International Atomic Energy Agency

INDC(NDS)-75/G+P

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

PROGRESS

IN

FISSION PRODUCT NUCLEAR DATA

Information about activities
in the field of measurements and compilations/evaluations
of fission product nuclear data (FPND)

collected
by

G. Lammer
Nuclear Data Section
International Atomic Energy Agency
Vienna, Austria

No. 2 May 1976

IAEA NUCLEAR DATA SECTION, KÄRNTNER RING 11, A-1010 VIENNA

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NOT FOR PUBLICATION

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FOREWORD

This is the second issue of a report series on Fission Product Nuclear Data (FPND) which is published by the Nuclear Data Section (NDS) of the International Atomic Energy Agency (IAEA). The purpose of this series is to inform scientists working on FPND, or using such data, about all activities in this field which are planned, ongoing, or have recently been completed.

This report consists of reproductions of essentially unaltered original contributions which the authors have sent to IAEA/NDS. Therefore, the IAEA cannot be held responsible for the information contained nor for any consequences resulting from the use of this information.

The types of activities being included in this report are measurements, compilations and evaluations of:

Fission product yields;
Neutron cross-section data of fission products;
Data related to β−, γ-decay of fission products;
Delayed neutron data; and
Fission product decay-heat.

The first issue has been published in November 1975 as INDC(NDS)-70/G+P. The present issue includes contributions which were received by NDS between 1 November 1975 and 15 May 1976.

The next issue of this report series is envisaged to be published in May 1977.

How to submit contributions:

The next issue is expected to be published in May 1977. All scientists who are presently working - or have recently completed work - in the field of FPND and who want to contribute to the 3rd issue of this series, are kindly asked to send contributions to me between now and the end of April 1977, so that they reach NDS before 30 April 1977.

Those scientists or groups who have already contributed to the present issue and who want to leave their contribution(s) unchanged or who wish to suggest only slight changes, should write an appropriate note to me before the above deadline.

Format of the contributions:

Generally, the size of one contribution should preferably not exceed one page. Of course, the number of contributions per working group or laboratory is not restricted. Similar experiments (or calculations, evaluations, etc.) performed by one person or group should preferably be combined to one contribution, if this is possible without loss of clarity.

The headings suggested for the 3 types of contributions are, for

Measurements:	Compilations:	Evaluations:
Laboratory and address Names: Facilities:	Laboratory and address: Names:	Laboratory and address: Names:
	Compilation:	Evaluation:
Experiment:	purpose:	purpose:
Method:	major sources of information:	method:
Accuracy:	deadline of literature coverage:	major sources of information:
Completion date:	cooperation:	deadline of literature coverage:
Discrepancies to other reported data	other relevant details:	status:
	computer file:	cooperation:
Publications:	completion date:	other relevant details:
	Publications:	computer file of compiled data:
		computer file of evaluated data:
		discrepancies encountered:
		completion date
		Publications:

For the sake of consistency it is requested that the suggested headings be used, except when they are not appropriate, and their order of sequence be kept.

Comments or suggestions concerning the format, content and layout of this report series are most welcome and should be directed to me in time before the next issue.

I would like to thank the contributors for their cooperation.

G. Lammer

Subject-index[a)]

1. Measurements

1.1. Fission Yields

Fissionable isotope	pages			
	Thermal reactor neutrons	fast reactor neutrons	$E_n \cong 14$ MeV	E_n pointwise
^{232}Th		36	(31), 36	
^{231}Pa		(1)		
^{233}U	2, 17, 35, 36	(1), 27, 36	10, 36	
^{234}U		(1)		
^{235}U	2, 5, 7, 17, 29, 35, 36	(1), 7, 17, (19), (21), (22), (23), 27	10	
^{236}U		(1)		
^{238}U		(1), (19), (23), 27, 36	10, 17, 36	
^{237}Np		(1), 27	10	
^{239}Pu	2, 5, 17, 29, 35, 36	17, (19), (21), (22), (23), 27		(20)
^{249}Pu		(22), (23), 27, (32)	(32)	
^{241}Pu	2	(23), 27		
^{242}Pu		27		
^{241}Am		27		
^{243}Am		27		
^{249}Cf	17			

a) as compared to INDC(NDS)-70:
underlined page-numbers refer to new contributions,
( ), page-numbers in brackets refer to unchanged contributions,
others refer to revised contributions.

1.2. Neutron cross-sections

Isotopes	pages	(type of c.s., energy)
$^{86-88}Sr$	33	((n,γ), E=2.6 - 500 keV)
^{89}Y	(33)	((n,γ), E=2.6-500 kev)
^{90}Zr	33	((n,γ), E=2.6-500 keV)
^{91}Zr	14 (33)	(reson.params., E=0-15 keV); (n,γ), E=2.6 - 500 keV)
$^{92,94}Zr$	33	((n,γ), E=2.6-500 keV)
^{96}Zr	14	(reson. params., E=0-15 keV)
^{93}Nb	33	((n,γ), E=2.6-500 keV)
$^{92,94-98,100}Mo$	33	((n,γ), E=2.6 - 500 keV)
^{99}Tc	6	(transmission, E= 1eV - 1.5 keV)
^{103}Rh	(33)	((n,γ), E=2.6-500 keV
$^{104-106,108,110}Pd$	(33)	((n,γ), E=2.6-500 keV
$^{106,108}Cd$	6	(transmission, E=1 eV-1.5 keV)
	33	((n,γ), E=2.6-500 keV)
$^{110-112,113,114,116}Cd$	33	((n,γ), E= 2.6 - 500 keV)
$^{122-126,128,130}Te$	(33)	((n,γ),E=2.6-500 keV)
$^{133/135/137}Cs$	6	(transmission, E=1 eV-1.5 keV) measured together
$^{134-136,138}Ba$	33	((n,γ), E=2.6-500 keV)
^{139}La	33	((n,γ), E=2.6-500 keV)
^{140}Ce	33	((n,γ),E=2.6-500 keV)
^{141}Pr	33	((n,γ), E=2.6-500 keV)
$^{142-146,148}Nd$	(33)	((n,γ), E=2.6-500 keV)
^{149}Pm	17	((n,γ), thermal
$^{151,153}Eu$	15	((n,γ), E=1-70 keV)
$^{151/152/153/154/155}Eu$	6	(transmission, E=1 eV-1.5 keV) measured together
^{156}Gd	14	(reson.params., E=0-3 keV)
^{159}Tb	(33)	((n,γ), E=2.6-500 keV)
^{165}Ho	33	((n,γ), E=2.6-500 keV)
^{169}Tm	(33)	((n,γ), E=2.6-500 keV)
FP-Mixtures	6	(transmission, E= 1 eV-1.5 keV)

1.3. Decay data

Isotopes or Mass Chains	Pages $T_{1/2}$	Pages γ-data	Pages Conversion Electrons
83	3	3	
85–88	3	3	
^{95}Zr		8	
96–102	3	3	
^{103}Ru		8	
^{106}Rh		8	
^{110m}Ag		8	
^{131}I		8	
^{133m}Xe			24
^{134}Cs		8	
135–137	3	3	
^{140}Ba		8	
^{140}La		8	
^{144}Ce–^{144}Pr		8	
145–150	3	3	
Shortlived FP:			
$90 < A < 106$	5	5	

1.4. Delayed neutron data [a]

Precursors	Pages	
	Pu-value	neutron-energy spectrum
^{79}Zn		(12)
$^{80,81}Ga$		(12)
$^{87-89}Br$	25	(12)
$^{90,91}Br$		(12)
$^{90-91}$ [b]	(4)	
$^{92-97}Rb$	25	25
^{93}Rb		(12)
$^{93-95}$ [b]	(4)	
^{99} [b]	(4)	
$^{129,130}In$		(12)
^{134}Sn		(12)
^{134} [b]	(4)	
^{135}Sb		(12)
^{136}Te		(12)
$^{137,138}I$	25	(12)
$^{139,140}I$		(12)
$^{137-139}$ [b]	(4)	
^{141}(I,Cs)		(12)
^{142}(Xe,Cs)		(12)
^{141}Cs	25	
^{142}Cs	25	25
$^{143-144}Cs$	25	(12), 25
^{145}Cs	25	25
^{146}Cs	25	

a) Half-lives of d.n. precursors are included in "decay data" (item 1.3.)

b) Only mass-chains are given in this contribution.

1.5. Decay heat

Fissioned isotope	Pages		
	thermal fission		fast fisscion
	β-heat	γ-heat	β-heat
^{235}U	16 ,37	16,37	(18)
^{239}Pu	37	37	(18)

2. Compilations, evaluations[a)]

(c ... compilation
e ... evaluation)

2.1. Fission yields

Fissionable isotope or element	neutron energy	c,e	page
^{235}U	fast spectrum, 14 MeV	e	41
Th, U, Pu	thermal, fast spectrum, 14MeV	c	(52)
All	" " " "	c	(48)
All	" " " "	e	42,(49)

2.2. Neutron cross sections

Isotopes	pages	Isotopes	pages
^{85}Rb	41(e)	^{103}Rh	39(e),42(c,e),47(e)
^{91}Y	41(e)	^{102}Pd	47(e)
$^{91,92}Zr$	41(e)	^{104}Pd	41(e),47(e)
^{93}Zr	41(e), 42(c,e)	^{105}Pd	39(e),42(c,e),47(e)
$^{94-96}Zr$	41(e)	^{106}Pd	41(e),47(e)
^{93}Nb	47(e)	^{107}Pd	39(e),42(c,e),47(e)
^{95}Nb	41(e)	$^{108,110}Pd$	41(e),47(e)
$^{92,94,96}Mo$	47(e)	^{109}Ag	39(e),42(c,e)
$^{95,97}Mo$	39(e),42(c,e)47(e)	^{111}Cd	41(e)
$^{98,100}Mo$	39(e),47(e)	^{115}In	41(e)
^{99}Tc	39(e),42(c,e),47(e)	^{128}Te	41(e)
^{100}Ru	41(e)	^{127}I	47(e)
$^{101,102}Ru$	39(e),42(c,e),47(e)	^{129}I	42(c,e)
^{103}Ru	39(e)	^{133}Cs	39(e),42(c,e),47(e)
^{104}Ru	39(e),42(c,e),47(e)	^{135}Cs	39(e),42(c,e)
^{106}Ru	41 (e)	$^{138,140}Ba$	41(e)

a) see footnote on p. VII

Isotopes	pages
^{139}La	41(e), 47(e)
$^{140-142,144}Ce$	41(e)
^{141}Pr	39(e),47 (e)
^{143}Pr	41(e)
^{143}Nd	39(e),42(c,e)
^{144}Nd	41(e),42(c,e)
^{145}Nd	39(e),42(c,e)
$^{146-148,150}Nd$	41(e)
^{147}Pm	39(e),42(c,e)
^{147}Sm	41(e),42(c,e)
^{149}Sm	39(e),42(c,e)
^{150}Sm	41(e)
^{151}Sm	39(e),42(c,e)
$^{152,154}Sm$	41(e)
^{153}Eu	39(e),42(c,e)
$^{154,155}Eu$	41(e)
$^{156,157}Gd$	41(e)
^{159}Tb	41(e)

Isotopes	pages
≈ 40 planned	39
≈ 70 "	42
≈ 35 "	47

2.3. Decay data

2.4. Delayed neutron data

2.5. Decay heat

I. MEASUREMENT ACTIVITIES

Laboratory and address: Department of Fundamental Research
Laboratory of Nuclear Physical Chemistry
Grenoble Nuclear Studies Centre
BP 85 Centre de Tri
GRENOBLE CEDEX, France

Names: J. BLACHOT, A. FERRIEU, G. LHOSPICE and A. MOUSSA.

Facilities: Study of the fission of uranium isotopes (233, 234, 235, 236, 238) and neptunium-237 irradiated in a fission spectrum. (Caramel mock-up inserted in core of the Mélusine reactor at the Grenoble Nuclear Studies Centre).

Experiment: Comparative study of the final mass distributions of the five uranium isotopes irradiated in the fission spectrum.

Method: The cumulative yields are measured by Ge/Li gamma spectrometry. The method is relative to the 537.3 keV ray of barium-140 (see publication (1)).

Accuracy: The mean accuracy of our measurements is 3 to 5%. Publication of the results is anticipated for the beginning of 1976. We expect subsequently to do the same study with fission by 3 MeV neutrons and to measure cumulative yields of ^{231}Pa in a fission spectrum.

Publications:

(1) Mass distribution in ^{238}U fission by 14 MeV neutrons, J. Inorg. Nucl. Chem. 36 (1974) 495-501.

(2) Cumulative fission yields of ^{252}Cf, Journal of Radioanalytical Chem. 26 (1975) 107-125.

(same as INDC(NDS)-70, p.7; still valid)

Laboratory and address : Département de Recherche Fondamentale
Laboratoire de Chimie Physique Nucléaire
Centre d'Etudes Nucléaires de Grenoble
85 X - 38041 GRENOBLE CEDEX - France

Names : R. BRISSOT, J. CRANÇON, Ch. RISTORI, J.P. BOCQUET et A. MOUSSA.

Facilities : On line isotopic separation of fission products (Ariel facility) connected with swimming pool reactor.

Experiment : Independent and cumulative yields of rare gas isotopes have been measured in thermal fission of ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu (from A = 87 to A = 93 for Krypton and 137 to 142 for xenon).

From our measurements, cumulative yields for Bromine and Iodine isotopes can be obtained and independent yields can be deduced.

Method : Cumulative yields are measured by $4\pi\beta$ counting (see publication 2).

Accuracy : The average relative uncertainty of our measurements is typically 4 %.

Publications :

1/ Distributions isotopiques des gaz rares dans la fission par neutrons thermiques de ^{235}U et ^{233}U.
Nuclear Physics A 255 (1975) p. 461-471.

2/ On line measurements of rare gas fission yields in 14 MeV neutron fission.
Nuclear Physics A 189 (1972) p. 556-576.

3/ Distributions isotopiques des gaz rares dans la fission par neutrons thermiques de ^{239}Pu et ^{241}Pu.
To be published.

Laboratory and address : -Département de Recherche Fondamentale
Laboratoire de Chimie Physique Nucléaire
Centre d'Etudes Nucléaires de Grenoble
BP.85 Centre de Tri - 38041 GRENOBLE CEDEX - France -

Names :: J. BLACHOT, E. MONNAND, F. SCHUSSLER (CENG/DRF)
G. BAILLEUL, J.P. BOCQUET, B. PFEIFFER (ILL).

:: This work is a collaboration between this laboratory and :
- Institut Laue-Langevin -BP 156 - 38042 (Grenoble)

- Institut fur Neutronenphysik Julich (RFA).

Facilities : Recoil focussing parabola type mass separator for unslowed fission products LOHENGRIN installed at the GRENOBLE high flux reactor.

Experiment : E_γ, I_γ, T 1/2 have been measured for the mass chains 96, 97, 98, 99, 100, 101, 102, 145, 146, 147, 148, 149, 150 and also 135, 136, 137, 83, 85, 86, 87, 88. Some decay schemes have been derived.

Method : The fission products are either handled with the use of a tape transport system or with a air jet device. The γ energy spectra are measured with a geLi detector and recorded in a 4096 channels memory of a Telefunken (TR 86) on line computer.

Publications : G. SADLER et al., Nucl. Phys. A 252 (1975), 365, "Studies of the β–decay of ^{96}Y and the level scheme of ^{96}Zr".

G. BAILLEUL et al., - Z. Physik A273 (1975) 2B3.

Laboratory and address : Département de Recherche Fondamentale
Laboratoire de Chimie Physique Nucléaire
Centre d'Etudes Nucléaires de Grenoble
BP.85 Centre de Tri - 38041 GRENOBLE CEDEX - France.

Names[*] : Ch. RISTORI and J. CRANÇON

[*] This work is a collaboration between this laboratory and :
- Institut Laue-Langevin - BP.156 - 38042 GRENOBLE) (M. ASGHAR, J.P. GAUTHERON).
- Kelvin Laboratory, University of Glasgow, Scotland. (G.I. CRAWFORD).

Facilities : Recoil focussing parabola type mass separator for unslowed fission products LOHENGRIN installed at the GRENOBLE high flux reactor.

Experiment : P_n values measurements of the $^{235}U(n_{th},f)$ produced precursors in the mass chains 90, 91, 93, 94, 95, 99, 134, 137, 138 and 139.

Method : A neutron detector and a $4\pi\beta$ detector were used simultaneously to measure the neutron and β activities (the ratio of the neutron activity of a nuclide to the β activity of its precursor defines the P_n value) collected on a continuous moving tape system.

Accuracy : The accuracy of each measure is depending on the level mass activity. Typically the uncertainty is 15%.
We plan to measure other P_n values up to the lower level sensitivity of this present detection system :
$P_n \times Y_q(m) > 0{,}4 10^{-6}$ n/f (see the publication).

Discrepancies to other reported data : ^{90}Br
^{137}Te

Publications :
- The P_n values of the $^{235}U(n_{th}, f)$ produced precursors. Nuclear Physics A 247 (1975) p.359-376.
- J.P. GAUTHERON, thesis, Université Scientifique et Médicale de Grenoble - Décembre 1974.

(same as INDC(NDS)-70, p.10; still valid)

Laboratory and address:

GSF, Forschungsreaktor Neuherberg
Ingolstädter Landstraße 1
8042 Neuherberg b. München

Names: H.J. Kreiner

Facilities: Pulsed Trigareactor Mark III
Ultrafast Conveyor Tube System

Experiment: E_γ, T 1/2, relativ yield, A(t) for shortlived, light fission products (FP)
(0.1s < T 1/2 < 15s) of U-235 and Pu-239 with 90 < A < 106.

Method: The thin actinide-target is irradiated by the reactor puls (HW: 11 ms), the FP were partly separated by mass absorption in thin foils and the catcher with the interested FP is shot in measuring position within a transport time of 50 ms. The γ-Energy spectra are measured with a GeLi-detector and recorded in multispectrum mode by an ND 812 multichannel analyser.

Accurancy: Expected $\pm$ 7%

Completion date: End of 1976

Publication: H.J. Kreiner Patent Nr. 2353 693 vom 27.10.1973
H.J. Kreiner ATKE Bd. 25 (1975) Lfg. 3

Laboratory and address:

Institut für Reine und Angewandte Kernphysik der Universität Kiel (IKK),
D-2054 Geesthacht, Reaktorstation

Names:

K. Freitag, U. Harz, P. Podewils, H. G. Priesmeyer

Facility:

Fast Chopper Neutron Time-of-Flight Spectrometer, 42 m flight path in front of beam hole of 5 MW - FRG-1 reactor. 15 ns/m nominal resolution, with special equipment for transmission measurements on highly radioactive samples; 11 Li-6 glass-scintillation detectors; max. rotor speed 15000 upm; min. burst width 0.64 μs; min. time channel width 100 ns.

Experiments:

Neutron resonance investigations by transmission measurements between 1 eV and 1.5 keV on separated stable or radioactive isotopes of special interest to reactor physics (especially fission products), gross fission products. Possibility of extending energy range to thermal region with crystal spectrometer, which can be made available.

Ongoing: separated Cd 106 (88.4 % enrichment, no FP, but for nuclear systematics and isotopic identification of Cd resonances), separated Cd 108 (to begin in May), low energy transmission of irradiated nuclear fuel and neutron scattering yield of 1.056 eV Pu 240 resonance (sample: 8 mm piece cut out of fuel rod); Cs 133/135/137 FP mixture (thick sample) in order to improve resonance parameter determination; gross FP cooling down behaviour of transmission.

Planned: Eu 151/152/153/154/155 mixture from fast reactor control rod; Tc 99, in order to clear up discrepancies in Γ_γ of first resonance; construction of cryo device to reduce resonance Doppler broadening; gross FP cooling down behaviour.

Method:

Sample-in-beam, sample-out-of-beam transmission measurement; black resonance or boron filter background determination technique.

Accuracy:

For resonance parameters: about 5 % or better, depending on statistical accuracy desired.

Recent publications:

ATKE 25 (1975) 109 and GKSS 75/E/17
NBS SP 425, p. 744 (Washington 1975)
IAEA-SM 201/4 and GKSS 76/E/10

Laboratory and address:	Physikalisch-Technische Bundesanstalt D - 33 Braunschweig, Bundesallee 100
Names:	K. Debertin
Facilities:	^{252}Cf-source; thermal reactor FMRB; calibrated Ge(Li)-spectrometer.
Experiment:	Determination of ^{235}U-fission yields in the fast neutron spectrum of a ^{252}Cf-source and in a thermal neutron spectrum. Only yield ratios (fast/thermal) are determined. The evaluation of the measurements is in progress.
Method:	The ^{252}Cf-source is mounted 15 m above ground in the open air. ^{235}U-samples, enriched to 93 % ^{235}U, are irradiated in a 1 cm distance. Fission product activities are determined by measuring the γ-ray spectrum with a calibrated Ge(Li)-spectrometer. Six irradiations of different duration (2 h to 10 d) were carried out.
Accuracy:	$\pm$ 1 % to $\pm$ 2 % (1σ uncertainty) for fast to thermal yield ratios
Completion date:	1976
Publication:	Preliminary results are published in PTB-Jahresbericht 1975 (appeared April 1976).

Laboratory and address:	Physikalisch-Technische Bundesanstalt, D - 33 Braunschweig, Bundesallee 100
Names:	K. Debertin, U. Schötzig, K. F. Walz and H. M. Weiß
Facilities:	1) $4\pi\beta$-γ-coincidence systems (normal and high pressure proportional-counters, NaI(Tl)-crystals);
	2) calibrated Ge(Li)- and Ge-spectrometers
Experiment:	Determination of absolute γ-ray emission probabilities for
	^{95}Zr, ^{106}Rh, ^{144}Ce - ^{144}Pr published
	$^{140}Ba/^{140}La$, ^{110m}Ag completed
	^{103}Ru, ^{134}Cs, ^{131}I ongoing
Method:	The decay rates are determined by facilities 1) using the extrapolation method; γ-ray emission rates are determined by facilities 2), the efficiency of which has been calibrated in the energy range of interest to an accuracy of $\pm$ 1 % or less (1σ). For this purpose PTB standard sources of about 15 radionuclides were used. Details are described in Annals of Nuclear Energy 2, 37 (1975) and PTB-Mitteilungen 83, 307 (1973).
Accuracy:	$\pm$ ... % to $\pm$ 2 % (1σ uncertainty)
Completion date:	End of 1976

- cont'd -

- cont'd -

Discrepancies to other reported data:

1. ^{144}Pr: For the emission probability of the 696 keV γ-radiation a value of 0,01342 $\pm$ 0,00014 was obtained which is about 10 % lower than the "recommended" value.
2. ^{140}Ba: For the emission probability of the 537 keV γ-radiation a value of 0,244 $\pm$ 0,003 was obtained which is about 20 % higher than the value given in the Nuclear Data Sheets (1974)

Publications:

"Gamma-Ray Emission Probabilities of the Fission Products ^{144}Ce - ^{144}Pr, ^{106}Rh, ^{95}Zr" in Annals of Nuclear Energy 2, 37 (1975)

"Messung von Gammastrahlen-Emissionswahrscheinlichkeiten der Nuklide ^{103}Ru, ^{140}Ba, ^{140}La und ^{152}Eu" in PTB-Jahresbericht 1974, p. 222 (Copies available on request).

Laboratory and address: Institute of Experimental Physics, Kossuth Lajos University, H-4026 Debrecen, Bem tér 18/a, Hungary.

Names: S.Daróczy, S.Nagy, P.Raics.

Facilities: Neutron generator with analysed deuteron beam /~0.5 mA/ and rotating tritium target, 0.5 mg ^{252}Cf source.

GeLi detector of 40 cm³ with Atomki /Hungary/ electronics, 4000 channel DIDAC analyser and Multi 20-Plurimat-N minicomputer-analyser system.

$4\pi/\beta$-counter /for counting of the activity of flux measuring foils/. Fission chambers /under construction/.

Experiment: Fission yield measurements at 14 MeV.
Completed: mass distribution of $^{238}U/n,f/$ reaction.
Ongoing: $^{235}U/n,f/$, for products with half life greater than 1 day, only.
Planned /for 1976-77/: $^{233}U/n,f/$ or $^{237}Np/n,f/$.

Method: Measurement of direct gamma spectra of a thick target with an absolutely calibrated GeLi spectrometer and determination of partial fission cross sections /cumulative yields/ relative to the $^{27}Al/n,alpha/$ or ^{63}Cu /n,2n/ reaction cross section.

Accuracy: Generally 2 - 5 % random and about 3 % systematic error reached.
Expected completion date: $^{235}U/n,f/$: 1976; $^{233}U/n,f/$ or $^{237}Np/n,f/$: 1977.

Discrepancies to other reported data: Pronounced left-right symmetry to A_o=117.3 was found in the mass distribution of the $^{238}U/n,f/$ reaction; there are no indications for fine structure.

- cont'd -

- cont'd -

Remarks: 47 cumulative yields for 37 mass chains in $^{238}U/n,f/$ have been measured using 65 gamma lines. The lowest measured partial fission cross section is 3 mb and the highest one is 70 mb. The shortest half-life investigated is about 3 minutes and the longest one is 30 years. The sum of the mass yields amounts the two-thirds of the total fission cross section.

Publications: Results have been presented at the Symposium on Fast Neutron Interactions and on the Problems of High Current Neutron Generators /27-30 August, 1975, Debrecen, Hungary/; will be published in ATOMKI Közl., 18, /2/, /1976/ and perhaps in J.inorg. nucl. Chem.

THE ENERGY DISTRIBUTION OF DELAYED NEUTRONS EMITTED FROM MASS-SEPARATED FISSION PRODUCTS

G. RUDSTAM — The Swedish Research Councils' Laboratory Studsvik, Nyköping, Sweden

S. SHALEV — Department of Nuclear Engineering Technion - Israel Institute of Technology Haifa, Israel

Facilities

The OSIRIS on-line isotope separator has been used to extract selected delayed neutron precursors from thermally-fissioned ^{235}U. Delayed neutron energy spectra have been measured with a very high resolution ^{3}He neutron spectrometer, developed and marketed by the Technion Research and Development Foundation.

Experiment

The energy distribution of delayed neutrons has been determined over the energy range 100 - 1600 keV for the following precursors:

^{79}Zn, $^{80\text{-}81}Ga$, $^{87\text{-}91}Br$, ^{93}Rb, $^{129\text{-}130}In$, ^{134}Sn, ^{135}Sb,

^{136}Te, $^{137\text{-}140}I$, $^{141}(I + Cs)$, $^{142}(Xe + Cs)$, $^{143\text{-}144}Cs$.

Many of the spectra exhibit discrete structure and well-spaced peaks, which are attributed to neutron emission from individual nuclear levels populated by β-decay from the precursor. Work is progressing on additional precursors.

Method

A small quantity of ^{235}U is located in the ion source of the OSIRIS isotope separator, and exposed to a beam of thermal neutrons from a 1 MW reactor. Fission products are extracted, formed into an ion beam and separated into isobaric beams by electromagnetic deflection. One selected

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(same as INDC(NDS)-70, p. 19; still valid)

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beam passes through a collimation system to impinge on an aluminized mylar tape in close proximity to the neutron spectrometer. The tape is continuously advanced to remove long-lived decay products. No detectable contamination exists from adjacent mass beams. In most cases the neutron-emitting isobar is positively identified by decay-time considerations, although for the mass numbers 141 and 142 at least two isobars contribute to the measured neutron spectrum.

The energy resolution of the spectrometer was determined experimentally, and shown to be in the range 16 - 35 keV for neutrons with energy up to 1 MeV. Corrections were applied for the finite resolution of the spectrometer, the energy-dependent detection efficiency and the background neutron energy distribution.

Publications

(1) LF-54, LF-55, LF-56, LF-57, LF-60, LF-61, LF-64
The Swedish Research Councils' Laboratory, Studsvik.

(2) Nuclear Instruments and Methods 120 (1974) 333-344.

(3) Nuclear Physics A230 (1974) 153-172.

(4) Nuclear Physics A235 (1974) 397-409.

Laboratory and address: C.N.E.N., Centro di Calcolo, Via Mazzini 2, 40138 BOLOGNA, Italy

1. Names: C. Coceva, A. Mauri, M. Stefanon

   Facilities: Neutron time-of-flight at the electron Linac of CBNM Euratom, Geel, Belgium

   Experiment: Measurement of S-wave neutron resonances of ^{156}Gd up to 3 keV. Aim of the experiment is to study the applicability of Mehta-Dyson statistics to practical cases and to obtain reliable confidence limits for the level spacing in terms of low variance estimates. The measurement is completed; computations and data analysis are in progress.

   Method: Montecarlo simulation of samples of experimental sequences, i.e. affected by missed and spurious levels, and comparison with the measurement for ^{156}Gd. The simulation has already been performed.

   Expected completion date: 1976.

2. Names: C. Coceva, P. Giacobbe, M. Magnani, A. Mauri

   Facilities: Electron Linac of CBNM Euratom, Geel, Belgium

   Experiment: Time-of-flight neutron transmission experiment with ^{91}Zr and ^{96}Zr enriched targets. Energy range 0-15 keV. Experiment completed. Analysis of resonance parameters, including spin and parity, in progress.

   Method: ZrO targets from 0.9×10^{-3} to 1.6×10^{-2} at/barn, 89.3% ^{91}Zr-enriched. ZrO targets from 0.9×10^{-3} to 6×10^{-3} at/barn, 57.4% ^{96}Zr-enriched. Shape analysis.

   Expected completion date: 1976 for ^{91}Zr, 1977 for ^{96}Zr.

Laboratory:	Japan Atomic Energy Research Institute, Tokai-Mura, Naka-Gun, Ibaraki-Ken, Japan.
Names:	M.Mizumoto, A.Asami, Y.Nakajima, Y.Kawarasaki, T.Fuketa, and H.Takekoshi*.
Facilities:	Neutron time-of-flight spectrometer at the 120 Mev Linac (pulse width 100 nsec; flight path 52 m).
Experiment:	Capture cross sections of ^{151}Eu, ^{153}Eu. Energy range: 1 keV - 70 keV.
Method:	Detector: 3500 l liquid scintillator. Sample materials: $^{151}Eu_2O_3$ (96.83 % enriched), $^{153}Eu_2O_3$ (98.76 % enriched). Neutron flux measurement: ^{6}Li-glass scintillator.
Accuracy:	Expected 5 - 10 % relative, 10 - 20 % absolute.
Expected completion date:	The measurements were completed, the results should be available by the end of 1976.

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* Present adress: Keage Laboratory of Nuclear Science, Kyoto University.

Laboratory and address:	AB ATOMENERGI Studsvik Fack S-611 00 NYKÖPING SWEDEN
Name:	Rolf Persson
Facilities:	R2-0 pool reactor Calorimeter (being constructed)
Experiment (planned):	Integral measurement of decay heat from thermal neutron fission of U-235
Method:	Calorimetric The design of a fast calorimeter for decay heat determinations from about 20 s to 10^4 s after stop of fission is under way. The heat from the β decay will - to a large extent - be separated from the γ heat.
Accuracy:	The accuracy is expected to be better than 10 %.
Completion date:	Expected in the middle of 1977.

Laboratory and address: Eidg. Institut für Reaktorforschung
CH-5303 Würenlingen
Switzerland

Names: H.R. von Gunten, A. Grütter

Facilities:
- Swimming-pool type reactor (SAPHIR)
- Heavy-water reactor (DIORIT)
- Zero-energy reactor (PROTEUS) with GCFR-neutron-spectrum
- 14 MeV neutron-generator

Experiments: Fission yields: - Thermal
- GCFR-spectrum } completed
- 14 MeV

Method:
- Radiochemical for independent yields
- Instrumental with GeLi-detectors, mostly relative to ^{235}U thermal

Accuracy: Independent yields of ^{150}Pm: 10-35 %
GCFR-spectrum 2-10 % for ^{235}U
R-values for ^{239}Pu 1.5-18 %
14 MeV 5-20 %

Measurements completed: Spring 1975

Publications:
- Mass yields in 14 MeV neutron-induced fission of ^{238}U, J. inorg. nucl. Chem. 38, 205 (1976)
- Mass yields in the fission of ^{235}U and ^{239}Pu in the neutron spectrum of a GCFR, Nucl. Sci. Eng. 58, 414 (1975)
- Independent yields of ^{150}Pm in the thermal neutron-induced fission of ^{233}U, ^{235}U, ^{239}Pu and ^{249}Cf and cross section for the $^{149}Pm(n,\gamma)^{150}Pm$ reaction. J. inorg. nucl. Chem. 38, 351 (1976)

Laboratory: AEE Winfrith

UKAEA
Atomic Energy Establishment
Winfrith
Dorchester, Dorset DT2 8DH

Names: M. F. Murphy, W. H. Taylor

Facilities: Zero-power fast reactor Zebra

Experiment: Measurement of gross beta-decay power from products of Pu239 and U235 fission in a fast reactor. Irradiation period 10^5 seconds, detection (continuing) for at least 10^7 seconds after shut-down. Experiment near completion.

Method: Thin deposits of Pu239 and U235 irradiated with catcher foils at centre of Zebra core with neutron energy spectrum close to that of fast power reactor. Fissions monitored by absolute (alpha-calibrated) counters. Catcher foils transferred rapidly to scintillation detector, current output from photo-multiplier being measure of beta power. Calibrated using standard Sr-90-Y-90 source. Various subsidiary experiments to obtain corrections and check for systematic errors.

Accuracy: Target accuracy is $\pm$ 7% (standard error) on absolute beta power as function of time from 30 sec. to 10^7 seconds after irradiation.

Expected completion date: mid-1976.

(same as INDC(NDS)-70, p.31/1; still valid)

Laboratory: AERE Harwell

UKAEA
AERE Harwell
Oxfordshire OX11 ORA

Names: E.A.C. Crouch, I.C. McKean

Facilities: D.F.R.

Experiment: Absolute yields of ^{95}Nb/Zr, ^{106}Ru, ^{137}Cs, ^{144}Ce, Nd isotopes, and perhaps other isotopes, from the fission of ^{235}U and ^{239}Pu in DFR.

Method: Samples of ^{235}U as enriched uranium dioxide, ^{238}U as depleted uranium dioxide and ^{239}Pu as plutonium dioxide were irradiated at various positions in DFR.

Four samples of ^{235}U have been dissolved, chemically separated and analysed using a mass spectrometer and the isotope dilution technique. The analysis is complete and the results are being calculated.

It is expected that ^{238}U and ^{239}Pu samples will be dissolved, separated and analysed during the next year.

Accuracy: Expected $\pm$ 2% (1σ)

Completion date: Expected end of 1976

(same as INDC(NDS)-70, p.31/2; still valid)

Laboratory: AERE Harwell

UKAEA,
AERE, Harwell,
Oxfordshire OX11 ORA

Names: J. G. Cuninghame, H. H. Willis

Facilities: 3 MeV van de Graaff "IBIS"

Experiment: Absolute fission yields of ^{99}Mo and 5 other nuclides in ^{239}Pu fission using monoenergetic neutrons. 6-8 energies from $\sim$ 130 keV to $\sim$ 2 MeV are being used; all irradiations now complete except at one energy.

Method: Flux measured by track detectors. Yields measured by thick source β-counting on very low count-rate samples.

Accuracy: Expected $\sim$ 4% relative, $\sim$ 5-10% absolute

Expected completion date: 1976

(same as INDC(NDS)-70, p. 31/3; still valid)

Laboratory: AERE Harwell

UKAEA,
AERE, Harwell,
Oxfordshire OX11 ORA

Names: J. G. Cuninghame, Mrs. J.A.B. Goodall, H. H. Willis

Facilities: Zero energy fast reactor "ZEBRA"

Experiment: Fission yields as a function of neutron spectrum - from core centre to blanket. Eight irradiations, each of 3 samples, carried out, 5 with ^{235}U as target, 3 with ^{239}Pu. Between 10 and 30 yields being measured per sample.
In progress.

Method: Flux measured by fission chambers and by track detectors, yields measured by absolute γ-counting.

Accuracy: Expected 3-5% relative, 5-10% absolute

Expected completion date: 1976

Publications: "The measurement by γ-counting of complete mass-yield curves for fission of U-235 in several different fast reactor neutron spectra",
Baghdad Conference 7-11 April 1975

(same as INDC(NDS)-70, p. 31/4; still valid)

Laboratory: DERE

UKAEA,
DERE, Thurso,
Caithness, Scotland KW14 7TZ

Names: W. Davies,
V. M. Sinclair

Facilities: DFR

Experiment: The measurement of the absolute yield of ^{90}Sr, ^{137}Cs, ^{144}Ce, $^{143,145,146,148,150}Nd$ and perhaps other fission products from the fission of ^{235}U, ^{239}Pu and ^{240}Pu. Irradiations completed.
It is expected that the capsules will be dissolved and analysed by mid-1976.

Method: Eleven sealed stainless steel capsules were irradiated over a period of 3 years, ending in February 1974.
Prior to irradiation,
3 capsules contained ^{235}U as highly enriched uranium dioxide,
3 capsules contained ^{239}Pu as low ^{240}Pu content plutonium dioxide,
3 capsules contained ^{240}Pu as a dried aqueous solution of plutonium with an isotopic analysis of 98% ^{240}Pu, and
2 capsules contained no added fissile material.

The ^{235}U and ^{239}Pu capsules have been irradiated to about 10% burn-up of the fissile material, and the ^{240}Pu capsules to about 2.5% burn-up.

It is expected that the capsules will be dissolved and analysed by mid-1976.

A set of capsules, identical to the irradiated set, except for irradiation in the reactor, will be dissolved and analysed alongside the irradiated set, with the objective of improving the reliability of the analyses.
The aim is to correlate loss of fissile material during irradiation with the amounts of fission products formed, for each capsule, to enable absolute measurements of fission yields to be obtained.

Accuracy: $\pm$ 2% for ^{235}U and ^{239}Pu fission yields.
$\pm$ 6% for ^{240}Pu fission yields. (Total uncertainties as one-sigma confidence limits).

Expected completion date: December 1976

(same as INDC(NDS)-70, p. 31/5; still valid)

Laboratory: DERE

UKAEA, DERE,
Thurso, Caithness, Scotland
KW14 7TZ

Names: W. Davies, V. M. Sinclair

Facilities: P.F.R.

Experiment: The measurement of the absolute yields of ^{90}Sr, ^{137}Cs, ^{144}Ce, $^{143,145,146,148,150}Nd$ and perhaps other fission products, from the fission of ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu and ^{241}Pu.

In progress.

Method: Twelve sealed stainless steel capsules are to be irradiated.

Of these,

3 capsules contain ^{235}U as highly enriched uranium dioxide,

3 capsules contain ^{239}Pu as low ^{240}Pu content plutonium dioxide,

2 capsules contain ^{238}U as depleted uranium dioxide with an isotopic analysis of 99.7% ^{238}U,

1 capsule contains ^{240}Pu as a dried aqueous solution of plutonium with an isotopic analysis of 99% ^{240}Pu,

1 capsule contains ^{241}Pu as a dried aqueous solution of plutonium with an isotopic analysis of 93% ^{241}Pu, and

2 capsules contain no added fissile material.

The ^{235}U and ^{239}Pu capsules contain stainless-steel powder mixed with the fissile material dioxide for heat transfer reasons.

It is expected that the ^{235}U and ^{239}Pu capsules will receive irradiation corresponding to about 16% burn-up of the fissile material, the ^{238}U capsule to about 0.7% burn-up, the ^{240}Pu capsule to about 4% burn-up and the ^{241}Pu capsule to about 23% burn-up.

A set of capsules identical to the irradiated set except for irradiation in the reactor will be dissolved and analysed alongside the irradiated set, the objective being to improve the reliability of the analyses.

The aim is to correlate loss of fissile material during irradiation with the amounts of fission products formed, for each capsule, (except ^{238}U) to enable absolute measurements of fission yields to be obtained.

Accuracy: $\pm$ 2% for ^{235}U and ^{239}Pu fission yields
$\pm$ 6% for ^{238}U, ^{240}Pu and ^{241}Pu fission yields

Expected completion date: mid-1977

(same as INDC(NDS)-70, p. 31/6; still valid)

Laboratory:	National Physical Laboratory	N.P.L., Teddington, Middlesex, England.
Names:	P. Christmas. P. Cross	
Facilities:	$\pi\sqrt{2}$ Beta-ray spectrometer, isotope separator.	
Experiment:	Determination of K and L internal conversion coefficients of ^{133m}Xe.	
Method:	Peak-to-Beta-Spectrum (PBS)	
Accuracy:	Target is $\pm$ 1 per cent	
Completion date:	1977	

Contribution to "Progress in Fission Product Nuclear Data"

IAEA - MAY 1976

Laboratory and Address:

Battelle-Pacific Northwest Laboratories
P. O. Box 999
Richland, Washington 99352

Names: P. L. Reeder, L. J. Alquist, and N. E. Ballou

Facilities: SOLAR - Spectrometer for On-Line Analysis of Radionuclides. This is an on-line mass spectrometer which incorporates a ^{235}U target in a surface ionization source located in the thermal column of a 1 MW TRIGA reactor at Washington State University, Pullman, Washington.

Experiment: Delayed-neutron emission probabilities have been measured for $^{87-89}Br$, $^{92-97}Rb$, $^{137-138}I$, and $^{141-146}Cs$. Average delayed-neutron energies have been determined for $^{92-97}Rb$ and $^{142-145}Cs$.

Method: Delayed-neutron emission probabilities were determined by counting the total number of ions deposited on the first dynode of an electron multiplier and simultaneously counting the total number of neutrons emitted. The neutron counting efficiency was determined as a function of neutron energy by use of photoneutron sources calibrated against a standard ^{252}Cf source and a precision long counter. The efficiency was determined for each of three rings of ^{3}He counter tubes. The ratio of counts in one ring to another was a function of neutron energy. Thus average (or effective) neutron energies could be determined from the ring ratios.

Accuracy: The main source of error in the delayed-neutron emission probabilities was the neutron counter efficiency calibration which had an uncertainty of 8%. The overall uncertainties in P_n were typically less than 10%. The ring ratios were determined to about 1% in many cases but the calibration curve of energy versus ring ratio had 10-15% uncertainties which introduced large uncertainties in the absolute value of the average energy. If the uncertainty in the calibration curve is ignored, the mean energy of the delayed-neutron spectrum from a particular nuclide is determined to less than 10 keV in several cases ($^{93,94}Rb$, ^{143}Cs).

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Results: The P_n values for 5 halogen nuclides generally agree with other recent determinations whereas our P_n values for 11 alkali metal nuclides tend to be higher than other recent measurements. The average energy measurements range from about 100 keV for ^{92}Rb and ^{142}Cs to 600 keV for ^{97}Rb.

Publications: Experimental work on delayed-neutron emission probabilities and average energies is completed. Final values of P_n and $\bar{E}$ will be available in May 1976 and will be published as soon as possible thereafter.

Future Work: The SOLAR facility will be used to measure energy spectra of delayed-neutrons from mass separated sources. Our neutron energy spectrometer is a ^{3}He ionization chamber built by Shalev in Israel. We have checked the resolution of this detector with monoenergetic neutrons from a Van de Graaff accelerator. It gives a FWHM of <30 keV for 1 MeV neutrons.

FPND NEWSLETTER CONTRIBUTION

Laboratory: Idaho National Engineering Laboratory

Address: Allied Chemical Corporation
550 Second Street
Idaho Falls, Idaho, 83401
United States

Name: William J. Maeck

Experiment: Fast Reactor Fission Yields and Determination of Burnup for Fast Reactor Fuels

A program is in progress to measure the major fraction of the mass yield curve for the fast fission of ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, and ^{243}Am. All irradiations have been completed and the analytical measurements completed for ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu. Yield calculations have been completed for ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu.

Method: The principal measurement technique is isotope dilution mass spectrometry for the isotopes of Kr, Rb, Sr, Zr, Mo, Ru, Xe, Cs, Ba, La, Ce, Nd, and Sm. The number of fissions is established by the summation of the total atoms in the heavy mass peak.

Accuracy: In general, the errors associated with the ^{233}U, ^{235}U, and ^{239}Pu yields are $\sim$1.5%. For ^{238}U the uncertainty in the reported yields are $\sim$3%.

Future Work: Reduction of the experimental measurements to fast fission yields for ^{240}Pu, ^{241}Pu, and ^{242}Pu is in progress and should be completed by June 1976. Fast yield measurements for ^{237}Np, ^{241}Am, and ^{243}Am will be started in June 1976 and should be completed by June 1977.

Special Comments: The yields reported in this program are for irradiations carried out in a neutron spectrum which is believed to be typical of a Liquid Metal Fast Breeder Reactor. An extensive effort was made to define the spectrum for these irradiations.

Because fast yields vary with neutron energy, all reported fast yield data must be associated with a known reactor spectrum.

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Publications: Maeck, W. J., Editor, "Fast Reactor Fission Yields for ^{233}U, ^{235}U, ^{238}U, ^{239}Pu and Recommendations for the Determination of Burnup on FBR Mixed-Oxide Fuels: An Interim Project Report", U.S. ERDA Rept. ICP-1050-I, January 1975.

Available from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia, 22161, USA.

The following is an abstract of this report.

Fast fission yield data are presented for over 40 stable and long-lived nuclides for ^{233}U, ^{235}U, and ^{238}U irradiated in EBR-II. Also reported are preliminary fast fission yield data for ^{239}Pu. Capture-fo-fission ratio measurements are reported for ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu irradiated in the same assembly. The neutron environment for the irradiation is described. Monitors and their fast fission yield values are recomended for the determination of burnup on uranium-plutonium mixed-oxide FBR fuels.

FPND NEWSLETTER CONTRIBUTION

Laboratory: Idaho National Engineering Laboratory

Address: Allied Chemical Corporation
550 Second Street
Idaho Falls, Idaho, 83401
United States

Name: William J. Maeck

Experiment: New thermal fission yield measurements for ^{235}U and ^{239}Pu.

As part of another nuclear constants measurement program, we have had the opportunity to again measure the fission product atom abundances for several capsules of highly enriched ^{235}U and ^{239}Pu irradiated in a water moderated thermal reactor. Two irradiations were made, one to ∿2% burnup and the other to ∿50%.

Method: The principal measurement technique is isotope dilution mass spectrometry. To date, the atom abundances of the isotopes of Kr, Rb, Xe, Cs, and Nd have been measured. Currently, no measurement of the number of fissions has been made.

Accuracy: To date, only the relative atom abundance of Kr/Nd, Rb/Nd, Xe/Nd, and Cs/Nd have been made. In general, the uncertainty associated with these measured ratios is better than 1.0%.

Discrepancies: The initial results based on relative atom and element ratios indicate significant discrepancies for certain thermal fissions yields based on a comparison of these new data with our previous data (Lisman, et al, Nucl. Sci. Eng. 42, 191-214(1970)) and various yield compilations. In particular, the observed abundance of xenon relative to neodymium is ∿9% higher than previously reported for ^{239}Pu thermal fission, and ∿2% higher for ^{235}U thermal fissions. The significant impact of a higher xenon abundance, especially for ^{239}Pu thermal fission, is that all of the yields in the heavy mass peak and possibly the light mass peak, must be adjusted to preserve the mass balance. A significant discrepancy in the ^{136}Ba yield for ^{239}Pu fission is also indicated.

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In addition to the xenon discrepancy, subtle differences in the isotopic composition of neodymium, and in particular ^{148}Nd were noted. This difference is due to a suspected large neutron capture cross section for the ^{147}Nd, which in long high-flux irradiations will produce abnormal amounts of ^{148}Nd. The net result is an over-estimate of the ^{148}Nd yield and an over-estimate of the burnup when ^{148}Nd is used as the fission monitor.

Although only relative fission product data are available at this time, we believe that the initial observations are of sufficient importance that they be given.

Future Work: Although not defined at this time, we hope to be able to continue and to complete the measurement program in progress and to eventually present a new and improved set of yield data for the thermal fission of ^{235}U and ^{239}Pu.

Publications: These new findings will be reported as "Discrepancies and Comments Regarding ^{235}U and ^{239}Pu Thermal Fission Yields and the Use of ^{148}Nd as a Burnup Monitor", ERDA Rept. ICP-1092 (To be published in June 1976).

CONTRIBUTION I

LABORATORY	Lawrence Livermore Laboratory University of California P. O. Box 808 Livermore, California 94550
NAMES	D. R. Nethaway A. L. Prindle N. L. Smith
FACILITY	Livermore ICT Facility (14-MeV neutron source)
EXPERIMENT	Measure fission yields (both total chain yields and independent yields) for fission of Th-232 with 14.8-MeV neutrons
METHOD	The Th-232 target foil is covered with U-238 foils so that the fission yields can be measured relative to the fission of U-238. Measurements are made both by doing chemical separations and by direct counting with Ge(Li) detectors. The accuracy of the measurements is about $\pm$ 5%.
COMPLETION DATE	The experimental measurements have been completed. The final results should be available as a UCRL report in the spring of 1976, and later as an article in The Physical Review.
DISCREPANCIES TO OTHER REPORTED DATA	The independent yields of Nb-96 and Cs-136 previously reported by S. A. Rao (Phys. Rev. C 5, 171 (1972)) were found to be in serious error.

(same as INDC(NDS)-70, p. 35: still valid)

CONTRIBUTION II

LABORATORY	Lawrence Livermore Laboratory University of California P. O. Box 808 Livermore, California 94550
NAMES	D. R. Nethaway A. L. Prindle W. A. Myers W. C. Fuqua
FACILITY	Livermore ICT Facility (14-MeV neutron source)
EXPERIMENT	Measure fission yields (both total chain yields and independent yields) for fission of Pu-240 with 14.8-MeV neutrons.
METHOD	The Pu-240 target material is covered with U-238 foils so that the fission yields can be measured relative to the fission of U-238. Measurements are made both by doing chemical separations and by direct counting with Ge(Li) detectors. The accuracy of the measurements is about $\pm$ 5%.
COMPLETION DATE	The experimental measurements are almost completed. The results should be published in 1976.

CONTRIBUTION III

LABORATORY	Lawrence Livermore Laboratory University of California P. O. Box 808 Livermore, California 94550
NAMES	D. R. Nethaway A. L. Prindle W. A. Myers M. Kantelo
FACILITY	Undecided
EXPERIMENT	Measure fission yields for fission of Pu-240 with fission-spectrum neutrons.
COMPLETION DATE	We plan to start the measurements early in 1976.

(same as INDC(NDS)-70, pp.36-37; still valid)

Laboratory: Oak Ridge National Laboratory, Bldg. 6010, P.O. Box X, Oak Ridge, Tenn., 37830

Names: R.L. Macklin, J. Halperin

Facilities: Oak Ridge Electron Linear Accelerator (ORELA)
Flight Path 7

Experiment: Fast Neutron (n,γ) Cross Sections E_n = 2.6 - ~500 keV
Target-isotopes: see Table I

Method: Total Prompt Photon Energy Detectors, Neutron Time-of-Flight.
Nucl.Instr. & Meth. 91, 565-571 (1971), Phys.Rev. C11, 1270-1279 (1975).

Accuracy: 2-5% in cross section, $\lesssim$ 0.2% resolution (FWHM)

[Expected] completion date:) see Table I
Publications:)

Table I

Isotopes	Completion date	Publications
^{86,87,88}Sr	indefinite	Data taken, some analysis at U. Antwerp by G. Vanpraet, ^{88}Sr analysis at Lucas Heights and Oak Ridge by J.W. Boldeman, B.J. Allen, R.R. Winters. ^{88}Sr : paper drafted (3/76).
^{89}Y	1976	Data taken, analysis at Lucas Heights, Australia, J. Boldeman starting resonance analysis (9/75) of the data.
^{90,91,92,94}Zr	1976	Data taken, analysis at Lucas Heights, Australia. J.W. Boldeman, A.R. Musgrove, B.J. Allen, R.L. Macklin, "Valence Component in the Neutron Capture Cross Section of ^{90}Zr", Nucl. Phys. A246, 1-20 (1975). ^{92,94}Zr: paper drafted (3/76).
^{93}Nb	Jan 1976	R.L. Macklin, Neutron Capture Cross Section of Niobium from 2.6 to 700 keV, accepted Nuclear Sci. & Eng. 59, 12-20 (1976).
^{92,94,95,96,97,98,100}Mo	1976	O.A. Wasson et al, Neutron Resonance Parameters of ^{92}Mo, Phys. Revw. C7, 1532-1541(1973). J. Boldeman, B.J. Allen et al.: paper drafted (3/76). H. Weigmann, resonance parameter analysis for ^{100}Mo(n,γ) in progress (9/75)
^{103}Rh	indefinite	Data taken, analyst needed.
^{104,105,106,108,110}Pd	indefinite	Data taking completed 1974, ^{105}Pd preliminary analysis (Rlm) distributed to requestors. Analyst needed.

continued

Table I, cont'd

Isotopes	Completion date	Publications
^{106,108,110,111,112,113,114,116}Cd	indefinite	Data taken, analysis being undertaken at Lucas Heights. O.A. Wasson and B.J. Allen, "P-Wave Resonances in ^{111}Cd(n.γ)", Phys.Rev. C7, 780-787 (1973).
^{122,123,124,125,126,128,130}Te	1977	R.R. Winters (Denison Univ., ORNL Consultant) analyzing the data.
^{134,135,136,138}Ba	1976	Data taken, analysis in progress at Lucas Heights, Australia. A.R. Musgrove, B.J. Allen, J.W. Boldeman, R.L. Macklin, "keV Neutron Resonance Capture in ^{138}Ba", Nucl. Phys. A152, 301-319 (1975). ^{134,136}Ba: Nucl. Phys. A256, 173-180 (1976). A.R. Musgrove, B.J. Allen, R.L. Macklin, "keV Neutron Resonance Capture in ^{135}Ba", AAEC/E327 (12/74) (INDC(AUL)-23/L) ^{137}Ba: preprint available (3/76).
^{139}La ^{140}Ce ^{141}Pr	1976-1977	Data taken, analysis is proceeding at Lucas Heights (1976)
^{142,143,144,145,146,148}Nd		Data taken, analysis at Lucas Heights, Australia, by A.R. Musgrove and B.J. Allen.
^{159}Tb	indefinite	Data taken, analyst needed.
^{165}Ho	1976	R.L. Macklin, "The ^{165}Ho(n,γ) Standard Cross Section from 3 to 450 keV", Nucl.Sci. & Eng. 59, 231-236 (1976).
^{169}Tm	indefinite	Data taken, analyst needed.

Laboratory and address: Nuclear Radiation Laboratory
Nuclear Engineering Program
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801
U.S.A.

Names: Bernard W. Wehring

Facilities: Illinois Advanced TRIGA 1.5-MW Nuclear Reactor,
HIAWATHA Fission-Fragment Mass Spectrometer.

Experiment: Direct Physical Measurement of the Primary Postneutron-Emission Nuclide Yields in Thermal-Neutron Fission of U-235, Pu-239, and U-233

Method: The fission-fragment recoil mass spectrometer HIAWATHA, consisting of a cylindrical focusing electrostatic analyzer and time-of-flight system, will be used to determine fragment masses while fragment energy loss will be used to identify fragment atomic numbers in a multiparameter experiment. All fragment velocities and charge states will be measured.

Accuracy: 0.5-amu mass resolution achieved,
about 1-Z atomic-number resolution expected,
2% standard error in largest mass yield, goal,
5% standard error in largest nuclide yield, goal.

Completion date: 1977-1978

Publications:

R. G. Bucher, "An Experimental Study of Stopping Powers for Ions of Intermediate Atomic Numbers," Ph.D. thesis, University of Illinois at Urbana-Champaign, 1975.

R. G. Bucher and B. W. Wehring, "Stopping Power of Nickel for Fission Fragments -- Z_1 Dependence," Trans. Am. Nucl. Soc. 22, 151 (1975).

B. W. Wehring and R. G. Bucher, "Stopping Power for Ions of Intermediate Atomic Numbers, "Proc. Fourth International Conf. Beam-Foil Spectroscopy and Heavy-Ion Atomic Physics Symposium, Sept. 15-19, 1975, Gatlinburg, Tennessee, pp. 679-686 Plenum Publishing Corp., 1976.

Gino DiIorio and B. W. Wehring, "Performance of HIAWATHA, A Fission-Fragment Mass Spectrometer," (accepted for presentation at the 1976 Annual Meeting of the American Nuclear Society, Toronto, 13-18 June 1976).

Laboratory and address: Nuclear Radiation Laboratory
Nuclear Engineering Program
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801
U.S.A.

Names: Bernard W. Wehring

Facilities: Illinois Advanced TRIGA 1.5-MW Nuclear Reactor,
5-μg Cf-252 Fast-Neutron Source,
150-kV Neutron Generator.

Experiment: Determination of Element Yields in Thermal-, Fast-, and 14-MeV-Neutron and Spontaneous Fission from Measured X-Ray Multiplicities

Method: Primary element yields are determined by measuring multiple characteristic x-ray emission rates for each Z split, extrapolating to the case where neither fragment emitted an x ray, and summing over all possibilities for multiple x-ray emission.

Accuracy: 10% standard error in absolute element yields in spontaneous fission of Cf-252 achieved,
5% standard error in absolute element yields in fissions of U-235, Pu-239, U-233, Th-232, and U-238, goal.

Completion date: 1977-1978

Publications:

Laboratory and address: Nuclear Radiation Laboratory
Nuclear Engineering Program
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801
U.S.A.

Names: Bernard W. Wehring

Facilities: Illinois Advanced TRIGA 1.5-MW Nuclear Reactor, Small Open Cf-252 Sources.

Experiment: Measurements of Time-Dependent Energy Spectra of Beta Rays and Gamma Rays from U-235, Pu-239, and Cf-252 Fission Fragments

Method: Beta-ray and gamma-ray spectra are measured for (1) spectrum buildup after initiation of a constant thermal-neutron fission rate in a clean foil, (2) spectrum decay after termination at 8 hr of the constant fission rate, and (3) spectrum decay following a burst of thermal fissions produced by a reactor power pulse. These cases are simulated for spontaneous fission of Cf-252 by using a fission-fragment catcher foil on a transport system. Comparisons of measured and calculated energy spectra provide a sensitive test of decay-heat energy release calculations.

Accuracy: 10% standard error in absolute spectra achieved

Completion date:

Publications:

N. Tsoulfanidis, B. W. Wehring, and M. E. Wyman, "Measurements of Time-Dependent Energy Spectra of Beta Rays from Uranium-235 Fission Fragments," Nucl. Sci. Eng. 43, 42 (1971).

R. A. Knief, B. W. Wehring, and M. E. Wyman, "Measurements of Equilibrium and Time-Dependent Energy Spectra of Beta Rays from Californium-252 Fission Fragments," Nucl. Sci. Eng. 53, 47 (1974).

II. COMPILATIONS, EVALUATIONS

Laboratory and address: DRE/SPNR - CEN.CADARACHE B.P. No. 1
13115 - SAINT PAUL LEZ DURANCE - FRANCE

Names: E. FORT, TRAN QUOC THUONG, J. BLUET

Evaluations:

Purpose: Evaluation of capture and inelastic cross sections for the fast neutron reactor programme.

Method: Selection of resonance parameters - Calculation by BW single and multi-level formalism.

Criticism of the experimental data

Adjustments on these data using statistical and optical model

Elaboration of local or total systematics for the mean parameters.

Major sources of information: Neutron physics literature, BNL 325, Nuclear Data Sheets (level scheme), ENDF/B files, CINDA, NEUDADA library.

Deadline of literature coverage: None

Status: Completed for 22 fission products: 95 Mo, 97 Mo, 98 Mo, 100 Mo, 99 Tc, 101 Ru, 102 Ru, 103 Ru, 104 Ru, 103 Rh, 105 Pd, 107 Pd, 133 Cs, 135 Cs, 141 Pr, 143 Nd, 145 Nd, 147 Pm 149 Sm, 151 Sm, 153 Eu, 109 Ag,
Participation planned for 40 other fission products.

Cooperation: CNEN/BOLOGNA.

Computer file of evaluated data: It will be possible to obtain from CCDN a common evaluation (CNEN-CEA) on magnetic tape (ENDF/B format, 22 FP) in the near future.

Completion date: second semester of 1976.

Publications: P. RIBON et al. - CEA-N-1832, "Evaluation des sections efficaces de capture et de diffusion inélastique de 26 produits de fission".

Laboratory and address : Département de Recherche Fondamentale
Laboratoire de Chimie Physique Nucléaire
Centre d'Etudes Nucléaires de Grenoble
BP.85 Centre de Tri - 38041 GRENOBLE CEDEX - France.

Names : Jean BLACHOT.

Compilation : Decay data (T 1/2, E_γ, I_γ, E_β, Q_β, Pn) of fission products.

Purpose : Library for the C.E.A.

Major sources of information : Nuclear Data Sheet and all journals.

Deadline of literature coverage : September 1975.

Cooperation : C. DEVILLERS (Saclay), C. FICHE (Cadarache).

Computer file : 2 files : 1/ Fission products
2/ Others isotopes.

Magnetic tape can be obtained from CCDN (ENDF/B3) and from Jean BLACHOT.

Publications :

C. DEVILLERS et al. - IAEA - SM - 170/63 (1975).

J. BLACHOT et al. - CEA-N-1822 (1975) "Bibliothèque de données nucléaires relatives aux produits de fission".

Laboratory and address: Health Physics Division,
Bhabha Atomic Research Centre,
Bombay 400 085, India.

Names : D.N.Sharma, M.R.Iyer and A.K.Ganguly.

A. THEORETICAL COMPILATION

(1) Type of data : Fission product independent yields for higher energy fission. (Fast and 14.7 MeV neutron fission of ^{235}U)

(2) Purpose : To predict fission product independent yields for higher energy fission using a fission model because experimentally determined data for these yields are very rare.

(3) Major sources of information: The Order-Disorder Model (ODM)[1,2] developed for thermal fission has been extended to higher energy fission case by evolving a scheme for the distribution of the extra excitation energy between the impending fragments. The experimental data on product mass yields and charge distribution parameters compiled by Meek and Rider[3] have been used as the input values for the computational purpose.

(4) Results and discripencies: The experimental[3] and predicted values as independent and cumulative yields of fission products do not agree very well in all cases. But generally speaking agreement seems to be better in higher yield region. In view of the large variations in the recommended values of Meek and Rider[3,4] and the range of experimental uncertainties quoted for experimental values, it can be stated that the present approach predicts the independent and

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cumulative yields within reasonable limits of error.

(5) Relevant details: The predicted total charge yield distribution shows a small peak in the vicinity of Z = 28. This can be attributed to the proton magic shell effect of Z = 28. Similar conclusion has been drawn after observing experimentally, a shoulder around Z = 28 by Iyer et al[5,6] of this research centre.

(6) Completion date : March 1975.

(7) Publications :

(i) Sharma,D.N., Charge Distribution, Neutron Evaporation and Energy Distribution in Higher Energy Binary Fission, M.Sc. Thesis, Bombay University, Bombay, India (1975).

(ii) Sharma,D.N., Iyer,M.R. and Canguly,A.K., Charge Distribution, Neutron Evaporation and Energy Distribution in Fast Binary Fission, B.A.R.C./I-408 (1976).

B. EVALUATION

(1) Type of data : Experimental data on fission product mass yields and charge distribution parameters.

(2) Purpose and method: The equality of yields of complementary charges is a built-in and necessary condition but not sufficient condition for a fission process. As the evaporation of neutrons from fragments does not shift the charge line of the fragment, the total charge yield distribution remains same for fragment and products. Based upon the above criterian various parameters have been derived to test the consistency of a given set of data on product mass yields and charge distribution parameter.

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(3) Results : The latest set of data compiled by Meek and Rider[3] has been evaluated. In general it is found that fast and high energy (14.7 MeV) data sets are not consistent but the thermal fission data are comparably more consistent except ^{235}U (Thermal) data which also falls in the category of less consistent one.

(4) Completion date : March, 1975.

(5) Publication :

(i) Sharma,D.N., Charge Distribution, Neutron Evaporation and Energy Distribution in Higher Energy Binary Fission, M.Sc. Thesis, Bombay University, India (1975).

(ii) Sharma, D.N., Iyer, M.R., and Ganguly. A.K., Charge Distribution, Neutron Evaporation and Energy Distribution in Fast Binary Fission. B.A.R.C./I-408 (1976).

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1. Iyer,M.R., Ganguly,A.K., Nuclear Charge Distribution in Fission Fragments, Phys. Rev. C 3 (1971) 785.

2. Iyer,M.R., Ganguly,A.K., Neutron Evaporation and Energy Distribution in Individual Fission Fragments, Phys. Rev. C 5 (1972) 1410.

3. Meek,M.E., Rider,B.F., Compilation of Fission Products Yields, Rep. NEDO-12154-1 (1974).

4. Meek,M.E., Rider,B.F., Compilation of Fission Products Yields, Rep. NEDO-12154 (1972).

5. Rao,V.K., Bhargava,V.K., Marathe,S.G., Sahakundu,S.M. and Iyer,R.H., Search for low-yield products in the neutron induced highly asymmetric fission of Uranium, Phys. Rev. C 9 (1974) 1506.

6. Marathe,S.G., Sahakundu,S.M., Bhargava,V.K., Rao,V.K. and Iyer,R.H., Possible Influence of the 28 Proton Shell on Fission Mass Distribution Nuclear Physics and Solid State Physics Symposium Indian Institute of Science, Bangalore (Proc. Symp. Bangalore, 1973) Bangalore, India (1973) 21.

Laboratory and address: CNEN, Centro di Calcolo, Via Mazzini 2, 40138 Bologna (Italy)

Names: V. Benzi, F. Fabbri, T. Martinelli, E. Menapace, M. Motta, G.C. Panini, G. Reffo, M. Vaccari

Evaluation: Complete evaluation and compilation in ENDF/B format, in the energy range 10^{-5}eV-15MeV, of the following 40 isotopes is in progress: Rb-85, Y-91, Zr-(91,92,93,94,95,96), Nb-95, Ru-(100,106), Pd-(104,106,108,110), Cd-111, In-115, Te-128, Ba-(138,140), La-139, Ce-(140,141,142,144), Pr-143, Nd-(144,146,147,148,150), Sm-(147,150, 152,154), Eu-(154,155), Gd-(156,157), Tb-159.
Each file contains resolved and mean resonance parameters, relevant cross sections (i.e., total, elastic, inelastic, n-2n, n-γ, n-p and n-α), angular and secondary energy distributions.

Purpose: Estimate of fast reactor long term reactivity changes.

Method: Calculations by BW-single and -multilevel formalism (resonance region) and by statistical and optical models.

Major sources of information: NEUDADA, CINDA.

Deadline of literature coverage: December 1975.

Status: 15 isotopes of the above list have been evaluated at the date of 30 April 1976.

Cooperation: CEA: Cadarache and Saclay; RCN: Petten.

Other relevant details: 25 group cross sections at infinite dilution and 0°K temperature have been generated for each evaluated isotope.

Computer file of compiled data: ENDF/B format.

Computer file of evaluated data: ENDF/B format.

Expected completion date: July 1976 for the complete files of about 20 isotopes.

Laboratory and Address: Japanese Nuclear Data Committee/F.P. Nuclear Data Working Group (Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken, Japan)

Names: S. Iijima (Nippon Atomic Industry Group Co.) group leader
T. Igarasi, T. Nakagawa, Y. Kikuchi, Z. Matsumoto (JAERI)
H. Matsunobu (Sumitomo Atomic Industries)
K. Kawai, T. Yoshida, T. Murata (Nippon Atomic Industry Group Co.)
H. Maeki (Mitsubishi Atomic Industries, Inc.)
H. Nakamura (Fuji Electric Co.)
T. Watanabe (Kawasaki Heavy Industries)
I. Otake (Power Reactor and Nuclear Fuel Development Corporation)
R. Nakasima (Hosei Univ.)

Compilation: (Nuclear level schemes by Nakasima, Matsumoto and Murata.
Neutron capture and inelastic cross sections by Matsunobu and Watanabe.)
Purpose: For evaluation of neutron cross sections of F.P.
Major sources of information:
Recent Reference List and Nuclear Data Sheets for level schemes.
CINDA75 and NEUDADA tape for neutron cross sections.
Deadline of literature coverage: Mid 1976
Cooperation with other groups : none in particular
Other relevant details: Compilation covers about 90 F.P. nuclides.
Computer files: A modified file based on ORNL nuclear structure data file format was prepared to store level scheme data and is under test.
NESTOR file is used for comparsion plotting of cross section data.
Expected completion date: Mid 1976
Publications: JAERI-M5752(1974) for level schemes of 28 nuclides.
Paper presented to Bologna conference(1973) by Matsunobu for capture cross sections of 11 nuclides.

Evaluation: (neutron cross section, ongoing)
Purpose: For entry to JENDL/1 (Japanese Evaluated Nuclear Data Library)
Method: Calculation with optical model and statistical theory, adjusted by capture data. Also, semi-empirical statistical theory in unresolved resonance region.
Major sources of information:
Compilation of level schemes and cross sections described above, and BNL-325 3rd edition for resonance parameters.

(continues)

(cont'd)

Deadline of literature coverage: Mid 1976

Cooperation with other groups: JNDC/F.P. Reactor Constants Working Group

Status: Evaluation was completed for 27 nuclides in March 1975. For other about 70 nuclides, the work started from April 1975. Preparation of input data is at the final stage.

Other relevant details: JNDC/F.P. Reactor Constants Working Group performed integral test of our evaluated data of 27 nuclides using F.P. reactivity measurements data in STEK reactor at Petten. The attched Table 1 shows our results in comparison with F.P. data of ENDF/B-4 for the measurements in STEK-1000 reactor. (communicated by Y. Kikuchi, A. Hasegawa and H. Nishimura, JAERI)

Computer file of compiled data: NESTOR

Computer file of evaluated data: JENDL

Discrepancies encountered: Not much to add to those reported in INDC(NDS)-70.

Expected completion date: End of 1976

Publication: JAERI-M5752(1974), Evaluation of Neutron Cross Sections of 27 Fission Product Nuclides important for Fast Reactor, submitted to Journal of Nucl. Sci. and Technol. (1976)

JNDC/FPND Working Group
April 24, 1976

Other relevant details :

Table 1. Cal./Exp. Values for F.P. Sample Reactivities in STEK-1000 Reactor

Isotopes	JENDL/1	ENDF/B-4	Comment
Zr-93	0.93	0.62	core dependence not understandable
Mo-95	0.98	0.97	
Mo-97	1.07	0.91	
Tc-99	0.66	0.62	
Ru-101	0.85	0.62	
Ru-102	2.2	2.0	small reactivity
Ru-104	2.5	2.35	small reactivity
Rh-103	0.88	0.98	
Pd-105	0.72	0.82	
Pd-107	0.67	0.50	
Ag-109	0.82	0.59	
I-129	2.7	2.2	
Cs-133	0.86	0.86	
Cs-135	0.4	-	core dependence not understandable
Nd-143	1.22	1.20	
Nd-144	3.0	3.7	small reactivity
Nd-145	0.76	0.69	
Pm-147	0.74	0.85	
Sm-147	0.94	0.65	
Sm-149	0.78	0.53	
Sm-151	0.49	0.50	
Eu-153	0.87	0.85	
U-235	0.94	-	JAERI-FAST set, Version 2
B-10	0.92	-	JAERI-FAST set, Version 2

Japanese Nuclear Data Committee/Decay Heat Nuclear Data Working Group

R. Nakasima (Hosei University) group leader
M. [illegible]
T. Tamai (Kyoto University, now at West-Germany)
I. [illegible]
S. Iijima, T. Murata and T. Yoshida (Nippon Atomic Industry Group Co.)
T. Hojuyama (Mitsubishi Atomic Power Industry)
K. Umemura, K. Tasaka, Y. Matumoto and T. Tamura (JAERI)

1. Compilation: Decay data and delayed neutron data (planned)

Purpose: For summation calculation of after heat

Major Sources of Information:

Nuclear Data Sheets, especially Recent Reference List appeared in Nuclear Data Sheets

Deadline of Literature Coverage: None

Cooperation: None

Other Relevant Details: Subgroup member (Hojuyama, Matumoto, Murata, Tasaka and Iijima) are now studying data storage and retrieval system referring to ORNL nuclear structure file

Computer file: None at present

Expected Completion Date: None, but the end of this year for data storage and retrieval system

Publications: None

2. Evaluation: Beta decay data (on going)

Purpose: Making more reliable estimation for short-lived nuclides for which experimental data are either not available or less reliable

Method: Application of gross theory of beta decay and various mass formulae

Major Sources of Information:

Several works by M. Yamada and his collaborators, for example Atom. Data and Nucl. Data Tables 12 (1973) 101

Deadline of Literature Coverage: None

Status: A computer programm based on gross theory of beta decay, originally developed by Waseda Group, has been revised by Yoshida for the present purpose (GROSS-M,-P) and some 100 nuclides have been tested comparing estimated and experimental results, but quite preliminary

Cooperation: Yamada's group at Waseda University

Other Relevant Details: Preliminary test shows that further investigation is necessary for parameters included in GROSS-M and -P.

Computer File of Compiled Data: None

Computer File of Evaluated Data: None

Discrepancies Encountered: Not clear yet

Expected Completion Date: April 1976 for important short-lived fission product nuclides

Publications: "Estimation of Decay Data for Short-Lived Fission Products" (1975), NEACRP A-241
T. Yoshida; JAERI-M 6313 (1975)

Evaluation: released beta and gamma energies from fission products: (planning)

Purpose: Making data file for calculation of after heat

Method: Use of yield and decay data compiled or estimated by ourselves

Major Sources of Information:

Our own compiled and estimated data supplemented by other evaluated data

Deadline of Literature Coverage: Not set up yet

Status: Decay data; as mentioned above
Yield data; going on

Cooperation: None

Other Relevant Details: Charge yield of fission product nuclides is not so easy to get recommendable value

Computer File of Compiled Data: None at present

Computer File of Evaluated Data: None

Discrepancies Encountered: Not clear yet

Expected Completion Date: Hopefully, early in 1977

Publications: None, but some of the members, for example, Tasaka and Umezawa reported some before our plan was discussed

Laboratory and address	Reactor Centrum Nederland Petten (N.H.) The Netherlands telephone: (02246) - 6262 telex : 57211 reacp nl
Names	J.B. Dragt, J.W.M. Dekker, H. Gruppelaar, R.J. Heyboer and A.J. Janssen
Evaluation	(1) RCN-2 evaluation of neutron cross sections (σ_t, σ_e, $\sigma_{n\gamma}$, $\sigma_{nn'}$-matrix, σ_{n2n}) for about 60 fission products in the energy range of 10^{-3} eV to 15 MeV, in KEDAK type format, for the following elements, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, Te, I, Xe, Cs, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb. (2) Generation of group cross sections for fast reactor calculations based on RCN-2 evaluation in the 26 group ABBN scheme with a fast reactor flux weighting spectrum and error files for capture group constants, including 26×26 covariance matrices. (3) Adjustment of capture group constants based on (2) and integral STEK measurements. (4) Generation of an adjusted point cross section library (RCN-3) based on STEK integral data.
Purpose	Fast breeder power reactor data needs.
Method	Calculation with multilevel Breit-Wigner formula, optical model and statistical model, taking into account all available experimental information.
Major sources of information	BNL-325, NEUDADA, CINDA, Nuclear Data Sheets.
Deadline of literature coverage	February 1975 to March 1976.
Status	(1-3) Completed for ^{101,102,104}Ru, ^{127}I, ^{103}Rh, ^{133}Cs, ^{99}Tc, ^{139}La, ^{141}Pr, ^{93}Nb, ^{92,94,95,96,97,98,100}Mo, ^{102,104,105,106,107,108,110}Pd; (4) planned for 1977.
Co-operation	CEA (Cadarache and Saclay), CNEN (Bologna).
Computer file	(1) KEDAK type format.
Completion date	(1-3) December 1976; (4) October 1977.
Publication	H. Gruppelaar, J.B. Dragt, A.J. Janssen and J.W.M. Dekker, Evaluation, uncertainty estimation and adjustment of capture cross sections for fission product nuclei; Nucl. Cross Sections and Technology (Conf. Washington), NBS special publ. 425, vol. 2 (1975) p. 165.

UKAEA
Atomic Energy Research
Establishment, Harwell,
Oxfordshire, OX11 ORA

Laboratory	AERE Harwell
Name	E.A.C. Crouch
Compilation	Chain, Cumulative and Indpendent fission product yields for all neutron induced fission reactions with neutrons of energy up to 14 MeV, including spontaneous fission. Ongoing compilation.
Purpose	Basic data for fission yield evaluation.
Sources	Journals, Proceedings of Learned Societies, or other open literature.
Deadline	No results prior to 1950 are collected.
Cooperation	We are prepared to exchange files with other groups.
Computer File	Information held in standard forms on Computer Files.
Completions	Continuous compilation.
Publications	AERE R6642 'A library of neutron induced fission product yields maintained and interrogated by computer methods'. 'Part I: The establishment of the library'. E.A.C. Crouch, December 1970. AERE R7207 'A library of neutron induced fission product yields maintained and interrogated by computer methods'. 'Part II: The interrogation of the library'. E.A.C. Crouch, August 1972

(same as INDC(NDS)-70, p. 54/1; still valid)

Laboratory	AERE, Harwell
Name	E.A.C. Crouch
Evaluation	Evaluation of neutron induced fission product yields for all fissile nuclides at neutron energies up to 14 MeV.
Purpose	Reactor design and operation
Method	The individual yields for a given reaction are examined, weighted and the means calculated together with the errors.
Sources	Compilation described above
Deadline	No results prior to 1950 are collected.
Status	Evaluation just started.
Co-operation	We are prepared to exchange files with other Groups.
Computer file	Compilation as above.
Computer file of Evaluated Data	Card file in ENDF/BIV Format.
Discrepancies	Not yet found.
Publication	Sometime in 1976

(same as INDC(NDS)-70, p. 54/2; still valid)

Laboratory: AERE Harwell

UKAEA
AERE Harwell,
Oxfordshire OX12 ORA,
England.

Working group: B.S.J. Davies — CEGB, Berkeley
M. F. James — AEE Winfrith
A. L. Nichols — AERE Harwell
D. G. Vallis — Aldermaston

Ongoing and planned activities

1) Compilation and evaluation

Fission Product decay data

purpose : to provide a comprehensive, continually updated data file of radionuclidic half-lives, β and γ energies and intensities.

major sources of information : an initial data base of two separate (pre-1974) γ-libraries are being used, and are to be merged into one data file. They are the FPND of A. Tobias (CEGB RD/B/M2669) and the comprehensive γ-library of G. Erdtmann and W. Soyka (Jülich 1003-AC). The recent literature and NDS are also being surveyed.

deadline of literature coverage : an acceptable data file is expected by late 1976, the first round of the literature evaluation being up to December 1975 and incorporated into the file.

co-operation : the French bibliography (J. Blachot) will be used to aid FP data input.

relevant details : it is hoped that further comparisons of this data with other data files (e.g. US ENDF/BIV file) will be possible. The literature is also continually being assessed, and it is hoped that updating will occur annually from the completion date onwards. The data file will eventually be in ENDF/BIV format. Although the first priority is FP data, the data file will also include decay data of non-FP nuclides.

expected completion date : late 1976, including the first round of literature evaluations.

(same as INDC(NDS)-70, p.54/3; still valid)

(cont'd)

2) Decay scheme calculations

purpose : to compare experimental data with decay data calculated from a more basic data set (e.g. spin, parity etc.)

major sources of information : ORNL data file containing the various parameters of decay levels. Internal conversion coefficient data of Trusov, and Hager and Seltzer will be used. The program also uses the calculated $(\bar{E}/E_o)_\beta$ of Widman et al, and the calculated EC/β^+ of Zweifel. The intention is also to use data from the latest Lederer and Hollander Table of Isotopes.

co-operation : Department of Nuclear Technology, Imperial College, London.

relevant details : CASCADE, a computer program written by D. G. Vallis, is being used to compute the decay data of a parent nuclide to its daughter(s). It is hoped that a direct comparison between the computed results and experimental data will highlight discrepancies, and also reveal compilation errors in decay data files. The program will be applied to FP nuclides initially.

publications : The CASCADE program, D.G. Vallis
AWRE Report No. O 45/74

(same as INDC(NDS)-70, p. 54/4; still valid)

Laboratory and address: General Electric Company, Vallecitos Nuclear Center, P. O. Drawer B, Pleasanton, CA 94566 U.S.A.

Name: B. F. Rider

Compilation: Fission product yields (from thermal, fast, 14 MeV neutron-induced fission in U, Pu, Th nuclides)

purpose: For burnup and fission rate and decay heat calculations. Basis for ENDF/B-IV FP yields.

major sources of information: ClNDA, Nuclear Science Abstracts, RECON, correspondence

deadline of literature coverage: ongoing

cooperation: (with other groups, if any) Brookhaven (SIGMA Center), Cross-Section Working Evaluation Group (LSWEG), Evaluation Nuclear Data File (ENDF/B-IV), Fission Product Decay Heat Task Force

other relevent details (if any): approximately 12000 entries from 800 references

Computer file: Tape available as ENDF/B-IV from Brookhaven National Lab., U.S.A.

[expected] completion date: August 1974. ENDF/B-V (next version) planned for 1976 or 1977.

Publications: "Compilation of Fission Product Yields," NEDO-12154-1 available from General Electric Co., P. O. Drawer B, Pleasanton, CA 94566, U.S.A., Attn: B. F. Rider

III. DISCREPANCIES

Apart from those already summarized in the first issue of this series, INDC(NDS)-70, p. 58, the following discrepancies have been reported:

A. Experiments:

p. 26: the measured P_n values of 11 'alkali metal nuclides' (Rb, Cs) tend to be higher than those obtained from other recent measurements.

B. Evaluations:

p. 44: the evaluated neutron cross-sections of JENDL/1 on the one hand and of ENDF/B-IV on the other hand were used to calculate reactivities for which experimental values exist. The fraction calculation/experiment for both libraries is given on p. 44.