International Atomic Energy Agency

INDC(NDS)-379
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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

PROGRESS

IN

FISSION PRODUCT NUCLEAR DATA

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

Collected by M. Lammer

Nuclear Data Section
International Atomic Energy Agency
Vienna, Austria

No. 15

1998

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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NOT FOR PUBLICATION

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Printed by the IAEA in Austria
June 1998

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Page numbers in brackets refer to collaborations, which are not listed under "Laboratory and Address".

FOREWORD

This is the 15th 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.

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

Fission product **yields** (from induced and spontaneous fission);
Neutron reaction **cross sections** of fission products;
Data related to the radioactive **decay** of fission products;
Delayed neutron data from neutron induced and spontaneous fission;
Lumped fission product data (decay heat, absorption etc.)

The **first part** of this report (Part A) consists of 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. Contributions containing information on the data types given above are accepted. Contributions on experimental work can usually be included repeatedly until the final publication is presented. Contributions on evaluations continue to be included as long as the data or files are not superseded.

The **Part B** contains some recent references relative to fission product nuclear data, which were not covered by the contributions submitted, and selected papers from conferences. However, completeness of literature citations in this part is not attempted, and only important or comprehensive work is included.

NOTE

Part C contains requirements for **further FPND measurements** (see also "Note to Measurers" on the next page, which were recommended by participants in IAEA Coordinated Research Programmes dealing with fission yield data.

The 14th issue of this series was published in June 1994 as INDC(NDS)-304. The present issue includes contributions which were received by NDS between July 1994 and 15 April 1998.

In case future issues of this report series will be published, the format for submitting contributions will be communicated together with the request for contributions.

NOTE TO MEASURERS

Participants of an earlier (now terminated) **IAEA Coordinated Research Programme (CRP) on the "Compilation and Evaluation of Fission Yield Nuclear Data"** and a new **CRP on "Fission Product Yield Data Required for Transmutation of Minor Actinide Nuclear Waste"** (see also Part C) issued several recommendations and requests of relevance to measurers, which are summarized below:

1) **EXFOR** (Exchange FORmat) will be commonly used as the format and data base for the compilation and exchange of experimental fission yield data. It provides for the inclusion of detailed information on the experimental conditions and data analysis. Authors of papers which are compiled into EXFOR receive copies of the entries for proof-reading, which makes an EXFOR entry a publication which can be cited. Therefore it is essential that **measurers respond to author proofs** and experimental details requested by compiler.

2) Special care should be taken by **measurers of independent yields** to take into account isomeric yields and branching fractions for decay and delayed neutron emission, and the numerical values used should be given. It should be clearly stated whether the data are before or after delayed neutron emission. Measurers are urgently requested to publish sufficient details on the method used, and how these data were used in the analysis.

3) **Publication of uncertainties and experimental details**:
Measurers should publish all contributions to the overall uncertainty in detail, i.e.: statistical error, systematic error contributions (determined or estimated), correlations and covariances (or at least estimates of correlation coefficients). Furthermore, sufficient details on the experiments, results, data and error analyses should be given which are pertinent for the data evaluation. If journal editors do not accept such lengthy descriptions of the experiments, the relevant details can be either

   - published in a laboratory report, or
   - communicated directly to evaluators. In any case should they be
   - provided to the EXFOR compiler for inclusion in the entry.

   This should also be done if errors in the data are detected or data are withdrawn by measurers.

4) Further **measurements** of fission yields are still needed as given in more detail in Part C of this issue.

   The tables of individual yields as requested by the earlier (terminated) CRP are given in the **Supplement to WRENDA 93/94, INDC(SEC)-105**. In summary, cumulative, independent and isomeric are requested as function of incident neutron energy and fissioning nuclide. Regarding the chain yields, measurers are asked to look at the tables of discrepancies in INDC(SEC)-105, look at their own measurements and analyse the data.

   For the new CRP, photon-, neutron and charged particle induced fission yields (in particular systematic studies) are required for projectile energies up to 150 MeV.

PART A: ORIGINAL CONTRIBUTIONS

A1 - Measurements

SUBJECT INDEX

1. Fission yields

1.1 Spontaneous fission

1.2 Photofission

1.2 Photofission (cont.)

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U-238	6.1,13.1 MeV	fragment kinetic energy and indep. yield	12
U-238	12,15,20 MeV	ternary fission yields (LCP emission)	11
Np-237	12,15,20 MeV	ternary fission yields (LCP emission)	11
Pu-242	12,15,20 MeV	ternary fission yields (LCP emission)	11

1.3 Neutron induced fission

nuclide	neutron energy	data measured	page
Th-229	thermal	charge distribution	40
		fragment angular momenta, A=128-138	41
Th-232	fast	cumulative and independent yields	71
U-233	thermal	charge distribution	40
		fragment angular momenta, A=128-138	41
		A=131-136 fragment kinetic energy	68
		cumulative and independent yields	71
	fast	cumulative and independent yields	70
U-235	thermal	fragment mass-energy-neutron correlation	36
		charge distribution	40
		fragment angular momenta, A=128-138	41
		A=131-136 fragment kinetic energy	68
	res. region	ternary α,t yields and energy distribution	18
	8 MeV	Zr-95, Ba-140, Nd-147 yields	27
U-238	pile	absolute yields	42
	1.2-5.8 MeV	fragment kinetic energy and mass distribution	19
	11.3 MeV	yields for 40 chains	28
Np-237	pile	absolute yields	42
		A=131-136 fragment kinetic energy	68
	fast	fragment angular momenta, A=128-138	41
	0.3-5.5 MeV	fragment kinetic energy and mass distribution	20
Np-239	thermal	shell effects in very asymmetric fission	38
Pu-238	pile	absolute yields	42
Pu-239	thermal	fragment kinetic energy and mass distribution	17
		charge distribution	40
		fragment angular momenta, A=128-138	41
		A=131-136 fragment kinetic energy	68
	res. region	ternary α,t yields and energy distribution	18
		fragment kinetic energy and mass distribution	21
Pu-240	pile	absolute yields	42

1.3 Neutron induced fission (cont.)

1.4 Light charged particle induced fission

1.4 Light charged particle induced fission (cont.)

nuclide	particle/energy	data measured	page
	antiprotons		
Au-197	0.1-1.9 GeV/c	fragment mass+energy distribution	36
Bi-209	0.1-1.9 GeV/c	fragment mass+energy distribution	36
Th-232	0.1-1.9 GeV/c	fragment mass+energy distribution	36
U-238	0.1-1.9 GeV/c	fragment mass+energy distribution	36
	alphas		
Bi-209	55.7-58.6 MeV	mass yields	43
	55.7-58.6 MeV	charge distribution	44
Th-232	29-44 MeV	fragment angular distribution	45
U-238	29-44 MeV	fragment angular distribution	45
	25-44	fragment (A=131-134) angular momenta	46
Np-237	29-44 MeV	fragment angular distribution	45
	25-44	fragment (A=131-134) angular momenta	46
Pu-240	29-44 MeV	fragment angular distribution	45

1.5 Heavy ion induced fission

nuclide	projectile: energy	data measured	page
Bi-209	O-16: 89.5 MeV	mass yield	47
Th-232	B-10: 72 MeV	angular distribution: 17 products	48
	C-12: 79 MeV	mass yield	47
	84 MeV	angular distribution: 17 products	48
	O-16: 98 MeV	independent yields of iodine isotopes	49
	92-100 MeV	angular distribution: 17 products	48
	92+105 MeV	mass yield	47
	F-19: 95+112 MeV	mass yield	47
U-238	98 MeV O-16	independent yields of iodine isotopes	49

2. Neutron reaction cross-sections

nuclide	neutron energy	data measured	page
As-75	thermal	thermal σ and resonance integral	73
Se-74	thermal	thermal σ and resonance integral	73
Kr-84	res. region	capture	23

2. Neutron reaction cross-sections (cont.)

nuclide	neutron energy	data measured	page
Kr-86	res. region	capture	23
Rb-87	25 keV	(n,γ) Maxwellian average	31
Sr-90	thermal	capture	50
	thermal	capture	59
Zr-94	thermal	thermal σ and resonance integral	73
Mo-92	0.2-3.3 MeV	inelastic	22
Mo-98	0.2-3.3 MeV	inelastic	22
Mo-100	0.2-3.3 MeV	inelastic	22
Tc-99	thermal	capture σ and resonance integral	60
	res. region	parity of neutron resonances	23
	3 eV - 100 keV	total, capture	29
Pd-104	0.2-3.3 MeV	inelastic	22
Pd-106	0.2-3.3 MeV	inelastic	22
Pd-108	0.2-3.3 MeV	inelastic	22
Pd-110	0.2-3.3 MeV	inelastic	22
Ag-107	res. region	capture	23
	res. region	parity of neutron resonances	23
Ag-109	res. region	capture	23
	res. region	parity of neutron resonances	23
Cd-106	14.6 MeV	(n,d)+(n,np)+(n,pn)	72
Cd-108	14.6 MeV	(n,d)+(n,np)+(n,pn)	72
Cd-110	14.6 MeV	(n,d)+(n,np)+(n,pn)	72
Cd-112	14.6 MeV	(n,d)+(n,np)+(n,pn)	72
Cd-114	14.6 MeV	(n,d)+(n,np)+(n,pn)	72
Cd-116	14.6 MeV	(n,d)+(n,np)+(n,pn)	72
Sn-112	14.6 MeV	(n,p), (n,α), (n,d)+(n,np)+(n,pn)	72
Sn-114	3-225 keV	(n,γ)	31
	14.6 MeV	(n,p), (n,α), (n,d)+(n,np)+(n,pn)	72
Sn-115	3-225 keV	(n,γ)	31
Sn-116	3-225 keV	(n,γ)	31
	<20 keV	resonance spectroscopy	31
	14.6	(n,p), (n,α), (n,d)+(n,np)+(n,pn)	72

2. Neutron reaction cross-sections (cont.)

2. Neutron reaction cross-sections (cont.)

many = several target nuclides not specified (often systematics)

3. Decay data

3. Decay data (cont.)

3. Decay data (cont.)

*) targets not specified

4. Delayed neutron data

5. Decay heat

nuclide	neutron energy	data measured	page
U-233	thermal	fragment prompt conversion electrons	66
U-235	thermal	fragment prompt conversion electrons	66
Np-237	fast	total decay heat	62
Pu-239	thermal	fragment prompt conversion electrons	66
Am-241	fast	total decay heat	62
Am-243	fast	total decay heat	62
Cm-244	fast	total decay heat	62

BELGIUM

Laboratory and address:	Vakgroep Subatomaire en Stralingsfysica Proeftuinstraat 86, B-9000 Gent (Belgium)
Names:	M. Verboven, E. Jacobs, D. De Frenne, H. Thierens, P. D'Hondt
Facilities:	70 MeV Linac
Experiment:	Emission of light charged particles in the spontaneous fission of ^{244}Pu and the photofisson of ^{230,232}Th, ^{233,234,235,238}U, ^{237}Np and ^{242}Pu with 12, 15 and 20 MeV bremsstrahlung.
Method:	Determination of the yield of ^{3}H and ^{4}He particles, using ΔE-E detectortelescopes for photofission experiments. Determination of yield of ^{4}He particles, using single surface barrier detector for s.f.
Completion date:	June 1994
Publications:	M. Verboven, E. Jacobs, D. De Frenne, Phys. Rev.C49(1994)991 M. Verboven, E. Jacobs, D. de Frenne, H. Thierens, P.D'hondt, Phys. Rev. C49(1994)1722
Contact:	E. Jacobs

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Laboratory and address:	Vakgroep Subatomaire en Stralingsfysica Proeftuinstraat 86, B-9000 Gent (Belgium)
Names:	S.Pommé, E. Jacobs, M. Piessens, D. De Frenne, K. Persyn, K. Govaert, M.L. Yoneama
Facilities:	15 MeV Linac
Experiment:	Measurement of kinetic energy and measurement and calculation of independent yields of fission fragments for the photofission of ^{232}Th, ^{235}U and ^{238}U with 6.1 - 13.1 MeV bremsstrahlung.
Method:	Measurement of E1 and E2 with surface barrier detectors. Gamma spectrometry on catcher foils or on pneumatically transported actinide disks
Completion date:	December 1996
Publications:	M. Piessens et al., Nucl. Phys. A556(1993)88 M. Piessens et al., Nucl. Instr. B82(1993)7 S. Pommé et al., Nucl. Phys. A560(1993)689 S. Pommé et al., Nucl. Phys. A572(1994)237 K. Persyn et al., Nucl. Phys. A615(1997)198 K. Persyn et al., Nucl. Phys. A620(1997)171
Contact:	E. Jacobs

BELGIUM

Laboratory	:	Department of Subatomic and Radiation Physics, University, B-9000 Gent, Belgium Institut Laue-Langevin, F-38042 Grenoble, France
Names	:	C. Wagemans, P. Geltenbort, P. Schillebeeckx, F. Gönnenwein
Facilities	:	High Flux Reactor, Institut Laue-Langevin, Grenoble
Experiment	:	Fission fragment kinetic energy, mass and charge distributions for $^{241}Pu(n_{th},f)$ and $^{243}Am(n_{th},f)$
Method	:	^{241}Pu : Cosi-Fan-Tutte fission fragment spectrometer ^{243}Am : coincident fission fragments detected with surface barrier detectors
Accuracy	:	
Completion date	:	1996
Discrepancies to other reported data	:	
Publications	:	1) P. Schillebeeckx, C. Wagemans, P. Geltenbort, F. Gönnenwein, A. Oed, Investigation of mass, charge and energy of $^{241}Pu(n_{th},f)$ fragments with the Cosi-Fan-Tutte spectrometer, Nucl. Phys. A580 (1994) 15. 2) C. Wagemans, L. Demattè, S. Pommé, P. Schillebeeckx, Mass and energy distributions for $^{243}Am(n_{th},f)$, Nucl. Phys. A597 (1996) 188.
Contact	:	C. Wagemans, Dept. of Subatomic and Radiation Physics, University, B-9000 Gent, Belgium e mail :WAGEMANS@IRMM.JRC.BE

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Names	:	C. Wagemans, P. Geltenbort, J. Wagemans
Facilities	:	High Flux Reactor, Institut Laue-Langevin, Grenoble
Experiment	:	Thermal neutron induced (n,α) and (n,p) reactions on fission products.
Method	:	Charged particle detection with surface barrier detectors and surface barrier telescope (ΔE-E) detectors.
Accuracy	:	
Completion date	:	Systematic study in progress.
Discrepancies to other reported data	:	
Publications	:	C. Wagemans et al., Proc. Int. Symp. Nuclei in the Cosmos, Baden/Vienna (Austria), 1990, 296.
Contact	:	C. Wagemans, Dept. of Subatomic and Radiation Physics, University, B-9000 Gent, Belgium e mail :WAGEMANS@IRMM.JRC.BE

E.C. BELGIUM

Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium
Names	:	F.-J. Hambsch, J. van Aarle
Facilities	:	Neutron time-of-flight spectrometer GELINA, 7 MV and 3,7 MV Van de Graaff
Experiment	:	Fission fragment total kinetic energy, mass and angular distributions of $^{252}Cf(sf)$ in correlation with prompt gamma detection.
Method	:	Twin Frisch gridded ionization chamber for coincident fission fragment detection. HP-Ge detector for gamma detection.
Accuracy	:	Fragment mass resolution better than 1 u. Fragment energy resolution about 0.5 MeV.
Completion date	:	Data evaluation pending.
Discrepancies to other reported data	:	
Publications	:	F.-J.. Hambsch, J. van Aarle, R. Vogt Proc. Of XIII Meeting on Physics of Nuclear Fission, Oct. 3-6, 1995, Obninsk, Russia, p. 27
Contact	:	F.-J. Hambsch e-mail : hambsch@irmm.jrc.be

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Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium
Names	:	F.-J. Hambsch, S. Oberstedt
Facilities	:	Neutron time-of-flight spectrometer GELINA, 7 MV and 3,7 MV Van de Graaff
Experiment	:	Far asymmetric fission fragment mass yield of ^{252}Cf(sf).
Method	:	Twin Frisch gridded ionization chamber for coincident fission fragment detection.
Accuracy	:	Fragment mass resolution better than 1 u. Fragment energy resolution about 0.5 MeV.
Completion date	:	1997
Discrepancies to other reported data	:	
Publications	:	F. -J. Hambsch, S. Oberstedt Nucl. Phys. A617 (1997) 347
Contact	:	F.-J. Hambsch e-mail : hambsch@irmm.jrc.be

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Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium Dept. of Subatomic and Radiation Physics, University, B-9000 Gent SCK/CEN, B-2400 Mol, Belgium
Names	:	L. Dematté, C. Wagemans, P.D'hondt, A.J. Deruytter
Facilities	:	Thermal neutron beam at the Reactor BR1
Experiment	:	Fission fragment kinetic energy and mass distributions for ^{236}Pu(s.f.), ^{238}Pu(s.f.), ^{239}Pu(n_{th},f), ^{240}Pu(s.f.), ^{242}Pu(s.f.) and ^{244}Pu(s.f.)
Method	:	Coincident fission fragments detected with surface barrier detectors. Deduced fragment mass and energy distributions.
Accuracy	:	
Completion date	:	1997
Discrepancies to other reported data	:	
Publications	:	L. Dematté, C. Wagemans, R. Barthélémy, P. D'hondt and A.J. Deruytter, Fragments' mass and energy characteristics in the spontaneous fission of ^{236,238,240,242,244}Pu, Nucl. Phys. A617 (1997) 331.
Contact	:	C. Wagemans, Dept. of Subatomic and Radiation Physics, University, B-9000 Gent, Belgium e mail : WAGEMANS@IRMM.JRC.BE

E.C. BELGIUM

Laboratory: EC-JRC, Institute for Reference Materials and Measurements
B-2440 Geel, Belgium

Dept. of Subatomic and Radiation Physics
University, B-9000 Gent

Names: O. Serot, C. Wagemans, S. Pommé

Facilities: Neutron time-of-flight spectrometer at the 150 MeV linac GELINA

Experiment: Yields and energy distributions of the ternary alpha's and tritons for spontaneously fissioning Pu- and Cm-isotopes and in the $^{235}U(n,f)$ and $^{239}Pu(n,f)$ resonances.

Method: The charged particles are identified with ΔE (ionization chamber) - E(surface barrier) telescope detectors.

Accuracy: -

Completion date: Measurements in progress

Discrepancies to other reported data: -

Publications:

1. S. Pommé and C. Wagemans
   Ternary-to-binary fission ratios in the resonance for $^{235}U(n,f)$,
   Nucl. Phys. A587 (1995) 1

2. O. Serot, C. Wagemans et al., Influence of the fission modes on the light charged particles emission in ternary fission, Proc. Int. Conf. On Nucl. Data for Science and Technology, Trieste (It.), 1997, $^{239}Pu(n,f)$, $^{238, 240, 242, 244}Pu(sf)$

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Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium
Names	:	F.-J. Hambsch, F. Vivès, H. Bax
Facilities	:	Neutron time-of-flight spectrometer GELINA, 7 MV and 3,7 MV Van de Graaff
Experiment	:	Fission fragment total kinetic energy and mass distribution for $^{238}U(n,f)$ from 1.2 MeV to 5.8 MeV incident neutron energy.
Method	:	Twin Frisch gridded ionization chamber for coincident fission fragment detection.
Accuracy	:	Fragment mass resolution about 2 u. Fragment energy resolution about 1.5 MeV, $2 \cdot 10^5$ coincident events recorded.
Completion date	:	Data evaluation and interpretation still ongoing.
Discrepancies to other reported data	:	
Publications	:	F.-J. Hambsch, S. Oberstedt, F. Vivès, J. van Aarle, H. Bax and G. Barreau, Int. Conf. on Fission and Properties of Neutron Rich Nuclei, Nov. 10-15,1997, Sanibel Island, Florida, USA
Contact	:	F.-J. Hambsch e-mail : hambsch@irmm.jrc.be

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Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium
Names	:	F.-J. Hambsch, P. Siegler
Facilities	:	Neutron time-of-flight spectrometer GELINA, 7 MV and 3,7 MV Van de Graaff
Experiment	:	Fission fragment total kinetic energy and mass distribution for ^{237}Np(n,f) from 0.3 MeV to 5.5 MeV incident neutron energy.
Method	:	Twin Frisch gridded ionization chamber for coincident fission fragment detection
Accuracy	:	Fragment mass resolution about 2 u. Fragment energy resolution about 2 MeV, $2 \cdot 10^5$ coincident events recorded.
Completion date	:	1995
Discrepancies to other reported data	:	
Publications	:	P. Siegler, F.-J. Hambsch, J.-P. Theobald Proc. Seminar on Fission Pont d'Oye III, Habay-la-Neuve, Belgium, May 9-11, 1995, p. 48 P. Siegler, F.-J. Hambsch, S. Oberstedt, J.P. Theobald Nucl. Phys. A594 (1995) 45
Contact	:	F.-J. Hambsch e-mail : hambsch@irmm.jrc.be

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Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium
Names	:	F.-J. Hambsch, L. Demattè, H. Bax
Facilities	:	Neutron time-of-flight spectrometer GELINA, 7 MV and 3,7 MV Van de Graaff
Experiment	:	Fission fragment total kinetic energy and mass distribution for ^{239}Pu(n,f) in the resonance region.
Method	:	Twin Frisch gridded ionization chamber for coincident fission fragment detection.
Accuracy	:	Fragment mass resolution about 2 u. Data acquisition in progress
Completion date	:	Measurement in progress
Discrepancies to other reported data	:	
Publications	:	None at present.
Contact	:	F.-J. Hambsch e-mail : hambsch@irmm.jrc.be

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Laboratory	:	EC-JRC, Institute for Reference Materials and Measurements B-2440 Geel, Belgium Part of the work performed in collaboration with ECN, Petten
Names	:	A. Meister, I. Birn, E. Wattecamps, H. Weigmann
Facilities	:	Neutron laboratory at 7 MV Van de Graaff
Experiment	:	Measurement of neutron inelastic scattering cross sections of ^{92,98,100}Mo and ^{104,106,108,110}Pd
Method	:	Gamma-ray production cross sections are measured for gamma-rays emitted after inelastic scattering of neutrons from elemental samples. A tailored white neutron spectrum from a thick Li target of the pulsed Van de Graaff and neutron time-of-flight techniques are used; gamma-rays are detected by a HPGe detector. From the measured data and known level schemes, the cross sections for neutron inelastic scattering from the lowest levels of the above isotopes are deduced.
Accuracy	:	between 5 and 20%, depending on energy and level
Completion date	:	completed
Discrepancies to other reported data	:	for some levels cross sections are much (up to 30%) lower than older ANL work
Publications	:	Proceedings of NDST Conference, Trieste 1997; for PD isotopes also: A. Meister, ECN-C-94-084, 1994
Contact	:	H. Weigmann e-mail : weigmann@irmm.jrc.be

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Names	:	F. Corvi, F. Malerba, P. Mutti,a. Noriega, L. Zanini
Facilities	:	GELINA pulsed neutron source
Experiment	:	Measurement of Resonance Neutron Capture Cross Section of ^{84,86}Kr, ^{107,109}Ag, ^{136}Ba. Spin and parity assignments of n-resonances of ^{99}Tc, ^{107,109}Ag and ^{115}In.
Method	:	Neutron capture in the resonance region measured with C_6D_6-based total energy detectors applying the time-of-flight method. Spins and parities derived from capture γ-ray spectra obtained with Ge-detectors.
Accuracy	:	5 - 10%
Completion date	:	^{136}Ba : Completed ^{107,109}Ag, ^{115}In : June '98 ^{84,86}Kr : Dec. '98
Discrepancies to other reported data	:	Present data for ^{136}Ba on average 10% lower than those of P.E. Koehler, Phys. Rev. C54 (1996) 1463
Publications	:	- P. Mutti et al., Nucl. Phys. A621 (1997) 262c - L. Zanini et al., Capture Gamma-ray Spectroscopy, edit. by G.L. Molnar et al., Springer Hungarica, Budapest, 1997, p. 379 - L. Zanini et al., Proc. Int. Conf. on Nuclear Data for Science and Technology, May 19-24, 1997, Trieste
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Names :	R.H. Martin, K.I.W. Burns and J.G.V. Taylor
Facilities :	1) $4\pi\beta$ gas flow proportional counter 2) Ge detector
EXPERIMENT :	The half-life of ^{90}Sr was determined at 10561 days.
Method :	Analyze the data acquired from the $4\pi\beta$ gas flow proportional counting of four sources over a period of 33 years.
Accuracy :	± 14 days (0.13%).
Completion Date :	The work is completed and a report has been published.
Discrepancies to other data :	This value supports the value recommended by Rajput and MacMahon (1992) in Nucl. Instr. and Meth. 312, 289. The value is in agreement with all but two previously-reported measurements.
Publication :	Martin R.H., Burns K.I.W. and Taylor J.G.V. (1994) Nucl. Instr. and Meth. A339, 158.
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CANADA

Laboratory and Address:	Chemistry and Chemical Engineering Division, AECL Chalk River Laboratories, Chalk River, Ontario, Canada K0J 1J0
Names:	K.I.W. Burns and R.H. Martin
Facilities:	Calibrated Ge detector, mass spectrometer
EXPERIMENT:	Measure the half-life of ^{94}Nb.
Method:	Measure the specific activity of a solution using Ge spectrometry and isotope dilution mass spectrometry.
Accuracy:	<10%.
Completion Date:	Undetermined at present.
Discrepancies to other data:	None at present.
Publication:	No publication at present.
Contact :	R.H. Martin AECL, CRL - Station 18B, General Chemistry, Chalk River, Ontario K0J 1J0 CANADA (e-mail : martinrh@aecl.ca)

CANADA

Laboratory and Address :	Chemistry and Chemical Engineering Division, AECL Chalk River Laboratories, Chalk River, Ontario, Canada K0J 1J0
Names :	R.H. Martin, K.I. W. Burns and J.G.V. Taylor
Facilities :	1) $4\pi\gamma$ ionization chamber 2) Ge spectrometer
EXPERIMENT :	Half-lives of ^{109}Cd, ^{133}Ba, ^{144}Ce and ^{152}Eu
Method :	$4\pi\gamma$ ionization chamber.
Accuracy :	<0.05 % (0.14 % for ^{152}Eu)
Completion Date :	1994 April
Discrepancies to other data :	The ^{144}Ce result is outside the combined uncertainties of the average of published values and the present value.
Publication :	Martin R.H., Burns K.I.W. and Taylor J.G.V. (1997) A measurement of the half-lives of ^{54}Mn, ^{57}Co, ^{59}Fe, ^{88}Y, ^{95}Nb, ^{109}Cd, ^{133}Ba, ^{134}Cs, ^{144}Ce, ^{152}Eu, Nucl. Instr. and Meth. A390, 267.
Contact :	R.H. Martin AECL, CRL - Station 18B, General Chemistry, Chalk River, Ontario K0J 1J0 CANADA (e-mail : martinrh@aecl.ca)

CHINA

Laboratory: China Institute of Atomic Energy

Names: Yang Yi, Liu Yonghui, Cui Anzhi, Li Ze.

Facilities: Tandem accelerator.
Heavy water research reactor.
HPGe gamma ray spectrometric systems.

Experiment: Fission product yields for ^{95}Zr, ^{140}Ba and ^{147}Nd were determined for the fission of ^{235}U induced by thermal and 8 MeV neutrons. Absolute fission rate is monitored with a double-fission chamber. The efficiency of the fission chamber is checked with absolute determination of ^{198}Au activity from $^{197}Au(n,\gamma)^{198}Au$ reaction for the first time. Fission product activities of irradiated ^{235}U foils were measured by HPGe γ-ray spectrometry without chemical separation. Time of flight technique and measurement of the fission ratio of $^{235}U/^{238}U$ were used to estimated the fission events induced by neutrons of other energies. Ratio of "fast yield" to "thermal yield" is also obtained precisely because of elimination of some systematic errors. The ratio and evaluated value of "thermal yield" are used to get more accurate "fast yield" values. The results document that the yield values at 8 MeV energy point deviate from those from exponential function values.

Method: γ-ray spectroscopy method.

Accuracy: better than 2.7%.

Completion date: September 1994

Discrepancies to other reported data:

Publications: Li Ze, Wang Xiuzhi, Jing Kexing, Cui Anzhi, Liu Daming, Li Daming, Liu Yonghui, Li Xueliang, Liu Conggui, Su Shuxin, Tang Peijia, Chih Dahai, Zhang Shulan, Zhang Shengdong and Guo Jingru.
Journal of Nuclear and Radiochemistry(China),Vol.17, 65(1995)

Contact: China Institute of Atomic Energy
P. O.Box 275(46),Beijing 102413, China.

CHINA

Laboratory: China Institute of Atomic Energy

Names: Li Ze, Wang Xiuzhi, Jing Kexing, Cui Anzhi, Liu Daming, Li Daming, Liu Yonghui, Li Xueliang, Liu Conggui, Su Shuxin, Tang Peijia, Chih Dahai, Zhang Shulan, Zhang Shengdong and Guo Jingru.

Facilities: Tandem accelerator.
HPGe gamma ray spectrometric systems.
Low background measurement system.

Experiment: Fission product yields for 40 mass chains were determined for the fission of ^{238}U induced by 11.3 MeV neutrons for the first time. Absolute fission rate was monitored with a double-fission chamber. Fission product activities of irradiated ^{238}U foils were measured by HPGe or Ge(Li) γ-ray spectrometry and by chemical separation of the fission product elements followed by β-counting and/or γ-ray spectrometry. Time of flight technique was used to measured the neutrons spectrum in order to estimate the fission events induced by break-up neutrons and scattering neutrons. A complete mass distribution curve has been obtained and the dependence of fission yield with neutron energy is discussed.

Method: Radiochemical method and γ-ray spectroscopy method.

Accuracy: 3.5-30%.

Completion date: December 1990.

Discrepancies to other reported data:

Publications: Li Ze, Wang Xiuzhi, Jing Kexing, Cui Anzhi, Liu Daming, Li Daming, Liu Yonghui, Li Xueliang, Liu Conggui, Su Shuxin, Tang Peijia, Chih Dahai, Zhang Shulan, Zhang Shengdong and Guo Jingru.
Radiochemica Acta 64,95-97(1994)

Contact: China Institute of Atomic Energy
P. O. Box 275(48), Beijing 102413, China.

France

Laboratory:	CEA Saclay, F-91191 Gif-sur-Yvette, France in collaboration with IRMM Geel, Retieseweg, B-2440 Geel, Belgium
Names:	F. Gunsing, A. Leprêtre, C. Mounier, C. Raepsaet, C. Bastian, A. Brusegan, F. Corvi, E. Macavero
Facility:	GELINA pulsed white neutron source (IRMM, Geel)
Experiment:	Measurement of the neutron total and capture cross section of ^{99}Tc from 3 eV to 100 keV.
Method:	The total cross section is measured in a transmission experiment using a lithium glass detector. The capture cross section is measured by means of C_6D_6 detectors gamma-ray detectors using a pulse height weighting method. The neutron energy is determined by time-of-flight. For both experiments several sample thicknesses have been measured.
Accuracy:	5 - 10%
Completion date:	Measurements finished, final results for end 1998.
Discrepancies to other reported data:	Several new resonances have been observed.
Publications:	Proceedings of NDST Conference, Trieste 1997.
Contact:	F. Gunsing, CEA Saclay, F-91191 Gif-sur-Yvette, France. email: gunsing@cea.fr

FRANCE

Precise determination of the half-life of the ground-state of ^{77}Ge

Laboratory :	Institut de Recherches Subatomiques
and address :	23, rue du Loess
	67037 STRASBOURG Cedex /France
Names :	M.S. Antony, D. Oster, M.S. Rouabah*, A. Hachem**
	* Institut de Physique, Université de Constantine
	Constantine, Algeria
	** Département de Physique
	Faculté des Sciences
	Université de Nice Sophia-Antipolis, Nice, France

Facilities :	Strasbourg University Research Reactor
	Fast transfer system
	Neutron flux of 1.1 $\times 10^{12}$ n.cm^{-2}.s^{-1}
	85 cc coaxial HP/Ge detector
Experiment :	Sample of 45 mg of natural GeO_2
	^{76}Ge (enriched to 7.44 %) irradiated for 30 minutes at
	the core of the reactor
Method :	Decay curve of the 264.4 keV γ-ray following
	β-decay of ^{77}Ge; counting interval 4.0 h
Result :	Half-life of ^{77}Ge 11.248$\pm$ 0.002 h
Other reported data :	$\sim$ 12 h Ref.1
	12(1)h Ref.2
	11.3(3)h Ref.3
	11.30(1)h Ref.4
Publication :	Journal of Radioanalytical and Nuclear
	Chemistry Letters, 200 (3) (1995) 223-225

Contact :	M.S. Antony
	e-mail : Mariasusai.Antony@IReS.IN2P3.Fr

References :

1. G.T. Seaborg, J.J. Livingood, G.Friedlander, Phys.Rev.,59 (1941) 320
2. S.A. Reynolds, ORNL-867 (1950) 24
3. W.S. Lyon, J.S. Eldridge, Phys. Rev.,107 (1957) 1056
4. S.A. Reynolds, J.F. Emery, E.I. Wyatt, Nucl. Sci. Eng.,32 (1968) 46

GERMANY

Laboratory and Address: Forschungszentrum Karlsruhe, Institut für Kernphysik
Postfach 3610, D-76021 Karlsruhe, Germany

Facilities: Pulsed 3.7 MV Van de Graaff

1. **Names:** S. Jaag and F. Käppeler
   Experiment: Measurement of the stellar (n,γ) cross section of ^{87}Rb at kT=25 keV
   Method: Time-of-flight technique with Moxon-Rac detectors in quasi-Maxwellian spectrum
   Accuracy: ± 10%
   Publication: Phys. Rev. C **53** (1996) 2474

2. **Names:** K. Wisshak, F. Voss, Ch. Theis, F. Käppeler, K. Guber, L. Kazakov, N. Kornilov, and G. Reffo
   Experiment: Measurement of the (n,γ) cross section of the tin isotopes between 3 and 225 keV
   Method: Time-of-flight technique with Karlsruhe 4πBaF_2 detector
   Accuracy: ± 1 to 2%
   Publication: Phys. Rev. C **54** (1996) 1451

3. **Names:** K. Wisshak, F. Voss, F. Käppeler
   Experiment: Neutron resonance spectroscopy of ^{116}Sn, ^{118}Sn, and ^{120}Sn below 20 keV
   Method: Time-of-flight technique with Karlsruhe 4πBaF_2 detector
   Accuracy: capture areas typically ± 5 to 10%
   Publication: Phys. Rev. C **54** (1996) 2732

4. **Names:** S. Jaag, F. Käppeler, G. Reffo, and P. Koehler
   Experiment: Stellar (n,γ) cross section of the unstable isotope ^{135}Cs at kT=25 keV
   Method: Activation technique in quasi-Maxwellian spectrum
   Accuracy: ± 8%
   Publication: Nucl. Phys. A **621** (1997) 247c

5. **Names:** F. Voss, K. Wisshak, K. Guber, F. Käppeler, and G. Reffo
   Experiment: Measurement of the (n,γ) cross sections of the Ba isotopes between 5 and 225 keV
   Method: Time-of-flight technique with Karlsruhe 4πBaF_2 detector
   Accuracy: ± 3%
   Publication: Phys. Rev. C **50** (1994) 2582

GERMANY (cont.)

6. **Names:** F. Voss, K. Wisshak, F. Käppeler
   Experiment: Neutron resonance spectroscopy of ^{136}Ba below 20 keV
   Method: Time-of-flight technique with Karlsruhe $4\pi BaF_2$ detector
   Accuracy: capture areas typically ± 5 to 10%
   Publication: Phys. Rev. C **52** (1995) 1102

7. **Names:** P. Mutti, F. Corvi, K. Athanassopulos, and H. Beer
   Experiment: Stellar capture rate of ^{136}Ba
   Method: Time-of-flight technique with C_6D_6 detectors at Geel linear accelerator between 400 eV and 60 keV
   Accuracy: capture areas typically ± 10%
   Publication: Nucl. Phys. A **621** (1997) 262c

8. **Names:** H. Beer, F. Corvi, and P. Mutti
   Experiment: Neutron capture studies on ^{138}Ba and ^{208}Pb
   Method: Time-of-flight technique with C_6D_6 detectors at Geel linear accelerator between 200 eV and 200 keV
   Accuracy: capture areas typically ± 10 to 15%
   Publication: Astrophys. J **474** (1997) 843

9. **Names:** F. Käppeler, K.A. Toukan, M. Schumann, and A. Mengoni
   Experiment: Neutron capture cross sections of the cerium isotopes at kT=25 keV
   Method: Activation technique in quasi-Maxwellian spectrum
   Accuracy: ± 3 to 7%
   Publication: Phys. Rev. C **53** (1996) 1397

10. **Names:** K.A. Toukan, K. Debus, F. Käppeler, and G. Reffo
    Experiment: Stellar (n,γ) cross section of ^{146}Nd, ^{148}Nd, and ^{150}Nd at kT=25 keV
    Method: Activation technique in quasi-Maxwellian spectrum
    Accuracy: ± 6%
    Publication: Phys. Rev. C **51** (1995) 1540

11. **Names:** K. Wisshak, F. Voss, F. Käppeler, and L. Kazakov
    Experiment: Measurement of the (n,γ) cross sections of the Nd isotopes between 3 and 225 keV
    Method: Time-of-flight technique with Karlsruhe $4\pi BaF_2$ detector
    Accuracy: ± 1 to 2%
    Publication: Nucl. Phys. A **621** (1997) 270c
    Phys. Rev. C **57** (1998) 391

GERMANY (cont.)

12. **Names:** S. Jaag and F. Käppeler
    Experiment: Stellar (n,γ) cross section of the unstable isotope ^{155}Eu at kT=25 keV
    Method: Activation technique in quasi-Maxwellian spectrum
    Accuracy: ± 6%
    Publication: Phys. Rev. C **51** (1995) 3465

13. **Names:** K. Wisshak, F. Voss, F. Käppeler, K. Guber, L. Kazakov, N. Kornilov, M. Uhl, and G. Reffo
    Experiment: Measurement of the (n,γ) cross sections of the Gd isotopes between 3 and 225 keV
    Method: Time-of-flight technique with Karlsruhe $4\pi BaF_2$ detector
    Accuracy: ± 1%
    Publication: Phys. Rev. C **52** (1995) 2762

Germany

Laboratory: Institut für Kernchemie der Philipps-Universität Marburg.

Names: K. Siemon, R.A. Esterlund, J. van Aarle, W. Westmeier, P. Patzelt.

Facilities: Neutron-sphere detector at the Institut für Kernchemie.

Experiment: Direct determination of the partial-neutron multiplicities accompanying the spontaneous-fission decay of ^{252}Cf and ^{257}Fm in correlation with fission-fragment mass and kinetic energy.

Method: The numbers of neutrons emitted in the spontaneous fission of ^{252}Cf and ^{257}Fm were measured, using a large Gd-doped liquid-scintillator tank (neutron sphere). The correlations between the number of neutrons emitted by the fission fragments and the total kinetic energy released in a particular fission event were investigated. In contrast to earlier work on this topic, the neutron signals in both halves of the neutron sphere were independently registered and electronically processed, so as to enable the direct determination of the partial-neutron multiplicities associated with each fission event.

Completion date: 2 December 1997.

Publications:
J. van Aarle, W. Westmeier, R.A. Esterlund, P. Patzelt: ^{252}Cf: Neutron Multiplicities in Correlation with Fission-Fragment Mass and Energy, Nucl. Phys. A578 (1994) 77.
K. Siemon, R.A. Esterlund, J. van Aarle, W. Westmeier, P. Patzelt: ^{252}Cf: Direct Determination of Partial Neutron Multiplicities in Correlation with Fission-Fragment Mass and Energy: Prog. Rept. on Nuclear Data Research in the FRG, 1 April 1994 - 31 March 1995, NEA/NSC/DOC(95)10, ed. S.M. Qaim (Jülich, FRG, July, 1995) 47.
Manuscript in progress, to be submitted to Nuclear Physics A.

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Germany

Laboratory:	Institut für Kernchemie der Philipps-Universität Marburg.
Names:	A. Kronenberg, K. Siemon, R. Weber, R.A. Esterlund, P. Patzelt.
Facilities:	Solid-state gamma-ray detectors and associated electronics at the Institut für Kernchemie.
Experiment:	New determination of the half-life of the fission-product ^{105m}Rh.
Method:	^{105m}Rh was produced at the Mainz TRIGA reactor via thermal-neutron-induced fission of ^{235}U followed by chemical separation, and its decay was studied using various forms of gamma-ray spectrometry. The resulting new half-life for ^{105m}Rh is 43.0 ± 0.3 s.
Accuracy:	± 0.7 %
Completion date:	11 June 1997.
Discrepancies to other reported data:	For well over two-score years, the half-life of ^{105m}Rh has been uncertain by a large factor. The two values given in the literature are 45 s and 30 s, both without any uncertainty. As a result, the editors for Nuclear Data Sheets have strongly recommended that the half-life of this level be remeasured.
Publications:	A. Kronenberg, K. Siemon, R. Weber, R.A. Esterlund, P. Patzelt: Determination of the Half-Life of ^{105m}Rh, Prog. Rept. on Nuclear Data Research in the FRG, 1 April 1996 - 31 March 1997, NEA/NSC/DOC(97)13, ed. S.M. Qaim (Jülich, FRG, July, 1997) 46. A. Kronenberg, K. Siemon, R. Weber, R.A. Esterlund, P. Patzelt: Determination of the Half-Life of ^{105m}Rh (Accepted for publication in Applied Radiation and Isotopes).
Contact:	R.A. Esterlund Institut für Kernchemie der Philipps-Universität Marburg Hans-Meerwein-Straße, D-35032 Marburg. esterlun@mailer.uni-marburg.de

GERMANY

Laboratory: Physik-Department, Technische Universität München

Names: T. von Egidy, C. Doll, H.-F. Wirth

Facilities: Tandem Accelerator in Munich, Research Reactor

EXPERIMENTS: Transfer reactions (d,p), (d,t), (^{3}He,d), etc.
(n,γ) reactions at the Grenoble and Munich reactors.

Publications: Fission induced by antiprotons on ^{197}Au, ^{209}Bi, ^{232}Th, ^{238}U:

P. Hofmann et al., Phys. Rev. **C 49** (1994) 2555
Y.S. Kim et al., Phys. Rev. **C 54** (1996) 2469
T. von Egidy, Acta Physica Polonica **B 24** (1993) 1823
T. von Egidy et al., Nucl. Phys. **A 558** (1993) 383c
S. Schmid et al., Z. Physik **A 359** (1997)27

Folding angle of fission fragments for ^{235}U(n_{th},f), ^{252}Cf(sf):

T. Haninger et al., Nucl. Phys. **A 572** (1994) 294
Y.S. Kim et al., Nucl. Instr. Meth. **A 329** (1993) 403

"Research with Fission Fragments"
T. von Egidy et al., editors, World Scientific, Singapore 1997

GERMANY

Laboratory: **Institut für Kernchemie, Universität Mainz**
Names: H. O. Denschlag, O. Alhassanieh, M. Weis, W. Faubel (Univ. Mainz), and H. R. Faust (ILL, Grenoble)
Facilities: LOHENGRIN mass separator for unslowed fission products at the Institut Laue-Langevin, Grenoble
Experiment: Determination of absolute γ-ray line intensities in the decay of 2.6 min ^{99}Nb and the branching ratio in the decay of ^{99}Zr to the two isomers ^{99m}Nb and ^{99g}Nb.
Method: The decay characteristics have been determined by comparing γ-ray spectra of a mass separated fraction of chain 99 with the known yield distribution.
Accuracy: A few percent
Completion: Experimentally completed
Publications: H. O. Denschlag, O. Alhassanieh, M. Weis, W. Faubel, and H. R. Faust; Radiochimica Acta, 62, 177-179 (1993)
Contact: Prof. Dr. J. O. Denschlag
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Laboratory: **Institut für Kernchemie, Universität Mainz**
Names: R. Hentzschel, H. O. Denschlag (Univ. Mainz), H. R. Faust (ILL, Grenoble), J. Gindler, B. D. Wilkins (Argonne, Natl. Lab., USA)
Facilities: LOHENGRIN mass separator for unslowed fission products at the Institut Laue-Langevin, Grenoble
Experiment: Determination of mass yields and charge distribution of very light fission products in the reaction ^{249}Cf(n,f) at various kinetic energies of the fission fragments.
Method: Mass separated fission products are stopped in a large ionisation chamber that provides a signal of the total fragment kinetic energy and of the specific energy loss.
Accuracy: A few percent
Completion: Experimentally completed
Publication: R. Hentzschel, H. R. Faust, H. O. Denschlag, B. D. Wilkins, J. Gindler: Mass, Charge and Energy Distributions in the Very Asymmetric Fission of ^{249}Cf Induced by Thermal Neutrons, Nuclear Physics, A571, 427-446 (1994)
Contact: Prof. Dr. J. O. Denschlag, address see 1st contribution from this laboratory.

GERMANY

Laboratory: **Institut für Kernchemie, Universität Mainz**
Names: O. Alhassanieh, H. O. Denschlag, V. Scheuermann (Univ. Mainz), H. R. Faust (ILL, Grenoble)
Facilities: LOHENGRIN mass separator for unslowed fission products at the Institut Laue-Langevin, Grenoble
Experiment: The fission yield ratios of isomeric states of several fragment masses in the reaction ^{249}Cf(n,f) have been measured at various kinetic energies and ionic charge states of the fragments.
Method: Mass separated fission fragments were intercepted on a moving transport tape, carried continuously in front of a Ge(Li) γ-ray detector, and relative fission yields were measured using the γ-rays emitted following the ß-decay of these fragments.
Accuracy: A few percent
Completion: Experimentally completed
Publication: O. Alhassanieh, Dissertation, Mainz, (1996); O. Alhassanieh, H.O. Denschlag, V. Scheuermann, H. R. Faust: Isomeric Yield Ratios and Distribution of Angular Momentum in the Fission of ^{249}Cf by Thermal Neutrons; Progress Report on the Nuclear Data Research in the Federal Republic of Germany, Report NEA/NSC/DOC(93)17 INDC(Ger)-037/LN Jül-2803 (1993)
Contact: Prof. Dr. J. O. Denschlag, address see 1st contribution from this laboratory.

Laboratory: **Institut für Kernchemie, Universität Mainz**
Names: H. O. Denschlag, M. Davi, I. Tsekhanovitch (IPEP, Minsk, Belarus), F. Gönnenwein, M. Wöstheinrich (Univ. Tübingen)
Facilities: LOHENGRIN mass separator for unslowed fission products at the Institut Laue-Langevin, Grenoble
Experiment: Search for odd-even and shell effects in the very asymmetric fission of the odd-Z compound nucleus ^{239}Np.
Method: Mass separated fission products are stopped in a large ionisation chamber that provides a signal of the total fragment kinetic energy and of the specific energy loss.
Accuracy: A few percent
Completion: End of 1998
Publication: Part of the results are given in: M. Davi, Dissertation, Mainz (1997) (in German)
Contact: Prof. Dr. J. O. Denschlag, address see 1st contribution from this laboratory.

GERMANY

Laboratory: **Institut für Kernchemie, Universität Mainz**
Names: M. Davi, O. Alhassanieh, H. O. Denschlag (Univ. Mainz), H. R. Faust, S. Oberstedt (ILL, Grenoble), F. Gönnenwein, M. Hesse, A. Kötzle, M. Wöstheinrich (Univ. Tübingen), Z. Büyükmumcu (METU, Ankara, Turkey).
Facilities: LOHENGRIN mass separator for unslowed fission products at the Institut Laue-Langevin, Grenoble
Experiment: The yields and kinetic energy distributions of heavy ternary products in the thermal neutron induced fission of ^{249}Cf are measured. So far ternary products up to mass number A=34 could be identified.
Method: Mass separated fission products are stopped in an ionisation chamber that provides a signal of the total fragment kinetic energy and of the specific energy loss.
Accuracy: A few percent
Completion: End of 1998
Publication: Part of the results are given in: M. Davi, Dissertation, Mainz (1997) (in German) and in: M. Davi, O. Alhassanieh, H. O. Denschlag, H. R. Faust, F. Gönnenwein, M. Hesse, A. Kötzle: Ternary Fission of ^{249}Cf; in F. David, J. C. Krupa (Edts.) Extended Abstracts of Fourth International Conference on Nuclear and Radiochemistry, St. Malo, France (1996).
Contact: Prof. Dr. J. O. Denschlag, address see 1st contribution from this laboratory.

Laboratory: **Institut für Kernchemie, Universität Mainz**
Names: I. Tsekhanovitch(Univ. Mainz and IPEP, Minsk, Belarus), M. Davi, H. O. Denschlag (Univ. Mainz), H. R. Faust, S. Oberstedt(ILL, Grenoble), M. Wöstheinrich (Univ. Tübingen)
Facilities: LOHENGRIN mass separator for unslowed fission products at the Institut Laue-Langevin, Grenoble
Experiment: .Search for odd-even and shell effects in the very asymmetric fission of the odd-Z compound nucleus ^{243}Am.
Method: Mass separated fission products are stopped in an ionisation chamber that provides a signal of the total fragment kinetic energy and of the specific energy loss.
Accuracy: A few percent
Completion: 1999
Publication: I. Tsekhanovitch, Dissertation, in preparation
Contact: Prof. Dr. J. O. Denschlag, address see 1st contribution from this laboratory.

INDIA

Laboratory and Address:	Radiochemistry Division Bhabha Atomic Research Centre Trombay, Mumbai 400 085
Names:	H. Naik, S.P. Dange, R.J. Singh, S.B. Manohar
Facilities:	Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Rector APSARA and Pneumatic carrier facility at CIRUS.
Experiment:	Charge distribution studies in thermal neutron induced fission of ^{229}Th, ^{233,235}U, ^{239,241}Pu and ^{245}Cm as well as in S.F. of ^{252}Cf.
Method:	Fractional cumulative yields and independent yields of number of fission products in thermal neutron induced fission of above actinides have been determined using gamma spectrometric and radiochemical technique to arrive at the charge distribution parameters such as the width of the charge dispersion, the most probable charge/mass, the charge polarization, proton odd-even effect.
Accuracy:	+10% on yields
Status:	The work has been completed.
Publications:	1. Radiochimica Acta. **62**, 1 (1993). 2. Nucl. Phys.A **612**, 143 (1997).
Contact:	Dr. S.B. Manohar Head, Radiochemistry Division E-mail: sbman@magnum.barc.ernet.in

INDIA

Laboratory and Address: Radiochemistry Division
Bhabha Atomic Research Centre
Trombay, Mumbai 400 085

Names: H. Naik, S.P. Dange, R.J. Singh

Facilities: Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Pneumatic carrier facility at CIRUS

Experiment: Fragment angular momenta of $^{128,130,132}Sb$, $^{131,133}Te$, $^{132,134,136}I$, ^{135}Xe and ^{138}Cs in thermal neutron induced fission of ^{229}Th, $^{233,235}U$, $^{239,241}Pu$, ^{245}Cm, in the fast neutron induced fission of ^{237}Np and in the spontaneous fission of ^{252}Cf have been determined.

Method: Independent isomeric yields ratios for number of fission products as mentioned above have been determined using radiochemical and gamma spectrometric technique to arrive at fragment angular momenta using spin dependent statistical model analysis.

Accuracy: +10% on yields

Status: The work is in progress.

Publications:

1. Nucl. Phys. A **587**, 273 (1995).
2. Nucl. and Radiochemistry Sym. NUCAR 97 SINP, Calcutta, India.

Contact: Dr. S.B. Manohar
Head, Radiochemistry Division

E-mail: sbman@magnum.barc.ernet.in

INDIA

Laboratory and Address:
Radiochemistry Division
Bhabha Atomic Research Centre
Trombay, Mumbai 400 085

Names:
R.H. Iyer, H. Naik, A.K. Pandey, P.C. Kalsi, R.J. Singh, A. Ramaswami, A.G.C. Nair.

Facilities:
Class A Laboratory, High resolution gamma spectrometric system with HPGe detector.

Experiment:
Absolute yields of fission products in the fast neutron induced fission of ^{238}U, ^{237}Np, $^{238, 240}Pu$, ^{243}Am and ^{244}Cm and in spontaneous fission of ^{244}Cm.

Method:
Absolute yields of number of fission products including the yields of short lived and low yield symmetric fission products have been determined using the track-etch cum gamma ray spectrometric technique. The number of fissions occurring in the targets are determined by recording the fission events in a solid state track detector and the fission products are analyzed gamma spectrometrically with or without radiochemical separation .

Accuracy:
+10% on yields

Status:
The work is in progress.

Publications:

1. Radiochimica Acta **75**, 69 (1996).
2. International seminar on development on enhancement of research reactor utilization (IAEA/SR-198) BARC, Bombay, India (1996).
3. National Sym. on SSNTD (SSNTD 96) Kurukhetra Uni., India (1996).
4. International Phys. Sym. (INPS 95) BARC, Bombay, India (1995).

Contact:

Dr. S.B. Manohar
Head, Radiochemistry Division

E-mail: sbman@magnum.barc.ernet.in

INDIA

Laboratory and Address: Radiochemistry Division
Bhabha Atomic Research Centre
Trombay, Mumbai 400 085

Names: S.S. Rattan, A.Ramaswami, R.J. Singh

Facilities: Class A Laboratory, High resolution gamma spectrometric system with HPGe detector, Variable Energy Cyclotron.

Experiment: Mass yield of the fission products in 55.7 and 58.6 MeV alpha induced fission of ^{209}Bi.

Method: The formation cross sections of number of fission products have been determined using recoil catcher technique followed by gamma spectrometric method.

Accuracy: +10% on yields

Status: The work has been completed

Publications: 1. Radiochimica Acta **55**, 169 (1991)

Contact: Dr. S.B. Manohar
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INDIA

Laboratory and Address:	Radiochemistry Division Bhabha Atomic Research Centre Trombay, Mumbai 400 085
Names:	S.S. Rattan, A. Ramaswami, R.J. Singh
Facilities:	Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Variable energy cyclotron at Calcutta
Experiment:	Charge distribution studies in alpha particle induced fission of ^{209}Bi.
Method:	Fractional cumulative yields of number of fission products in 55.7 and 58.6 MeV alpha particle induced fission of ^{209}Bi have been determined using direct gamma spectrometry to arrive at the charge dispersion parameter and the most probable charge.
Accuracy:	+10% on yields
Status:	The work has been completed.
Publications:	1. Radiochimica Acta. **55**, 169 (1991)
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Laboratory and Address: Radiochemistry Division
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Trombay, Mumbai 400 085

Names: S.B. Manohar, A. Goswami, B.S. Tomar,
G.K. Gubbi, H. Naik, S.P. Dange

Facilities: Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Variable Energy Cyclotron at Calcutta.

Experiment: Mass resolved angular distribution of number of fission products have been measured as a function of mass asymmetry in the range of 29-44 MeV alpha particle induced fission of ^{232}Th, ^{238}U, ^{237}Np and ^{240}Pu as well as in 20 MeV proton induced fission of ^{243}Am.

Method: The angular anisotropy of the fission products in the above mentioned fissioning systems were determined using recoil catcher technique and off-line gamma spectrometric technique to study their mass dependence.

Accuracy: +10% on anisotropy values

Status: The work is in progress.

Publications:

1. Phys. Rev. C **48**, 221 (1993).
2. Z. Phys. A **351**, 305 (1995).

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Laboratory and Address: Radiochemistry Division
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Names: H. Naik, S.P. Dange, R J. Singh

Facilities: Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Variable Energy Cyclotron at Calcutta.

Experiment: Fragment angular momenta of ^{131,133}Te and ^{132,134}I at various excitation energies in ^{238}U(α,f) and the emission angle dependence of ^{131}Te and ^{132}I in ^{238}U(α,f) and ^{237}Np(α,f) has been studied in the range of 25-44 MeV.

Method: Independent isomeric yields ratios (IYR) for the above mentioned fission products have been determined using radiochemical and gamma spectrometric technique. Fragment angular momentum was deduced from IYR using statistical model analysis. The effect of entrance channel parameters were examined. The emission angle dependence of fragment angular momentum was interpreted in the light of the tilting mode and single particle effect.

Accuracy: +10% on IYR and fragment angular momentum

Status: The work is in progress.

Publications:

1. Z. Phys. A **342**, 95 (1992).
2. Phys. Rev. C **46**, 1445 (1992).
3. Phys. Rev. C **51**, 3104 (1995).
4. DAE Nucl. Phys. Sym., Banglore, (1997).
5. Nucl. Phys. A (Communicated).

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Laboratory and Address: Radiochemistry Division
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Names: S.B. Manohar, G.K. Gubbi, A. Goswami, B.S. Tomar, S.S. Rattan, A. Ramaswami, A.V.R. Reddy, P.P. Burte

Facilities: Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Medium Energy Heavy Ion Accelarator.

Experiment: Mass yield of the fission products in ^{12}C, ^{16}O and ^{19}F induced fission of ^{232}Th and ^{16}O induced fission of ^{209}Bi.

Method: The formation cross sections of several fission products have been determined using recoil catcher technique followed by gamma spectrometric method in ^{12}C, ^{16}O and ^{19}F induced fission of ^{232}Th, and ^{16}O induced fission of ^{209}Bi.

Accuracy: +10% on yields

Status: The work has been completed.

Publications:

1. Radiochimica Acta **58**, 69 (1992). - 79 MeV $^{12}C + ^{232}Th$
2. Radiochimica Acta **62**, 173 (1993). - 92 + 105 MeV $^{16}O + ^{232}Th$
3. Phys. Rev. C **53**, 796 (1996). - 95 + 112 MeV $^{19}F + ^{232}Th$
4. Radiochimica Acta **65**, 9 (1994). - 89.5 MeV $^{16}O + ^{209}Bi$

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Names:	A. Goswami, B.S. Tomar, A.V.R. Reddy, S.B. Manohar
Facilities:	Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Medium Energy Heavy Ion Accelerator.
Experiment:	Mass resolved angular distribution of number of 17 fission products have been measured as a function of mass asymmetry in ^{10}B (72 MeV), ^{12}C (84 MeV) and ^{16}O (92, 96, 100 MeV) induced fission of ^{232}Th at near barrier energies.
Method:	The recoil catcher technique and gamma spectrometric assay of fission products was used to determined the anisotropies for studying their mass dependence.
Accuracy:	+10% on anisotropy values
Status:	The work has been completed.
Publications:	1. Phys. Rev. C **51**, 165 (1995).
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Names: A.V.R. Reddy, A. Goswami, B.S. Tomar, S.B.Manohar, S.K. Das, P.P. Burte, A.G.C. Nair, G.K. Gubbi

Facilities: Class A Laboratory, High resolution Gamma ray spectrometric system with HPGe detector, Medium energy heavy ion accelerator.

Experiment: Charge distribution studies in ^{16}O ion induced fission of ^{232}Th & ^{238}U

Method: Independent yields of number of iodine isotopes in 98 MeV ^{16}O induced fission of ^{232}Th and ^{238}U have been determined using radiochemical and gamma spectrometric technique to deduced the width and the most probable mass of isotopic yield distribution.

Accuracy: +10% on yields

Status: The work has been completed.

Publications:

1. Radiochimica Acta. **64**, 149 (1994).
2. Nucl. and Radiochemistry Sym. NUCAR 95 Kalpakkam, India

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JAPAN

Laboratory:

Japan Atomic Energy Research Institute

Names:

H. Harada, T. Sekine, Y. Hatsukawa, N. Shigeta, K. Kobayashi, T. Ohtsuki, T. Kato

Facilities:

Japan Research Reactor-4

Experiment:

Measurement of Thermal Neutron Cross Section of $^{90}Sr(n,\gamma)^{91}Sr$ Reaction

Method:

Radiochemical

Accuracy:

8.5 %

Completion date:

Apr. 1993

Discrepancies to other reported data:

in good agreement with the value by McVey et al. (1983)

Publications:

Journal of Nuclear Science and Technology, **31**, p. 173-179 (1994)

Contact:

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JAPAN

Laboratory:	Research Reactor Institute, Kyoto University
Names:	K. Okano, A. Taniguchi, S. Yamada, T. Sharshar, M. Shibata and K. Yamauchi
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	Identification of beta-decay of ^{150}La
Method:	Decay of ^{150}La was studied by $\beta\gamma, \gamma\gamma$ coincidences and the half-life of the β decay was deduced.
Accuracy:	The estimated error of the half-life is 6 %.
Completion date:	January 1995
Discrepancies to other reported data:	The half-life of ^{152}La, 0.51±0.3s, is shorter than the reported value of 0.86±0.5s by G. Rudstam et al. (At. Data and Nucl. Data Tables 53(1993)1)
Publications:	Z. Phys. A351(1995)243
Contact:	Akihiro Taniguchi, Research Reactor Institute, Kyoto University, Kumatori-cho, Sennan-gun, Osaka 590 0494, Japan e-mail address:taniguti@rri.kyoto-u.ac.jp

JAPAN

Laboratory:	Research Reactor Institute, Kyoto University
Names:	S. Yamada, A. Taniguchi and K. Okano
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	Excited Levels in ^{152}Pr through the β-Decay of ^{152}Ce
Method:	Decay scheme of ^{152}Ce was established by γγ coincidences. The half-life of the 114.8 keV state in ^{152}Pr was deduced from the time spectrum of βγ coincidence as 4.1(1)μs.
Accuracy:	The estimated error of the half-life is 5 %.
Completion date:	October 1995
Publications:	J. Phys. Soc. Japan, 64(1995)4047
Contact:	Shigeru Yamada, Research Reactor Institute, Kyoto University, Kumatori-cho, Sennan-gun, Osaka 590 0494, Japan e-mail address:yamada@rri.kyoto-u.ac.jp

JAPAN

Laboratory:	Research Reactor Institute, Kyoto University
Names:	Y. Toh, K. Okano, A. Taniguchi, S. Yamada and Y. Kawase
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	Excited states of ^{154}Nd studied through the decay of ^{154}Pr
Method:	Decay of ^{154}Pr was studied by Xγ−, γγ−coincidences and the decay scheme was constructed.
Accuracy:	The estimated error of γ−ray energies are 0.1-1keV.
Completion date:	May 1996
Publications:	Z. Phys. A355(1996)345
Contact:	Yoichi Kawase, Research Reactor Institute, Kyoto University, Kumatori-cho, Sennan-gun, Osaka 590 0494, Japan e-mail address:kawase@rri.kyoto-u.ac.jp

JAPAN

Laboratory:	Research Reactor Institute, Kyoto University
Names:	A. Taniguchi, T. Ikuta, A. Osa, H. Yamamoto, K. Kawade, J. Z. Ruan, S. Yamada, Y. Kawase and K. Okano
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	Decay properties of ^{153}Nd
Method:	Gamma-ray singles, coincidences, angular correlations and conversion electrons were measured with HPGe and Si(Li) detectors. The half-life of the β-decay was deduced from γ-ray and X-ray multi-spectra.
Accuracy:	Estimated errors of γ-ray energies are 0.1-0.5 keV. Errors of γ-ray intensities are 2-30% . The half-life of the β-decay was determined with accuracy of ±0.1s.
Completion date:	December 1996
Discrepancies to other reported data:	The half-life of the β-decay,32.3±0.1s, is longer than the reported value of 28.9±0.4s by Greenwood et al.(Phys.Rev. C35(1987)1965)
Publications:	J. Phys.Soc. Japan, 65(1996)3824
Contact:	Akihiro Taniguchi, Research Reactor Institute, Kyoto University, Kumatori-cho, Sennan-gun, Osaka 590 0494, Japan e-mail address:taniguti@rri.kyoto-u.ac.jp

JAPAN

Laboratory:	Research Reactor Institute, Kyoto University
Names:	S. Yamada, A. Taniguchi, Y. Toh and K. Okano
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	A new isomeric state in ^{153}Nd
Method:	Beta- gamma coincidence was measured with HPGe and plastic detectors. The half-life of the 191.7 keV state was deduced from the time spectrum.
Accuracy:	The estimated error of the half-life is 5 %.
Completion date:	October 1996
Publications:	J. Phys. Soc. Japan, 65(1996)3390
Contact:	Shigeru Yamada, Research Reactor Institute, Kyoto University, Kumatori-cho, Sennan-gun, Osaka 590 0494, Japan e-mail address:yamada@rri.kyoto-u.ac.jp

JAPAN

Laboratory and Address: Department of Nuclear Engineering, Graduate School of Engineering, Nagoya University

Names: H. Miyahara, N. Marnada, N. Ueda, N. Hayashi, K. Ikeda, G. Wurdiyanto, C. Mori

Facility: $4\pi\beta$(ppc)-γ (HPGe) coincidence apparatus using two-dimensional data acquisition system

Experiments: Gamma-ray emission probabilities of ^{75}Ge, ^{128}I and ^{116m}In

Method: Sources were prepared by neutron irradiation of enriched samples. Disintegration rates and gamma-ray intensities were measured by the above apparatus and the gamma-ray emission probabilities were determined.

Accuracy: 0.7-1.7%

Completion data: 1995

Discrepancies to other data:

Nuclide	Main γ-ray (keV)	Present P_γ	Reference P_γ*
^{75}Ge	265	0.1020(17)	0.114(11)
^{116m}In	1294	0.852(4)	0.844(4)
^{128}I	443	0.1261(8)	0.169(17)

*:Table of Isotopes 8th edn (John Wiley and Sons, Inc., New York, 1996)

Publications:

1. H. Miyahara et al., Precise Measurement of Gamma-ray Emission Probability for Germanium-75, J. Nucl. Sci. Technol. 31 (1994) 1038-1042.
2. H. Miyahara et al., Gamma-Ray Emission Probability Measurement by a Two-dimensional $4\pi\beta$-γ Coincidence System, Nucl. Instrum. and Meth. A353 (1994) 229-233.
3. G. Wurdiyanto et al., Precise Measurement of the Gamma-ray Emission Probabilities for ^{116m}In with Half-life of 54.15 min, J. Nucl. Sci. Technol. 32 (1995) 1090-1097.

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JAPAN

Laboratory:	Department of Energy Engineering and Science, Nagoya University
Names:	T. Ikuta, A. Taniguchi, H. Yamamoto, K. Kawade and Y. Kawase
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	Q_β measurements of neutron-rich isotopes in the mass region $147 \leq A \leq 152$
Method:	Beta-gamma coincidences were measured with HPGe and plastic detectors. Corrections were made to deduce the maximum energy of β-rays by using experimentally determined response function.
Accuracy:	Estimated errors of Q_β Values are 1-5 %.
Completion date:	September 1995
Discrepancies to other by reported data:	The Q_β values of ^{147}La and ^{150}Pr deviate 200-300keV from evaluated values
Publications:	J. Phys.Soc. Japan, 64(1995)3244
Contact:	Hiroshi Yamamoto, Department of Energy Engineering and Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-01, Japan e-mail address:a40867a@nucc.cc.nagoya-u.ac.jp

JAPAN

Laboratory:	Department of Energy Engineering and Science, Nagoya University
Names:	M. Shibata, T. Ikuta, A. Taniguchi, A. Osa, A. Tanaka, H. Yamamoto, K. Kawade, J. Z. Ruan, Y. Kawase and K. Okano
Facilities:	On-line mass separator(KUR-ISOL) installed at 5MW Kyoto University Reactor
Experiment:	Beta decay of ^{151}Pr into levels in ^{151}Nd
Method:	Gamma-ray singles, $\gamma\gamma$coincidences and conversion electrons were measured with HPGe and Si(Li) detectors.
Accuracy:	Estimated errors of γ-ray energies are 0.1-0.5 keV. Errors of γ-ray intensities are 2-30% .
Completion date:	September 1994
Publications:	J. Phys. Soc. Japan, 63(1994)3263
Contact:	Michihiro Shibata, Department of Energy Engineering and Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-01, Japan e-mail address:i45329@nucc.cc.nagoya-u.ac.jp

JAPAN

Laboratory: Power Reactor and Nuclear Fuel Development Corp.(PNC), Japan
Nagoya University, Japan
Japan Atomic Energy Research Institute(JAERI), Japan

Names: H. Harada, T. Sekine, Y. Hatsukawa, N. Shinohara, N. Shigeta, K. Kobayashi, T. Ohtsuki, T. Katoh .

Facilities: Research Reactor, JRR-4, at JAERI,
Pneumatic tube system with a movable Cd shield.

Experiment: Measurement of the Thermal Neutron Cross Section of the $^{90}Sr(n, \gamma)^{91}Sr$.
Results; $0.0153\ ^{+0.0013}_{-0.0042}$ barns for thermal neutron capture cross section. Less than 0.16 barns for resonance integral.

Method: Activation of samples and measurement of γ-ray spectra.

Accuracy: 27%.

Completion date: April 20, 1993.

Discrepancies to other reported data:
G. Zeisel reported a value of 0.8 ± 0.5 barns for the cross section, and L. A. McVey et al. reported a value of 0.0140 ± 0.0024 barns. The present measurement supports the value by McVey.

Publication: J. Nuclear Science & Technology, 31, p 173(1994).

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JAPAN

Laboratory: Power Reactor and Nuclear Fuel Development Corp.(PNC), Japan
Nagoya University, Japan

Names: H. Harada, S. Nakamura, T. Katoh, Y. Ogata.

Facilities: TRIGA Mark II Reactor at Rikkyo University.

Experiment: Measurements of Thermal Neutron Capture Cross Sections and Resonance Integrals of $^{99}Tc(n, \gamma)^{100}Tc$ and $^{129}I(n, \gamma)^{130}I$ Reactions.

Results;

	capture cross section(σ_0)	resonance integral(I_0)
^{99}Tc;	22.9 ± 1.3 barns	398 ± 38 barns
^{129}I;	30.3 ± 1.2 barns	33.8 ± 1.4 barns

Method : Activation of samples and measurement of γ-ray spectra.

Accuracy: 4 ~ 10 %

Completion date: ^{99}Tc; May 31, 1994,
^{129}I; August 10, 1995

Discrepancy to other reported data: The σ_0 of ^{99}Tc agrees with the most of reported and evaluated values, the I_0, however, is about twice of that by Lucas et al. For ^{129}I, the σ_0 and I_0 producing the isomeric and the ground states of ^{130}I were obtained separately in the present measurement, but other reported data gave combined values.

Publication: ^{99}Tc; J. Nuclear Science & Technology, 32, p 395(1995),
^{129}I; ibid., 33, p 283(1996).

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Laboratory: Power Reactor and Nuclear Fuel Development Corp.(PNC), Japan
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Japan Atomic Energy Research Institute(JAERI), Japan

Names: T. Katoh, S. Nakamura, H. Harada, Y. Hatsukawa, N. Shinohara, K. Hata, K. Kobayashi, S. Motoishi, M. Tanase.

Facilities: Research Reactor, JRR-3, at JAERI.

Experiment: Measurement of Thermal Neutron Cross Section and Resonance Integral of the Reaction $^{135}Cs(n, \gamma)^{136}Cs$,
Result; 8.3 ± 0.3 barns for capture cross section,
37.9 ± 2.7 barns for resonance integral

Method Activation of samples and measurement of γ-ray spectra.

Accuracy: 3.6 % for cross section,
7.1 % for resonance integral.

Completion date: Sept. 3, 1996.

Discrepancies to other reported data: N. Sugarman reported a value of 14.5 ± 4 barns for the cross section, and Baerg et al. reported 8.7 ± 0.5. The present result supports the value by Baerg et al. However, the present result of resonance integral is abot 2/3 of that given by Baerg et al.

Publication: J. Nuclear Science & Technology, 34, p 431(1997)

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JAPAN

Laboratory : Cooperation between

PNC, Reactor Physics Section, Advanced Technology Division, O-arai Engineering Center, RPS, ATD/OEC, Oarai- machi, Higashi-gun, Ibaraki-ken, Japan

Nuclear Engineering Research Laboratory, Faculty of Engineering, University of Tokyo, 2-22 Shirakata-Shirane, Tokai-mura, Ibaraki, 319-11 Japan

The Decay Heat Working Group of the Japanese Nuclear Data Committee (DHWG/JNDC), chaired by Prof. T. Yoshida, Faculty of Engineering, Musashi Institute of Technology, 1-28-1 Tamazutsumi, Setagaya-ku, Tokyo 158, Japan

CEA-Cadarache, Reactor Physics Laboratory, Reactor and Cycle Physics Service, SPRC/LEPh, Bldg 230, F-13108 St Paul Lez Durance, France

Names : T. Wakabayashi and Y. Ohkawachi (PNC), Y. Oka and I. Saitoh (Univ. of Tokyo), T. Yoshida and K. Oyamatsu (DHWG/JNDC), F. Storrer (CEA).

Facility : YAYOI reactor (Tokyo University) as a fast neutron source, associated with a pneumatic system to transfer the sample from the irradiation channel to the measurement room where are located the monitoring, detection and data acquisition systems (the β or γ spectrum is recorded from the ADC versus cooling time).

Experiment : Decay Heat Measurement of Minor Actinides (^{237}Np, ^{241}Am, ^{243}Am, ^{244}Cm) for Fast Fission at YAYOI

Method : γ spectroscopy using a NaI(Tl) scintillation detector
β spectroscopy using a plastic scintillation detector coupled with a proportional counter to substract the γ component.

Accuracy : ~5 %

Completion: in progress.

Publication : to be published

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THE NETHERLANDS

Laboratory : Kernfysisch Versneller Instituut (KVI), Groningen, The Netherlands
Netherlands Energy Research Foundation (ECN), Petten, The Netherlands

Names : M. C. Duijvestijn, J. P. M. Beijers, A. Ferrari, M. Gastal, J. van Klinken, A. J. Koning and R. W. Ostendorf

Facilities : AGOR (Groningen)

Experiment : Proton Induced Fission of ^{232}Th, ^{208}Pb, ^{nat}Pb, ^{197}Au and ^{nat}W at 190 MeV: Fission Cross Sections and Mass Distributions

Method : The stacked foil technique was employed to bombard the targets with 190 MeV protons simultaneously at 10 nA. Both short-lived and long-lived isotopes have been observed, with half lives varying from 5 minutes up to 2 years. The identification of the fission products and the determination of the yields was carried out by means of off-line γ-ray-spectroscopy with Ge-detectors. Background reduction from evaporation residues was established by collecting the fission fragments in separate foils, which were placed on both sides of the targets. Partly independent yields and partly cumulative yields have been measured, from which the fission fragment mass distribution could be reconstructed. The total fission cross section was extracted by integrating over the measured mass distribution.

Accuracy : 10 - 20 %

Completion date : March 1998

Publications : Proc. Int. Conf. on Fission and Properties of Neutron-Rich Nuclei

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RUSSIA

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117259 Moscow, Russia

Names:
Yu.E. Titarenko, E.I. Karpikhin, V.M. Zhivin,
V.F. Batyaev, A.B. Koldobsky

Facilities:
ITEP proton synchrotron

Experiment:
Experimental measurements of the yields of radioactive product nuclei produced by intermediate energy protons in construction and target materials of Accelerator-Driven facilities

Method:
Measurement of gamma spectrum of irradiated foils. Produced nuclides are identified using decay irradiation database.

Accuracy:
above 3 percentage plus monitor cross section error (about 10%).

Completion date:
Determining of cross section production of the yields produced in:
^{209}Bi irradiated with 130 MeV protons;
^{209}Bi irradiated with 1500 MeV protons;
have been completed.

Determining of cross section production of the yields produced in:
^{206}Pb irradiated with 130 MeV protons;
^{206}Pb irradiated with 1500 MeV protons;
^{207}Pb irradiated with 130 MeV protons;
^{207}Pb irradiated with 1500 MeV protons;
^{208}Pb irradiated with 130 MeV protons;
^{208}Pb irradiated with 1500 MeV protons;
is expected to be completed before the end of March 1998.

Discrepancies to other reported data:
Discrepancies to other reported data are discussed in details in the publications.

Publications:
1. Yu.E. Titarenko, E.I. Karpikhin, A.F. Smolyakov, M.M. Igumnov, S.G. Mashnik, T.A. Gabriel, N.V. Stepanov, V.D. Kazaritsky, V.F. Batyaev and O.V. Shvedov, "Experimental and Theoretical Study of Radionuclide Production on the Electronuclear Plant Target and Construction Materials Irradiated by 1.5 GeV and 130 MeV Protons", Proc. Int. Workshop on Nucl. Methods for Transmutation of Nuclear Wastes: Problems, Perspectives, Cooperative Research, Dubna, Russia, May 29-31, 1996, eds. M.Kh. Khankhasayev, Zh.B. Kurmanov and H.S. Plendl (World Scientific, Singapore, 1997) p. 207.

2. Yu.E. Titarenko, E.I. Karpikhin, A.F. Smolyakov, M.M. Igumnov, S.G. Mashnik, T.A. Gabriel, N.V. Stepanov, V.D. Kazaritsky, V.F. Batyaev and O.V. Shvedov, "Experimental and Theoretical Study of Radionuclide Production on the Electronuclear Plant Target and Construction Materials Irradiated by 1.5 GeV and 130 MeV Protons". Proc. Second Int. Conf. on Accelerator-Driven Transmutation Technologies and Applications, Kalmar, Sweden, June 3-7, 1996, ed. H. Condé (Uppsala University Press, 1997), Vol. 2, p. 585.

3. Yu.E. Titarenko et al., "Experimental and computer simulation study of the radionuclides produced in thin ^{209}Bi targets by 130 MeV and 1.5 GeV protons", LANL Preprint IA-UR-97-3787, submitted to Nucl. Instr. Meth.

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RUSSIA

Laboratory:	General and Nuclear Physics Institute of Russian Research Centre "Kurchatov Institute"
Names:	V.I. Pelekhov, M.V. Sergeev, V.A. Letarov
Facilities:	Conversion electron spectrometer with Si(Li) detector and superconducting solenoid, installed at the neutron beam from the IR-8 research nuclear reactor of this institute. At present the spectrometer is not in operation because of high prices of the coolants (LHe and LN2) and for other reasons.
Experiment:	A study of the prompt conversion transitions in the postneutron-emission pre-beta decay mass-assigned fragments from thermal-neutron-induced fission of heavy nuclei.
Method:	The prompt conversion electron spectroscopy with the help of semiconductor detectors from mass and total kinetic energy (TKE) identified fragments. The electron energy spectra in the energy range of 15-250 keV of electrons emitted by one of the complementary fragments within 0.6-1.4 nsec after fission moment are measured.
Accuracy:	For the measurement of electron energies in intensive conversion transitions is 1 keV; with the mass resolution of 4 amu FWHM the error in the fragments mass assignment is about 1 amu; the accuracy of electron peaks intensity determination (relative or absolute) is 7-20% respectively. The errors of the TKE are ~2 MeV. A total of 5*10(5) three-parameter fission events for each of the investigated fissioning nuclei were accumulated.
Completion date:	Were obtained with uranium-233, -235 and plutonium-239: 1) integral and many a mass-sorted conversion electrons energy spectra from the fragments, 2) the two-dimensional matrix (provisional mass versus TKE array) of the conversion electrons yield per fragment. The purpose of the further analysis of the experimental data will be searching of TKE - dependencies.
Discrepancies to other reported data:	No such data be available.

RUSSIA (cont.)

Publications:

1. V.I. Pelekhov, V.P. Moryakov, V.V. Martinenko and M.V. Sergeev. An economical helium cryostat for a superconducting solenoid of a conversion electron spectrometer. Nuclear Instruments and Methods in Physics Research A 337 (1993) 101-105.

2. V.A. Letarov, V.I. Pelekhov, M.V. Sergeev. On the Possible Coexistence of Nuclear Forms for Pre-Beta-Decay Fragments with Post-Neutron-Emission Mass A=87-88 in 233, ^{233,235}U Fission by Thermal Neutrons. Yadernaya Fizika, Vol. 57, No. 7, 1994, pp. 1192-1197

3. V.A. Letarov, V.I. Pelekhov, M.V. Sergeev. New information on the excitation of the fragments with A~100 for ^{235}U thermal-neutron-induced fission. Proceedings of the 13 Meeting on Physics of Nuclear Fission, Obninsk, October 1995, pp. 80-87. Published by State Scientific Center of Russian Federation-Institute of Physics & Power Engineering, 1996.

Contact:

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Russian Research Centre "Kurchatov Institute"
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123182 Moscow
Russia

RUSSIA

Laboratory:
and Address:

St. Petersburg State Institute of Technology
Department of Radiation Technology
Moskovsky 26
St. Petersburg, 198013
Russia

Names:

V.F. Teplykh. E.V. Platygina, K.A. Petrzhak

Facilities:

Gatchina SPNFI Nuclear Reactor WWR-M, Mass-spectrometer MI-1201m

Experiment:

The recoil ranges and kinetic energy of fission fragments. The ranges of fission fragments in mass region A=131 - 136, where the greatest anomalies are observed, were received. The fission induced by reactor neutrons of nucleuses ^{237}Np, ^{243}Am and thermal neutron of ^{233}U, ^{235}U. ^{239}Pu were studied.

Method:

The recoil ranges of the fission products were measured using target integral range measurement technique. The fission products from various parts of a complicated Al-foil target were retrieved. The isotopic distributions of fission products by the mass-spectrometer method were obtained. The relative isotope xenon distributions, retrieved from the filter, substrate and catchers, were used to calculate relative recoil ranges. Corrections for fission layer thickness were introduced. The recoil ranges by two methods were obtained:

1. As starting point the known recoil range of 131 mass (R_1) were used. The recoil ranges of other masses were obtained from the value R_1 and appropriate relative distributions.

2. New technique: Relative distributions of xenon isotopes, retrieved from the filter, substrate and catcher, are used to derive a set of linear equations (yields-range dependence). By solving these equations for several filters we have recoil range sets for each fission product. This numerical results are analyzed in terms of least squares method.

The ranges of the fission products were converted into respective kinetic energies by using semiempirical range-energy relation.

Accuracy:

Statistical accuracy relative recoil ranges ~1%, calculated kinetic energies ~1.5%.

Completion date:

Completed December 1997

RUSSIA (cont.)

Discrepancies to other reported data: The data obtained were found to be in good agreement with ones published in the literature. The information on fission fragments ranges in a mass region A=131 - 136 for ^{237}Np and ^{243}Am is received for the first time.

Publications: unpublished

Contact:

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plateb@tu.spb.ru (Dr. Elena V. Platygina)

SWEDEN

Laboratory : Cooperation between

Uppsala University, *Department of Neutron research,* Studsvik, S-611 82 Nyköping, Sweden

and

CEA-Cadarache, Reactor Physics Laboratory, Reactor and Cycle Physics Service, SPRC/LEPh, Bldg 230, F-13108 St Paul Lez Durance, France.

Names : J. Galy (PhD student cofinanced by the CEA and Uppsala University, based in Studsvik, Sweden), B. Fogelberg (INF), F. Storrer (CEA)

Facility: OSIRIS on-line mass separator for fission products

Experiment : Measurements of the fission yields of U233 in a fast neutron spectrum

Method : γ spectroscopic assay of individual mass separated fission products

Completion : Late 1999

Publication : J. Galy et al., Contribution to the International Conference on Nuclear data for Science and Technology, Trieste, May 19-24 (1997)

Contact : J. Galy,
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SWEDEN

Laboratory : Uppsala University, *Department of Neutron research,* Studsvik, S-611 82 Nyköping, Sweden

Names : B. Fogelberg, P-I Johansson, H. Mach and G. Rudstam (Uppsala University)
P. Hoff and J. P. Omtvedt (Oslo University)
N. J. Stone (Oxford University)
K. A. Mezilev and Yu. N. Novikov (PNPI, Gatchina, St. Petersbourg)

Facility: OSIRIS on-line mass separator for fission products

1. Experiment : Spectroscopy of neutron rich nuclides produced in fission

Method : Nuclear spectroscopy including nuclear orientation studies

Completion date : Indefinite

Publications :
B. Fogelberg et al., Phys. Rev. Lett. 73 (1994) 2413 Sn-132
H. Mach et al., Phys. Rev. C51 (1995) 509 Eu-154
H. Mach et al., Phys.Rev. C51 (1995) 500 Sn-132
J. P. Omtvedt et al., Phys. Rev. Lett. 75 (1995) 3090 Sb-134
P. Hoff et al., Phys. Rev. Lett. 77 (1996) 1020 In-134
N. J. Stone et al., Phys. Rev. Lett. 78 (1997) 820 Sb-129, 31, 33
P.Hoff et al., Phys. Rev C56 (1997) 2865 Sb-136

2. Experiment : Total β-decay energies and Atomic masses .

Method : β-γ coincidence measurements using HPGe or Si(Li) detectors for β-spectroscopy

Completion date : indefinite

Publication :
K.A. Mezilev et al., Phys. Scripta T56 (1995) 272
B. Fogelberg et al., in "Research with Fission Fragments, ed. By T. von Egidy et al., (World Scientific, Singapore, 1997) p242

3. Experiment : Thermal neutron fission of ^{233}U and fast fission of ^{232}Th

Method : γ spectroscopic assay of individual mass separated fission products

Completion date : Measurements are completed for ^{233}U and are planned for early 1998 for ^{232}Th

Publication : P.-I. Johansson et al., contribution to the International Conference on Nuclear Data for Science and Technology, Trieste, May 19-24 (1997)

UKRAINE

Laboratory and address:	Kharkiv State University, Kharkiv, 310077 Ukraine
Names:	P.M.Gopych, I.I.Zalubovskii
Facilities:	Neutron Generator NG-150M, Ge(Li) gamma ray spectrometer, transport pneumatic system, enriched samples
Experiment:	Measurements of (n,p), (n,alpha), (n,d)+(n,np)+(n,pn) reactions cross sections at the neutron energy of 14.6 MeV
Method:	Activation thechnique
Accuracy:	10-50%
Completion date:	1997
Discrepancies to other reported data:	Descovery [1,2] and systematic investigation of a new effect of regular spin splitting of nuclear reactions cross-sections and it local violation [5]. Cross sections sytematics and nonstatistical effects study using nuclear pleiad parameters. Some new empirical formulae for cross sections estimation are proposed [6,7,9].

Publications:

1. P.M.Gopych, O.I.Zabashta, I.I.Zalubovskii et al. Regular Spin Splitting of (n,p) Reaction Cross Sections on Tin Isotopes. Yadernaya Fizika,1988,v.47, p.602–603.

2. P.M.Gopych, I.I.Zalubovskii, P.S.Kizim et al. Regular Spin Splitting of Nuclear Reactions Cross Sections Induced by 14 MeV Neutrons. Pis'ma v JETF,1989,v.50, p.273–275.

3. P.M.Gopych, I.I.Zalubovskii, P.S.Kizim et al. Isotope Systematics of (n,gamma) Cross Sections for Even Tellurium Isotopes. Atomnaya Energiya,1993,v.74, p.78–79.

4. P.M.Gopych, M.N.Demchenko, I.I.Zalubovskii et al. (n,d)+(n,np)+(n,pn) Reaction Cross Sections on Even Cadmium and Tin Isotopes at the Neutron Energy of 14 Mev. Atomnaya Energiya, 1993, v.75, p.2 3–2 5.

5. P.M.Gopych, I.I.Zalubovskii, P.S.Kizim et al. Regular Spin Splitting of (n,p) Reaction Cross Sections on Tellurium Isotopes. Yadernaya Fizika, 1994, v.57, p.387–397.

6. P.M.Gopych, M.N.Demchenko, I.I.Zalubovskii et al. Total and Partial Cross Sections of (n,p)+(n,np)+(n,pn) Reaction induced by 14 MeV Neutrons. Izvestiya RAN, ser.fiz., 1994,v.58, No.1, p.163–172.

7. M.P.Gopych, P.M.Gopych, M.N.Demchenko. Shell Effects in Cross Sections Systematics of (n,alpha) Reaction induced by 14 MeV Neutrons. Izvestiya RAN,ser.fiz., 1994, v.58, No.11, p.196–203.

8. P.M.Gopych, M.N.Demchenko, I.I.Zalubovskii, P.S.Kizim. Cross Sections of (n,alpha) Reaction on ^{112,114,116}Sn at the Neutron Energy of 14.6 Mev. Atomnaya Energiya, 1995, v.78, p.229–331.

9. M.P.Gopych, P.M.Gopych, I.I.Zalubovskii. Nonstatistical Effects in Cross Sections Systematics of (n,p) Reaction induced by 14 MeV Neutrons. Izvestiya RAN,ser.fiz.,1996, v.60, No.5, p.189–197.

UNITED KINGDOM

Laboratory: Centre for Analytical Research in the Environment, Imperial College of Science, Technology and Medicine.

Names: T.D. MacMahon, M.U. Rajput, M.A. Hammed, A.H. Naboulsi.

Facilities: 100 kW teaching and research reactor;
$4\pi\beta - \gamma$ coincidence system

Experiments: 1. relative gamma ray emission probabilities in ^{101}Mo and ^{101}Tc;
2. thermal neutron cross-sections and resonance integrals of ^{74}Se, ^{75}As, ^{94}Zr, ^{134}Cs and ^{238}U.

Results: Results of these measurements are in the publications below.

Publications: 1. M.A. Hammed, T.D. MacMahon, A.H. Naboulsi, "Decay scheme data for ^{101}Mo and ^{101}Tc", Nucl. Instr. & Methods in Phys. Res. A334 (1993) 485-494.

2. M.U. Rajput, T.D. MacMahon, "Measurements of thermal neutron cross-sections and resonance integrals of ^{74}Se, ^{75}As, ^{94}Zr, ^{134}Cs and ^{238}U", J. Radioanal. Nucl. Chem. 189 (1995) 51-58.

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U.S.A.

Laboratory:	Idaho National Engineering and Environmental Laboratory Lockheed Martin Idaho Technology Company P.O. Box 1625 Idaho Falls, ID 83415-2114 USA
Names:	R. C. Greenwood, K. D. Watts
Facility:	TRISTAN ISOL system at Brookhaven National Laboratory
Experiment:	Delayed-neutron energy spectral measurements of fission-product isotopes.
Method:	Isotope separation on line with gas-filled proton-recoil proportional counters and liquid scintillation detectors used to measure delayed-neutron spectra.
Completion date:	All work has been done.
Publications:	"Delayed Neutron Energy Spectra of ^{87}Br, ^{88}Br, ^{89}Br, ^{90}Br, ^{137}I, ^{138}I, ^{139}I, and ^{136}Te," R. C. Greenwood and K. D. Watts, Nucl. Sci. Eng. 126, 324 (1997).
Contact:	R. G. Helmer

U.S.A.

Laboratory:	Idaho National Engineering and Environmental Laboratory Lockheed Martin Idaho Technology Company P.O. Box 1625 Idaho Falls, ID 83415-2114 USA
Names:	R. C. Greenwood, C. W. Reich, K. D. Watts, H. Willmes (U. Idaho)
Facility:	INEEL ^{252}Cf-based ISOL facility.
Experiment:	Nuclear decay properties (T½, decay energies, β- branching, γ-branching) of short-lived fission products.
Method:	On-line mass separations followed by γ, γ-γ, β and β-γ measurements.
Completion date:	All work has been completed.
Publications:	1. "Measurement of β^- End-point Energies using a Ge Detector with Monte Carlo Generated Response Functions," R. C. Greenwood and M. H. Putnam, Nucl. Instrum. and Methods, A337, 106 (1993). 2. "Measurement of ground-state β^--branching intensities of deformed rare-earth nuclides using a total absorption γ-ray spectrometer", R. C. Greenwood, M. H. Putnam, K. D. Watts, Nucl. Instrum. and Methods A356, 385 (1995). 3. "Ground-state β^--branching intensities of several fission-product isotopes measured using a total absorption γ-ray spectrometer", R. C. Greenwood, M. H. Putnam, K. D. Watts, Nucl. Instrum. and Methods A378, 312 (1996).
Contact:	R. G. Helmer

1. With this system, β^- end-point energies have been measured and Q_β values deduced, for ^{32}P, ^{90}Y, ^{140}Cs, ^{151}Pr, ^{153}Nd, ^{153}Pm, ^{154}Pm (1.7 min), ^{155}Nd, ^{155}Pm, ^{155}Sm, ^{157}Sm and ^{158}Sm.

2. Results obtained for ^{153}Nd, ^{153}Pm, ^{154}Nd, ^{154}Pm(1.7 min), ^{155}Pm, ^{156}Pm, ^{157}Pm, ^{157}Sm and ^{158}Sm are presented and compared with existing published data.

3. Results obtained for ^{89}Rb, ^{90g}Rb, ^{91}Rb, ^{93}Rb, ^{93}Sr, ^{94}Sr, ^{94}Y, ^{95}Sr, ^{95}Y, ^{140}Cs, ^{142}La, ^{143}Ba, ^{143}La, ^{144}Ba, ^{144}La, ^{145}Ba, ^{145}La, ^{146}Ce, ^{146}Pr, ^{147}Ce, ^{147}Pr, ^{148}Ce, ^{148}Pr (2.27 min), ^{149}Pr, ^{149}Nd, ^{151}Pr, ^{151}Nd, ^{152}Pm (4.1 min), ^{153}Nd, ^{155}Nd, ^{157}Pm, ^{157}Sm, ^{158}Sm and ^{158}Eu are presented and compared with existing published data.

U.S.A.

Laboratory:	Idaho National Engineering and Environmental Laboratory Lockheed Martin Idaho Technology Company P.O. Box 1625 Idaho Falls, ID 83415-2114 USA
Names:	R. C. Greenwood, R. G. Helmer, M. H. Putnam, K. D. Watts
Facility:	INEEL ^{252}Cf-based ISOL facility.
Experiment:	Beta-decay feeding (β- strength) distributions of short-lived fission-product isotopes.
Method:	Measurement of the distribution of β-decay feeding intensities of fission product decay nuclides using a total absorption γ-ray spectrometer (TAGS).
Completion date:	All work has been completed.
Publications:	"Beta-decay intensity distributions for the fission products ^{139}Cs and ^{140}Cs measured with a total absorption γ-ray spectrometer", R. G. Helmer, R. C. Greenwood, M. H. Putnam, K. D. Watts, Nucl. Instrum. and Methods A353, 222 (1994). "Beta-particle feeding distributions for $^{138-141}$Cs from total absorption gamma-ray spectrometer (TAGS)", R. G. Helmer, R. C. Greenwood, K. D. Watts, M. H. Putnam, Nucl. Instrum. and Methods A339, 189 (1994). "Methodology for the measurement of β^--decay intensity distributions from the analysis of total absorption γ-ray spectra", R. G. Helmer, M. H. Putnam, R. C. Greenwood, H. Willmes, Nucl. Instrum. and Methods A351, 406 (1994). "Measurement of β^--decay intensity distributions of several fission-product isotopes using a total absorption γ-ray spectrometer", R. C. Greenwood, R. G. Helmer, M. H. Putnam, K. D. Watts, Nucl. Instrum. and Methods A390, 95 (1997). *)
Contact:	R. G. Helmer

*) New β^--decay intensity distributions have been deduced for the decay of these radionuclides. Radionuclides which have been studied in this manner include ^{89}Rb, ^{90g}Rb, ^{90m}Rb, ^{91}Rb, ^{93}Rb, ^{93}Sr, ^{94}Sr, ^{94}Y, ^{95}Sr, ^{95}Y, ^{138g}Cs, ^{138m}Cs, ^{139}Cs, ^{140}Cs, ^{141}Cs, ^{141}Ba, ^{142}Ba, ^{142}La, ^{143}Ba, ^{143}La, ^{144}Ba, ^{144}La, ^{145}Ba, ^{145}La, ^{145}Ce, ^{146}Ce, ^{146}Pr, ^{147}Ce, ^{147}Pr, ^{148}Ce, ^{148}Pr (2.0 min), ^{148}Pr (2.27 min), ^{149}Pr, ^{149}Nd, ^{151}Pr, ^{151}Nd, ^{152}Nd - ^{152}Pm (4.1 min.), ^{153}Nd, ^{153}Pm, ^{154}Nd, ^{154}Pm (1.7 min), ^{155}Nd, ^{155}Pm, ^{156}Pm, ^{157}Pm, ^{157}Sm, ^{158}Sm, and ^{158}Eu.

A2 - Compilations and Evaluations

SUBJECT INDEX

BELARUS

Laboratory:	Physics and Chemistry Problems Institute
Names:	M. Maslov, Yu.V. Porodzinskij
Evaluation:	Emissive and non-emissive fission contribution to the observed fission cross section of mino actinide nuclei
Purpose:	Evaluation and prediction of neutron-induced fission yields for incident neutron energies up to 30 MeV
Method:	Statistical theory of nuclear reactions
Major sources of information:	EXFOR data base
Deadline of literature coverage:	0.5 1998
Status:	Model testing
Cooperation:	IPPE (Obninsk, Russia)
Other relevant details:	accomplished under IAEA CRP "Fission Product Yield Data acquired for transmutation of minor actinide nuclear waste"
Computer file of evaluated data:	partial contribution of n-chance fission would be provided.
Completion date:	12.1998
Contact:	V.M. Maslov Radiation Physics and Chemistry Problems Institute Minsk-Sosny, 220109, Belarus E-mail: maslov@ndel.belpak.minsk.by maslov@sosny.bas-net.by

CHINA

Laboratory:	Chinese Nuclear Data Center China Institute of Atomic Energy
Address:	Chinese Nuclear Data Center P.O. Box 275(41) Beijing 102413, P.R. China
Names:	Liang Qichang, Liu Tingjin
Compilation:	Yields of products from neutron induced fission measured in China (in EXFOR format).
Purpose:	For application evaluation, and international exchange (contributing to master EXFOR library).
Major sources of information:	Chinese J. of Nuclear Physics (CNP); High Energy Physics and Nucl. Physics, Chinese ed. (PHE) J. of Nuclear and Radiochemistry (HPH); Atomic Energy Science and Technology; and Private Communication.
Deadline of literature coverage:	End of 1997
Cooperation:	NDS/IAEA under CRP and RCP
Computer file:	EXFOR.CHN
Completion date:	December 1997
Contact:	Liang Qichang Chinese Nuclear Data Center China Institute of Atomic Energy P.O. Box 275(41) Beijing 102413, P.R. China E-mail: lqc@mipsa.ciae.ac.cn

CHINA

Laboratory:	Chinese Nuclear Data Center China Institute of Atomic Energy
Address:	Chinese Nuclear Data Center P.O. Box 275(41) Beijing 102413, P.R. China
Names:	Liu Tingjin, Liang Qichang, Cai Dunjiu
Evaluation:	Cumulative fission yield of ^{235}U, ^{238}U and ^{239}Pu fission for each about 30 important fission products
Purpose:	For application in nuclear engineering, as reference and updating CENDL-FY.
Method:	Based on available experimental data, correction for standard, gamma intensity and fission cross section, average with weight and simultaneous evaluation.
Major sources of information:	EXFOR master file and publications
Status:	Completed
Cooperation:	Partially supported by IAEA under CRP and RCP contracts
Other relevant details:	Some programs for fission yield data retrieval and evaluation were developed during the work
Computer file of evaluated data:	EVFY.DAT kept at CNDC Alpha server computer
Discrepancies encountered:	Most evaluated are consistent with ENDF/B-6 and other existing evaluated fission yield data, but some are discrepant over data error.
Completion date:	October 1997
Publication:	Liu Tingjin, "Evaluation of ^{235}U Fission Product Yield Data and Study of the Dependence of FY Data on Neutron Energy", CNDP, 18 (1997) "Some ^{235}U Reference Fission Product Yield Data Evaluation", Oct. 1997, to be published Liang Qichang, "Evaluation of ^{238}U Fission Product Yield Data", Feb. 1977, to be published

"The evaluation for Reference Fission Yield of ^{238}U",
Oct. 1997, to be published.
Cai Dunjiu et al., "Evaluation of ^{239}Pu Fission Product Yield
Data for 18 Product Nuclides", Feb. 1977, to be published

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ITALY

Laboratory: ENEA Applied Physics Division, Bologna, Italy

Names:
- Giuseppe Maino
- Enzo Menapace
- Alfio Musumeci
- Maurizio Rosetti
- Elisabetta Canetta (guest student)
- Umberto Lucia (University of Ferrara, Italy)

Evaluation:
Theoretical models and cross-section calculations of photon-induced fission reactions at low and intermediate energies for medium and heavy mass nuclei (40<A<240)

Purpose:
Aim of this work is to develop a consistent set of nuclear models and the relevant computing codes for the description of photon-indiced fission reactions and the yields of products in a broad energy range, spanning from a few MeV to 1-2 GeV. Numerical calculations of cross sections and production yields for many nuclei of interest in technological as well as medical (production of radionuclides, shielding, etc.) applications have been performed and compared with the existing experimental data. Further work is in progress, both from theoretical and evaluation point of view.

Method:
Interacting boson-fermion model of nuclear structure; cascade-exciton model of nuclear dynamics; thermodynamical analysis of photofission excitation potential.

Major sources of information:

1. G.Maino, *Group-theory approach to nuclear photoreactions*, *in Dynamical Symmetries and Chaotic Behaviour in Physical Systems*, World Scientific, Singapore, 1991, pp.141-165.
2. F.Iachello and P.Van Isacker, *The interacting boson-fermion model*, Cambridge University Press, Cambridge, 1991.
3. G.Kaniadakis, U.Lucia and P.Quarati, *Probability and time of photofission in the quasi-deuteron energy region*, Int. J. Mod. Phys. **E2** (1993) 827-834.

Deadline of literature coverage: December 1997

Status: work in progress

Cooperations:
- Sloane Center for Theoretical Physics, Yale University, USA
- Bogoliubov Laboratory of Theoretical Physics, JINR, Russia

Computer file of evaluated data:
The TRIAXI code (see: E.Bortolani and G.Maino, *Isospin and deformation splittings of the giant dipole resonance for triaxial nuclei*, Phys. Rev. **C43** (1991) 353-356; *Photon absorption and scattering cross sections by triaxial nuclei*, Comp. Phys. Comm. **70** (1992) 207-218) is available on request; calculated cross sections and product yields are available for selected reactions.

Completion date: December 1998

Recent publications:

- A.Ventura, G.Maino and L.Zuffi, *Giant dipole resonances in the SU(3)⊗ SU(2) limit of the interacting boson-fermion model,* in Symmetries in Science VII: Spectrum Generating Algebras and Dynamic Symmetries in Physics, Plenum Press, New York, 1994, pp.575-585.
- A.Ventura, G.Maino and L.Zuffi, *Giant dipole resonances in odd-mass nuclei and the interacting boson - fermion model,* Nuovo Cim. **A107** (1994) 43-58, errata 817-818.
- A.Ventura, G.Maino and L.Zuffi, *Algebraic description of giant dipole resonances in tungsten isotopes*, in Proceed. of Eigth Int. Symp. on Capture Gamma-Ray Spectroscopy, Fribourg, Sept. 20-24, 1993, J. Kern ed., World Scientific, Singapore (1994) 467-469.
- T.Gabriel, G.Maino and S.G.Mashnik, *Analysis of intermediate energy photomuclear reactions,* in Proceedings of XII Int. Seminar on High Energy Physics Problems, Dubna, Sept. 12-17, 1994, Relativistic Nuclear Physics and Quantum Chromodynamics, A.M.Baldin and V.V.Burov, eds., Dubna (1994) 1-10.
- G.Maino, S.G.Mashnik, S.A.Smolyansky, A.V.Tarakanov, A.V.Prozorkevich and D.Tocci, *Hartree-Fock approximation for a relativistic kinetic equation in hadrodynamics,* in Proceed. of 3rd Int. Symp. Dubna - Deuteron - 95, Dubna, July 4-7, 1995, Dubna (1996) 46-51.
- G.Maino, S.G.Mashnik, S.A.Smolyansky, A.V.Tarakanov and D.Tocci, *A relativistic Vlasov-type kinetic equation in hadrodynamics (Hartree-Fock approximation),* Izvestiya Akad. Nauk, Ser. Fiz. **60** (1996) 58-62 (in Russian); Engl. transl. in Bull. Russian Acad., Ser. Phys.**60** (1996).
- T.Gabriel, G.Maino and S.G.Mashnik, *Cascade-exciton model analysis of photofission cross sections and (γ ,xnyp) excitation functions*, in Proceed. of 46th Int. Conf. on Nuclear Structure and Nuclear Spectroscopy, Dubna, June 18-21, 1996.
- S.G.Mashnik, A.V.Prozorkevich, S.A.Smolyansky and G.Maino, *Comparison of two forms of Vlasov-type relativistic kinetic equations in hadrodynamics*, Nuovo Cim. **A109** (1996) 1699-1708.
- G.Maino, *Interacting boson-fermion description of odd-odd nuclei,* Int. J. Mod. Phys. **E6** (1997) 287-300.
- U.Lucia, *Total photoabsorption cross section and excitation function in the quasi-deuteron energy region*, Commun. Theor. Phys. **28** (1997) 237-240.
- U.Lucia, *pn-Pair average velocity in statistical model of photofission*, Commun. Theor. Phys. **28** (1997) 367-368.
- J.L.M.Duarte, T.Borello-Lewin, G.Maino, L.Zuffi, *Effective triaxial deformations of even-even Ru isotopes in the neutron-proton interacting boson model*, Physical Review**C57** (1998).
- U.Lucia and G.Maino, *Thermodynamical considerations about the photofission excitation potential*, submitted for publication.
- S.A.Smolyansky, A.V.Prozorkevich, S.G.Mashnik and G.Maino, *Recent advances in the theory of relativistic kinetic equations for hadrodynamics,* in Proceed. of Int. Conf. on Nuclear Data for Science and Technology, Trieste, May 19-24, 1997 (in press).

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JAPAN

Laboratory Address:

Japanese Nuclear Data Committee
Decay Heat Evaluation Working Group

Members:

K.Ikeda(MHI), Y.Kaise(ArTech), J.Katakura (JAERI), T.Katoh(GCMT), T.Murata(Aitel), R.Nakasima(Hosei Univ), I.Ohtake(Data Eng), K.Oyamatsu(Nagoya Univ.), T.Tachibana(Waseda Univ.), Y.Tahara(MHI), M.Yamada(Waseda Univ.), T.Yoshida(Musashi-Tech;WG Leader), A.Zukeran(Hitachi)

Compilation and Evaluation

Purpose:

To improve the present version of the JNDC FP Decay Data Library Version 2 completed in 1989.

Major Source of Infomation:

Journals, Nuclear Data Sheets, ENSDF and theoretical claculations

Status:

Summation calculations based on world major libraries including JNDC Library Ver.2 persistently underestimate the gamma-ray component of FP hecay heat after 300 ~ 3000 s after fission burst. The recent WG activity focuses on solving this gamma-ray discrepancy. Theoretical studies on the energy release from individual nuclides and on the systematics of decay heat among various fissioning systems are also under way.

Availability of the Data:

Contact Dr. J. katakura,
Nuclear Data Center, Japan Atomic Energy Research Laboratory
Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan

Recent Publications:

1) K.Oyamatsu, H.Ohta, T.Miyazono and K.Tasaka : Uncertainties in fission product decay-heat calculations, Proc. Internet Sympo. on Nucl. Data 1996, JAERI, Tokai, Japan, JAERI-Conf 97-004, pp. 141-148, 1997.
2) K.Oyamatsu, M.Sagisaka and T. Miyazono : Comparison of Yield and Decay Data among JNDC2, ENDF/B-VI and JEF2.2, Proc. 1996 Symposium on Nuclear Data, Nov. 1996, JAERI, Tokai, Japan, JAERI-Conf 97-005, pp. 153-158, 1997
3) K. Oyamatsu, M. Sagisaka, H. Takeuchi and T. Miyazono : Two methods for evaluation and benchmark test of fission product summation calculations, Proc. Int. Conf. Nucl. Data for Sci. and Technol., Trieste (May, 1997) in press
4) T. Yoshida, J. Katakura and K. Oyamatsu : On a possible Level-Missing in Aggregate Fission Product from the Point of Decay Heat Calculations, ibid., in press.
5) T. Yoshida, Y.Naito, A.Hasegawa : Fuel cycle nuclear data activity in Japan, ibid., in press.
6) H. Nakata, T. Tachibana, M.Yamada, Refinement of the gross theory of beta-decay for odd-odd nuclei, Nucl. Phys., A594 (1995) 27
7) H. Nakata, T. Tachibana, M. Yamada, Semi-gross theory of nuclear beta-decay, Nucl. Phys., A625 (1997) 521

UKRAINE

Laboratory:	Scientific Center «Institute for Nuclear Research» of Ukrainian National Academy of Sciences.
Names:	N.I.Zaika, Yu.V.Kibkalo, V.P.Tokarev, A.I.Ustinov
Evaluation:	Energy dependence of ^{240}Pu mass fission fragment distribution.
Purpose:	To describe form of fragment mass distribution for fission of ^{240}Pu formed in reactions with different light particles up to 30 MeV excitation energy.
Method:	Phenomenological model with accounting of total angular momentum and excitation energy of fissioning nucleus.
Major sources of information:	Literature and our experimental data.
Deadline of literature coverage:	1996
Status:	The evaluation program for phenomenological description of fission fragment mass distribution with accounting of total angular momentum and excitation energy of fissioning nucleus is preparing. The experimental date of fragment mass distribution of ^{240}Pu fission in different reaction induced by light particles and with excitation energy range up to 30 MeV are analyzed.
Cooperation:	The work is carried out in the frame of IAEA Co-ordinated Research Programme «Fission product yield data for transmutation of minor actinide nuclear waste»
Computer file of compiled data:	in preparation
Computer file of evaluated data:	in preparation
Discrepancies encountered:	Statistical error.
Completion date:	May, 1998
Publication:	Ukr.Fiz.Journal, **37**, (1992) 327. Sov.Yad.Fiz., **42**, (1985) 304. Collective Nuclear Dynamics, The Fourth KINR Int. School on Nuclear Physics, Kyiv, 1994, p.399. Ibid, p.415.
Contact:	Yu.V.Kibkalo, Sci. Centre «Inst.Nuclear Research» of Ukrainian Academy of Science, Prospekt Nauki 47, Kiev-28, 252028, Ukraine e-mail: «kibkalo@kinr.kiev.ua»

UNITED KINGDOM

Laboratory and Address:

British Nuclear Fuels plc
BNFL Sellafield Works
Seascale, Cumbria, CA27 0EF
United Kingdom, Europe

Names:

R.W. Mills British Nuclear Fuels plc.
D.R. Weaver The University of Birmingham
D.J. Hale The University of Birmingham

Compilation and Evaluation:

Fission product yields for spontaneous and neutron induced fission for the UKFY3 evaluation.

Purpose:

To compile experimental fission product yield data, and evaluate this data to produce a set of libraries in ENDF/B-VI format.

Method:

Weighted averaging of experimental data, fitting data to various models for chain and fractional independent yields, adjustment for physical constraints, isomeric splitting and the production of ENDF/B-VI formatted libraries.

Fissile materials considered:

The UKFY3 Database contains spontaneous and neutron induced fission yield data for all published nuclides.

A study using the FISPIN code has shown the following nuclides to be significant for a wide range of nuclear fuel types and therefore were included in UKFY2 and UKFY3:

Th: 232FH.
U: 233FTH, 234F, 235TFH, 236F, 238FH.
Np: 237TF, 238TF.
Pu: 238TF, 239TF, 240F, 241TF, 242F.
Am: 241TF, 242mTF, 243TF.
Cm: 242S, 243TF, 244TFS, 245TF.
Cf: 252S.

Major sources of data:

Source include compilations from: Crouch(1), England and Rider(2), James(3,4,5,6), EXFOR and searches of the open literature.

Compilation:

Details of data, methods and discrepancies were published in 1995(7).

Evaluated files:

UKFY2 was completed and accepted for inclusion in JEF2.2. This evaluation is described in references 3, 4, 5 and 6.

Status:

A preliminary version of UKFY3 was completed in 1994(7). Final modifications to this file are awaiting decay data improvements due for completion in 1998. The current plan is for a revised file to be produced in 1999. This is intended to be submitted to the NEA for inclusion in JEFF3 after a detailed review.

The UK group continues international collaboration with colleagues in the USA, China, France, Germany, Japan, Netherlands, Russia and Sweden within the forum of the IAEA's CRP on Fission Product Yield Data Required for Transmutation of Minor Actinide Nuclear Waste.

A PhD student, D. Hale, is currently studying the modeling and evaluation of fission yield distributions and, their effects on delayed neutron emission. The aim of this PhD project is to provide an investigation into the evaluation of nuclear fission data using current and new theories of nuclear fission. It is hoped that by applying more recent models to the available experimental fission chain yields, values for the modeled yields can be improved. The Brosa and Mebel models have been applied to many fissioning systems within the UKFY3 experimental fission yield file. Analysis is currently being performed on the output parameters to determine equations, which can describe the variation of the parameters with fissioning system mass and inducing neutron energy. Fission theory will be carefully examined to pursue the question of the variation of the fission yields with neutron energy to determine the effects on parameters such as yield of burn-up monitors and yield of nuclides significant to decay heat and disposal for example. Wahl's Ap' model is being applied to the isobaric yield data within the UKFY3 experimental fission yield file in order to see if this model is an improvement over the Zp model. The Ap' model will be applied to as many fissioning systems as is practically possible in order to make an attempt at extrapolating the model parameters to other fissioning systems and inducing neutron energies. However, due to the large number of parameters that this model uses the number of fissioning systems from which useful results can be obtained will be small.

It is hoped that improved results from Hale's work will be incorporated in the revised version of UKFY3.

References:

1) E.A. Crouch, "Fission product yields from neutron induced fission.", Atomic and Nuclear Data Sheets Vol.19, No.5, May 1977.

2) T.R. England and B.F. Rider, private communication, May 1989.

3) M.F. James, R.W. Mills and D.R. Weaver. Report AEA-TRS-1015. "A new evaluation of fission product yields and the production of a new library (UKFY2) of independent and Cumulative Yields. Part I. Methods and outline of evaluation.", January 1991.

4) M.F. James, R.W. Mills and D.R. Weaver. Report AEA-TRS-1018. "A new evaluation of fission product yields and the production of a new library (UKFY2) of independent and Cumulative Yields. Part II. Tables of measured and recommended fission yields.", January 1991.

5) M.F. James, R.W. Mills and D.R. Weaver. Report AEA-TRS-1019. "A new evaluation of fission product yields and the production of a new library (UKFY2) of independent and Cumulative Yields. Part III. Tables of fission yields with discrepant or sparse data.", January 1991.

6) M.F. James, R.W. Mills and D.R. Weaver. "A new evaluation of fission product yields and the production of a new library (UKFY2).

7) R.W. Mills. "Fission Product Evaluation", PhD Thesis, The University of Birmingham, UK. (1995).

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UNITED KINGDOM

Evaluations

Laboratory: Centre for Analytical Research in the Environment, Imperial College of Science, Technology and Medicine.

Names: S.I. Kafala, T.D. MacMahon.

Purpose: (i) to test different methods for the evaluation of discrepant data sets;
(ii) application of chosen methods to fission product half-life data;
(iii) application of chosen methods to fission product cross-section data.

Method: (i) many data sets were generated by the random selection of values from a normal distribution of known mean and standard deviation, and a few from a log-normal distribution; uncertainties were assigned to produce several types of inconsistency; a modified Bayesian procedure was shown to be the most reliable (reference 1).
(ii) this procedure was applied to the following fission product half-life data (reference 1):

^{90}Sr	10544 (20)	days
^{137}Cs	10985 (12)	"
^{154}Eu	3138.5 (3)	"

(iii) neutron cross-sections in the energy range 10^{-5} eV to 20 MeV, including resonance parameters, have been evaluated for ^{147}Sm and ^{149}Sm (reference 2).

References:

1. S.I. Kafala, T.D. MacMahon, P.W.Gray, "Testing of data evaluation methods", Nucl. Instr. & Methods in Phys. Res. A339 (1994) 151-7.

2. S.I. Kafala, T.D. MacMahon, "Evaluation of total, capture and (n,α) cross-sections of ^{147}Sm and ^{149}Sm", United Kingdom Nuclear Science Forum paper UKNSF(97)P81, April 1997.

Contact:

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Fax: **44 181 293 1982

U.S.A.

Laboratory:	Idaho National Engineering and Environmental Laboratory Lockheed Martin Idaho Technology Company P.O. Box 1625 Idaho Falls, ID 83415-2114 USA
Names:	R. G. Helmer, C. W. Reich
Evaluation:	Nuclear Data Sheets for A=155, 157, 158, 159, and 160
Purpose:	To give a critical survey of all available nuclear structure and data information concerning the nuclides of these masses and derivation of consistent best or preferred values with their uncertainties
Method:	Those defined by the National Nuclear Data Center (NNDC).
Major sources of information:	Recent references of Nuclear Structure References file at NNDC.
Deadline of literature coverage:	A=155, March 1994 A=159, March 1994 A=158, October 1995 A=157, March 1996 A=160, June 1996
Computer file of evaluated data:	ENSDF
Publications:	A=155, C. W. Reich, Nucl. Data Sheets 71, 709 (1994). A=159, R. G. Helmer, Nucl. Data Sheets 72, 83 (1994). A=158, R. G. Helmer, Nucl. Data Sheets 77, 471 (1996). A=157, R. G. Helmer, Nucl. Data Sheets 78, 219 (1996). A=160, C. W. Reich, Nucl. Data Sheets 78, 547 (1996).
Contact:	R. G. Helmer

U.S.A.

Laboratory:	Idaho National Engineering and Environmental Laboratory Lockheed Martin Idaho Technology Company P.O. Box 1625 Idaho Falls, ID 83415-2114 USA
Names:	R. G. Helmer (Idaho National Engineering and Environmental Laboratory), E. Browne (Lawrence Berkeley National Laboratory), M.-M. Bé (DAMRI/LPRI), E. Schönfeld (Physikalisch-Technische Bundesanstalt), T. D. MacMahon (Imperial College), and J. K. Tuli (Brookhaven National Laboratory)
Evaluation:	Evaluation of decay data for various applications have been carried out for the following thirty one nuclides: ^{7}Be, ^{22}Na, ^{24}Na, ^{26}Al, ^{40}K, ^{41}Ar, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{65}Zn, ^{68}Ge, ^{68}Ga, ^{75}Se, ^{95}Zr, ^{96}Nb, ^{109}Cd, ^{113}Sn, ^{125}I, ^{137}Cs, ^{139}Ce, ^{140}Ba, ^{140}La, ^{141}Ce, ^{143}Pr, ^{153}Sm, ^{153}Gd, ^{188}Re, ^{192}Ir, ^{194}Ir, and ^{207}Bi.
Purpose:	To provide high-quality, well document evaluations of decay data for about 250 radionuclides and promote their use.
Major source of information:	Journal and laboratory publications.
Completion data:	These evaluations should be completed by mid 1998. Other nuclides will follow.
Publications:	E. Schönfeld and G. Rodloff, "Evaluation der Zerfallsdaten von 21 Radionukliden", PTB-6.11-97-1 (Oktober 1997).
Contact:	R. G. Helmer

U.S.A.

Laboratory	Los Alamos National Laboratory
Name	Arthur C. Wahl
Compilation and evaluation for models	Chain yields, independent yields, and other data related to systematic trends in fission yields are compiled and evaluated for fission reactions with excitation energies up to ~150 MeV.
Purpose	Systematic trends in chain yields (Y(A)) and in independent yields (IN) are derived from the data by use of empirical models, which allow estimates to be made of chain and independent yields for all fission products and contribute to the understanding of fission-reaction mechanisms.
Sources of information	Journals, reports, preprints, other compilations, and personal communcations.
Method	Average and original values of experimental data and uncertainties are maintained in files. The sets of yield values for each fission reaction are treated by the method of least squares to derive equations representing systematic trends in the yields by the multi-Gaussian Y(A) model and the Z_P nuclear-charge-distribution model or by or A'_P model for both chain yields and nuclear-charge-distributions. Also, the dependencies of parameters for these models on mass, charge, excitation energy, etc. of fissioning nuclides are investigated, as described in references 1 and 2.
Cooperation	Information can be exchanged with other groups.
Computer files	Information is held in computer files.

Completions

Compilation is continuous; evaluations and redetermination of parameters for models occurs periodically. Recent reports of data, evaluations, and model-estimated yields and uncertainties are given in the references below.

Publications

1. A. C. Wahl," Systematic Trends in Fission Yields", in Proceedings of a Specialists' Meeting on Fission Product Nuclear Data, Japan Atomic Energy Research Institute, Tokai-Mura, Ibaraka-Ken, Japan, May 25–27, 1992, pp. 334–351; Los Alamos National Laboratory Report No. LA-UR-92-1425 also contains tables of parameter values for empirical models.

2. A. C. Wahl, "Nuclear-Charge and Mass Distribution from Fission" in *50 Years with Nuclear Fission*, James W. Behrens and Allan D. Carlson editors, American Nuclear Society, La Grange Park, Illinois (1989), Vol. 2, pp. 525–532; presented at the Conference on 50 Years with Nuclear Fission, Washington D. C., April 25–28, 1989.

3. A. C. Wahl, "Nuclear-Charge Distribution and Delayed-neutron Yields for Thermal-neutron-induced Fission of ^{235}U, ^{233}U, and ^{239}Pu and for Spontaneous Fission of ^{252}Cf", *Atomic Data and Nuclear Data Tables* **39**, 1-156 (1988).

Contact

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A3 - Data Testing, Examination and Utilization

SUBJECT INDEX

FRANCE

Laboratory : CEA-Cadarache, Reactor Physics Laboratory, Reactor and Cycle Physics Service, SPRC/LEPh, Bldg 230, F-13108 St Paul-Lez-Durance, France.

Names : E. Fort, F. Storrer, V. Zammit, A. Filip*, J. Blachot*.
* retired, CEA consultant.

Evaluation : Integral Testing of the Fission Product Decay, Fission Yield and Delayed Neutron Data (Validation of JEF-2, Comparison JEF-2 and NUBASE, Evaluation of JEFF-3)

Purpose : Safety-Related Data for Nuclear Fission Reactors
(Decay Heat and Delayed Neutron Data)

Major sources of information :

- JEF-2 Special Purpose File (Decay and Fission Yield Data),
- NUBASE Data Library
- Available experimental decay heat curves and standards for burst fission
- β_{eff} measurements performed at MASURCA, SNEAK, ZPR, and FCA facilities
- Available Measured Data of Total Delayed Neutron Yields (ν_d)

Deadline of literature coverage :
August 1994 for the JEF-2 Special Purpose File
and December 31, 1996, for NUBASE.

Computer files : JEF-2 and NUBASE

Completion status: Evaluation and Validation of JEF-2 completed, Comparison JEF-2/NUBASE and JEFF-3 Evaluation ongoing.

Publications :

JEF-2.2 Radioactive Decay Data, JEF Report 13,
OECD, Nuclear Energy Agency, Data Bank, Paris, August 1994
(WWW : http ://www.nea.fr)

G. Audi, O. Bersillon, J. Blachot, and A.H. Wapstra
The NUBASE evaluation of nuclear and decay properties
Nucl. Physics A, Volume A624 (1997) No.1, 29 September 1997.
(Atomic Mass Data Center at Orsay University, France :
WWW : http ://csnwww.in2p3.fr, E-mail : audi@csn.in2p3.fr)

F. Storrer
Test of JEF-2 Decay Data and Fission Yields by means of Decay Heat Calculations.
Proc. Inter. Conf. on Nucl. Dat. For Sci. & Tech., Gatlinburg, USA, 1994.

J. Blachot, C. Chung, F. Storrer.
JEF-2 Delayed Neutron Yields for 39 Fissioning Systems
Ann. Nucl. Energy, Vol.24, No. 6, pp. 489-504, 1997.

E. Fort, V. Zammit, A.Filip, E. Dupont.
Preliminary Evaluation of the LENDEL et al. Model to Calculate the Delayed Neutron Yield as a Function of Energy.
Specialists' Meet. of the Subgroup 6 of the Working Party on International Evaluation Co-operation, Obninsk, Russia, April 1997.

Contact :
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INDIA

Laboratory and Address:	Bhabha Atomic Research Centre Theoretical Physics Division Trombay, Bombay-400 085, India
Names:	S. Das
Date examination:	Impact of Delayed Neutron Energy Spectra on reactor kinetics, uses of DN in nuclear research, comparative study of DN data.
Method:	Reactor kinetics, reactivity estimates, Physics
Deadline of literature coverage:	To-date
Status:	Further study
Cooperation:	IAEA (Lammer M) Los Alamos (England T.R.)
Contact:	Dr. S. DAS FAX: +91-22-5560750
Publications:	1. S. Das, "Effect of uncertainty in Total Delayed Neutron Yield on Reactivity of a Fast Reactor core", Twelfth National Symposium on Radiation Physics, Jodhpur, January 28-30, 1998. 2. S. Das, "A comparative study of the Reactivity Effects of Uncertainty in Absolute Delayed-Neutron yield in Neutron yield in Neutron Multiplying Systems", Report:BARC/1997/E/028. 3. S. Das, "A point-kinetics Approach to Sensitivity Study of Fast Reactor Dynamic Behaviour of Delayed Neutron Spectra", Nucl. Sci. Eng., Vol.122, No.3(1996)344-358. 4. S. Das, "The imporance of delayed neutrons in nuclear research - a review", Progress in Nuclear Energy, Vol.28, No.3(1994) 209-264. 5. S. Das, "Sensitivity of Indians' 500 MWe fast breeder reactor dynamic behaviour & delayed neutron energy spectra", Proc. of Third Int. Seminar on Small & Medium-Sized Nuclear Reactors: Planning for World Energy Demand and Supply, New Delhi, India, Aug. 1991, 356-355.

6. S. Das and J. Walker, "The sensitivity of fast reactor kinetic behaviour and variations in delayed neutron energy spectra', Delayed Neutron Properties Proceedings of the Specialists", Meeting, University of Birmingham, England (Sept.1986) pp.276-287.

7. S. Das and J. Walker, "Sensitivity of fast reactor kinetic behaviour do variations in delayed-neutron energy spectra", Nucl. Energy, 26, No.1(1987)47-55.

8. S. Das, "Sensitivity study of a fast breeder reactor dynamic behaviour using point kinetics method", Report BARC - 1525, BARC, Bombay, India(1990).

INDIA

Laboratory and Address:	Theoretical Physics Division Bhabha Atomic Research Centre Trombay, Mumbai 400 085
Names:	S. Ganesan
Facilities:	Multi-disciplinary research centre. Excellent computing facilities
Data processing:	Preparation of a list of fission product nuclides contributing to photo-neutron source in heavy water.
Purpose:	Provide data services upon request within India
Method:	Identify all high energy gamma emitters from the decay data file and the fission yield data.
Deadline of literature survey:	1997
Status:	In progress
Cooperation:	Nuclear Data Section, IAEA, for supply of complete ENDF/B-VI Fission yield data and decay data files
Computer file of compiled data:	Complete ENDF/B-VI Fission yield data and decay data files
Contact:	Dr. S. Ganesan Theoretical Physics Division Bhabha Atomic Research Centre Trombay, Mumbai 400 085, India Email: ganesan@magnum.barc.ernet.in

INDIA

Laboratory and Address:	Indira Gandhi Centre for Atomic Research Kalpakkam 603102 Tamil Nadu, India
Names:	K. Devan and V. Gopalakrishnan
Data processing:	Preparation of Multigroup Lumped fission-product cross sections suitable for FBR calculations.
Method:	Multigroup averaging and lumping using burnup dependent concentrations as weights
Deadline of literature coverage:	1990
Status:	Planned data prepared.
Cooperation:	Nuclear Data Section, IAEA, for supply of Preprocessing Codes and ENDF/B-VI Data.
Computer file of evaluated data:	(used) ENDF/B-VI (Rev 0)
Publications:	K. Devan, V. Gopalakrishnan, P. Mohanakrishnan, and M.S. Sridharan, "Preparation of Multigroup lumped fission product cross sections from ENDF/B-VI for FBRs", Annals of Nucl. Energy, Vol 25 No. 1-3 (1998) p161.
Contact:	V. Gopalakrishnan, K. Devan Indira Gandhi Centre for Atomic Research Kalpakkam 603102 Tamil Nadu, India Email: nds@igcar.ernet.in or lee@igcar.ernet.in;

INDIA

Laboratory and Address:	Indira Gandhi Centre for Atomic Research Kalpakkam 603102 Tamil Nadu, India
Names:	M.S. Sridharan, A.K. Jena and S.M. Lee
Data utilization:	Use of fission product decay data in calculation of radioactivity in fast reactors.
Method:	By analytical solution of a set of First order coupled differential equations using CHANDY code system.
Deadline of literature coverage:	1985
Cooperation:	Tobias A., CEGB, Berkeley Nucl. Lab. for supply of Fission Product Decay Data.
Computer file of evaluated data:	(used) ENDF/B-VI (Rev 0)
Publications:	M.S. Sridharan, A.K. Jena and S.M. Lee, "A study on Fission Product Activity in Typical Fast Reactors", To be published in Proc. National Symp. On Radiation Physics (NSRP-12), January 28-30, 1998, Jodhpur, India.
Contact:	M.S. Sridharan, Reactor Physics Division Indira Gandhi Centre for Atomic Research Kalpakkam 603102 Tamil Nadu, India Email: lee@igcar.ernet.in

INDIA

Laboratory and Address:	Indira Gandhi Centre for Atomic Research Kalpakkam 603102 Tamil Nadu, India
Names:	P. Mohanakrishnan and V. Gopalakrishnan
Data examination:	Comparison of different evaluations of delayed neutron data.
Method:	Prediction of experimental worths of control rods in FBTR
Deadline of literature coverage:	1993
Status:	Planned data prepared.
Cooperation:	IAEA (Lammer M) Los Alamos (England T.R)
Computer file of evaluated data:	(used) ENDF/B-VI (Rev 0)
Publications:	P. Mohananakrishnan, C.P. Reddy, V. Gopalakrishnan and John Arun, "Estimation of Measured Control Rod Worths in FBTR - Effect of Different Delayed Neutron Parameters", Nucl. Sci. Engg., Vol 122 (1996) p359.
Contact:	P. Mohanakrishnan and V. Gopalakrishnan Indira Gandhi Centre for Atomic Research Kalpakkam 603102 Tamil Nadu, India Email: nds@igcar.ernet.in or lee@igcar.ernet.in

PART B: RECENT PUBLICATIONS RELATED TO FPND

(Completeness of this section has not been attempted)

B1 - Publications Not Covered By Contributions

The publications listed below refer to activities related to FPND which are not covered by the contributions contained in this issue. They are sorted according to (if present):

Fission yields and charge distribution
Neutron reaction cross sections
Decay data
Delayed neutron data
FP decay heat
Reviews and summaries

For papers presented at meetings see section 2.

1.1 Fission yields and charge distribution

Spontaneous fission

Observation of cold fission in ^{242}Pu spontaneous fission
Y.X. Dardenne, R. Aryaeinejad, S.J. Asztalos, B.R.S. Babu, K. Butler-Moore, S.Y. Chu, J.D. Cole, M.W. Drigert, K.E. Gregorich, J.H. Hamilton, J. Kormicki, I.Y. Lee, R.W. Lougheed, Q.H. Lu, W.C. Ma, M.F. Mohar, K.J. Moody, S.G. Prussin, A.V. Ramayya, J.O. Rasmussen, M.A. Stoyer, J.F. Wild
Phy. Rev. C **54** (1996) 206

New insights from studies of spontaneous fission with large detector arrays
J.H. Hamilton, A.V. Ramayya, S.J. Zhu, G.M. Ter-Akopian, Yu.Ts. Oganessian, J.D. Cole, J.O. Ramussen, M.A. Stoyer
Prog. Part. Nucl. Phys. **35** (1995) 635
(^{242}Pu, ^{248}Cm and ^{252}Cf)

Inclusive energy spectra and yields of light nuclei from the spontaneous fission of ^{248}Cm
M.P. Ivanov, I.V. Kuznetsov, V.F. Kushniruk, YuG. Sobolev
Yad. Fiz. **60** (1997) 399 (Engl.: Phys. At. Nucl. **60** (1997) 329)

Measurement of fragment mass-energy correlations for ^{248}Cm (sf): far-out fission and cold fragmentations
A. Benoufella, G. Barreau, M. Asghar, P. Audouard, F. Brisard, T.P. Doan, M. Hussonnois, B. Leroux, J. Trochon, M.S. Moore
Nucl. Phys. A**565** (1993) 563

Nuclear charge distribution in the spontaneous fission of ^{252}Cf: determination of fractional cumulative yields of ^{133m}Te and ^{133g}Te

Zhang Yan-Ling, Li Xue-Liang, Wang Fang-Ding, Guo Jing-Ru, Tang Pei-Jia, Liu Da-Ming, Cui An-Zhi, Su Shu-Xin
J. Radioanal. Nucl. Chem. **189** (1995) 165

Isotopic yields for the cold fission of ^{252}Cf

A. Sandulescu, A. Florescu, F. Carstoiu, W. Greiner, J.H. Hamilton, A.V. Ramayya, B.R.S. Babu
Phys. Rev. C **54** (1996) 258

Neutron multiplicities and yields of correlated Zr-Ce and Mo-Ba fragment pairs in spontaneous fission of ^{252}Cf

G.M. Ter-Akopian, J.H. Hamilton, Yu.Ts. Oganessian, J. Kormicki, G.S. Popeko, A.V. Daniel, A.V. Ramayya, Q. Lu, K. Butler-Moore, W.-C. Ma, J.K. Deng, D. Shi, J. Kliman, V. Polhorsky, M. Morhac, W. Greiner, A. Sandelescu, J.D. Cole, R. Aryaeinejad, N.R. Johnson, I.Y. Lee, F.K. McGowan
Phys. Rev. Lett. **73** (1994) 1477

Yields of correlated fragment pairs in spontaneous fission of ^{252}Cf

G.M. Ter-Akopian, J.H. Hamilton, Yu.Ts. Oganessian, A.V. Daniel, J. Kornicki, A.V. Ramayya, G.S. Popeko, B.R.S. Babu, Q.–H. Lu, K. ButlerüMoore, W.–C. Ma, E.F. Jones, J.K. Deng, D. Shi, J. Kliman, M. Morhác, J.D. Cole, R. Aryaeinejad, N.R. Johnson, I.Y. Lee, F.K. McGowan
Phys. Rev. C **55** (1997) 1146

Yields of fragment pairs and other characteristics of spontaneous ^{252}Cf fission

G.M. Ter-Akopian, Yu.Ts. Oganessian, G.S. Popeko, A.V. Daniel, J. Hamilton, J. Kormicki, A.V. Ramayya, W.–C. Ma, B.R.S. Babu, T. Ginter, S.J. Zhu, J. Rasmussen, M. Stoyer, I.Y. Lee, S. Asztalos, S.Y. Chu, K.E. Gregorich, A.O. Macchiavelli, M.F. Mohar, S. Prussin, J. Kliman, M. Morhác, J.D. Cole, R. Aryaeinejad, Y.K. Daren, M. Driget
Izv. Ross. A.N., Ser. Fiz. **61** (1997) 746
(Engl.: Bull. Russ. Acad. Sci., Physics, **61** (1997) 587)

Neutron induced fission

Measuring the isomeric ratios in nuclei produced by fission of ^{232}Th

I.N. Vishnevsky, V.A. Zheltonozhsky, S.V. Reshitko
Izv. Ross. A.N., Ser. Fiz. **61** (1997) 102
(Engl.: Bull. Russ. Acad. Sci., Physics, **61** (1997) 81)
(fission of ^{232}Th induced by 14-MeV neutrons)

Measurement of cold fission for ^{229}Th(n_{th},f), ^{232}U(n_{th},f) and ^{239}Pu(n_{th},f) with the Cosi fan tutte spectrometer

M. Asghar, N. Boucheneb, G. Medkour, P. Geltenbort, B. Leroux
Nucl. Phys. **A560** (1993) 677

The origin of the proton odd-even effect in low-energy fission

G. Medkour, M. Asghar, M. Djebara, B. Bouzid

J. Phys. G **23** (1997) 103

(mass, charge and kinetic energy correlated yield data on the light group for $^{232}U(n_{th},f)$)

Cold fission of $^{233}U(n_{th},f)$

W. Schwab, H.–G. Clerc, M. Mutterer, J.P. Theobald, H. Faust

Nucl. Phys. A **577** (1994) 674

(yields of light fission fragments ($76 \leq A_L \leq 93$))

Parity nonconservation and Brosa modes in nuclear fission

U. Graf, F. Gönnenwein, P. Geltenbort, K. Schreckenbach

Z. Phys. A **351** (1995) 281

(angular distribution of fragments from fission of ^{233}U irradiated by polarized thermal neutrons)

Interference effects in the angular distributions of fragment of heavy-nucleus fission induced by thermal and resonance neutrons

V.P. Alfimenkov, G.V. Val'skii, A.M. Gagarskii, P. Geltenbort, I.S. Guseva, J. Last, G.A. Petrov, A.K. Petukhov, L.B. Pikel'ner, Yu.S. Pleva, V.E. Sokolov, V.I. Furman, K. Schreckenbach, O.A. Shcherbakov

Yad. Fiz. **58** (1995) 799 (Engl.: Phys. At. Nucl. **58** (1995) 737)

($^{233,235}U$ and ^{239}Pu)

Study of multichannel theory for the neutron induced fissions of actinide nuclei

Tie-shuan Fan, Ji-min Hu, Shang-lian Bao

Nucl. Phys. A **591** (1995) 161

(fragment properties of the neutron induced fissions of ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{242}Pu are investigated)

Mass-angle correlations of uranium-fission fragments

A.A. Goverdovskii, V.A. Khryachkov, B.D. Kuzminov, V.F. Mitrofanov

Yad. Fiz. **58** (1995) 230 (Engl.: Phys. At. Nucl. **58** (1995) 188)

(^{236}U fission induced by 1 MeV neutrons)

Anisotropy of the angular distribution of fragments in ^{238}U ternary fission induced by 1.6-MeV neutrons

L.N. Bondarenko, E. Gönnenwein, J. Kaufmann, V. Rohou, H. Stefan, G.V. Danilyan, V.S. Pavlov, V.A. Shchenev

Yad. Fiz. **58** (1995) 1152 (Engl.: Phys. At. Nucl. **58** (1995) 1077)

Temperature effects in prescission-deformation spectra of ^{238}Np fission fragments

A.A. Goverdovski, V.A. Khryachkov, V.V. Ketlerov, V.F. Mitrofanov, Yu.B. Ostapenko

Yad. Fiz. **60** (1997) 1586 (Engl.: Phys. At. Nucl. **60** (1997) 1441)

(mass and kinetic-energy distributions of fragments of ^{237}Np fission induced by 1 and 18 MeV neutrons)

Measurement of fragment mass dependent kinetic energy and neutron multiplicity for thermal neutron induced fission of plutonium-239

K. Nishio, Y. Nakagome, I. Kanno, I. Kimura

J. Nucl. Sci. Technol. **32** (1995) 404

Light charged particle induced fission

Most probable charge of fission products in 24 MeV proton induced fission of ^{238}U

H. Kudo, M. Maruyama, M. Tanikawa

Phys. Rev. C **57** (1998) 178

Measuring the isomeric ratios in nuclei produced by fission of ^{232}Th

I.N. Vishnevsky, V.A. Zheltonozhsky, S.V. Reshitko

Izv. Ross. A.N., Ser. Fiz. **61** (1997) 102

(Engl.: Bull. Russ. Acad. Sci., Physics, **61** (1997) 81)

(fission of ^{232}Th induced by 13.6-MeV deuterons)

Lifetime measurement of fissionable nuclei produced in the development of neutron emission (III) lifetime of protactinium isotopes

D.O. Eremenko, V.O. Kordyukevich, S.Yu. Platonov, O.V. Fotina, O.A. Yuminov, G. Giardina, F. Malaguti, G. Vannini

Nucl. Phys. A **589** (1995) 395

(^{232}Th(d, *x*nf), E=8.0-15.6 MeV; measured fission fragment angular distributions)

Angular distributions of fission fragments of nuclei with two types of excited states

D.O. Eremenko, G. Giardina, F. Malaguti, B. Mellado, S.Yu. Platonov, O.V. Fotina, O.A. Yuminov

Izv. Ross. A.N., Ser. Fiz. **61** (1997) 24

(Engl.: Bull. Russ. Acad. Sci., Physics, **61** (1997) 18)

(37 + 43 MeV α induced fission of ^{238}U)

1.2 Neutron reaction cross sections

The fast cyclic neutron activation technique at the Karlsruhe 3.75 MV Van de Graaff accelerator and the measurement of the ^{107,109}Ag(n,γ)^{108,110}Ag cross sections at kT=25 keV

H. Beer. G. Rupp, G. Walter, F. Voss, F. Käppeler

Nucl. Instr. Meth. Phys. Res. A **337** (1994) 492

1.3 Decay data

Measurement of the Q_β value for the β decay of mass separated ^{84}As$\rightarrow$^{84}Se

R.L. Gill

Phys. Rev. C **50** (1994) 2612

Decays of the ^{97}Y isomers to the single neutron nucleus ^{97}Zr

G. Lhersonneau, P. Dendooven, S. Hankonen, A. Honkanen, M. Huhta, R. Julin, S. Juutinen, M. Oinonen, H. Penttilä, A. Savelius, S. Törmänen, J. Äystö, P.A. Butler, J.F.C. Cocks, P.M. Jones, J.F. Smith
Phys. Rev. C **54** (1996) 1117

Beta-decay half-lives and neutron-emission probabilities of very neutron-rich Y to Tc isotopes

T. Mehren, B. Pfeiffer, S. Schoedder, K.-L. Kratz
Phys. Rev. Lett. 77 (1996) 458

Level scheme of ^{101}Zr and structure of the $N = 61$ Sr, Zr, and Mo isotones

G. Lhersonneau, H. Gabelmann, M. Liang, B. Pfeiffer, K.-L. Kratz, H. Ohm, and the ISOLDE Collaboration
Phys. Rev. C **51** (1995) 1211

β-decay of ^{113}Rh and the observation of ^{113m}Pd: Isomer systematics in odd-A palladium isotopes

H. Penttilä, T. Enqvist, P.P. Jauho, A. Jokinen, M. Leino, J.M. Parmonen, J. Äystö, K. Eskola
Nucl. Phys. A**561** (1993) 416

Level structures in ^{147}Pm from ^{147}Nd decay

M. Sainath, K. Venkataramaniah, P.C. Sood
Phys. Rev. C **56** (1997) 2468

Studies on the level structure of ^{152}Sm due to β^+ decay of ^{152}Eu

A.M. Hassan, A. Sroor, M.A. Abou-Leila, S. Abdel Malak, Emad H. Aly
Nucl. Sci. J. (Taiwan) **33** (1996) 173

Measurements of absolute and relative emission probabilities of gamma- and X-rays and data evaluation in the decay of ^{155}Eu

A.G. Egorov, V.P. Chechev
Nucl. Instr. Meth. Phys. Res. A**339** (1994) 248

1.4 Delayed neutron data

Measurements of absolute delayed neutron yield and Group constants in the fast fission of ^{235}U and ^{237}Np

D.J. Loaiza, G. Brunson, R. Sanchez, K. Butterfiled
Nucl. Sci. Eng. **128** (1998) 270

1.5 FP decay heat

Measurement of decay heat of fast neutron fission products

M. Akiyama, Y. Oka, S. An
Prog. Nucl. En. **32** (1998) 53
(measured on ^{233}U, ^{235}U, ^{239}Pu, ^{238}U and ^{232}Th using beta- and gamma-spectroscopic method)

1.6 Reviews and Summaries

Energy released in ternary fission
D.N. Poenaru, W. Greiner, R.A. Gherghescu
At. Data. Nucl. Data Tables **68** (1998) 91-147
(Calculated Q values for the cold splitting of even-even nuclei into three particles of equal size, as well as for various fission processes accompanied by light-particle emission, are listed for nuclides with Z = 90-116.)

B2 - Meetings

Listed here are only articles containing numerical FPND or relevant theoretical information or recent developments for compilations/evaluations.

Second International Conference on Dynamical Aspects of Nuclear Fission
Smolenice, Slovakia, 14-18 June 1993

Proceedings: JINR report E7-94-19

XIII Meeting on Physics of Nuclear Fission in the Memory of Prof. G.N. Smirenkin
Obninsk, Russia, 3-6 October 1995

International Workshop on
Research with Fission Fragments
Benediktbeuern, Germany, 28-30 October 1996

9th International Symposium on
Capture Gamma-Ray Spectroscopy and Related Topis
Budapest, Hungary, 8-12 October 1996

Volume 1

Volume 2

International Conference on
Nuclear Data for Science and Technology
Trieste, Italy, 19-24 May 1997

PART C: REQUESTS FOR FISSION YIELD MEASUREMENTS

issued by the participants of the IAEA Co-ordinated Research Programmes (CRP) on fission yield data

C1 The IAEA CRP on the Compilation and Evaluation of Fission Yield Nuclear Data

The IAEA CRP on the Compilation and Evaluation of Fission Yield Nuclear Data had been established to enable and support the co-operation of scientists in the improvement of existing fission yield evaluations. The fission yield requirements issued by that CRP were published as Supplement to **WRENDA 93/94**, IAEA/NDS report **INDC(SEC)-105, 1994**. That report contains detailed tables of requested yield data. The introduction and general requests were reproduced (with modifications) in part 3 of the previous issue no. 14 of Progress in FPND (published as **INDC(NDS)-304**, 1994).

This CRP is now terminated and the final report is in preparation. However, most of the requests issued, particularly those for the energy dependence of fission yields, are still valid.

C2 The IAEA CRP on Fission Yield Data Required for Transmutation of Minor Actinide Nuclear Waste

Proposal and Scope of the CRP

This CRP was proposed by the International Nuclear Data Committee (INDC) in 1995. Following a recommendation of the INDC, the proposed goal of this CRP has been coordinated with the efforts of the NEA International Evaluation Cooperation in the field of transmutation of waste.

The **goal of the CRP** is to develop fission yield systematics and nuclear models as a tool for an **evaluation of energy dependent fission yields up to 150 MeV**. A computer code will be developed/adapted that will allow the calculation of fission yields for any given actinide at any desired neutron energy, although with varying accuracy.

Problems and a new approach to fission yield evaluation

Users doing calculations in the field of nuclear transmutation have to be able to obtain, from evaluations, **fission yields for any desired fissioning nuclide at any desired energy up to 150 MeV**. This requires a new approach to fission yield evaluation.

For the development and realization of this new approach to fission yield evaluation, it has to be borne in mind that for certain targets, neutron fission yield measurements are impossible, and for other targets, measurements at certain (higher) neutron energies are at least extremely difficult. Therefore it is necessary to develop, from relatively few measurements, **fission yield systematics** to estimate the yields over a wide range of fissioning nuclides and the neutron energy range from thermal to 150 MeV. The accuracies of these estimates will of course be poorer where experimental data are lacking. However, for many of

the fissioning nuclides considered, namely those present in only small quantities, the accuracy requirements are not very high.

For the **development of the nuclear model** for the yield systematics, the following points have to be considered:

- Existing empirical models for charge, mass and energy distributions have to be further developed and modified.
- Measurements of neutron induced fission yields for certain targets at several energy points are needed to derive the systematics and model parameters.
- Results from charged particle induced fission and photofission (where measurements are often easier), leading to the same compound nuclei as the corresponding neutron induced fission, could provide valuable information for the development of the systematics.
- Due to multiple chance fission, measured yield distributions at higher neutron energies result from a mixture of fissioning nuclides, which has to be accounted for in the systematics.

Existing neutron fission yield data

Evaluated data are not available for the required neutron energy range. The current data situation can be summarized as follows:

- Energy dependent data exist only up to 14 MeV neutron energy.
- Yields files are available only for thermal and fast neutron fission, for some targets also for spontaneous and 14 MeV neutron induced fission.
- Yield sets for minor actinides are incomplete.
- There are no tools yet available to allow the calculation of yields at all energies from 14 to 150 MeV neutron energy (~20-150 MeV excitation energy).

Existing **experimental data** are insufficient for energies above thermal and practically non-existent above 20 MeV. Further measurements are indispensable. Since these are easier and more frequent for the 'major' actinides, these have to be included in the development of the systematics.

Tasks to be performed during the CRP

Study the problem of multiple chance fission at higher energies and find solutions how to account for it in systematics and calculated yields.

Study the differences between neutron and charged particle induced and photofission reactions, the possiblity of and corrections needed for their combined use in systematics.

Study cascade and evaporation models used for higher energies, together with the models developed during the previous CRP:

- Goverdovski's model for the energy dependence of yields,
- Wahl's mass and charge distribution models, and
- Rudstam's isomeric yield model.

Elaborate the necessary adaptations of models and parameters.

Analysis of the experimental data for neutron, photon and charged particle induced fission with respect to their use in the development the above models.

Performance of selected key measurements.

With the results of all these studies, develop systematics for the dependence of fission yields on (Z,A) of fissioning nuclides and neutron energies up to 150 MeV.

Recommend a specific computer program (possibly that of A. Wahl after adaptation) and parameter data base for use in actual yield evaluations.

Further tasks:

- evaluation of further reference yield sets and yields for monitor fission products;
- checks for discrepancies among evaluations;
- comparison with user needs: transmutation calculations.

Required measurements of fission yields

Measurements of charge and mass distributions are required for a wide range of projectiles, energies, targets and yield types. In particular:

The type of fission resp. projectiles of interest are:
- spontaneous fission
- photofission
- neutron induced fission
- charged particle induced fission

at energies up to 150 MeV.

The target nuclides of interest range from Rn-222 to Lr-258, the more important ones from Th-229 to Cm-245, and Cf-252.

Systematic studies of the energy dependence of yields or variations with fissioning nuclides are particularly important.

Also important are measurements of yields at the wings and in the valleys of mass distributions for many fission reactions to allow a systematic study of Gaussian shapes to represent mass distributions.

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FENDL2 for FTP file transfer of FENDL-2.0;
RIPL for FTP file transfer of RIPL
Web: http://www-nds.iaea.or.at