

HIGH PRIORITY NUCLEAR DATA MEASUREMENT REQUIREMENTS FOR THE REACTOR PROGRAMME

NEANDC Technical Activities Subcommittee

The tables in this paper summarise, in a much abbreviated form, high priority measurement requirements for the nuclear fission reactor programmes of NEA Member States.

The first version of the high priority request list was produced jointly by the French, German and UK members of NEACRP ("Consideration of NEACRP Category 1 Requests for Nuclear Data" by C G Campbell; NEACRP-A-314, NEANDC-110 "A"). It was later extended to include high priority requests from Japan and the USA. The 1981 edition also contained the Priority 1 Dosimetry Requirements produced on behalf of the EWGRD by W L Zijp (ECN Petten) (December, 1980) and the high priority requirements contained in the Dutch Request List for Fission Product Capture Cross-sections by H Gruppelaar and R J Heijboer (Nov 1980). Both these lists contain assessments of the current status of the data and these have been abbreviated in the present tables. The US, Japanese and UK request lists were also revised in the 1981 edition.

Since the September 1981 NEACRP Meeting the USA have produced a revised high priority list (January 1982) and these revisions are now included. The remaining requests are the same as in the 1981 version of the list.

For some of the requirements status comments have been added. These are based on the conclusions of specialist meetings, the status reports of the Standards and Discrepancies Subcommittees of the NEANDC and INDC and the judgement of members of the NEANDC. In particular, the comments on the requirements for Standards have been provided by the NEANDC Standards Subcommittee. The Discrepancies Subcommittee has discussed the following items in the high priority list:

- (i) Capture cross sections of Cr, Fe and Ni.
- (ii) Zr resonance parameters.
- (iii) The dosimetry reaction $^{93}\text{Nb}(n,n')m$.
- (iv) The resonance parameters of ^{235}U , ^{238}U and ^{239}Pu .
- (v) Capture cross sections of ^{232}Th and ^{238}U .
- (vi) Inelastic scattering in ^{238}U .

Members of NEACRP are invited to consider whether this list of high priority requirements adequately represents current differential nuclear data measurement priorities.

Members of the NEANDC are invited to consider the current status of measured data in relation to these high priority requirements, and measurements recently completed, in progress or planned which could meet the requirements. Members are asked to bring the requirements to the attention of those planning new measurement programmes.

It is proposed to produce revised versions of the list for each NEACRP and NEANDC Meeting to incorporate changes proposed by NEA Member Countries (or organisations, such as the EWGRD) and status comments provided by NEANDC.

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TABLES OF REQUIREMENTS

1. Standards
2. Dosimetry
3. Structural materials
4. Moderators and coolants
5. Fission product capture
6. Primary actinides
7. Secondary actinides

Key to Requesters

- D Dutch request list for fission product capture cross sections.
- E● Europe (France, Germany and UK joint request listed in NEACRP-A-514, NEANDC-110 A.)
- F France
- G Federal Republic of Germany
- J Japan
- UK United Kingdom
- US United States of America

Notations Used in the Tables

Th denotes thermal energies $\approx 0.025\text{eV}$

Thr denotes threshold energy

m● meV

K KeV

M MeV

STANDARDS

Reaction	Energy Range	Typical accuracy request (percent)	Requester	Status Remarks
$^{10}\text{B}(n,\alpha)$ and α_0/α_1 (n,γ)	100 K - 1M	2	E	Although the ENDF/B-V evaluation claims accuracies close to this request, an independent evaluation by Liskien and Wattecamps suggests that larger uncertainties may be warranted.
	Thermal-200K	20	UK	
$^{235}\text{U}(n,f)$	1K - 14M	1	US	(Ratio to H(n,p) and $^{10}\text{B}(n,\alpha)$ and possibly other standards.) The ENDF/B-V evaluation is said to have an accuracy of approximately $\pm 3\%$ in the range 150K to 10M.
$^{252}\text{Cf } \nu_s$		0.25	US	Quoted accuracies $\pm 0.2\%$ but differences in evaluated values of $\pm 0.5\%$. Further analysis needed. (Request may be satisfied by a recent ORNL measurement, to be published.)
$^{252}\text{Cf} \cdot \chi(E)$	\bar{E} $\Phi(E)$ ($E > 5\text{M}$) ($E < 250\text{K}$))	1-2 5-10	E, US	Estimated accuracy of \bar{E} is $\pm 2\%$ but the shape requirements are not met.

The status of data for standards is reviewed in the INDC/NEANDC Standards File, the latest issue being INDC-36/LNJ

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DOSIMETRY

Priority 1 requirements from the EWGRD Request List
(prepared by W L Zijp)

Reactions	Energy Range	Accuracy Required (percent)	Status Remarks
271Al(n,α)	$\bar{\chi}_5$	2	Present accuracy 5.7% for $\bar{\chi}_5$ and about 2% for $\bar{\chi}_{252}$
58Ni(n,p)	$\bar{\chi}_5$	2	Present accuracy 5% for $\bar{\chi}_5$ and 1.9% for $\bar{\chi}_{252}$
93Nb(n,n')m	Thr-8M	5	Present uncertainty 15% to 30% (nuclear theory value)
115In(n,n')m	$\bar{\chi}_5$	2	Present accuracy 4.2% for $\bar{\chi}_5$ and 2.2% for $\bar{\chi}_{252}$ Differential cross-sections ±6% above 1 MeV.
237Np(n,f)	To 3M Above 3M	2 5	
238U(n,f)/ 235U(n,f)	$\bar{\chi}_5$	2	

$\bar{\chi}$ denotes a fission spectrum averaged value, $\bar{\chi}_5$ for 235U fission and $\bar{\chi}_{252}$ for 252Cf spontaneous fission.

Fission spectrum averaged values have been reviewed by H J Holthenius, J L Zijp and W J Hoogendam, ECN-80-143, by W Mannhart in the German F R Progress Report NEANDC(E)-212U Vol. V and by D L Smith "Status of Database and some Integral-Differential Comparisons for Non-Fission Threshold Dosimetry Reactions from ENDF/B-V" page 105 Proc NEANDC Topical Conference Aix-en-Provence (April, 1981) NEANDC 150-U.

STRUCTURAL MATERIALS

Requirement

Reaction	Energy Ranges	Typical Requirement (percent)	Requester	Status (Geel 1977) (percent)
<u>Capture</u>				
Cr	0.1 - 100K	20	E	20
Fe	0.1K - 1M	5-10	E	10-20
Fe56	0.01 - 1M	10-15	US	
Ni	0.1K - 1M	10-20	E	10-20

Corresponding total cross section measurements and resonance parameter analyses are needed. There are some large differences in the resonance parameters derived in different analyses and this could have implications for the calculation of resonance shielding effects. Resolution of some normalisation problems could reduce the uncertainties in the average infinite dilute cross sections to about $\pm 10\%$ in the energy range up to 300 KeV and new evaluations are required.

Zr	Thermal	5	France) Evaluations of existing data required
	RI	5	France	

ORNL and BCMN resonance region measurements for Zr are being analysed by CNEN.

Scattering

Fe (n,n')	Thr - 4M	5-10	E	20% to 5MeV
	4 - 15M	5-30	E	
57Fe (n,n')	Thr - 10M	20	US	
Ni (n,n')	Thr - 4	5	E	20% to 5MeV
	4 - 15	5-30	E	

High resolution scattering measurements can be used to determine the level spins for p- and d-wave resonances and these are needed to determine self-shielding factors. Data on scattering anisotropy are required for multiple scattering calculations.

COOLANT AND MODERATOR MATERIALS

1H (n, γ)	Th - 10eV	0.3	US	Discrepancies in thermal criticality parameters
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FISSION PRODUCT CAPTURE

Requirements from the Dutch and Japanese Request Lists

Isotope	Energy Range	Accuracy	Requester	Status Report
99Tc	20eV-400K	10	D	Discrepancies between measurements
	25K (point value)	10	J	
107Pd	700eV-400K	10	D	RPI data to 600eV
	500eV-500K	10	J	
131Xe	100eV-500K	20	J	Resonance data to 4KeV
135Cs	100eV-500K	10	J	Only 1 resonance identified (42.1eV)
	Res. Param.	10	J	
147Pm	320eV-400K	10	D	Resonance data to 316KeV (KAP)
	100eV-500K	10	J	
149Sm	25K (point value)	5	J	25KeV measurement could resolve discrepancies
151Sm	1eV-400K	10	D	Resolved resonance data to 105eV (KAP). New data to 17eV (NIR)
	100eV-500K	10	J	
152Eu	100eV-500K	10	J	
	Res. Param.	10	J	
154Eu	100eV-500K	10	J	
	Res. Param.	10	J	

● The French programme aims to meet fission product data requirements by integral measurements.

PRIMARY ACTINIDES

Isotope	Energy Range	Typical Accuracy Requirement (percent)	Requester	Status (percent)
(a) $\bar{\nu}_p$				
239Pu	Th - 0.5M - 15M	0.3 0.5	US J	0.2* 2
241Pu	1K - 1M	2	US	2-3
(* denotes relative accuracy, in particular to 252Cf spontaneous fission.)				
(b) Cross section shapes at thermal energies (σ_f, σ_c, α and η)				
235U	10m - 1eV 10m - 0.4eV	0.5 0.5	US UK,F	
238U	5m - 6eV	0.03 barns	UK	
239Pu	10m - 0.5eV 10m - 1eV	0.75 0.5	UK,F US	
241Pu	10m - 1eV 1 - 15eV 10m - 1eV	2 6 0.5	UK UK US	
(c) Resonance parameters (Resolved resonance data and thick sample and self-indication measurements in unresolved ranges to enable shielded cross sections to be calculated to the requested accuracies.)				
232Th	- 10K	10	G	
235U	1eV - 1K	1	US	
238U	1K - 30K - 10K	3 3	US UK	
239Pu σ_T , σ_f	1eV -	(σ_T) 3, (σ_f) 1	US	
240Pu	1eV	1	US	
(d) Fission (Including ratio measurements to 235U (n,f))				
235U (Standard above 1keV)	1eV - 1K	1	US	
239Pu	1eV - 1.5M 1 - 100K 10k - 20M	1 2 3	US G J)) 5-10)
240Pu	Th - 1M	10	J) 5-10
241Pu	Th - 10eV 20 - 400K	3 3	US US)) 5
(e) Capture and Alpha				
232Th	4K - 2M 2M - 10M	5 10	G G	
233U	Th - 1M 1M - 20M	20 10	G J)) 10-20
235U	1M - 10M	5-10	J	

Cont/.....

PRIMARY ACTINIDES (Cont)

Isotope	Energy Range	Typical Accuracy Requirement (percent)	Requester	Status (percent)
<u>(e) Capture and Alpha (cont)</u>				
238U	1K - 30K	3	US) 5-10
	30K - 1M	2-3	US	
	Th - 80K	3	UK	
239Pu	- 600K	6	US	10-20
240Pu	Th - 100eV	3	US	10-20
<u>(f) Inelastic scattering (Total inelastic and secondary energy distribution eg. half lethargy width group transfer matrix elements.)</u>				
238U	Thr - 10M	5-7	US) 10-20
	0.5 - 5M	5	E	
239Pu	0.05 - 10M	10-15	US	20-30
240Pu	Thr - 10M	20-25	US	
<u>(g) n,Xn(E,En) (Spectrum of emitted neutrons at several energies)</u>				
235U	0.1 - 14M	10-15	US	
239Pu	0.1 - 14M	10-15	US	
<u>(h) Total cross section (Energy resolution should resolve secondary structure)</u>				
239Pu	1eV - 500K	3	US) 5-10
	1 - 200K	2	J	
240Pu	5KeV - 10MeV	1-2	US	
<u>(i) Prompt Fission Neutron Spectrum (Mean energy and overall characteristics of the shape)</u>				
238U	$\bar{E}/\bar{E}(252Cf)$	1-1.5	US	
239Pu	Mean E and fractions	2	G,UK,	
	>5M; <300K	10		
	$\bar{E}/\bar{E}(252Cf)$	1-1.5	US	
<u>(j) Delayed neutron yield</u>				
238U	Thr - 5MeV	3-5 (absolute)	US	

SECONDARY ACTINIDES

From the Japanese and UK Request Lists

Isotope	Reaction	Energy Range	Accuracy (percent)	Requester	Status			
					Thermal	RI	Fast	
233Pa	(n, γ)	20eV-15M	10	J	15%			
237Np	(n, γ)	0.025eV-1K 1K-15M	10	J	2%	8%		
			20	J				
241Am	(n, γ)	100eV-100K 500K-15M Branching Ratio	8	UK)		10%	
			10	J				
				J,UK				
243Am	(n, γ)	100eV-100K 20eV-15M	10	UK)	2%	4%	25%
				J				
242Cm	(n, γ)	0.025eV-15M	10-20	J	40%	40%		
	(n,f)	0.025eV-15M	10-20	J				
243Cm	(n, γ)	20eV-10M	10-20	J	40%	40%		
	(n,f)	3M-10M	10-20	J				