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CROSS-SECTIONS FOR

FISSION NEUTRON SPECTRUM INDUCED REACTIONS

by

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Cross-sections for fission neutron spectrum induced reactions.

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Abstract

This chapter includes a review of cross-sections averaged in a uranium-235 fission neutron spectrum. The review extends to all integral measurements available in the literature up to April 1973 for (n,p), (n,α), (n,2n) and (n,n') reactions. Whenever possible cross-sections have been renormalized to a standard value of 1250±70 mb for the uranium-235 fission cross-section averaged in the thermal fission neutron spectrum of uranium-235. Recommended values have been attributed.

Parallel to this review, an estimation of averaged (n,p), (n,α), (n,2n) cross-sections has been carried out for all stable and a few long-lived isotopes.

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I. Introduction

The fast component of a reactor neutron flux induces activity which can be used for neutron activation analysis, but which can also interfere with activity induced by thermal neutrons.

In both cases, the knowledge of the cross-sections averaged in the fast neutron spectrum is required. Since the shape of this fast neutron spectrum changes from one reactor to another, even from one position in the reactor to another, one must refer to a precisely defined averaged cross-section. For this one uses the cross-section averaged in the uranium-235 thermal fission neutron spectrum

$$\bar{\sigma} = \int_0^\infty \sigma(E)\,\chi(E)\,dE$$ where $\sigma(E)$ is

the activation cross-section and $\chi(E)$ the normalized ($\int_0^\infty \chi(E)\,dE = 1$) fission neutron spectrum.

Estimates of $\bar{\sigma}$ are made either by integral or differential measurements. In integral measurements, the samples are exposed to fission neutrons, $\bar{\sigma}$ is deduced from the measured induced activity and the determined fission neutron flux. In differential measurements, $\sigma(E)$ is measured and $\bar{\sigma}$ is computed using various representations of $\chi(E)$.

This chapter contains a review of integral measurements for (n,p), (n,α), (n,2n) and (n,n') reactions and an estimation of (n,p), (n,α) and (n,2n) averaged cross-sections for the stable and long lived isotopes of the elements from lithium to bismuth.

II. Review of integral measurements

for (n,p), (n,α), (n,2n) and (n,n') reactions

INTRODUCTION

Unlike other works, we are more interested in this review in the knowledge of all available data rather than in a very precise assessment of a few reactions important for neutron dosimetry and/or fast reactor technology. This means that we will not discuss or analyze the discrepancies between differential and integral measurements. For most reactions, the agreement between the results from each method is adequate for our purpose.

We have chosen to review only the integral measurements, simply because they are more numerous than the differential ones while at the same time including practically all of them. Therefore when not otherwise indicated, the original values quoted in the tables are derived from integral measurements. In some rare cases, where integral measurements are not available or are too discrepant, we have used differential or calculated data.

In some integral measurements, great care is exercised in exposing the samples to a neutron flux which is as close as possible to a thermal neutron induced uranium-235 fission neutron spectrum. This is achieved using fission plate or converter techniques. In most other cases, one simply checks that the reactor spectrum does not deviate "significantly" from a pure fission spectrum. This spectrum equivalence will be true in general for the energy range above about 1.5MeV. Therefore for threshold reactions, the fission neutron spectrum is used as zero order approximation to the true spectrum independent of reactor type and irradiation position.

Most of the integral measurements are made relative to a standard reaction and have therefore to be renormalized for intercomparison. Table I gives the most commonly used standard reactions with the values adopted in this review. These values are taken from a work by A. Fabry (FA72), which is an evaluation of experimental microscopic integral cross-sections measured in the thermal fission neutron spectrum of uranium-235 for 29 nuclear reactions relevant to neutron dosimetry and fast reactor technology.

RENORMALIZATION

Whenever possible and when not already renormalized by Fabry, the original data have been renormalized according to the standard values given in table I. For some less common standards, recommended values from the tables II, III and IV have been used.

The renormalization is done by multiplying, for each reaction , the original data by the ratio of the new standard value to the old one. Branching ratios were not taken into account in this renormalization. Errors have been considered as standard deviations. Renormalized errors always include the uncertainty in the standard cross-section used for renormalization.

In Fabry's evaluation a least squares method is used to produce a recommended set of fission spectrum integral data scaled to a unique standard, chosen to be the uranium-235 fission cross-section averaged in the uranium-235 thermal fission neutron spectrum for which a value of 1250 mb has been accepted.

Fabry first renormalized experimental data sets of various authors to his own experimental data set, for which a uranium-235 standard value of

1335 mb had been accepted. All the renormalized data sets together with Fabry's data set were then scaled to a value of 1250 mb for the fission spectrum averaged uranium-235 fission cross-section.

Consequently all renormalized values appearing in the tables are linked to the uranium-235 standard value. Except for the values renormalized by Fabry, the absolute errors on renormalized values include an absolute error of 70 mb on the uranium-235 standard value.

DETERMINATION OF RECOMMENDED VALUES

Keeping in mind the practical use of these tables, we have decided to give a "recommended" value for each single reaction appearing in the table even if some values are of doubtful quality.

For the reactions which he has evaluated, Fabry recommends values, which are a weighted average of his renormalized then scaled values. In most cases, Fabry's recommended values will also be ours, except for the errors which, in our case, always include the error in the uranium-235 standard. These values are strongly recommended.

For the cross-sections not evaluated by Fabry a selection has been made among the available renormalized values. A weighted average (using the inverse of the squared errors as weight) of the selected values, was then performed. Averaged values of at least three renormalized values agreeing within 15% are also strongly recommended. Both these values and Fabry's recommended values appear underlined in the tables.

Other "recommended" values are, either the average of discrepant values, or the average of only two agreeing values, or no average at all for single measurements.

STRUCTURE OF THE TABLES II, III, IV AND V

Tables II, III, IV and V summarize the status of integral measurements. For each reaction all data available in the common literature up to April 1973 are given together with the standard used when known or relevant. The first column gives the reactions. In the second column appear the references to the original values given in the third column. The fourth column includes the standard used by the author. The numbers in parenthesis refer to footnotes. Renormalized values are given in the fifth column and recommended values are given in the sixth.

The boxes drawn within the tables for some reactions, contain the original data and their renormalized values used by Fabry in his evaluation. The result of the evaluation, Fabry's recommended value, given in the third column, appears in the last line of the box, attached to the underlined reference FA72. Our recommended value, identical to Fabry's value except for the error as explained previously, is given in the last column. The dotted line separates in the box the measurements performed with fission plates or converter (upper part) from the ones done by exposure to pile neutrons (lower part).

The renormalized values selected for averaging are flagged with a"-"on the right hand side. The brace } collects the renormalized values in an average recommended value. Absolute errors may appear in parenthesis, this means they have been arbitrarily chosen when not given by the author.

III. Estimated average fission neutron cross-sections for (n,p), (n,α) and (n,2n) reactions

INTRODUCTION

The tables II to V are far from being complete and numerous cross-sections required by the experimentalist are unknown, hence the need for a complete estimation. Some works provide an answer for some cross-sections which have been theoretically calculated (see for example Pearlstein's calculations (PL73) using an empirical model based on statistical theory for nuclides having 21 to 41 protons) or evaluated (see for example Pope & Story (PO73) evaluation using the U.K. Nuclear Data Library for 64 data files). But, so far, only Roy & Hawton (RO60) have attempted an estimation covering all stable isotopes and a few long-lived radionuclides from lithium to bismuth.

Their work is now twelve years old. Since the number of available measurements, on which the estimation is based has nearly doubled since 1960, we thought it to be useful to review the Roy and Hawton estimated values.

THE BASIS OF THE ESTIMATION

Hughes (HU53) has defined a useful quantity E_{eff}, called the effective energy, assuming that the cross-section $\sigma(E)$ is proportional to the penetrability P(E) of the Coulomb barrier which confronts the charged particle leaving the compound nucleus. In this case, the reaction rate, as a function of the energy E of the incoming neutrons, is proportional to the product of P(E) and $\chi(E)$. Thus the spectrum averaged cross-section is proportional to the area under the curve $P(E)\chi(E)$ (see fig. 1).

E_{eff} is defined, as shown on the figure 1, as the energy for which the area marked A is equal to area marked B, so that the area under the curve $P(E)\,\chi(E)$ is the same as the one delimited by $\chi(E)$ and a vertical dotted line drawn at E_{eff}. At unit penetrability, the cross-section $\sigma(E)$ becomes constant and equals σ_o, which Hughes measurements have shown to be roughly proportional to the surface of the nucleus. The cross-section $\sigma(E)$ can then be written $\sigma(E) = a\,P(E)A^{2/3}$, where A is the mass number and a is a constant. The spectrum averaged cross section can then be written:

$$\bar{\sigma} = \int_0^\infty \sigma(E)\,\chi(E)d\,E = aA^{2/3}\int_0^\infty P(E)\,\chi(E)d\,E$$

$$= aA^{2/3}\int_{E_{eff}}^\infty \chi(E)dE$$

The quantity $\frac{\bar{\sigma}}{A^{2/3}}$ is proportional to the integral of the fission neutron spectrum from E_{eff} to infinity and it is then possible to predict an average cross-section if the effective energy of a given reaction is known. The validity of this very simple model was tested by the old Hughes measurements. Later on, large discrepancies with more recent measurements have shown the inadequacy of the Hughes model to predict average cross-sections.

Rather than trying to refine the previous theory, Roy and Hawton (RO60) have looked for an empirical correlation between $\bar{\sigma}$ and E_{eff}. For each measurement, they have plotted the quantity $\frac{\bar{\sigma}\,25}{A^{2/3}}$ versus E_{eff} (E_{eff} being obtained from Hughes plots (Fig. 4-3, HU53). 25 means that the cross-sections have arbitrarily been normalized to a nucleus of mass A = 125, for which $A^{2/3} = 25$. The (n,2n) cross-sections have been plotted versus the threshold energy E_T. From the line giving the best fit of the experimental points, Roy and Hawton have then tabulated the estimated cross-sections. Roy and Hawton fitted lines have a greater slope than the ones given by the integral of the fission neutron spectrum from Hughes model. Moreover, for (n,p) cross-sections, the data split along two parallel lines: the odd-A nuclei having much lower cross-sections than the even-A nuclides.

Our present work assumes the Roy and Hawton approach to the measurements available presently. Except for the data flagged with a "+", all recommended values of the tables II, III and IV have been used for the fit. Relative errors on data from a single measurement or averaged over two measurements have arbitrarily been increased up to 20% whenever their relative error was lower than this value. This was done in order to give lower weight to the unsupported measurements. The 20% arbitrary errors appear in the graphs (fig. 2, 3 and 4) as dotted error bars.

Threshold energies E_T have also been recalculated using the latest Q-value evaluation (GV72); for exoergic reactions $E_T = -Q$, for endoergic reactions $E_T = -Q(A+1)/A$ where A is the mass number of the target nuclide. Some threshold values, for which Q was not evaluated have been taken from HW70. These changes in the threshold values resulted in corrected effective energies.

The graphs of figures 2, 3 and 4 show the results. The shaded areas define a 67% confidence interval. It can be seen that our best fits have consistently greater slopes than the ones of Roy and Hawton. Except for (n,p) cross-sections of odd-A nuclei, the dispersion of which is anyway large, our fit is not very much different from that of Roy and Hawton.

TABLES OF ESTIMATED VALUES

The neutron fission spectrum averaged cross-sections are estimated from the solid lines giving the best fits to the experimental data (fig. 2, 3 and 4) and are given in table VI together with their estimated relative errors (one standard deviation). For those reactions where $\bar{\sigma}$ is less than 0.1 microbarn, $\bar{\sigma}$ is simply given as $<$ 0.0001 millibarn. No value has been given for the few reactions for which E_{eff} is less than 2MeV, the validity of the estimation being doubtful in this case. Recommended values of $\bar{\sigma}$, appearing in tables II, III and IV should of course be preferred to the estimated ones.

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Table I Adopted standards

	$\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{24}Mg(n,p)^{24}Na$	1.53±0.09
$^{27}Al(n,\alpha)^{24}Na$	0.725±0.045
$^{32}S(n,p)^{32}P$	69±4
$^{46}Ti(n,p)^{46}Sc$	12.5±0.9
$^{54}Fe(n,p)^{54}Mn$	82.5±5
$^{58}Ni(n,p)^{58}Co$	113±7
$^{235}U(n,f)F P$	1250±70
$^{238}U(n,f)F P$	328±10

Explanation of signs appearing in the tables II, III, IV and V.

( ) *	The reaction has been used as standard with the numerical value given in parenthesis.
(±0.05)	The error given in parenthesis has been arbitrarily chosen.
–	flags the data selected for use in the averaging process
}	collects renormalized values in an averaged recommended value.
+	flags the data not accepted for the fit of the estimated values.
1.53±0.09	Underlined data are strongly recommended
FA72	refers to Fabry's recommended values (reported in the "original values" column of the tables.

The boxes drawn within the tables for some reactions, include the original data and their renormalized values used by Fabry (FA72) in his evaluation.

– – – –	separates within the box the measurements performed with fission plates or converter (uppert part) from the ones done by exposure to pile neutrons (lower part).

(1), (2) ....(29) refer to footnotes given after table V.

Table II   Integral (n,p) cross-sections averaged in the uranium-235 thermal fission neutron spectrum

Reactions	References	Original values $\overline{\sigma} \pm \Delta\overline{\sigma}$ (mb)	Standards (mb)	Renormalized values $\overline{\sigma} \pm \Delta\overline{\sigma}$ (mb)	Recommended values $\overline{\sigma} \pm \Delta\overline{\sigma}$ (mb)
$^{16}O(n,p)^{16}N$	HU53	0.014	(1)	0.022	
	RY58	0.019±25%	$^{27}Al(n,\alpha)$=0.6±20%	0.023±0.003	0.019±0.001 +
	HE58	(1.85±0.11)10^{-2}	(2)	0.018±0.0011	
$^{17}O(n,p)^{17}N$	RY58	0.0052±30%	$^{27}Al(n,\alpha)$=0.6±20%	0.0063±0.0013	
	HE58	(9.3±0.9) 10^{-3}	(2)	0.0093±0.0009	0.0086±0.0008 +
	AM64	(7.4±0.6)10^{-3}	$^{27}Al(n,\alpha)$=0.6	0.0089±0.0009	
$^{19}F(n,p)^{19}O$	HU53	0.5	(1)	0.8	1.35±0.8
	SA59	0.99	$^{31}P(n,p)$=19	1.9	
$^{23}Na(n,p)^{23}Ne$	HU53	0.7	(1)	1.1	1.5±0.6
	SA59	1.0	$^{31}P(n,p)$=19	1.9	
$^{24}Mg(n,p)^{24}Na$	HU53	1.0	(1)	1.6	
	WA62	1.05±0.25	unknown		
	BO64	1.31±0.06	$^{32}S(n,p)$=60	1.53±0.07	
	BR67,70	1.44±0.05	(3)	1.53±0.053	
	NJ70	1.31±0.05	$^{27}Al(n,\alpha)$= 0.61	1.58±0.06	
	KI71	(1.4)*	(4)	1.56	
	FA72	1.62±0.07	$^{235}U(n,f)$=1335 (7)	1.52±0.045	
	RI57	1.29	$^{238}U(n,f)$=304	1.53	
	PA61	1.2	$^{27}Al(n,\alpha)$=0.60	1.51	
	HO62	1.1	$^{27}Al(n,\alpha)$=0.57	1.41	
	NS68	1.30±0.17	(5)	1.53±0.20	
	KI71	(1.4)*	(4)	1.56	
	MC72	(6)		1.51±0.12	
	FA72	1.53±0.03	$^{235}U(n,f)$=1250	1.53±0.09	1.53±0.09

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)		Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{25}Mg(n,p)^{25}Na$	HU53	2.0	(1)	3.2		3.2(±1.6) +
$^{27}Al(n,p)^{27}Mg$	HU53	2.8	(1)	4.5		
	BO64	2.9±0.5	$^{32}S(n,p)$=60	3.4±0.6		
	GR68	(8)		4.7±0.3		
	NJ70	2.9±0.3	$^{27}Al(n,\alpha)$=0.61	3.5±0.35		
	FA72	4.35±0.20	$^{235}U(n,f)$=1335 (7)	4.07±0.15		
	RI57	3.43	$^{238}U(n,f)$=304	4.01		
	MC72	(6)		4.17±0.33		
	FA72	4.0 ±0.4	$^{235}U(n,f)$=1250	4.0±0.45	-	4.0±0.45
	FH64	3.40±0.38	unknown			
$^{28}Si(n,p)^{28}Al$	HU53	4	(1)	6.4		
	BU70	6.68±0.08	$^{32}S(n,p)$=65	7.1±0.4	-	6.4±0.8
	KI71	4.90±0.32	(4)	5.4±0.5	-	
$^{29}Si(n,p)^{29}Al$	HU53	2.7	(1)	4.3		
	NS68	2.40±0.18	(5)	2.8±0.3	-	3.3±0.2
	BU70	3.41±0.04	$^{32}S(n,p)$=65	3.6±0.2	-	
	KI71	2.98±0.17	(4)	3.3±0.3	-	
$^{31}P(n,p)^{31}Si$	HU53	19	(1)	30		
	RR60	(23)	$^{32}S(n,p)$=69±4	35±3		
	BO64	30.5±1.2	$^{32}S(n,p)$=60	35.5±1.4		
	GR68	(8)		38.6±2.5		
	RI57	31.2	$^{238}U(n,f)$=304	36.5		
	FA72	36±2	$^{235}U(n,f)$=1250	36±3	-	36±3

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{32}S(n,p)^{32}P$	HU53	30	(1)	48	
	SA59	21	$^{31}P(n,p)$=19	40	
	DU62	58±15%	$^{238}U(n,f)$=310	61±9	
	DE62	65±3	(9)		
	FH64	61±5	unknown		
	LW66,68	41	$^{54}Fe(n,p)$=60	56	
	BO64	(60)*±1.2	$^{32}S(n,p)$=60	70±1.4	
	FA72	73±3	$^{235}U(n,f)$=1335 (7)	68.5±2	
	RI57	60.3	$^{238}U(n,f)$=304	71.2	
	PA61	58 (16)	$^{27}Al(n,\alpha)$=0.6	73±7	
	MA64/1	65 (17)	$^{32}S(n,p)$=65	68.5	
	MC72	(6)		70.5±5.6	
	FA72	69±2	$^{235}U(n,f)$=1250	69±4	69±4
$^{33}S(n,p)^{33}P$	KO66/2	376±20	$^{32}S(n,p)$=66	383±31	
	LW66,68	55	$^{54}Fe(n,p)$=60	76	76(±15) +
$^{34}S(n,p)^{34}P$	RA67/1	0.36±0.032	$^{58}Ni(n,p)$=95	0.43±0.05	0.43±0.05
$^{35}Cl(n,p)^{35}S$	HU53	16	(1)	26	
	GI66	~810±40	unknown		
	RA67/1	78.3(calc.)	(24)		78 (±23) +
$^{37}Cl(n,p)^{37}S$	HU53	0.24	(1)	0.38	0.38(±0.19) +
$^{41}K(n,p)^{41}Ar$	LA65	2.73±0.41	unknown		
	RA67/1	1.78±0.14	$^{58}Ni(n,p)$=95	2.1±0.2	2.1±0.2

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{43}Ca(n,p)^{43}K$	GI66	0.3	unknown		0.3(±0.15) +
$^{45}Sc(n,p)^{45}Ca$	MU61	9±1	$^{32}S(n,p)$=66	9.4±1.2	15±12 +
	RG68/2	34.6±0.5	$^{32}S(n,p)$=60	39.8±2.4	
$^{46}Ti(n,p)^{46}Sc$	ME58	4.1	$^{32}S(n,p)$=30	9.4	
	DU62	10±15%	$^{238}U(n,f)$=310	10.6±1.6	
	NL63	15±2	$^{58}Ni(n,p)$=101	17±2	
	NI63	17±3	$^{58}Ni(n,p)$=92	21±4	
	ZJ	12.8	$^{27}Al(n,\alpha)$=0.608	15±3	
	KO66/1	12.6±0.4	$^{32}S(n,p)$=66	13.2±0.9	
	DS67	8.6±1.4	unknown		
	BO64	12.8±0.6	$^{32}S(n,p)$=60	15	
	BR67,70	11.6±0.5	(3)	12.3±0.5	
	KI71	10.8±0.61	(4)	12.0±0.7	
	FA72	13.0±0.6	$^{235}U(n,f)$=1335 (7)	12.2±0.4	
	HO62	9.0	$^{27}Al(n,\alpha)$=0.57	11.4	
	BO64	8.0±0.6	$^{58}Ni(n,p)$=90	9.3	
	MA64/2	8.±0.8	$^{58}Ni(n,p)$=107	8.45±0.85	
	RA67/1	(12.6)*	$^{46}Ti(n,p)$=12.6	12.3	
	NS68	9.30±0.73	(5)	10.9±0.9	
	SC69	10.9±0.7	$^{27}Al(n,\alpha)$=0.767	10.6±0.7	
	KI71	11.2±0.63	(4)	12.5±0.7	
	MC72	(6)		13.0±1	
	FA72	12.5±0.5	$^{235}U(n,f)$=1250	12.5±0.9	12.5±0.9

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{47}Ti(n,p)^{47}Sc$	ME58	0.21	$^{32}S(n,p)=30$	0.48	
	DU62	18±15%	$^{238}U(n,f)=310$	19±3	
	NI63	18±3	$^{58}Ni(n,p)=92$	22±4	
	KO66/1	13.2±1	$^{32}S(n,p)=66$	13.8±1.3	
	DS67	18.2±2.6	unknown		
	BO64	22±1.5	$^{32}S(n,p)=60$	25.6±1.7	
	KI71	17.3±0.90	(4)	19.3±1	
	HO62	15	$^{27}Al(n,\alpha)=0.57$	19.2	
	NS68	26±3.1	(5)	30.5±3.6	
	SC69	19.8±1.2	$^{27}Al(n,\alpha)=0.767$	19.2±1.1	
	KI71	19.0±1.2	(4)	21.2±1.3	
	FA72	20±2	$^{235}U(n,f)=1250$	20±2.3	20±2.3
$^{48}Ti(n,p)^{48}Sc$	ME58	0.077	$^{32}S(n,p)=30$	0.18	
	DU62	0.53±15%	$^{238}U(n,f)=310$	0.56±0.09	
	NI63	0.44±0.08	$^{58}Ni(n,p)=92$	0.54±0.10	
	KO66/1	3.3±0.2	$^{32}S(n,p)=66$	3.45±0.3	
	DS67	0.11±0.01	unknown		
	BO64	0.21±0.016	$^{32}S(n,p)=60$	0.245±0.002	
	KI71	0.272±0.052	(4)	0.303±0.058	
	HO62	0.25	$^{27}Al(n,\alpha)=0.57$	0.32	
	NS68	0.240±0.054	(5)	0.282±0.063	
	SC69	0.334±0.02	$^{27}Al(n,\alpha)=0.767$	0.324±0.02	
	KI71	0.294±0.025	(4)	0.328±0.028	
	FA72	0.315±0.02	$^{235}U(n,f)=1250$	0.315±0.027	0.315± 0.027
$^{51}V(n,p)^{51}Ti$	NS68	0.74±0.08	(5)	0.87±0.11	0.87±0.11
$^{52}Cr(n,p)^{52}V$	RA67/1	0.92±0.037	$^{58}Ni(n,p)=95$	1.09±0.08	1.09±0.08

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{53}Cr(n,p)^{53}V$	RA67/1	0.37±0.026	$^{58}Ni(n,p)$=95	0.44±0.04	0.44±0.04
$^{54}Cr(n,p)^{54}V$	RA67/1	(4.9±0.8)10^{-3}	$^{58}Ni(n,p)$=95	(5.8±1.0)10^{-3}	0.0058±0.001
$^{54}Fe(n,p)^{54}Mn$	SC57	15	(10)	46	
	ME58	23	$^{32}S(n,p)$=30	53	
	RC59	56	$^{27}Al(n,\alpha)$=0.6	68	
	DU62	59±15%	$^{238}U(n,f)$=310	62±10	
	BA68	59.8±14%	unknown		
	ST70	63±1	$^{58}Ni(n,p)$=105	68±4	
	BO64	66±3.5	$^{32}S(n,p)$=60	77±4	
	BR67,70	76.5±3.0	(3)	81.5±3.2	
	FA72	89±5	$^{235}U(n,f)$=1335 (7)	83.5±2.5	
	PA61	54	$^{27}Al(n,\alpha)$=0.60	73	
	HO62	65	$^{27}Al(n,\alpha)$=0.57	83	
	MA64/3	76±3	$^{58}Ni(n,p)$=107	83.3± 3.3	
	NS68	67±9	(5)	84.7±10.5	
	MC72	(6)		81.5±4.5	
	FA72	82.5±2	$^{235}U(n,f)$=1250	82.5±5	82.5±5
$^{56}Fe(n,p)^{56}Mn$ (see also next page)	ME58	0.44	$^{32}S(n,p)$=30	1.0	
	DU62	1.2±15%	$^{238}U(n,f)$=310	1.3±0.2	
	BO64	0.90±0.05	$^{32}S(n,p)$=60	1.05±0.06	
	GR68	(a)	(8)	1.07±0.07	
	BR67,70	1.06±0.04	(3)	1.13±0.043	
	NJ70	0.85±0.05	$^{27}Al(n,\alpha)$=0.61	1.025±0.06	
	FA72	1.15±0.04	$^{235}U(n,f)$=1335 (7)	1.08±0.035	

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{56}Fe(n,p)^{56}Mn$ (cont'd)	PA61	0.82	$^{27}Al(n,\alpha)$=0.60	1.03	
	HO62	0.71	$^{27}Al(n,\alpha)$=0.57	0.91	
	NS68	0.96±0.09	(5)	1.13±0.11	
	MC72	(6)		1.29±0.10	
	FA72	1.07±0.06	$^{235}U(n,f)$=1250	1.07±0.08	1.07±0.08
$^{59}Co(n,p)^{59}Fe$	SC57	0.25	(10)	0.77	
	ME58	5.7	$^{32}S(n,p)$=30	13	
	RC59	~0.3	$^{27}Al(n,\alpha)$=0.6		
	DU62	1.4±15%	$^{238}U(n,f)$=310	1.5±0.2	1.42±0.14
	WA63	0.5	unknown		
	BA68	1.46±23%	unknown		
	NS68	1.15±0.15	(5)	1.35±0.2	
$^{58}Ni(n,p)^{58}Co$ (see also next page)	ME58	45	$^{32}S(n,p)$=30	103.5	
	RB59	225	$^{32}S(n,p)$=30	517.5	
	RC59	140	$^{27}Al(n,\alpha)$=0.60	169	
	DU62	97±15%	$^{238}U(n,f)$=310	103±16	
	ZJ63	120	$^{27}Al(n,\alpha)$=0.608	143	
	BA68	75.7±12%	unknown		
	BO64	105±5	$^{32}S(n,p)$=60	122.5±6	
	BR67,70	104.5±4.0	(3)	113.3±4.3	
	KI71	(104)*	(4)	116	
	FA72	120±6	$^{235}U(n,f)$=1335 (7)	112.5±3.5	
	PA51	92	$^{27}Al(n,\alpha)$=0.60	115.5	
	HO62	90	$^{27}Al(n,\alpha)$=0.57	115	
	MA64/1	107 (17)	$^{32}S(n,p)$=65	113	
	RA67/1	(95)*	$^{58}Ni(n,p)$=95	111	

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{58}Ni(n,p)^{58}Co$ (cont'd)	NS68	96±13	(5)	113±15	
	SC69	114±7	$^{27}Al(n,\alpha)$=0.767	110.5±7	
	KI71	(104)*	(4)	116	
	MC72	(6)		110±5.7	
	FA72	113±2.5	$^{235}U(n,f)$=1250	113±7	113±7
$^{58}Ni(n,p)^{58m}Co$	ME58	13	$^{32}S(n,p)$=30	30	
	BO64	30±7	$^{32}S(n,p)$=60	35±8	
	BR67,70	33.7±1.1	(3)	35.8±1.2	
	FA72	37.5±5	$^{235}U(n,f)$=1335 (7)	35.1±1.1	
	PA61	28	$^{27}Al(n,\alpha)$=0.60	35	
	HO62	30.5	$^{27}Al(n,\alpha)$=0.57	39	
	FA72	35.4±1.0	$^{235}U(n,f)$=1250	35.4±2.2	35.4±2.2
$^{60}Ni(n,p)^{60}Co$	RB59	<4.5	$^{32}S(n,p)$=30		
	SC57	0.56	(10)	1.72	
	ME58	3-7	$^{32}S(n,p)$=30		
	RC59	<2	$^{27}Al(n,\alpha)$=0.60		
	DU62	3.2±15%	$^{238}U(n,f)$=310	3.4±0.5	2.3±0.4
	HO62	<0.5	$^{27}Al(n,\alpha)$=0.57		
	NS68	1.69±0.18	(5)	2.0±0.2	
	HA72	4.4±1.0	$^{58}Ni(n,p)$=105	4.7±1.1	
$^{60}Ni(n,p)^{60m}Co$	HA72	1.98±0.20	$^{58}Ni(n,p)$=105	2.1±0.3	2.1±0.3
$^{61}Ni(n,p)^{61}Co$	SC69	1.3±0.1	$^{27}Al(n,\alpha)$=0.767	1.23±0.12	1.4±0.2
	HA72	1.63±0.12	$^{58}Ni(n,p)$=105	1.75±0.17	

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{62}Ni(n,p)^{62}Co$	HA72	$(9\pm3)10^{-3}$	$^{58}Ni(n,p)$=105	$(9.7\pm3.4)10^{-3}$	0.0097±0.0034
$^{65}Cu(n,p)^{65}Ni$	PA61	0.36	Al(n,α)=0.6	0.435(±10%)	0.48±0.08
	NS68	0.52±0.05	(5)	0.61±0.07	
$^{64}Zn(n,p)^{64}Cu$	ME58	22	$^{32}S(n,p)$=30	51	
	RC59	35	$^{27}Al(n,\alpha)$=0.60	42	
	DU62	31±15%	$^{238}U(n,f)$=310	33±5	
	BO64	27±1.6	$^{32}S(n,p)$=60	31.5±1.9	
	NJ70	25.2±1.3	$^{27}Al(n,\alpha)$=0.61	30.4±1.6	
	KI71	37.4±3.0	(4)	41.7±3.3	
	FA72	32±1.7	$^{235}U(n,f)$=1335 (7)	30±1.2	
	PA61	28	$^{27}Al(n,\alpha)$=0.60	35	
	HO62	25	$^{27}Al(n,\alpha)$=0.57	32	
	RA67/1	26.9±1.2	$^{58}Ni(n,p)$=95	31.4±1.3	
	NS68	27.0±4.1	(5)	31.7±4.8	
	SC69	32±2	$^{27}Al(n,\alpha)$=0.767	31±2	
	KI71	35.5±2.8	(4)	39.6±3.1	
	FA72	31±1.5	$^{235}U(n,f)$=1250	31±2.3	31±2.3
$^{66}Zn(n,p)^{66}Cu$	RA67/1	0.56±0.034	$^{58}Ni(n,p)$=95	0.67±0.06	0.62±0.11
	NS68	0.32±0.11	(5)	0.38±0.13	
$^{67}Zn(n,p)^{67}Cu$ (see also next page)	ME58	0.27	$^{32}S(n,p)$=30	0.62	
	PA61	0.57	$^{27}Al(n,\alpha)$=0.60	0.69	
	DU62	0.88±15%	$^{238}U(n,f)$=310	0.93±0.14	
	BO64	0.9±0.1	$^{32}S(n,p)$=60	1.04±0.13	

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{67}Zn(n,p)^{67}Cu$ (cont'd)	NI65/2	0.88±0.11	$^{58}Ni(n,p)$=92	1.08±0.15	1.07±0.04
	RA67/1	0.96±0.067	$^{58}Ni(n,p)$=95	1.14±0.11	
	OB69	0.82±0.04	$^{54}Fe(n,p)$=61	1.11±0.09	
	HP69	0.8	unknown		
	SC69	1.11±0.08	$^{27}Al(n,\alpha)$=0.767	1.05±0.10	
$^{68}Zn(n,p)^{68}Cu$	RA67/1	(13.1±1.9)10−3	$^{58}Ni(n,p)$=95	0.0156±0.0025	0.0156±0.0025
$^{69}Ga(n,p)^{69m}Zn$	HP69	0.496±0.073	unknown		0.496±0.073 +
$^{72}Ge(n,p)^{72}Ga$	RC59	<0.01	$^{27}Al(n,\alpha)$=0.6		
	RA67/1	0.0218	(24)		0.022(±0.006)+
$^{75}As(n,p)^{75}Ge$	NS68	0.45 (cal.val)	(19)		0.45(±0.15) +
$^{74}Se(n,p)^{74}As$	GI66	6.6	unknown		6.6(±3.3) +
$^{81}Br(n,p)^{81g}Se$	ST67	0.020±0.004	$^{27}Al(n,\alpha)$=0.6	0.024±0.005	0.024±0.005
$^{81}Br(n,p)^{81m}Se$	ST67	0.012±0.003	$^{27}Al(n,\alpha)$=0.6	0.0145±0.004	0.0145±0.004
$^{88}Sr(n,p)^{88}Rb$	NS68	0.01 (cal. Val)	(19)		0.01(±0.003) +
$^{89}Y(n,p)^{89}Sr$	BA68	0.31±19%	unknown		0.31±0.06 +
$^{90}Zr(n,p)^{90}Y$	NS68	0.18 (cal.Val)	(19)		0.18(±0.06) +
$^{92}Mo(n,p)^{92m}Nb$	ME58	1.3	$^{32}S(n,p)$=30	3	
(see also next page)	GO62	3.64±10%	$^{58}Ni(n,p)$=105	3.92±0.05	

Table II (continued)

Reactions	References	Original values $\sigma \pm \Delta\sigma$ (mb)	Standards (mb)	Renormalized values $\sigma \pm \Delta\sigma$ (mb)	Recommended values $\sigma \pm \Delta\sigma$ (mb)
$^{92}Mo(n,p)^{92m}Nb$ (cont'd)	BO64	6.2±0.4	$^{32}S(n,p)$=60	7.23±0.5	
	BR67,70	6.57±0.28	(3)	7.00±0.30	
	KI71	6.04±0.45	(4)	6.73±0.05	
	FA72	7.7±0.5	$^{235}U(n,f)$=1335 (7)	7.2±0.3	
	HO62	6.0	$^{27}Al(n,\alpha)$=0.57	7.65	
	RA67/1	6.74±0.27	$^{46}Ti(n,p)$=12.6	6.58±0.26	
	NS68	6.70±0.63	(5)	7.87±0.74	
	KI71	6.00±0.43	(4)	6.70±0.47	
	FA72	7.0±0.4	$^{235}U(n,f)$=1250	7.0±0.6	7.0±0.6
$^{95}Mo(n,p)^{95}Nb$	ME58	<0.1	$^{32}S(n,p)$=30		
	GO62	0.12±10%	$^{92}Mo(n,p)$=3.64	0.23±0.03	
	HO62	<0.1	$^{27}Al(n,\alpha)$=0.57		
	BO64	0.13±0.02	$^{32}S(n,p)$=60	0.150±0.02	0.14±0.01
	RA67/1	0.138±0.006	$^{46}Ti(n,p)$=12.6	0.137±0.012	
$^{96}Mo(n,p)^{96}Nb$	GO62	0.03±10%	$^{92}Mo(n,p)$=3.64	0.058±0.008	0.058±0.008 +
$^{103}Rh(n,p)^{103}Ru$	FR67	0.093±0.001	$^{32}S(n,p)$=60	0.107±0.006	0.107±0.006
$^{109}Ag(n,p)^{109}Pd$	NS68	0.06 (cal.val.)	(19)		0.06(±0.02) +
$^{106}Cd(n,p)^{106}Ag$	ST67	2.7±0.2	$^{27}Al(n,\alpha)$=0.6	3.3±0.3	3.3±0.3
$^{110}Cd(n,p)^{110}Ag$	RC59	~0.1	$^{27}Al(n,\alpha)$=0.6		0.1(±0.05) +
$^{127}I(n,p)^{127m}Te$	RG68/1	$(11.1\pm0.2)10^{-3}$	$^{32}S(n,p)$=60	$(12.8\pm0.8)10^{-3}$	0.0128±0.0008

Table II (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{127}I(n,p)^{127g}Te$	RG68/1	$(7.62 \pm 0.11)10^{-3}$	$^{32}S(n,p)=60$	$(8.8 \pm 0.5)10^{-3}$	0.0088 ± 0.0005
$^{132}Ba(n,p)^{132}Cs$	RB59	5.3	$^{32}S(n,p)=30$	12	12($\pm$6) +
$^{136}Ba(n,p)^{136}Cs$	RB59	0.0015	$^{32}S(n,p)=30$	0.0035	0.0035($\pm$0.0017) +
$^{140}Ce(n,p)^{140}La$	DS68	3.5 ± 0.9	$^{58}Ni(n,2n)=0.004$	4.3 ± 1.6	4.3 ± 1.6 +
$^{141}Pr(n,p)^{141}Ce$	OB67	0.12	unknown		0.12($\pm$0.06) +
$^{182}W(n,p)^{182}Ta$	RV67	$(3.8 \pm 0.6)10^{-3}$	(11)	$(4.0 \pm 0.7)10^{-3}$	0.004 ± 0.0007
$^{183}W(n,p)^{183}Ta$	RV67	$(2.8 \pm 0.5)10^{-3}$	(11)	$(3.0 \pm 0.6)10^{-3}$	0.003 ± 0.0006
$^{203}Tl(n,p)^{203}Hg$	ME58	0.004	$^{32}S(n,p)=30$	0.009	0.009($\pm$0.004)+

Table III — Integral (n,α) cross-sections averaged in the uranium-235 thermal fission neutron spectrum

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{9}Be(n,\alpha)^{6}He$	HU53	10	(1)	16	
	GN68	38.2±3.8	(15)		32.8±3.8
$^{11}B(n,\alpha)^{8}Li$	HU53	0.085	(1)	0.14	0.14(±0.07) +
$^{19}F(n,\alpha)^{16}N$	HU53	4.5	(1)	7.2	7.85±0.9
	SA59	4.5	$^{31}P(n,p)$=19	8.5	
$^{23}Na(n,\alpha)^{20}F$	HU53	0.4	(1)	0.64	0.765±0.17
	SA59	0.47	$^{31}P(n,p)$=19	0.89	
$^{27}Al(n,\alpha)^{24}Na$ (see also next page)	HU53	0.6	(1)	0.96	
	SA59	0.44	$^{31}P(n,p)$=19	0.83	
	ME60	0.48	$^{32}S(n,p)$=60	0.55	
	DE62	0.63±0.03	(9)		
	DU62	0.85±15%	$^{238}U(n,f)$=310	0.90±0.14	
	FH64	0.62±0.03	unknown		
	BO64	0.60±0.03	$^{32}S(n,p)$=60	0.70±0.035	
	GR68		(8)	0.75±0.0045	
	BR67,70	0.695±0.02	(3)	0.74±0.02	
	NJ70	(0.61)*	$^{27}Al(n,\alpha)$=0.61	0.735	
	KI71	(0.63)*	(4)	0.70	
	FA72	0.78±0.03	$^{235}U(n,f)$=1335 (7)	0.73±0.02	
	RI57	0.60	$^{238}U(n,f)$=304	0.71	
	PA61	(0.60)*	$^{27}Al(n,\alpha)$=0.60	0.755	
	HO62	(0.57)*	$^{27}Al(n,\alpha)$=57	0.73	
	RA67/1	0.61±0.028	$^{58}Ni(n,p)$=95	0.71±0.03	
	NS68	0.58±0.07	(5)	0.68±0.08	

Table III (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{27}Al(n,\alpha)^{24}Na$ (cont'd)	SC69	(0.767)*	$^{27}Al(n,\alpha)$=767	0.744±0.045	
	KI71	(0.63)*	(4)	0.70	
	MC72	(6)		0.73±0.015	
	FA72	0.725±0.02	$^{235}U(n,f)$=1250	0.725±0.045	0.725±0.045
$^{30}Si(n,\alpha)^{27}Mg$	NI64	0.15±0.02	$^{27}Al(n,p)$=3.43	0.175±0.03	0.155±0.02
	KI71	0.130±0.020	(4)	0.144±0.023	
$^{31}P(n,\alpha)^{28}Al$	HU53	1.43	(1)	2.29	1.9±0.6
	SA59	0.75	$^{31}P(n,p)$=19	1.44	
$^{34}S(n,\alpha)^{31}Si$	HU53	3.0	(1)	4.8	
	SA59	1.2	$^{31}P(n,p)$=19	2.3	
	BL65	2.23 (calc.)	(18)		2.2(±0.2)
$^{35}Cl(n,\alpha)^{32}P$	HU53	3.0	(1)	4.8	8.8±4.6
	SA59	4.1	$^{31}P(n,p)$=19	7.8	
	DU59	15	unknown		
	NI65/1	12.4	$^{32}S(n,p)$=62	13.8	
	LW66,68	32	$^{54}Fe(n,p)$=60	44	
$^{36}Cl(n,\alpha)^{33}P$	LW66,68	52	$^{54}Fe(n,p)$=60	72	72(±36) +
$^{39}K(n,\alpha)^{36}Cl$	NS68	8.0 (calc.)	(19)		8.0(±0.3) +
$^{41}K(n,\alpha)^{38}Cl$	RA67/1	0.61±0.032	$^{58}Ni(n,p)$=95	0.73±0.06	0.76±0.05
	JO68	0.68±0.05	$^{27}Al(n,\alpha)$=0.6	0.82±0.08	

Table III (continued)

Reactions	References	Original values $\sigma \pm \Delta\sigma$ (mb)	Standards (mb)	Renormalized values $\sigma \pm \Delta\sigma$ (mb)	Recommended values $\sigma \pm \Delta\sigma$ (mb)
$^{40}Ca(n,\alpha)^{42}K$	GI66.	13.2	unknown		13($\pm$6) +
$^{44}Ca(n,\alpha)^{41}Ar$	LA65	$(61.1\pm9.2)10^{-3}$	unknown		0.0611$\pm$0.0092+
$^{45}Sc(n,\alpha)^{42}K$	RC59	<5	$^{27}Al(n,\alpha)$=0.6		
	RG68/2	0.158$\pm$0.004	$^{32}S(n,p)$=60	0.182$\pm$0.012	0.182$\pm$0.012
$^{48}Ti(n,\alpha)^{45}Ca$	ME58	0.0055	$^{32}S(n,p)$=30	0.013	0.013($\pm$0.006)+
$^{50}Ti(n,\alpha)^{47}Ca$	ME58	0.0002	$^{32}S(n,p)$=30	0.00046	$(4.6(\pm2.3))10^{-4}$+
$^{51}V(n,\alpha)^{48}Sc$	HU53	0.08	(1)	0.13	
	SA59	0.0099	$^{31}P(n,p)$=19	0.0187	
	NS68	$(15.3\pm2.7)10^{-3}$	(5)	0.018$\pm$0.003	0.022$\pm$0.003
	KI71	0.0217$\pm$0.0015	(4)	0.024$\pm$0.002	
$^{55}Mn(n,\alpha)^{52}V$	NS68	0.11 (calc.)	(19)		0.11($\pm$0.03) +
$^{54}Fe(n,\alpha)^{51}Cr$	ME58	0.37	$^{32}S(n,p)$=30	0.85	
	BA68	0.79$\pm$15%	unknown		
	NS68	0.50$\pm$0.15	(5)	0.6$\pm$0.2	0.6$\pm$0.2
$^{56}Fe(n,\alpha)^{53}Cr$	BY65	0.397$\pm$0.12	unknown		0.397$\pm$0.12 +
$^{59}Co(n,\alpha)^{56}Mn$ (see also next page)	SA59	0.14	$^{31}P(n,p)$	0.265	
	BA68	0.32$\pm$18%	unknown		
	NS68	0.131$\pm$0.011	(5)	0.154$\pm$0.016	

Table III (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{59}Co(n,\alpha)^{56}Mn$ (cont'd)	BR70	0.147±0.005	(3)	0.156±0.006	0.156±0.009
	FA72	0.156±0.006	$^{235}U(n,f)$=1250	0.156±0.011	
$^{58}Ni(n,\alpha)^{55}Fe$	Sc57	0.17	(10)	0.52	
	BA68	2.95±32%	unknown		3±0.9
$^{62}Ni(n,\alpha)^{59}Fe$	SC57	0.013	(10)	0.04	
	ME58	0.025	$^{32}S(n,p)$=30	0.0575	0.09±0.07
	RC59	0.14	$^{27}Al(n,\alpha)$=0.6	0.17	
$^{63}Cu(n,\alpha)^{60}Co$	RC59	0.72	$^{27}Al(n,\alpha)$=0.6	0.87	
	NL63	0.54±0.07	$^{58}Ni(n,p)$=101	0.60±0.09	
	LL65	0.44	unknown		
	NI65/2	0.9	$^{58}Ni(n,p)$=92	1.1	
	FA72	0.66±0.06	$^{235}U(n,f)$=1335 (7)	0.62±0.04	
	HO62	0.42	$^{27}Al(n,\alpha)$=0.57	0.535	
	MA64/4	0.45±0.05	$^{54}Fe(n,p)$=76	0.475±0.05	
	NS68	0.382±0.036	(5)	0.449±0.042	
	MC72	(6)		0.495±0.05	
	FA72	0.50±0.05	$^{235}U(n,f)$=1250	0.50±0.06	0.50±0.06
$^{68}Zn(n,\alpha)^{65}Ni$	SA59	0.020	$^{31}P(n,p)$=19	0.038	
	RA67/1	$(6.3\pm0.4)10^{-2}$	$^{58}Ni(n,p)$=95	0.075±0.007	0.074±0.006
	SC69	0.077±0.01	$^{27}Al(n,\alpha)$=0.767	0.073±0.011	

Table III (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{72}Ge(n,\alpha)^{69m}Zn$	RC59 NI63	<1 0.020±0.005	$^{31}P(n,p)$=19 $^{58}Ni(n,p)$=92	 0.025±0.006 –	 0.025±0.006 +
$^{74}Ge(n,\alpha)^{71m}Zn$	NI63	0.002±0.001	$^{58}Ni(n,p)$=92	0.0025±0.0013	0.0025±0.0013 +
$^{79}Br(n,\alpha)^{76}AS$	NS68	0.02 (cal.)	(19)		0.02(±0.006) +
$^{89}Y(n,\alpha)^{89}Sr$	BA68	0.002±27%	unknown		0.002±0.0006 +
$^{92}Zr(n,\alpha)^{89}Sk$	NS68	0.014 (calc.)	(19)		0.014(±0.004)+
$^{93}Nb(n,\alpha)^{90g}y$	RG72	0.0585±0.0022	$^{27}Al(n,\alpha)$=0.6	0.0707±0.0051	0.0707±0.0051
$^{93}Nb(n,\alpha)^{90m}y$	RG72	0.0221±0.0003	$^{27}Al(n,\alpha)$=0.6	0.0267±0.0017	0.0267±0.0017
$^{92}Mo(n,\alpha)^{89}Zr$	ME58	0.017	$^{32}S(n,p)$=30	0.04	0.04(±0.02) +
$^{98}Mo(n,\alpha)^{95}Zr$	RA67/1	$(14.0\pm1.3)10^{-3}$	$^{46}Ti(n,p)$=12.6	0.0139±0.0016	0.0139±0.0016
$^{133}Cs(n,\alpha)^{130}I$	SA59 ME58 ST67	$2.4x10^{-4}$ 0.0005 0.0027±0.0006	$^{31}P(n,p)$=19 $^{32}S(n,p)$=30 $^{27}Al(n,\alpha)$=0.6	0.00045 0.0012 0.0033±0.0008 –	 0.0033±0.0008
$^{138}Ba(n,\alpha)^{135}Xe$	LA65	$(1.9\pm0.3)10^{-3}$	unknown		0.0019±0.0003+
$^{181}Ta(n,\alpha)^{178}Lu$	SA59	$8.5x10^{-5}$	$^{31}P(n,p)$=19	$1.6x10^{-4}$	$(1.6(\pm0.8))10^{-4}$+
$^{184}W(n,\alpha)^{181}Hf$	RV67	$(0.19\pm0.04)10^{-3}$	(11)	$(0.20\pm0.05)10^{-3}$	$(2\pm0.5)10^{-4}$

Table IV Integral (n,2n) cross-sections averaged in the uranium-235 thermal fission neutron spectrum

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{9}Be(n,2n)^{8}Be$	DB57	73±20	(12)		
	ZH63	70–140	(13)		
	FE66	116.2±13%	(14)	148±19	
	GN68	144±6	(15)		144±6
$^{12}C(n,2n)^{11}C$	RO60	$3x10^{-6}$	$^{32}S(n,p)$=60	$3.5x10^{-6}$	
	NS68	$(3.6±1.2)10^{-7}$	(5)	$(4.2±1.4)10^{-7}$	$(4.2±1.4)10^{-7}$
$^{16}O(n,2n)^{15}O$	NS68	$(4.5±2.0)10^{-6}$	(5)	$(5.3±2.4)10^{-6}$	$(5.3±2.4)10^{-6}$
$^{19}F(n,2n)^{18}F$	LE63	$(8.6±1.3)10^{-3}$	$^{32}S(n,p)$=69	$(8.6±1.4)10^{-3}$	
	RE67	$7.10x10^{-3}$±20%	$^{58}Ni(n,p)$=85	$(9.4±2.0)10^{-3}$	
	NS68	$(7.2±1.0)10^{-3}$	(5)	$(8.5±1.3)10^{-3}$	$(7.3±0.7)10^{-3}$
	NJ70	$(5.3±0.5)10^{-3}$	$^{27}Al(n,\alpha)$=0.61	$(6.3±0.7)10^{-3}$	
$^{23}Na(n,2n)^{22}Na$	BE57	6.10^{-3}	unknown		
	WA62	0.0012	unknown		
	NS68	$(2.7±0.7)10^{-3}$	(5)	$(3.2±0.8)10^{-3}$	$(2.2±0.2)10^{-3}$
	ST70	$(2.0±0.1)10^{-3}$	$^{58}Ni(n,p)$=105	$(2.15±0.2)10^{-3}$	
$^{48}Ca(n,2n)^{47}Ca$	KU65	0.3±0.03	$^{27}Al(n,\alpha)$=0.6	0.36±0.04	0.36±0.04
$^{46}Ti(n,2n)^{45}Ti$	RO60	0.0063	$^{32}S(n,p)$=60	0.0072(±20%)	0.0078±0.0009
	SC69	0.0087±0.001	$^{27}Al(n,\alpha)$=0.767	0.0082±0.0011	
$^{50}Cr(n,2n)^{49}Cr$	QA71	0.0054±0.0008	(20)	0.006±0.001	0.006±0.001

Table IV (continued)

Reactions	References	Original values $\sigma \pm \Delta\sigma$ (mb)	Standards (mb)	Renormalized values $\sigma \pm \Delta\sigma$ (mb)	Recommended values $\sigma \pm \Delta\sigma$ (mb)
^{55}Mn(n,2n)^{54}Mn	SC57	0.05	(10)	0.15	
	RO60	0.19	^{32}S(n,p)=60	0.22	
	HO62	0.18	^{27}Al(n,α)=0.57	0.23	
	NS68	0.202±0.018	(5)	0.24±0.025	
	ST70	0.26±0.02	^{58}Ni(n,p)=105	0.28±0.03	
	QA71	0.258±0.03	(20)	0.285±0.04	0.258±0.013
	FA72	0.27±0.015	^{235}U(n,f)=1335(7)	0.253±0.01	
	FA72	0.253±0.01	^{235}U(n,f)=1250	0.253±0.02	
^{54}Fe(n,2n)^{53}Fe	HU53	0.0032	(1)	0.005	0.005(±0.0025) +
	BE57	0.1±0.02	unknown		
^{59}Co(n,2n)^{58}Co	NS68	0.340±0.0030	(5)	0.40±0.04	0.40±0.04
^{58}Ni(n,2n)^{57}Ni	SC57	0.0012	(10)	0.0037	
	RO60	0.006	^{32}S(n,p)=60	0.007(±20%)	0.0049±0.0014
	BA68	0.004±0.0009	unknown		
^{63}Cu(n,2n)^{62}Cu	GR68		(8)	0.124±0.009	
	FA72	0.124±0.009	^{235}U(n,f)=1250	0.124±0.011	0.124±0.011
^{66}Zn(n,2n)^{65}Zn	HO62	<4	^{27}Al(n,α)=0.57	<5	<5 +
^{70}Ge(n,2n)^{69}Ge	RC59	1.5	^{27}Al(n,α)=0.6	1.8	1.8(±0.9) +
^{75}As(n,2n)^{74}As	RO60	0.29	^{32}S(n,p)=60	0.33(±20%)	
	NS68	0.304±0.036	(5)	0.36±0.05	0.33±0.02
	ST70	0.30±0.01	^{58}Ni(n,p)=105	0.32±0.02	
^{78}Se(n,2n)^{77m}Se	KR65	<1	(21)	<1	<1 +

Table IV (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{80}Se(n,2n)^{79m}Se$	KR65	<10	(21)	<10	<10 +
$^{85}Rb(n,2n)^{84}Rb$	RN66	0.2	unknown		0.2(±0.1) +
$^{88}Sr(n,2n)^{87m}Sr$	KR65	<10	(21)	<10	<10 +
$^{89}Y(n,2n)^{88}Y$	RO60	0.12	$^{32}S(n,p)=60$	0.14±(20%)	0.156±0.011
	BA68	0.22±23%	unknown		
	RA67/2	0.2±0.01	$^{46}Ti(n,p)=12.6$	0.20±0.02	
	ST70	0.137±0.005	$^{58}Ni(n,p)=105$	0.147±0.010	
	QA71	0.144±0.02	(20)	0.16±0.024	
$^{90}Zr\ (n,2n)^{89}Zr$	QA71	0.0687±0.01	(20)	0.076±0.01	0.076±0.01
$^{93}Nb(n,2n)^{92m}Nb$	HG66	~0.4	unknown		0.48±0.04
	KI71	0.402±0.034	(4)	0.448±0.038	
	FA72	0.52±0.03	$^{235}U(n,f)=1335$ (7)	0.487±0.02	
	NS68	0.370±0.030	(5)	0.435±0.035	
	KI71	0.432±0.033	(4)	0.482±0.037	
	FA72	0.47±0.03	$^{235}U(n,f)=1250$	0.47±0.04	
	RG72	0.420±0.007	$^{27}Al(n,\alpha)=0.6$	0.51±0.03	
$^{107}Ag(n,2n)^{106m}Ag$	NS68	0.39±0.07	(5)	0.46±0.09	0.46±0.09
$^{112}Cd(n,2n)^{111m}Cd$	KR65	0.35±0.4	(21)	0.42±0.06	0.42±0.06

Table IV (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
^{127}I(n,2n)^{126}I	RO60	1.7	^{32}S(n,p)=60	2.0(±20%)	0.9±0.1
	MC72	(6)		1.09±0.05	
	FA72	1.09±0.05	^{235}U(n,f)=1250	1.09±0.08	
	NS68	1.62±0.24	(5)	1.9±0.3	
	RG68/1	0.647±0.010	^{32}S(n,p)=60	0.744±0.044	
	ST70	1.02±0.01	^{58}Ni(n,p)=105	1.10±0.07	
^{138}Ba(n,2n)^{137m}Ba	KR65	2.0±10%	(21)	2.4±0.3	2.4±0.3
^{186}W(n,2n)^{185}W	DR66	10.0±0.7	^{197}Au(n,γ)=133±10 (22)		10.0±0.7 +
^{185}Re(n,2n)^{184}Re	ST70	4.3±0.3	^{58}Ni(n,p)=105	4.6±0.4	4.6±0.4
^{185}Re(n,2n)^{184m}Re	ST70	0.58±0.03	^{58}Ni(n,p)=105	0.62±0.05	0.62±0.05
^{187}Re(n,2n)^{186}Re	DR67	10±6	^{197}Au(n,γ)=190±19 (22)		10±6 +
^{197}Au(n,2n)^{196}Au	SC69	3.14±0.2	^{27}Al(n,α)=0.767	2.97±0.26	3.0±3
^{203}Tl(n,2n)^{202}Tl	RO60	4.0	^{32}S(n,p)=60	4.6±(20%)	3.0±0.5
	NS68	2.75±0.55	(5)	3.23±0.67	
	QA71	2.41±0.35	(20)	2.64±0.42	

Table IV (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm' \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{204}Pb(n,2n)^{203}Pb$	RO60	3.3	$^{32}S(n,p)$=60	3.8±(20%)	2.45±0.4
	DU62	5.0±15%	$^{238}U(n,f)$=310	5.3±0.8	
	KI71	1.90±0.18	(4)	2.11±0.23	
	QA71	2.19±0.30	(20)	2.41±0.36	
$^{232}Th(n,2n)^{231}Th$	PH58	12.4±0.6	$^{32}S(n,p)$=60.3	14.2±1.1	14.2±1.1
	SC69	~10	$^{27}Al(n,\alpha)$=0.767		

Table V   Integral (n,n') cross-sections averaged in the uranium-235 thermal fission neutron spectrum

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{77}Se(n,n')^{77m}Se$	KR65	600±60	(21)	725±86	733±46
	KO67	652±30	Ni(n,p)=100	737±57	
$^{87}Sr(n,n')^{87m}Sr$	KR65	120±12	(21)	145±17	112±17
	KO67	91±5	$^{58}Ni(n,p)$=100	103±9	
$^{89}Y(n,n')^{89m}Y$	DI68	128.4±25%	(25)		128±32
$^{93}Nb(n,n')^{93m}Nb$	HG71	97±35 (calc.)	$^{103}Rh(n,n')$=595±150(26)	87±14	87±14
$^{103}Rh(n,n')^{103m}Rh$	RO64	535.8 (calc.)	(27)		533±33
	KO67	403±40	$^{58}Ni(n,p)$=100	455±53	
	BT68	716±40 (calc.)	(28)		
	KI69	558±32 (calc.)	(29)		
	HG71	595±150(calc.)	(26)		
$^{111}Cd(n,n')^{111m}Cd$	KR65	140±14	(21)	169±20	228±76
	KO67	289±15	$^{58}Ni(n,p)$=100	327±26	
$^{115}In(n,n')^{115m}In$	KO67	181±10	$^{58}Ni(n,p)$=100	205±15	
	BR67,70	177±6.0	(3)	188.5±6.4	
	NJ70	156±5	$^{27}Al(n,\alpha)$=61	188±6	
	FA72	200±8	$^{235}U(n,f)$=1335 (7)	187.5±6	
	FA72	188±4	$^{235}U(n,f)$=1250	188±11	188±11
$^{137}Ba(n,n')^{137m}Ba$	KR65	220±22	(21)	266±32	225±22
	KO67	189±10	$^{58}Ni(n,p)$=100	214±17	

Table V (continued)

Reactions	References	Original values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Standards (mb)	Renormalized values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)	Recommended values $\bar{\sigma} \pm \Delta\bar{\sigma}$ (mb)
$^{197}Au(n,n')^{197m}Au$	DI68	379.8±25%	(25)		380±95
$^{204}Pb(n,n')^{204m}Pb$	DU62	22±15%	$^{238}U(n,f)$=310	23.3±3.5 -	18.6±1.5
	KO67	15.3±0.7	$^{58}Ni(n,p)$=100	17.3±1.3 -	
	KI71	18.9±2.0	(4)	21.0±2.5 -	

FOOTNOTES TO THE TABLES II, III, IV AND V

(1) The fission flux was determined by comparison with another fission flux produced in a simpler geometry such as a converter. Hughes old data set could not be ignored since some of his measurements are still unique or among the few. It was then necessary to perform an empirical renormalization. This was performed by comparing Hughes values with well established ones whenever the comparison was possible. Hughes data were found to be consistently too low by an average factor of 1.6.

(2) The fission flux was deduced from the power generated in the uranium rod. This power was calculated from the flow and temperature rise of the cooling water. No renormalization was performed.

(3) Bresesti's data were first reported relative to a value of 0.61 mb for $^{27}Al(n,\alpha)^{24}Na$ (BR67). After comparison with data obtained by integration of excitation functions over various spectral representations for the fission spectrum, these data were rescaled by a factor of 1.14. The values for $^{46}Ti(n,p)^{46}Sc$, $^{58}Ni(n,p)^{58m}Co$, $^{92}Mo(n,p)^{92}Nb$ which do not appear in BR70 were multiplied by 1.14 by Fabry (FA72) and included in his evaluation.

(4) The fast neutron flux was monitored using the following standards: 104 mb, 1.4 mb and 0.63 mb for $^{58}Ni(n,p)^{58}Co$, $^{24}Mg(n,p)^{24}Na$ and $^{27}Al(n,\alpha)^{24}Na$ respectively. New values for these standards (see table I) lead to an average renormalization factor of 1.11.

(5) The fission spectrum averaged cross-sections $\bar{\sigma}$ were found by correcting the average cross-sections $\bar{\sigma}_0$ measured in a critical assembly of enriched uranium. In this case, our renormalized values are obtained by multiplying Nasyrov's data by Fabry's rescaling factor which is 1.175 for these data.

(6) The core center reaction rate measurements of McElroy have been transformed by Fabry (see FA72) into fission spectrum averaged cross-sections. Fabry's scaling is relative to a value of 0.73±0.015 for the $^{27}Al(n,\alpha)$ cross-section.

(7) Fabry's data were directly quoted from FA72, although practically all of them were reported in FA70/1. Although they result from absolute measurements, using the technique described in FA67 (see footnote (9) for description of a similar technique) they are all consistently scaled to the uranium-235 average fission cross-section value of 1335 mb, which can therefore rightly be considered as the standard.

(8) The double ratio measurements of Grundl (GR67, GR68) have been converted to fission spectrum average cross-sections by Fabry. All details are to be found in FA72.

(9) Depuydt et al. have used the converter technique for their measurements. The absolute value of the fast flux Φ_f was determined from the absolute value of the thermal flux Φ_{th} by means of the relation:

$$\Phi_f = \nu \Sigma_f \Phi_{th} G\, f_{cor}$$ where

ν = 2.43 ± 0.02 is the mean number of neutrons emitted per thermal fission of uranium-235.

Σ_f = 23.8 ± 0.2 cm^{-1} is the macroscopic fission cross-section of the converter, computed for a microscopic thermal fission cross-section of (587 ± 6) b for uranium-235.

G is a geometrical factor.

f_{cor} takes into account the secondary processes in the facility

Φ_{th} is determined using (98.8 ± 0.3) b for the thermal capture cross-section of gold-197.

We have not renormalized in this case.

(10) Data based on assumption that fission-neutron flux inside uranium receptacle slug equals thermal neutron flux outside slug. Renormalized by multiplying by $\frac{69}{22.5}$ as shown by Mellish (see ME60).

(11) Two standards were used for the neutron flux determination: 0.54 mb and 10.6 mb for $^{63}Cu(n,\alpha)$ and $^{46}Ti(n,p)$ cross-sections respectively.

(12) Neutron multiplication was measured in beryllium spheres. The quantity $\bar{\sigma}_{n,2n} - \bar{\sigma}_{n,\alpha}$ was determinated and $\bar{\sigma}_{n,2n}$ was deduced taking 10mb for the $^{9}Be(n,\alpha)$ cross-section. No renormalization.

(13) The same method as above was used with the same value of 10 mb for the $^{9}Be(n,\alpha)$ cross-section. No renormalization.

(14) Three standards were used for the neutron flux determination: 95 ± 6 mb, 61 ± 8 mb and 9.8 ± 1.1 mb for the $^{58}Ni(n,p)$, $^{54}Fe(n,p)$ and $^{46}Ti(n,p)$ cross-sections respectively.

(15) Green has used a manganese sulphate bath technique to make an accurate measurement of the $^{9}Be(n,2n)$ cross-section averaged over a pure ^{252}Cf fission neutron spectrum . The technique measures neutron multiplication and therefore eliminates completely the need for a flux measurement. Correction for the $^{9}Be(n,\alpha)$ reaction was performed using a calculated average cross-section 38.2 ± 3.8 mb. Fission neutron spectra of ^{252}Cf and ^{235}U are similar enough to average Green's and Feller's (n,2n) cross-section values.

(16) The original value of 65 mb has been corrected by Fabry (see FA72).

(17) Data communicated by S.B. Wright to Martin and Clare.

(18) The original value was computed by integration of an evaluated excitation function $\sigma(E)$ over a Watt spectrum. It is clearly our recommended value in this case. Whenever a check is possible, agreement between our recommended values and Barrall's computed values is generally good, therefore we can arbitrarily use a 10% relative error.

(19) Nasyrov's computed values are based on the relation

$$\bar{\sigma} = \sigma_{eff} \int_{E_{eff}}^{\infty} \chi(E)\, dE \qquad \left(\int_{0}^{\infty} \chi(E)\, dE = 1 \right) \quad \text{where } \chi(E) \sim e^{-0.766E}$$

The calculation was performed whenever it was possible to choose σ_{eff} among experimental or evaluated data.
When no other data are available, Nasyrov's calculated data become our recommended values with an arbitrary relative error of 30%.

(20) Two standards were used for the neutron flux determination:
72.6 mb and 0.307 mb for $^{54}Fe(n,p)$ and $^{75}As(n,2n)$ cross-sections respectively.

(21) Four standards were used for the neutron flux determination:
92 mb, 3.4 mb, 1.2 mb and 0.63 mb for $^{58}Ni(n,p)$, $^{27}Al(n,p)$, $^{24}Mg(n,p)$ and $^{27}Al(n,\alpha)$ cross-sections respectively.

(22) The standard chosen depends too much upon the shape of the fission spectrum to allow a renormalization.

(23) Ricabarra et al. have measured the following ratio:
$\bar{\sigma}[^{31}P(n,p)^{31}Si] / \bar{\sigma}[^{32}S(n,p)^{32}P] = 0.51 \pm 0.03$

(24) Value calculated from an empirical formula valid for $8 \leq Z \leq 42$. This value becomes our recommended value for which we estimate a 30% relative error.

(25) Cross-section averaged over a reactor spectrum from 0.1 MeV to infinity. The standard reaction used was $^{28}Si(n,p)$ for which an average cross-section of (10.4 ± 2.4) mb computed over the same energy range has been accepted. No renormalization.

(26) Hegedüs has measured the excitation function of $^{93}Nb(n,n')\,^{93m}Nb$ which he integrated over a Watt spectrum (WT 52) to obtain = 97±35 mb. He used a standard value of 595±150 mb for $^{103}Rh(n,n')^{103m}Rh$. This value was computed from Butler's excitation curve (BT68) using a larger conversion coefficient ratio $\frac{\alpha_k}{\alpha}$ for ^{103m}Rh (0.131 instead of 0.099). This explains the lower value of 595 mb instead of 716 mb obtained by Butler et al. The error on the $^{93}Nb(n,n')\,^{93m}Nb$ cross-section includes the uncertainty on the standard.

(27) Obtained by integration of a Vogt and Cross (VC64) excitation function over a Cranberg spectrum (CR56). No renormalization.

(28) The measured excitation function was integrated over a Cranberg spectrum (CR56). Value not retained for the average (see footnote 26). No renormalization.

(29) Kimura et al. measured the excitation curve up to 4.6 MeV. Above this value, they used Vogt and Cross (VC64) calculated curve to compute $\bar{\sigma}$ using a Cranberg spectrum (CR56).

T A B L E VI Estimated average cross-sections for (n,p), (n,α) and $(n,2n)$ reactions in a fission neutron spectrum

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
3	Li	6	3.18	3.8	39.	+35,-25	-4.78				6.41	2.1	+70,-40
		7	11.91	12.5	<0.0001		6.13				8.29	0.37	↓
4	Be	9	14.26	15.1	<0.0001		0.67	2.1	33.	+80,-45	1.85	250.	
		10	24.15	24.9	<0.0001		8.64	10.3	0.029	↓	7.49	1.0	
5	B	10	-0.23	0.7			-2.79	-0.8			9.28	0.18	
		11	11.70	12.6	<0.0001		7.24	9.2	0.15		12.50	0.008	
6	C	12	13.64	14.7	<0.0001		6.18	8.6	0.37		20.28	<0.0001	
		13	13.63	14.8	<0.0001		4.13	6.5	3.3		5.33	10.	+70,-40
7	N	14	-0.63	0.7			0.17	3.1	25.		11.31	0.030	↓
		15	9.59	11.0	0.001	+150,-60	8.13	11.1	0.012		11.56	0.024	
8	O	16	10.24	11.8	0.0005	"	2.35	5.7	6.0		16.65	0.0002	
		17	8.36	9.9	0.0006	+150,-60	-1.82	1.6			4.39	31.	
		18	14.01	15.5	<0.0001		5.29	8.7	0.42		8.49	0.56	
9	F	19	4.25	5.9	0.23	+150,-60	1.60	5.4	8.0		10.98	0.050	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
10	Ne	20	6.56	8.5	0.078	+100,-50	0.62	4.8	12.	+80,-45	17.71	0.0001	+70,-40
		21	5.14	7.0	0.049	+150,-60	-0.70	3.5	26.	↓	7.08	2.5	↓
		22	10.53	12.4	0.0003	"	5.97	10.2	0.056		10.84	0.064	
11	Na	23	3.75	5.8	0.31	"	4.03	8.7	0.49		12.96	0.008	
12	Mg	24	4.93	7.2	0.62	+100,-50	2.66	7.8	1.8		17.22	0.0001	
		25	3.17	5.4	0.58	+150,-60	-0.48	4.7	14.		7.63	1.6	
		26	8.22	10.5	0.005	"	5.63	10.8	0.027		11.52	0.036	
13	Al	27	1.90	4.3	3.1	"	3.25	8.8	0.48		13.54	0.005	
14	Si	28	4.00	6.5	2.0	+60,-40	2.75	8.7	0.56		17.79	0.0001	
		29	3.00	5.5	0.56	+150,-60	0.03	5.9	7.9		8.77	0.59	
		30	8.02	10.5	0.005	"	4.34	10.2	0.069		10.96	0.0070	
15	P	31	0.73	3.5	11.	"	2.01	8.3	1.1		12.70	0.013	
16	S	32	0.96	3.9	100.	+35,-25	-1.53	5.1	13.		15.56	0.0008	
		33	-0.53	2.4	58.	+150,-60	-3.49	3.2	41.		8.91	0.56	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
16	S	34	4.45	7.4	0.58	+100,-50	1.37	8.0	1.7	+80,-45	11.75	0.035	+70,-40
		36	10.44	13.4	0.0001	+150,-60	4.23	10.9	0.029	↓	10.17	0.17	↓
17	Cl	35	-0.62	2.5	52.0	"	-0.94	6.1	8.0		13.01	0.010	
		36	-1.93	1.1			-2.46	4.6	19.		8.82	0.65	
		37	4.18	7.3	0.046	"	1.32	8.3	1.2		10.59	0.12	
18	A	36	-0.07	3.2	320.	+35,-25	-2.00	5.4	12.		15.68	0.0008	
		38	4.24	7.5	0.54	+100,-50	0.23	7.7	2.9		12.15	0.025	
		40	6.89	10.2	0.010	+150,-60	2.55	10.0	0.11		10.12	0.19	
19	K	39	-0.22	3.2	20.	"	-1.36	5.4	13.		13.42	0.007	
		40	-2.29	1.2			-3.87	3.9	31.		8.00	1.6	
		41	1.75	5.2	1.1	"	0.11	7.8	2.6		10.34	0.16	
20	Ca	40	0.54	4.2	77.	+35,-25	-1.75	6.3	7.8		16.02	0.0006	
		42	2.80	6.5	2.6	+60,-40	-0.35	7.8	2.7		11.75	0.040	
		43	1.06	4.7	2.3	+150,-60	-2.29	5.9	10.		8.12	1.5	
		44	4.99	8.6	0.11	+100,-50	2.81	10.9	0.033		11.39	0.059	
		46	7.08	10.7	0.005	+150,-60	6.05	14.2	0.0003		10.63	0.13	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
20	Ca	48	13.22	16.8	< 0.0001		8.81	16.9	<0.0001		10.16	0.21	+70,-40
21	Sc	45	-0.53	3.2	22.	+150,-60	0.40	8.8	0.67	+80,-45	11.57	0.050	↓
22	Ti	46	1.62	5.5	12.	+60,-40	0.08	8.9	0.59	↓	13.48	0.008	
		47	-0.18	3.7	11.	+150,-60	-2.18	6.6	7.3		9.06	0.61	
		48	3.27	7.2	0.98	+100,-50	2.07	10.9	0.035		11.87	0.039	
		49	1.25	5.1	1.4	+150,-60	-0.23	9.0	0.53		8.31	1.3	
		50	6.23	10.1	0.013	"	3.51	12.3	0.005		11.17	0.079	
23	V	50	-3.00	1.0			-0.76	8.3	1.5		9.52	0.40	
		51	1.71	5.7	0.60	"	2.10	11.2	0.024		11.27	0.073	
24	Cr	50	0.26	4.5	57.	+35,-25	-0.32	9.1	0.47		13.20	0.011	
		52	3.26	7.5	0.66	+100,-50	1.23	10.6	0.057		12.27	0.028	
		53	2.69	6.8	0.12	+150,-60	-1.80	7.6	4.1		8.09	1.7	
		54	6.34	10.5	0.008	"	1.57	11.0	0.033		9.90	0.29	
25	Mn	55	1.84	6.2	0.30	"	0.64	10.3	0.090		10.41	0.18	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
26	Fe	54	-0.09	4.4	70.	+35,-25	-0.84	9.1	0.49	+80,-45	13.63	0.007	+70,-40
		56	2.97	7.4	0.81	+100,-50	-0.32	9.6	0.25	↓	11.40	0.068	↓
		57	1.81	6.3	0.27	+150,-60	-2.40	7.5	5.0		7.78	2.5	
		58	5.41	9.8	0.023	"	1.41	11.4	0.019		10.22	0.22	
27	Co	59	0.80	5.4	1.0	"	-0.32	9.9	0.17		10.64	0.15	
28	Ni	58	-0.39	4.3	85.	+35,-25	-2.89	7.6	4.4		12.41	0.026	
		59	-1.86	2.9	41.	+150,-60	-5.09	5.4	17.		9.15	0.65	
		60	2.08	6.8	2.1	+60,-40	-1.35	9.2	0.46		11.58	0.060	
		61	0.53	5.2	1.4	+150,-60	-3.57	6.9	7.3		7.95	2.2	
		62	4.51	9.2	0.058	↓	0.44	11.0	0.036		10.77	0.14	
		63	2.92	7.6	0.043		-1.56	9.0	0.63		6.95	5.9	
		64	6.32	11.1	0.004		2.47	13.0	0.002		9.81	0.36	
29	Cu	63	-0.72	4.2	6.3		-1.71	9.1	0.55		11.03	0.11	
		65	1.37	6.2	0.34		0.09	10.9	0.043		10.06	0.28	
30	Zn	64	-0.21	4.8	43.	+35,-25	-3.87	7.3	6.0		12.04	0.040	
		66	1.88	6.8	2.2	+60,-40	-2.27	8.8	0.86		11.22	0.091	

T A B L E VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
30	Zn	67	-0.21	4.8	2.7	+150,-60	-4.88	6.2	12.	+80,-45	7.16	5.0	+70,-40
		68	3.86	8.9	0.098	+100,-50	-0.78	10.3	0.10	↓	10.35	0.22	↓
		70	6.3	11.3	0.003	+150,-60	0.72	11.8	0.012		9.35	0.60	
31	Ga	69	0.13	5.2	1.5	"	-2.58	9.0	0.67		10.46	0.20	
		71	2.05	7.2	0.083	"	-0.93	10.4	0.092		9.43	0.56	
32	Ge	70	0.88	6.1	6.5	+60,-40	-2.96	8.7	1.0		11.70	0.059	
		72	3.26	8.5	0.18	+100,-50	-1.48	10.2	0.12		10.90	0.13	
		73	0.78	6.0	0.49	+150,-60	-3.91	7.7	4.4		6.88	7.0	
		74	4.78	10.0	0.020	↓	0.45	12.1	0.008		10.34	0.23	
		76	6.72	11.9	0.001		2.4	14.0	0.0006		9.57	0.51	
33	AS	75	0.41	5.8	0.67		-1.20	10.7	0.0063		10.38	0.23	
34	Se	74	0.58	6.0	7.9	+60,-40	-3.34	9.3	0.46		12.23	0.036	
		76	2.21	7.7	0.63	+100,-50	-1.69	10.5	0.084		11.31	0.091	
		77	-0.10	5.3	1.4	+150,-60	-4.47	7.7	4.6		7.51	3.9	
		78	3.53	9.0	0.092	"	-0.46	11.8	0.013		10.63	0.18	
		80	5.29	10.7	0.007	"	0.96	13.0	0.002		10.02	0.34	

T A B L E VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
34	Se	82	7.17	12.6	0.0004	+150,-60	2.58	14.7	0.0002	+80,-45	9.39	0.64	+70,-40
35	Br	79	-0.64	5.0	2.3	"	-1.86	10.6	0.075	↓	10.83	0.15	↓
		81	0.81	6.4	0.29	"	-0.43	12.0	0.010		10.29	0.26	
36	Kr	78	-0.09	5.6	15.	+60,-40	-3.67	9.0	0.72		12.13	0.041	
		80	1.24	6.9	2.2	"	-2.35	10.4	0.10		11.67	0.066	
		82	2.33	8.0	0.42	+100,-50	-0.99	11.8	0.014		11.11	0.12	
		83	0.19	5.9	0.62	+150,-60	-3.42	9.1	0.66		7.56	3.9	
		84	3.97	9.6	0.039	↓	0.40	13.1	0.002		10.64	0.19	
		86	6.60	12.3	0.0007		2.20	14.9	0.0002		9.97	0.37	
37	Rb	85	-0.10	5.7	0.85		-0.99	12.0	0.011		10.60	0.20	
		87	3.15	9.0	0.007		1.22	14.3	0.0004		10.04	0.35	
38	Sr	84	0.11	6.0	8.6	+60,-40	-2.69	10.6	0.078		12.16	0.042	
		86	1.00	7.0	2.0	———	-1.12	12.2	0.0081		11.62	0.073	
		87	-0.51	5.4	1.3	+150,-60	-3.21	10.1	0.16		8.53	1.6	
		88	4.57	10.5	0.011	"	0.80	14.1	0.0006		11.24	0.11	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
39	Y	89	0.72	6.8	0.17	+150,-60	-0.70	12.9	0.003	+80,-45	11.60	0.076	+70,-40
40	Zr	90	1.52	7.7	0.71	+100,-50	-1.75	12.1	0.010	↓	12.07	0.048	↓
		91	0.77	7.0	0.13	+150,-60	-5.66	8.3	2.2		7.28	5.5	
		92	2.87	9.0	0.10	↓	-3.39	10.5	0.096		8.73	1.3	
		94	4.26	10.5	0.011		-2.07	11.8	0.015		8.28	2.1	
		96	6.08	12.2	0.0009		-0.17	13.8	0.0009		7.91	3.1	
41	Nb	93	-0.72	5.6	1.0		-4.91	9.2	0.61		8.92	1.1	
		94	-1.68	4.6	75.		-5.63	8.6	1.5		7.31	5.4	
42	Mo	92	-0.43	6.0	9.1	+60,-40	-3.69	10.7	0.072		12.83	0.023	
		94	1.28	7.7	0.73	+100,-50	-5.13	9.3	0.54		9.78	0.48	
		95	0.14	6.6	0.24	+150,-60	-6.39	8.0	3.4		7.45	4.8	
		96	2.43	8.9	0.12	+100,-50	-3.99	10.4	0.11		9.25	0.81	
		97	1.16	7.6	0.057	+150,-60	-5.37	9.0	0.84		6.89	8.4	
		98	3.86	10.3	0.015	↓	-3.20	11.2	0.037		8.73	1.4	
		100	5.27	11.7	0.002		-2.39	12.0	0.012		8.38	2.0	
43	TC	97	-1.13	5.4	1.4		-4.81	9.9	0.23		9.51	0.63	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
43	TC	98	-2.37	4.1	160.	+35,-25	-5.91	8.8	1.1	+80,-45	7.47	4.8	+70,-40
		99	0.60	7.2	0.10	+150,-60	-3.92	10.8	0.065	↓	8.97	1.1	↓
44	Ru	96	-0.57	6.1	8.1	+60,-40	-6.38	8.5	1.7	↓	10.81	0.17	↓
		98	0.93	7.6	0.87	+100,-50	-5.14	9.8	0.27	↓	10.35	0.28	↓
		99	-0.49	6.2	0.45	+150,-60	-6.82	8.1	3.1	↓	7.54	4.5	↓
		100	2.62	9.3	0.069	↓	-3.97	10.9	0.057	↓	9.77	0.50	↓
		101	0.86	7.5	0.067	↓	-5.80	9.1	0.75	↓	6.87	8.8	↓
		102	3.76	10.5	0.012	↓	-2.50	12.4	0.007	↓	9.31	0.80	↓
		104	4.56	11.2	0.004	↓	-1.06	13.8	0.0009	↓	9.00	1.1	↓
45	Rh	103	-0.02	6.7	0.22	↓	-3.48	11.8	0.016	↓	9.40	0.74	↓
46	Pd	102	0.37	7.2	1.6	+100,-50	-5.34	10.1	0.18	↓	10.69	0.20	↓
		104	1.70	8.6	0.20	"	-4.19	11.3	0.033	↓	10.12	0.36	↓
		105	-0.22	6.7	0.22	+150,-60	-6.33	9.1	0.77	↓	7.14	6.9	↓
		106	2.78	9.7	0.040	↓	-3.00	12.4	0.007	↓	9.65	0.59	↓
		107	0.73	7.6	0.061	↓	-5.37	10.0	0.22	↓	6.59	12.	↓
		108	3.75	10.6	0.010	↓	-2.05	13.6	0.001	↓	9.31	0.83	↓
		110	4.66	11.6	0.002	↓	-1.02	14.5	0.0004		8.89	1.3	

T A B L E VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
47	Ag	107	-0.75	6.2	0.47	+150,-60	-4.18	11.5	0.025	+80,-45	9.64	0.60	+70,-40
		109	0.34	7.3	0.095	"	-3.29	12.4	0.007	↓	9.27	0.87	↓
48	Cd	106	-0.58	6.5	4.7	+60,-40	-5.98	10.3	0.14		11.02	0.15	
		108	0.87	8.0	0.51	+100,-50	-4.81	11.2	0.039		10.42	0.28	
		110	2.13	9.2	0.086	+150,-60	-3.67	12.3	0.008		9.97	0.44	
		111	0.25	7.4	0.083	↓	-5.92	10.1	0.19		7.04	7.9	
		112	3.25	10.4	0.014		-2.68	13.7	0.001		9.48	0.72	
		113	1.24	8.3	0.022		-4.94	11.1	0.046		6.60	12.	
		114	4.26	11.4	0.003		-1.66	14.3	0.0005		9.12	1.0	
		116	5.57	12.7	0.0005		-0.19	15.8	0.0001		8.77	1.5	
49	In	113	-0.49	6.7	0.24		-3.76	12.4	0.007		9.51	0.70	
		115	0.67	7.9	0.041		-2.68	13.6	0.001		9.11	1.1	
50	Sn	112	-0.12	7.2	1.7	+100,-50	-5.54	11.1	0.046		10.90	0.18	
		114	1.21	8.6	0.22	"	-4.33	12.2	0.010		10.41	0.29	
		115	-0.30	7.1	0.13	+150,-60	-6.20	10.3	0.15		7.60	4.7	
		116	2.51	9.9	0.031	"	-3.17	13.4	0.002		9.64	0.63	
		117	0.69	8.0	0.036	"	-5.27	11.2	0.041		7.00	8.5	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
50	Sn	118	3.45	10.8	0.008	+150,-60	-2.09	14.4	0.0004	+80,-45	9.41	0.80	+70,-40
		119	1.58	8.9	0.009	↓	-4.30	11.9	0.015	"	6.54	14.	↓
		120	4.86	12.2	0.001	↓	-0.96	15.6	0.0001	"	9.18	1.0	↓
		122	5.97	13.3	0.0002	↓	0.08	16.5	<0.0001		8.88	1.4	↓
		124	6.67	14.0	0.0001	↓	1.98	18.5	<0.0001		8.56	1.9	↓
51	Sb	121	-0.40	7.0	0.16	↓	-3.51	14.5	0.0004	+80,-45	9.32	0.89	↓
		123	0.63	8.1	0.032		-1.92	14.8	0.0003	↓	9.04	1.2	↓
52	Te	120	0.21	7.7	0.86	+100,-50	-6.64	10.4	0.13	↓	10.37	0.31	↓
		122	1.21	8.8	0.17	"	-5.40	11.6	0.024	↓	9.87	0.52	↓
		123	-0.84	6.7	0.25	+150,-60	-7.58	9.4	0.56	↓	6.99	8.9	↓
		124	2.13	9.7	0.044	↓	-4.34	12.6	0.006	↓	9.50	0.76	↓
		125	-0.02	7.5	0.078	↓	-6.56	10.4	0.13	↓	6.64	13.	↓
		126	2.97	10.5	0.013	↓	-3.39	13.6	0.001	↓	9.18	1.0	↓
		128	3.53	11.0	0.006	↓	-2.55	14.5	0.0004	↓	8.84	1.5	↓
		130	4.25	11.8	0.002	↓	-1.81	15.1	0.0002	↓	8.48	2.1	↓
53	I	127	-0.09	7.6	0.068	↓	-4.28	13.0	0.003	↓	9.21	1.0	↓
		129	0.72	8.4	0.021		-3.47	13.8	0.001		8.91	1.4	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	σ(mb)	$\frac{\Delta\sigma}{\sigma}$ (%)	E_T (MeV)	Eeff(MeV)	σ(mb)	$\frac{\Delta\sigma}{\sigma}$ (%)	E_T (MeV)	σ (mb)	$\frac{\Delta\sigma}{\sigma}$ (%)
54	Xe	124	-0.69	7.0	2.5	+60,-40	-6.79	10.8	0.076	+80,-45	10.31	0.34	+70,-40
		126	0.47	8.2	0.42	+100,-50	-5.64	11.8	0.018	↓	10.17	0.39	↓
		128	1.35	9.1	0.11	+150,-60	-4.81	12.6	0.006		9.69	0.64	
		129	-0.59	7.2	0.12	↓	-7.02	10.5	0.12		6.96	9.5	
		130	2.23	10.0	0.029		-4.06	13.4	0.002		9.33	0.92	
		131	0.19	8.0	0.038		-6.22	11.2	0.044		6.66	13.	
		132	2.82	10.6	0.012		-3.37	14.1	0.0007		9.00	1.3	
		134	3.40	11.2	0.005		-2.72	14.8	0.0003		8.60	1.9	
		136	6.27	14.0	0.0001		-2.12	15.3	0.0001		8.05	3.4	
55	Cs	133	-0.36	7.5	0.081		-4.45	13.3	0.002		9.05	1.2	
		135	0.38	8.3	0.025		-3.67	14.1	0.0007		8.89	1.5	
		137	3.59	11.5	0.0002		-3.06	14.7	0.0003		8.34	2.5	
56	Ba	130	-0.34	7.6	1.0	+100,-50	-6.67	11.4	0.033		10.30	0.35	
		132	0.49	8.5	0.28	"	-5.89	12.1	0.012		9.88	0.54	
		134	1.29	9.3	0.084	+150,-60	-5.10	12.9	0.004		9.54	0.76	
		135	-0.57	7.4	0.095	↓	-7.06	11.0	0.06		7.03	9.1	
		136	1.78	9.8	0.040		-4.40	13.6	0.0015		9.17	1.1	
		137	0.39	8.4	0.022		-6.04	12.0	0.015		6.95	10.	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
56	Ba	138	4.65	12.7	0.0005	+150,-60	-3.88	14.2	0.0006	+80,-45	8.67	1.8	+70,-40
57	La	138	-2.58	5.5	25.	+60,-40	-6.83	11.5	0.030	↓	7.37	6.6	↓
		139	1.49	9.6	0.004	+150,-60	-4.82	13.5	0.002		8.84	1.6	
58	Ce	136	-0.36	7.8	0.80	+100,-50	-6.76	11.8	0.019		10.08	0.45	
		138	0.28	8.5	0.28	"	-5.98	12.5	0.007		9.64	0.71	
		140	3.01	11.2	0.005	+150,-60	-5.34	13.1	0.003		9.27	1.0	
		142	3.76	11.9	0.002	↓	-6.09	12.4	0.008		7.21	7.9	
59	Pr	141	-0.20	8.1	0.035		-6.15	12.5	0.007		9.46	0.86	
60	Nd	142	1.39	9.8	0.042		-6.64	12.3	0.010		9.88	0.57	
		143	0.15	8.6	0.017		-9.72	9.3	0.71		6.17	22.	
		144	2.23	10.6	0.013		-7.33	11.6	0.027		7.87	4.2	
		145	1.03	9.4	0.005		-8.73	10.2	0.20		5.80	32.	
		146	3.32	11.7	0.002		-6.34	12.7	0.006		7.62	5.4	
		148	4.15	12.5	0.0008	↓	-5.37	13.5	0.002	↓	7.37	6.9	↓
		150	4.25	12.7	0.0006		-4.21	14.7	0.0003		7.41	6.7	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
62	Sm	144	-0.22	8.3	0.39	+100,-50	-7.92	11.5	0.031	+80,-45	10.63	0.27	+70,-40
		147	-0.56	7.9	0.048	+150,-60	-10.11	9.4	0.63	↓	6.42	18.	↓
		148	1.69	10.2	0.023	↓	-7.73	11.7	0.024		8.20	3.1	
		149	0.29	8.8	0.013		-9.43	10.2	0.20		5.91	29.	
		150	2.74	11.3	0.005		-6.74	12.8	0.005		8.04	3.6	
		152	2.64	11.2	0.005		-5.28	14.1	0.0008		8.32	2.8	
		154	3.24	11.7	0.003		-4.10	15.4	0.0001		8.03	3.7	
63	En	151	-0.71	7.9	0.049		-7.87	11.8	0.021		8.03	3.7	
		153	0.02	8.7	0.015		-5.83	13.8	0.001		8.61	2.1	
64	Gd	152	1.05	9.7	0.050		-8.07	11.9	0.018		8.65	2.0	
		154	1.20	9.9	0.038		-6.51	13.4	0.002		8.71	1.9	
		155	-0.54	8.2	0.032		-8.33	11.7	0.024		6.49	17.	
		156	1.68	10.3	0.021		-5.67	14.3	0.0006		8.59	2.2	
		157	0.58	9.3	0.006		-7.28	12.7	0.006		6.41	19.	
		158	2.67	11.4	0.004		-5.16	14.8	0.0003		7.98	4.0	
		160	3.64	12.4	0.0009		-3.5	16.9	<0.0001		7.50	6.4	
65	Tb	159	0.17	9.0	0.010		-6.22	14.1	0.0008	+80,-45	8.19	3.2	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
66	Dy	156	-0.52	8.3	0.42	+100,-50	-8.26	12.3	0.010	+80,-45	9.50	0.88	+70,-40
		158	0.16	9.1	0.13	+150,-60	-7.33	13.3	0.003	↓	9.12	1.3	↓
		160	1.06	9.9	0.039	↓	-6.82	13.7	0.001		8.64	2.1	
		161	-0.20	8.7	0.016		-8.30	12.2	0.012		6.49	17.	
		162	1.69	10.6	0.014		-6.05	14.5	0.0005		8.25	3.1	
		163	0.91	9.8	0.003		-7.23	13.3	0.003		6.31	21.	
		164	2.58	11.6	0.003		-5.21	15.3	0.0002		7.70	5.4	
67	Ho	165	0.52	9.6	0.004		-6.46	14.3	0.0006		8.04	3.9	
68	Er	162	-0.46	8.7	0.23	+100,-50	-8.49	12.5	0.008		9.27	1.1	
		164	0.18	9.4	0.083	+150,-60	-7.76	13.3	0.003		8.91	1.6	
		166	1.08	10.3	0.022	↓	-7.09	13.9	0.001		8.53	2.4	
		167	0.19	9.4	0.006		-8.31	12.7	0.006		6.47	18.	
		168	2.00	11.2	0.006		-6.26	14.7	0.0004		7.82	4.8	
		170	2.94	12.1	0.002		-4.58	16.4	<0.0001		7.31	8.1	
69	Tm	169	-0.43	8.8	0.014		-7.44	13.8	0.001	+80,-45	8.11	3.7	
70	Yb	168	-0.50	8.9	0.18	+100,-50	-8.60	12.9	0.005	"	9.11	1.4	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	σ (mb)	$\frac{\Delta\sigma}{\sigma}$ (%)	E_T (MeV)	Eeff (MeV)	σ (mb)	$\frac{\Delta\sigma}{\sigma}$ (%)	E_T (MeV)	σ (mb)	$\frac{\Delta\sigma}{\sigma}$ (%)
70	Yb	170	0.19	9.6	0.063	+150,-60	-8.17	13.3	0.003	+80,-45	8.52	2.4	+70,-40
		171	-0.69	8.7	0.016	↓	-9.33	12.2	0.013	↓	6.66	15.	↓
		172	1.09	10.5	0.017		-7.31	14.2	0.0007		8.07	3.8	
		173	0.54	10.0	0.002		-8.20	13.3	0.003		6.40	20.	
		174	2.29	11.7	0.003		-6.41	15.1	0.0002		7.51	6.7	
		176	3.38	12.8	0.0005		-5.58	15.9	0.0001		6.92	12.	
71	Lu	175	-0.31	9.2	0.008		-7.87	13.8	0.001		7.70	5.6	
		176	-0.90	8.5	0.33	+100,-50	-8.49	13.2	0.003		6.33	22.	
72	Hf	174	-0.58	9.0	0.16		-9.17	12.8	0.005		8.64	2.2	
		176	0.41	10.0	0.036	+150,-60	-8.62	13.4	0.002		8.13	3.7	
		177	-0.29	9.3	0.007	↓	-9.71	12.3	0.011		6.42	20.	
		178	1.48	11.1	0.007		-7.91	14.1	0.0009		7.67	5.8	
		179	0.57	10.1	0.002		-8.68	13.3	0.003		6.13	27.	
		180	2.53	12.2	0.001		-6.86	15.2	0.0002		7.43	7.4	
73	Ta	180	-1.71	8.0	0.72	+100,-50	-9.18	13.0	0.004		6.62	17.	
		181	0.24	10.0	0.003	+150,-60	-7.41	14.8	0.0003		7.69	5.8	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff(MeV)	$\bar{\sigma}$(mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
74	W	180	0.03	9.8	0.049	+150,-60	-8.86	13.6	0.002	+80,-45	8.54	2.5	+70,-40
		182	1.03	10.9	0.009	↓	-7.89	14.9	0.0003	↓	8.10	3.9	↓
		183	0.29	10.1	0.002		-9.09	13.6	0.002		6.23	25.	
		184	2.26	12.1	0.002		-7.37	15.4	0.0001		7.45	7.4	
		186	3.14	13.0	0.0004		-6.39	16.4	<0.0001		7.24	9.2	
75	Re	185	-0.35	9.4	0.006		-8.28	14.4	0.0006	+80,-45	7.83	5.1	
		187	0.53	10.2	0.002		-7.10	15.8	0.0001	↓	7.41	7.8	
76	Os	184	-0.68	10.4	0.020		-9.71	13.2	0.003		8.91	1.8	
		186	0.30	10.3	0.024		-9.02	13.9	0.001		8.31	3.2	
		187	-0.78	9.2	0.008		-10.13	12.7	0.007		6.33	23.	
		188	1.34	11.3	0.005		-7.89	15.0	0.0003		8.03	4.2	
		189	0.23	10.2	0.002		-9.17	13.7	0.002		5.95	33.	
		190	2.41	12.4	0.001		-6.84	16.0	0.0001		7.83	5.2	
		192	3.19	13.2	0.0003		-5.24	17.7	<0.0001		7.60	6.6	
77	Ir	191	-0.47	9.6	0.005		-7.96	15.5	0.0001	+80,-45	8.16	3.8	
		193	0.35	10.4	0.001		-6.64	16.5	<0.0001		7.81	5.4	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
78	Pt	190	-0.11	10.1	0.032	+150,-60	-9.54	13.9	0.001	+80,-45	8.86	1.9	+70,-40
		192	0.68	10.9	0.010	↓	-8.34	15.1	0.0002	↓	8.70	2.2	↓
		194	1.46	11.6	0.003		-7.28	16.1	0.0001		8.41	3.0	
		195	0.15	10.3	0.002		-8.71	14.7	0.0004		6.16	28.	
		196	2.40	12.6	0.0008		-6.38	17.1	< 0.0001		7.96	4.7	
		198	3.64	13.8	0.0001		-5.59	17.8	< 0.0001		7.60	6.7	
79	Au	197	-0.04	10.2	0.002		6.98	16.4	< 0.0001		8.12	4.0	
80	Hg	196	-0.10	10.3	0.024		-8.25	15.0	0.0003	+80,-45	8.79	2.1	
		198	0.59	11.0	0.009		-7.46	16.3	< 0.0001		8.34	3.2	
		199	-0.33	10.0	0.003		-8.73	15.0	0.0003	+80,-45	6.68	17.	
		200	1.43	11.8	0.003		-6.55	17.3	< 0.0001		8.07	4.3	
		201	0.72	11.1	0.0005		-7.89	15.9	< 0.0001		6.26	25.	
		202	2.73	13.1	0.0004		-5.71	18.0	< 0.0001		7.79	5.6	
		204	3.74	14.1	0.0001		-4.46	19.2	< 0.0001		7.53	7.3	
81	Tl	203	-0.29	10.2	0.002		-7.20	16.8	< 0.0001		7.76	5.8	
		204	-1.13	9.4	0.096		-7.46	16.2	0.0001	+80,-45	6.69	17.	
		205	0.75	11.2	0.0005		-5.68	18.0	< 0.0001	"	7.58	7.0	

TABLE VI (cont'd)

Samples			(n,p) reactions				(n,α) reactions				(n, 2n) reactions		
Z	Element	Mass	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	Eeff (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)	E_T (MeV)	$\bar{\sigma}$ (mb)	$\frac{\Delta\bar{\sigma}}{\bar{\sigma}}$ (%)
82	Pb	204	-0.02	10.5	0.019	+150,-60	-8.20	16.1	0.0001	+80,-45	8.44	3.0	+70,-40
		206	0.75	11.3	0.006	"	-7.14	17.1	<0.0001		8.12	4.1	
		207	0.65	11.2	0.0005	"	-7.89	16.4	<0.0001		6.77	16.	
		208	4.23	14.8	<0.0001		-6.19	18.2	<0.0001		7.40	8.5	
83	Bi	208	-3.65	7.3	2.2	+100,-50	-10.58	14.1	0.001	+80,-45	6.94	13.	
		209	-0.14	10.5	0.001	+150,-60	-9.63	14.9	0.0003	"	7.49	7.8	
		210	-0.72	9.9	0.046	"	-11.88	12.6	0.008	"	4.62	130.	

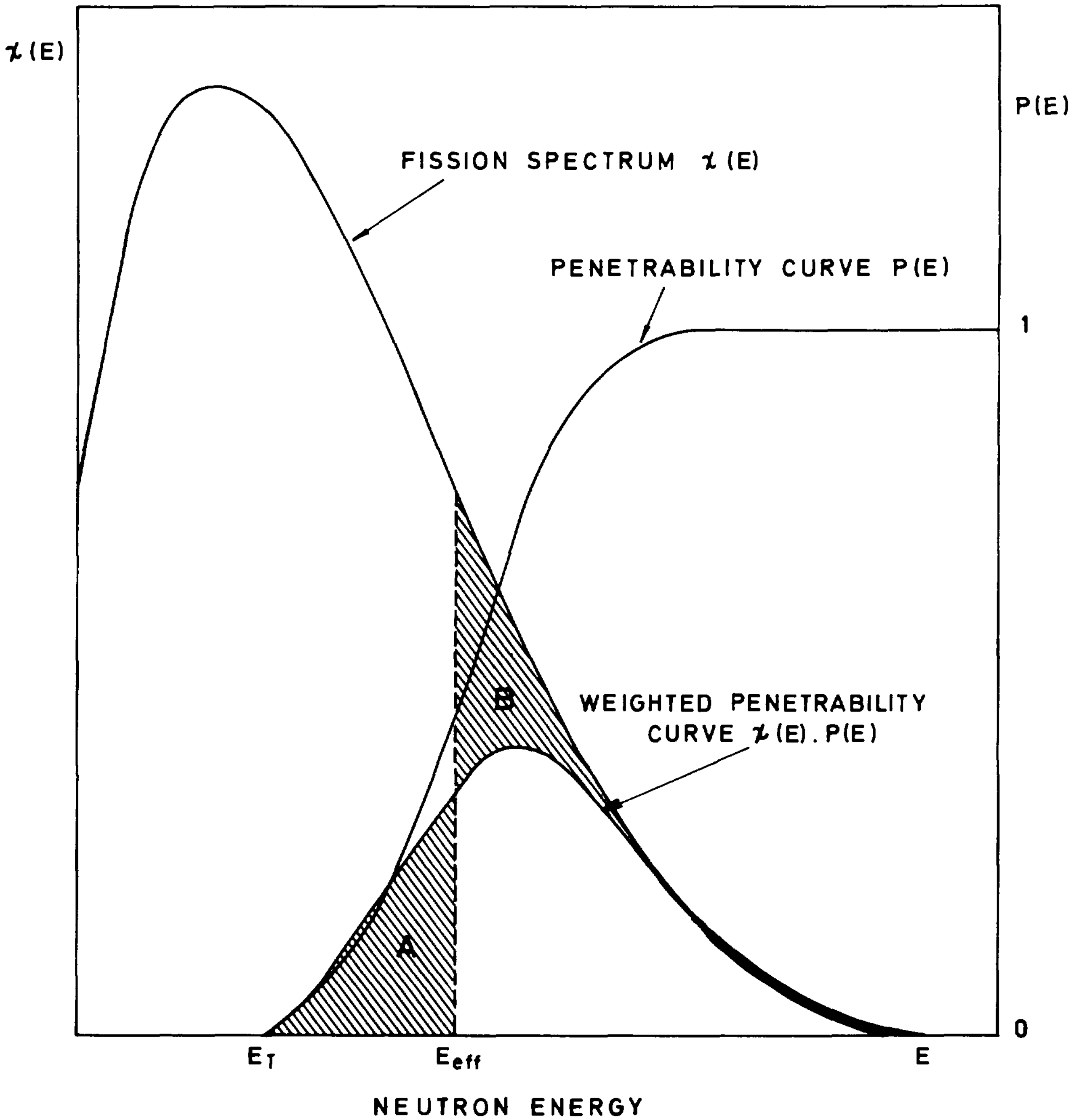

Fig. 1 - E_{eff} is defined in such a way that area A = area B

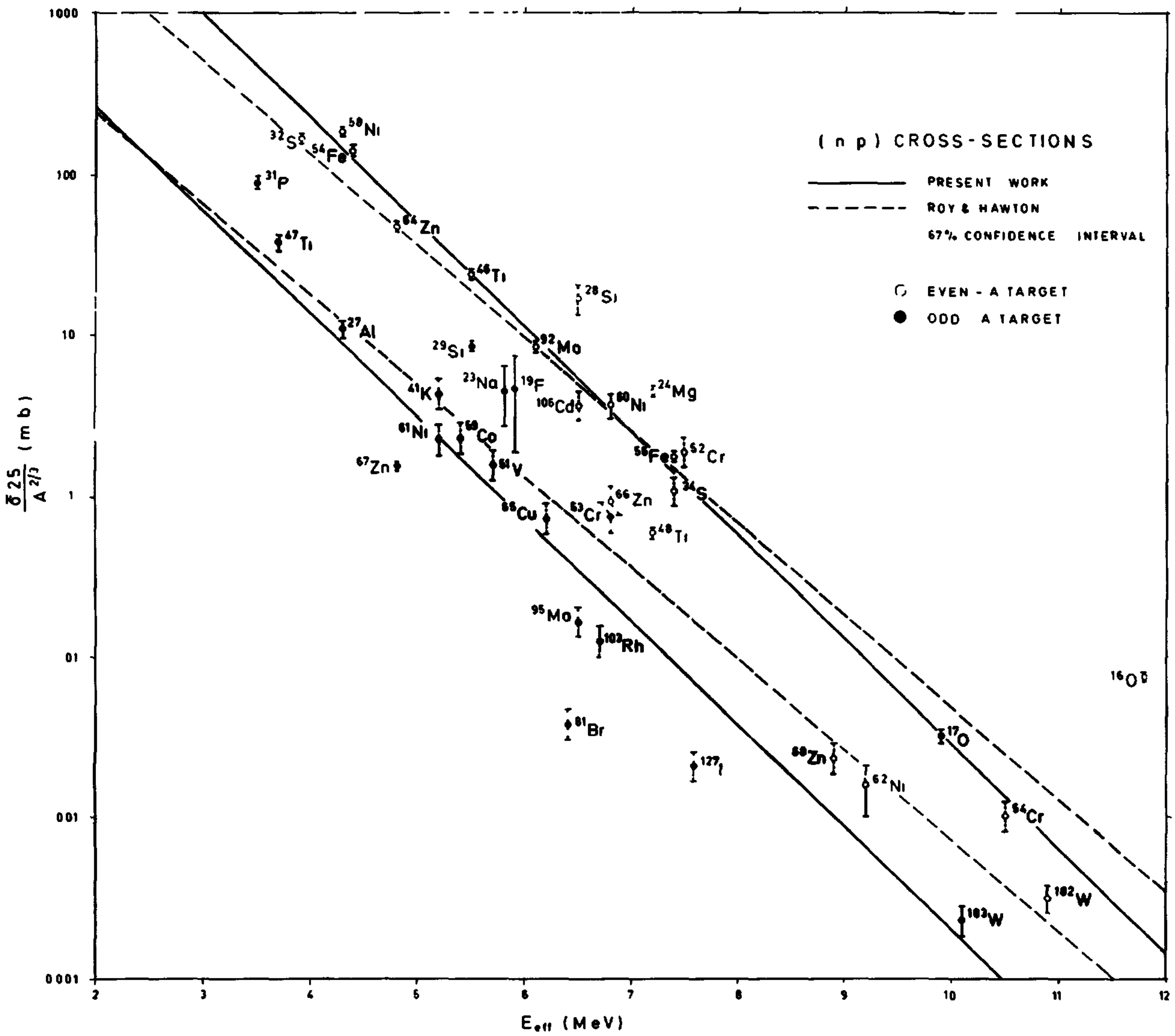

Fig. 2 - (n,p) cross-sections averaged in a fission neutron spectrum.

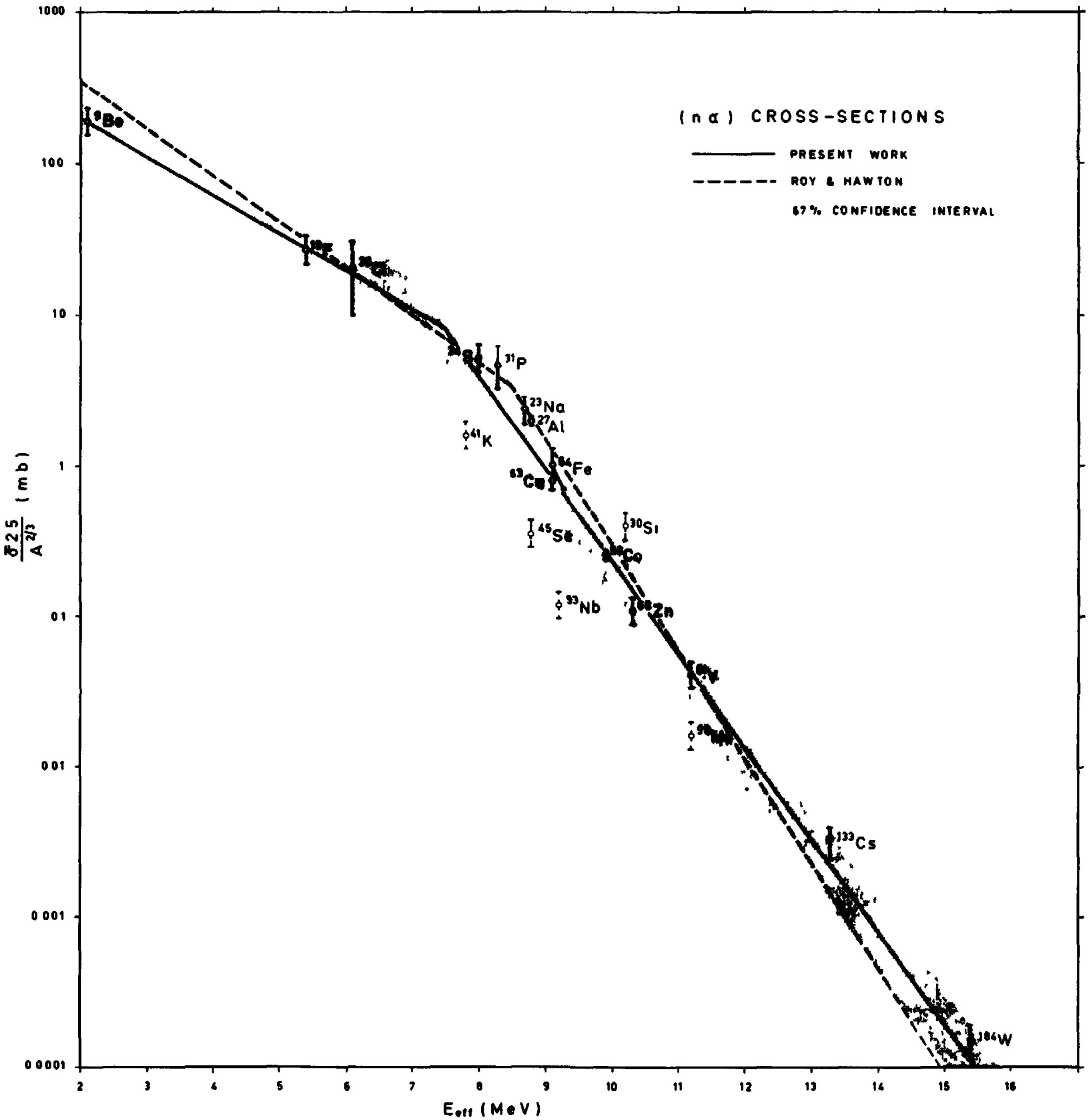

Fig. 3 - (n,) cross-sections averaged in a fission neutron spectrum.

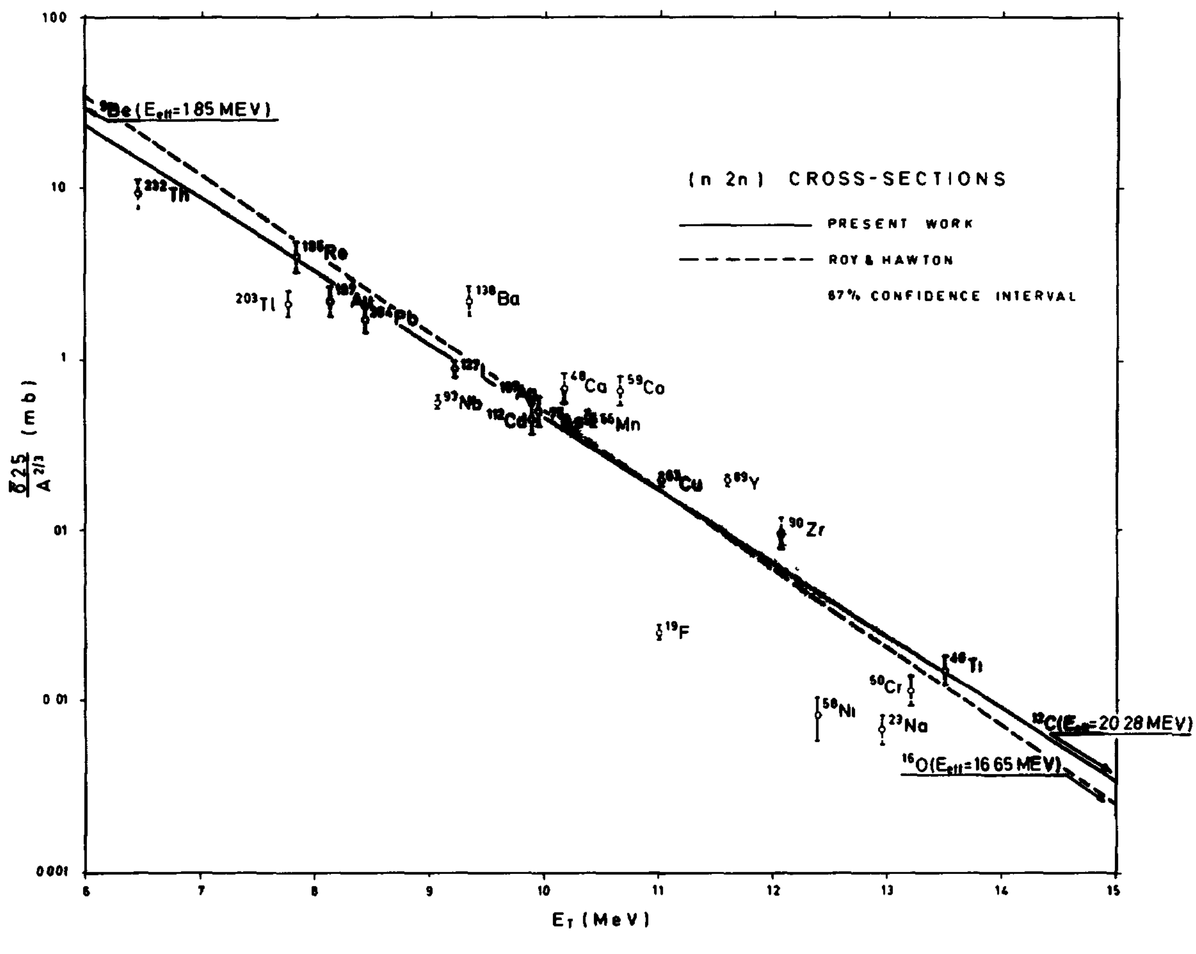

Fig. 4 - (n,2n) cross-sections averaged in a fission neutron spectrum.