International Atomic Energy Agency

INDC(NDS)-95/G+P

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

PROGRESS IN FISSION PRODUCT NUCLEAR DATA

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

collected
by
G. Lammer

Nuclear Data Section
International Atomic Energy Agency
Vienna, Austria

No. 4 July 1978

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

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FOREWORD

This is the fourth 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 main part of this report 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. The present issue contains also a section with some recent references relative to fission product nuclear data, which were not covered by the contributions submitted.

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

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

The third issue of this series has been published in May 1977 as INDC(NDS)-86/G+P. The present issue includes contributions which were received by NDS between 1 June 1977 and 15 June 1978.

The next issue of this report series is envisaged to be published in May 1979.

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SUBMITTING CONTRIBUTIONS

The next issue is expected to be published in May 1979. All scientists who are presently working - or have recently completed work - in the field of FPND and who want to contribute to the 5th issue of this series, are kindly asked to send contributions to me between now and the end of April 1979, so that they reach NDS before 30 April 1979.

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

Format:

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

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

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

For the sake of consistency it is requested that the suggested headings be used as far as appropriate.

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

I would like to thank the contributors for their cooperation.

G. Lammer

SUBJECT INDEX [a]

1. MEASUREMENTS

1.1. Fission yields

a) with respect to the last issue, INDC(NDS)-86,
underlined page numbers refer to new work,
page numbers in brackets refer to unchanged contributions, and
others refer to revised contributions.

1.1. Fission yields (continued)

1.2. Neutron reaction cross sections

1.2. Neutron reaction cross sections (continued)

FP isotope	reaction(s)	incident neutron energy	page
Mo-98 Mo-100	(n,γ),res.	2.6-500 keV	(57)
Tc-99	transmission	1-1500 eV	(12)
Ru-100 Ru-101 Ru-102 Ru-104 Rh-103	(n,γ),res.	2.6-500 keV	(57)
Pd-104	(n,γ),res.,tot.	50 keV	6
	(n,γ),res.	2.6-500 keV	57
Pd-105	(n,γ),res.,tot.	50 keV	6
	(n,γ),res.	2.6-500 keV	57
Pd-106	(n,γ),res.,tot.	50 keV	6
	(n,γ),res.	2.6-500 keV	57
Pd-108	(n,γ),res.,tot.	50 keV	6
	(n,γ),res.	2.6-500 keV	57
Pd-110	(n,γ),res.,tot.	50 keV	6
	(n,γ),res.	2.6-500 keV	57
Cd-106 Cd-108 Cd-110 Cd-111 Cd-112 Cd-113 Cd-114 Cd-116	(n,γ),res.	2.6-500 keV	57
Te-122 Te-123 Te-124 Te-125 Te-126 Te-128 Te-130	(n,γ),res.	2.6-500 keV	(57)
Cs-133	transmission	1-1500eV	(12)
	(n,γ),res.	2.6-500 keV	57
Cs-135	transmission	1-1500 eV	(12)
Cs-137	"	" "	(12)
Ba-134 Ba-135 Ba-136 Ba-137 Ba-138 La-139 Ce-140 Pr-141 Nd-142	(n,γ)res.	2.6-500 keV	(57)
Nd-143	integral (n,γ)	EBR-II	47
	(n,γ),res.	2.6-500 keV	(57)
Nd-144	integral (n,γ)	EBR-II	47
	(n,γ),res.	2.6-500 keV	(57)
Nd-145	integral (n,γ)	EBR-II	47
	(n,γ),res.	2.6-500 keV	(57)

1.2. Neutron reaction cross sections (continued)

FP isotope	reaction(s)	incident neutron energy	page
Nd-146	integral (n,γ)	EBR-II	47
	(n,γ),res.	2.6-500 keV	(57)
Nd-148	integral (n,γ)	EBR-II	47
	(n,γ),res.	2.6-500 keV	(57)
Nd-150	integral (n,γ)	EBR-II	47
Sm-147	integral (n,γ)	EBR-II	47
Sm-149	" "	"	47
Eu-151	transmission	1-1500 eV	(12)
	integral (n,γ)	EBR-II	47
Eu-152	transmission	1-1500 eV	(12)
	integral (n,γ)	EBR-II	47
Eu-153	transmission	1-1500 eV	(12)
	integral (n,γ)	EBR-II	47
Eu-154	transmission	1-1500 eV	(12)
	integral (n,γ)	EBR-II	47
Eu-155	transmission	1-1500 eV	(12)
Gd-156	(n,γ),trans.,res.		24
Tb-159 Ho-165 Tm-169	(n,γ),res.	2.6-500 keV	(57)
unseparated fission products	integral (n,γ)	FBR	8

1.3. Decay data

FP isotope	data type	page
Rb-89 Rb-91 Rb-93 Rb-94 Rb-95 Rb-97	β-strength shape	21
Zr-95	γ-intens.	(14)
Mo-99	γ-intens.	14
Tc-106	HL;γ-spectra	28
Tc-107	HL;γ-spectra	28
Tc-108	HL;γ-spectra	28
Ru-103	γ-intens.	14
Rh-106		(14)
Ag-110m		14
Sb-125		(14)

FP isotope	data type	page
Te-132	γ-intens.	(14)
	γ-intens.	(46)
I-131	γ-intens.	14
I-132		(14)
I-134	γ-intens.	(46)
A = 133	HL;γ-,β-spec.,Q	15
Xe-133m	conv.coeff.(K,L)	38
Cs-134	γ-intens.	14
Ba-139	γ-intens.	(46)
Ba-140	γ-intens.	14
La-140		
La-141	γ-intens.	(46)
Ce-144	γ-intens.	(14)
Pr-144		
Pr-145	γ-intens.	(46)
Pr-146		

1.4. Delayed neutron data

1.5. Decay heat

2. COMPILATIONS and EVALUATIONS

I. MEASUREMENTS

(in order to be conspicuous, revisions with respect to the last issue, INDC(NDS)-86, are marked by vertical lines; new contributions do not have a mark)

BELGIUM

Laboratory :	Centre d'Etude de l'Energie Nucléaire C.E.N./S.C.K. B-2400 MOL, Belgium
Names :	P. del MARMOL, P. FETTWEIS
Facilities :	BR-1 reactor
Experiment :	The independent isomeric yield ratio of $^{83m}Se/^{83g}Se$ is being determined in thermal neutron fission of ^{235}U.
Method :	Fast radiochemical separation of Se followed by Y-counting of the resulting activities.
Completion date :	1978

E.E.C. Belgium

Laboratory and address: JRC, CBNM, Geel, Belgium
+CNEN, Bologna, Italy

Names: A. Brusegan, C. Coceva+, F. Corvi, P. Giacobbe+, M. Magnani+, G. Rohr.

Facilities: Neutron time-of-flight spectrometers at the 60 MeV Linac (pulse width: 23 nsec).

Experiment: Resonance parameters for ^{91}Zr and ^{96}Zr.

Separated isotopes: 89% enriched ^{91}Zr and 57% ^{96}Zr.

1) Capture γ-ray measurements (^{91}Zr only).

Energy range: 150 eV - 3200 eV.

2) Capture measurement.

Energy range ^{91}Zr: 150 eV - 20 keV
^{96}Zr: 150 eV - 100 keV.

3) Total cross section measurements.

Energy range ^{91}Zr: 150 eV - 14.8 keV
^{96}Zr: 150 eV - 130 keV.

Method:

1) High and low energy γ-ray spectra measurements.

Detector: GeLi gamma ray spectrometer.
Flightpath: 13 m.
Sample thickness: $14.4 \cdot 10^{-3}$ at/barn.

2) Capture cross section measurements.

Detector: C_6F_6 detectors using Maier-Leibnitz method.
Flightpath: 60 m.
Sample material: ZrO_2
Sample thicknesses: ^{91}Zr: $7.310 \cdot 10^{-3}$ at/barn
^{96}Zr: $4.780 \cdot 10^{-3}$ at/barn
Neutron flux: boron slab with C_6F_6 detectors.
Normalization: Ag using black resonance technique.

3) Total cross section measurements.

Detectors: NaI(Tl) crystals with a boron slab.
Flightpath: 100 m.
Sample material: ZrO_2 enriched to 57% ^{96}Zr and 89% ^{91}Zr.
Sample thicknesses: ^{91}Zr $0.8 \cdot 10^{-3}$ at/barn
$2.4 \cdot 10^{-3}$ at/barn
$6.4 \cdot 10^{-3}$ at/barn
$14.4 \cdot 10^{-3}$ at/barn

Cont. E.E.C. Belgium

^{96}Zr	$0.8 \cdot 10^{-3}$	at/barn
	$3.5 \cdot 10^{-3}$	at/barn
	$4.3 \cdot 10^{-3}$	at/barn

Accuracy: Expected on final resonance parameters

^{91}Zr $g\Gamma_n$, Γ_γ between 5% and 20%

^{96}Zr $g\Gamma_n$, Γ_γ between 10% and 20%

depending on the energy range and the strength of the resonances.

Expected completion date: ^{91}Zr : analysis finished

^{96}Zr : end of 1978

Publications: ^{91}Zr data will be presented at the "International Conference on Neutron Physics and Nuclear Data for Reactors and other Applied Purposes", Harwell 25th to 29th September, 1978.

E.E.C, Belgium

Laboratory and address : JRC, CBMN, Geel, Belgium
+S.C.K./C.E.N, Mol, Belgium

Names: +P.Staveloz, +E. Cornelis, +L.Mewissen, +F. Poortmans
G. Rohr, R. Shelley, J. Winter, T. van de Veen

Facilities: Neutron time-of-flight spectrometers at the 150 MeV Linac (pulse width: 4 nsec)

Experiments: Resonance parameters for ^{104,105,106,108,110}Pd below 50 keV

1) Capture γ-ray experiments in preparation.

2) Capture cross-section measurements.
Measurements completed for ^{108}Pd.

3) Total cross-section measurements.
^{108}Pd: measurements and analysis completed for thin sample.
thick-sample run in preparation.
^{105}Pd: measurements completed
analysis in progress.

4) Scattering cross-section
^{108}Pd: measurements completed
analysis in progress.

Method:

1) Capture γ-ray spectra measurements.
High energy gamma-ray measurements and eventually low level population method to determine J and ℓ of resonances.
Detector: GeLi gamma ray spectrometer flight path length 15 m.

2) Capture cross section measurements.
Detector: C_6D_6-detectors using Maier Leibnitz method.
flight path length :60 m.

3) Total cross section measurements.
Detector: ^{3}He gaseous scintillators.
flight path length :30 m and 60 m.
cooled samples at liquid nitrogen temperature.

4) Scattering cross section measurements.
Detector: ^{3}He gaseous scintillators.
flight path length :30 m.

Accuracy: Expected on final resonance parameters $g\Gamma_n, \Gamma_\gamma$ between 5 % and 20 % depending on the energy range and on the strength of the resonances.

Expected completion date: ^{105}Pd and ^{108}Pd : June 1979
other isotopes : June 1980.

FRANCE

Laboratory and address : DEDR/DRE/SEN
Centre d'Etudes Nucléaires de CADARACHE
B.P. N°1 - 13115 - Saint Paul lez Durance
FRANCE

Names : M. DARROUZET - L. MARTIN-DEIDIER

Facilities : MINERVE reactor (ERMINE facility)

Experiments : Integral measurements of fission products capture in fast breeder reactor spectra.

Method :
- Total effect of fission products have been measured by oscillation of irradiated fuels (RAPSODIE and PHENIX fuels)
- Capture cross sections of fission product isotopes have been measured by oscillation and activation method.

Accuracy :
- The accuracy of the total effect measurements is about 10%
- The accuracy of separated isotopes measurements is 5% by activation and 10% by oscillation.

Publications :
- G. LANGLET - L. MARTIN-DEIDIER
  The french Program for the determination of fission product worthes in fast reactors.
  Paper presented at the meeting on F.P.N.D organized by AIEA (PETTEN, 5-9 September 1977)
- L. MARTIN-DEIDIER - M. DARROUZET - P. HAMMER - E. FORT
  Integral measurements of fission product capture in fast and thermal reactor spectra.
  To be presented in the International OECD Conférence on Neutron Physics and Nucelar Data for reactors and other Applied Purposes.
  (HARWELL - 25-29 Septembre 1978).

FRANCE

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

Names : J. BLACHOT, J. CRANÇON, Ch. HAMELIN, G. LHOSPICE et A. MOUSSA.

Facilities : Melusine reactor (thermal neutron and caramel system for fast neutrons) 3 MeV neutrons generator and high flux reactor of I.L.L..

Experiment : The fractionnal independent yield of I^{134}, Xe^{135}, Cs^{136}, Cs^{138} isotopes and the fractionnal cumulative yields of the parents have been measured for U233(n,th), (n,f) U235 (n,th) (n,f) U238 (n,f) U234 (n,f) Np237 (n,f) Th232 (n,f) Cf252 (SF) Pa231 (n,f).

Method : Radiochemical separations for Cs136 and Ge/Li gamma spectrometry. For the others, direct growth and decay activities are measured with a Ge/Li detector and recorded in a multispectrum mode by a 4K multichannel analyser.

Accuracy : The average relative uncertainty of our measurements is between 5 and 10 %.

Completion date : July 1979.

FRANCE

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

Names : J. BLACHOT et G. LHOSPICE.

Facilities : "Caramel" system in the Melusine reactor for fast neutrons.

Experiment : Determination of cumulative and chain yields in the fast neutron fission of Np^{237}.

Method : High resolution gamma spectrometry were made without and after radiochemical separations. The yields are measured relatively to the Ba140.

Accuracy : 5 %.

Publication : Preliminary results contribution to review paper 10 of the meeting on fission product Nuclear Data, PETTEN, 5-9 Septembre 1977 - IAEA.

FRANCE

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

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

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

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

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

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

Publications :

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

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

3/ Distributions isotopiques des gaz rares dans la fission par neutrons thermiques de ^{239}Pu et ^{241}Pu.
Le Journal de Physique Lettres, tome 37 p. L-241 (1976).

GERMANY, FED. REP.

Laboratory and address:

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

Names:

P. FISCHER, U. HARZ, P. PODEWILS, H.G. PRIESMEYER

Facility:

Fast Chopper Neutron Time-of-Flight Spectrometer, 42 m flight path in front of beam hole of 5 MW FRG-1 reactor. 15 ns/m nominal resolution, with special equipment for transmission measurements on highly radioactive samples; 11 Li-6 glass-scintillation detectors; max. rotor speed 15 000 upm; min. burst width 0.64 μs; min. time channel width 100 ns.

Experiments:

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

Completed: Tc 99 transmission with different sample thickness to clear up discrepancies in Γ_γ of first resonance; low energy transmission of gross fission product mixture; SHAPE analysis of resonance parameters in progress.

Ongoing: Cs 133/135/137 FP mixture for isotope identification of 42.8 eV and 880 eV resonances;
Pu 240 precision measurement for resonance parameter determination of 1.056 eV resonance.

Planned: EuO isotope mixture from fast reactor control rod (transmission and resonance identification);
Kr transmission (stable isotopes), in order to prepare Kr 85 measurement.

Method:

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

Accuracy:

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

GERMANY, FED. REP.

Laboratory and address:	Physikalisch-Technische Bundesanstalt D-3300 Braunschweig, Bundesallee 100
Name:	K. Debertin
Facilities:	^{252}Cf-source; calibrated Ge(Li)-spectrometer.
Experiment:	Determination of ^{238}U-fission yields in the fast neutron spectrum of a ^{252}Cf-source. The evaluation of the measurements is in progress.
Method:	The ^{252}Cf-source is mounted 15 m above ground in the open air. ^{238}U-samples are irradiated in a 1 cm distance. Fission product activities are determined by measuring the γ-ray spectrum with a calibrated Ge(Li)-spectrometer.
Accuracy:	$\pm$ 2 % to $\pm$ 5 % (1σ uncertainty)
Completion date:	1978

GERMANY, FED. REP.

Laboratory and address:	Physikalisch-Technische Bundesanstalt D-3300 Braunschweig, Bundesallee 100
Names:	K. Debertin, U. Schötzig, K.F. Walz and H.M. Weiß
Facilities:	1) $4\pi\beta$-γ-coincidence systems (normal and high pressure proportional-counters, NaI(Tl)-crystals); 2) calibrated Ge(Li)- and Ge-spectrometers
Experiment:	Determination of absolute γ-ray emission probabilities for ^{95}Zr, ^{106}Rh, ^{110m}Ag, $^{140}Ba/^{140}La$, ^{144}Ce-^{144}Pr published ^{103}Ru, ^{134}Cs, ^{131}I completed ^{99}Mo, ^{125}Sb, ^{132}Te-^{132}I ongoing
Method:	The decay rates are determined by facilities 1) using the extrapolation method; γ-ray emission rates are determined by facilities 2), the efficiency of which has been calibrated in the energy range of interest to an accuracy of $\pm$ 1 % or less (1σ). For this purpose PTB standard sources of about 15 radionuclides were used. Details are described in Annals of Nuclear Energy 2, 37 (1975) and PTB-Mitteilungen 83, 307 (1973).
Accuracy:	$\pm$ 1 % to $\pm$ 2 % (1σ uncercainty)
completion date:	End of 1978
Publications:	"Gamma-Ray Emission Probabilities of the Fission Products ^{144}Ce-^{144}Pr, ^{106}Rh, ^{95}Zr" in Annals of Nuclear Energy 2, 37 (1975) "Gamma-Ray Emission Probabilities in the Decay of Barium-140 and Lanthanum-140" in Nucl. Sci. Eng. 64, 784 (1977)

GERMANY, FED. REP.

Laboratory:	Institut für Kernchemie Universität Mainz Postfach 3980 D-6500 Mainz, Germany
Names:	H. Braun, H.O. Denschlag
Facilities:	TRIGA Mark II Reactor
Experiment:	Yields and decay properties of the fission product chain with mass number A = 133 are being redetermined.
Method:	Radiochemical and by mass-spectrometry
Completion date:	1979
Publications:	Jahresbericht 1977 Institut für Kernchemie Universität Mainz

GERMANY, FED. REP.

Laboratory:	Institut für Kernchemie Universität Mainz Postfach 3980 D-6500 Mainz, Germany
Names:	H. Meixler, K. Wolfsberg (LASL), H.O. Denschlag
Facilities:	TRIGA Mark II Reactor
Experiment:	Fractional cumulative fission yields of Kr-89, -91, -92 and Xe-139 to -143 for $^{249}Cf(n_{th},f)$ and Kr-91, -92 and Xe-139 for $^{250}Cf(sp,f)$ have been determined.
Method:	Radiochemical: Fission fragments from a thin layer of the fission material are stopped in Mg-stearate. Fission rare gases are diffusing through the stearate layer into an evacuated chamber. Fractional yields are calculated from the ratio of long lived descendants in the stearate and on the walls of chamber.
Accuracy:	∿ 10% (relative to value)
Completion date:	Completed
Publications:	Jahresberichte 1975 and 1976, Institut für Kernchemie Universität Mainz

GERMANY, FED. REP.

Laboratory: Institut für Kernchemie
Universität Mainz
D-6500 Mainz, Germany and
Institut Laue Langevin
38 Grenoble, France

Names: H.O. Denschlag, Z. Alfassi (U. Beersheva, Israel), J. Blachot (CENG, Grenoble), H. Braun, W. Faubel, T. Izak-Biran (SOREQ, Israel), H. Meixler, G. Paffrath, W. Pörsch, H. Schrader, G. Siegert, T. Tamai (KURRI, Japan), A.C. Wahl (U.St.Louis, Mo,USA), K. Wolfsberg (LASL, USA)

Facilities: LOHENGRIN Mass-separator for unslowed fission products at ILL, Grenoble

Experiment: The charge distribution in the heavy-mass-peak fission products from $^{235}U(n_{th},f)$ is being measured at various well defined kinetic energies (excitation energies) of the fission fragments.

Method: Fission fragments separated according to mass (Resolution $\frac{M}{\Delta M} = 400$) and kinetic energy (resolution $\sim$2 MeV) are intercepted on a moving transport tape, transported continuously or discontinuously in front of a Ge(Li) γ-ray detector, and counted via the γ-rays emitted in their β-decay.

Accuracy: Varying

Completion: 1979

Publication: Progress reports are appearing since 1975 in Jahresberichte, Institut für Kernchemie, Universität Mainz and Annex to the Annual Reports, Institut Laue Langevin, Grenoble.

GERMANY, FED. REP.

Laboratory:	Institut für Kernchemie Universität Mainz Postfach 3980 D-6500 Mainz, Germany
Names:	M. Weis, H.O. Denschlag
Facilities:	TRIGA Mark II Reactor
Experiment:	The fractional independent or fractional cumulative (FC) yields of the following nuclides were determined in the fission of ^{235}U by thermal neutrons: Y-99 (FC), Zr-99, Nb-99m, Nb-99g, Zr-101 (FC), Nb-101, Mo-101, Zr-102 (FC), Nb-102m, Nb-102g, Nb-104 (FC), Nb-105 (FC). Measurements on Nb-96, Nb-97 (m+g) and Nb-98 (m+g) are in progress.
Method:	Fast radiochemical separation of Nb or Zr after pulsed irradiation.
Accuracy:	Generally ±5% (relative to value).
Completion date:	1978
Publications:	Jahresberichte 1975, 1976 and 1977 Institut für Kernchemie Universität Mainz

GERMANY, FED. REP.

Laboratory:	Institut für Kernchemie Universität Mainz Postfach 3980 D-6500 Mainz, Germany
Names:	G. Fischbach, H.O. Denschlag
Facilities:	TRIGA Mark II Reactor
Experiment:	The fractional cumulative (*independent) yields of the following isotopes were measured in $^{235}U(n_{th},f)$: Ba-141*, Ba-143 to Ba-146, La-146, Ce-146, Ce-148 and Ce-149
Method:	Fast radiochemical separations and direct γ-ray spectroscopic measurement and/or indirect measurements via daughter nuclides.
Accuracy:	Varying
Completion date:	1978
Publications:	Jahresberichte 1975, 1976 and 1977 Institut für Kernchemie Universität Mainz

GERMANY, FED. REP.

Laboratory and address: Institut für Kernchemie
Universität Mainz
Postfach 3980
D-6500 Mainz, Germany

Names*: H. Ohm, W. Rudolph, M. Zendel, W. Ziegert,
K.-L. Kratz (Kernchemie Mainz), F.M. Nuh,
S.G. Prussin (Univ. of Calif., Berkeley)
C. Ristori, J. Crancon (CEN Grenoble),
K.D. Wünsch, G. Jung (Univ. Giessen/ILL Grenoble)

*This work is a collaboration with:
- Department of Nuclear Engineering
  Univ. of California, Berkeley, Calif. 94720
- Laboratoire de Chimie Physique Nucléaire,
  DRF - CENG - 38041 Grenoble.
- Institut Laue-Langevin - BP 156 - 38042 Grenoble.
- II. Physikal. Institut, Univ. Giessen - D-6300 Giessen.

Facilities: Triga Mark II reactor (Kernchemie Mainz). Alkali isotope separator OSTIS installed at the Grenoble high-flux reactor.

Experiment: Using high-resolution ^{3}He ionization chambers, the energy spectra of β^--delayed neutrons have been measured in the energy range 10-3500 keV for the following precursors:
^{85}As, ^{87}Se, $^{87,88}Br$, $^{93-97}Rb$, ^{135}Sb, ^{136}Te, $^{137-138}I$, $^{141-146}Cs$.
From these spectra, the average neutron energies have been deduced. Compared to the results of other groups considerable discrepancies appear, probably arising from the effects of insufficiently known detector response functions and neutron background problems.

Accurary: Estimated uncertainties in E_n between $\pm$10 keV and $\pm$50 keV.

Publications:
K.-L. Kratz et al., CERN-Report 76-13 (1976) 304.
K.-L. Kratz et al., Proc. Int. Workshop, Hirschegg, Austria, AED-Conf. 77-017-001 ff (1977) 208.
K.-L. Kratz, Proc. 2nd AGM on FPND, Petten, Netherlands (1977), to be publ. in the IAEA Technical Report series.

GERMANY, FED. REP.

Laboratory and address: Institut für Kernchemie
Universität Mainz
Postfach 3980
D-6500 Mainz, Germany

Names*: H. Ohm, A. Schröder, K.-L. Kratz (Kernchemie Mainz), K.D. Wünsch, G. Jung (Univ. Giessen/ILL Grenoble), C. Ristori, J. Crancon (CEN Grenoble)

*This work is a collaboration with:
- Institut Laue-Langevin - BP 156 - 38042 Grenoble.
- II. Physikal.Institut, Univ. Giessen - D-6300 Giessen.
- Laboratoire de Chimie Physique Nucléaire - DRF - CENG - 38041 Grenoble.

Facilities: Alkali isotope separator OSTIS installed at the Grenoble high-flux reactor.

Experiment: Energy spectra of β^--delayed neutrons have been measured in coincidence with γ-rays depopulating excited states in the respective neutron final nucleus.

With these data and the information from neutron singles and γ-ray spectra β^--strength functions which extend to near Q_β of six Rb isotopes have been constructed (A = 89,91, 93-95,97), their shapes exhibiting - in contrast to the present theoretical concepts - pronounced resonances and a systematic behaviour as a function of mass number an Q_β as expected from general nuclear strucutre considerations. The particular importance of these investigations lies in the fact that the shape of the β^--strength function is decisive not only in predictions of β-decay half-lives and β-delayed neutron emission probabilities, but also for radioactive decay heat analyses, especially for "loss-of-coolant accidents" (LOCA).

Work is progressing.

Publications: K.-L. Kratz et al., Proc. Int. Workshop, Hirschegg, Austria, AED-Conf. 77-017-001 ff (1977) 208.
K.-L. Kratz et al., NEA-NDC Progress Report 1978.

GERMANY, FED. REP.

Laboratory and address:	Institut für Kernchemie Universität Mainz Postfach 3980 D-6500 Mainz, Germany
Names:	W. Rudolph, K.-L. Kratz, G. Herrmann
Facilities:	TRIGA Mark II reactor
Experiment:	The fractional independent fission yields and β^--delayed neutron abundances of the following nuclides were determined in thermal-neutron induced fission of ^{235}U: $^{87-92}Br$, $^{134,135}Sb$, $^{137-141}I$. With these data the neutron emission probabilities of the above precursors were obtained.
Method:	After pulsed irradiation (30 msec FWHM), fast chemical separations by hydride volatilization for Sb, and by formation of volatile methyl-compounds through recoil reactions for Br and I. γ-spectroscopic measurements via daughter nuclides, and neutron counting.
Accurary:	Error margins between $\pm$10 % and $\pm$60 % of the resulting value.
Publications:	W. Rudolph et al., J. Inorg. Nucl. Chem. 39 (1977) 753. K.-L. Kratz, Radiochim. Acta (in press).

INDIA

Laboratory and Address: Radiochemistry Division
Bhabha Atomic Research Centre
Bombay 400 085, India

Names : Ramaswami A., Natarajan V., Srivastava B.K., Sampath Kumar R., Chaudhuri N.K., and Iyer R.H.

Facilities : High Resolution Ge(Li) detector, multichannel analyser, solid state track detector, and optical microscope.

Experiment : Measurement of the absolute fission yields in the neutron induced fission of actinide isotopes.

Method : Absolute fission yields in the thermal neutron induced fission of ^{239}Pu were determined using high resolution gamma spectrometry. The total number of fissions in the sample was obtained by track etch technique using mica as the track detector.

Accuracy : 1 to 5% for the asymmetric fission products.

Completion Date : Twelve asymmetric fission product yields are completed. Similar more extensive studies on other fissile isotopes are in progress.

Remarks : In this technique errors arising out of inaccuracies in the estimation of fission cross-section due to variation of neutron energy spectrum, flux determination and in the estimation of the fissile atoms are eliminated. The work on the fission yields of ^{232}Th is in progress.

Publications : To be published.

References :

1. Iyer R.H., Sampath Kumar R., and Chaudhuri N.K., Nucl. Inst. Methods, 115, 23 (1974).

2. Ramaswami A., Srivastava B.K., Natarajan V., Sampathkumar R., Chaudhuri N.K., and Iyer R.H., Presented in "Nuclear Physics and Solid State Physics Symposium", December 1977, held in Poona, India.

3. J.G. Cuninghame and H.H., Willis, J. Inorg. Nucl. Chem., 39, 383 (1977).

ITALY

Laboratory and address: CNEN, Via Mazzini, 2, 40138 Bologna, Italy

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

Facilities: Neutron Time-of-Flight at the Electron Linac of BCMN Euratom, Geel, Belgium

Experiment: Measurement of ^{156}Gd Neutron Transmission and Capture. Determination of the Average Γ_γ and of the values of the energies and of $g\Gamma_n$ of 87 resonances. Comparison with the statistical theory based on the Gaussian Orthogonal Ensamble. Determination of the average level spacing and of s- and p-wave neutron strength functions

Method: Montecarlo simulation of experimental sequences and maximum likelihood estimates taking into account the efforts of the experimental observability threshold of the resonances and of the presence of resonances of different parity.

Expected completion date: June 1978.

JAPAN

Laboratory and address: Institute of Atomic Energy, Kyoto University, Uji, Kyoto 611, Japan

Names: Tomota Nishi, Ichiro Fujiwara and Nobutsugu Imanishi

Facilities. 5 MW research reactor [Research Reactor Institute, Kyoto University]

Experiment: Cumulative and independent fission-yields of some fission products in the thermal neutron induced fission of ^{233}U, ^{235}U and ^{239}Pu.

Method: Radiochemical for fission yields; Instrumental with Ge(Li) detectors

Accuracy: Errors range from 7% to 20 % with different combinations of the fission products and the fissile isotopes.

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

Table I

Nuclides		Completion date	Publication
$^{128,130,132}Sn, ^{133}Sb$	[Cum.]		N.Imanishi, I.Fujiwara and T.Nishi,
$^{128,130,132}Sb^{m,g}$,		Sep. 1975	"Independent isomer yields of Sb
$^{131}Sb, ^{131,133}Te^{m,g}$	[Ind.]		and Te isotopes in thermal-neutron fission of ^{233}U, ^{235}U and ^{239}Pu", Nucl. Phys. A263,141(1976)
^{135}I	[Cum.]		T.Nishi, I.Fujiwara and N.Imanishi,
$^{131,133}I$,			"Mean angular momenta of primary
$^{132,134,136}I^{m,g}$	[Ind.]	Dec. 1976	fission fragments", Int. Conf. on Nucl. Structure, Tokyo, Sep. 1977
$^{90}Rb^{m,g}$, $^{138}Cs^{m,g}$	[Ind.]	End of 1978	

JAPAN

Laboratory and address: Nuclear Engineering Research Laboratory
Faculty of Engineering
University of Tokyo
2-22 Shirane Shirakata, Tokai-mura Naka-gun
Ibaraki, Japan

Names: M. Akiyama and S. An

Facilities: Fast Neutron Source Reactor "YAYOI"

Experiment: Fission Product Decay Heat for Fast-Neutron Fission of ^{235}U, ^{238}U, Nat.U. and ^{232}Th for Cooling Times of 10^3 to 10^6 secs.

Method: Samples have been irradiated for 5 to 10 min. with fast neutrons. Gamma-ray energy spectra have been measured using NaI detector and beta-ray energy spectra have been obtained using plastic scintillation detector combined with $\Delta E/\Delta x$ type proportional counter to eliminate gamma-ray effects. Counting times have been chosen to provide good statistics within the time range of interest. Total energy release rates for beta and gamma-rays have been obtained to integrated beta and gamma-energy spectra respectively and summed to obtain the fission product decay heat.

The same experimental program has been planed for the more short cooling times using the fast pneumatic-tube irradiation facility and other fissile materials (^{239}Pu and ^{233}U).

Accuracy: <10% (expected)

(Expected) Completion Date: December 1978 for the more short cooling times
August 1979 for ^{239}Pu and ^{233}U.

Discrepancies to other Reported Data: Preliminary Data are in good agreement with other recent experiments.

Publications: M. Akiyama et al., "Kyōdō Riyō Seika Hōkoku-sho at Nuclear Engineering Research Laboratory U. of Tokyo, 1976, 1977.

Laboratory and address:	Neutron Physics Laboratory AB Atomenergi Fack S-611 01 NYKÖPING Sweden
Names:	P-I. Johansson and G. Nilsson
Facilities:	6 MeV VdG accelerator PDP-15 Computer 24 k memory (on line) NaI(Tl) and Ge(Li) spectrometers, β-spectrometer CDC-CYBER 172 Computer (off line).
Experiment:	The objective of the experiment is to improve on the accuracy of currently available fission product decay heat data by means of radiometric study of small uranium specimens at cooling times longer than 3 seconds after irradiation with thermal neutrons. The residual power of gamma radiation from thermal fission of ^{235}U has been obtained with an accuracy of ± 7 % in the time interval 10 sec to 25 min after fission. Measurements are in progress for studying also the residual power due to β-emission.
Method:	A facility for thermal neutron irradiation of fissile specimens using a VdG accelerator has been built. Specimens are transported between the neutron source and a spectrometer by means of a pneumatic system. The absolute number of fissions in the sample is determined by two independent methods: a) by utilizing an absolutely calibrated fission chamber with an active volume of about the same size as the samples, b) by counting the number of gamma quanta emitted from fission products with known yields and decay properties. The beta radiation is measured with a Si(Li) crystal. Sample transportation, irradiation and counting times are handled by a PDP-15 computer. Spectra are automatically stored on magnetic tape for off-line data analysis, i.e. the transformation from measured pulse height spectra to energy spectra.
Accuracy:	Better accuracy than ± 10 % is expected for the total energy released as β or γ-radiation from the fission products at any time between a few seconds and 30 minutes after fission.
Completion date:	Measurements on gamma-radiation were completed in December 1976 and the study on beta emission will be finished at the end of this year.

SWEDEN

Laboratories:

Department of Nuclear Chemistry
Chalmers University of Technology
Fack
S-402 20 GÖTEBORG 5
Sweden

Department of Nuclear Chemistry
University of Oslo
Oslo 3
Norway

Institut für Kernchemie
Johannes Gutenberg Universität
Postfach 3980
D-6500 Mainz
Germany

Names:

The SISAK Collaboration:

G. Skarnemark and K. Brodén (Göteborg)

T. Björnstad and I. Haldorsen (Oslo)

N. Kaffrell, E. Stender, K. Sümmerer and N. Trautmann (Mainz)

Facilities:

Two SISAK systems for studies of radionuclides with half-lives >0.5 s.

Experiments:

$T_{1/2}$-determinations, γ-singles, γ-γ coincidence and γ-γ angular correlation measurements in the energy range 0 - 6 MeV, at present on $^{106\text{-}108}Tc$.

Method:

Fast chemical on-line separations. The measurements are carried out on flow cells or ion exchange columns. Ge(Li)-detectors are used.

Discrepancies to other data:

There are very few data available in this region.

SWITZERLAND

Laboratory and address:	Eidg. Institut für Reaktorforschung, CH-5303 Würenlingen Institut für anorganische, analytische und physikalische Chemie, Universität Bern, CH-3012 Bern, Switzerland
Name:	H. R. von Gunten
Facility:	Swimming-pool type reactor (SAPHIR)
Experiments:	Determination of independent and cumulative yields in the fission of ^{233}U, ^{235}U, ^{239}Pu, and other nuclides. Presently under investigation: Independent yields of ^{148m}Pm and ^{148g}Pm in the thermal neutron-induced fission of ^{233}U and ^{239}Pu.
Method:	Radiochemical and instrumental (GeLi).
Accuracy:	5 - 10 %
Measurements completed:	End of 1978
Publications:	- H. Gäggeler and H.R. von Gunten, Cumulative yields of rare earth elements in the thermal neutron-induced fission of ^{249}Cf, J. Inorg. Nucl. Chem. 39, 1105 (1977). - H. Gäggeler and H.R. von Gunten, Charge distribution in the thermal neutron-induced fission of ^{249}Cf: Independent and fractional cumulative yields of isotopes of Nb, I, and Cs, Phys. Rev. C17, 172 (1978). - T. Kaiser and H.R. von Gunten, Independent yields of ^{96}Nb and 51 min ^{98}Nb in the thermal neutron-induced fission of ^{233}U, ^{235}U and ^{239}Pu, J. Inorg. Nucl. Chem. 40, 377 (1978). - T. Kaiser and H.R. von Gunten, Cumulative mass yields in the neutron-induced fission of ^{239}Pu at the resonance energy of 0.3 eV. Phys. Rev. C17, in press.

UNITED KINGDOM

Laboratory and Address:	AEE Winfrith	UKAEA Atomic Energy Establishment Winfrith Dorchester, Dorset DT2 8DH
Names:	M.F. Murphy, W.H. Taylor	
Experiment	Measurement of gross beta-decay power from products of ^{239}Pu and ^{235}U fission in a fast reactor. Irradiation period 10^5 seconds, detection continued up to 3.10^7 seconds after shutdown. Experiment completed.	
Method:	Thin deposits of ^{239}Pu and ^{235}U irradiated with catcher foils at centre of Zebra core with neutron energy spectrum close to that of fast power reactor. Fissions monitored by absolute (Alpha-calibrated) counters. Catcher foils transferred rapidly to scintillation detector, current output from photo-multiplier being measure of beta power. Calibrated using standard Sr-90/Y-90 source. Results of various subsidiary experiments have confirmed the validity of the experimental method and determined the necessary corrections.	
Accuracy:	Target accuracy is $\pm$ 7% (standard error) on absolute beta power as function of time from 30 seconds to 1 year after irradiation.	
Expected Completion Date:	An internal report has been written.	

UNITED KINGDOM

(same as in INDC(NDS)--86)

Laboratory and Address:	AERE Harwell	UKAEA, AERE, Harwell, Oxfordshire OX11 ORA
Names:	E.A.C. Crouch, I.C. McKean	
Facilities:	D.F.R.	
Experiment:	Absolute yields of ^{95}Nb/Zr, ^{106}Ru, ^{137}Cs, ^{144}Ce, Nd isotopes, and perhaps other isotopes, from the fission of ^{235}U, ^{238}U and ^{239}Pu in DFR.	
Method:	Samples of ^{235}U as enriched uranium dioxide, ^{238}U as depleted uranium dioxide and ^{239}Pu as plutonium dioxide were irradiated at various positions in DFR. Four samples of ^{235}U have been dissolved, chemically separated and analysed using a mass spectrometer and the isotope dilution technique. The analysis is complete. It is expected that ^{238}U and ^{239}Pu samples will be dissolved, separated and analysed during the next year.	
Accuracy:	Expected $\pm$ 2% (1σ)	
Completion date:	Delayed due to lack of effort.	

Laboratory and Address:	AERE Harwell	UKAEA AERE, Harwell, Oxfordshire OX11 ORA
Names:	J.G. Cuninghame, H.H. Willis	
Facilities:	P.F.R./ZEBRA-BIZET	
Experiment:	To measure the effect of change of reactor neutron spectrum on fission yields	
Method:	The original experiment has been abandoned in favour of irradiations in the ZEBRA-BIZET core. Samples of ^{235}U, ^{238}U and ^{239}Pu will be irradiated in four different fast reactor spectra. Analysis will probably be via the simultaneous measurement of γ-spectra after little or no chemical separation.	
Accuracy:	Expected $\pm$ 10%	
Completion date:	Expected mid-1979	

UNITED KINGDOM

Laboratory and Address:	AERE Harwell	UKAEA AERE, Harwell, Oxfordshire OX11 ORA
Names:	J.G. Cuninghame, H.H. Willis	
Facilities:	IBIS (Intense Bunched Ion Source)	
Experiment:	To determine absolute fission yields in the fission of ^{238}U by mono-energetic neutrons of energies in the range 900-1700 KeV.	
Method:	Radio-chemical analysis of the targets with β-counting of the selected fission products. Flux measured by solid state track detectors.	
Accuracy:	± 5%	
Completion date:	Work halted - to be completed when possible.	

Laboratory: and Address:	AERE Harwell	UKAEA AERE, Harwell Oxfordshire, OX11 ORA
Names:	I.C. McKean and E.A.C. Crouch	
Experiment:	^{3}H yield in thermal and fast fission spectra for U and Pu isotopes	
Facilities:	GLEEP and 'ZEBRA' Reactors	
Method:	The tritium produced in fission is converted to tritiated water, separated from other fission products and measured by liquid scintillation counting. A preliminary experiment has been completed in which solutions of ^{235}U were irradiated in a thermal flux. Samples will next be irradiated in GLEEP (^{235}U + ^{239}Pu in solution) and in ZEBRA-BIZET(^{235}U + ^{239}Pu metal).	
Accuracy:	$\pm$ 10%	
Completion date:	Uncertain; proceeding slowly.	

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Laboratory and Address: AWRE Aldermaston — MOD(PE) AWRE Aldermaston, Reading RG7 4PR.

Names: C.B. Besant*, P.J. Challen+, M.H. McTaggart+ P. Tavoularidis* and J.G. Williams*

*Imperial College, University of London

+MOD(PE) AWRE Aldermaston, Berkshire

Facilities: Pulsed reactor VIPER

Experiment: Absolute Yields and Group Constants of Delayed Neutrons in the Fast Fission of ^{235}U, ^{238}U and ^{239}Pu

Method:

Absolute yields and group constants of the delayed neutrons from the fast fission of ^{235}U, ^{238}U and ^{239}Pu have been measured. The method was based on irradiating a sample in the fast pulsed reactor VIPER and transferring it pneumatically to the neutron detector, outside the biological shield of the reactor. The neutron efficiency of the detector was measured by a number of calibrated neutron sources and account was taken of its energy response function.

The fissions in the sample were measured by an activation technique. The 1596 Kev gamma activity, emitted by ^{140}La, of the sample was measured using a high resolution detector. The necessary conversion factor of activity into the number of fissions was determined by a calibration experiment where a thin deposit of known mass was irradiated within a fission chamber, along with a thick foil which was subsequently gamma counted.

The delayed neutron decay curve was approximated by six groups, using the least squares technique.

Results:

The absolute delayed neutron yields were found to be

^{235}U 0.0164 $\pm$ 0.0006 (n/F)

^{238}U 0.0439 $\pm$ 0.0017 (n/F)

^{239}Pu 0.00598 $\pm$ 0.00022 (n/F)

The reactivity (dollars) - period relationship, using the present group constants, is in agreement with the currently used values to within 3% for any isotope and practically used period.

Completion Date: Completed.

Publications: Journal of the British Nuclear Energy Society 1977, 16, Apr., No. 2, 161-176.

Laboratory and Address:	DNPDE	Dounreay Nuclear Power Development Establishment, UKAEA, Northern Division, Thurso, Caithness, Scotland KW14 7TZ

Names: W. Davies, V.M. Sinclair

Facilities: PFR

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

In progress

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

3 capsules contain ^{235}U as highly enriched uranium dioxide,
3 capsules contain ^{239}Pu as low ^{240}Pu content plutonium dioxide,
2 capsules contain ^{238}U as depleted uranium dioxide with an isotopic analysis of 99.7% ^{238}U,
1 capsule contains ^{240}Pu as a dried aqueous solution of plutonium with an isotopic analysis of 99% ^{240}Pu,
1 capsule contains ^{241}Pu as a dried aqueous solution of plutonium with an isotopic analysis of 93% ^{241}Pu, and
2 capsules contain no added fissile material.

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

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

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

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

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

Expected completion date: 1980

Laboratory and Address	N.P.L. Teddington	Division of Radiation Science and Acoustics National Physical Laboratory Teddington Middlesex TW11 OLW
Names:	P. Christmas, P. Cross	
Facilities:	$\pi\sqrt{2}$ Beta-ray spectrometer, isotope separator	
Experiment:	Determination of K & L internal conversion coefficients of ^{133m}Xe.	
Method:	Peak-to-Beta-Spectrum (PBS). The study of instrumental distortions of beta-spectra in the $\pi\sqrt{2}$ spectrometer has been completed and submitted for publication, together with a paper describing the application of the PBS method to ^{137}Cs. The results quoted in the latter include precise values for the internal conversion coefficients and gamma-ray intensity per disintegration for the 662 KeV transition.	
Accuracy:	Target is $\pm$ 1 per cent.	
Completion Date:	Uncertain, due to lack of effort.	

U. S. A.

Laboratory and address:	Argonne National Laboratory 9700 South Cass Avenue Argonne, Illinois 60439 USA
Names:	L. E. Glendenin, J. E. Gindler, J. W. Meadows, Jr.
Facilities:	Fast-neutron generator facility (FNGF)
Experiment:	Fission yields as a function of incident neutron energy
Method:	Yields determined (1) radiochemically with either β- or γ-counting and (2) by γ-counting irradiated foils of fissionable material. Neutrons produced by Li-p or D-d reaction. Flux monitored with fission chamber utilizing as the fission source the same material as that being irradiated. Absolute yields determined from flux measurements and/or 200% normalization of mass-yield distribution.
Accuracy:	Yields > 1% determined by γ-counting: 3-5% Yields < 1% determined by γ-counting: 5-20% Yields determined radiochemically with β-counting: 10-20%
Completion date:	Measurements of ^{238}U(n,f) for 1.5, 2.0, 3.9, 5.5, 6.9, and 7.7-MeV neutrons (published Jan. 1978). ^{233}Th(n,f) in progress. Continuing program for other fissile and fertile materials.
Publications:	"Monoenergetic neutron fission of ^{238}U", K. F. Flynn, S. Nagy, L. E. Glendenin, J. E. Gindler, and J. W. Meadows, Amer. Nucl. Soc. Transact. 22, 677 (1975). "Mass distributions in monoenergetic-neutron-induced fission of ^{238}U", S. Nagy, K. F. Flynn, J. E. Gindler, J. W. Meadows, and L. E. Glendenin, Phys. Rev. C17, 163 (1978).

U.S.A.

CONTRIBUTION TO "PROGRESS IN FISSION PRODUCT NUCLEAR DATA"

Laboratory and Address:

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

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

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

Experiment: Energy spectra of neutrons emitted from the delayed neutron precursors $^{93,94,95}Rb$ and ^{143}Cs have been measured.

Method: Delayed-neutron energy spectra from mass separated precursors were measured by use of a ^{3}He ionization chamber. The detector resolution (FWHM) for thermal neutrons was 18 keV. Delayed neutron peaks as low as 30 kev could be resolved from the thermal peak background. The efficiency of the detector as a function of neutron energy was determined by use of monoenergetic neutron from the ^{7}Li (p,n) ^{7}Be reaction. The observed delayed-neutron spectra have been corrected for the thermal neutron background and for counter efficiency.

Accuracy: The present data have not yet been analyzed by a response function fitting procedure.

Completion Date: This work is continuing with the intent of measuring delayed-neutron spectra for as many precursors as possible with the SOLAR facility.

Publications:

P. L. Reeder, J. F. Wright, and L. J. Alquist,"Phys. Rev. C 15, 2198 (1977), "Average Neutron Energies from Separated Delayed Neutron Precursors."

P. L. Reeder, J. F. Wright, and L. J. Alquist, Phys. Rev. C 15, 2108 (1977), "Delayed Neutron Emission Probabilities of Separated Isotopes of Br, Rb, I, and Cs."

U. S. A.

FPND NEWSLETTER CONTRIBUTION - I

Laboratory: Idaho National Engineering Laboratory

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

Name: William J. Maeck

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

A program is in progress at the Idaho Chemical Processing Plant (ICPP) laboratories to accurately measure absolute fast reactor fission yields for ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, and ^{243}Am. All irradiations (EBR-II, Row-8) have been completed and the analytical measurements completed for all samples except ^{241}Am and ^{243}Am. Analysis of the ^{241}Am samples is in progress. Data reduction and yield calculations have been completed for ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu and ^{241}Pu. Data analysis is in progress for the ^{240}Pu and ^{242}Pu samples.

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

Accuracy: In general, the uncertainties associated with ^{233}U, ^{235}U, ^{237}Np, ^{239}Pu, and ^{241}Pu yields range from 1.0-1.5% relative, and for ^{238}U, ^{240}Pu, and ^{242}Pu yields, the uncertainties range from 1.5-3.0% relative.

Future Work: Data reduction, statistical analysis and calculation of the fast fission yields for ^{240}Pu and ^{242}Pu should be completed by July 1978. Analysis of the ^{241}Am samples will be completed by September 1978.

(cont'd)

U. S. A.

To augment the fast yield data obtained from the irradiation in Row-8 of EBR-II, samples of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu which were irradiated in Row-2 of EBR-II are being analyzed. These data will provide more information relative to the effect of neutron energy on fission yields. The analysis of the ^{233}U and ^{235}U samples will be completed by September 1978, and for ^{239}Pu and ^{241}Pu by July 1979.

Plans are in progress to conduct an irradiation in the Fast Flux Test Facility (FFTF) at Hanford, Washington, late in 1979. These samples will provide FFTF benchmark fast yield data for ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu.

Special Comments: All yield data reported from this work are associated with a measured or calculated neutron spectrum. The study to correlate yields with neutron energy is continuing.

Publications: The results of this measurement program are published in a series of Allied Chemical Corporation - Idaho Chemical Programs reports designated ICP-1050-I, II, III, etc. The following reports are available from the National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia, 22161, USA.

1. W. J. Maeck, Editor, "Fast Reactor Fission Yields for ^{233}U, ^{235}U, ^{238}U, ^{239}Pu and Recommendations for the Determination of Burnup on FBR Mixed-Oxide Fuels: An Interim Project Report", Allied Chemical Corporation - Idaho Chemical Programs Rept. ICP-1050-I (Jan. 1975).

2. W. J. Maeck, Editor, "Fast Reactor Fission Yields for ^{239}Pu and ^{241}Pu", Allied Chemical Corporation - Idaho Chemical Programs Rept., ICP-1050-II (Aug. 1977).

3. W. J. Maeck, W. A. Emel, A. L. Erikson, J. E. Delmore, J. W. Meteer, "Fast Reactor Fission Yields for ^{237}Np", Allied Chemical Corporation - Idaho Chemical Programs Rept., ICP-1050-III (Sept. 1977).

4. The ^{240}Pu and ^{242}Pu data should be published about September 1978 and will carry the designation ICP-1050-IV.

U. S. A.

FPND NEWSLETTER CONTRIBUTION - II

Laboratory: Idaho National Engineering Laboratory

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

Name: William J. Maeck

Experiment: Thermal Fission Yields for ^{235}U and ^{239}Pu

An existing experiment has been extended to remeasure the major fraction of the mass yield curve for the thermal fission of ^{235}U and ^{239}Pu. The need for this program resulted from serious discrepancies in some measured relative isotopic ratios for certain isotopes in the thermal fission of ^{239}Pu. Analysis, data reduction and yield calculations have been completed for six samples (three at 1 a/oF and three at ~35 a/oF of ^{235}U).

Method: The principal measurement technique is isotope dilution mass spectrometry for the isotopes of Kr, Rb, Sr, Zr, Mo, Ru, Xe, Cs, Ba, La, Ce, Nd, and Sm. The number of fissions will be established by two methods: 1) the summation of the total atoms in the heavy mass peak, and 2) the heavy element difference technique.

Accuracy: The uncertainties associated with these new yields range from 0.5-1.5% relative. A comparison of the number of fission determined by the summation technique and the heavy element difference technique show an agreement of ±0.5% relative.

Future Work: Analysis of six ^{239}Pu samples (three at 1 a/oF and three at ~40 a/oF) will be completed by July 1978. Final reports giving new ^{235}U and ^{239}Pu thermal yield data will be issued.

Data Discrepancies: See Publication 1.

(cont'd)

U. S. A.

Publications:

1. W. J. Maeck, W. A. Emel, J. E. Delmore, F. A. Duce, L. L. Dickerson, J. H. Keller, R. L. Tromp, "Discrepancies and Comments Regarding ^{235}U and ^{239}Pu Thermal Fission Yields and the Use of ^{148}Nd as a Burnup Monitor", Allied Chemical Corporation - Idaho Chemical Programs Rept., ICP-1092 (Dec. 1976).

2. "Absolute Thermal Fission Yields for ^{235}U", Allied Chemical Corporation - Idaho Chemical Programs Rept., ICP-1142 (To be published August 1978).

U. S. A.

FPND NEWSLETTER CONTRIBUTION - III

Laboratory: Idaho National Engineering Laboratory

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

Name: William J. Maeck

Experiment: Natural Fission Reactor Studies: ^{238}U Spontaneous Fission Yields

In the process of analyzing approximately 25 rich uranium ore samples for fissiogenic ruthenium, a preliminary estimate of the ^{238}U spontaneous fission yields for ^{99}Ru, ^{101}Ru, ^{102}Ru, and ^{104}Ru has been obtained. The measurement technique was mass spectrometry.

After correction for the natural Ru component and the fissiogenic component resulting from ^{235}U induced fission, the best estimate for the isotopic composition of ^{238}U spontaneous fission Ru is:

99	0.236
101	0.285
102	0.314
104	0.165

Using a value of 6.0% for the ^{238}U spontaneous fission yield of ^{99}Mo, the preliminary ^{238}U spontaneous fission yields for the Ru isotopes are:

^{99}Ru	6.0% (relative to ^{99}Mo)
^{101}Ru	7.25
^{102}Ru	8.0
^{104}Ru	4.2

These values have been updated and supersede those reported in INDC (NDS)-86.

U.S.A.

(same as in INDC(NDS)-86)

Laboratory and address: Idaho National Engineering Laboratory
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 73401 USA

Names: R. J. Gehrke, R. G. Helmer

Facilities: 1) 4π β-γ coincidence counting system
2) Calibrated Ge(Li) spectrometers

Experiment: Determination of absolute γ-ray emission probabilities for:
^{139}Ba, and ^{134}I ongoing
^{146}Pr, ^{145}Pr, ^{132}Te and ^{141}La planned

Method: The decay rates are determined by the 4π β-γ coincidence counting system, which has two separate pulse-processing systems. One system is based on fixed pulse widths. The other is based on veriable pulse widths and an overlap coincidence circuit. The dead time of the beta, gamma and coincidence channels is measured by counting the pulses from a 10 MHZ clock.
The variable pulse width system is useful in measuring the γ-ray emission probabilities of short-lived (< 30 m) fission products, where high count rates are needed.
The γ-ray emission rates are determined by Ge(Li) spectrometers whose efficiencies have been measured to an accuracy of $\pm 1\frac{1}{2}\%$ (1σ) between 0.3 and 2 MeV.

Accuracy: $\pm$ 1% to $\pm$ 5% (1σ uncertainty)

Completion date: Dec. 1977.

U.S.A.

Laboratory and address:	Idaho National Engineering Laboratory EG&G Idaho, Inc. P. O. Box 1625 Idaho Falls, Idaho 83401 U.S.A.
Names:	Y. D. Harker, R. A. Anderl
Experiment:	Integral cross-section measurements in fast-reactor type environments.
Method:	Multiple samples of highly-enriched isotopes of neodymium, samarium, and europium, specifically, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, ^{150}Nd, ^{147}Sm, ^{149}Sm, ^{151}Eu, ^{152}Eu, ^{153}Eu, and ^{154}Eu were irradiated in a row 8 position of EBR-II. Samples and dosimetry sets of spectrum monitors were located both at the reactor midplane and at +35 cm above midplane in the axial reflector. Reaction rates for the spectrum monitors were determined by the gamma-spectrometric technique using Ge(Li) spectrometers. A spectrum-unfolding code was used to obtain flux and neutron-spectral shape information from the monitor reaction rates. Mass-spectrometric methods were used to measure the products of neutron absorption in each isotopic sample.
Accuracy:	5% to 10%
Measurements Completed:	Integral capture cross sections obtained for ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{147}Sm and ^{149}Sm are presented in Table I. Also included in the table is a comparison to ENDF/B-IV calculated integral cross sections.
Completion Date:	Remaining measurements and analysis will be completed by end of 1978.
Publications:	R. A. Anderl et al, "EBR-II Irradiation of Enriched Isotopes of Neodymium, Samarium, and Europium," Trans. Am. Nucl. Soc. 28, 745 (1978).

TABLE I

SPECTRAL-AVERAGED CROSS SECTIONS OF SELECTED Nd AND Sm ISOTOPES RELATIVE TO THAT FOR ^{235}U

Isotope	Axial Position	Measured	Calculated	Calculated/Measured
^{143}Nd	0	0.221	0.193	0.873
	+35	0.389	0.323	0.830
^{144}Nd	0	0.0471	0.0419	0.890
	+35	0.0443	0.0314	0.709
^{145}Nd	0	0.336	0.224	0.665
	+35	0.647	0.386	0.597
^{147}Sm	0	1.03	0.987	0.968
	+35	1.91	1.95	1.02
^{149}Sm	0	1.80	1.50	0.833
	+35	3.47	3.13	0.902

U. S. A.

Laboratory: Los Alamos Scientific Laboratory, Group CNC-11, Los Alamos, NM 87545, USA

Names: B. R. Erdal, G. W. Butler, D. W. Barr

Facilities: Absolute fission chamber; Big-10 critical assembly; Omega-West reactor; Cockroft-Walton accelerator; radiochemical laboratory; calibrated Ge(Li) and β-proportional detectors

Experiment: Measurement of true radiometric fission yields for several primary fission monitors from ^{235}U, ^{238}U, ^{239}Pu and ^{240}Pu with thermal-, fission-specturm-, and 14-MeV neutrons

Method: Determination of the number of fissions in sample by use of an NBS fission chamber followed by standard radiochemistry and nuclear measurement techniques

Accuracy: Typical uncertainty in the yields is 1-2% relative to ^{235}U thermal-neutron fission

Completion date: Continuing

Publications: A. E. Norris and G. P. Ford, Los Alamos Scientific Laboratory Report No. LA-6129 (1976)

U. S. A.

Laboratory: Los Alamos Scientific Laboratory, Group CNC-11
Los Alamos, NM 87545, USA

Names: B. R. Erdal, G. P. Ford, K. Wolfsberg, D. C. Hoffman

Facilities: Godiva-IV fast burst reactor; Omega West reactor; Cockroft-Walton accelerator; radiochemical laboratory; calibrated Ge(Li) detectors

Experiment: Measurement of absolute cumulative yields of ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{133g}Xe and ^{135g}Xe from thermal-, fission-spectrum-, and 14-MeV-neutron fission of ^{235}U, ^{238}U, ^{239}Pu, and ^{233}U

Method: Delayed removal of Kr and Xe from irradiated stearates followed by gamma-ray spectrometry of Ge(Li) detectors

Completion date: Continuing

U. S. A.

Laboratory: Los Alamos Scientific Laboratory, Group CNC-11
Los Alamos, NM 87545, USA

Names: K. Wolfsberg, G. P. Ford, B. R. Erdal, D. C. Hoffman

Facilities: Godiva-IV fast burst reactor; Omega West reactor; Cockroft-Walton accelerator; radiochemical laboratory; calibrated Ge(Li) detectors

Experiment: Fractional independent yields of ^{133m}Xe, ^{133g}Xe, ^{135m}Xe and ^{135g}Xe from thermal-, fission-spectrum-, and 14-MeV-neutron fission of ^{235}U, ^{238}U, ^{239}Pu, ^{242m}Am, and ^{233}U

Method: Quick removal of Xe from irradiated stearates followed by gamma-ray spectrometry on Ge(Li) detectors

Completion date: Continuing

U.S.A.

LABORATORY	Lawrence Livermore Laboratory University of California P.O. Box 808 Livermore, CA 94550, U.S.A.
NAMES	D. R. Nethaway A. L. Prindle W. A. Myers W. C. Fuqua M. V. Kantelo
FACILITY	Livermore ICT Facility (14-MeV neutron source)
EXPERIMENT	Measure fission yields (both total chain yields and independent yields) for fission of Pu-240 with 14.8-MeV neutrons.
METHOD	The Pu-240 target material is covered with U-238 foils so that the fission yields can be measured relative to the fission of U-238. Measurements are made both by doing chemical separations and by direct counting with Ge(Li) detectors. The accuracy of the measurements is about ± 4%.
COMPLETION DATE	The experiment is finished.
PUBLICATION	Phys. Rev. C 16, 1907 (1977), (UCRL Report 79335).

U.S.A.

LABORATORY	Lawrence Livermore Laboratory University of California P.O. Box 808 Livermore, CA 94550, U.S.A.
NAMES	D. R. Nethaway A. L. Prindle W. A. Myers M. V. Kantelo R. L. Osborne
FACILITY	FLATTOP Critical Assembly (Pu), Los Alamos Scientific Laboratory.
EXPERIMENT	Measure fission yields (both total chain yields and independent yields) for fission of Pu-240 induced by fission-spectrum neutrons.
METHOD	Measurements were made both by doing chemical separations and by direct counting with Ge(Li) detectors. The accuracy of the measurements is about ± 5%. Absolute yields are based on a comparison with U-235 fission yields and on a normalization of the mass-yield curve.
COMPLETION DATE	The experiment is finished.
PUBLICATION	Lawrence Livermore Laboratory Report UCRL-80020 (Sept. 8, 1977). Submitted to Phys. Rev. C.

U.S.A.

LABORATORY	Lawrence Livermore Laboratory University of California P.O. Box 808 Livermore, CA 94550, U.S.A.
NAMES	D. R. Nethaway D. H. Sisson A. L. Prindle M. V. Kantelo R. A. Sigg L. L. Nolen
FACILITY	FLATTOP Critical Assembly (Pu), Los Alamos Scientific Laboratory.
EXPERIMENT	Measure fission yields for fission of Am-241 induced by fission-spectrum neutrons.
METHOD	Measurements are being made by doing chemical separations on the irradiated Am-241 samples and by using the recoil catcher-foil technique. Absolute yields will be based on a comparison with U-235 fission yields and on a normalization of the mass-yield curve.
COMPLETION DATE	The measurements have been started and should be finished this year.

U.S.A.

LABORATORY	Lawrence Livermore Laboratory University of California P.O. Box 808 Livermore, CA 94550, U.S.A.
NAMES	D. H. Sisson A. L. Prindle D. R. Nethaway M. V. Kantelo L. L. Nolen R. A. Sigg
FACILITY	Livermore ICT Facility (14-MeV neutron source)
EXPERIMENT	Measure fission yields for fission of Am-241 induced by 14.8-MeV neutrons.
METHOD	Measurements are being made by doing chemical separations on the irradiated Am-241 samples, and by using the recoil catcher-foil technique. The accuracy of the measurements is about ± 5%. Absolute yields are based on a comparison with U-238 fission yields and on a normalization of the mass-yield curve.
COMPLETION DATE	We have almost finished the experimental measurements on 59 nuclides, and plan to start preparing a report for publication in the near future.

U.S.A.

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

Names: Bernard W. Wehring

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

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

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

Accuracy: 0.5-amu mass resolution, achieved,
about 1-Z atomic-number resolution, achieved,
1% standard error (relative error) in largest mass yield, achieved,
0.02-0.1% standard error (absolute error) in nuclide yields, achieved.

Completion date: 1979

Publications:

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

Gino DiIorio, "Direct Physical Measurement of Mass Yields in Thermal Fission of Uranium 235," Ph.D. Thesis, University of Illinois at Urbana-Champaign, 1976.

Gino DiIorio and B. W. Wehring, "Direct Physical Measurement of Mass Yields for $^{235}U(n_{th},f)$," Trans. Am. Nucl. Soc. 24, 459 (1976).

R. B. Strittmatter, R. G. Bucher, and B. W. Wehring, "Atomic-Number Dependence of Fission-Fragment Energy Loss: Evidence for Z_1 Oscillations," Phys. Rev. A 15, 2230 (1977).

Gino DiIorio and B. W. Wehring, "HIAWATHA, A Fission-Fragment Recoil Mass Spectrometer," Nucl. Instr. Methods 147, 487 (1977).

R. B. Strittmatter and B. W. Wehring, "Direct Physical Measurement of Nuclide Yields for $^{235}U(n_{th},f)$," Trans. Am. Nucl. Soc. 27, 862 (1977).

R. B. Strittmatter, "Nuclide Yields for Thermal Fission of Uranium 235," Ph.D. Thesis, University of Illinois at Urbana-Champaign, 1978.

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

Names: R. L. Macklin, J. Halperin

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

Experiment: Fast Neutron (n,γ) Cross Sections E_n = 2.6 - ∿500 keV
Target-isotopes: see Table 1

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

Accuracy: 2-5% in cross section, ≳ 0.2% resolution (FWHM)

[Expected] completion date:) See Table 1

Publications:

Table I

Isotopes	Completion date	Publications
$^{86,87,88}Sr$	indefinite	"Valence Neutron Capture in ^{88}Sr", J. W. Boldeman, B. J. Allen, A. R. de L. Musgrove and R. L. Macklin, Nucl. Phys. A269, 397 (1976).
^{89}Y	1976	Data taken, analysis at Lucas Heights, Australia, J. Boldeman et al, submitted to Nuclear Science and Engineering.
$^{90,91,92,94}Zr$	1976	"The 292.4 eV Neutron Resonance Parameters of ^{91}Zr", R. L. Macklin, et al, Nucl. Sci. & Eng 62, 174 (1977). "keV Neutron Capture in Zirconium-91", J. W. Boldeman et al, AAEC/E 367. "The Neutron Total and Capture Cross Sections of $^{92,94}Zr$", J. W. Boldeman, et al., Nucl. Phys. A263, 389 (1976). "Valence Component in the Neutron Capture Cross Section of ^{90}Zr", J. W. Boldeman, et at., Nucl. Phys. A246, 1 (1975). "High Resolution Neutron Transmission and Capture for ^{91}Zr", A. R. de L. Musgrove, et al., Nucl. Phys.
^{93}Nb	Jan. 1976	R. L. Macklin, Neutron Capture Cross Section of Niobium from 2.6 to 700 keV, Nuclear Sci. & Eng. 59, 12-20 (1976).
$^{92,94,95,96,97,98,100}Mo$	1976	O. A. Wasson et al., Neutron Resonance Parameters of ^{92}Mo, Phys. Rev. Revw. C7, 1532-1541 (1973).

U. S. A.

Isotopes	Completion Date	Publications
		"Average Neutron Resonance Parameters and Radiative Capture Cross Sections for the Isotopes of Molybdenum", A. R. de L. Musgrove, et al., Nucl. Phys. A270, 108 (1976).
^{100,101,102,104}Ru	indefinite	Data taken
^{103}Rh	indefinite	Data taken, analyst needed.
^{104,105,106,108,110}Pd	indefinite	Resonances analyzed (Rlm)
^{106,108,110,111,112,113,114,116}Cd	indefinite	Data taken, analysis being undertaken at Lucas Heights. O. S. Wasson and B. J. Allen, "P-Wave Resonances in ^{111}Cd(n,γ)", Phys. Rev. C7, 780-787 (1973). A.R. Musgrove, B.J. Allen and R.L. Macklin, "Neutron capture resonance parameters and cross sections for the even-A isotopes of Cd", J. Phys. G, 4, 771 (1978)
^{122,123,124,125,126,128,130}Te	1977	R. R. Winters (Denison Univ., ORNL consultant) analyzing the data.
^{133}Cs	indefinite	Data taken.
^{134,135,136,137,138}Ba	1976	Data taken, analysis in progress at Lucas Heights, Australia. A. R. Musgrove, B. J. Allen, R. L. Macklin, "keV Neutron Resonance Capture in ^{135}Ba", AAEC/E327 (12/74) (INDC(AUL)-23/L) "keV Neutron Resonance Capture in Barium-137", A. R. de L. Musgrove, et al., Aust. J. Phys. "keV Neutron Capture Cross Sections of ^{134}Ba and ^{136}Ba", Nucl. Phys. A256, 173 (1976). A. R. de L. Musgrove et al. "Neutron Resonance Capture in ^{138}Ba", A. R. de L. Musgrove et al., Nucl. Phys. A252, 1975).
^{139}La	1977	"Resonant Neutron Capture in ^{139}La", A. R. de L. Musgrove, B. J. Allen and R. L. Macklin, Preprint available.
^{140}Ce ^{141}Pr	1977	Data taken, analysis at Lucas Heights.
^{142,143,144,145,146,148}Nd		"Non-Statistical Effects in the Radiative Capture Cross Sections of the Neodymium Isotopes", A. R. de L. Musgrove, et al., AAEC/E 401.
^{159}Tb	indefinite	Data taken, analysis in progress, M. Mitzumoto, JAERI-ORNL (4/77). M. Mitsumoto, R.L. Macklin and J. Halperin, "Neutron capture cross section of ^{159}Tb from 2.6 to 700 keV", Phys. Rev. C, in press.
^{165}Ho	1976	R. L. Macklin, "The ^{165}Ho(n,γ) Standard Cross Sections from 3 to 450 keV", Nucl. Sci. & Engr. 59, 231-236 (1976).
^{169}Tm	indefinite	Data taken, analysis by D. Drake, J. Malanify LASL and R. Macklin, ORNL, in progress (4/77).

Laboratory and address: Oak Ridge National Laboratory
P. O. Box X, Building 6010
Oak Ridge, Tennessee 37830

Names: J. K. Dickens and R. W. Peelle

Facilities: Fast Rabbit Transport Station at Oak Ridge Research Reactor (ORR)

Experiment: Total Beta and Gamma Energy Release for Thermal-Neutron Fission of ^{235}U, ^{239}Pu, and ^{241}Pu for Cooling Times of 2 to 14000 secs.

Method: Microgram samples of ^{235}U and ^{239}Pu have been irradiated for short periods with thermal neutrons, and returned pneumatically to a counting area. Beta- and gamma-ray energy spectra of moderate resolution have been obtained using scintillation detectors (NE110 for beta rays and NaI for gamma rays) for selected time intervals within the time range of interest. The spectra have been reduced to differential production cross sections $d\sigma/dE$ and have been integrated to obtain total energy release rates for beta and gamma rays (separately). These data have been summed to obtain the total energy release.

The same experimental program is in progress for ^{241}Pu.

Accuracy: 3% (1σ) for ^{235}U and ^{239}Pu, < 5% for ^{239}Pu

(Expected) Completion Date: May 1977 for ^{235}U, December 1977 for ^{239}Pu, and September 1978 for ^{241}Pu

Discrepancies to Other Reported Data: Data are in reasonable agreement with other recent experiments and with results of summation calculations.

Publications:

J. K. Dickens, J. F. Emery, T. A. Love, J. W. McConnell, K. J. Northcutt, R. W. Peelle, and H. Weaver, "Fission-Product Energy Release for Times Following Thermal-Neutron Fission of ^{235}U Between 2 and 14000 Seconds," ORNL/NUREG-14 (October 1977)

J. K. Dickens, J. F. Emery, T. A. Love, J. W. McConnell, K. J. Northcutt, R. W. Peelle, and H. Weaver, "Fission-Product Energy Release for Times Following Thermal-Neutron Fission of ^{239}Pu Between 2 and 14000 Seconds," ORNL/NUREG-34 (April 1978)

II. COMPILATIONS AND EVALUATIONS

FRANCE

Laboratory and address : DRNR/SPNR
CEN/CADARACHE
B.P. N°1
13115 St PAUL LEZ DURANCE

NAMES : E. FORT, D. LAFOND,

EVALUATIONS :

Purpose : Complete evaluation of F.P which are of importance for gaz migration, delayed neutrons emission, irradiation correlation effects.

Method : - Selection of resonance parameters. Calculation by B.W single and multilevel formalisms.

- Criticism and renormalization of experimental microscopic data .

- Calculation making use of statistical and optical models, adjusted on renormalized microscopic data. The integral data are used as tendancy indicators.

Major source of information : Neutron Physics literature BNL 325 (resonance parameters), Nuclear data sheets (level scheme) CINDA, NEUDADA library.

Deadline of literature coverage : None

Status : Participation to revision of 5 F.P. evaluation.
Evaluation of the 27 following nuclides.
75 As, 83,84,85,86 Kr, 87,88,89,90,91 Br, 90 Sr,
96 Mo, 93,94,95,96,97 Rb, 127,129,137,139 I, 130,
131,132,133 Xe, 135,136 Sb.

Cooperation : partly with CNEN/Bologna, ECN Petten

Computer file of evaluated data : ENDF/B format

Expected completion data : End of 1980.

FRANCE

Laboratory and address :	DEDR/DRE/SEN Centre d'Etudes Nucléaires de Cadarache B.P. n° 1-13115 ST PAUL LEZ DURANCE FRANCE.
Names :	C. FICHE, J. BLACHOT *
Compilation :	Decay data for fission products. T 1/2 ; Qβ; branching fractions for the various decay modes ; energies and intensities of all emitted radiations, total ICC; uncertainties in all measured values.
Purpose :	Decay data file

Major sources of information: ENSDF, LMRI (CEA Saclay) journals.

Deadline of literature coverage :	Ongoing. no cut off date.
Computer File :	Decay data are included in special FORMAT Fission product and actinides files. Tapes available through CCDN (Saclay).
Publications :	- C. FICHE - J. BLACHOT Contribution to Review paper 12 of the meeting on F.P.N.D. organized by IAEA (Petten 5,9 September 1977). - J. BLACHOT - C. FICHE Atomic Data and Nuclear Data Tables Volume 20 3 (1977).

* DRF/CPN Centre d'Etudes Nucléaires de Grenoble
85X - 38041 - GRENOBLE CEDEX
FRANCE.

Laboratory and address: Max-Planck-Institut für Kernphysik
Postfach 103 980, 6900 Heidelberg, Germany

Names: H.V. Klapdor, C.-O. Wene[+], I.N. Isosimow[++], and Yu.W. Naumow[++]

Evaluation: Shape of beta-strength function S_β in ß-decay of neutron- and proton-rich fission products.

Purpose: Knowledge of the shape of S_β is important for calculation of ß-decay half-lives, of ß-delayed neutron yield and of production rates for heavy nuclides by astrophysical processes and thermo-nuclear explosions and for optimizing the emergency cooling systems of nuclear reactors.

Method: Information on the structure of S_β is obtained from nuclear structure considerations as well as from microscopic calculations.

Deadline of literature coverage: June 1978

Status and results: The results are clearly indicating the importance of "resonances" in S_β. Agreement of the predictions is found with recent experimental data[1].

Cooperation: with Institut für Kernchemie, Mainz

Discrepancies encountered: The assumptions S_β = const or $S_\beta \sim \varrho(E)$ (still used in ref.2) or the gross theory of ß-deday[3] are far from reality.

Completion date: June 1978

Publications:
H.V. Klapdor CERN-Report 76-13 (1976) 311 and Phys. Lett. 65B (1976) 35
H.V. Klapdor, C.-O. Wene, M. Schrader, G. Bergdolt, A.M. Bergdolt, Yu. Naumow, Isv. Akad. Nauk SSSR (ser.fiz.) 42 (1978) 64
H.V. Klapdor, C.-O. Wene, I.N. Isosimow, Yu. Naumow Phys. Lett., in press (1978)
H.V. Klapdor, C.-O. Wene, to be published (1978)

References:
1) K.-L. Kratz et al., Phys. Lett. 65B (1976) 231 and Proceed. Int. Workshop V on Gross Properties of Nuclei, Hirschegg (1977) 208
2) J.C. Hardy, B. Jonson, P.G. Hansen, Nucl. Phys. A, in press (1978)
3) K. Takahashi, M. Yamada, T. Kondoh, Atomic Data and Nuclear Data Tables 12 (1973) 101 and refs. therein.

[+] Institute of Technology, Lund, Sweden

[++] Institute of Physics, University of Leningrad, USSR

INDIA

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

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

A. THEORETICAL COMPILATION

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

(same as INDC(NDS)-86, p. 89; for the full text, see there)

ITALY

Laboratory and address:	CNEN, Centro di Calcolo Via Mazzini, 2 - 40138 Bologna, Italy
Names:	F. Fabbri, T. Martinelli, E. Menapace, A. Montaguti, M. Motta, G.C. Panini, G. Reffo, M. Vaccari, A. Ventura
Evaluation:	The complete evaluation and compilation in ENDF/B format of the 40 FP, listed in the progress report No. 2,INDC(NDS)75/C+P
Purpose:	Estimate of long term reactivity changes and FP accumulation in fast reactor
Method:	Calculations by BW-single and -multilevel formalism (resonance region) and by statistical and optical models

Major sources of information: NEUDADA, CINDA

Deadline of literature coverage: December 1976

Status:	The full evaluation and file compilation in the range 0-15 MeV of all the 40 isotopes of the above mentioned list has been completed at the date December 31, 1977
Cooperation:	CEA - Cadarache and Saclay and ECN Petten
Other relevant details:	25 group cross sections at infinite dilution and 0°K temperature have been generated for each evaluated isotope

Computer file of evaluated data: ENDF/B format.

JAPAN

Laboratory and adress : Japanese Nuclear Data Committee/ FPND W.G.,
Japan Atomic Energy Research Institute,
Tokai-mura, Naka-gun, Ibaraki-ken, Japan.

Names : S. Iijima, M. Kawai, T.Murata (Nippon Atomic Industry Group Co.)
S. Igarasi, T. Nakagawa, Y. Kikuchi, Z. Matumoto, H. Nishimura (JAERI)
H. Matsunobu (Sumitomo Atomic Energy Industries, Ltd.)
H. Sasaki (Mitsubishi Atomic Industries, Inc.)
T. Aoki (Fuji Electric Co.)
K. Maki (Hitachi Ltd.)
T. Watanabe (Kawasaki Heavy Industries)
I. Otake, A. Zukeran (PNC)
R. Nakasima (Hosei Univ.)

1. Compilation : Level scheme and neutron cross section.
Se-82, Br-81, Kr-(83,84,85,86), Rb-(85,87), Sr-(88,89,90), Y-(89,91), Zr-(90,91,92,93,94,95,96), Nb-(93,95), Mo-(95,96,97,98,100), Tc-99, Ru-(100,101,102,103,104,106), Rh-(103,105), Pd-(104,105,106,107,108,110), Ag-(107,109,110m), Cd-(110,111,112,113), Te-(127m,128,129m, 130), I-(127,129,131), Xe-(131,132,133,134,135,136), Cs-(133,134,135,137), Ba-(138,140), La-139, Ce-(140,141,142,144), Pr-(141,143), Nd-(142,143,144,145, 146,147,148,150), Pm-(147,148m,148g), Sm-(147,148,149, 150,151,152,154), Eu-(151,153,154,155), Gd-(155,156,157).

Purpose : For evaluation of neutron cross sections.

Source : Recent literatures and Nuclear Data Sheet (level scheme).
CINDA and NEUDADA (neutron cross section).

Deadline of literature coverage : Mid 1976

Computer file of compiled data :
A modified file based on ORNL nuclear structure data file (level scheme, under test).
NESTOR file (cross section).

Completion date : Completed (Aug. 1977)

Recent publications :

1. H. Matsunobu and T. Watanabe, Compilation of measured capture cross sections for JENDL FPND file, JAERI-M 7568 (1978)

2. Z. Matumoto, T. Murata and R. Nakasima, Level scheme for some fission product nuclides. Comparison of level schemes used by JAERI and Petten, JAERI-M report (to be published)

2. Evaluation : Neutron cross sections of Nd isotopes

Purpose : For entry to JENDL-2

cont'd

JAPAN

cont'd

Method : Calculation with spherical optical model and statistical theory. Single and multi-level BW formula in thermal and resonance regions. Optical model parameters will be determined by SPRT method. Local systematics of level density parameters, etc. will be utilized as fully as possible.

Source : NEUDADA, CINDA, BNL-325 3rd ed., and the present compilations of level scheme and cross sections.

Deadline of literature coverage : End of 1977

Status : Stated from April 1978.

Other relevant details :
The evaluation for 68 nuclides was completed in Aug. 1977, and the file is available from NEA Data Bank. Integral test is in progress using STEK reactivity data and CFRMF activation data. The present evaluation of Nd-isotopes is the first part of complete re-evaluation program.

Computer file of evaluated data : JENDL (ENDF/B-4 format)

Expected completion dat : Fall, 1978

Discrepancies encountered :
Summarized in No. 4 of publication list.

Recent publications :

3. S. Iijima et al., J. Nucl. Sci. and Technol. 14 161 (1977)

4. S. Iijima, Review paper No. 9, IAEA Second Advisory Group Meeting on Fission Product Nuclear Data, Petten, 5-9 September 1977

JAPAN

Japanese Nuclear Data Committee / Decay Heat Nuclear Data Working Group

R. Nakasima (Hosei University) group leader
M. Yamada (Waseda University),
T. Tamai (Kyoto University)
I. Otake and A. Zukeran (Power Reactor and Nuclear Fuel Development Corp.)
S. Iijima, T. Murata, T. Yoshida and M. Iida (Nippon Atomic Industry Group Co.)
T. Hojuyama (Mitsubishi Atomic Power Industry)
K. Umezawa, T. Tasaka, Z. Matumoto and T. Tamura (Japan Atomic Energy Research Institute)
M. Akiyama (University of Tokyo)
T. Yamamoto (Tohoku University)

1. Compilation: Decay data and delayed neutron data
Purpose: For summation calculation of decay heat
Major Sources of Information: Journals, Nuclear Data Sheets and ENSDF
Deadline of Literature Coverage: None
Cooperation: None
Computer File: Nuclear structure data file NDFILE and retrieval program ABEG. ORNL Evaluated Nuclear Structure Data File, ENSDF.
Expected Completion Date: Continuous compilation
Publication: in plan

2. Evaluation: Estimation of decay and delayed neutron data
Sensitivity study for decay heat
Purpose: Making more reliable estimation of released beta and gamma energies for short-lived fission products
Estimation of delayed neutron emission probability
Estimation of the effects of experimental errors in decay data
Method: Application of gross theory of beta decay
Search and use of systematics
Major Sources of Information: Own compiled data
Deadline of Literature Coverage: None
Status: Estimation of released beta and gamma energies completed, but minor correction required
Estimation of delayed neutron emission probability almost completed, but quite preliminary
Computer program for sensitivity studies in preparation
Cooperation: None
Computer File of Evaluated Data: in plan
Discrepancy Encountered: Gamma ray assignments in the case of beta decays of both the ground and isomeric states, for example Rb-90
Intensity of the ground state beta
Publication: T. Yoshida, Nucl. Sci. Eng. 63 (1977) 376

NETHERLANDS

Laboratory and address
Netherlands Energy Research Foundation (ECN)
Petten (N.H.), The Netherlands.
Telephone: (02246) - 6262, telex: 57211 reacp nl

Names
J.W.M. Dekker, H. Gruppelaar, R.J. Heijboer and A.J. Janssen

Evaluation
(1) RCN-2 evaluation of neutron cross sections (σ_t, σ_e, $\sigma_{n\gamma}$, $\sigma_{nn'}$-matrix, σ_{n2n}) for about 60 fission products in the energy range of 10^{-3} eV to 15 MeV, in KEDAK type format, for the following elements, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, Te, I, Xe, Cs, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb.
(2) Generation of group cross sections for fast reactor calculations based on RCN-2 evaluation in the 26 group ABBN scheme with a fast reactor flux weighting spectrum and error files for capture group constants, including 26×26 covariance matrices.
(3) Adjustment of capture group constants based on (2) and integral STEK+CFRMF measurements.
(4) Generation of an adjusted point cross sections library based on STEK+CFRMF integral data.

Purpose
Fast breeder power reactor data needs.

Method
Calculation with multilevel Breit-Wigner formula, optical model and revised statistical model, taking into account all available experimental information.

Major sources of information
BNL-325, NEUDADA, CINDA, Nuclear Data Sheets, recent literature, integral data mainly from STEK and CFRMF.

Status
(1-3) Completed and published for 34 isotopes; nearly finished: Nd-isotopes and ^{147}Pm; planned for 1978: Eu-isotopes; planned for 1980: 25 other isotopes.
(4) In progress, completed 1979-1980.

Computer file
(1) KEDECN, KEDAK type format (co-operation with Dr. B. Goel, KfK, Karlsruhe), has been sent to NEA Data Bank at Saclay.

Completion date
1979/1980.

Recent publications
(1) H. Gruppelaar, Tables of RCN-2 fission-product cross section evaluation, part 1 (24 nuclides), ECN-13 (1976) and part 2 (13 nuclides), ECN-33 (1977).
(1,3) H. Gruppelaar, Impact of integral measurements on the capture cross sections evaluations of individual fission product isotopes, ECN-24 (1977).
(2,3) J.W.M. Dekker, Tables and figures of adjusted and unadjusted capture group cross sections based on the RCN-2 evaluation and integral measurements in STEK, part 1, ECN-14 (1977) and part 2, ECN-30 (1977).
(2,3) J.W.M. Dekker and H.Ch. Rieffe, Adjusted capture cross sections of fission-product nuclides from STEK reactivity worths and CFRMF activation data, ECN-28 (1977).

(3) M. Bustraan, J.W.M. Dekker, R.J. Heijboer and A.J. Janssen.
Integral determination of fission product neutron capture cross sections for application in fast reactors, ECN-27 (1977).

TURKEY

Laboratory and address:	Hacettepe University Department of Physics, Ankara Middle East Technical University Department of Chemistry, Ankara
Names:	G.Yener, Ö.Birgül, N.K.Aras

Evaluation:

Purpose:	Evaluation of total kinetic energies of fragments and kinetic energy deficit in spantaneous fission of Cf-252
Method:	The kinetic energies of the fragments were calculated from experimental ranges in aluminum by using LSS theory of Range-Energy relations. From kinetic energy distribution total kinetic energy released and kinetic energy deficit were obtained.
Major Sources:	The ranges measured previously by the same group.
Compilation Date:	1977
Relevant Details:	Total kinetic energy curve had a sharp rise around masses A=131,132 indicating strong closed shell effect on low energy fission.This lead to a kinetic energy deficit of 19 MeV which is in agreement with the earlier result, 16 MeV obtained in this laboratory.
Recent Publication:	G. Yener, Ö.Birgil and N.K.Aras " Ranges and Kinetic Energies of Fragments From Spantaneous Fission of Cf-252" accepted to Nuclear Physics.in May1978

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x Present Address: Ege University
Nuclear Research and Training Institute
Bornova, İzmir
Turkey

- cont'd-

TURKEY

-cont'd-

Results:

A	TKE (MeV)
95	180.67
97	172.73
99	175.14
103	183.20
105	182.84
115	195.03
131	205.94
132	207.47
133	207.85
135	202.84
140	196.37
141	197.18
142	194.34
143	190.20
147	186.27
149	192.04
153	175.52

Laboratory and Address:	AERE Harwell	UKAEA AERE, Harwell, Oxfordshire, OX11 ORA
Name:	E.A.C. Crouch	
Compilation:	Chain, Cumulative and Independent fission product yields for all neutron induced fission reactions with neutrons of energy up to 14 MeV, including spontaneous fission. Ongoing compilation.	
Purpose:	Basic data for fission yield evaluation.	
Sources:	Journals, Proceedings of Learned Societies, or other open literature, Project reports if the work is complete but unlikely to be published.	
Deadline:	No results prior to 1950 are collected.	
Cooperation:	We are prepared to exchange files with other groups.	
Computer File:	Information held in standard forms on Computer Files.	
Completion Date:	Continuous compilation.	
Publications:	AERE R6642 'A library of neutron induced fission product yields maintained and interrogated by computer methods'. 'Part I: The establishment of the library'. E.A.C. Crouch, December 1970. AERE R7207 'A library of neutron induced fission product yields maintained and interrogated by computer methods'. 'Part II: The interrogation of the library'. E.A.C. Crouch, August 1972. Fission Product Yields from Neutron-Induced Fission - E.A.C. Crouch. Atomic Data and Nuclear Data Tables, Vol. 19, 5, May 1977. (Contains experimental values and adjusted values after fitting to conservation laws.)	

Laboratory and Address:	AERE Harwell	UKAEA AERE Harwell Oxfordshire OX11 ORA
Name:	E.A.C. Crouch	
Evaluation:	(1) Neutron induced fission product yields for all fissile nuclides at neutron energies up to 15 MeV; chain yields and independent yields. (2) Adjustments of the chain yields and the calculated independent yields to force agreement with the conservation laws i.e. to form a 'consistent set'.	
Purpose:	UKND File to be used in Reactor design and operation.	
Method:	(1) The individual yields for a given reaction (both chain and independent), are examined, weighted and the means calculated together with the errors. (2) The evaluated yields are augmented by interpolation to fill missing values or in the case of independent yields by calculation based on parameters estimated from known values. The results are fitted by least squares to the conservation conditions to give adjustments for chain yields and independent yields. Now proceeding - the fitting of conservation laws and the equality of yields of complementary elements.	
Sources:	Compilation mentioned above.	
Deadline:	No results prior to 1950 are collected. Compilations believed to be complete up to end 1975, some 1976 results included.	
Status:	Evaluation and Consistent set complete at January 1977. Further development continuing.	
Co-operation:	We are prepared to exchange files with other groups.	
Computer Files of Compiled Data:	Compilation as above.	
Computer File of Evaluated data:	Magnetic tape or punched cards of the consistent set in ENDF/BIV format.	
Discrepancies found:	Files are compared with those of B.F. Rider and discrepancies found are resolved.	
Publication:	Fission Product Yields from Neutron-Induced Fission. E.A.C. Crouch. Atomic Data and Nuclear Data Tables, vol. 19, 5, May 1977.	

UNITED KINGDOM

Laboratory and Address:	AERE Harwell	UKAEA AERE, Harwell, Oxfordshire OX11 ORA
Working Group:	B.S.J. Davies) A. Tobias)	CEGB Berkeley Nuclear Laboratories
	J.R. Parkinson	BNFL Windscale
	M.F. James) A.L. Nichols)	AEE Winfrith
	D.G. Vallis	AWRE Aldermaston
	G. Evangelides	Imperial College, London

Ongoing and planned activities:

1) Compilation & evaluation:

Radionuclide decay data

purpose: to provide a comprehensive, updated data file of radioactive decay data, including half-lives, Q-values, branching ratios, mean α, β and γ energies and intensities, with associated uncertainties.

progress: the FPND set, formed by merging the data of A. Tobias with the U.S. ENDF/B-IV decay data file, has been tested against a number of recent bench-mark decay heat measurements. The yield data used was that due to Crouch (Atomic Data and Nuclear Data Tables, 19, 5,1977). Agreement between calculation and experiment was found to be somewhat better than that reported for calculations based upon the US ENDF/B-IV data. The file is being updated on the basis of recent literature, Nuclear Data Sheets and the mass-chain evaluation file in ENSDF format. New data for some 80 nuclides will be available by June 1978.

2) Decay scheme calculations

purpose: to compare experimental data with decay data calculated from a more basic data set (e.g. U.S. ENSDF file), and to produce mutually consistent catalogues of emission data for different radiation types.

progress: the CASCADE code can now handle decay by neutron or proton emission and is able to account for any fraction of the parent isotope decaying by spontaneous fission. Output data can now be catalogued according to user requirements. E.g. ordered lists may be produced according to:

1. Half-life
2. Decay energy
3. Decay type; half-life
4. Decay type; decay energy
5. Z,A, state; decay energy
6. Decay type; Z,A, state; decay energy

etc.

Input data is taken from NSDF or ENSDF compilations.

co-operation: Mr. George Evangelides,
Department of Chemical Engineering and Chemical Technology,
Nuclear Technology Section,
Imperial College,
London, S.W.7.

expected completion date: late 1978

U.S.A.

Laboratory and address:		General Electric Company, Vallecitos Nuclear Center, P. O. Box 460, Pleasanton California 94566 U.S.A.
Name	:	B. F. Rider
Compilation	:	Fission product yields (from thermal, fast, 14 MeV neutron-induced fission in U, Pu, Th, Np, and Cf nuclides.
Purpose	:	For burnup and fission rate and decay heat calculations. Basis for ENDF/B-V FP yields.
Sources	:	CINDA, Nuclear Science Abstracts, INIS Atomindex, Correspondence
Deadline	:	May 31, 1978
Cooperation	:	Brookhaven National Laboratory, Cross-Section Evaluation Working Group (CSEWG), Evaluated Nuclear Data File (ENDF/B-V), Fission Product Decay Heat Task Force, Fission Yield Subcommittee.
Details	:	Approximately 18,000 entries from 1030 references.
Computer File	:	Tape available as ENDF/B-V from The USA National Nuclear Data Center, Brookhaven National Laboratory Upton, New York 11973, USA
(expected) completion Date	:	June, 1978
Publications	:	"Compilation of Fission Product Yields", NEDO-12154-2E (1978) available from General Electric Company, P. O. Box 460, Pleasanton, California 94566, USA, ATTN: B. F. Rider

U.S.A.

Laboratory and address:	Idaho National Engineering Laboratory EG&G Idaho, Inc. P.O. Box 1625 Idaho Falls, Idaho 83401 USA
Names:	C.W. Reich, R.L. Bunting, R.G. Helmer, M.A. Lee
Compilation:	Decay data for fission products. Quantities treated include: T1/2; Qβ; branching fractions for the various decay modes; energies and intensities of all emitted radiations (e.g. β, γ, c.e., x-ray); K-, L- and total ICC; delayed-neutron energy spectra for individual precursors; uncertainties in all measured values.
Purpose:	Decay data file for ENDF/B.
Major sources of information:	Nuclear Data Sheets, journals and preprints of recent work.
Deadline of literature coverage:	Ongoing. For Version V of ENDF/B, cut-off date is Sept. 1977.
Computer File:	Decay data are included in ENDF/B Fission Product File. Tapes available through normal ENDF/B procedures.
Publications:	C.W. Reich, R.G. Helmer and M.H. Putnam, "Radioactive-Nuclide Decay Data for ENDF/B", U.S. AEC Report ANCR-1157 (ENDF/210), (1974).

U.S.A.

(same as in INDC(NDS)-86)

Laboratory and Address:

University of California
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545

Names:

T. R. England
R. J. LaBauve
D. G. Madland
M. G. Stamatelatos
W. B. Wilson

Compilations:

A) Nuclide Parameter Evaluated Compilations

1) β and γ decay energies, branching fractions [decay and (n,γ)], halflives, Q-values and cross sections for 824 fission products are tabulated in Ref. 1. This is a basic data set that includes the major types of parameters, with corrections, from ENDF/B-IV, except for yields and the energy dependence of cross sections.

This reference data was compiled in cooperation with R. E. Schenter of the Hanford Engineering Development Laboratory, P. O. Box 1970, Richland, Washington 99352.

2) Multigroup β and γ spectra are tabulated in Ref. (2) for 180 fission product nuclides. The β spectra are given in 75 groups and the γ spectra in 150 groups. These data are based on ENDF/B-IV.

3) Multigroup cross sections are compiled in Ref. 11.

B) Evaluations

1) Yield distribution (pairing effects) and branching to isomeric states are evaluated and modeled in Ref. 3 and 4. Estimated values from the modeling are also included in these references.

2) Ternary fission is evaluated and compiled in Ref. (5).

3) β and γ spectra, decay heating and absorption buildup are evaluated by comparison with experiment in Ref. 6-11.

C) Purpose

Research by the Los Alamos nuclear data group (t-2) is directed at improvement in the national data file ENDF/B and at the use of these data in, e.g., determining a new decay heat standard.

References

1. T. R. England and R. E. Schenter, "ENDF/B-IV Fission Product Files: Summary of Major Nuclide Parameters," Los Alamos Scientific Laboratory report LA-6116-MS [ENDF-223] (Oct. 1975).

2. T. R. England and M. G. Stamatelatos, "Multigroup Beta and Gamma Spectra of Individual ENDF/B-IV Fission-Product Nuclides," Los Alamos Scientific Laboratory report LA-NUREG-6622-MS (Dec. 1976).

3. D. G. Madland and T. R. England, "The Influence of Pairing on the Distribution of Independent Yield Strengths in Neutron-Induced Fission," Los Alamos Scientific Laboratory report LA-6430-MS [ENDF-240] (July 1976).

4. D. G. Madland and T. R. England, "Distribution of Independent Fission-Product Yields to Isomeric States," Los Alamos Scientific Laboratory report LA-6596-MS [ENDF-241] (Nov. 1976).

5. D. G. Madland and Leona Stewart, "Light Ternary Fission Products: Probabilities and Charge Distributions," Los Alamos Scientific Laboratory report LA-6783-MS [ENDF-247) (April 1977).

6. D. G. Foster, Jr. and T. R. England, "Time-Dependent Spectra of Photons and Spontaneous-Fission Neutrons for Applied Problems," Invited Paper, Trans. Am. Nucl. Soc. 23, 551 (1976).

7. T. R. England and M. G. Stamatelatos, "Beta and Gamma Spectra and Total Decay Energies from Fission Products," Trans. Am. Nucl. Soc. 23, 493 (1976).

8. M. G. Stamatelatos and T. R. England, "Fission-Product Gamma-Ray and Photoneutron Spectra and Energy-Integrated Sources," NUREG-0155 [LA-NUREG-6345-MS] (Issued Dec. 1976) (See also Addendum 1, March 1977).

9. R. J. LaBauve, T. R. England, M. G. Stamatelatos, and D. G. George, "Approximations to Summation Calculations of Delayed Energy and Spectra," Los Alamos Scientific Laboratory report LA-6684-MS (Jan. 1977).

10. M. G. Stamatelatos and T. R. England, "Short Irradiation Fission-Product Beta Spectra and Total Energy: Calculations Versus Experiment," (ANS Summary accepted for ANS Annual Meeting June 12-17, 1977).

11. T. R. England, W. B. Wilson, and M. G. Stamatelatos, "Fission-Product Data for Thermal Reactors
Part 1
A Data Set for EPRI-CINDER Using ENDF/B-IV
Part 2
Users Manual for EPRI-CINDER Code and Data" Los Alamos Scientific Laboratory reports LA-6745-MS and LA-6746-MS (Dec. 1975) [To be issued by EPRI ~ March 1977].

LABORATORY AND ADDRESS:

University of California
Los Alamos Scientific Laboratory
P O Box 1663
Los Alamos, New Mexico 87545 (USA)

NAMES:

T. R. England
R. J. LaBauve
W. B. Wilson

COMPILATION:

Library of processed 154-group ENDF/B-IV fission_product reaction cross sections.

PURPOSE:

Data file of multigroup values (10^{-5} eV-20 MeV) for use in collapsing to few-group values.

MAIN SOURCE OF INFORMATION:

ENDF/B-IV Fission-Product Data File

OTHER RELEVANT DETAILS:

Cross sections were processed into the Power Reactor Studies (PRS) 154-group structure described in Ref. 1 and 2, using the PRS Neutron Flux Weighting Function described in Ref. 1. Cross sections were processed at 900 or 1000 K at infinite dilution. A total of 181 nuclides are described with total, elastic, total inelastic, and radiative capture multigroup values. Additional neutron absorption reaction cross-section tabulations are given for 36 of the nuclides. A total of 960 multigroup cross-section tabulations are included in the data file, which is issued with a companion collapsing code TOAFEW.

COMPUTER FILE:

The data file and collapsing code are available from the Radiation Shielding Information Center, Oak Ridge National LAboratory, P O Box X, Oak Ridge, Tennessee 37830 (USA).

REFERENCES:

1. W. B. Wilson, T. R. England, and R. J. Labauve, "Multigroup and Few-Group Cross Sections for ENDF/B-IV Fission Products; the TOAFEW Collapsing Code and Data File of 154-Group Fission-Product Cross Sections," Los Alamos Scientific LAboratory report LA-7174-MS (March 1978).

2. R. J. LaBauve and W. B. Wilson, "Proposal to Extend CSEWG Neutron and Photon Multigroup Structures for Wider Applications," Los Alamos Scientific Laboratory report LA-6240-P (February 1976).

3. T. R. England, W. B. Wilson, and M. G. Stamatelatos, "Fission Product Data for Thermal Reactors, Part 1: A Data Set for EPRI-CINDER Using ENDF/B-IV," Los Alamos Scientific Laboratory report LA-6745-MS (December 1976); "Fission Product Data for Thermal Reactors, Part 2: Users Manual for EPRI-CINDER Code and Data," Los Alamos Scientific Laboratory report LA-6746-MS (December 1976). (Also published as Electric Power Research Institute reports EPRI-NP-356, Part 1 and Part 2 [December 1976]).

Laboratories	Washington University, Dept. of Chemistry, St. Louis, MO., USA Los Alamos Scientific Laboratory, Group CNC-11, Los Alamos, NM USA
Names	A. C. Wahl and K. Wolfsberg
Compilation and Evaluation	Independent yields and other data related to nuclear charge distribution in fission are being compiled and evaluated for low-energy fission processes (excitation energies up to ~ 20 MeV).
Purpose	Development of systematics that will allow reliable estimates to be made for unmeasured independent yields and that will increase understanding of the fission mechanism.
Sources	Journals, reports, preprints, and personal communications
Method	Data from various types of measurements are compared for evaluation of the reliability of the newer methods.
Cooperation	We are prepared to exchange files with other groups.
Computer File	Information is held in standard forms on computer files.
Completions	Continuous compilation
Publications	A. C. Wahl, A. E. Norris, R. A. Rouse, and J. C. Williams, in Proceedings of the Second International Atomic Energy Symposium on Physics and Chemistry of Fission, Vienna, Austria, 1969 (I.A.E.A.), p. 813. K. Wolfsberg, Los Alamos Scientific Laboratory Report No. LA-5553-MS (1974). A. C. Wahl, "Nuclear-Charge Distribution in Fission - Investigation of Systematics and Methods of Estimation of Independent Yields," Contribution to IAEA Petten Panel on Fission Product Nuclear Data - Sept., 1977. To be published in INDC(NDS)-87 (1978).

III. RECENT PAPERS RELATED TO FPND

The papers listed below refer to activities relative to FPND which are not covered by the contributions contained in this issue. They are sorted according to

1. Fission yields
2. Neutron reaction cross sections
3. Decay data
4. Delayed neutron data
5. FP decay heat
6. FP data reviews

first, and then alphabetically by reference.

Completeness of this Section has not yet been attempted.

1. Fission yields

Charge distributions in ^{235}U, ^{233}U and ^{239}Pu low energy fissions: A tabulation by the partial equilibrium model.

U. Facchini, G. Sassi:
Doc. Cec. (78) 1 (1978) (CNEN Bologna report series).

Cumulative and independent yields of krypton and xenon isotopes from reactor neutron induced fission of ^{232}Th.

T. Izak-Biran, S. Amiel:
J. Inorg. Nucl. Chem. 40 (1978) 757.

Distribution of fission yields for fission spectrum neutron-induced fission of ^{238}U.

D.C. Harris, J.N. Beck, W.L. Raines, J.T. Harvey, K.G.W. Inn, J.L. Meason, H.L. Wright:
Nucl. Scie. & Engg. 63 (4) 504 (1977).

Independent isomeric yield ratio of ^{148}Pm in fission of the moderately excited ^{236}U compound nucleus as a measure of fragment angular momentum.

D.C. Aumann, W. Gückel, E. Nirschl, H. Zeising:
Phys. Rev. C 16 (1) 254 (July 1977).

Fission yields from ^{235}U and ^{239}Pu irradiated in the BOR-60 reactor.

V. Ya. Gabeskiriya et al:
Soviet Atomic Energy 43 (1) 670 (Jan. 1978)

[Chain yields for A = 135, 137, 140, 142-146, 148, 150].

2. Neutron reaction cross sections

Evaluated neutron cross sections for zirconium and hafnium. Final report.

M.K. Drake, D.A. Sargis, T. Maung:
EPRI-NP-250 (PB-261828) (Nov. 1976).

Total neutron cross sections of lanthanum and praseodymium in the energy range from 20 to 240 keV.

K. Nishimura, Y. Yamanouti, S. Kikudu, T. Nakagawa:
JAERI-M-6883 (Jan. 1977) [La-139, Pr-141].

Neutron capture cross-section measurements of ^{99}Tc up to 80 keV.

R.C. Little, R.C. Block
Trans. Am. Nucl. Soc. 26 (1977) 574.

3. Decay data

Evaluation of gamma-ray intensities.

Y. Yoshizawa, H. Inoue, M. Hoshi, K. Shizuma, Y. Iwata:
JAERI-M-7567 (Jan. 1978) [for 19 nuclides, among them: Nb-95, Zr-95, Cs-134, Cs-137, Ce-144, Pr-144].

Decay properties of some neutron-rich cerium isotopes.

T. Björnstad, E. Kvåle, G. Skarnemark, O. Aronsson:
J. Inorg. Nucl. Chem. 39 (1977) 1929.

Investigations of nuclear structure of the fission products ^{97}Sr, ^{97}Zr, ^{99}Zr and ^{99}Nb. (Thesis, in German)

H.A. Selič:
JUL-1431 (June 1977).

Total β–decay energies and masses of tin, antimony, and tellurium isotopes in the vicinity of $^{132}_{50}Sn_{82}$.

E. Lund, K. Aleklett, G. Rudstam:
Nucl. Phys. A286 (1977) 403.

Studies of ^{132}Sn and ^{133}Sb.

K. Sistemich, W.D. Lauppe, T.A. Khan, H. Lawir, H.A. Selič:
ZFK–336: Int. Symposium on High Spin States and Nuclear Structure, Dresden, 19–24 September 1977.

The β–decay of ^{100}Y: Discovery of a very low lying 0^+ state in ^{100}Zr.

T.A. Khan, W.D. Lauppe, K. Sistemich, H. Lawin, G. Sadler, H.A. Selič:
Z. Phys. A283 (1977) 105

Investigation of the neutron rich nuclei ^{108}Rh and ^{109}Pd.

H. Bartsch, K. Huber, U. Kneissl, H. Krieger:
Z. Phys. A283 (1977) 199.

Total β–decay energies of heavy fission products.

F. Munnich, H. Schrader, K. Hawerkamp, R. Decker, B. Pfeiffer, H. Wollnik, E. Monnand, F. Schussler:

Z. Phys. A285 (1978) 287 [$^{144, 145}Ba$, $^{144,145,147}La$, $^{145,147,148}Ce$, ^{148}Pr].

4. Delayed neutron data

Delayed neutron emission probabilities for Rb and Cs isotopes.

G. Engler, E. Ne'eman, S. Shalev, Y. Nir–El, M. Shmid:
IA–1338 (1976) (Israel AEC Progress report).

[direct determination, P_n and half–lives given]

Delayed neutron yield calculations for the neutron–induced fission of ^{235}U as a function of the incident neutron energy.

D.R. Alexander, M.S. Krick:
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[the calculations are based on evaluations by Tomlinson and Wahl et al.].

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Decay heat from products of ^{235}U thermal fission by fast-response boil-off calorimetry.

J.L. Yarnell, P.J. Bendt:
LA-NUREG-6713 (September 1977).

A review of short-term fission-product-decay power.

M.A. Bjerke, J.S. Hohn, M.R. Shay, B.I. Spinrad:
Nuclear Safety 18 (5) 596 (Oct. 1977).

6. FP data review

Status of fission-product data for absorption calculations.

W.B. Wilson, T.R. England:
LA-UR-78-1452 (1978).

IV. MEETINGS ON FPND

IAEA Advisory Group Meeting on Fission Product Nuclear Data

ECN Petten, Netherlands

5-9 September 1977

The Second Advisory Group Meeting on Fission Product Nuclear Data was convened by the Nuclear Data Section (NDS) in Petten, Netherlands, from 5-9 September 1977. This was a follow-up meeting of the first Panel on the same subject which had been organized by IAEA/NDS in Bologna, Italy, in November 1973.

In the four years after the Bologna Panel, not only a considerable improvement of the knowledge and accuracy of FPND has been achieved, but also new requirements for FPND have emerged, partly as a result of sensitivity studies which have been performed in the meantime, partly because the accuracy limits have been changed, and partly because new nuclear technologies have been conceived or developed.

The Second Advisory Group Meeting on FPND was attended by 52 scientists from 13 countries and 3 international organisations. Fifteen comprehensive review papers and several contributed papers were presented and discussed at the meeting. Most of the conclusions and recommendations were worked out by subgroups which were formed to discuss specific data types. The principal results of this meeting were:

- the development of FPND application fields has been assessed, as well as the status of the data themselves;
- the importance of individual fission products in the various fields of applications and for the different existing calculation methods has been defined;
- detailed lists of requirements for FPND were issued, reflecting the present status of knowledge;
- priorities of requirements have been agreed, and technical recommendations about the best way of fulfilling the requirements were made;
- ways of improved cooperation and intercommunication between data users, measurers and evaluators have been recommended.

The Proceedings of the Second Advisory Group Meeting on FPND, including the review papers and the conclusions and recommendations, will be published as Technical Report IAEA-213, probably in August 1978. In addition, it is intended to publish annexes to review papers and selected contributions in the report INDC(NDS)-87.

The Table of Contents of the Proceedings and a list of participants are given below.

Table of Contents of the Proceedings

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Petten, Netherlands
5-9 September 1977

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IAEA Consultants' Meeting on Delayed Neutrons

Vienna, March 1979

Uncertainties in delayed neutron yields, periods and spectra have been a long-term concern in the development of fission-energy systems. This has been recognized with a number of measurement programs that have provided a wealth of new information in the last year.

In order to review the progress achieved by these measurements, the Nuclear Data Section of the IAEA, in accordance with the recommendation issued by the International Nuclear Data Committee (INDC) at its 9th Meeting in May 1977, is planning to hold a small Consultants' Meeting on Delayed Neutron Properties at IAEA Headquarters in Vienna, March 1979.

Objectives

The meeting should bring together 10–15 specialists to achieve the following objectives:

- review the current requirements for delayed neutron data with special emphasis on energy applications;
- review and discuss the status of delayed neutron data and, in particular, try to resolve the existing discrepancies in experimental data;
- formulate specific recommendations for necessary future work and its coordination.

Organization

The meeting will be organized around two sets of review papers covering delayed neutron data requirements for energy applications and the status of integral and differential delayed neutron data, respectively. In addition to the review papers the presentation of contributed papers, especially on recent experimental results, would be welcome.