.5624e+00	7.7993e-06
3.4430e+01	6.1781e+00	7.3979e-06	3.4718e+01	5.7912e+00	7.2101e-06
3.5009e+01	5.4009e+00	7.1351e-06	3.5302e+01	5.0072e+00	7.5665e-06
3.5597e+01	4.7542e+00	8.7243e-06	3.5895e+01	4.6684e+00	8.6589e-06
3.6195e+01	4.6074e+00	4.4255e-06	3.6498e+01	4.5458e+00	6.7859e-07
3.6804e+01	4.4838e+00	2.0487e-06	3.7112e+01	4.4212e+00	5.8555e-06
3.7422e+01	4.3580e+00	9.4199e-06	3.7736e+01	4.2944e+00	1.0927e-05
3.8052e+01	4.2302e+00	7.9129e-06	3.8370e+01	4.1655e+00	9.3512e-06
3.8691e+01	4.1140e+00	1.4858e-05	3.9014e+01	4.0951e+00	1.6050e-05
3.9341e+01	4.0955e+00	1.6782e-05	3.9671e+01	4.0959e+00	1.7643e-05
4.0003e+01	4.0963e+00	1.8308e-05	4.0337e+01	4.0967e+00	1.8508e-05
4.0674e+01	4.0971e+00	1.8323e-05	4.1015e+01	4.0975e+00	1.3816e-05
4.1358e+01	4.0979e+00	7.5972e-06	4.1704e+01	4.0983e+00	1.2594e-05
4.2053e+01	4.0987e+00	2.1010e-05	4.2406e+01	4.0991e+00	2.3015e-05
4.2760e+01	4.1285e+00	2.3490e-05	4.3118e+01	4.2682e+00	2.3533e-05
4.3479e+01	4.4896e+00	2.3316e-05	4.3843e+01	4.7126e+00	2.1494e-05
4.4210e+01	4.9378e+00	1.4486e-05	4.4580e+01	5.1647e+00	1.6632e-05
4.4953e+01	5.3935e+00	2.5166e-05	4.5328e+01	5.6242e+00	2.6443e-05
4.5707e+01	5.8567e+00	2.6582e-05	4.6090e+01	6.0913e+00	2.6168e-05
4.6476e+01	6.3281e+00	2.5350e-05	4.6865e+01	6.5379e+00	2.4392e-05
4.7257e+01	6.6849e+00	2.1987e-05	4.7652e+01	6.7977e+00	2.2431e-05
4.8051e+01	6.9115e+00	2.6099e-05	4.8453e+01	7.0261e+00	2.7424e-05
4.8859e+01	7.1417e+00	2.6699e-05	4.9268e+01	7.2583e+00	2.5320e-05
4.9680e+01	7.3758e+00	2.0136e-05	5.0096e+01	7.4003e+00	2.1959e-05
5.0516e+01	7.3243e+00	3.0108e-05	5.0938e+01	7.2410e+00	3.1799e-05
5.1364e+01	7.1570e+00	3.1722e-05	5.1794e+01	7.0722e+00	3.0314e-05
5.2227e+01	6.9867e+00	1.9986e-05	5.2665e+01	6.9005e+00	2.1346e-05
5.3105e+01	6.8137e+00	3.3446e-05	5.3550e+01	6.7905e+00	3.5474e-05
5.3998e+01	6.9222e+00	3.5566e-05	5.4449e+01	7.1457e+00	3.5046e-05
5.4905e+01	7.3715e+00	3.3539e-05	5.5364e+01	7.5991e+00	3.0233e-05
5.5828e+01	7.8283e+00	3.1727e-05	5.6294e+01	8.0596e+00	3.4597e-05
5.6766e+01	8.2931e+00	3.1070e-05	5.7242e+01	8.5285e+00	2.7144e-05
5.7721e+01	8.7657e+00	2.8181e-05	5.8204e+01	9.0049e+00	3.2334e-05
5.8691e+01	9.2460e+00	2.9566e-05	5.9181e+01	9.4892e+00	3.1165e-05
5.9677e+01	9.7343e+00	4.1069e-05	6.0176e+01	9.9816e+00	4.5514e-05
6.0680e+01	1.0231e+01	4.7047e-05	6.1187e+01	1.0482e+01	4.6965e-05

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
6.1699e+01	1.0691e+01	4.5239e-05	6.2216e+01	1.0791e+01	4.4411e-05
6.2736e+01	1.0825e+01	4.3541e-05	6.3261e+01	1.0859e+01	4.6029e-05
6.3790e+01	1.0894e+01	5.0711e-05	6.4324e+01	1.0928e+01	5.8540e-05
6.4862e+01	1.0963e+01	5.9556e-05	6.5405e+01	1.0999e+01	2.9327e-05
6.5953e+01	1.1034e+01	1.0351e-05	6.6505e+01	1.1070e+01	2.9691e-05
6.7061e+01	1.1106e+01	5.5724e-05	6.7623e+01	1.1143e+01	7.0324e-05
6.8188e+01	1.1180e+01	7.4105e-05	6.8758e+01	1.1217e+01	7.5936e-05
6.9334e+01	1.1254e+01	7.6447e-05	6.9915e+01	1.1292e+01	7.6591e-05
7.0499e+01	1.1330e+01	7.7748e-05	7.1089e+01	1.1368e+01	8.1615e-05
7.1684e+01	1.1407e+01	8.3465e-05	7.2284e+01	1.1446e+01	6.2603e-05
7.2889e+01	1.1486e+01	6.1912e-05	7.3499e+01	1.1526e+01	7.2652e-05
7.4114e+01	1.1566e+01	5.8412e-05	7.4734e+01	1.1607e+01	5.2856e-05
7.5360e+01	1.1648e+01	7.3626e-05	7.5990e+01	1.1689e+01	9.8363e-05
7.6626e+01	1.1731e+01	1.0248e-04	7.7267e+01	1.1773e+01	1.0404e-04
7.7914e+01	1.1815e+01	1.0597e-04	7.8566e+01	1.1858e+01	1.0473e-04
7.9223e+01	1.1901e+01	1.0188e-04	7.9886e+01	1.1945e+01	7.7095e-05
8.0554e+01	1.1988e+01	6.7619e-05	8.1228e+01	1.2033e+01	9.1642e-05
8.1909e+01	1.2077e+01	1.0203e-04	8.2594e+01	1.2122e+01	1.0349e-04
8.3285e+01	1.2168e+01	1.0378e-04	8.3982e+01	1.2168e+01	1.0108e-04
8.4685e+01	1.2122e+01	8.4108e-05	8.5393e+01	1.2073e+01	8.3347e-05
8.6108e+01	1.2024e+01	1.1125e-04	8.6829e+01	1.1974e+01	1.3234e-04
8.7555e+01	1.1923e+01	1.4329e-04	8.8288e+01	1.1873e+01	1.4264e-04
8.9027e+01	1.1821e+01	1.4979e-04	8.9772e+01	1.1770e+01	1.2684e-04
9.0523e+01	1.1718e+01	1.0362e-04	9.1281e+01	1.1665e+01	1.3701e-04
9.2044e+01	1.1612e+01	1.5332e-04	9.2815e+01	1.1559e+01	1.5856e-04
9.3591e+01	1.1505e+01	1.7295e-04	9.4374e+01	1.1451e+01	1.6837e-04
9.5165e+01	1.1396e+01	1.5643e-04	9.5960e+01	1.1341e+01	1.5349e-04
9.6763e+01	1.1286e+01	1.5857e-04	9.7573e+01	1.1230e+01	1.6172e-04
9.8390e+01	1.1173e+01	1.6485e-04	9.9213e+01	1.1116e+01	1.7574e-04
1.0004e+02	1.1058e+01	2.3579e-04	1.0088e+02	1.1001e+01	2.6395e-04
1.0172e+02	1.0942e+01	1.2501e-04	1.0258e+02	1.0883e+01	5.2683e-05
1.0344e+02	1.0824e+01	1.3336e-04	1.0430e+02	1.0764e+01	1.3737e-04
1.0517e+02	1.0703e+01	1.5101e-04	1.0605e+02	1.0643e+01	1.7797e-04
1.0694e+02	1.0581e+01	1.9958e-04	1.0784e+02	1.0519e+01	2.4273e-04
1.0873e+02	1.0457e+01	2.4081e-04	1.0965e+02	1.0394e+01	2.3448e-04
1.1056e+02	1.0330e+01	2.3479e-04	1.1149e+02	1.0266e+01	2.3943e-04
1.1242e+02	1.0201e+01	2.3866e-04	1.1336e+02	1.0136e+01	2.3720e-04
1.1431e+02	1.0089e+01	2.7029e-04	1.1527e+02	1.0074e+01	2.6271e-04
1.1623e+02	1.0071e+01	1.4590e-04	1.1721e+02	1.0067e+01	1.4960e-04
1.1819e+02	1.0064e+01	1.9943e-04	1.1917e+02	1.0060e+01	2.2923e-04
1.2017e+02	1.0057e+01	2.6479e-04	1.2118e+02	1.0053e+01	2.5300e-04
1.2219e+02	1.0050e+01	2.8137e-04	1.2322e+02	1.0046e+01	3.0102e-04
1.2425e+02	1.0043e+01	3.0086e-04	1.2528e+02	1.0039e+01	2.8992e-04
1.2633e+02	1.0035e+01	2.9108e-04	1.2739e+02	1.0032e+01	3.0087e-04
1.2846e+02	1.0028e+01	3.0217e-04	1.2953e+02	1.0024e+01	2.9817e-04

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.3062e+02	1.0020e+01	2.9388e-04	1.3171e+02	1.0016e+01	2.9711e-04
1.3281e+02	1.0012e+01	2.8358e-04	1.3393e+02	1.0009e+01	2.6731e-04
1.3505e+02	1.0005e+01	2.9563e-04	1.3618e+02	1.0001e+01	3.1429e-04
1.3731e+02	9.9966e+00	3.2633e-04	1.3846e+02	9.9926e+00	3.4799e-04
1.3962e+02	9.9885e+00	3.4629e-04	1.4079e+02	9.9844e+00	3.4217e-04
1.4197e+02	9.9802e+00	3.1384e-04	1.4316e+02	9.9780e+00	3.1184e-04
1.4436e+02	9.9780e+00	3.0992e-04	1.4556e+02	9.9782e+00	2.9213e-04
1.4678e+02	9.9785e+00	3.3227e-04	1.4801e+02	9.9787e+00	3.6137e-04
1.4925e+02	9.9789e+00	3.6993e-04	1.5050e+02	9.9792e+00	3.5070e-04
1.5175e+02	9.9794e+00	3.4766e-04	1.5302e+02	9.9796e+00	3.7135e-04
1.5431e+02	9.9799e+00	3.6499e-04	1.5560e+02	9.9801e+00	3.3805e-04
1.5690e+02	9.9803e+00	3.3663e-04	1.5821e+02	9.9806e+00	3.7222e-04
1.5953e+02	9.9808e+00	3.9044e-04	1.6087e+02	9.9811e+00	3.8467e-04
1.6222e+02	9.9813e+00	3.8897e-04	1.6357e+02	9.9816e+00	2.9570e-04
1.6494e+02	9.9818e+00	2.8749e-04	1.6632e+02	9.9821e+00	3.8500e-04
1.6772e+02	9.9824e+00	4.0670e-04	1.6912e+02	9.9826e+00	3.9912e-04
1.7053e+02	9.9829e+00	4.0161e-04	1.7197e+02	9.9831e+00	4.3691e-04
1.7340e+02	9.9834e+00	4.4283e-04	1.7485e+02	9.9837e+00	4.3906e-04
1.7631e+02	9.9817e+00	4.1469e-04	1.7779e+02	9.9754e+00	4.0619e-04
1.7928e+02	9.9667e+00	4.1848e-04	1.8078e+02	9.9581e+00	4.1914e-04
1.8229e+02	9.9493e+00	4.0984e-04	1.8381e+02	9.9405e+00	4.0280e-04
1.8535e+02	9.9315e+00	6.1204e-04	1.8690e+02	9.9226e+00	6.6463e-04
1.8847e+02	9.9135e+00	2.7871e-04	1.9005e+02	9.9043e+00	1.6080e-04
1.9164e+02	9.8951e+00	3.2330e-04	1.9325e+02	9.8858e+00	3.7165e-04
1.9486e+02	9.8765e+00	3.6521e-04	1.9649e+02	9.8670e+00	4.0580e-04
1.9813e+02	9.8575e+00	4.2376e-04	1.9979e+02	9.8479e+00	4.3565e-04
2.0146e+02	9.8382e+00	4.4630e-04	2.0315e+02	9.8284e+00	4.4030e-04
2.0485e+02	9.8186e+00	5.8070e-04	2.0656e+02	9.8087e+00	4.7188e-04
2.0829e+02	9.7987e+00	3.3216e-04	2.1003e+02	9.7885e+00	4.6655e-04
2.1179e+02	9.7784e+00	5.1783e-04	2.1356e+02	9.7681e+00	5.2637e-04
2.1535e+02	9.7577e+00	5.0962e-04	2.1716e+02	9.7473e+00	5.1121e-04
2.1897e+02	9.7368e+00	5.1312e-04	2.2080e+02	9.7262e+00	5.1548e-04
2.2265e+02	9.7155e+00	5.3426e-04	2.2451e+02	9.7046e+00	5.4149e-04
2.2640e+02	9.6938e+00	5.4495e-04	2.2829e+02	9.6828e+00	5.5164e-04
2.3020e+02	9.6717e+00	5.2665e-04	2.3213e+02	9.6606e+00	5.3489e-04
2.3406e+02	9.6493e+00	6.1883e-04	2.3603e+02	9.6380e+00	4.7591e-04
2.3800e+02	9.6265e+00	4.0750e-04	2.3999e+02	9.6150e+00	5.5347e-04
2.4200e+02	9.6033e+00	5.8415e-04	2.4403e+02	9.5916e+00	6.0794e-04
2.4606e+02	9.5798e+00	6.1576e-04	2.4813e+02	9.5678e+00	5.9222e-04
2.5020e+02	9.5558e+00	5.5794e-04	2.5230e+02	9.5437e+00	5.7422e-04
2.5441e+02	9.5321e+00	6.0504e-04	2.5654e+02	9.5214e+00	6.0717e-04
2.5869e+02	9.5111e+00	5.8981e-04	2.6085e+02	9.5008e+00	5.7066e-04
2.6303e+02	9.4903e+00	6.1254e-04	2.6524e+02	9.4797e+00	6.5321e-04
2.6745e+02	9.4690e+00	6.8586e-04	2.6969e+02	9.4583e+00	6.9852e-04
2.7194e+02	9.4474e+00	5.0662e-04	2.7422e+02	9.4365e+00	4.4408e-04

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
2.7651e+02	9.4255e+00	6.3363e-04	2.7883e+02	9.4143e+00	7.1933e-04
2.8116e+02	9.4031e+00	7.0961e-04	2.8352e+02	9.3918e+00	7.0726e-04
2.8589e+02	9.3804e+00	7.1109e-04	2.8828e+02	9.3689e+00	6.0675e-04
2.9069e+02	9.3573e+00	6.2968e-04	2.9313e+02	9.3456e+00	7.5899e-04
2.9558e+02	9.3338e+00	7.6219e-04	2.9805e+02	9.3220e+00	7.6764e-04
3.0055e+02	9.3100e+00	7.5909e-04	3.0306e+02	9.2979e+00	7.5966e-04
3.0560e+02	9.2857e+00	7.7891e-04	3.0815e+02	9.2734e+00	7.5105e-04
3.1074e+02	9.2610e+00	7.4879e-04	3.1333e+02	9.2485e+00	7.8726e-04
3.1595e+02	9.2359e+00	8.1872e-04	3.1860e+02	9.2232e+00	8.0997e-04
3.2127e+02	9.2104e+00	7.7533e-04	3.2395e+02	9.1975e+00	7.7211e-04
3.2666e+02	9.1845e+00	8.1586e-04	3.2940e+02	9.1713e+00	8.4110e-04
3.3215e+02	9.1581e+00	8.1470e-04	3.3494e+02	9.1447e+00	7.7179e-04
3.3774e+02	9.1327e+00	8.0157e-04	3.4056e+02	9.1241e+00	9.3980e-04
3.4341e+02	9.1176e+00	9.7223e-04	3.4629e+02	9.1110e+00	6.9630e-04
3.4918e+02	9.1044e+00	6.2106e-04	3.5211e+02	9.0978e+00	8.2066e-04
3.5505e+02	9.0911e+00	8.8634e-04	3.5802e+02	9.0843e+00	8.9285e-04
3.6102e+02	9.0774e+00	8.6155e-04	3.6405e+02	9.0705e+00	8.6149e-04
3.6709e+02	9.0636e+00	8.7985e-04	3.7016e+02	9.0566e+00	8.5846e-04
3.7325e+02	9.0495e+00	8.3870e-04	3.7638e+02	9.0424e+00	8.5831e-04
3.7953e+02	9.0352e+00	8.8682e-04	3.8271e+02	9.0280e+00	8.7461e-04
3.8591e+02	9.0207e+00	8.7795e-04	3.8914e+02	9.0133e+00	8.9983e-04
3.9239e+02	9.0059e+00	8.8621e-04	3.9568e+02	8.9984e+00	8.3359e-04
3.9899e+02	8.9908e+00	8.4499e-04	4.0233e+02	8.9832e+00	8.2694e-04
4.0570e+02	8.9755e+00	7.7319e-04	4.0910e+02	8.9678e+00	8.1819e-04
4.1251e+02	8.9620e+00	8.9788e-04	4.1597e+02	8.9611e+00	9.2605e-04
4.1944e+02	8.9633e+00	9.3441e-04	4.2296e+02	8.9654e+00	9.4991e-04
4.2650e+02	8.9676e+00	9.4670e-04	4.3007e+02	8.9698e+00	8.6651e-04
4.3366e+02	8.9720e+00	8.6668e-04	4.3729e+02	8.9743e+00	9.4693e-04
4.4095e+02	8.9765e+00	9.5365e-04	4.4464e+02	8.9788e+00	9.5844e-04
4.4837e+02	8.9811e+00	9.3506e-04	4.5212e+02	8.9834e+00	8.8872e-04
4.5590e+02	8.9857e+00	9.0956e-04	4.5972e+02	8.9881e+00	9.0608e-04
4.6356e+02	8.9904e+00	9.1682e-04	4.6744e+02	8.9928e+00	9.8045e-04
4.7136e+02	8.9952e+00	9.7891e-04	4.7530e+02	8.9976e+00	9.3298e-04
4.7927e+02	9.0001e+00	9.4060e-04	4.8328e+02	9.0026e+00	9.6931e-04
4.8733e+02	9.0051e+00	9.5541e-04	4.9140e+02	9.0076e+00	9.6578e-04
4.9551e+02	9.0101e+00	9.6191e-04	4.9966e+02	9.0126e+00	9.6546e-04
5.0385e+02	9.0152e+00	9.7016e-04	5.0807e+02	9.0178e+00	9.8042e-04
5.1232e+02	9.0204e+00	9.6473e-04	5.1660e+02	9.0231e+00	8.7685e-04
5.2092e+02	9.0257e+00	8.6263e-04	5.2528e+02	9.0284e+00	9.6276e-04
5.2968e+02	9.0311e+00	9.5105e-04	5.3412e+02	9.0338e+00	9.3753e-04
5.3858e+02	9.0366e+00	1.0052e-03	5.4309e+02	9.0394e+00	1.0222e-03
5.4763e+02	9.0421e+00	1.0144e-03	5.5222e+02	9.0450e+00	1.0060e-03
5.5684e+02	9.0478e+00	1.0038e-03	5.6150e+02	9.0507e+00	1.0179e-03
5.6620e+02	9.0493e+00	1.1167e-03	5.7093e+02	9.0411e+00	1.1187e-03
5.7571e+02	9.0301e+00	9.4292e-04	5.8053e+02	9.0190e+00	1.0253e-03

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
5.8538e+02	9.0078e+00	1.2757e-03	5.9028e+02	8.9966e+00	1.0628e-03
5.9522e+02	8.9852e+00	9.3368e-04	6.0021e+02	8.9738e+00	1.0914e-03
6.0523e+02	8.9622e+00	1.1146e-03	6.1029e+02	8.9506e+00	1.1888e-03
6.1539e+02	8.9388e+00	1.0771e-03	6.2054e+02	8.9270e+00	9.9656e-04
6.2574e+02	8.9151e+00	1.0692e-03	6.3098e+02	8.9030e+00	1.0944e-03
6.3626e+02	8.8909e+00	1.1483e-03	6.4159e+02	8.8786e+00	1.1595e-03
6.4695e+02	8.8663e+00	1.2865e-03	6.5237e+02	8.8538e+00	1.3991e-03
6.5783e+02	8.8413e+00	1.0208e-03	6.6333e+02	8.8286e+00	8.8728e-04
6.6888e+02	8.8159e+00	1.1216e-03	6.7448e+02	8.8030e+00	1.1280e-03
6.8013e+02	8.7900e+00	1.1785e-03	6.8582e+02	8.7769e+00	1.1280e-03
6.9155e+02	8.7637e+00	1.0984e-03	6.9734e+02	8.7504e+00	1.2004e-03
7.0317e+02	8.7370e+00	1.1026e-03	7.0906e+02	8.7235e+00	1.0616e-03
7.1499e+02	8.7119e+00	1.1533e-03	7.2097e+02	8.7027e+00	1.1754e-03
7.2701e+02	8.6937e+00	1.1631e-03	7.3310e+02	8.6847e+00	1.1601e-03
7.3923e+02	8.6756e+00	1.1817e-03	7.4541e+02	8.6665e+00	1.1412e-03
7.5165e+02	8.6572e+00	1.1417e-03	7.5794e+02	8.6479e+00	1.1445e-03
7.6429e+02	8.6385e+00	1.1563e-03	7.7068e+02	8.6290e+00	1.1732e-03
7.7713e+02	8.6195e+00	1.1612e-03	7.8363e+02	8.6098e+00	1.1321e-03
7.9019e+02	8.6001e+00	1.1464e-03	7.9680e+02	8.5903e+00	1.2217e-03
8.0347e+02	8.5804e+00	1.2175e-03	8.1019e+02	8.5704e+00	1.2627e-03
8.1698e+02	8.5604e+00	1.0995e-03	8.2381e+02	8.5503e+00	1.0172e-03
8.3070e+02	8.5423e+00	1.2123e-03	8.3765e+02	8.5399e+00	1.3298e-03
8.4466e+02	8.5409e+00	1.2483e-03	8.5173e+02	8.5418e+00	9.6983e-04
8.5886e+02	8.5428e+00	9.9375e-04	8.6605e+02	8.5438e+00	1.1630e-03
8.7329e+02	8.5448e+00	1.2194e-03	8.8060e+02	8.5458e+00	1.2281e-03
8.8797e+02	8.5468e+00	1.2023e-03	8.9540e+02	8.5478e+00	1.1401e-03
9.0289e+02	8.5488e+00	1.0984e-03	9.1045e+02	8.5499e+00	1.1543e-03
9.1807e+02	8.5509e+00	1.2200e-03	9.2575e+02	8.5520e+00	1.2929e-03
9.3350e+02	8.5530e+00	1.1207e-03	9.4131e+02	8.5541e+00	1.1718e-03
9.4918e+02	8.5552e+00	1.2293e-03	9.5713e+02	8.5563e+00	1.0627e-03
9.6514e+02	8.5439e+00	1.1277e-03	9.7321e+02	8.5155e+00	1.3384e-03
9.8136e+02	8.4846e+00	1.3352e-03	9.8957e+02	8.4533e+00	1.0347e-03
9.9785e+02	8.4219e+00	1.0325e-03	1.0062e+03	8.3901e+00	1.1730e-03
1.0146e+03	8.3581e+00	1.1752e-03	1.0231e+03	8.3258e+00	1.1447e-03
1.0317e+03	8.2931e+00	1.2335e-03	1.0403e+03	8.2604e+00	1.3260e-03
1.0490e+03	8.2273e+00	1.1243e-03	1.0578e+03	8.1939e+00	1.0432e-03
1.0666e+03	8.1602e+00	1.1570e-03	1.0755e+03	8.1264e+00	1.1959e-03
1.0845e+03	8.0921e+00	1.2582e-03	1.0936e+03	8.0575e+00	1.1900e-03
1.1028e+03	8.0227e+00	1.0897e-03	1.1120e+03	7.9876e+00	1.1970e-03
1.1213e+03	7.9614e+00	1.3340e-03	1.1307e+03	7.9581e+00	1.1553e-03
1.1401e+03	7.9685e+00	9.1725e-04	1.1497e+03	7.9791e+00	1.1280e-03
1.1593e+03	7.9897e+00	1.2831e-03	1.1691e+03	8.0004e+00	1.1899e-03
1.1788e+03	8.0112e+00	1.2603e-03	1.1887e+03	8.0221e+00	1.1692e-03
1.1986e+03	8.0331e+00	1.0891e-03	1.2087e+03	8.0441e+00	1.2135e-03
1.2188e+03	8.0554e+00	1.3727e-03	1.2290e+03	8.0666e+00	1.4937e-03

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.2393e+03	8.0779e+00	1.1996e-03	1.2496e+03	8.0893e+00	1.0860e-03
1.2600e+03	8.1009e+00	1.1774e-03	1.2706e+03	8.1125e+00	1.1679e-03
1.2813e+03	8.1243e+00	1.2798e-03	1.2920e+03	8.1361e+00	1.2577e-03
1.3028e+03	8.1481e+00	1.2459e-03	1.3137e+03	8.1601e+00	1.2504e-03
1.3247e+03	8.1722e+00	1.2347e-03	1.3358e+03	8.1797e+00	1.2513e-03
1.3470e+03	8.1799e+00	1.2585e-03	1.3583e+03	8.1777e+00	1.2671e-03
1.3696e+03	8.1754e+00	1.3431e-03	1.3811e+03	8.1732e+00	1.2836e-03
1.3926e+03	8.1709e+00	1.1354e-03	1.4043e+03	8.1686e+00	1.1568e-03
1.4160e+03	8.1663e+00	1.1743e-03	1.4278e+03	8.1640e+00	1.1720e-03
1.4398e+03	8.1616e+00	1.2098e-03	1.4518e+03	8.1592e+00	1.2730e-03
1.4640e+03	8.1568e+00	1.1807e-03	1.4763e+03	8.1465e+00	1.1203e-03
1.4886e+03	8.1279e+00	1.2512e-03	1.5010e+03	8.1088e+00	1.3348e-03
1.5136e+03	8.0896e+00	1.1398e-03	1.5263e+03	8.0701e+00	1.0358e-03
1.5391e+03	8.0505e+00	1.1395e-03	1.5519e+03	8.0308e+00	1.1146e-03
1.5649e+03	8.0109e+00	1.2108e-03	1.5781e+03	7.9908e+00	1.3068e-03
1.5913e+03	7.9706e+00	1.0867e-03	1.6045e+03	7.9502e+00	9.6775e-04
1.6179e+03	7.9297e+00	1.0164e-03	1.6315e+03	7.9089e+00	1.0788e-03
1.6452e+03	7.8880e+00	1.1313e-03	1.6590e+03	7.8669e+00	1.1000e-03
1.6728e+03	7.8456e+00	1.0920e-03	1.6868e+03	7.8241e+00	1.1099e-03
1.7009e+03	7.8025e+00	1.0583e-03	1.7152e+03	7.7808e+00	1.0075e-03
1.7295e+03	7.7588e+00	1.1071e-03	1.7440e+03	7.7365e+00	1.1284e-03
1.7586e+03	7.7142e+00	1.1943e-03	1.7733e+03	7.6982e+00	9.7512e-04
1.7882e+03	7.6920e+00	8.1158e-04	1.8031e+03	7.6893e+00	9.8680e-04
1.8182e+03	7.6865e+00	1.0159e-03	1.8335e+03	7.6838e+00	9.7996e-04
1.8488e+03	7.6809e+00	9.5865e-04	1.8643e+03	7.6781e+00	9.7595e-04
1.8798e+03	7.6753e+00	9.6063e-04	1.8956e+03	7.6724e+00	8.9992e-04
1.9114e+03	7.6695e+00	8.8162e-04	1.9274e+03	7.6666e+00	1.0102e-03
1.9435e+03	7.6636e+00	1.1391e-03	1.9598e+03	7.6607e+00	8.2348e-04
1.9762e+03	7.6577e+00	6.4775e-04	1.9928e+03	7.6546e+00	8.5982e-04
2.0095e+03	7.6516e+00	7.9876e-04	2.0263e+03	7.6485e+00	7.3842e-04
2.0432e+03	7.6454e+00	7.7590e-04	2.0603e+03	7.6423e+00	7.6245e-04
2.0775e+03	7.6391e+00	7.2856e-04	2.0949e+03	7.6360e+00	7.1228e-04
2.1125e+03	7.6328e+00	7.5350e-04	2.1302e+03	7.6295e+00	7.0408e-04
2.1479e+03	7.6257e+00	6.7714e-04	2.1659e+03	7.6211e+00	6.6612e-04
2.1841e+03	7.6163e+00	5.7917e-04	2.2024e+03	7.6115e+00	5.6661e-04
2.2208e+03	7.6067e+00	5.9401e-04	2.2394e+03	7.6018e+00	5.7997e-04
2.2581e+03	7.5969e+00	5.0828e-04	2.2770e+03	7.5920e+00	4.7368e-04
2.2961e+03	7.5870e+00	4.7469e-04	2.3153e+03	7.5820e+00	4.6384e-04
2.3346e+03	7.5769e+00	4.2831e-04	2.3542e+03	7.5718e+00	3.9660e-04
2.3738e+03	7.5666e+00	3.8602e-04	2.3937e+03	7.5614e+00	3.7432e-04
2.4138e+03	7.5561e+00	3.4698e-04	2.4339e+03	7.5509e+00	2.9974e-04
2.4543e+03	7.5455e+00	2.8169e-04	2.4748e+03	7.5401e+00	2.6511e-04
2.4956e+03	7.5347e+00	2.5112e-04	2.5164e+03	7.5292e+00	2.4695e-04
2.5375e+03	7.5237e+00	2.0943e-04	2.5588e+03	7.5182e+00	1.8033e-04
2.5802e+03	7.5125e+00	1.6141e-04	2.6018e+03	7.5069e+00	1.4221e-04

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
2.6235e+03	7.5012e+00	1.3565e-04	2.6454e+03	7.4954e+00	1.2109e-04
2.6676e+03	7.4896e+00	1.0753e-04	2.6899e+03	7.4838e+00	9.6432e-05
2.7124e+03	7.4779e+00	8.6299e-05	2.7351e+03	7.4719e+00	7.8119e-05
2.7580e+03	7.4659e+00	7.1258e-05	2.7811e+03	7.4599e+00	6.6330e-05
2.8044e+03	7.4553e+00	6.3130e-05	2.8279e+03	7.4530e+00	6.2344e-05
2.8515e+03	7.4517e+00	6.0075e-05	2.8754e+03	7.4504e+00	5.9528e-05
2.8994e+03	7.4490e+00	6.2924e-05	2.9237e+03	7.4477e+00	6.6842e-05
2.9482e+03	7.4463e+00	7.2241e-05	2.9728e+03	7.4450e+00	7.8137e-05
2.9977e+03	7.4436e+00	8.4490e-05	3.0228e+03	7.4422e+00	9.2374e-05
3.0481e+03	7.4407e+00	1.0227e-04	3.0736e+03	7.4393e+00	1.1201e-04
3.0993e+03	7.4379e+00	1.2190e-04	3.1253e+03	7.4364e+00	1.3363e-04
3.1514e+03	7.4350e+00	1.4353e-04	3.1778e+03	7.4335e+00	1.5271e-04
3.2043e+03	7.4320e+00	1.6665e-04	3.2311e+03	7.4305e+00	1.8303e-04
3.2582e+03	7.4290e+00	1.9274e-04	3.2855e+03	7.4275e+00	2.0050e-04
3.3130e+03	7.4260e+00	2.1224e-04	3.3407e+03	7.4244e+00	2.2251e-04
3.3687e+03	7.4228e+00	2.3985e-04	3.3969e+03	7.4213e+00	2.5934e-04
3.4253e+03	7.4197e+00	2.5899e-04	3.4539e+03	7.4174e+00	2.5765e-04
3.4829e+03	7.4144e+00	2.7757e-04	3.5120e+03	7.4113e+00	3.0527e-04
3.5413e+03	7.4082e+00	2.9945e-04	3.5710e+03	7.4051e+00	3.0098e-04
3.6009e+03	7.4019e+00	3.1072e-04	3.6311e+03	7.3987e+00	3.1673e-04
3.6615e+03	7.3955e+00	3.3083e-04	3.6921e+03	7.3923e+00	3.2880e-04
3.7229e+03	7.3890e+00	3.3981e-04	3.7541e+03	7.3857e+00	3.3478e-04
3.7855e+03	7.3824e+00	3.4350e-04	3.8172e+03	7.3790e+00	3.6507e-04
3.8492e+03	7.3757e+00	3.5919e-04	3.8814e+03	7.3723e+00	3.4538e-04
3.9138e+03	7.3688e+00	3.3724e-04	3.9466e+03	7.3654e+00	3.4938e-04
3.9796e+03	7.3619e+00	3.6394e-04	4.0129e+03	7.3584e+00	3.6566e-04
4.0464e+03	7.3548e+00	3.6119e-04	4.0803e+03	7.3512e+00	3.6555e-04
4.1145e+03	7.3476e+00	3.7655e-04	4.1489e+03	7.3440e+00	3.6650e-04
4.1836e+03	7.3403e+00	3.6201e-04	4.2186e+03	7.3366e+00	3.8155e-04
4.2539e+03	7.3329e+00	3.8859e-04	4.2896e+03	7.3295e+00	3.7477e-04
4.3255e+03	7.3263e+00	3.7133e-04	4.3616e+03	7.3230e+00	3.8533e-04
4.3981e+03	7.3197e+00	3.9199e-04	4.4349e+03	7.3164e+00	4.0519e-04
4.4720e+03	7.3130e+00	4.0265e-04	4.5095e+03	7.3096e+00	3.9037e-04
4.5473e+03	7.3062e+00	3.9631e-04	4.5853e+03	7.3028e+00	4.0514e-04
4.6236e+03	7.2993e+00	4.1462e-04	4.6624e+03	7.2958e+00	4.1143e-04
4.7014e+03	7.2923e+00	4.1135e-04	4.7406e+03	7.2888e+00	4.2313e-04
4.7804e+03	7.2852e+00	4.2112e-04	4.8204e+03	7.2816e+00	4.2167e-04
4.8607e+03	7.2779e+00	4.2990e-04	4.9014e+03	7.2742e+00	4.2525e-04
4.9424e+03	7.2705e+00	4.2930e-04	4.9838e+03	7.2668e+00	4.3637e-04
5.0255e+03	7.2630e+00	4.3691e-04	5.0675e+03	7.2592e+00	4.3599e-04
5.1099e+03	7.2554e+00	4.3637e-04	5.1526e+03	7.2515e+00	4.4593e-04
5.1958e+03	7.2476e+00	4.4862e-04	5.2393e+03	7.2437e+00	4.4333e-04
5.2831e+03	7.2385e+00	4.4088e-04	5.3273e+03	7.2319e+00	4.3301e-04
5.3719e+03	7.2250e+00	4.3170e-04	5.4169e+03	7.2180e+00	4.3737e-04
5.4621e+03	7.2110e+00	4.0730e-04	5.5079e+03	7.2039e+00	3.8072e-04

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
5.5539e+03	7.1968e+00	3.8287e-04	5.6004e+03	7.1896e+00	3.5870e-04
5.6474e+03	7.1823e+00	3.3938e-04	5.6946e+03	7.1750e+00	3.6263e-04
5.7423e+03	7.1676e+00	3.9932e-04	5.7903e+03	7.1601e+00	4.1416e-04
5.8388e+03	7.1526e+00	4.2423e-04	5.8876e+03	7.1451e+00	4.2662e-04
5.9369e+03	7.1374e+00	4.3028e-04	5.9866e+03	7.1297e+00	4.2629e-04
6.0366e+03	7.1220e+00	4.0870e-04	6.0871e+03	7.1141e+00	4.2440e-04
6.1381e+03	7.1062e+00	3.8184e-04	6.1895e+03	7.0983e+00	3.4636e-04
6.2413e+03	7.0902e+00	3.7630e-04	6.2935e+03	7.0821e+00	3.8205e-04
6.3461e+03	7.0740e+00	4.0117e-04	6.3993e+03	7.0658e+00	4.1510e-04
6.4528e+03	7.0575e+00	4.1539e-04	6.5068e+03	7.0515e+00	4.0090e-04
6.5613e+03	7.0491e+00	3.9777e-04	6.6161e+03	7.0480e+00	4.2921e-04
6.6715e+03	7.0468e+00	4.2127e-04	6.7274e+03	7.0457e+00	4.0396e-04
6.7836e+03	7.0445e+00	4.1728e-04	6.8404e+03	7.0434e+00	4.0984e-04
6.8976e+03	7.0422e+00	3.9440e-04	6.9554e+03	7.0410e+00	4.0339e-04
7.0136e+03	7.0398e+00	4.0382e-04	7.0723e+03	7.0386e+00	4.0355e-04
7.1315e+03	7.0374e+00	3.9720e-04	7.1912e+03	7.0362e+00	3.8477e-04
7.2513e+03	7.0349e+00	3.6591e-04	7.3120e+03	7.0337e+00	3.5190e-04
7.3732e+03	7.0324e+00	3.4259e-04	7.4349e+03	7.0312e+00	3.2794e-04
7.4971e+03	7.0299e+00	3.1401e-04	7.5598e+03	7.0286e+00	2.9124e-04
7.6231e+03	7.0273e+00	2.8096e-04	7.6869e+03	7.0260e+00	2.7867e-04
7.7512e+03	7.0247e+00	2.6865e-04	7.8161e+03	7.0233e+00	2.6366e-04
7.8815e+03	7.0220e+00	2.7092e-04	7.9474e+03	7.0206e+00	2.7840e-04
8.0139e+03	7.0193e+00	2.7532e-04	8.0810e+03	7.0179e+00	2.8093e-04
8.1487e+03	7.0165e+00	2.8737e-04	8.2168e+03	7.0151e+00	2.8277e-04
8.2855e+03	7.0133e+00	2.8765e-04	8.3549e+03	7.0105e+00	3.0072e-04
8.4248e+03	7.0072e+00	3.1389e-04	8.4953e+03	7.0038e+00	3.1871e-04
8.5664e+03	7.0004e+00	3.2743e-04	8.6381e+03	6.9969e+00	3.3575e-04
8.7104e+03	6.9934e+00	3.4351e-04	8.7833e+03	6.9899e+00	3.5127e-04
8.8568e+03	6.9864e+00	3.5564e-04	8.9309e+03	6.9828e+00	3.6358e-04
9.0056e+03	6.9792e+00	3.6831e-04	9.0810e+03	6.9756e+00	3.6762e-04
9.1570e+03	6.9720e+00	3.7238e-04	9.2336e+03	6.9683e+00	3.8708e-04
9.3109e+03	6.9646e+00	3.9467e-04	9.3888e+03	6.9608e+00	3.8601e-04
9.4673e+03	6.9570e+00	3.8824e-04	9.5466e+03	6.9532e+00	3.9308e-04
9.6265e+03	6.9494e+00	3.9160e-04	9.7070e+03	6.9455e+00	4.0263e-04
9.7883e+03	6.9416e+00	4.0474e-04	9.8701e+03	6.9377e+00	4.1015e-04
9.9528e+03	6.9337e+00	4.1345e-04	1.0036e+04	6.9297e+00	3.9881e-04
1.0120e+04	6.9256e+00	3.8933e-04	1.0205e+04	6.9212e+00	4.0534e-04
1.0290e+04	6.9167e+00	4.1048e-04	1.0376e+04	6.9122e+00	3.8687e-04
1.0463e+04	6.9076e+00	3.8861e-04	1.0551e+04	6.9030e+00	4.0644e-04
1.0639e+04	6.8984e+00	4.0624e-04	1.0728e+04	6.8937e+00	4.0199e-04
1.0818e+04	6.8890e+00	4.1630e-04	1.0909e+04	6.8842e+00	4.0749e-04
1.1000e+04	6.8794e+00	3.9413e-04	1.1092e+04	6.8746e+00	3.9175e-04
1.1185e+04	6.8697e+00	3.9438e-04	1.1278e+04	6.8648e+00	4.0918e-04
1.1373e+04	6.8598e+00	4.0082e-04	1.1468e+04	6.8548e+00	3.8386e-04
1.1564e+04	6.8498e+00	3.8308e-04	1.1661e+04	6.8447e+00	3.7431e-04

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.1758e+04	6.8396e+00	3.5197e-04	1.1857e+04	6.8344e+00	3.4794e-04
1.1956e+04	6.8292e+00	3.4204e-04	1.2056e+04	6.8239e+00	3.3053e-04
1.2157e+04	6.8186e+00	3.2622e-04	1.2258e+04	6.8133e+00	3.1257e-04
1.2361e+04	6.8079e+00	3.0774e-04	1.2464e+04	6.8024e+00	3.0689e-04
1.2569e+04	6.7969e+00	2.9256e-04	1.2674e+04	6.7914e+00	2.9396e-04
1.2780e+04	6.7858e+00	3.0323e-04	1.2887e+04	6.7802e+00	2.9964e-04
1.2995e+04	6.7745e+00	3.0419e-04	1.3104e+04	6.7705e+00	3.1197e-04
1.3213e+04	6.7691e+00	3.0366e-04	1.3324e+04	6.7685e+00	3.1438e-04
1.3435e+04	6.7679e+00	3.3872e-04	1.3548e+04	6.7674e+00	3.3584e-04
1.3661e+04	6.7668e+00	3.4058e-04	1.3775e+04	6.7662e+00	3.5947e-04
1.3890e+04	6.7656e+00	3.6464e-04	1.4007e+04	6.7650e+00	3.7864e-04
1.4124e+04	6.7644e+00	3.8645e-04	1.4242e+04	6.7638e+00	3.7044e-04
1.4361e+04	6.7632e+00	3.6023e-04	1.4482e+04	6.7626e+00	3.4905e-04
1.4603e+04	6.7620e+00	3.2088e-04	1.4725e+04	6.7614e+00	2.8700e-04
1.4848e+04	6.7608e+00	2.5739e-04	1.4972e+04	6.7601e+00	2.3155e-04
1.5097e+04	6.7595e+00	2.0871e-04	1.5224e+04	6.7589e+00	1.9354e-04
1.5351e+04	6.7582e+00	1.8677e-04	1.5480e+04	6.7576e+00	1.8651e-04
1.5609e+04	6.7569e+00	1.9308e-04	1.5740e+04	6.7562e+00	2.0183e-04
1.5871e+04	6.7547e+00	2.1336e-04	1.6004e+04	6.7523e+00	2.2127e-04
1.6138e+04	6.7496e+00	2.2417e-04	1.6273e+04	6.7469e+00	2.3348e-04
1.6410e+04	6.7442e+00	2.4644e-04	1.6547e+04	6.7415e+00	2.4987e-04
1.6686e+04	6.7387e+00	2.5368e-04	1.6825e+04	6.7360e+00	2.6003e-04
1.6966e+04	6.7332e+00	2.6616e-04	1.7108e+04	6.7304e+00	2.7158e-04
1.7251e+04	6.7275e+00	2.7076e-04	1.7395e+04	6.7247e+00	2.7566e-04
1.7541e+04	6.7218e+00	2.8465e-04	1.7688e+04	6.7189e+00	2.8427e-04
1.7836e+04	6.7160e+00	2.7934e-04	1.7985e+04	6.7130e+00	2.8844e-04
1.8136e+04	6.7100e+00	2.8663e-04	1.8287e+04	6.7070e+00	2.8690e-04
1.8440e+04	6.7040e+00	2.9686e-04	1.8595e+04	6.7009e+00	2.9326e-04
1.8750e+04	6.6978e+00	2.9996e-04	1.8907e+04	6.6947e+00	2.9433e-04
1.9065e+04	6.6916e+00	2.8667e-04	1.9225e+04	6.6884e+00	2.9862e-04
1.9386e+04	6.6852e+00	3.0496e-04	1.9548e+04	6.6820e+00	2.9100e-04
1.9711e+04	6.6788e+00	2.8866e-04	1.9876e+04	6.6755e+00	2.9749e-04
2.0043e+04	6.6722e+00	2.9405e-04	2.0210e+04	6.6689e+00	3.0066e-04
2.0379e+04	6.6655e+00	3.1065e-04	2.0550e+04	6.6622e+00	3.0706e-04
2.0722e+04	6.6595e+00	2.9900e-04	2.0895e+04	6.6581e+00	3.0204e-04
2.1070e+04	6.6572e+00	3.0665e-04	2.1247e+04	6.6562e+00	3.0010e-04
2.1424e+04	6.6553e+00	2.9394e-04	2.1603e+04	6.6543e+00	2.9011e-04
2.1784e+04	6.6534e+00	2.9274e-04	2.1967e+04	6.6524e+00	2.9902e-04
2.2151e+04	6.6514e+00	2.9139e-04	2.2336e+04	6.6504e+00	2.8253e-04
2.2523e+04	6.6494e+00	2.7565e-04	2.2711e+04	6.6484e+00	2.6223e-04
2.2901e+04	6.6474e+00	2.6219e-04	2.3093e+04	6.6464e+00	2.7810e-04
2.3286e+04	6.6453e+00	2.8048e-04	2.3481e+04	6.6443e+00	2.8663e-04
2.3678e+04	6.6432e+00	2.8778e-04	2.3876e+04	6.6422e+00	2.9564e-04
2.4076e+04	6.6411e+00	3.1399e-04	2.4277e+04	6.6400e+00	3.2600e-04
2.4480e+04	6.6389e+00	3.4322e-04	2.4685e+04	6.6378e+00	3.7360e-04

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
2.4892e+04	6.6367e+00	3.9796e-04	2.5100e+04	6.6356e+00	4.0175e-04
2.5310e+04	6.6345e+00	4.1379e-04	2.5522e+04	6.6334e+00	4.2059e-04
2.5735e+04	6.6322e+00	4.0226e-04	2.5950e+04	6.6311e+00	3.8796e-04
2.6167e+04	6.6305e+00	3.6681e-04	2.6386e+04	6.6305e+00	3.1557e-04
2.6607e+04	6.6307e+00	2.5845e-04	2.6830e+04	6.6309e+00	2.1010e-04
2.6971e+04	6.6310e+00	1.7563e-04	2.7084e+04	6.6311e+00	1.3928e-04
2.7281e+04	6.6312e+00	1.0087e-04	2.7509e+04	6.6314e+00	7.5385e-05
2.7740e+04	6.6315e+00	6.3506e-05	2.7972e+04	6.6317e+00	6.3007e-05
2.8206e+04	6.6319e+00	6.8578e-05	2.8412e+04	6.6321e+00	7.3787e-05
2.8530e+04	6.6322e+00	7.7671e-05	2.8680e+04	6.6324e+00	8.5728e-05
2.8920e+04	6.6327e+00	9.7973e-05	2.9162e+04	6.6330e+00	1.0926e-04
2.9406e+04	6.6334e+00	1.1955e-04	2.9652e+04	6.6337e+00	1.2805e-04
2.9900e+04	6.6340e+00	1.3670e-04	3.0150e+04	6.6343e+00	1.4676e-04
3.0403e+04	6.6346e+00	1.5238e-04	3.0657e+04	6.6350e+00	1.5734e-04
3.0913e+04	6.6353e+00	1.6296e-04	3.1172e+04	6.6356e+00	1.6680e-04
3.1433e+04	6.6360e+00	1.6751e-04	3.1696e+04	6.6363e+00	1.7024e-04
3.1961e+04	6.6366e+00	1.7520e-04	3.2229e+04	6.6370e+00	1.7584e-04
3.2499e+04	6.6373e+00	1.7781e-04	3.2771e+04	6.6377e+00	1.8190e-04
3.3045e+04	6.6381e+00	1.8513e-04	3.3321e+04	6.6386e+00	1.8626e-04
3.3600e+04	6.6392e+00	1.8977e-04	3.3881e+04	6.6399e+00	1.9105e-04
3.4165e+04	6.6406e+00	1.8998e-04	3.4451e+04	6.6412e+00	1.9089e-04
3.4739e+04	6.6419e+00	1.9357e-04	3.5029e+04	6.6426e+00	1.9868e-04
3.5323e+04	6.6433e+00	1.9576e-04	3.5618e+04	6.6439e+00	1.9190e-04
3.5916e+04	6.6446e+00	1.8844e-04	3.6217e+04	6.6453e+00	1.8524e-04
3.6520e+04	6.6460e+00	1.8578e-04	3.6826e+04	6.6468e+00	1.8442e-04
3.7134e+04	6.6475e+00	1.8468e-04	3.7444e+04	6.6482e+00	1.8503e-04
3.7758e+04	6.6489e+00	1.8599e-04	3.8074e+04	6.6497e+00	1.8671e-04
3.8392e+04	6.6504e+00	1.8492e-04	3.8714e+04	6.6512e+00	1.8454e-04
3.9038e+04	6.6528e+00	1.8674e-04	3.9364e+04	6.6554e+00	1.8620e-04
3.9694e+04	6.6583e+00	1.8328e-04	4.0026e+04	6.6611e+00	1.8369e-04
4.0361e+04	6.6640e+00	1.8622e-04	4.0699e+04	6.6669e+00	1.8585e-04
4.1039e+04	6.6698e+00	1.8306e-04	4.1383e+04	6.6727e+00	1.8312e-04
4.1729e+04	6.6757e+00	1.8394e-04	4.2078e+04	6.6787e+00	1.8284e-04
4.2430e+04	6.6817e+00	1.8252e-04	4.2785e+04	6.6847e+00	1.7739e-04
4.3143e+04	6.6878e+00	1.7914e-04	4.3504e+04	6.6909e+00	1.8506e-04
4.3868e+04	6.6940e+00	1.8627e-04	4.4235e+04	6.6971e+00	1.9265e-04
4.4605e+04	6.7003e+00	1.9796e-04	4.4979e+04	6.7035e+00	1.9932e-04
4.5355e+04	6.7067e+00	2.0551e-04	4.5735e+04	6.7100e+00	2.0037e-04
4.6117e+04	6.7133e+00	1.9724e-04	4.6503e+04	6.7166e+00	2.0682e-04
4.6892e+04	6.7199e+00	2.0486e-04	4.7285e+04	6.7233e+00	2.0137e-04
4.7681e+04	6.7266e+00	1.9672e-04	4.8080e+04	6.7297e+00	1.8768e-04
4.8482e+04	6.7323e+00	1.7905e-04	4.8888e+04	6.7348e+00	1.6326e-04
4.9297e+04	6.7372e+00	1.3929e-04	4.9709e+04	6.7397e+00	1.1562e-04
5.0125e+04	6.7422e+00	9.8404e-05	5.0545e+04	6.7448e+00	9.5342e-05
5.0968e+04	6.7473e+00	1.0073e-04	5.1394e+04	6.7499e+00	1.0018e-04

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
5.1824e+04	6.7525e+00	8.7055e-05	5.2258e+04	6.7551e+00	7.2639e-05
5.2695e+04	6.7577e+00	6.6087e-05	5.3136e+04	6.7604e+00	7.3833e-05
5.3581e+04	6.7630e+00	9.6167e-05	5.4029e+04	6.7657e+00	1.1578e-04
5.4481e+04	6.7685e+00	1.2687e-04	5.4937e+04	6.7712e+00	1.3402e-04
5.5397e+04	6.7740e+00	1.4106e-04	5.5860e+04	6.7768e+00	1.4721e-04
5.6328e+04	6.7796e+00	1.4978e-04	5.6799e+04	6.7824e+00	1.5133e-04
5.7274e+04	6.7853e+00	1.4659e-04	5.7754e+04	6.7882e+00	1.4952e-04
5.8237e+04	6.7911e+00	1.6057e-04	5.8724e+04	6.7940e+00	1.6105e-04
5.9216e+04	6.7970e+00	1.5756e-04	5.9711e+04	6.8000e+00	1.6029e-04
6.0211e+04	6.8030e+00	1.6642e-04	6.0715e+04	6.8060e+00	1.6545e-04
6.1223e+04	6.8092e+00	1.5816e-04	6.1735e+04	6.8126e+00	1.4928e-04
6.2252e+04	6.8162e+00	1.3922e-04	6.2773e+04	6.8198e+00	1.2843e-04
6.3298e+04	6.8235e+00	1.2121e-04	6.3827e+04	6.8271e+00	1.1826e-04
6.4362e+04	6.8308e+00	1.1651e-04	6.4901e+04	6.8346e+00	1.1342e-04
6.5444e+04	6.8384e+00	1.1427e-04	6.5991e+04	6.8422e+00	1.1916e-04
6.6543e+04	6.8460e+00	1.2334e-04	6.7100e+04	6.8499e+00	1.2751e-04
6.7661e+04	6.8538e+00	1.3132e-04	6.8228e+04	6.8577e+00	1.3629e-04
6.8799e+04	6.8617e+00	1.4396e-04	6.9374e+04	6.8657e+00	1.5083e-04
6.9955e+04	6.8697e+00	1.5416e-04	7.0540e+04	6.8738e+00	1.5361e-04
7.1131e+04	6.8779e+00	1.4859e-04	7.1726e+04	6.8820e+00	1.4385e-04
7.2326e+04	6.8862e+00	1.3958e-04	7.2931e+04	6.8904e+00	1.2300e-04
7.3542e+04	6.8946e+00	8.1069e-05	7.4157e+04	6.8989e+00	6.4797e-05
7.4778e+04	6.9031e+00	8.6976e-05	7.5403e+04	6.9070e+00	1.0150e-04
7.6034e+04	6.9108e+00	1.0819e-04	7.6671e+04	6.9147e+00	1.1288e-04
7.7312e+04	6.9185e+00	1.2109e-04	7.7959e+04	6.9224e+00	1.3318e-04
7.8612e+04	6.9264e+00	1.4415e-04	7.9220e+04	6.9300e+00	1.5004e-04
7.9550e+04	6.9320e+00	1.5486e-04	7.9933e+04	6.9343e+00	1.5821e-04
8.0602e+04	6.9383e+00	1.6523e-04	8.1276e+04	6.9424e+00	1.7022e-04
8.1956e+04	6.9465e+00	1.5967e-04	8.2399e+04	6.9492e+00	1.4009e-04
8.2743e+04	6.9512e+00	1.0361e-04	8.3334e+04	6.9548e+00	6.6024e-05
8.4031e+04	6.9590e+00	6.2304e-05	8.4734e+04	6.9632e+00	7.8197e-05
8.5443e+04	6.9675e+00	8.9972e-05	8.6158e+04	6.9718e+00	9.5611e-05
8.6879e+04	6.9762e+00	9.9978e-05	8.7606e+04	6.9805e+00	1.0563e-04
8.8339e+04	6.9850e+00	1.0933e-04	8.9078e+04	6.9894e+00	1.1129e-04
8.9824e+04	6.9939e+00	1.0941e-04	9.0576e+04	6.9984e+00	1.1075e-04
9.1334e+04	7.0030e+00	1.1417e-04	9.2098e+04	7.0076e+00	1.1164e-04
9.2868e+04	7.0122e+00	1.0680e-04	9.3646e+04	7.0169e+00	1.0057e-04
9.4430e+04	7.0216e+00	9.2268e-05	9.5220e+04	7.0264e+00	8.6436e-05
9.6016e+04	7.0312e+00	8.3856e-05	9.6820e+04	7.0353e+00	8.0362e-05
9.7630e+04	7.0383e+00	7.6113e-05	9.8447e+04	7.0409e+00	7.4707e-05
9.9271e+04	7.0435e+00	7.7349e-05	1.0010e+05	7.0461e+00	8.0779e-05
1.0094e+05	7.0488e+00	8.3830e-05	1.0179e+05	7.0515e+00	8.4673e-05
1.0264e+05	7.0542e+00	8.7664e-05	1.0350e+05	7.0569e+00	9.2869e-05
1.0437e+05	7.0597e+00	9.5719e-05	1.0524e+05	7.0624e+00	9.5926e-05
1.0612e+05	7.0652e+00	9.5766e-05	1.0701e+05	7.0681e+00	9.1154e-05

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.0790e+05	7.0709e+00	8.2214e-05	1.0880e+05	7.0738e+00	8.0431e-05
1.0971e+05	7.0767e+00	8.3614e-05	1.1063e+05	7.0796e+00	8.4004e-05
1.1156e+05	7.0825e+00	8.4025e-05	1.1249e+05	7.0855e+00	8.7817e-05
1.1343e+05	7.0885e+00	9.0914e-05	1.1438e+05	7.0915e+00	9.2167e-05
1.1534e+05	7.0946e+00	9.3711e-05	1.1631e+05	7.0976e+00	9.5396e-05
1.1728e+05	7.1016e+00	9.5738e-05	1.1826e+05	7.1067e+00	9.5369e-05
1.1925e+05	7.1119e+00	9.4560e-05	1.2024e+05	7.1172e+00	9.2579e-05
1.2125e+05	7.1225e+00	8.3033e-05	1.2226e+05	7.1279e+00	7.6512e-05
1.2329e+05	7.1334e+00	7.9533e-05	1.2432e+05	7.1389e+00	8.3997e-05
1.2536e+05	7.1444e+00	9.0901e-05	1.2640e+05	7.1499e+00	9.4032e-05
1.2747e+05	7.1556e+00	9.4159e-05	1.2854e+05	7.1613e+00	8.1826e-05
1.2961e+05	7.1670e+00	6.7388e-05	1.3070e+05	7.1727e+00	8.0955e-05
1.3179e+05	7.1786e+00	1.0461e-04	1.3289e+05	7.1844e+00	1.1643e-04
1.3400e+05	7.1903e+00	1.2178e-04	1.3513e+05	7.1963e+00	1.2253e-04
1.3626e+05	7.2023e+00	1.1310e-04	1.3740e+05	7.2083e+00	9.8113e-05
1.3855e+05	7.2144e+00	7.6040e-05	1.3970e+05	7.2206e+00	4.9975e-05
1.4087e+05	7.2268e+00	3.9706e-05	1.4205e+05	7.2331e+00	4.0753e-05
1.4324e+05	7.2394e+00	4.6185e-05	1.4444e+05	7.2458e+00	5.2403e-05
1.4565e+05	7.2522e+00	5.5283e-05	1.4687e+05	7.2586e+00	5.7656e-05
1.4810e+05	7.2652e+00	5.9747e-05	1.4934e+05	7.2718e+00	6.3535e-05
1.5059e+05	7.2784e+00	6.7155e-05	1.5185e+05	7.2851e+00	6.9177e-05
1.5312e+05	7.2907e+00	7.0316e-05	1.5440e+05	7.2946e+00	7.0281e-05
1.5569e+05	7.2978e+00	6.7578e-05	1.5699e+05	7.3010e+00	6.4240e-05
1.5830e+05	7.3042e+00	6.2836e-05	1.5963e+05	7.3075e+00	6.2735e-05
1.6096e+05	7.3108e+00	6.3302e-05	1.6231e+05	7.3142e+00	6.5638e-05
1.6367e+05	7.3175e+00	6.8902e-05	1.6504e+05	7.3209e+00	7.1108e-05
1.6642e+05	7.3243e+00	7.3226e-05	1.6781e+05	7.3278e+00	6.1531e-05
1.6922e+05	7.3312e+00	4.9438e-05	1.7063e+05	7.3347e+00	5.3608e-05
1.7206e+05	7.3383e+00	5.7426e-05	1.7350e+05	7.3418e+00	6.0354e-05
1.7495e+05	7.3454e+00	6.6781e-05	1.7642e+05	7.3491e+00	7.2549e-05
1.7789e+05	7.3527e+00	7.5598e-05	1.7938e+05	7.3564e+00	7.7273e-05
1.8089e+05	7.3601e+00	8.1326e-05	1.8240e+05	7.3639e+00	8.2548e-05
1.8393e+05	7.3676e+00	7.5800e-05	1.8546e+05	7.3714e+00	6.1536e-05
1.8701e+05	7.3753e+00	4.4980e-05	1.8858e+05	7.3791e+00	3.8264e-05
1.9016e+05	7.3830e+00	4.0128e-05	1.9175e+05	7.3870e+00	4.1775e-05
1.9336e+05	7.3910e+00	4.3348e-05	1.9497e+05	7.3950e+00	4.4974e-05
1.9660e+05	7.3990e+00	4.4271e-05	1.9825e+05	7.4031e+00	4.3208e-05
1.9991e+05	7.4072e+00	4.3486e-05	2.0158e+05	7.4113e+00	4.5968e-05
2.0327e+05	7.4155e+00	4.7615e-05	2.0497e+05	7.4197e+00	4.5866e-05
2.0668e+05	7.4239e+00	4.5727e-05	2.0841e+05	7.4282e+00	4.7454e-05
2.1016e+05	7.4325e+00	4.8457e-05	2.1192e+05	7.4369e+00	4.9694e-05
2.1369e+05	7.4413e+00	5.1426e-05	2.1548e+05	7.4451e+00	5.2854e-05
2.1728e+05	7.4481e+00	5.4660e-05	2.1910e+05	7.4508e+00	4.7183e-05
2.2093e+05	7.4536e+00	3.9809e-05	2.2278e+05	7.4564e+00	4.2836e-05
2.2465e+05	7.4592e+00	4.5256e-05	2.2653e+05	7.4620e+00	4.7170e-05

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
2.2842e+05	7.4648e+00	4.7818e-05	2.3033e+05	7.4677e+00	4.5206e-05
2.3226e+05	7.4706e+00	4.0646e-05	2.3421e+05	7.4735e+00	3.6369e-05
2.3617e+05	7.4764e+00	3.4404e-05	2.3814e+05	7.4794e+00	3.6827e-05
2.4013e+05	7.4824e+00	4.0251e-05	2.4214e+05	7.4854e+00	4.1694e-05
2.4417e+05	7.4884e+00	3.8702e-05	2.4621e+05	7.4915e+00	3.6505e-05
2.4827e+05	7.4946e+00	3.8242e-05	2.5035e+05	7.4977e+00	3.9111e-05
2.5244e+05	7.5008e+00	4.0064e-05	2.5456e+05	7.5040e+00	4.2042e-05
2.5669e+05	7.5072e+00	4.2192e-05	2.5883e+05	7.5104e+00	4.3195e-05
2.6100e+05	7.5138e+00	4.5637e-05	2.6319e+05	7.5172e+00	4.6868e-05
2.6539e+05	7.5207e+00	4.7524e-05	2.6761e+05	7.5243e+00	4.8050e-05
2.6985e+05	7.5278e+00	4.9242e-05	2.7211e+05	7.5314e+00	4.6874e-05
2.7438e+05	7.5350e+00	3.7567e-05	2.7668e+05	7.5387e+00	2.9389e-05
2.7899e+05	7.5424e+00	2.9732e-05	2.8133e+05	7.5461e+00	3.1299e-05
2.8368e+05	7.5498e+00	3.2484e-05	2.8606e+05	7.5536e+00	3.4539e-05
2.8845e+05	7.5579e+00	3.5358e-05	2.9086e+05	7.5628e+00	3.5314e-05
2.9330e+05	7.5679e+00	3.6833e-05	2.9575e+05	7.5730e+00	3.9075e-05
2.9709e+05	7.5758e+00	3.9051e-05	2.9785e+05	7.5774e+00	3.5362e-05
2.9899e+05	7.5797e+00	3.3444e-05	3.0072e+05	7.5833e+00	3.7044e-05
3.0324e+05	7.5886e+00	3.8705e-05	3.0578e+05	7.5938e+00	3.8774e-05
3.0834e+05	7.5992e+00	3.9484e-05	3.1092e+05	7.6045e+00	3.9860e-05
3.1352e+05	7.6099e+00	3.7748e-05	3.1614e+05	7.6154e+00	3.1080e-05
3.1879e+05	7.6209e+00	2.5931e-05	3.2145e+05	7.6264e+00	2.5843e-05
3.2414e+05	7.6320e+00	2.6115e-05	3.2686e+05	7.6377e+00	2.6008e-05
3.2959e+05	7.6434e+00	2.5992e-05	3.3235e+05	7.6491e+00	2.6245e-05
3.3513e+05	7.6549e+00	2.8010e-05	3.3794e+05	7.6607e+00	2.8561e-05
3.4076e+05	7.6666e+00	2.8711e-05	3.4361e+05	7.6725e+00	2.9399e-05
3.4649e+05	7.6785e+00	2.8034e-05	3.4939e+05	7.6845e+00	2.7319e-05
3.5231e+05	7.6906e+00	2.7339e-05	3.5526e+05	7.6956e+00	2.4944e-05
3.5824e+05	7.6989e+00	2.1722e-05	3.6124e+05	7.7016e+00	1.8706e-05
3.6426e+05	7.7044e+00	1.7535e-05	3.6730e+05	7.7071e+00	1.8951e-05
3.7038e+05	7.7099e+00	2.1401e-05	3.7348e+05	7.7127e+00	2.3004e-05
3.7660e+05	7.7156e+00	2.1458e-05	3.7975e+05	7.7184e+00	1.8587e-05
3.8293e+05	7.7213e+00	1.6574e-05	3.8613e+05	7.7242e+00	1.5856e-05
3.8937e+05	7.7271e+00	1.6115e-05	3.9263e+05	7.7301e+00	1.6082e-05
3.9591e+05	7.7331e+00	1.6079e-05	3.9922e+05	7.7361e+00	1.5643e-05
4.0256e+05	7.7391e+00	1.5478e-05	4.0593e+05	7.7422e+00	1.5253e-05
4.0933e+05	7.7452e+00	1.4714e-05	4.1275e+05	7.7483e+00	1.4355e-05
4.1621e+05	7.7515e+00	1.3281e-05	4.1969e+05	7.7546e+00	1.3067e-05
4.2321e+05	7.7578e+00	1.3108e-05	4.2675e+05	7.7610e+00	1.2590e-05
4.3032e+05	7.7649e+00	1.2484e-05	4.3392e+05	7.7696e+00	1.2675e-05
4.3755e+05	7.7745e+00	1.2643e-05	4.4121e+05	7.7794e+00	1.2902e-05
4.4490e+05	7.7843e+00	1.3357e-05	4.4862e+05	7.7893e+00	1.4330e-05
4.5238e+05	7.7943e+00	1.6065e-05	4.5616e+05	7.7994e+00	1.7245e-05
4.5998e+05	7.8045e+00	1.8266e-05	4.6383e+05	7.8097e+00	1.9792e-05
4.6771e+05	7.8148e+00	1.9393e-05	4.7163e+05	7.8201e+00	1.8687e-05

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
4.7557e+05	7.8254e+00	1.9781e-05	4.7955e+05	7.8309e+00	2.0880e-05
4.8357e+05	7.8364e+00	2.1489e-05	4.8761e+05	7.8419e+00	2.0480e-05
4.9169e+05	7.8475e+00	2.1212e-05	4.9581e+05	7.8532e+00	2.2253e-05
4.9996e+05	7.8589e+00	2.0631e-05	5.0414e+05	7.8646e+00	2.0506e-05
5.0836e+05	7.8704e+00	1.9999e-05	5.1261e+05	7.8762e+00	2.0055e-05
5.1690e+05	7.8821e+00	2.1865e-05	5.2123e+05	7.8881e+00	2.1917e-05
5.2559e+05	7.8937e+00	2.1456e-05	5.2999e+05	7.8988e+00	2.0738e-05
5.3442e+05	7.9040e+00	1.9161e-05	5.3890e+05	7.9092e+00	1.8359e-05
5.4341e+05	7.9145e+00	1.8276e-05	5.4795e+05	7.9198e+00	1.8348e-05
5.5254e+05	7.9251e+00	1.8431e-05	5.5716e+05	7.9305e+00	1.7142e-05
5.6182e+05	7.9359e+00	1.6462e-05	5.6652e+05	7.9414e+00	1.6831e-05
5.7126e+05	7.9469e+00	1.5928e-05	5.7604e+05	7.9525e+00	1.4855e-05
5.8086e+05	7.9587e+00	1.5733e-05	5.8572e+05	7.9658e+00	1.6626e-05
5.9063e+05	7.9730e+00	1.6583e-05	5.9557e+05	7.9803e+00	1.6839e-05
6.0055e+05	7.9877e+00	1.6778e-05	6.0558e+05	7.9951e+00	1.6441e-05
6.1065e+05	8.0026e+00	1.5085e-05	6.1576e+05	8.0102e+00	1.4448e-05
6.2091e+05	8.0178e+00	1.5133e-05	6.2610e+05	8.0255e+00	1.5193e-05
6.3134e+05	8.0332e+00	1.5300e-05	6.3663e+05	8.0410e+00	1.5499e-05
6.4196e+05	8.0489e+00	1.4669e-05	6.4733e+05	8.0568e+00	1.4227e-05
6.5274e+05	8.0648e+00	1.3878e-05	6.5821e+05	8.0729e+00	1.3063e-05
6.6372e+05	8.0811e+00	1.2436e-05	6.6927e+05	8.0893e+00	1.1231e-05
6.7487e+05	8.0975e+00	1.0685e-05	6.8052e+05	8.1059e+00	1.0796e-05
6.8621e+05	8.1143e+00	1.0858e-05	6.9195e+05	8.1228e+00	1.0421e-05
6.9774e+05	8.1313e+00	1.0643e-05	7.0358e+05	8.1400e+00	1.1112e-05
7.0947e+05	8.1487e+00	1.0257e-05	7.1541e+05	8.1554e+00	9.3480e-06
7.2140e+05	8.1589e+00	9.0141e-06	7.2743e+05	8.1614e+00	9.7268e-06
7.3352e+05	8.1639e+00	1.0697e-05	7.3966e+05	8.1664e+00	1.0563e-05
7.4585e+05	8.1690e+00	1.0197e-05	7.5209e+05	8.1715e+00	9.5377e-06
7.5838e+05	8.1741e+00	9.5309e-06	7.6473e+05	8.1767e+00	9.6056e-06
7.7113e+05	8.1794e+00	8.6829e-06	7.7758e+05	8.1820e+00	8.3115e-06
7.8409e+05	8.1847e+00	7.8909e-06	7.9065e+05	8.1874e+00	7.9509e-06
7.9726e+05	8.1901e+00	8.3079e-06	8.0393e+05	8.1929e+00	8.4144e-06
8.1066e+05	8.1956e+00	8.4135e-06	8.1745e+05	8.1984e+00	8.2411e-06
8.2429e+05	8.2012e+00	7.9711e-06	8.3119e+05	8.2041e+00	7.5033e-06
8.3814e+05	8.2069e+00	7.1046e-06	8.4515e+05	8.2098e+00	7.0808e-06
8.5222e+05	8.2127e+00	7.0348e-06	8.5936e+05	8.2157e+00	6.5611e-06
8.6655e+05	8.2186e+00	6.1141e-06	8.7380e+05	8.2215e+00	5.9991e-06
8.8111e+05	8.2245e+00	6.0526e-06	8.8849e+05	8.2275e+00	5.8783e-06
8.9592e+05	8.2305e+00	5.5864e-06	9.0342e+05	8.2335e+00	5.1316e-06
9.1098e+05	8.2366e+00	4.7025e-06	9.1860e+05	8.2397e+00	4.5624e-06
9.2629e+05	8.2428e+00	4.5945e-06	9.3404e+05	8.2460e+00	4.5443e-06
9.4186e+05	8.2491e+00	4.5419e-06	9.4974e+05	8.2523e+00	4.4231e-06
9.5768e+05	8.2555e+00	4.3218e-06	9.6570e+05	8.2585e+00	4.1163e-06
9.7378e+05	8.2615e+00	3.7274e-06	9.8193e+05	8.2646e+00	3.5824e-06
9.9015e+05	8.2677e+00	3.5309e-06	9.9844e+05	8.2708e+00	3.5134e-06

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
1.0068e+06	8.2740e+00	3.6434e-06	1.0152e+06	8.2771e+00	3.6671e-06
1.0237e+06	8.2803e+00	3.6478e-06	1.0323e+06	8.2836e+00	3.6757e-06
1.0409e+06	8.2868e+00	3.6972e-06	1.0496e+06	8.2901e+00	3.7731e-06
1.0584e+06	8.2935e+00	3.6904e-06	1.0673e+06	8.2972e+00	3.7010e-06
1.0762e+06	8.3010e+00	3.8651e-06	1.0852e+06	8.3048e+00	3.9323e-06
1.0943e+06	8.3086e+00	3.9832e-06	1.1034e+06	8.3124e+00	4.0310e-06
1.1127e+06	8.3163e+00	4.1513e-06	1.1220e+06	8.3202e+00	4.3126e-06
1.1314e+06	8.3242e+00	4.2886e-06	1.1409e+06	8.3282e+00	4.2240e-06
1.1504e+06	8.3322e+00	4.2382e-06	1.1600e+06	8.3362e+00	4.1861e-06
1.1697e+06	8.3417e+00	4.2181e-06	1.1795e+06	8.3490e+00	4.3118e-06
1.1894e+06	8.3566e+00	4.4229e-06	1.1993e+06	8.3643e+00	4.2645e-06
1.2094e+06	8.3720e+00	4.0427e-06	1.2195e+06	8.3798e+00	3.9827e-06
1.2297e+06	8.3877e+00	3.9950e-06	1.2400e+06	8.3956e+00	4.1310e-06
1.2504e+06	8.4036e+00	4.1413e-06	1.2609e+06	8.4116e+00	4.0692e-06
1.2714e+06	8.4198e+00	3.9141e-06	1.2820e+06	8.4279e+00	3.5296e-06
1.2927e+06	8.4427e+00	3.0804e-06	1.3035e+06	8.4654e+00	2.7824e-06
1.3145e+06	8.4894e+00	2.7264e-06	1.3255e+06	8.5137e+00	2.9047e-06
1.3366e+06	8.5381e+00	3.1715e-06	1.3478e+06	8.5628e+00	3.3620e-06
1.3590e+06	8.5877e+00	3.4222e-06	1.3704e+06	8.6127e+00	3.4065e-06
1.3819e+06	8.6379e+00	3.3371e-06	1.3934e+06	8.6633e+00	3.2655e-06
1.4051e+06	8.6890e+00	3.1802e-06	1.4168e+06	8.7149e+00	3.1712e-06
1.4287e+06	8.7410e+00	3.2765e-06	1.4407e+06	8.7674e+00	3.2838e-06
1.4528e+06	8.7941e+00	3.1087e-06	1.4649e+06	8.8208e+00	3.0300e-06
1.4772e+06	8.8478e+00	3.0388e-06	1.4895e+06	8.8750e+00	3.0085e-06
1.5020e+06	8.9007e+00	2.9062e-06	1.5145e+06	8.9222e+00	2.8402e-06
1.5272e+06	8.9413e+00	2.8111e-06	1.5400e+06	8.9606e+00	2.7924e-06
1.5529e+06	8.9800e+00	2.7113e-06	1.5659e+06	8.9996e+00	2.5725e-06
1.5790e+06	9.0193e+00	2.5420e-06	1.5922e+06	9.0392e+00	2.4255e-06
1.6055e+06	9.0594e+00	2.3730e-06	1.6190e+06	9.0796e+00	2.4315e-06
1.6325e+06	9.1001e+00	2.2817e-06	1.6462e+06	9.1207e+00	2.2403e-06
1.6599e+06	9.1414e+00	2.4719e-06	1.6738e+06	9.1623e+00	2.5444e-06
1.6878e+06	9.1834e+00	2.4427e-06	1.7019e+06	9.2047e+00	2.3663e-06
1.7162e+06	9.2262e+00	2.3661e-06	1.7305e+06	9.2478e+00	2.2887e-06
1.7450e+06	9.2697e+00	2.2064e-06	1.7596e+06	9.2917e+00	2.2401e-06
1.7743e+06	9.3138e+00	2.2557e-06	1.7892e+06	9.3362e+00	2.2023e-06
1.8042e+06	9.3588e+00	2.1623e-06	1.8193e+06	9.3816e+00	1.9877e-06
1.8345e+06	9.4022e+00	1.9089e-06	1.8498e+06	9.4170e+00	2.0192e-06
1.8653e+06	9.4284e+00	2.0173e-06	1.8810e+06	9.4400e+00	1.9035e-06
1.8967e+06	9.4516e+00	1.7629e-06	1.9126e+06	9.4632e+00	1.7354e-06
1.9286e+06	9.4750e+00	1.7379e-06	1.9447e+06	9.4869e+00	1.7151e-06
1.9610e+06	9.4989e+00	1.6924e-06	1.9774e+06	9.5110e+00	1.7130e-06
1.9939e+06	9.5232e+00	1.6801e-06	2.0106e+06	9.5355e+00	1.6519e-06
2.0275e+06	9.5479e+00	1.6725e-06	2.0444e+06	9.5604e+00	1.6597e-06
2.0615e+06	9.5730e+00	1.6277e-06	2.0788e+06	9.5857e+00	1.6076e-06
2.0962e+06	9.5985e+00	1.6334e-06	2.1137e+06	9.6114e+00	1.6505e-06

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Table B.1. ***Continued***

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
2.1314e+06	9.6239e+00	1.6310e-06	2.1492e+06	9.6358e+00	1.6302e-06
2.1672e+06	9.6477e+00	1.6419e-06	2.1853e+06	9.6596e+00	1.5883e-06
2.2036e+06	9.6717e+00	1.5643e-06	2.2221e+06	9.6839e+00	1.5729e-06
2.2407e+06	9.6962e+00	1.5685e-06	2.2594e+06	9.7086e+00	1.5960e-06
2.2783e+06	9.7211e+00	1.6264e-06	2.2974e+06	9.7337e+00	1.6642e-06
2.3166e+06	9.7464e+00	1.7394e-06	2.3360e+06	9.7593e+00	1.7312e-06
2.3555e+06	9.7702e+00	1.6782e-06	2.3752e+06	9.7789e+00	1.6174e-06
2.3951e+06	9.7874e+00	1.5009e-06	2.4152e+06	9.7959e+00	1.4154e-06
2.4354e+06	9.8045e+00	1.3529e-06	2.4558e+06	9.8131e+00	1.3565e-06
2.4763e+06	9.8219e+00	1.3773e-06	2.4970e+06	9.8307e+00	1.3361e-06
2.5179e+06	9.8395e+00	1.3063e-06	2.5390e+06	9.8485e+00	1.2735e-06
2.5603e+06	9.8575e+00	1.2886e-06	2.5817e+06	9.8666e+00	1.2994e-06
2.6033e+06	9.8758e+00	1.2656e-06	2.6251e+06	9.8850e+00	1.2596e-06
2.6470e+06	9.8944e+00	1.2364e-06	2.6692e+06	9.9038e+00	1.2187e-06
2.6915e+06	9.9133e+00	1.1966e-06	2.7140e+06	9.9228e+00	1.1179e-06
2.7367e+06	9.9312e+00	1.0821e-06	2.7596e+06	9.9367e+00	1.0808e-06
2.7827e+06	9.9403e+00	1.0430e-06	2.8060e+06	9.9440e+00	1.0069e-06
2.8295e+06	9.9477e+00	9.8204e-07	2.8532e+06	9.9515e+00	9.7825e-07
2.8770e+06	9.9552e+00	9.6450e-07	2.9011e+06	9.9590e+00	9.5311e-07
2.9254e+06	9.9629e+00	9.4800e-07	2.9499e+06	9.9667e+00	9.4320e-07
2.9746e+06	9.9706e+00	9.2443e-07	2.9994e+06	9.9746e+00	9.1403e-07
3.0245e+06	9.9785e+00	9.2424e-07	3.0499e+06	9.9825e+00	9.1494e-07
3.0754e+06	9.9866e+00	9.0418e-07	3.1011e+06	9.9906e+00	8.8000e-07
3.1271e+06	9.9947e+00	8.2840e-07	3.1533e+06	9.9989e+00	7.7721e-07
3.1797e+06	1.0003e+01	7.4048e-07	3.2063e+06	1.0007e+01	7.1656e-07
3.2331e+06	1.0011e+01	6.8526e-07	3.2601e+06	1.0016e+01	6.4748e-07
3.2874e+06	1.0020e+01	6.2849e-07	3.3149e+06	1.0024e+01	6.1433e-07
3.3427e+06	1.0027e+01	5.9114e-07	3.3707e+06	1.0025e+01	5.6531e-07
3.3989e+06	1.0020e+01	5.5451e-07	3.4273e+06	1.0016e+01	5.4405e-07
3.4559e+06	1.0011e+01	5.2065e-07	3.4849e+06	1.0006e+01	5.0805e-07
3.5141e+06	1.0001e+01	4.9996e-07	3.5435e+06	9.9966e+00	4.9029e-07
3.5731e+06	9.9917e+00	4.7868e-07	3.6030e+06	9.9868e+00	4.6613e-07
3.6332e+06	9.9818e+00	4.5480e-07	3.6636e+06	9.9768e+00	4.4631e-07
3.6942e+06	9.9718e+00	4.3457e-07	3.7251e+06	9.9667e+00	4.0634e-07
3.7563e+06	9.9615e+00	3.9396e-07	3.7877e+06	9.9564e+00	4.1267e-07
3.8194e+06	9.9511e+00	4.2421e-07	3.8514e+06	9.9459e+00	4.1962e-07
3.8836e+06	9.9406e+00	4.1431e-07	3.9161e+06	9.9352e+00	4.0233e-07
3.9489e+06	9.9298e+00	3.9270e-07	3.9819e+06	9.9244e+00	3.9190e-07
4.0153e+06	9.9189e+00	3.9801e-07	4.0489e+06	9.9134e+00	4.0493e-07
4.0827e+06	9.9084e+00	3.9822e-07	4.1169e+06	9.9050e+00	3.7688e-07
4.1513e+06	9.9025e+00	3.5232e-07	4.1861e+06	9.8999e+00	3.4110e-07
4.2211e+06	9.8973e+00	3.4451e-07	4.2564e+06	9.8948e+00	3.3321e-07
4.2920e+06	9.8921e+00	2.9674e-07	4.3280e+06	9.8895e+00	2.7596e-07
4.3642e+06	9.8869e+00	2.8053e-07	4.4007e+06	9.8842e+00	2.8480e-07
4.4375e+06	9.8815e+00	2.8560e-07	4.4747e+06	9.8788e+00	2.7956e-07

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
4.5121e+06	9.8760e+00	2.6941e-07	4.5499e+06	9.8732e+00	2.6416e-07
4.5879e+06	9.8705e+00	2.5951e-07	4.6263e+06	9.8676e+00	2.5803e-07
4.6651e+06	9.8648e+00	2.5933e-07	4.7041e+06	9.8619e+00	2.5715e-07
4.7435e+06	9.8591e+00	2.5014e-07	4.7832e+06	9.8562e+00	2.3232e-07
4.8232e+06	9.8532e+00	2.1602e-07	4.8635e+06	9.8503e+00	2.1481e-07
4.9042e+06	9.8473e+00	2.1697e-07	4.9453e+06	9.8443e+00	2.1390e-07
4.9867e+06	9.8438e+00	2.0722e-07	5.0284e+06	9.8498e+00	1.9444e-07
5.0705e+06	9.8597e+00	1.7479e-07	5.1129e+06	9.8697e+00	1.6673e-07
5.1557e+06	9.8798e+00	1.7103e-07	5.1988e+06	9.8900e+00	1.7013e-07
5.2423e+06	9.9002e+00	1.6768e-07	5.2862e+06	9.9105e+00	1.6126e-07
5.3304e+06	9.9210e+00	1.5383e-07	5.3750e+06	9.9315e+00	1.5143e-07
5.4200e+06	9.9421e+00	1.4737e-07	5.4653e+06	9.9528e+00	1.4202e-07
5.5111e+06	9.9635e+00	1.3598e-07	5.5572e+06	9.9744e+00	1.2623e-07
5.6037e+06	9.9853e+00	1.1856e-07	5.6506e+06	9.9964e+00	1.1609e-07
5.6979e+06	1.0008e+01	1.1498e-07	5.7456e+06	1.0019e+01	1.1357e-07
5.7937e+06	1.0035e+01	1.1108e-07	5.8422e+06	1.0057e+01	1.0607e-07
5.8911e+06	1.0080e+01	1.0023e-07	5.9404e+06	1.0104e+01	9.9216e-08
5.9901e+06	1.0128e+01	9.8474e-08	6.0402e+06	1.0151e+01	9.3812e-08
6.0907e+06	1.0175e+01	9.0513e-08	6.1417e+06	1.0200e+01	8.8335e-08
6.1931e+06	1.0224e+01	8.5725e-08	6.2449e+06	1.0249e+01	8.2781e-08
6.2972e+06	1.0273e+01	7.8882e-08	6.3499e+06	1.0299e+01	7.3778e-08
6.4030e+06	1.0332e+01	7.2361e-08	6.4565e+06	1.0375e+01	7.2585e-08
6.5106e+06	1.0421e+01	6.9391e-08	6.5651e+06	1.0466e+01	6.5220e-08
6.6200e+06	1.0512e+01	6.2140e-08	6.6754e+06	1.0559e+01	5.9631e-08
6.7313e+06	1.0606e+01	5.6272e-08	6.7876e+06	1.0653e+01	5.3808e-08
6.8444e+06	1.0700e+01	5.3275e-08	6.9017e+06	1.0748e+01	5.2340e-08
6.9594e+06	1.0797e+01	4.9722e-08	7.0177e+06	1.0845e+01	4.7159e-08
7.0764e+06	1.0895e+01	4.4856e-08	7.1356e+06	1.0944e+01	4.1455e-08
7.1953e+06	1.0994e+01	3.9001e-08	7.2555e+06	1.1045e+01	3.7840e-08
7.3162e+06	1.1096e+01	3.6551e-08	7.3775e+06	1.1147e+01	3.5353e-08
7.4392e+06	1.1194e+01	3.4133e-08	7.5015e+06	1.1232e+01	3.2959e-08
7.5642e+06	1.1264e+01	3.1372e-08	7.6275e+06	1.1295e+01	2.9765e-08
7.6914e+06	1.1328e+01	2.8271e-08	7.7557e+06	1.1360e+01	2.6604e-08
7.8206e+06	1.1393e+01	2.5345e-08	7.8861e+06	1.1426e+01	2.4918e-08
7.9521e+06	1.1459e+01	2.4568e-08	8.0186e+06	1.1493e+01	2.3520e-08
8.0857e+06	1.1526e+01	2.1920e-08	8.1534e+06	1.1560e+01	2.0313e-08
8.2216e+06	1.1595e+01	1.9114e-08	8.2904e+06	1.1630e+01	1.8276e-08
8.3598e+06	1.1665e+01	1.7525e-08	8.4297e+06	1.1700e+01	1.6861e-08
8.5003e+06	1.1735e+01	1.6224e-08	8.5714e+06	1.1771e+01	1.5325e-08
8.6431e+06	1.1807e+01	1.4291e-08	8.7154e+06	1.1844e+01	1.3509e-08
8.7884e+06	1.1881e+01	1.3076e-08	8.8619e+06	1.1918e+01	1.2647e-08
8.9361e+06	1.1955e+01	1.1970e-08	9.0109e+06	1.1993e+01	1.1269e-08
9.0863e+06	1.2026e+01	1.0780e-08	9.1623e+06	1.2049e+01	1.0337e-08
9.2389e+06	1.2066e+01	9.7662e-09	9.3163e+06	1.2083e+01	9.1566e-09
9.3943e+06	1.2100e+01	8.6165e-09	9.4729e+06	1.2117e+01	8.1480e-09

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Table B.1. *Continued*

Energy	Adj. funct.	Spectrum	Energy	Adj. funct.	Spectrum
9.5521e+06	1.2135e+01	7.6656e-09	9.6321e+06	1.2152e+01	7.1967e-09
9.7127e+06	1.2170e+01	6.7605e-09	9.7939e+06	1.2188e+01	6.3710e-09
9.8759e+06	1.2206e+01	6.0222e-09	9.9585e+06	1.2224e+01	5.6123e-09
1.0042e+07	1.2242e+01	5.3057e-09	1.0126e+07	1.2260e+01	5.0495e-09
1.0211e+07	1.2279e+01	4.7319e-09	1.0296e+07	1.2298e+01	4.5192e-09
1.0382e+07	1.2316e+01	4.2477e-09	1.0469e+07	1.2335e+01	4.0114e-09
1.0557e+07	1.2355e+01	3.8164e-09	1.0645e+07	1.2374e+01	3.5993e-09
1.0734e+07	1.2393e+01	3.3922e-09	1.0824e+07	1.2419e+01	3.1776e-09
1.0915e+07	1.2452e+01	2.9677e-09	1.1006e+07	1.2489e+01	2.7390e-09
1.1098e+07	1.2527e+01	2.5515e-09	1.1191e+07	1.2564e+01	2.3740e-09
1.1284e+07	1.2602e+01	2.2317e-09	1.1379e+07	1.2640e+01	2.0933e-09
1.1474e+07	1.2678e+01	1.9763e-09	1.1570e+07	1.2717e+01	1.8550e-09
1.1667e+07	1.2756e+01	1.7345e-09	1.1765e+07	1.2796e+01	1.6380e-09
1.1863e+07	1.2836e+01	1.5382e-09	1.1962e+07	1.2876e+01	1.4470e-09
1.2063e+07	1.2916e+01	1.3790e-09	1.2164e+07	1.2957e+01	1.3104e-09
1.2265e+07	1.2998e+01	1.2260e-09	1.2368e+07	1.3040e+01	1.1500e-09
1.2471e+07	1.3081e+01	1.0786e-09	1.2576e+07	1.3124e+01	1.0170e-09
1.2681e+07	1.3168e+01	9.5827e-10	1.2787e+07	1.3241e+01	8.9744e-10
1.2894e+07	1.3342e+01	8.4153e-10	1.3002e+07	1.3445e+01	8.0219e-10
1.3111e+07	1.3548e+01	7.5697e-10	1.3220e+07	1.3652e+01	7.1302e-10
1.3331e+07	1.3757e+01	6.7025e-10	1.3443e+07	1.3863e+01	6.3372e-10
1.3556e+07	1.3970e+01	6.0168e-10	1.3669e+07	1.4077e+01	5.6797e-10
1.3783e+07	1.4186e+01	5.3828e-10	1.3898e+07	1.4295e+01	5.1200e-10
1.4015e+07	1.4406e+01	4.9002e-10	1.4132e+07	1.4517e+01	4.6896e-10
1.4250e+07	1.4629e+01	4.4804e-10	1.4369e+07	1.4742e+01	4.2791e-10
1.4490e+07	1.4853e+01	4.0907e-10	1.4611e+07	1.4965e+01	3.9478e-10
1.4733e+07	1.5077e+01	3.7807e-10	1.4856e+07	1.5190e+01	3.6093e-10
1.4981e+07	1.5304e+01	3.4856e-10	1.5106e+07	1.5419e+01	3.3885e-10
1.5233e+07	1.5535e+01	3.3188e-10	1.5360e+07	1.5652e+01	3.2362e-10
1.5489e+07	1.5770e+01	3.1460e-10	1.5618e+07	1.5889e+01	1.0000e-10
1.5749e+07	1.6009e+01	0.0000e+00	1.5881e+07	1.6130e+01	0.0000e+00
1.6014e+07	1.6252e+01	0.0000e+00	1.6148e+07	1.6365e+01	0.0000e+00
1.6283e+07	1.6463e+01	0.0000e+00	1.6419e+07	1.6557e+01	0.0000e+00
1.6556e+07	1.6652e+01	0.0000e+00	1.6695e+07	1.6748e+01	0.0000e+00
1.6835e+07	1.6845e+01	0.0000e+00	1.6976e+07	1.6942e+01	0.0000e+00
1.7118e+07	1.7040e+01	0.0000e+00	1.7261e+07	1.7140e+01	0.0000e+00
1.7406e+07	1.7239e+01	0.0000e+00	1.7551e+07	1.7340e+01	0.0000e+00
1.7698e+07	1.7441e+01	0.0000e+00	1.7846e+07	1.7544e+01	0.0000e+00
1.7995e+07	1.7647e+01	0.0000e+00	1.8146e+07	1.7751e+01	0.0000e+00
1.8298e+07	1.7856e+01	0.0000e+00	1.8451e+07	1.7962e+01	0.0000e+00
1.8605e+07	1.8068e+01	0.0000e+00	1.8761e+07	1.8176e+01	0.0000e+00
1.8918e+07	1.8285e+01	0.0000e+00	1.9076e+07	1.8394e+01	0.0000e+00
1.9236e+07	1.8505e+01	0.0000e+00	1.9397e+07	1.8616e+01	0.0000e+00
1.9559e+07	1.8728e+01	0.0000e+00	1.9640e+07	1.8784e+01	0.0000e+00

APPENDIX C

Detailed Results for the Lumped Nuclide

Figure C.1. The radiative capture cross-section of the lumped nuclide as a function of the energy

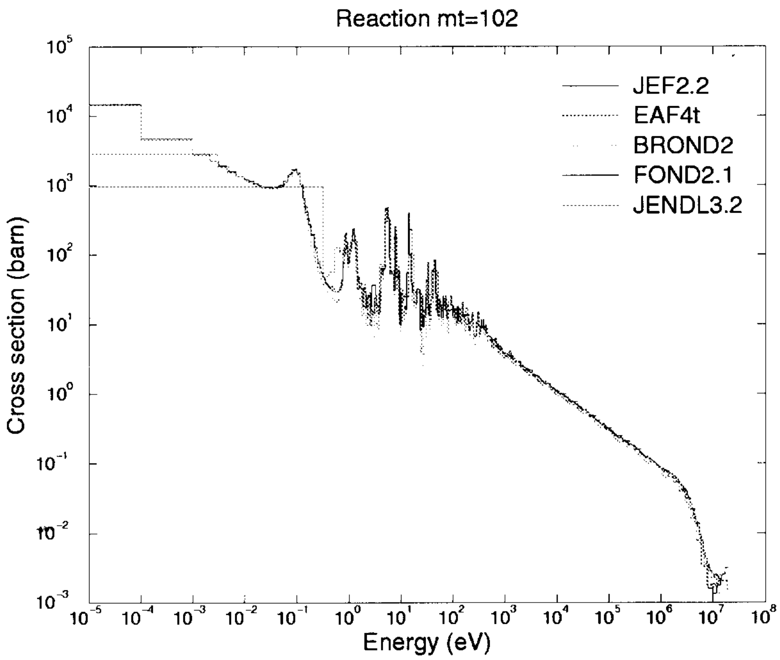


Figure C.2. The radiative capture cross-section of the lumped nuclide as a function of the energy

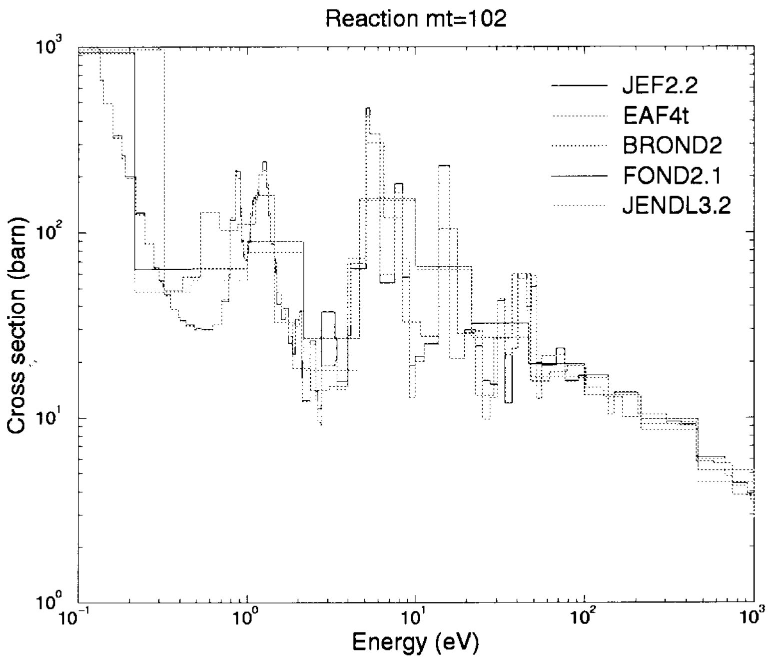


Figure C.3. The radiative capture cross-section of the lumped nuclide as a function of the energy

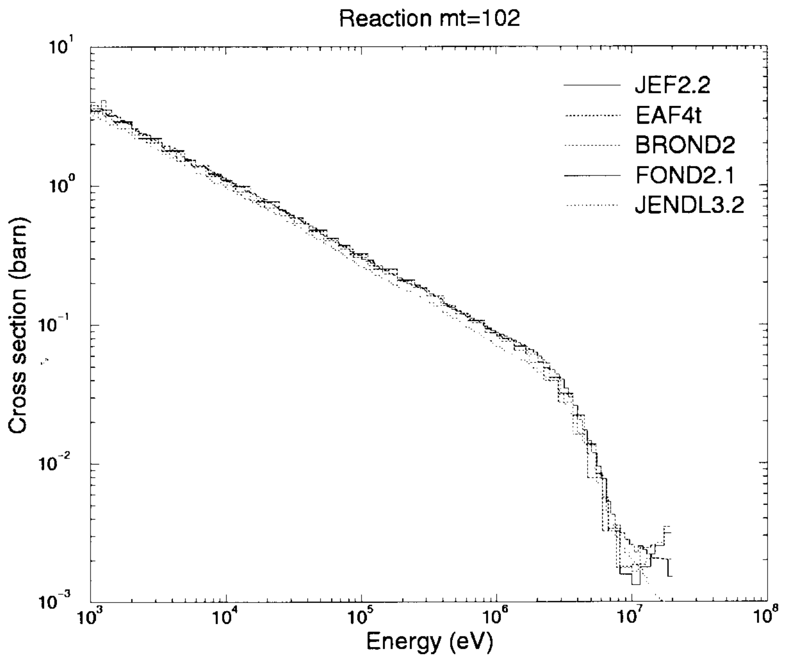


Figure C.4. The inelastic scattering cross-section of the lumped nuclide as a function of the energy

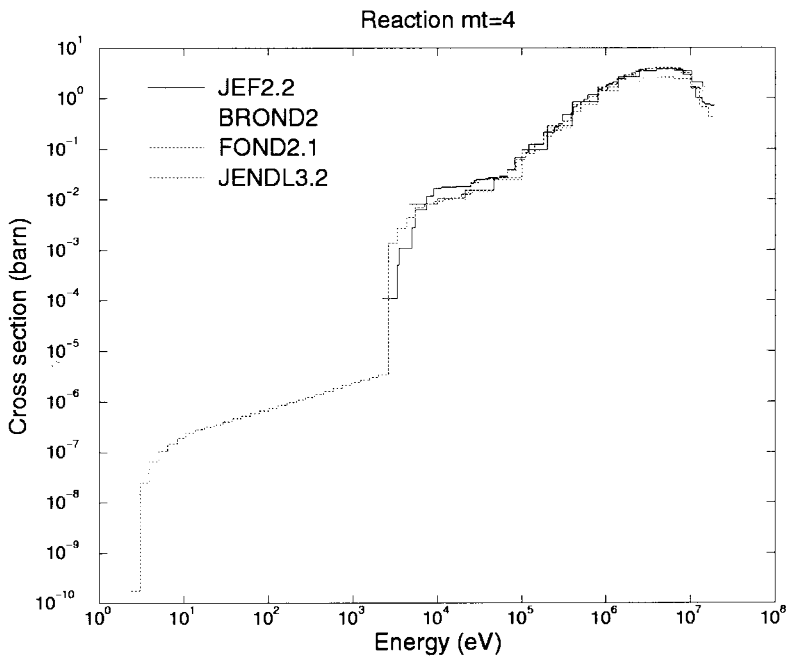


Figure C.5. The inelastic scattering cross-section of the lumped nuclide as a function of the energy

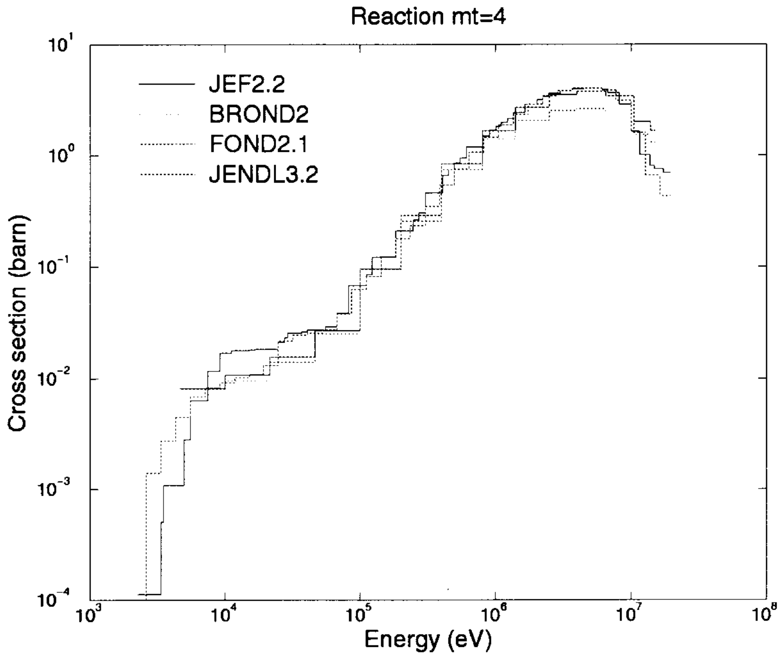
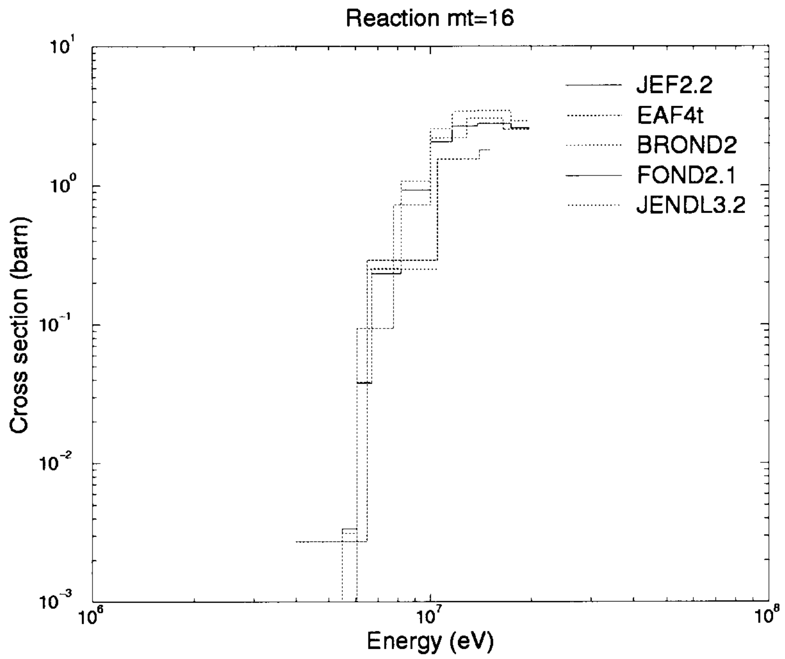


Figure C.6. The (n,2n) cross-section of the lumped nuclide as a function of the energy



APPENDIX D

Detailed Analysis of the Energy Dependence of Individual Fission-Product Capture Cross-Sections

This appendix has been prepared by JNDC.

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Table 1. Status of JENDL-3.2 capture data compared with the “average” of one group cross-sections for 40 high contribution FP nuclides, given in Table 5.1

In the following table, the difference between JENDL-3.2 and the others (ECN, JEF-2.2 and FOND-2.1) are shown with the symbol of the sign of plus, minus and asterisk.

Ru101+	Pd105-	Sm149-**	Tc99-*	Cs133-
Pd107-	Rh103+	(Pm147)-*	(Sm151)-**	(Ru103)-**
Mo97-*	Nd145+	(Xe131)-*	Eu153-*	Nd143+
Ru102-	Ag109-*	Ru104+	(Cs135)+**	Pr141+
Mo95+	Mo98-	Mo100+	(Eu155)-**	Pd108+*
Xe132+**	Zr93-*	Sm152-	(Ce141)+	I129+
(Ru106)+	Zr96-**	Pd106+**	I127-	Nd146+
Nd148-*	Xe134-**	La139-	(Nb95)+**	(Zr95)+**

N.B. * Difference > 5% (-: 6 nuclides, +: 2 nuclides)
** Difference > 10% (-:6 nuclides, +: 5 nuclides)
-,+ JENDL-3.2 is smaller and larger than average, respectively.
( ) No experimental data.

Note on energy dependence of capture cross-section for individual nuclides
(including 20 highest contribution nuclides and 7 nuclides with RMS (> 10%))

<Data source>

JEF-2.2: Mainly RCN and ENDF/B-V, partially JENDL-1.
Cross-section adjustment based on the integral test results with the STEK experiments.
Artificial resonance parameters: ^{155}Eu.

JENDL-3.2: JNDC original evaluation (JENDL-3.1: *J. Nucl. Sci. Technol.*, 29, 195 (1992) and re-evaluation: 1994 Gatlinburg Conf., p. 809).
Almost all evaluation for capture cross-section was made with the statistical model calculation taking into consideration of level overlapping and fluctuation effects on inelastic scattering cross-section. The optical parameters in the local mass ranges were determined to reproduce systematics of total cross-sections, s- and p-wave strength functions and scattering radius. Gamma-ray strength functions were determined on the basis of the differential experimental data of capture cross-sections.
Cross-section adjustment due to integral test was made only for ^{132,134}Xe, ^{152,154}Eu because there were no experimental data in the keV energy region.
Artificial resonance parameters for ^{101,102}Ru, ^{107,109}Ag were added to compensate missed levels.

ENDF/B-VI: ENDF/B-V and re-evaluation (mainly for resonance parameters).

BROND-2: IPPE original evaluation.

FOND-2.1: BROND-2 + others.

Ru101+ One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.7243, 0.7616, 0.7523.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.94=0.01.

All evaluated data of JEF-2.2, BROND-2 and JENDL-3 agree well with the experimental data of Macklin *et al.* [1-3] in the energy range below 1 MeV. The data of JENDL-3.2 were modified by adopting the level scheme taken from the ENSDF.

Pd105+ One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.9490, 0.9161, 0.9594.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.92±0.06.

JENDL-3.2 and JEF-2.2 agree well with the experimental data of Macklin *et al*. [1,3,4] JENDL-3.2 connects smoothly with the resonance cross-sections but larger than the experimental data of Macklin *et al*. and Musgrove *et al*. [5] between 3 keV and 7 keV, where the other evaluated data agree with them.

Sm149-** One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 2.5437, 2.8700, 2.2990.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.88±0.06.

JENDL-3.2 adopted the new experimental data of Macklin [6]. Thus, it is systematically lower than the others which were evaluated on the basis of the older measurements in the energy range between 3 keV and 400 keV.

Tc99-* One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.6479, 0.6561, 0.5923.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.80±0.01.

Above 3 keV, JENDL-3.2, JEF-2.2 and BROND-2 are in agreement with the experimental data of Macklin *et al*. [7], while ENDF/B-VI runs along the averaged values of Macklin *et al*. and Little *et al*. [8] and is systematically larger than the other files below 100 keV. Below 3 keV, histogram of JENDL-3 calculated from the resolved resonance parameters is slightly lower than the others.

Cs133- One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 0.5167, 0.5184, 0.4874.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.80±0.05.

All evaluated data of JEF-2.2, ENDF/B-VI and JENDL-3.2 agree with the experimental data of Yamamuro *et al*. [9] and Macklin [10], although one group cross-section of JEF-2.2.2 is 6% larger than JENDL-3.2. The difference seems to come from the difference in the evaluated resonance parameters.

Pd107- One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 1.0700, 1.0399, 1.0520.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.94±0.01.

All evaluated data of JEF-2.2, BROND-2, ENDF/B-VI and JENDL-3.2 agree well with experimental data of Macklin [11] above 1.3 keV, while the cross-sections of JEF-2.2 are different from those of JENDL-3.2 and ENDF/B-VI in the resolved resonance region between 50 eV and 1.3 keV.

Rh103+ One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.6832, 0.6526, 0.6774.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.96±0.00.

JENDL-3.2, JEF-2.2 and BROND-2 are in good agreement with each other and close to the experimental data of Wisshak [12]. ENDF/B-VI and JENDL-3.1 are in agreement with Macklin's experimental data [1-3] and larger than the former three libraries.

(Pm147)-* One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 1.5167, 1.4309, 1.2753.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.88±0.05.

There is no experimental data of cross-sections in the keV energy range. The cross-sections of JENDL-3.2 were evaluated so as to smoothly continue to the cross-sections calculated from the resolved resonance parameters and is 10-15% smaller than the other evaluated data (JEF-2.2, ENDF/B-VI and BROND-2) in the energy region below 100 keV. ENDF/B-VI shows steep reduction above 100 keV.

(Sm151)-** One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 3.3998, 2.9413, 2.1080.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.90±0.03.

There is no experimental data of cross-sections in the keV energy range. JENDL-3.2 is several ten per cent smaller than JEF-2.2. Below 100 keV, ENDF/B-VI and BROND-2 are in agreement with each other but different from JEF-2.2 and JENDL-3.2.

(Ru103)-** One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 1.1992, 1.2140, 0.5047.

There is no experimental data of cross-sections in the keV energy range. JENDL-3.2 is a factor of 2 to 4 smaller than JEF-2.2. ENDF/B-VI is also smaller than JEF-2.2 and crosses JENDL-3.2.

Mo97-* One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 0.3406, 0.3568, 0.3484.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.96±0.02.

All of JENDL-3.2, JEF-2.2 and ENDF/B-VI agree with the experimental data of Musgrove *et al*. [13,14].

Nd145+ One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.5700, 0.5124, 0.5648.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.85±0.03.

JENDL-3.2 and JEF-2.2 are close to the experimental data of Jakajima *et al*. [15], while JENDL-3.2 is slightly larger than JEF-2.2 between 60 keV and 700 keV. ENDF/B-VI and BROND-2 generally agree with the data of Musgrove *et al*. [5,14,16] and Bokhovko *et al*. [17] and are 15% or more small compared to JENDL-3.2. Above 70 keV, BROND-2 steeply decreases along the data of Bokhovko *et al*.

(Xe131)+* One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.2937, 0.3323, 0.3461.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=1.00±0.10.

Although there is no experimental data of cross-sections in the keV energy range, difference between the different evaluated files is considerably small. In the resolved resonance energy region below 4 keV, level missing effect is observed in ENDF/B-VI.

Eu153-* One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 2.7655, 2.9288, 2.5958.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.92±0.01.

JENDL-3.2 agrees well with the experimental data of Macklin & Young [18] which are the lowest in the experimental data. JENDL-3.2, JEF-2.2 and ENDF/B-VI are in agreement with each other in the wide energy range, while BROND-2 is discrepant from them in the energy range between 1 keV and 20 keV.

Nd143+ One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.3550, 0.3370, 0.3589.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.90±0.01.

JENDL-3.2 and ENDF/B-VI agree with the experimental data of Nakajima *et al*. [15], while JEF-2.2 is lower than these experimental data in the energy region between 5 keV and 40 keV. BROND-2 is in coincident with the JENDL-3.2 and ENDF/B-VI below 40 keV, but discrepant from them above 40 keV along the experimental data of Bokhovko *et al*. [17], of which energy dependence showing a steep decrease seems to be anomalous.

Ru102- One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.1581, 0.1796, 0.1642.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=1.07±0.14.

In the energy region above 5 keV, JENDL-3.2, JEF-2.2 and ENDF/B-VI are in good agreement with the experimental data of Macklin [1-3]. BROND-2 is about 20% larger than the others. In the resolved resonance region, large difference is observed among libraries.

Ag109-* One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.7927, 0.7203, 0.6916.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.66±0.01.

Above 3 keV, JENDL-3.2, ENDF/B-VI and BROND-2 agree with the experimental data of Macklin [19], Mizumoto *et al*. [20] and Bokhovko *et al*. [17], while JEF-2.2 is considerably larger than the others above 30 keV. In the energy region between 1 keV and 2.6 keV, JENDL-3.2 was revised taking account of resonance level missing effect so that discrepancy between JENDL-3.2 and JEF-2.2 become quite small in this energy range.

Ru104+ One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.1546, 0.1658, 0.1685.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=1.06±0.14.

All libraries of JENDL-3.2, JEF-2.2, ENDF/B-VI and BROND-2 remarkably agree with each other and reproduce the average value of the experimental data of Macklin *et al*. [1-3]. Evaluation well reproduce the fine structure due to competition with inelastic scattering at 360 keV and 900 keV.

(Cs135)+** One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 0.2445, 0.1361, 0.2284.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.88±0.05.

There is no experimental data of cross-sections in the keV energy range. Evaluation of JENDL-3.2 was made so as to reproduce the experimental data of thermal value and resonance integral connecting the statistical model calculation with resonance cross-section due to the resonance parameter of Priesmyer [21] at 4 keV. JEF-2.2 contains the resonances belong to other isotopes, but agree with JENDL-3.2 above 600 eV. ENDF/B-VI shows an artificial shape between 10 and 100 eV.

Pr141+ One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 0.1582, 0.1540, 0.1564.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=0.96±0.02.

JENDL-3.2, JEF-2.2 and ENDF/B-VI agree well with each other and reproduce the experimental data of Stupeiga [22], Zaikin *et al*. [23], Taylor *et al*. [14,24] and Voignier *et al*. [25].

(Eu155)-** One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 2.8428, 2.9559, 1.3368.

^{155}Eu determine capture cross-sections of pseudo-fission-products in the energy range below 1 keV. JENDL-3.1 and ENDF/B-VI were evaluated with the measured resonance parameters given by Moller *et al.* [26], Friesenhahn *et al.* [27] and Ribon [28], while JEF-2.2 seems to adopt the artificially generated ones. FOND-2 may also take them. In evaluation of JENDL-3.2, a part of parameters in JENDL-3.1 were modified so as to reproduce the new experimental data of thermal value and resonance integral reported by Sekine *et al*. [29]. Above 100 eV where there is no experimental data, JENDL-3.2 is about a factor of 2 smaller than JEF-2.2.

Pd108+* One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.1770, 0.2507, 0.2358.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=1.09±0.11.

JENDL-3.2 and BROND-2 agree with the experimental data of Macklin *et al*. [1-3]. ENDF/B-VI is about 20% larger than them and close to the experimental data of Musgrove *et al*. [5]. On the other hand, JEF-2.2 which runs along the experimental data of Cornelis *et al*. [30] is about 20% smaller than JENDL-3.2.

Xe132+** One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 0.0708, 0.0755, 0.0980.
JENDL-3.2 reproduce the experimental data of Beer *et al*. [31], while JEF-2.2 and ENDF/B-VI are about a factor of 2 larger than JENDL-3.2 above 4 keV. Resolved resonance cross-sections of JENDL-3.2 based on the measurements of Ribon [28] are larger than ENDF/B-VI and JEF-2.2 for which the effect of level missing seems to appear.

Zr96-** One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.0358, 0.0590, 0.0391.
Integral test result of JENDL-3.2 with the STEK experiment:
C/E=0.66±0.05 (0.97 for capture component).

JENDL-3.2 is in general agreement with the experimental data of Wyrick & Poenitz [32] and shows the lowest in the evaluated data, but the other libraries, JEF-2.2, BROND-2 and ENDF/B-VI are not. Moreover, there are large discrepancies between the different libraries. Below 3 keV, ENDF/B-VI and JEF-2.2 took the same resonance parameters which could not reproduce the experimental data of Macklin *et al*. [33,34] and Lyon *et al*. [35].

Pd106+** One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.2027, 0.2553, 0.2772.
Integral test result of JENDL-3.2 with the STEK experiment: C/E=1.17±0.09.

JENDL-3.2 runs in the intermediate between the experimental data of Macklin *et al*. [1-3] and Musgrove *et al*. [5] ENDF/B-VI is close to JENDL-3.2 except for the energy range below 10 keV. JEF-2.2 agree with the lower experimental data of Conelis *et al*. [30] and is systematically about 30% smaller than JENDL-3.2. BROND-2 is twisted between JENDL-3.2 and JEF-2.2.

Xe134-** One group cross-sections for JEF-2.2, FOND-2.1 and JENDL-3.2: 0.0360, 0.0374, 0.0272.

JENDL-3.2 reproduces the experimental data of Beer *et al*. [31], but JEF-2.2 which is the same as ENDF/B-VI is about a factor of 2 larger than JENDL-3.2 above 10 keV. Resolved resonance parameters of JENDL-3.2 were evaluated on the basis of the new measurements of Macklin [36].

(Zr95)+** One group cross-sections for JEF-2.2, BROND-2 and JENDL-3.2: 0.0643, 0.1229, 0.1489.

Since there is no experimental data of cross-sections in the keV energy range, a large difference is observed between the different evaluated data files among JENDL-3.2, JEF-2.2, ENDF/B-VI and BROND-2. They are arranged in decreasing order of magnitude from ENDF/B-VI, JENDL-3.2, BROND-2 and JEF-2.2. JEF-2.2 is about a factor of 2 smaller than JENDL-3.2.

Summary

Data comparison should be made for originally evaluated data. In statistics of the result of benchmark study, each data should be equally treated not to make a double count. In the present case, ideal benchmark study will be accomplished with that all participants will calculate the quantities of pseudo-FP from the common evaluated FP libraries, JEF-2.2, JENDL-3.2, ENDF/B-VI and BROND-2 with their own method. Unfortunately, we did not use such a method and no person has not participate the study from ENDF/B side. I think it is not easy to make a fair conclusion to satisfy all participants. The following is a summary of the present comparison study for capture cross-sections emphasising the reason of discrepancy between JEF-2.2 and JENDL-3.2.

In the present benchmark study, the JENDL-3.2 capture cross-sections of pseudo-fission-product is found to be smaller than JEF-2.2 and FOND-2.1. In order to clarify the reason for the discrepancy, I compare the evaluated capture cross-sections for 40 FP nuclides. It was surprising that the JENDL-3.2

data were larger than JEF-2.2 for about half the number of nuclides. Further check of cross-section was made for important 27 nuclides by comparing the evaluated data with the experimental data.

Large discrepancies are observed among the libraries for nuclides such as ^{151}Sm, ^{103}Ru and ^{155}Eu, whose experimental data is not available in the keV region and contribution to FBR capture rates is high. For these nuclides, JENDL-3.2 shows smaller values than JEF-2.2 and BROND-2. It might be pointed out that this discrepancy is due to the difference of parametrisation of nuclear model for such nuclides.

The selection of experimental is one of the cause to originate discrepancy between JENDL-3.2 and JEF-2.2. As shown in the figures, the JENDL-3.2 evaluation stands on later experimental data of ORNL and JAERI, which were not used for the JEF-2.2 evaluation. The later experiments show a tendency becoming smaller than older ones, for example ^{109}Ag and ^{149}Sm. New experiments have been made for important nuclides so the difference might affect to the pseudo-FP cross-sections. Another typical example is the resonance parameters of ^{155}Eu which determine cross-section of the pseudo-FP in the lower energy below 10 eV: JEF-2.2 adopted artificial ones to give large cross-sections, but JENDL-3.2 did the experimental data.

Besides, the cross-sections of JEF-2.2 are those adjusted to the integral data of the STEK experiments. For many nuclides, the C/E values of JENDL-3.2 to the STEK experiments correlate with the cross-section ratios of JENDL-3.2 to JEF-2.2. The results of integral test for JENDL-3.2 shows a trend of underestimation of reactivity worth by 5-10% for nuclides having masses more than 130. Accordingly, it is not strange that there is a systematic difference between JENDL-3.2 and JEF-2.2.

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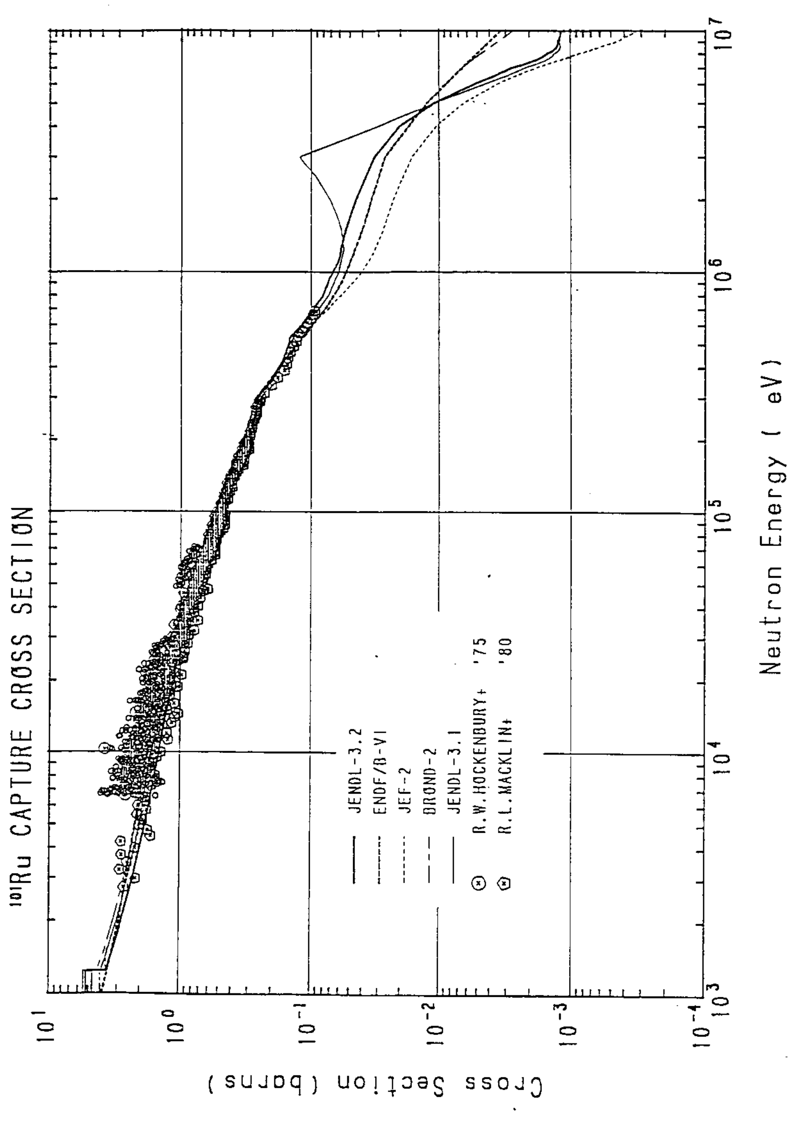
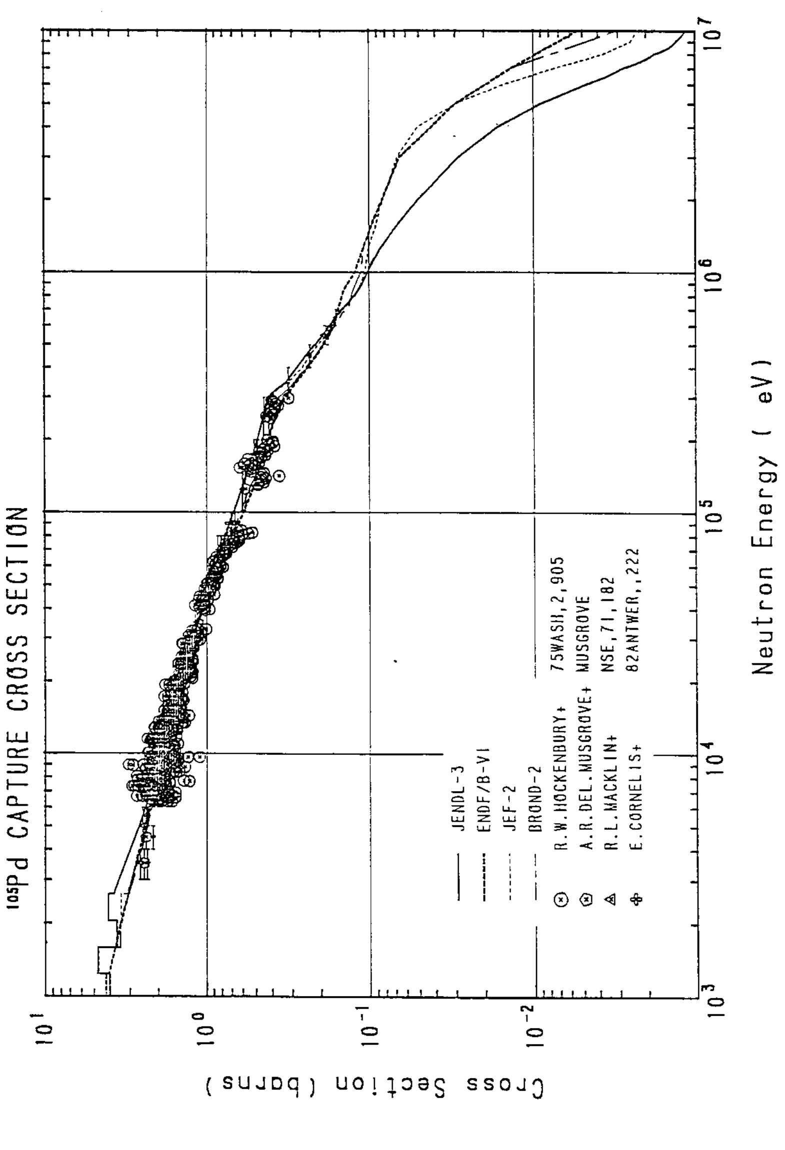
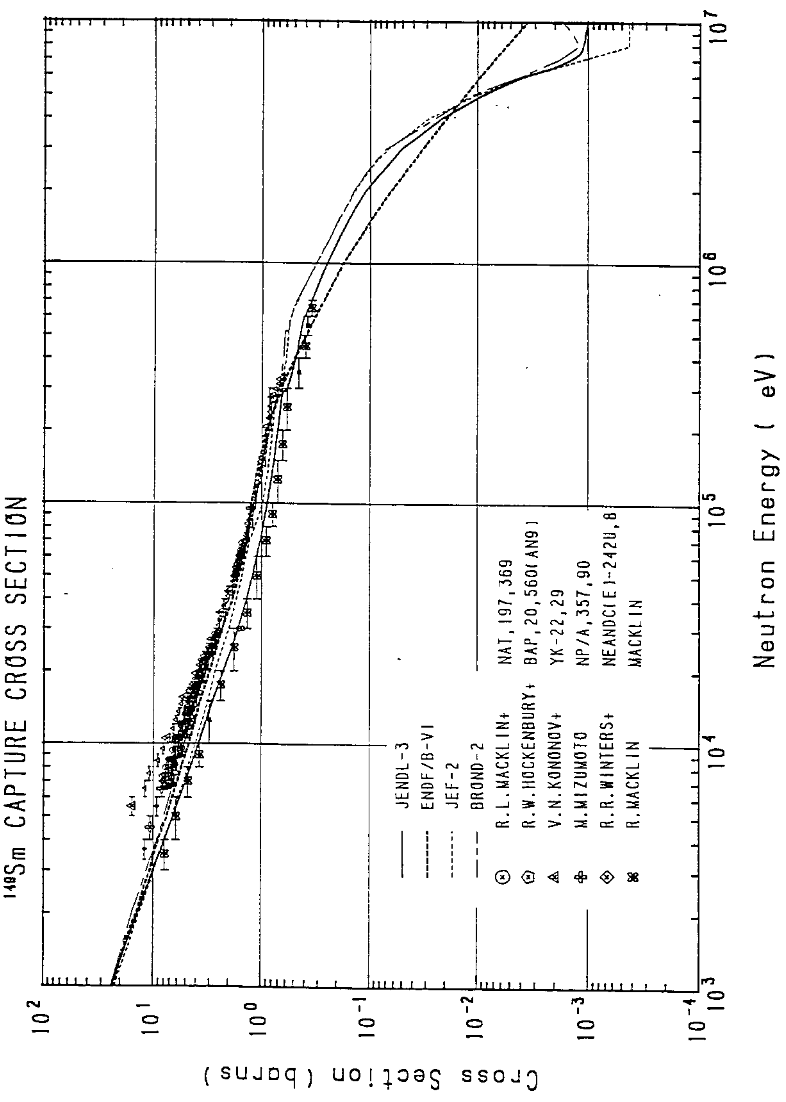
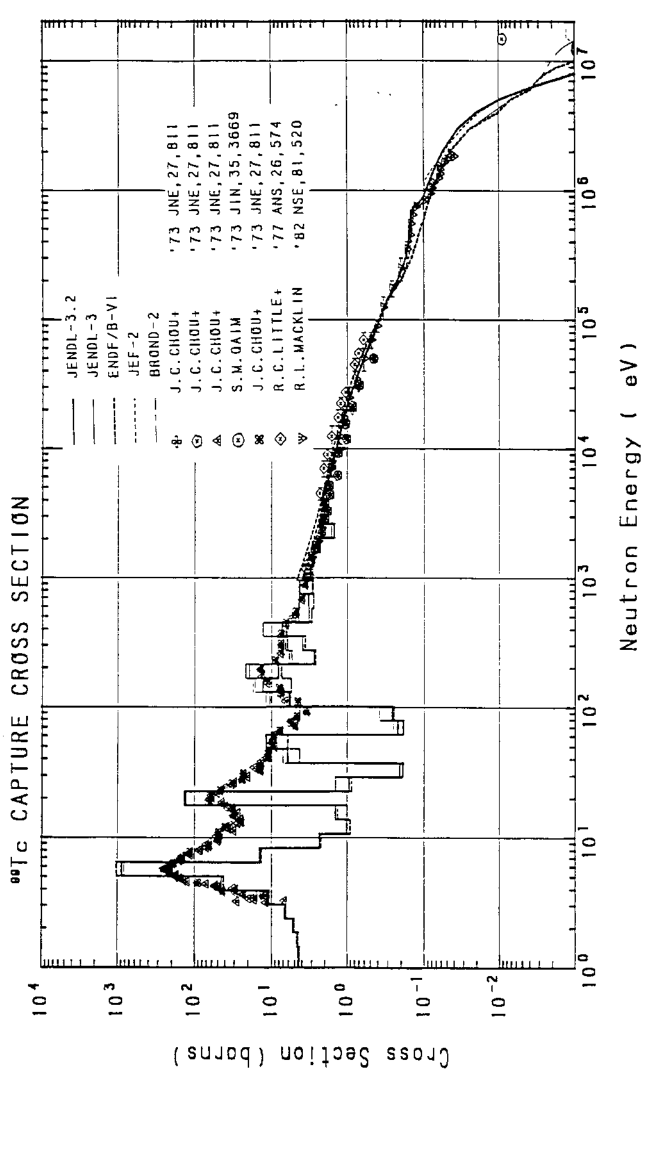


101Ru CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3.2
ENDF/B-VI
JEF-2
BROND-2
JENDL-3.1
R.W.HOCKENBURY+ '75
R.L.MACKLIN+ '80

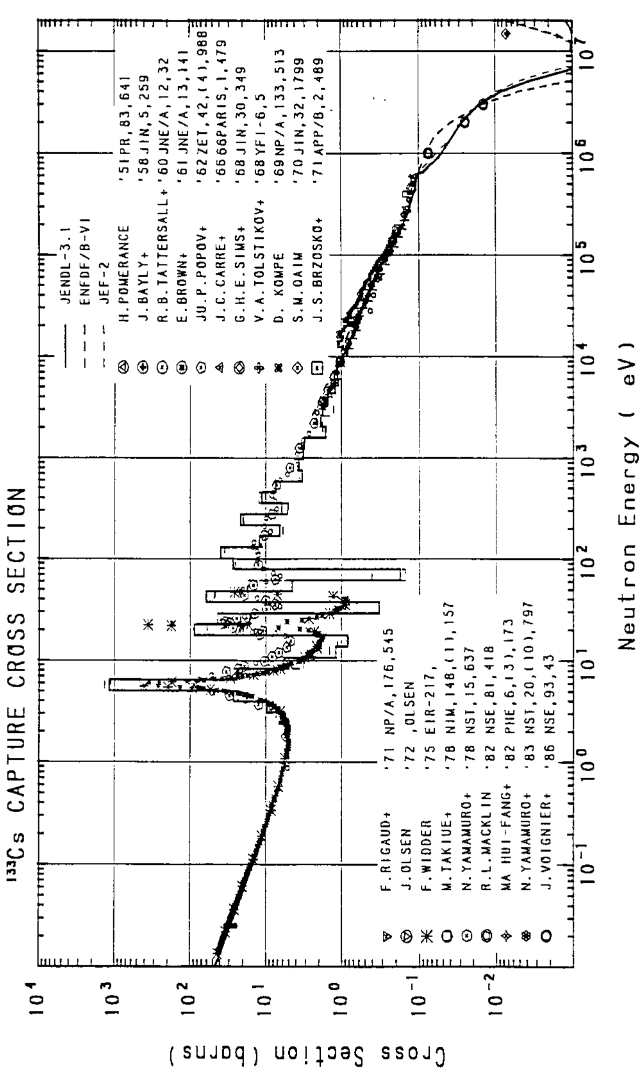


105Pd CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.W.HOCKENBURY+ 75WASH,2,905
A.R.DEL.MUSGROVE+ MUSGROVE
R.L.MACKLIN+ NSE,71,182
E.CORNELIS+ 82ANTWER,,222

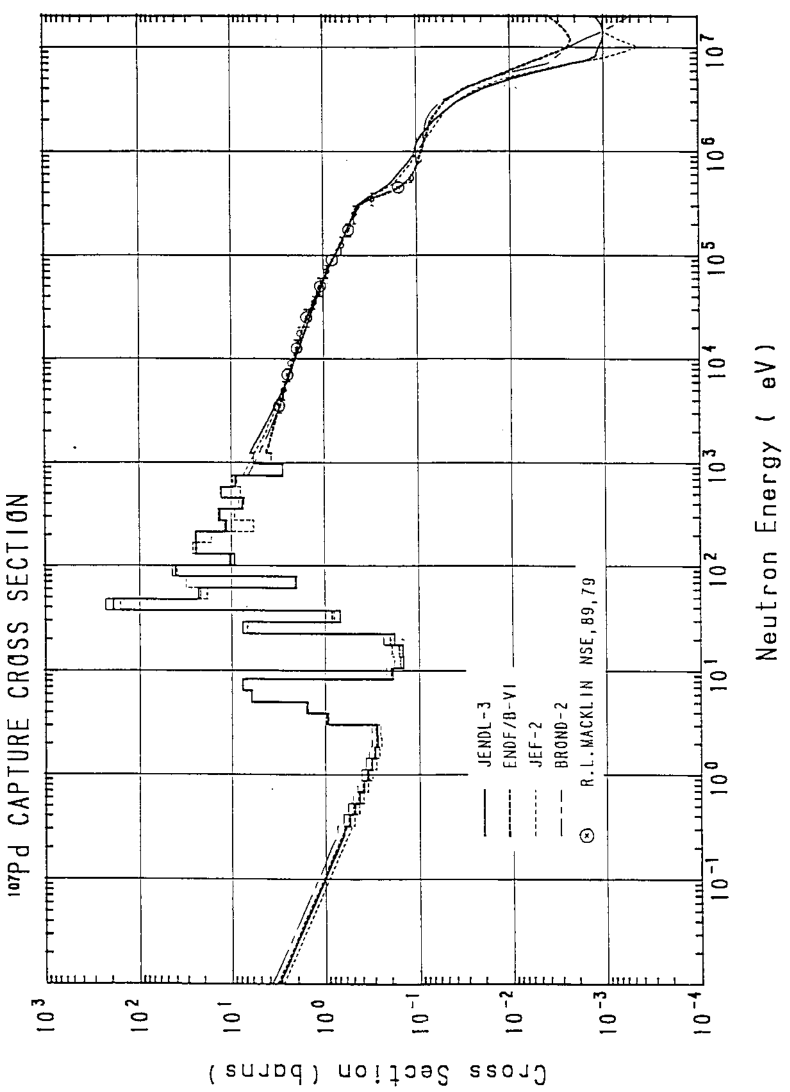

149Sm CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN+ NAT,197,369
R.W.HOCKENBURY+ BAP,20,560(AN9)
V.N.KONONOV+ YK-22,29
M.MIZUMOTO NP/A,357,90
R.R.WINTERS+ NEANDC(E)-242U,8
R.MACKLIN MACKLIN
Cross Section (barns)
Neutron Energy (eV)



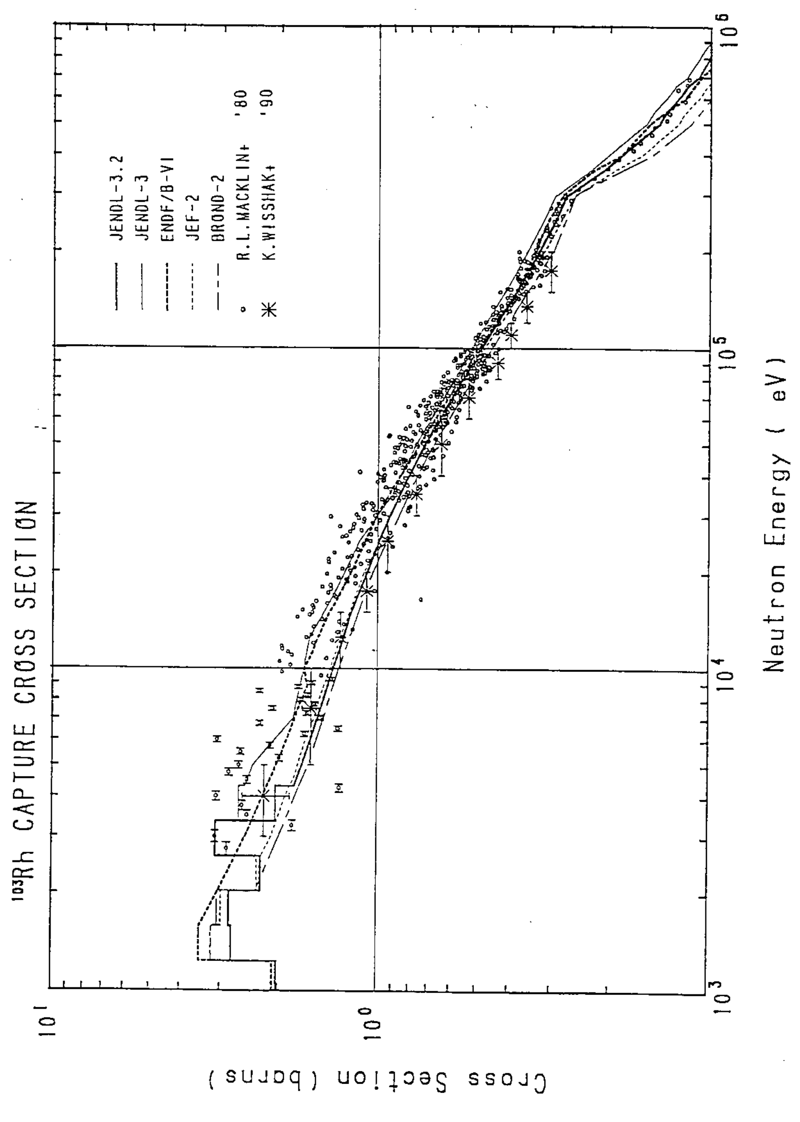
99Tc CAPTURE CROSS SECTION
JENDL-3.2
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
J.C.CHOU+ '73 JNE,27,811
J.C.CHOU+ '73 JNE,27,811
J.C.CHOU+ '73 JNE,27,811
S.M.QAIM '73 JIN,35,3669
J.C.CHOU+ '73 JNE,27,811
R.C.LITTLE+ '77 ANS,26,574
R.L.MACKLIN '82 NSE,81,520
Cross Section (barns)
Neutron Energy (eV)



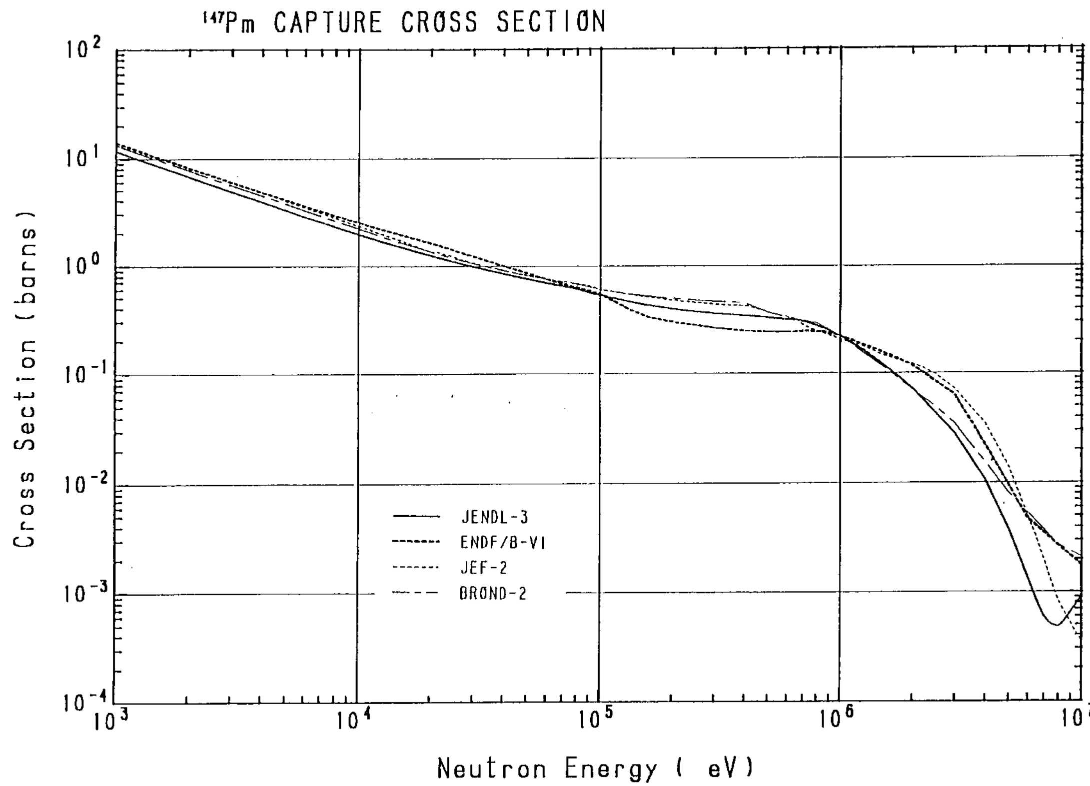
133Cs CAPTURE CROSS SECTION
JENDL-3.1
ENDF/B-VI
JEF-2
H.POMERANCE '51PR,83,641
J.BAYLY+ '58JIN,5,259
R.B.TATTERSALL+ '60JNE/A,12,32
E.BROWN+ '61JNE/A,13,141
JU.P.POPOV+ '62ZET,42,(4),988
J.C.CARRE+ '66PARIS,1,479
G.H.E.SIMS+ '68JIN,30,349
V.A.TOLSTIKOV+ '68YFI-6,5
D. KOMPE '69NP/A,133,513
S.M.QAIM '70JIN,32,1799
J.S.BRZOSKO+ '71APP/B,2,489
F.RIGAUD+ '71 NP/A,176,545
J.OLSEN '72 ,OLSEN
F.WIDDER '75 EIR-217,
M.TAKIUE+ '78 NIM,148,(1),157
N.YAMAMURO+ '78 NST,15,637
R.L.MACKLIN '82 NSE,81,418
MA HUI-FANG+ '82 PHE,6,(3),173
N.YAMAMURO+ '83 NST,20,(10),797
J.VOIGNIER+ '86 NSE,93,43
Cross Section (barns)
Neutron Energy (eV)



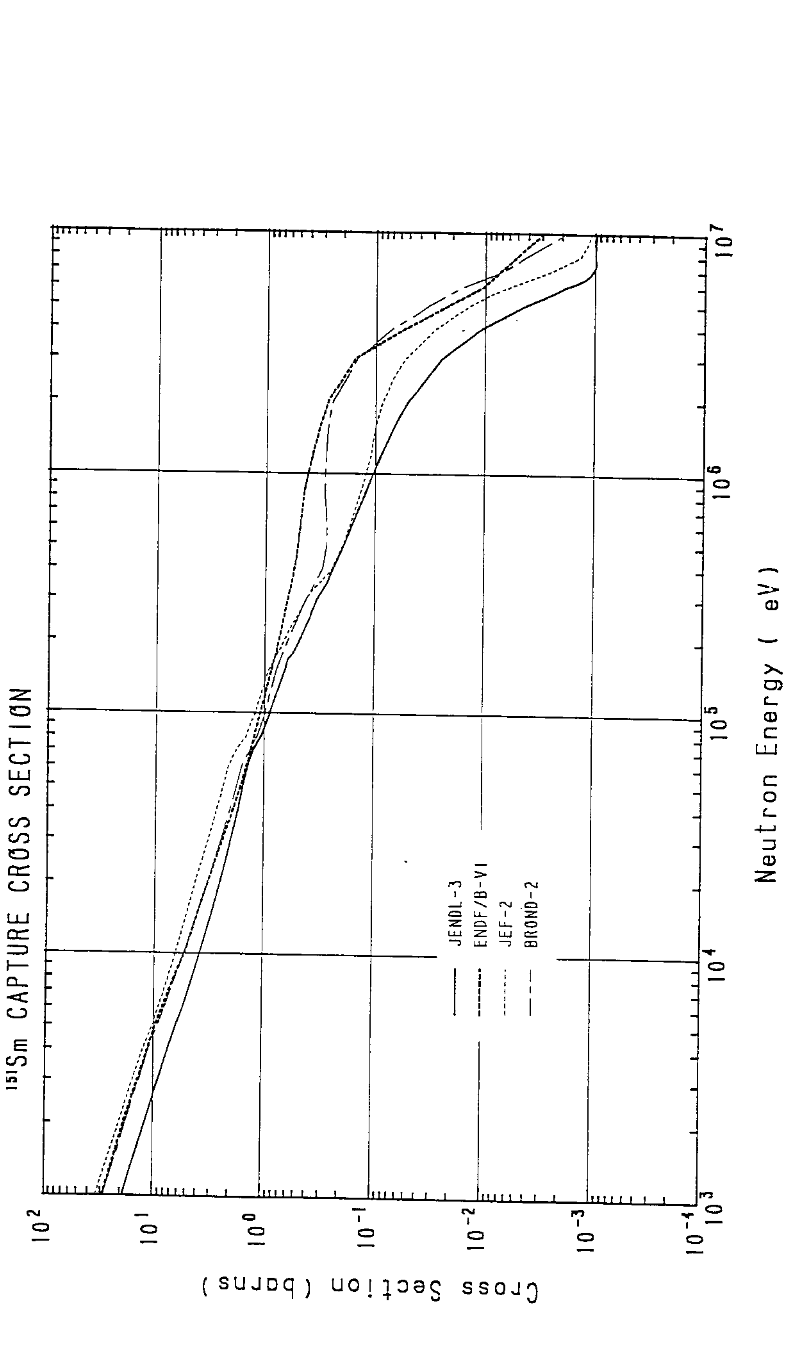
107Pd CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN NSE,89,79



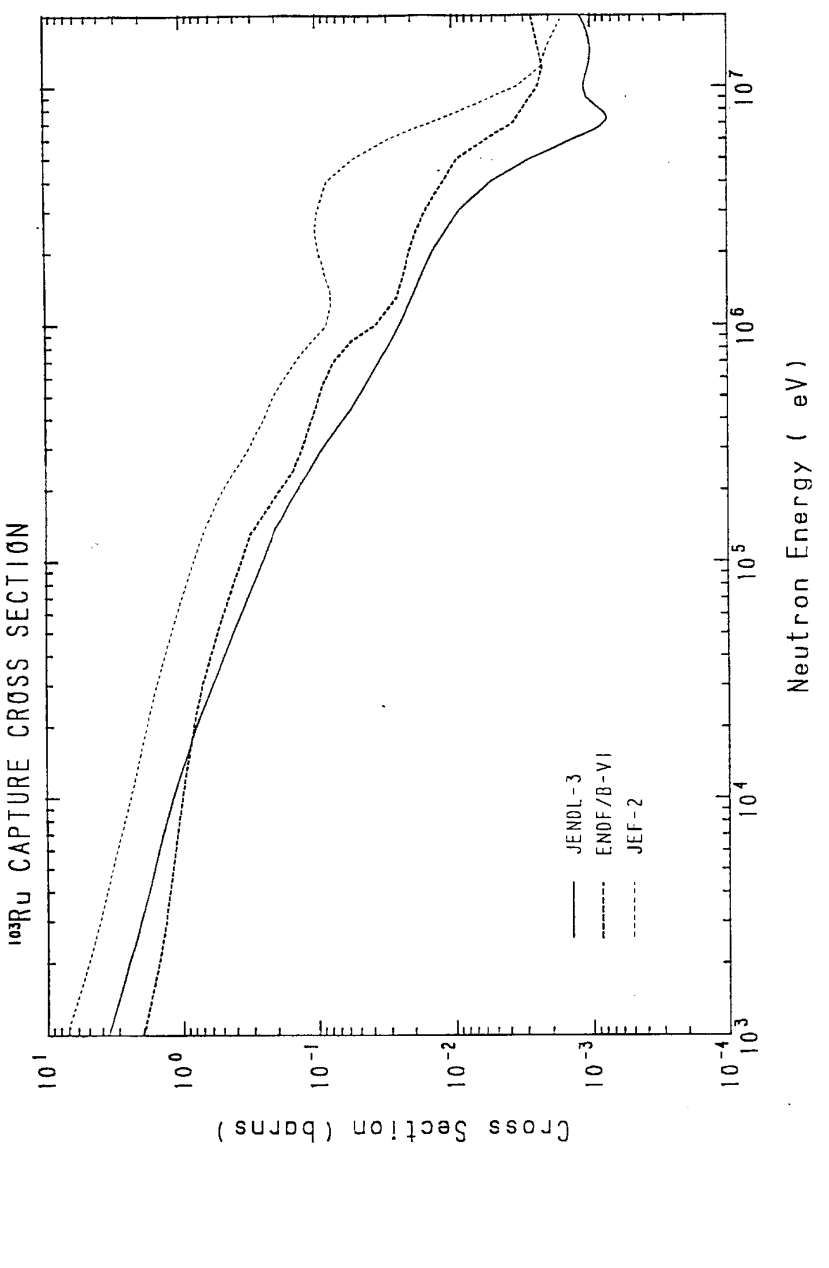
103Rh CAPTURE CROSS SECTION
JENDL-3.2
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN+ '80
K.WISSHAK+ '90
10^1
10^0
10^3
10^4
10^5
10^6
Cross Section (barns)
Neutron Energy (eV)



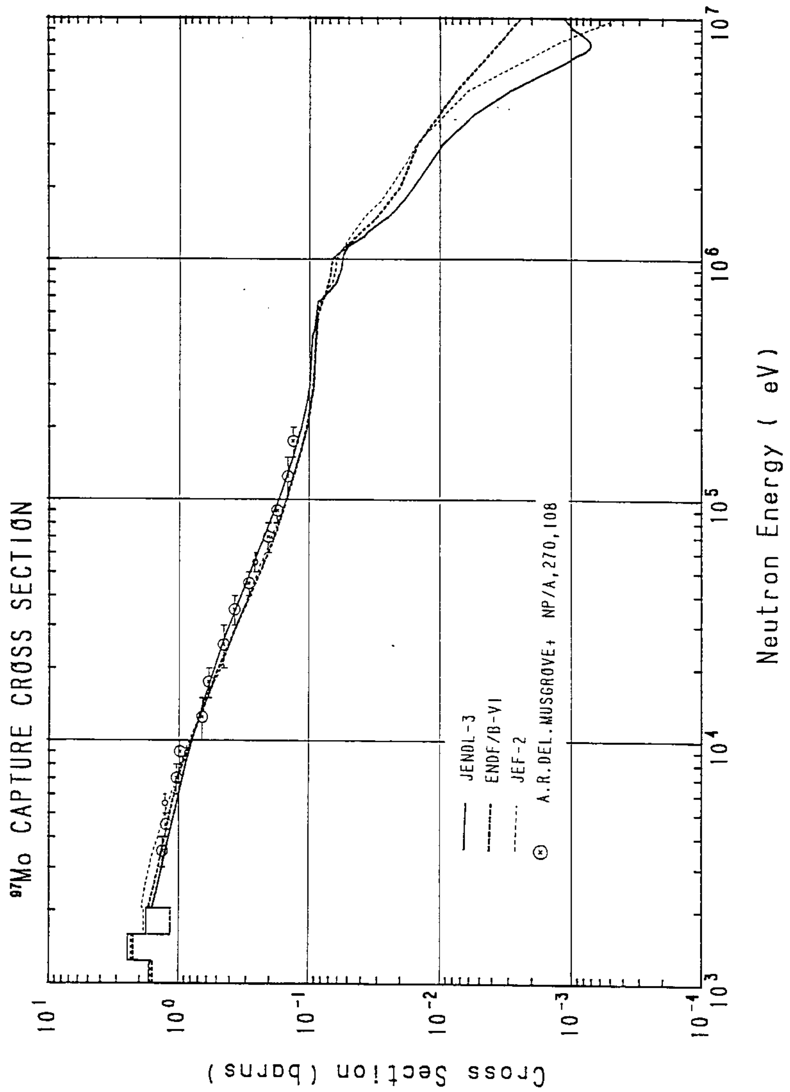
^{147}Pm CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2



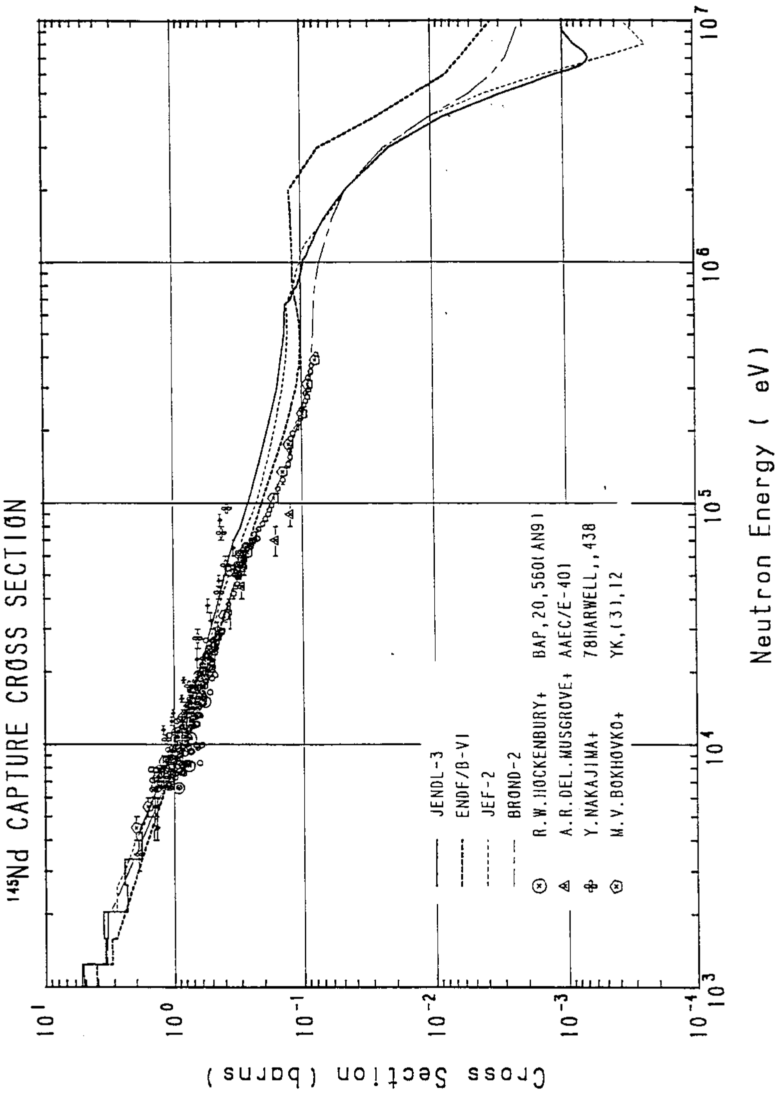
151Sm CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
Cross Section (barns)
Neutron Energy (eV)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^3
10^4
10^5
10^6
10^7

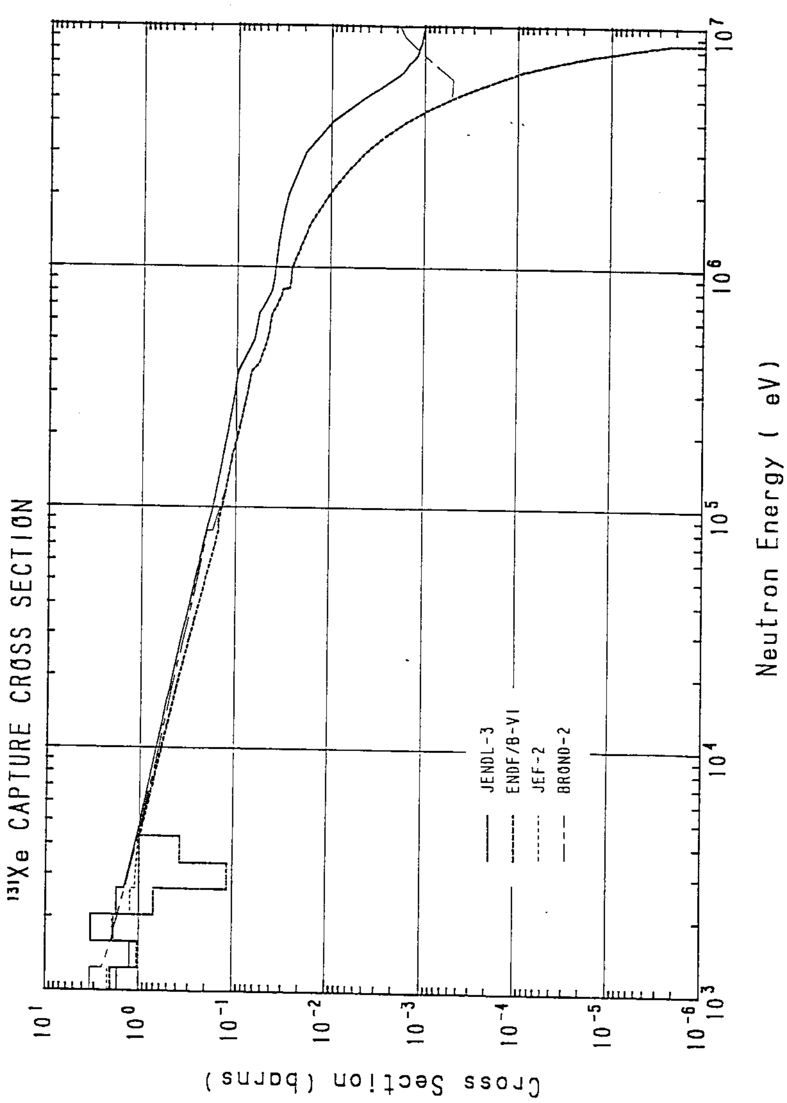


103Ru CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^3
10^4
10^5
10^6
10^7

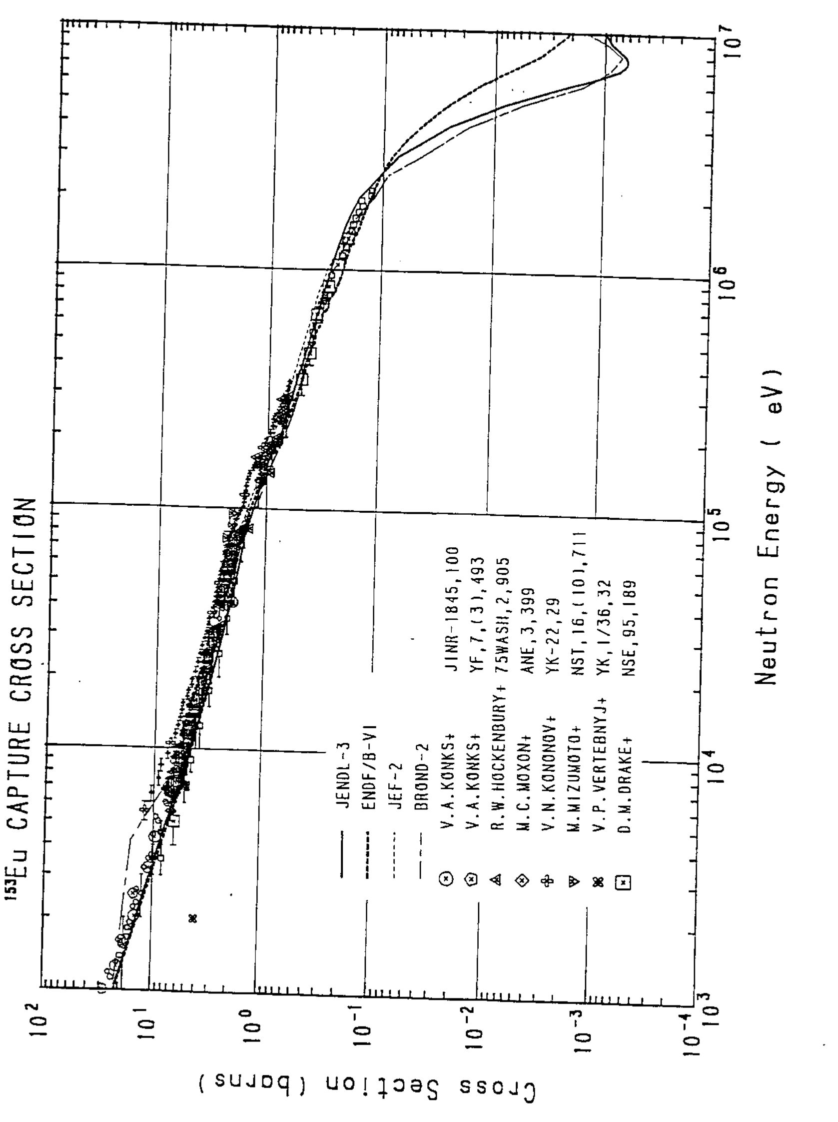


97Mo CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
A.R.DEL.MUSGROVE+ NP/A,270,108
Neutron Energy (eV)
Cross Section (barns)

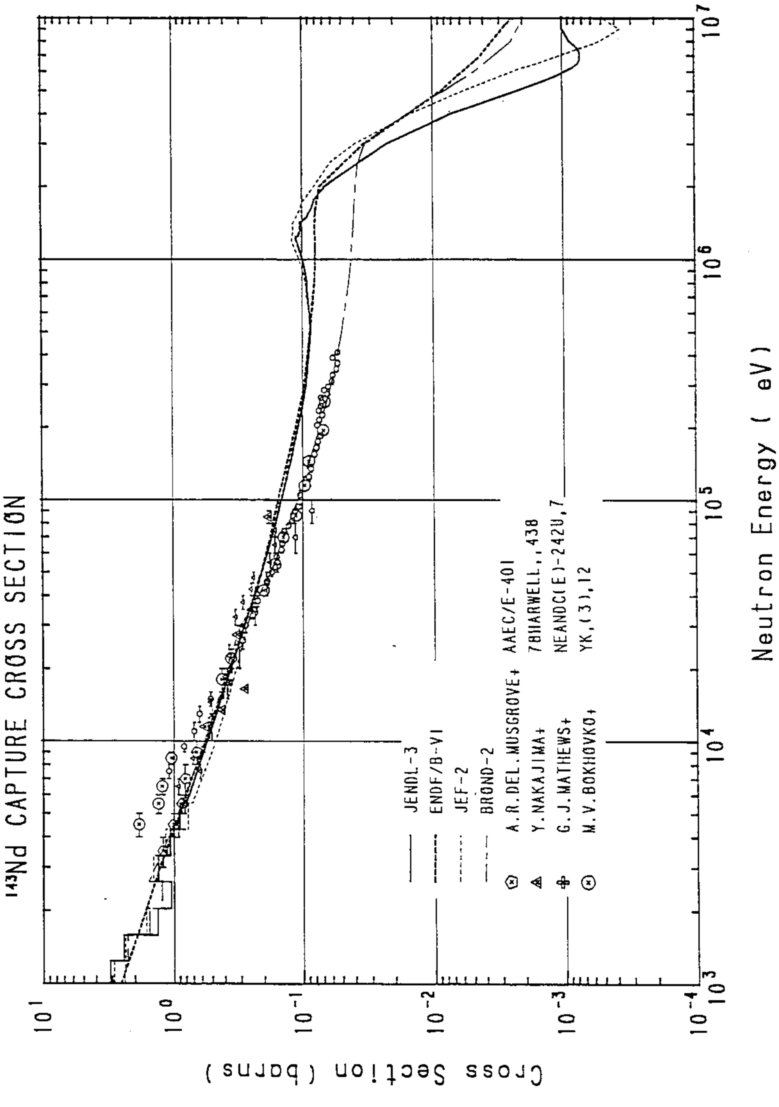

145Nd CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^3
10^4
10^5
10^6
10^7
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.W.HOCKENBURY+ BAP,20,560(AN9)
A.R.DEL.MUSGROVE+ AAEC/E-401
Y.NAKAJIMA+ 78HARWELL,,438
M.V.BOKHOVKO+ YK,(3),12



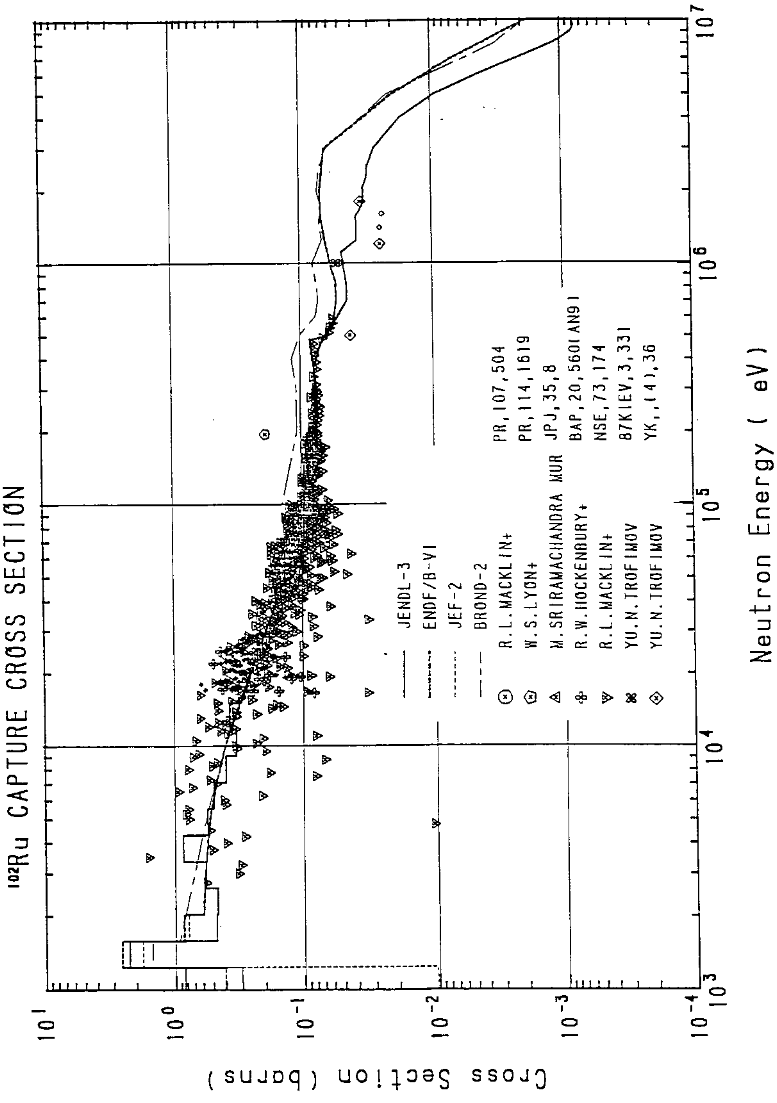
131Xe CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
Neutron Energy (eV)
Cross Section (barns)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^3
10^4
10^5
10^6
10^7



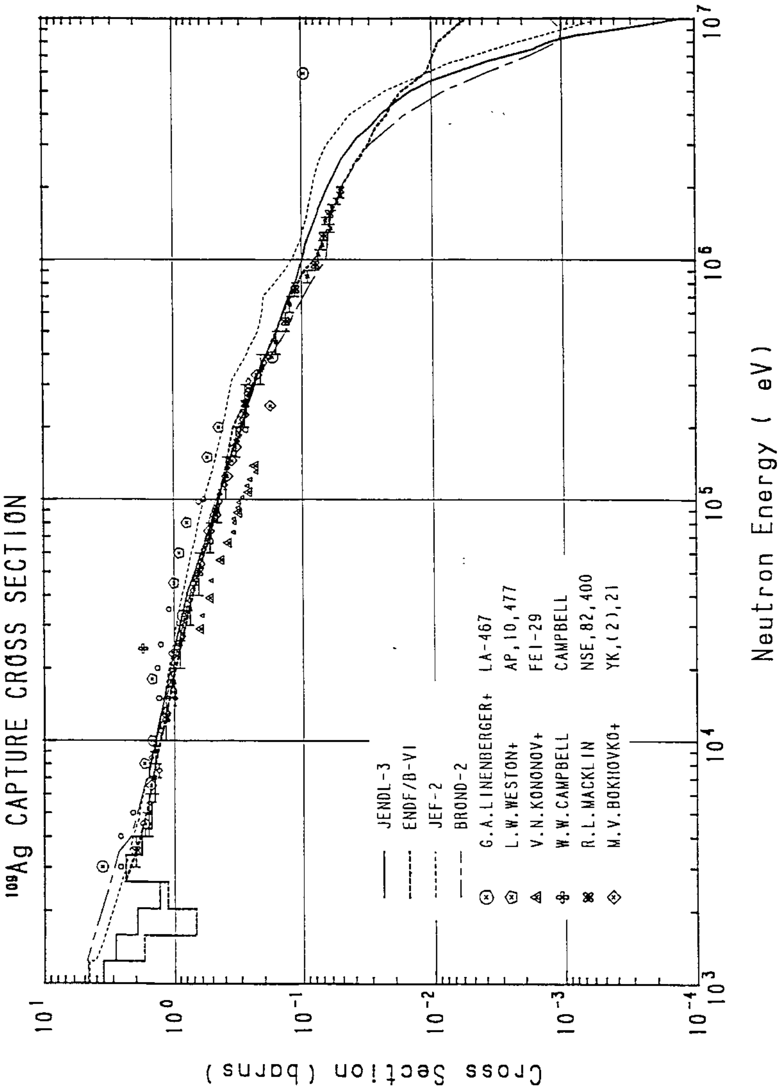
153Eu CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
V.A.KONKS+ JINR-1845,100
V.A.KONKS+ YF,7,(3),493
R.W.HOCKENBURY+ 75WASH,2,905
M.C.MOXON+ ANE,3,399
V.N.KONONOV+ YK-22,29
M.MIZUMOTO+ NST,16,(10),711
V.P.VERTEBNYJ+ YK,1/36,32
D.M.DRAKE+ NSE,95,189



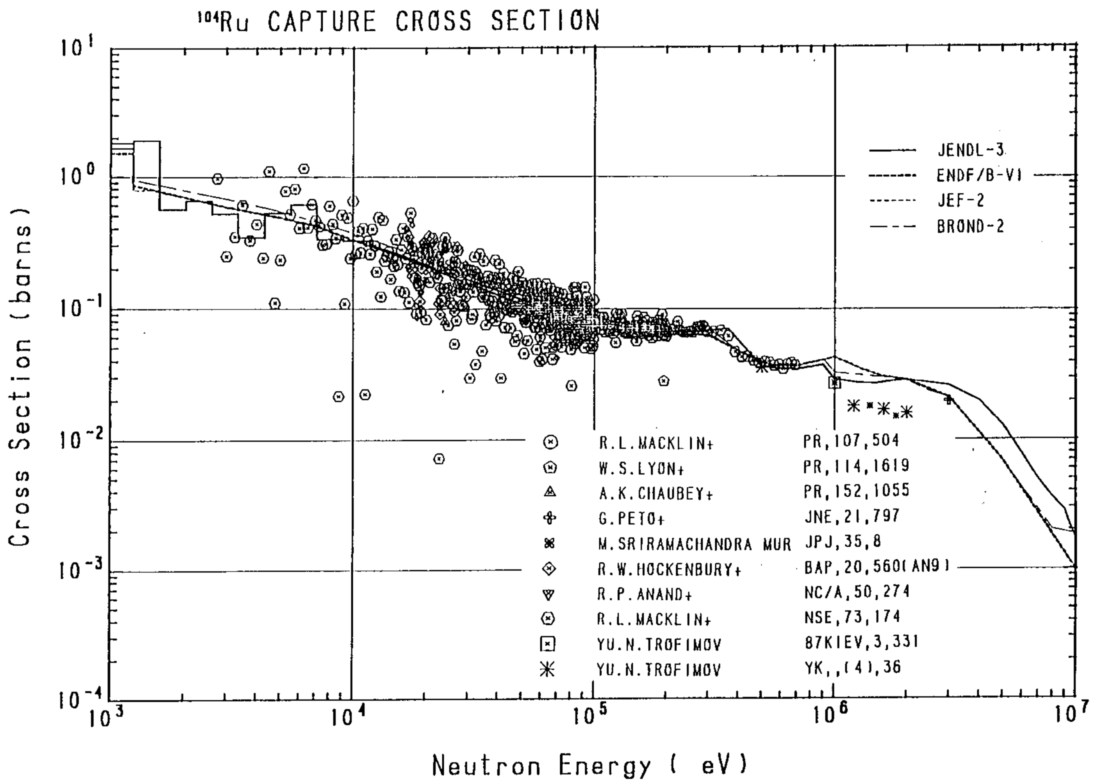
¹⁴³Nd CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
A.R.DEL.MUSGROVE+ AAEC/E-401
Y.NAKAJIMA+ 78HARWELL,,438
G.J.MATHEWS+ NEANDC(E)-242U,7
M.V.BOKHOVKO+ YK,(3),12
Neutron Energy (eV)
Cross Section (barns)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^3
10^4
10^5
10^6
10^7



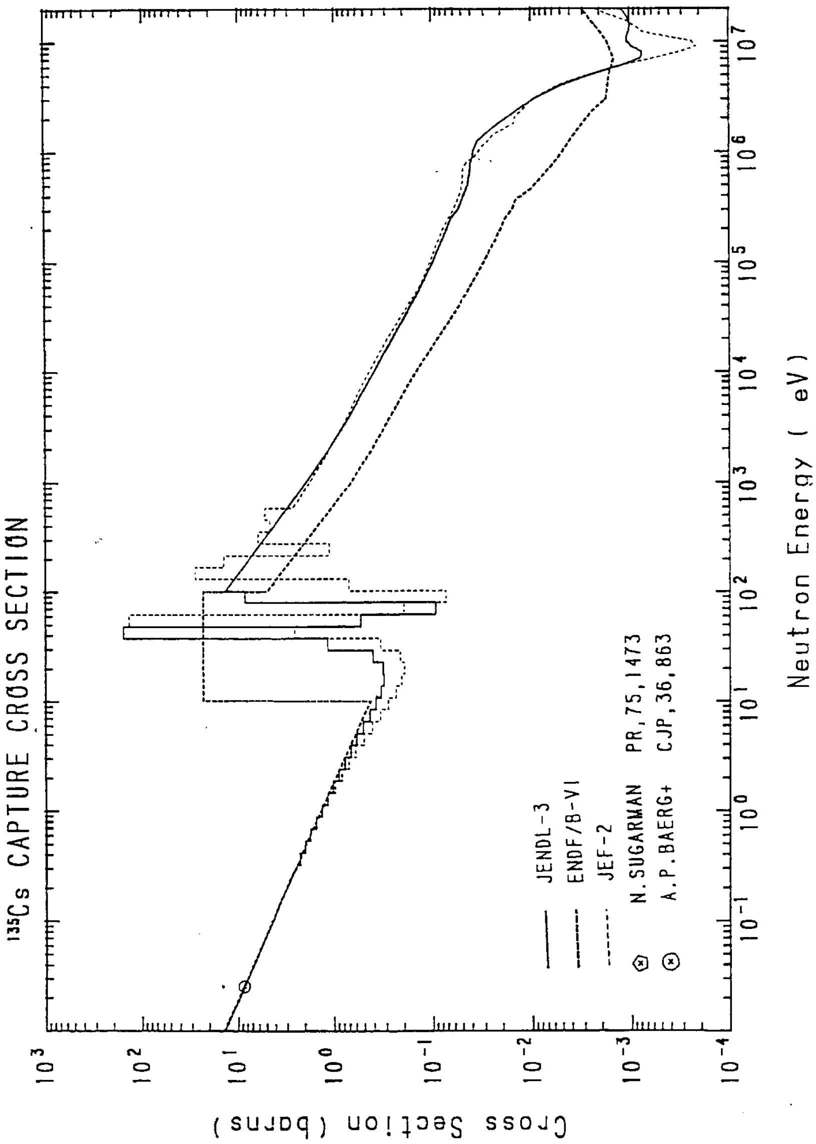
102Ru CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN+ PR,107,504
W.S.LYON+ PR,114,1619
M.SRIRAMACHANDRA MUR JPJ,35,8
R.W.HOCKENBURY+ BAP,20,560(AN9)
R.L.MACKLIN+ NSE,73,174
YU.N.TROFIMOV 87KIEV,3,331
YU.N.TROFIMOV YK,,(4),36



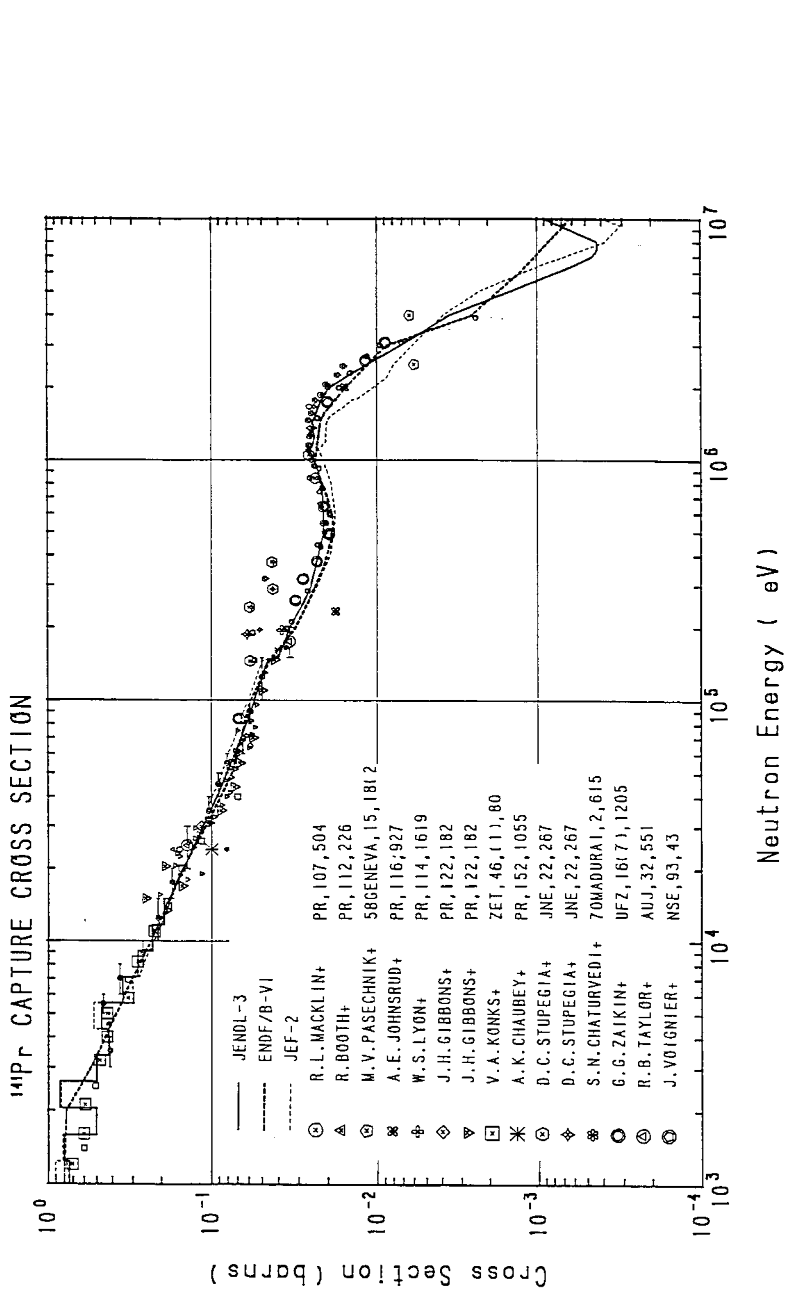
109Ag CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
G.A.LINENBERGER+ LA-467
L.W.WESTON+ AP,10,477
V.N.KONONOV+ FEI-29
W.W.CAMPBELL CAMPBELL
R.L.MACKLIN NSE,82,400
M.V.BOKHOVKO+ YK,(2),21
Cross Section (barns)
Neutron Energy (eV)



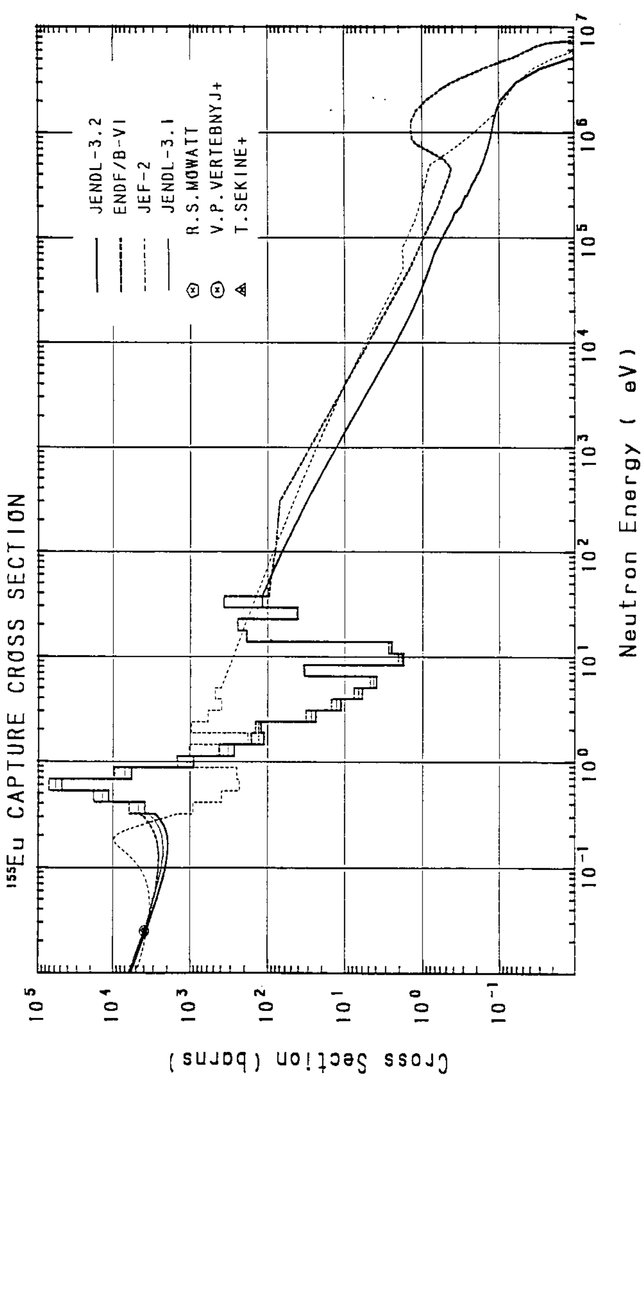
^{104}Ru CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{3}
10^{4}
10^{5}
10^{6}
10^{7}
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN+ PR,107,504
W.S.LYON+ PR,114,1619
A.K.CHAUBEY+ PR,152,1055
G.PETO+ JNE,21,797
M.SRIRAMACHANDRA MUR JPJ,35,8
R.W.HOCKENBURY+ BAP,20,560(AN9)
R.P.ANAND+ NC/A,50,274
R.L.MACKLIN+ NSE,73,174
YU.N.TROFIMOV 87KIEV,3,331
YU.N.TROFIMOV YK,,(4),36



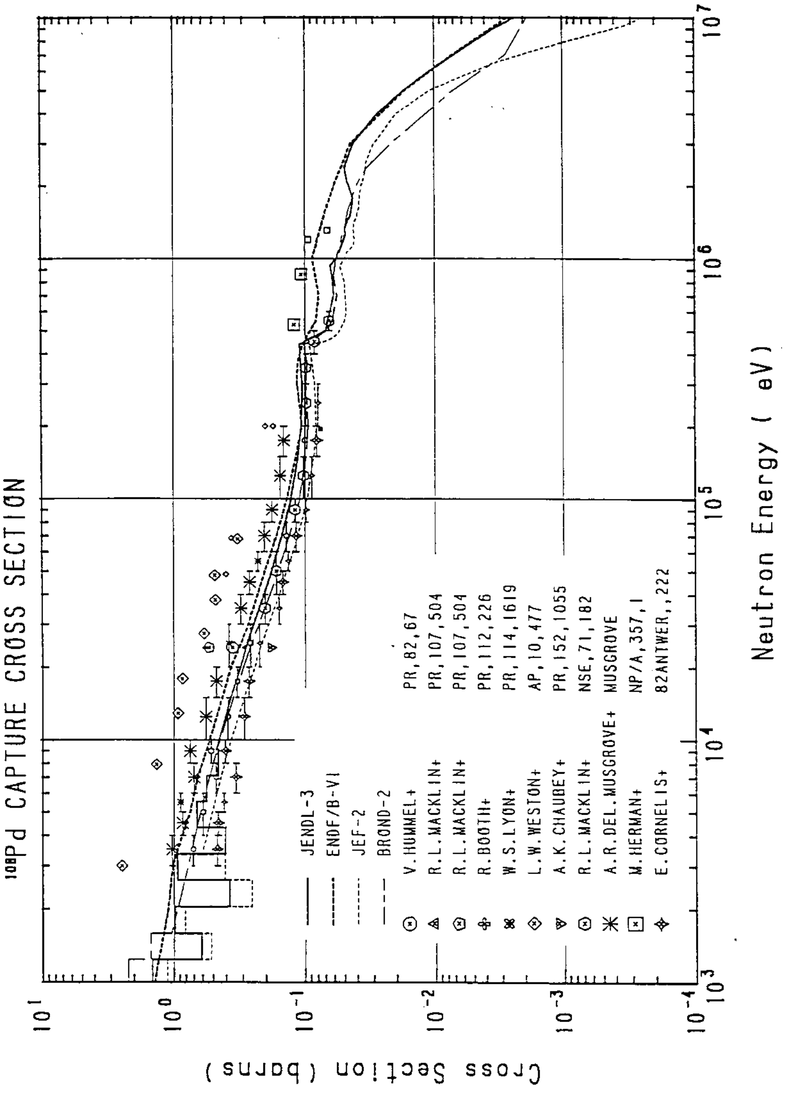
135Cs CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
N.SUGARMAN PR,75,1473
A.P.BAERG+ CJP,36,863
Cross Section (barns)
Neutron Energy (eV)
10^3
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-1
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7



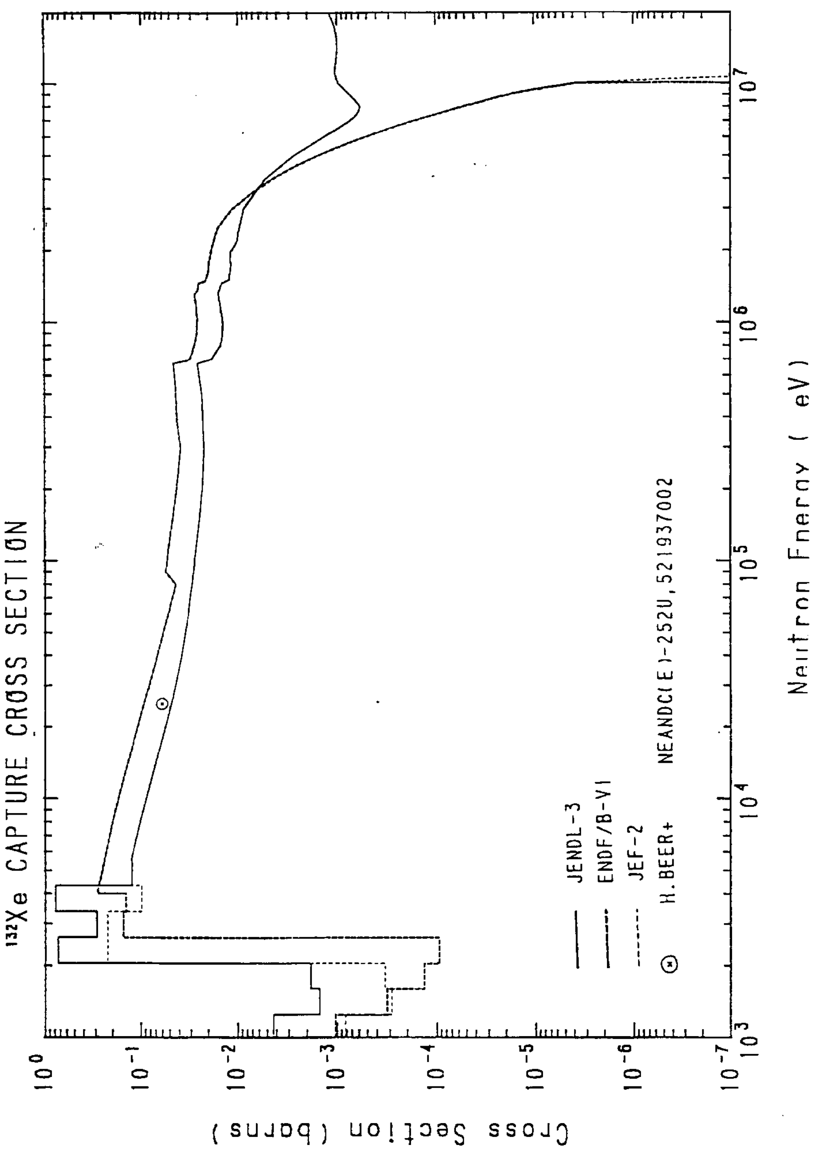
141Pr CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
R.L.MACKLIN+ PR,107,504
R.BOOTH+ PR,112,226
M.V.PASECHNIK+ 58GENEVA,15,18(2
A.E.JOHNSRUD+ PR,116,927
W.S.LYON+ PR,114,1619
J.H.GIBBONS+ PR,122,182
J.H.GIBBONS+ PR,122,182
V.A.KONKS+ ZET,46,(1),80
A.K.CHAUBEY+ PR,152,1055
D.C.STUPEGIA+ JNE,22,267
D.C.STUPEGIA+ JNE,22,267
S.N.CHATURVEDI+ 70MADURAI,2,615
G.G.ZAIKIN+ UFZ,16(7),1205
R.B.TAYLOR+ AUJ,32,551
J.VOIGNIER+ NSE,93,43
Cross Section (barns)
Neutron Energy (eV)



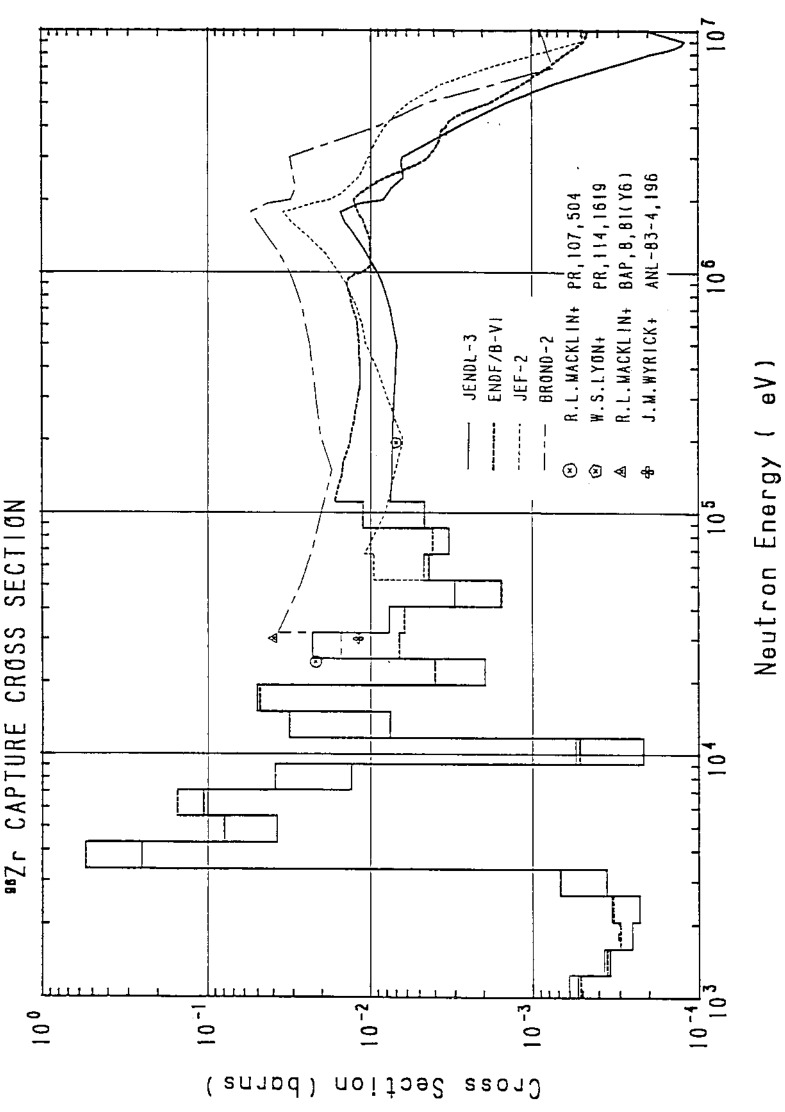
155Eu CAPTURE CROSS SECTION
JENDL-3.2
ENDF/B-VI
JEF-2
JENDL-3.1
R.S.MOWATT
V.P.VERTEBNYJ+
T.SEKINE+
Neutron Energy (eV)
Cross Section (barns)



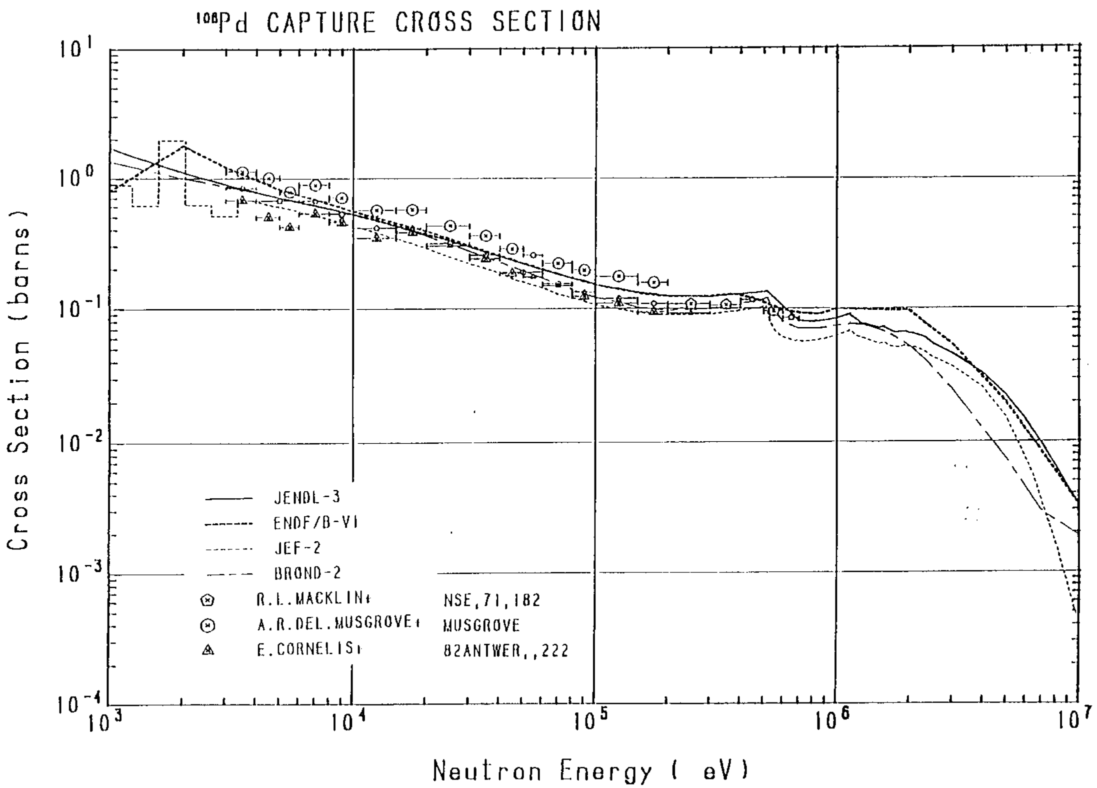
108Pd CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
V.HUMMEL+ PR,82,67
R.L.MACKLIN+ PR,107,504
R.L.MACKLIN+ PR,107,504
R.BOOTH+ PR,112,226
W.S.LYON+ PR,114,1619
L.W.WESTON+ AP,10,477
A.K.CHAUBEY+ PR,152,1055
R.L.MACKLIN+ NSE,71,182
A.R.DEL.MUSGROVE+ MUSGROVE
M.HERMAN+ NP/A,357,1
E.CORNELIS+ 82ANTWER,,222



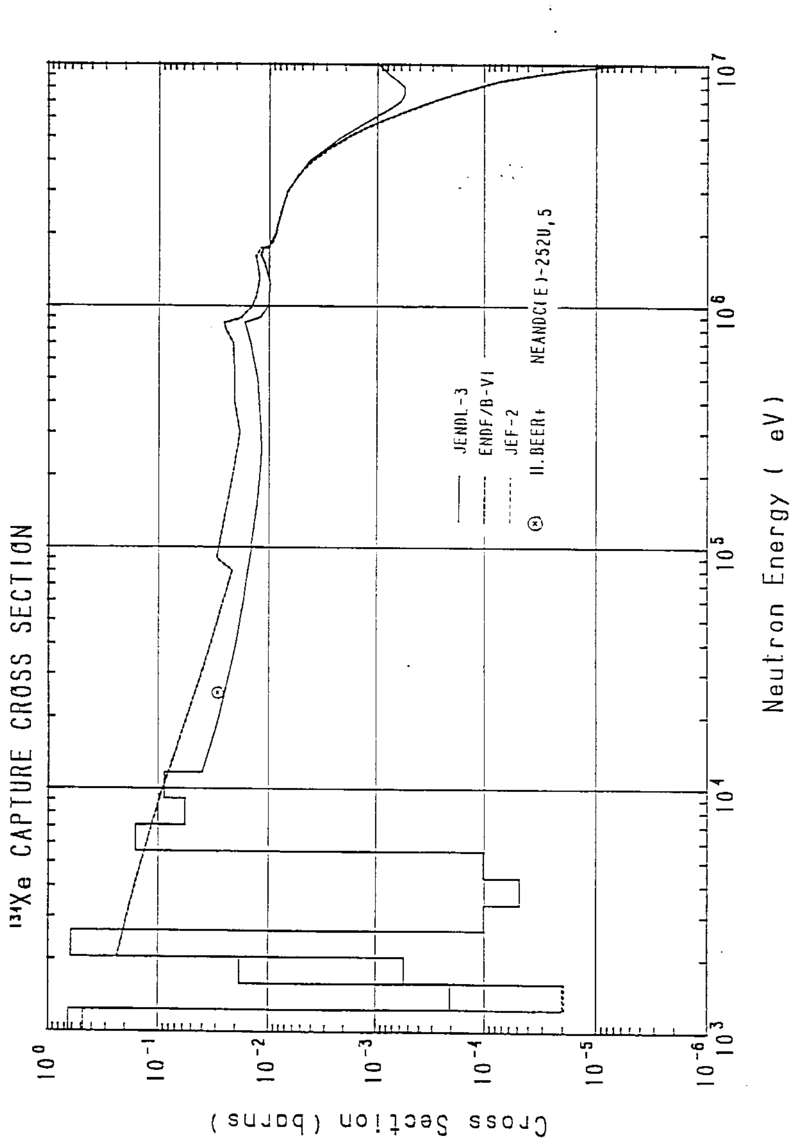
132Xe CAPTURE CRØSS SECTIØN
JENDL-3
ENDF/B-VI
JEF-2
H.BEER+
NEANDC(E)-252U,521937002
Cross Section (barns)
Neutron Energy (eV)
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^3
10^4
10^5
10^6
10^7

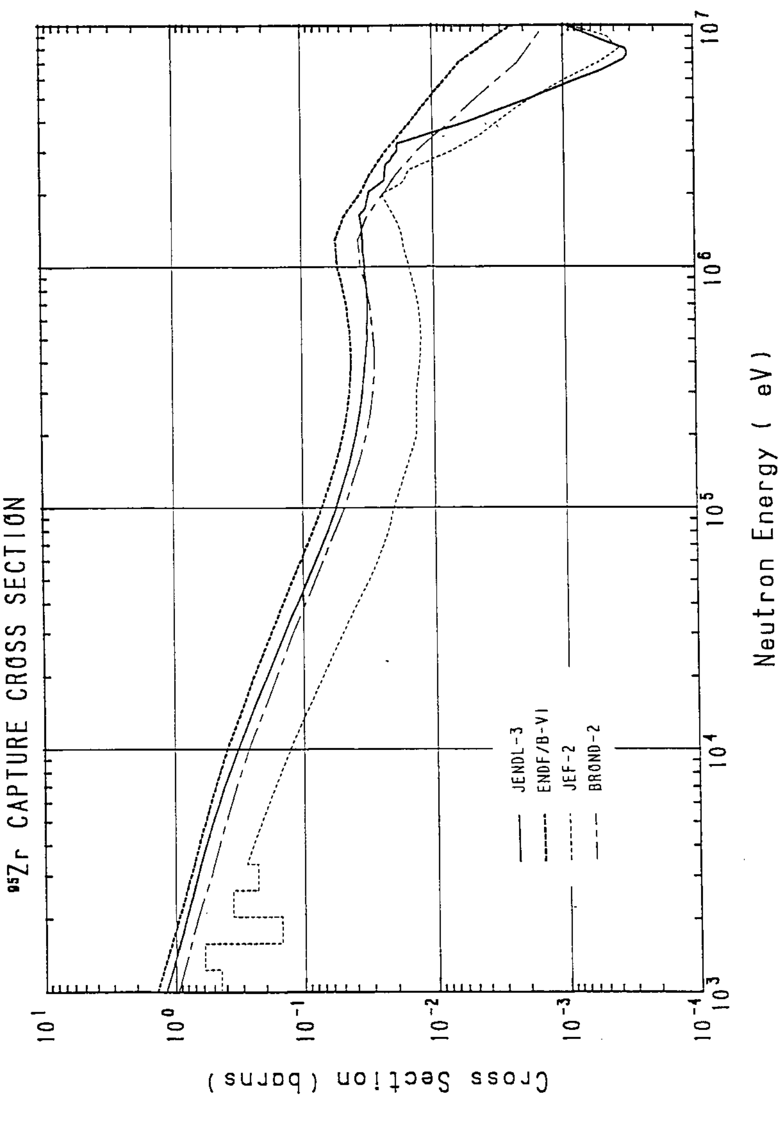


95Zr CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
10^0
10^-1
10^-2
10^-3
10^-4
10^3
10^4
10^5
10^6
10^7
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN+ PR,107,504
W.S.LYON+ PR,114,1619
R.L.MACKLIN+ BAP,8,81(Y6)
J.M.WYRICK+ ANL-83-4,196



108Pd CAPTURE CRØSS SECTION
Cross Section (barns)
Neutron Energy (eV)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^3
10^4
10^5
10^6
10^7
JENDL-3
ENDF/B-VI
JEF-2
BROND-2
R.L.MACKLIN, NSE,71,182
A.R.DEL.MUSGROVE, MUSGROVE
E.CORNELIS, 82ANTWER,,222


¹³⁴Xe CAPTURE CROSS SECTION
JENDL-3
ENDF/B-VI
JEF-2
H.BEER+
NEANDC(E)-252U,5
Neutron Energy (eV)
Cross Section (barns)
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
10³
10⁴
10⁵
10⁶
10⁷



95Zr CAPTURE CROSS SECTION
Cross Section (barns)
Neutron Energy (eV)
JENDL-3
ENDF/B-VI
JEF-2
BROND-2