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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

HANDBOOK

OF

NUCLEAR DATA FOR SAFEGUARDS

N. Kocherov, M. Lammer, O. Schwerer

Nuclear Data Section
International Atomic Energy Agency
Vienna, Austria

December 1997

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

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ABSTRACT

This handbook contains nuclear data needed by safeguards users for their work. It was initiated by an IAEA Working Group. The contents were defined by the replies to a questionnaire sent to safeguards specialists, and restricted by the availability of evaluated nuclear data. This revised edition was updated after review of the preliminary issue by safeguards and nuclear data experts and when updates of nuclear data libraries were released.

The handbook contains the following basic nuclear data:

actinides:
- nuclear decay data
- thermal neutron cross sections and resonance integrals
- prompt neutron data
- delayed neutron data

fission products:
- nuclear data
- thermal neutron capture cross sections and resonance integrals

fission product yields

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FOREWORD

This handbook was initiated by an IAEA working group, and the contents were defined by the replies to a quiestionnaire sent to safeguards experts, as outlined in the preliminary edition (INDC(NDS)-248, June 1991; see in particular Appendix A). The preliminary edition of the handbook was distributed to safeguards and nuclear (and other) data specialists for review.

The replies and comments on the preliminary edition received from experts did not contain major changes or suggestions for new sources of nuclear and other data. Therefore we waited with the update of the handbook until revisions and updates of the major data files and other sources of nuclear data became available.

This edition contains no additional tables. The data have been revised in accordance with suggestions and comments received from experts and the latest available nuclear data. Again, each set of tables is preceded by explanations, information on the data selection, the sources of data used and the availability of complete data files. The Handbook is also available in a PC version, which was used for updating the handbook, and which can be obtained on diskette in a slightly different format from the Nuclear Data Section (see introduction for the address).

Acknowledgement

We would like to thank S. Aung, M.M. Seits and M. O'Connell, who have helped to produce the preliminary as well as the final version of the handbook, and G. Pospischil who has written the PC code for the handbook on diskette.

Contact

Scientists who wish to be included in the distribution list for this handbook, should contact M. Lammer at the address given below. Then they will also automatically receive all later revisions and amendments to the handbook. Any mistakes found, comments or suggestions for additions should also be communicated to this address.

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INTRODUCTION

This handbook contains recommended values of nuclear data needed for the development and application of safeguards nuclear materials accounting techniques. We have included only those data that were requested by safeguards users and which were readily available to us. The data given are grouped in 3 sections: **Section A** contains decay data, thermal neutron cross section data, resonance integrals and data on neutron emission in fission for actinide isotopes. **Section B** contains decay data and thermal neutron cross section data of fission product nuclides. **Section C** contains fission product yield data.

We have used the following criteria for selecting the data for the handbook: When available, we have generally given preference to data recommended by international committees or working groups. When such data were not available or superseded by more recent values, generally available data files were used. When different values were found in different data files, we have given preference to data with uncertainties, or to the most recent suitable values. In the case of fission yield data, a group of specialists recommended not to give a single "best" data set; considering the different existing views on data evaluation methods in this case, two data sets have been included.

Introductory pages to the data tables give further explanations, arguments for the selection of the recommended values (special remarks are given in footnotes), references of the sources of data and information on the availability of larger or complete data sets that are not included in the handbook.

Users of this handbook who wish to receive complete data files, can either request them on magnetic tape or PC diskette from one of the four regional Nuclear Data Centres, or use their on-line services for direct retrieval of some of the data files. Further information can be obtained from the Nuclear Data Centres (see their addresses below).

The handbook is also available as a PC version 'SGNucDat' from the IAEA Nuclear Data Section (see address below) together with guidelines for its use. It can be used to display the data contained in the handbook, and to perform data searches, selections and different sortings, on a PC or laptop.

For USA and Canada:

National Nuclear Data Center
Brookhaven National Laboratory
P.O. Box 5000
Upton, N.Y. 11973-5000
USA
INTERNET: SERVICES@BNL.GOV

For other OECD countries:

NEA Data Bank
Le Seine Saint-Germain
12 Blvd. des Isles
F-92130 Issy-les-Moulineaux
FRANCE
INTERNET: NEA@NEA.FR

For former USSR countries:

Centr po Jadernym Dannym
Fiziko-Energeticheskij Institut
Ploschad Bondarenko
249020 Obninsk, Kaluga Region
RUSSIA
INTERNET: MANOKHIN@CJD.OBNINSK.SU

For all other countries:

IAEA Nuclear Data Section
P.O. Box 100
A-1400 Vienna
AUSTRIA
INTERNET: SERVICES@IAEAND.IAEA.OR.AT

SECTION A: ACTINIDE NUCLEAR DATA

A-1: Half-lives and decay branching fractions

Description of table entries:

decay mode:	α	alpha decay	IT	isomeric transition
	β-	beta decay	SF	spontaneous fission
	ec	electron capture	T	total half-life

units:	s	second	d	day
	m	minute	y	year = 365.2422 days
	h	hour		

rel err: relative 1σ uncertainty (in %)

branching: given for each decay mode (should sum up to 100%)

exponents: read E±n as $10^{\pm n}$

Source of data:

The tabulated data have been extracted from a data set recommended by participants of an IAEA Co-ordinated Research Programme (CRP). The complete data set is published in: IAEA Technical Report Series No. 261 (STI/DOC/10/261), pp.154-159 (1986).

The data were revised in October 1997. Updated values of half-lives and branching ratios were taken from the ENSDF file, revision of May 1997, and the compilation by R.B. Firestone and V.S.Shirley (Ed.) "Table of Isotopes", 8th edition, New York, J.Wiley & Sons,Inc.,1996.

Table A-1

nuclide	decay mode	units	half-life value	rel err	branching (percent/decay)
81-Tl-208	ß-	m	(3.053 ± 0.004) E+00	(0.13)	
82-Pb-212	ß-	h	(1.064 ± 0.001) E+01	(0.09)	*)
83-Bi-212	T	m	(6.055 ± 0.006) E+01	(0.1)	
	α	m	(1.685 ± 0.003) E+02	(0.18)	35.94 ± 0.06
	ß-	m	(9.452 ± 0.013) E+01	(0.14)	64.06 ± 0.06
86-Rn-220	α	s	(5.56 ± 0.01) E+01	(0.18)	
87-Fr-221	α	m	(4.9 ± 0.2) E+00	(4.1)	
88-Ra-224	α	d	(3.66 ± 0.04) E+00	(1.1)	
88-Ra-225	ß-	d	(1.49 ± 0.02) E+01	(1.4)	
88-Ra-226	α	y	(1.600 ± 0.007) E+03	(0.44)	
88-Ra-228	ß-	y	(5.75 ± 0.03) E+00	(0.52)	
89-Ac-225	α	d	(1.00 ± 0.01) E+01	(1.0)	
89-Ac-227	T	y	(2.177 ± 0.003) E+01	(0.14)	
	α	y	(1.578 ± 0.011) E+03	(0.7)	1.38 ± 0.01
	ß-	y	(2.207 ± 0.003) E+01	(0.14)	98.62 ± 0.01

nuclide	decay mode	units	half-life value	rel err	branching (percent/decay)
89-Ac-228	ß-	h	(6.15 ± 0.02) E+00	(0.33)	
90-Th-228	α	y	(1.912 ± 0.002) E+00	(0.1)	
90-Th-229	α	y	(7.34 ± 0.16) E+03	(2.2)	
90-Th-230	α	y	(7.54 ± 0.03) E+04	(0.4)	
	SF	y	1.98 E+18		3.8 E-12
90-Th-231	ß-	h	(2.552 ± 0.001) E+01	(0.04)	
90-Th-232	α	y	(1.405 ± 0.006) E+10	(0.43)	
	SF	y	>7.8 E+20		<1.8 E-09
90-Th-233	ß-	m	(2.23 ± 0.01) E+01	(0.45)	
90-Th-234	ß-	d	(2.410 ± 0.003) E+01	(0.12)	
91-Pa-231	α	y	(3.276 ± 0.011) E+04	(0.34)	
	SF	y	>2.05 E+17		<1.6 E-11
91-Pa-233	ß-	d	(2.697 ± 0.002) E+01	(0.37)	
91-Pa-234	ß-	h	(6.70 ± 0.05) E+00	(0.75)	
91-Pa-234m	ß-	m	(1.17 ± 0.03) E+00	(2.6)	99.84 ± 0.04
	IT	h	(1.5 ± 0.2) E+01	(10.)	0.16 ± 0.04
92-U -232	α	y	(6.89 ± 0.04) E+01	(0.72)	
	SF	y	(8. ± 6.) E+13	(80.)	(0.9 ± 0.7) E-10
92-U -233	α	y	(1.592 ± 0.002) E+05	(0.13)	
	SF	y	>2.7 E+17		<0.59 E-10
92-U -234	α	y	(2.457 ± 0.003) E+05	(0.12)	
	SF	y	(1.50 ± 0.08) E+16	(5.6)	(1.64 ± 0.02) E-09
92-U -235	α	y	(7.038 ± 0.005) E+08	(0.1)	
	SF	y	(1.01 ± 2.8) E+18	(30.)	(7.0 ± 0.21) E-09
92-U -235m	IT	m	(2.6 ± 0.2) E+01	(7.7)	
92-U -236	α	y	(2.342 ± 0.003) E+07	(0.13)	
	SF	y	(2.43 ± 0.07) E+16	(2.9)	(9.64 ± 0.03) E-08
92-U -237	ß-	d	(6.75 ± 0.01) E+00	(0.15)	
92-U -238	α	y	(4.468 ± 0.005) E+09	(0.11)	
	SF	y	(8.2 ± 0.1) E+15	(1.2)	(5.45 ± 0.07) E-05
92-U -239	ß-	m	(2.347 ± 0.005) E+01	(0.21)	
93-Np-236	T	y	(1.54 ± 0.06) E+05	(10.)	
	ß-	y	(1.23 ± 0.3) E+06	(20.)	12.5 ± 0.5
	ec	y	(1.76 ± 0.03) E+05	(2.4)	87.5 ± 0.5
93-Np-236m	T	h	(2.25 ± 0.04) E+01	(1.8)	
	ß-	h	(4.69 ± 0.13) E+01	(2.8)	48. ± 1.
	ec	h	(4.33 ± 0.11) E+01	(2.5)	52. ± 1.
93-Np-237	α	y	(2.14 ± 0.01) E+06	(0.47)	
	SF	y	>1. E+18		<2. E-10
93-Np-239	ß-	d	(2.355 ± 0.004) E+00	(0.17)	
94-Pu-236	α	y	(2.851 ± 0.008) E+00	(3.5)	
	SF	y	(2.081 ± 0.6) E+09	(20.)	(1.37 ± 0.07) E-07

nuclide	decay mode	units	half-life value	rel err	branching (percent/decay)
94-Pu-238	α	y	(8.77 ± 0.03) E+01	(0.34)	
	SF	y	(4.7 ± 0.2) E+10	(4.3)	(1.85 ± 0.04) E-07
94-Pu-239	α	y	(2.411 ± 0.003) E+04	(0.12)	
	SF	y	8.04 E+15		(3.0 ± 0.8) E-10
94-Pu-240	α	y	(6.563 ± 0.007) E+03	(0.11)	
	SF	y	(1.16 ± 0.04) E+11	(3.5)	(5.75 ± 0.05) E-06
94-Pu-241	ß-	y	(1.435 ± 0.01) E+01	(0.7)	
	α	y	(6.00 ± 0.05) E+05	(0.83)	(2.45 ± 0.02) E-03
94-Pu-242	α	y	(3.735 ± 0.011) E+05	(0.29)	
	SF	y	(6.8 ± 0.1) E+10	(1.5)	(5.54 ± 0.06) E-04
94-Pu-243	ß-	h	(4.956 ± 0.003) E+00	(0.06)	
94-Pu-244	α	y	(8.00 ± 0.09) E+07	(1.1)	99.879 ± 0.004
	SF	y	(6.7 ± 0.3) E+10	(4.5)	0.121 ± 0.004
94-Pu-245	ß-	h	(1.05 ± 0.01) E+01	(0.95)	
94-Pu-246	ß-	d	(1.085 ± 0.002) E+01	(0.18)	
95-Am-240	ec	h	(5.08 ± 0.03) E+01	(0.59)	
	α	y	(3.0 ± 1.1) E+03	(40.)	(1.9 ± 0.7) E-04
95-Am-241	α	y	(4.327 ± 0.005) E+02	(0.12)	
	SF	y	(1.00 ± 0.024) E+14	(2.1)	(4.3 ± 0.18) E-10
95-Am-242	T	h	(1.602 ± 0.002) E+01	(0.12)	
	ß-	h	(1.937 ± 0.007) E+01	(0.36)	82.7 ± 0.3
	ec	h	(9.26 ± 0.16) E+01	(1.7)	1.73 ± 0.3
95-Am-242m	IT	y	(1.41 ± 0.02) E+02	(1.4)	99.541 ± 0.0012
	α	y	(3.11 ± 0.05) E+04	(1.6)	0.459 ± 0.0012
	SF	y	>3.0 E+12	(40.)	<4.7 E-9
95-Am-243	α	y	(7.370 ± 0.015) E+03	(0.2)	
	SF	y	(2.0 ± 0.3) E+13	(20.)	(3.7 ± 0.9) E-09
96-Cm-242	α	d	(1.629 ± 0.002) E+02	(0.04)	
	SF	y	(7.05 ± 0.14) E+06	(2.0)	(6.37 ± 0.018) E-06
96-Cm-243	T	y	(2.85 ± 0.02) E+01	(0.7)	
	α	y	(2.86 ± 0.02) E+01	(0.7)	99.71 ± 0.03
	ec	y	(1.19 ± 0.15) E+04	(10.)	0.29 ± 0.03
	SF	y	5.37 E+11		(5.3 ± 0.9) E-09
96-Cm-244	α	y	(1.810 ± 0.002) E+01	(0.11)	
	SF	y	(1.320 ± 0.007) E+07	(0.52)	(1.371 ± 0.002) E-04
98-Cf-252	T	y	(2.645 ± 0.008) E+00	(0.3)	
	α	y	(2.73 ± 0.01) E+00	(0.37)	96.908 ± 0.008
	SF	y	(8.55 ± 0.03) E+01	(0.35)	3.092 ± 0.008

*) Note: 100% decay of Pb-212 to the 6.055 min ground state of Bi-212.

A-2: Alpha radiation energies and emission probabilities

Description of table entries:

The second column gives alpha energies and their errors in keV for the nuclides listed in the first column. The third column gives alpha emission probabilities and their uncertainties (1σ) in percent per decay.

Source of data:

The tabulated data have been extracted from a data set recommended by participants of an IAEA Co-ordinated Research Programme (CRP) on "Decay data of the transactinium nuclides" (1978-1984). The complete data set is published in IAEA Technical Report Series No 261 (STI/DOC/10/261), pp.167-170 (1986).

Note: The data were revised and updated in October 1997. The source of new data is the ENSDF file, revision of May 1997.

Table A-2

nuclide	energy (keV)	emission probability (percent per decay)
90-Th-228	5340.36 ± 0.15	27.2 ± 1.0
	5423.15 ± 0.22	72.2 ± 1.1
90-Th-229	4797.8 ± 1.2	1.50 ± 0.20
	4814.6 ± 1.2	9.30 ± 0.08
	4838.0 ± 2.0	5.00 ± 0.20
	4845.3 ± 1.2	56.20 ± 0.20
	4901.0 ± 1.2	10.20 ± 0.08
	4967.5 ± 1.2	5.97 ± 0.06
	4978.5 ± 1.2	3.17 ± 0.04
	5053.0 ± 2.0	6.60 ± 0.10
90-Th-230	4438.4 ± 1.6	0.030 ± 0.015
	4479.8 ± 1.6	0.12
	4620.5 ± 1.5	23.40 ± 0.10
	4687.0 ± 1.5	76.3 ± 0.3
90-Th-232	3830.0 ± 10.0	0.059 ± 0.01
	3947.2 ± 2.0	22.1 ± 1.4
	4012.3 ± 1.4	77.8 ± 1.4
91-Pa-231	4508.0 ± 2.0	0.003
	4566.0 ± 2.0	0.008
	4599.0 ± 2.0	0.015
	4632.0 ± 2.0	0.1
	4643.0 ± 2.0	0.1
	4681.0 ± 2.0	1.50
	4713.0 ± 2.0	1.00
	4736.0 ± 0.8	8.4
	4795.0 ± 2.0	0.04
	4853.0 ± 2.0	1.4
	4934.0 ± 2.0	3.00
	4951.3 ± 1.4	22.8
	4975.0 ± 2.0	0.4
	4986.0 ± 2.0	1.4
	5013.8 ± 1.4	25.4
	5028.4 ± 1.0	20.0
	5032.0 ± 2.0	2.5
	5058.6 ± 1.5	11.0

nuclide	energy (keV)	emission probability (percent per decay)
92-U-232	5139.0 ± 1.5	0.3 ± 0.02
	5263.36 ± 0.09	31.7 ± 0.4
	5320.12 ± 0.14	68.0 ± 0.4
92-U-233	4729.2 ± 1.2	1.61
	4783.5 ± 1.2	13.2 ± 0.2
	4824.2 ± 1.2	84.4 ± 0.5
92-U-234	4603.5 ± 1.5	0.2 ± 0.01
	4722.4 ± 1.4	28.42 ± 0.09
	4774.6 ± 1.4	71.38 ± 0.16
92-U-235	4150.0 ± 5.0	0.9 ± 0.2
	4214.7 ± 1.9	5.7 ± 0.6
	4323.0 ± 1.3	4.4 ± 0.5
	4325.8 ± 1.3	0.21 ± 0.04
	4359.6 ± 1.3	0.24 ± 0.07
	4366.1 ± 2.0	17.0 ± 2.0
	4378.6 ± 1.3	0.16 ± 0.16
	4397.8 ± 1.3	55.0 ± 3.0
	4414.0 ± 4.0	2.1 ± 0.1
	4435.0 ± 5.0	0.7
	4502.0 ± 2.0	1.7 ± 0.2
	4556.0 ± 2.0	4.2 ± 0.3
	4596.4 ± 1.3	5.0 ± 0.5
92-U-236	4332.0 ± 8.0	0.26 ± 0.01
	4445.0 ± 5.0	26.0 ± 4.0
	4494.0 ± 3.0	74.0 ± 4.0
92-U-238	4038.0 ± 5.0	0.078 ± 0.012
	4151.0 ± 5.0	21.0 ± 3.0
	4198.0 ± 3.0	79.0 ± 3.0
93-Np-237	4581.0 ± 2.0	0.40 ± 0.04
	4598.6 ± 2.0	0.34 ± 0.04
	4639.4 ± 2.0	6.18 ± 0.12
	4664.0 ± 2.0	3.32 ± 0.1
	4766.0 ± 1.5	8.0 ± 3.0
	4771.0 ± 1.5	25.0 ± 6.0
	4788.0 ± 1.5	47.0 ± 9.0
	4803.3 ± 2.0	1.560
	4817.3 ± 2.0	2.5 ± 0.4
94-Pu-236	5613.61 ± 0.09	0.18
	5721.0 ± 0.10	30.6 ± 0.5
	5767.66 ± 0.08	69.3 ± 0.5
94-Pu-238	5207.76 ± 0.20	0.003
	5357.91 ± 0.20	0.105 ± 0.005
	5456.3 ± 0.30	28.98 ± 0.1
	5499.03 ± 0.20	70.91 ± 0.1
94-Pu-239	4829.23 ± 0.14	0.00373
	4866.76 ± 0.14	0.0021
	4870.23 ± 0.14	0.00070
	4911.54 ± 0.14	0.0031
	4934.85 ± 0.14	0.0041
	4962.69 ± 0.14	0.006 ± 0.003
	4987.98 ± 0.14	0.0052

nuclide	energy (keV)	emission probability (percent per decay)
94-Pu-239	4988.65 ± 0.14	0.0022
	5008.54 ± 0.14	0.0182
	5029.37 ± 0.14	0.0051
	5055.19 ± 0.14	0.030 ± 0.004
	5076.13 ± 0.14	0.036 ± 0.004
	5105.5 ± 0.8	11.5 ± 0.8
	5111.20 ± 0.2	0.015 ± 0.015
	5144.3 ± 0.8	15.1 ± 0.8
	5156.50 ± 0.14	0.030
	5156.59 ± 0.14	73.3 ± 0.8
94-Pu-240	4863.60 ± 0.15	0.00108
	5021.23 ± 0.15	0.08520
	5123.68 ± 0.23	27.10 ± 0.1
	5168.17 ± 0.15	72.80 ± 0.1
94-Pu-241	4784. ± 5.	0.000005 ± 0.000002
	4798. ± 3.	0.000029 ± 0.000003
	4853.4 ± 1.2	0.000292 ± 0.000005
	4896.4 ± 1.2	0.00201 ± 0.00002
	4972. ± 2.	0.000031 ± 0.000006
	4998. ± 2.	0.000010 ± 0.000001
	5042. ± 2.	0.000025
	5054. ± 2.	0.0000025
94-Pu-242	4598.5 ± 1.6	0.00130
	4754.6 ± 1.3	0.098 ± 0.017
	4856.2 ± 1.2	22.4 ± 2.0
	4900.5 ± 1.2	78.0 ± 3.0
95-Am-241	5322.0 ± 1.0	0.015 ± 0.005
	5388.23 ± 0.13	1.6 ± 0.2
	5442.80 ± 0.13	13.0 ± 0.6
	5485.56 ± 0.12	84.5 ± 1.0
	5511.47 ± 0.13	0.22 ± 0.03
	5544.5 ± 1.6	0.34 ± 0.05
95-Am-242m	5062.9 ± 0.5	0.00101
	5081.2 ± 0.5	0.000138
	5087.1 ± 0.5	0.000872
	5141.6 ± 0.5	0.02671
	5206.8 ± 0.5	0.412 ± 0.011
	5246.3 ± 0.9	0.000505
	5248.6 ± 0.5	0.000184
	5271.1 ± 0.5	0.003947
	5313.1 ± 1.0	0.003167
	5365.8 ± 0.5	0.005370
	5408.2 ± 0.5	0.004774
95-Am-243	4695.0 ± 3.0	0.00170
	4930.0 ± 3.0	0.0002
	4946.0 ± 3.0	0.0003
	5088.0 ± 3.0	0.004
	5113.0 ± 1.0	0.005
	5181.0 ± 1.0	1.10
	5233.3 ± 1.0	11.0 ± 0.4
	5275.3 ± 1.0	87.4 ± 0.4
	5321.0 ± 1.0	0.120 ± 0.020
	5349.4 ± 2.3	0.160 ± 0.020
96-Cm-242	5814.0 ± 2.0	0.0031 ± 0.0005
	5971.0 ± 3.0	0.035 ± 0.002
	6069.42 ± 0.12	25.0 ± 0.5
	6112.72 ± 0.08	74.0 ± 0.5

nuclide	energy (keV)	emission probability (percent per decay)
96-Cm-243	5316. ± 3.	0.000998
	5323. ± 3.	0.002993
	5332. ± 3.	0.002993
	5523. ± 3.	0.001995
	5537. ± 3.	0.001995
	5568. ± 3.	0.006983
	5575. ± 3.	0.006983
	5582. ± 3.	0.008978
	5587. ± 3.	0.01995
	5593. ± 3.	0.009976
	5609. ± 3.	0.005 ± 0.005
	5612. ± 3.	0.02993
	5623. ± 5.	0.05986
	5639. ± 3.	0.1397
	5646. ± 3.	0.02993
	5682. ± 3.	0.1995
	5686. ± 3.	1.5962 ± 0.0005
	5713. ± 5.	0.020 ± 0.020
	5742.1 ± 0.9	11.5 ± 0.5
	5785.2 ± 0.9	72.7 ± 1.0
	5876. ± 3.	0.5986
	5907. ± 3.	0.09976
	5991.8 ± 1.5	5.69 ± 0.20
	6010. ± 3.	0.9976
	6058.0 ± 1.0	4.7 ± 0.3
	6066.2 ± 1.7	1.50 ± 0.20
96-Cm-244	5513. ± 3.	0.003500
	5664. ± 3.	0.0221
	5762.70 ± 0.03	23.60 ± 0.20
	5804.82 ± 0.05	76.40 ± 0.20
98-Cf-252	5976.50 ± 0.06	0.23 ± 0.04
	6075.77 ± 0.11	15.2 ± 0.3
	6118.24 ± 0.04	81.6 ± 0.3

A-3: Gamma ray energies and emission probabilities

The table does not contain γ-rays from daughter products in equilibrium.

Description of table entries:

The second column gives γ-ray energies and their errors in keV for the nuclides listed in the first column. The third and fourth columns give γ-ray emission probabilities and their uncertainties (1σ) in percent per decay and relative errors (in %) in brackets ("rel err"). In general, γ-rays with energies below 50 kev were omitted, as they are not measured in applied NDA.

Source of data:

For the revision of October 1997, the new data were taken from the ENSDF file, revision of May 1997. Most of the original data (preliminary version) were superseded and replaced in the table. The original data were extracted from a data set recommended by participants of an IAEA Co-ordinated Research Programme (CRP) on "Decay data of the transactinium nuclides", published in the IAEA Technical Report Series No 261 (STI/DOC/10/61), pp.162-166, (1986).

Table A-3

nuclide	energy (keV)	emission probability (percent per decay)	rel err
81-Tl-208	252.6 ± 0.3	0.807 ± 0.011	(1.4)
	277.35 ± 0.06	6.4 ± 0.06	(0.94)
	510.80 ± 0.08	22.8 ± 0.3	(1.3)
	583.191 ± 0.002	85.1 ± 0.6	(0.71)
	763.13 ± 0.08	1.89 ± 0.06	(3.2)
	860.37 ± 0.08	12.52 ± 0.12	(0.96)
	1093.1 ± 0.1	0.45 ± 0.06	(10.)
	2614.6 ± 0.1	99.83 ± 0.17	(0.17)
82-Pb-212	115.176 ± 0.007	0.6 ± 0.02	(3.3)
	238.632 ± 0.002	43.5 ± 0.4	(0.92)
	300.087 ± 0.010	3.25 ± 0.04	(1.2)
83-Bi-212	288.07 ± 0.07	0.31 ± 0.04	(10.)
	327.96 ± 0.10	0.12 ± 0.008	(6.7)
	452.83 ± 0.10	0.36 ± 0.04	(10.)
	727.330 ± 0.009	6.64 ± 0.09	(1.4)
	785.42 ± 0.06	1.1 ± 0.02	(1.8)
	893.408 ± 0.005	0.381 ± 0.014	(3.7)
	1078.62 ± 0.10	0.574 ± 0.015	(2.6)
	1620.735 ± 0.010	1.49 ± 0.06	(4.0)
86-Rn-220	549.7 ± 0.5	0.114 ± 0.017	(10.)
88-Ra-224	241.0 ± 0.1	4.05 ± 0.04	(0.99)
90-Th-228	84.40 ± 0.05	1.22 ± 0.03	(2.5)
	131.62 ± 0.20	0.127 ± 0.007	(5.5)
	166.37 ± 0.20	0.107 ± 0.004	(3.7)
	215.94 ± 0.08	0.26 ± 0.01	(3.9)
90-Th-229	56.52 ± 0.01	0.312 ± 0.007	(2.2)
	94.73 ± 0.02	0.465 ± 0.008	(1.7)
	107.11 ± 0.01	0.809 ± 0.013	(1.6)
	110.33 ± 0.01	0.128 ± 0.003	(2.3)

nuclide	energy (keV)	emission probability (percent per decay)	rel err
90-Th-229	123.19 ± 0.01	0.197 ± 0.003	(1.5)
	124.60 ± 0.05	1.449 ± 0.02	(1.4)
	131.93 ± 0.01	0.327 ± 0.005	(1.5)
	136.990 ± 0.004	1.171 ± 0.016	(1.4)
	142.96 ± 0.01	0.401 ± 0.006	(1.5)
	148.0 ± 0.2	1.091 ± 0.015	(1.4)
	156.41 ± 0.01	1.237 ± 0.018	(1.5)
	179.76 ± 0.01	0.215 ± 0.004	(1.9)
	193.509 ± 0.004	4.41 ± 0.06	(1.4)
	204.69 ± 0.01	0.595 ± 0.009	(1.5)
	210.8 ± 0.1	3.18 ± 0.04	(1.3)
90-Th-230	67.672 ± 0.002	0.376 ± 0.043	(10.)
	143.872 ± 0.004	0.0486 ± 0.0051	(10.)
	186.053 ± 0.004	0.0088 ± 0.0009	(10.)
	253.729 ± 0.010	0.0111 ± 0.0012	(10.)
90-Th-231	58.570 ± 0.003	0.5 ± 0.05	(10.)
	72.751 ± 0.003	0.26 ± 0.02	(7.7)
	81.228 ± 0.003	0.85 ± 0.03	(3.5)
	82.087 ± 0.003	0.37 ± 0.02	(5.4)
	84.214 ± 0.003	6.71 ± 0.1	(1.5)
	89.95 ± 0.02	0.94 ± 0.08	(0.8)
	99.278 ± 0.004	0.12 ± 0.01	(0.8)
	102.270 ± 0.003	0.4 ± 0.02	(5.0)
	124.914 ± 0.017	0.06 ± 0.003	(5.0)
	134.03 ± 0.02	0.025 ± 0.005	(20.)
	135.664 ± 0.011	0.084 ± 0.007	(8.3)
	217.94 ± 0.03	0.037 ± 0.001	(2.7)
90-Th-232	59. ± 1.	0.19	
	126. ± 5.	0.043	
90-Th-233	29.36 ± 0.04	2.5	
	86.50 ± 0.05	2.7	
	88.0 ± 0.2	0.3	
	94.68 ± 0.05	0.8	
	162.5 ± 0.1	0.32	
	169.1 ± 0.2	0.34	
	170.7 ± 0.3	0.13	
	190.54 ± 0.08	0.13	
	194.90 ± 0.05	0.16	
	359.9 ± 0.2	0.12	
	441.0 ± 0.3	0.23	
	447.7 ± 0.3	0.15	
	459.2 ± 0.2	1.4	
	490.8 ± 0.3	0.17	
	499.0 ± 0.3	0.21	
	595.2 ± 0.2	0.16	
	669.8 ± 0.2	0.68	
	764.4 ± 0.4	0.12	
	890.1 ± 0.5	0.14	
90-Th-234	63.29 ± 0.02	4.47 ± 0.88	(20.)
	92.38 ± 0.01	2.60 ± 0.53	(20.)
	92.80 ± 0.02	2.56 ± 0.52	(20.)
	112.81 ± 0.05	0.256 ± 0.054	(20.)
91-Pa-231	255.90 ± 0.04	0.107 ± 0.003	(2.8)
	260.3 ± 0.1	0.182 ± 0.005	(2.8)
	273.237 ± 0.117	0.059 ± 0.002	(3.4)
	277.322 ± 0.013	0.069 ± 0.002	(2.9)
	283.690 ± 0.013	1.65 ± 0.04	(2.4)
	300.069 ± 0.008	2.41 ± 0.06	(2.5)

nuclide	energy (keV)	emission probability (percent per decay)	rel err
91-Pa-231	302.669 ± 0.006	2.47 ± 0.06	(2.4)
	330.057 ± 0.015	1.36 ± 0.03	(2.2)
	340.77 ± 0.07	0.178 ± 0.004	(2.3)
	354.474 ± 0.075	0.097 ± 0.003	(3.1)
	357.16 ± 0.07	0.169 ± 0.005	(3.0)
91-Pa-233	75.28 ± 0.01	1.32 ± 0.04	(3.0)
	86.59 ± 0.01	1.97 ± 0.12	(6.1)
	103.86 ± 0.02	0.87 ± 0.03	(3.5)
	271.48 ± 0.08	0.32 ± 0.01	(3.1)
	300.12 ± 0.03	6.63 ± 0.06	(0.9)
	311.98 ± 0.03	38.63 ± 0.39	(1.0)
	340.50 ± 0.04	4.50 ± 0.05	(1.1)
	375.45 ± 0.04	0.68 ± 0.01	(1.5)
	398.62 ± 0.08	1.41 ± 0.02	(1.4)
	415.76 ± 0.04	1.74 ± 0.02	(1.2)
92-U -232	57.78 ± 0.05	0.200 ± 0.002	(1.0)
	129.08 ± 0.05	0.0682 ± 0.0004	(0.59)
	270.2 ± 0.2	0.00316 ± 0.00005	(1.6)
	327.9 ± 0.2	0.00283 ± 0.00006	(2.1)
92-U -233	54.699 ± 0.001	0.0182 ± 0.0003	(1.7)
	118.968 ± 0.002	0.00406 ± 0.00004	(0.99)
	120.816 ± 0.001	0.00332 ± 0.00003	(0.9)
	135.3	0.00232 ± 0.00002	(0.86)
	146.345 ± 0.002	0.00657 ± 0.00006	(0.91)
	164.522 ± 0.002	0.00623 ± 0.00005	(0.8)
	208.171 ± 0.002	0.00229 ± 0.00003	(1.3)
	245.345 ± 0.002	0.00362 ± 0.00003	(0.83)
	291.354 ± 0.004	0.00537 ± 0.00005	(0.93)
	317.2	0.00776 ± 0.00007	(0.9)
	320.541 ± 0.005	0.00290 ± 0.00003	(1.0)
92-U -234	53.20 ± 0.02	0.123 ± 0.002	(1.6)
	120.90 ± 0.02	0.0342 ± 0.0005	(1.5)
92-U -235	109.16 ± 0.02	1.54 ± 0.05	(3.3)
	140.76 ± 0.04	0.22 ± 0.02	(10.)
	143.76 ± 0.02	10.96 ± 0.08	(0.73)
	163.33 ± 0.02	5.08 ± 0.04	(0.79)
	182.61 ± 0.05	0.34 ± 0.02	(5.9)
	185.715 ± 0.005	57.2 ± 0.5	(0.87)
	194.94 ± 0.01	0.63 ± 0.01	(1.6)
	202.11 ± 0.02	1.08 ± 0.02	(1.9)
	205.311 ± 0.010	5.01 ± 0.05	(1.0)
	221.38 ± 0.02	0.12 ± 0.01	(8.3)
92-U -236	49.369 ± 0.009	0.078 ± 0.008	(10.)
	112.750 ± 0.015	0.019 ± 0.005	(30.)
92-U -237	51.01 ± 0.03	0.20 ± 0.09	(50.)
	59.543 ± 0.015	34.5 ± 0.8	(2.3)
	64.83 ± 0.02	1.31 ± 0.03	(2.3)
	164.61 ± 0.02	1.87 ± 0.05	(2.7)
	208.005 ± 0.023	21.6 ± 0.5	(2.3)
	221.80 ± 0.04	0.0205 ± 0.0008	(3.9)
	234.40 ± 0.04	0.0205 ± 0.0008	(3.9)
	267.54 ± 0.04	0.730 ± 0.018	(2.5)
	332.36 ± 0.04	1.21 ± 0.03	(2.5)
	335.38 ± 0.04	0.097 ± 0.003	(3.1)
	368.59 ± 0.04	0.042 ± 0.002	(4.8)
	370.94 ± 0.04	0.11 ± 0.004	(3.6)

nuclide	energy (keV)	emission probability (percent per decay)	rel err
92-U -238	49.55 ± 0.06	0.064 ± 0.008	(10.)
92-U -239	43.533 ± 0.001	4.16 ± 0.11	(2.6)
	74.664 ± 0.001	48.1 ± 1.	(2.1)
	100.	0.5 ± 0.1	(20.)
	104.	7.5 ± 0.2	(2.7)
	160.2 ± 0.6	27.6 ± 0.6	(2.2)
93-Np-236m	44.6 ± 0.1	0.0110 ± 0.0002	(1.8)
	538.09 ± 0.15	0.011 ± 0.001	(10.)
	642.33 ± 0.09	0.92 ± 0.06	(6.5)
	687.61 ± 0.10	0.25 ± 0.02	(8.0)
93-Np-237	46.53 ± 0.04	0.106 ± 0.006	(5.7)
	57.15 ± 0.04	0.382 ± 0.011	(2.9)
	86.503 ± 0.020	12.3 ± 0.2	(1.6)
	88.04 ± 0.16	0.138 ± 0.003	(2.2)
	117.681 ± 0.030	0.173 ± 0.003	(1.7)
	131.04	0.086 ± 0.002	(2.3)
	134.23	0.071 ± 0.002	(2.8)
	143.208 ± 0.025	0.432 ± 0.008	(1.9)
	151.37 ± 0.04	0.234 ± 0.004	(1.7)
	155.22	0.092 ± 0.002	(2.2)
	169.17	0.071 ± 0.001	(1.4)
	195.096 ± 0.020	0.185 ± 0.002	(1.1)
	212.415 ± 0.025	0.151 ± 0.002	(1.3)
	238.0	0.059 ± 0.001	(1.7)
93-Np-238	101.9 ± 0.03	0.27 ± 0.01	(3.7)
	119.9 ± 0.1	0.108 ± 0.006	(5.6)
	882.63 ± 0.03	0.87 ± 0.03	(3.5)
	918.69 ± 0.04	0.59 ± 0.02	(3.4)
	923.98 ± 0.02	2.86 ± 0.09	(3.2)
	936.61 ± 0.06	0.40 ± 0.01	(2.5)
	941.38 ± 0.05	0.54 ± 0.02	(3.7)
	962.77 ± 0.03	0.70 ± 0.02	(2.9)
	984.45 ± 0.02	27.8 ± 0.8	(2.9)
	1025.87 ± 0.02	9.6 ± 0.5	(5.2)
	1028.54 ± 0.02	20.3 ± 0.8	(3.9)
93-Np-239	61.460 ± 0.002	1.29 ± 0.02	(1.6)
	106.123 ± 0.002	27.2 ± 0.4	(1.5)
	209.753 ± 0.002	3.42 ± 0.05	(1.5)
	226.42 ± 0.08	0.28 ± 0.02	(7.1)
	228.183 ± 0.001	11.27 ± 0.18	(1.6)
	277.599 ± 0.001	14.38 ± 0.21	(1.5)
	285.460 ± 0.002	0.79 ± 0.02	(2.5)
	315.880 ± 0.003	1.60 ± 0.03	(1.9)
	334.310 ± 0.002	2.07 ± 0.03	(1.5)
94-Pu-236	47.6	0.069 ± 0.021	(30.)
	109.0	0.012 ± 0.004	(30.)
	165.	0.00066 ± 0.0002	(30.)
	515.6	0.00017 ± 0.00005	(30.)
	563.2	0.00010 ± 0.00003	(30.)
	645.	0.00024 ± 0.00008	(30.)
94-Pu-238	43.498 ± 0.001	0.0395 ± 0.0008	(2.0)
	99.853 ± 0.003	0.00735 ± 0.00008	(1.1)
	152.720 ± 0.002	0.000937 ± 0.000010	(1.1)
94-Pu-239	51.624 ± 0.001	0.0271 ± 0.0005	(1.9)
	56.825 ± 0.003	0.001130 ± 0.000025	(2.2)
	123.62 ± 0.05	(1.97 ± 0.21) E-05	(10.)

nuclide	energy (keV)	emission probability (percent per decay)	rel err
94-Pu-239	124.51 ± 0.03	(6.13 ± 0.22) E-05	(3.6)
	125.21 ± 0.10	(7.11 ± 0.2) E-05	(2.8)
	129.296 ± 0.001	0.00631 ± 0.00006	(0.95)
	141.657 ± 0.020	(3.2 ± 0.09) E-05	(2.8)
	144.201 ± 0.003	0.000304 ± 0.000004	(1.2)
	146.094 ± 0.006	0.000119 ± 0.000003	(2.1)
	161.482 ± 0.021	0.000123 ± 0.000002	(1.6)
	171.393 ± 0.006	0.000110 ± 0.000002	(1.8)
	179.220 ± 0.012	(6.6 ± 0.1) E-05	(1.5)
	188.23 ± 0.10	(1.09 ± 0.11) E-05	(10.)
	189.360 ± 0.010	(8.3 ± 0.1) E-05	(1.2)
	195.679 ± 0.008	0.000107 ± 0.000001	(0.93)
	203.550 ± 0.005	0.000569 ± 0.000003	(0.53)
	255.384 ± 0.015	(8.0 ± 0.1) E-05	(1.3)
	297.46 ± 0.03	(4.98 ± 0.08) E-05	(1.6)
	311.78 ± 0.04	(2.58 ± 0.07) E-05	(2.7)
	332.845 ± 0.005	0.000494 ± 0.000003	(0.61)
	341.502 ± 0.019	(6.62 ± 0.14) E-05	(2.1)
	345.013 ± 0.004	0.000556 ± 0.000005	(0.9)
	375.054 ± 0.003	0.001554 ± 0.000009	(0.58)
	380.191 ± 0.006	0.000305 ± 0.000006	(2.0)
	382.698 ± 0.016	0.000259 ± 0.000005	(1.9)
	392.914 ± 0.014	0.000553 ± 0.000012	(2.2)
	413.713 ± 0.005	0.001466 ± 0.000011	(0.75)
	422.598 ± 0.019	0.000122 ± 0.000002	(1.6)
	445.81 ± 0.10	(8.8 ± 0.6) E-06	(6.8)
	451.481 ± 0.010	0.000189 ± 0.000002	(0.84)
	481.78 ± 0.12	(4.6 ± 0.2) E-06	(4.4)
	639.99 ± 0.10	(8.7 ± 0.2) E-06	(2.3)
	645.98 ± 0.03	(1.52 ± 0.03) E-05	(2.0)
	651.79 ± 0.10	(6.6 ± 0.2) E-06	(3.0)
	658.63 ± 0.15	(9.7 ± 0.2) E-06	(2.1)
	718.0 ± 0.5	(2.8 ± 0.2) E-06	(7.1)
	769.19 ± 0.04	(1.19 ± 0.02) E-05	(1.7)
94-Pu-240	45.242 ± 0.003	0.0447 ± 0.0007	(1.6)
	104.235 ± 0.005	0.00714 ± 0.00006	(0.84)
	160.307 ± 0.003	0.000402 ± 0.000004	(1.0)
94-Pu-241	77.10 ± 0.10	(2.07 ± 0.04) E-05	(1.9)
	103.680 ± 0.005	0.000102 ± 0.000002	(2.0)
	148.567 ± 0.010	0.000186 ± 0.000002	(0.86)
	159.955 ± 0.020	(6.58 ± 0.09) E-06	(1.4)
94-Pu-242	44.915 ± 0.013	0.0373 ± 0.0007	(1.9)
	103.50 ± 0.04	0.00255 ± 0.00010	(3.9)
	158.80 ± 0.08	0.00030 ± 0.00002	(6.7)
95-Am-241	59.537 ± 0.001	35.9 ± 0.4	(1.1)
	98.97 ± 0.02	0.020 ± 0.001	(5.0)
	102.98 ± 0.02	0.0196 ± 0.0010	(5.1)
	123.01 ± 0.02	0.001 ± 0.0001	(10.)
	125.30 ± 0.02	0.0041 ± 0.0001	(2.4)
	146.55 ± 0.03	0.00046 ± 0.00002	(4.4)
	164.69 ± 0.04	(7.2 ± 1.5) E-05	(20.)
	169.56 ± 0.03	0.000172 ± 0.000015	(8.7)
	208.01 ± 0.03	0.00079 ± 0.00002	(2.5)
	322.52 ± 0.03	0.00015 ± 0.00001	(6.7)
	332.35 ± 0.03	0.00015 ± 0.00001	(6.7)
	335.37 ± 0.03	0.000495 ± 0.000010	(2.0)
	368.65 ± 0.03	0.00022 ± 0.00002	(10.)
	662.40 ± 0.02	0.00036 ± 0.00002	(5.6)

nuclide	energy (keV)	emission probability (percent per decay)	rel err
95-Am-242m	48.63 ± 0.05	99.5 *)	
	49.367 ± 0.004	0.19 ± 0.01	(5.3)
	66.898 ± 0.020	0.021 ± 0.001	(4.8)
	67.9	0.0073 ± 0.0002	(2.7)
	86.68 ± 0.03	0.04 ± 0.01	(30.)
	92.5	0.004 ± 0.001	(30.)
	109.6	0.024 ± 0.001	(4.2)
	111.1	0.003 ± 0.001	(30.)
	121.8	0.0060 ± 0.0002	(3.3)
	135.17 ± 0.06	0.011 ± 0.001	(10.)
	136.1	0.0096 ± 0.0003	(3.1)
	152.75 ± 0.06	0.0014 ± 0.0003	(20.)
	153.84 ± 0.06	0.0046 ± 0.0001	(2.2)
	163.24 ± 0.04	0.024 ± 0.001	(4.2)
95-Am-243	74.67 ± 0.15	68.2 ± 1.4	(2.1)
	86.79 ± 0.15	0.338 ± 0.007	(2.1)
	142.18 ± 0.15	0.12 ± 0.01	(8.3)
96-Cm-242	44.08 ± 0.03	0.0325 ± 0.0012	(3.7)
	101.93 ± 0.04	0.0025 ± 0.0004	(20.)
	157.42 ± 0.05	0.0014 ± 0.0002	(10.)
	561.02 ± 0.10	0.00015 ± 0.00004	(30.)
	605.04 ± 0.10	0.00011 ± 0.00003	(30.)
96-Cm-243	209.753 ± 0.002	3.29 ± 0.10	(3.0)
	228.184 ± 0.002	10.6 ± 0.3	(2.8)
	277.599 ± 0.002	14.0 ± 0.4	(2.9)
	285.460 ± 0.002	0.73 ± 0.02	(2.7)
96-Cm-244	42.824 ± 0.008	0.0248 ± 0.0006	(2.4)
	98.860 ± 0.013	0.0011 ± 0.0001	(10.)
	152.630 ± 0.020	0.00099	
98-Cf-252	43.399 ± 0.025	0.0148 ± 0.0009	(6.1)
	100.2	0.013	
	160. ± 5.	0.0019	

*) Internal conversion not considered.

A-4: X-ray energies and intensities

Description of table entries:

First column: the **element** considered, followed by the **type** of the X-ray transition. Only K X-rays are included as the energies of other X-rays are too low to be visible in γ-ray spectra.

The following **notation** for X-ray transitions is used (e.g. K α1 = Siegbahn notation, K-L_3 = associated initial - final shell vacancy):

K α1 ... K-L_3	K β2 ... K-N_2N_3	K β5 ... K-M_4M_5
K α2 ... K-L_2	K β3 ... K-M_2	K O ... K-O_2O_3
K β1 ... K-M_2	K β4 ... K-N_4N_5	K P ... K-P_2P_3

Group designations: K β1′ = K β1 + K β3 + K β5
K β2′ = K β2 + K β4 + K O + K P

The **energies** of individual X-rays and mean energies of groups are given in column 2.

The X-ray **intensities** per 100 K-shell vacancies are given in column 3. The X-ray intensities per 100 decays of the nuclide given are listed in columns 4 to 6, where the following notation is used:

α = alpha decay β- = beta decay ec = electron capture

Source of data:

Table of Radioactive Isotopes, E. Browne, R.B. Firestone (V.S. Shirley, editor), publ. by John Wiley & Sons, USA, 1986. The tables used are:

(a) A-chain tables, pp.208 ff.: for X-ray group energies and decay intensities (columns 4-6).

(b) X-ray tables, pp.C-19 to C-24: for notation and all other data.

Note: The data were revised in October 1997. The new "Table of Isotopes", 8^{th} Edition, R.B. Firestone, V.S. Shirley (Ed.), J. Wiley & Sons, Inc, USA, 1996 contains in vol.2, pp. F-42 to F-77 the same data as (b) above. However, the data (a) above are not contained therein. Therefore the old "Table of Radioactive Isotopes" is also used here.

Table A-4

element type	**energy (keV)**	**intensity per 100 K-shell vacancies (left column), or per 100 decays of nuclide given**	
81-Tl			83-Bi-212 α
K α1	72.873	46.3 ±0.9	0.127 ±0.021
K α2	70.832	27.6 ±0.6	0.075 ±0.012
K ß1	82.574	10.70 ±0.22	
K ß3	82.115	5.59 ±0.11	
K ß5	83.093	0.303±0.012	
K ß1'	82.434	0.045±0.007	
K ß2	84.865	3.90 ±0.08	
K ß4	85.134	0.09 ±0.04	
K O	85.444	0.67 ±0.07	
K ß2'	85.185		0.0125±0.0021

element type	energy (keV)	intensity per 100 K-shell vacancies (left column), or per 100 decays of nuclide given	
82-Pb			81-Tl-208 ß-
K α1	74.969	46.2 ±0.9	3.60 ±0.11
K α2	72.805	27.7 ±0.6	2.14 ±0.07
K ß1	84.938	10.70 ±0.22	
K ß3	84.450	5.58 ±0.11	
K ß5	84.470	0.312±0.012	
K ß1'	84.789		1.27 ±0.04
K ß2	87.300	3.91 ±0.08	
K ß4	87.580	0.09 ±0.04	
K O	87.911	0.70 ±0.07	
K P	88.003	0.017±0.002	
K ß2'	87.632		0.367 ±0.013
83-Bi			82-Pb-212 ß-
K α1	77.107	46.2 ±0.9	17.70 ±0.6
K α2	74.815	27.7 ±0.6	10.5 ±0.4
K ß1	87.349	10.70 ±0.21	
K ß3	86.830	5.59 ±0.11	
K ß5	87.892	0.321±0.013	
K ß1'	87.190		6.27 ±0.22
K ß2	89.784	3.93 ±0.08	
K ß4	90.074	0.09 ±0.04	
K O	90.421	0.73 ±0.08	
K P	90.522	0.031±0.003	
K ß2'	90.128		1.86 ±0.07
84-Po			83-Bi-212 ß-
K α1	79.290	46.1 ±0.9	0.10 ±0.03
K α2	76.863	27.7 ±0.6	0.060 ±0.016
K ß1	89.807	10.70 ±0.21	
K ß3	89.256	5.57 ±0.11	
K ß5	90.388	0.330±0.013	
K ß1'	89.639		0.035 ±0.010
K ß2	92.317	3.95 ±0.08	
K ß4	92.618	0.09 ±0.04	
K O	92.983	0.76 ±0.08	
K P	93.095	0.049±0.005	
K ß2'	92.673		0.011 ±0.003
86-Rn			88-Ra-224 α
K α1	83.787	46.0 ±0.9	0.20 ±0.06
K α2	81.069	27.9 ±0.6	0.12 ±0.04
K ß1	94.868	10.60 ±0.21	
K ß3	92.247	5.56 ±0.11	
K ß5	95.449	0.349±0.014	
K ß1'	94.966		0.072 ±0.020
K ß2	97.530	3.98 ±0.08	
K ß4	97.853	0.10 ±0.05	
K O	98.257	0.81 ±0.08	
K P	98.389	0.094±0.010	
K ß2'	97.907		0.023 ±0.007
87-Fr			89-Ac-224 α
K α1	86.105	45.8 ±0.9	0.28 ±0.04
K α2	83.231	27.9 ±0.6	0.17 ±0.03
K ß1	97.474	10.70 ±0.21	
K ß3	96.815	5.58 ±0.11	
K ß5	98.069	0.358±0.014	

element type	energy (keV)	intensity per 100 K-shell vacancies (left column), or per 100 decays of nuclide given			
87-Fr			89-Ac-224 α		
K ß2	100.214	4.01 ±0.08			
K ß4	100.548	0.10 ±0.05			
K O	100.972	0.84 ±0.09			
K P	101.118	0.114±0.012			
K ß2'	100.599		0.032 ±0.005		
88-Ra			89-Ac-224 ec	90-Th228 α	
K α1	88.471	45.7 ±0.9	35. ±16.	0.0288±0.0019	
K α2	85.431	28.0 ±0.6	22. ±10.	0.0175±0011	
K ß1	100.130	10.70 ±0.21			
K ß3	99.432	5.59 ±0.11			
K ß5	100.738	0.362±0.015			
K ß1'	99.915		13. ±6.	0.0103±0.0007	
K ß2	102.948	4.04 ±0.08			
K ß4	103.295	0.11 ±0.05			
K O	103.740	0.86 ±0.09			
K P	103.899	0.132±0.013			
K ß2'	103.341		4.1 ±1.9	0.0034±0.0002	
89-Ac			91-Pa-231 α		
K α1	90.886	45.5 ±0.9	0.78 ±0.03		
K α2	87.675	28.1 ±0.6	0.476 ±0.018		
K ß1	102.841	10.70 ±0.21			
K ß3	102.101	5.61 ±0.11			
K ß5	103.462	0.371±0.015			
K ß1'	102.613		0.280 ±0.011		
K ß2	105.738	4.07 ±0.08			
K ß4	106.098	0.11 ±0.05			
K O	106.563	0.89 ±0.09			
K P	106.738	0.146±0.015			
K ß2'	106.137		0.092 ±0.004		
90-Th			89-Ac-228 ß-	92-U-233 α	92-U-235 α
K α1	93.350	45.4 ±0.9	5.6 ±1.3	0.0169±0.0014	5.5 ±0.3
K α2	89.957	28.1 ±0.6	3.4 ±0.8	0.0104±0.0008	3.36±0.21
K ß1	105.604	10.70 ±0.21			
K ß3	104.819	5.61 ±0.11			
K ß5	106.239	0.380±0.015			
K ß1'	105.362		2.0 ±0.5	0.0061±0.0005	1.98±0.12
K ß2	108.582	4.10 ±0.08			
K ß4	108.955	0.11 ±0.05			
K O	109.442	0.90 ±0.09			
K P	109.630	0.160±0.016			
K ß2'	108.990		0.67 ±0.15	0.0020±0.0002	0.66±0.04
91-Pa			90-Th-231 ß-	90-Th-233 ß-	93-Np-237 α
K α1	95.863	45.3 ±0.9	0.63 ±0.05	0.83 ±0.06	2.58±0.21
K α2	92.282	28.1 ±0.6	0.39 ±0.03	0.51 ±0.04	1.59±0.13
K ß1	108.422	10.70 ±0.22			
K ß3	107.595	5.64 ±0.11			
K ß5	109.072	0.389±0.016			
K ß1'	108.166		0.228 ±0.019	0.301 ±0.023	0.94±0.08
K ß2	111.486	4.13 ±0.08			
K ß4	111.870	0.12 ±0.06			
K O	112.380	0.93 ±0.10			
K P	112.575	0.156±0.016			
K ß2'	111.897		0.076 ±0.006	0.100 ±0.008	0.31±0.03

element type	energy (keV)	intensity per 100 K-shell vacancies (left column), or per 100 decays of nuclide given			
92-U			91-Pa-232 ß-	91-Pa-233 ß-	91-Pa-234 ß-
K α1	98.434	45.1 ±0.9	1.76 ±0.07	16. ±3.	23.3 ±1.6
K α2	94.654	28.2 ±0.6	1.10 ±0.04	10.2 ±1.6	15.7 ±1.0
K ß1	111.298	10.70 ±0.22			
K ß3	110.421	5.65 ±0.11			
K ß5	111.964	0.397±0.016			
K ß1'	111.025		0.644 ±0.024	6.0 ±1.0	9.2 ±0.6
K ß2	114.445	4.15 ±0.08			
K ß4	114.844	0.12 ±0.06			
K O	115.377	0.97 ±0.10			
K P	115.580	0.159±0.016			
K ß2'	114.866		0.217 ±0.009	2.0 ±0.3	3.11±0.21
92-U			93-Np-236 ec	94-Pu-239 α	94-Pu-241 α
K α1	98.434	45.1 ±0.9	17.8 ±1.0	(5.90±0.06)E-3	(4.48±0.09)E-4
K α2	94.654	28.2 ±0.6	11.6 ±0.6	(3.67±0.04)E-3	(2.80±0.07)E-4
K ß1	111.298	10.70 ±0.22			
K ß3	110.421	5.65 ±0.11			
K ß5	111.964	0.397±0.016			
K ß1'	111.025		6.5 ±0.4	(2.25±0.02)E-3	(1.6 ±0.1)E-4
K ß2	114.445	4.15 ±0.08			
K ß4	114.844	0.12 ±0.06			
K O	115.377	0.97 ±0.10			
K P	115.580	0.159±0.016			
K ß2'	114.866		2.20 ±0.13	(5.59±0.06)E-4	(4.46±0.12)E-5
93-Np			92-U-237 ß-	95-Am-241 α	
K α1	101.059	45.1 ±0.9	26. ±4.	(2.01±0.17)E-3	
K α2	97.069	28.3 ±0.6	16. ±3.	(1.26±0.11)E-3	
K ß1	114.224	10.70 ±0.22			
K ß3	113.303	5.65 ±0.11			
K ß5	114.912	0.405±0.016			
K ß1'	113.944		9.6 ±1.5	(7.4 ±0.6)E-4	
K ß2	117.463	4.17 ±0.08			
K ß4	117.876	0.12 ±0.06			
K O	118.429	0.97 ±0.10			
K P	118.646	0.162±0.017			
K ß2'	117.891		3.3 ±0.5	(2.49±0.22)E-4	
94-Pu			93-Np-238 ß-	93-Np-239 ß-	95-Am-242 ec
K α1	103.734	45.1 ±0.9	0.341 ±0.014	23.9 ±0.8	5.8 ±1.2
K α2	99.525	28.4 ±0.6	0.214 ±0.009	15.0 ±0.5	3.6 ±0.7
K ß1	117.228	10.70 ±0.22			
K ß3	116.244	5.44 ±0.11			
K ß5	117.918	0.413±0.016			
K ß1'	116.930		0.123 ±0.005	8.6 ±0.3	2.1 ±0.4
K ß2	120.540	4.18 ±0.08			
K ß4	120.969	0.13 ±0.06			
K O	121.543	0.99 ±0.10			
K P	121.768	0.157±0.016			
K ß2'	120.974		0.0426±0.0019	2.98±0.11	0.72±0.15
94-Pu			96-Cm-243 α		
K α1	103.734	45.1 ±0.9	23.0 ±0.6		
K α2	99.525	28.4 ±0.6	14.4 ±0.4		
K ß1	117.228	10.70 ±0.22			
K ß3	116.244	5.44 ±0.11			
K ß5	117.918	0.413±0.016			

element type	energy (keV)	intensity per 100 K-shell vacancies (left column), or per 100 decays of nuclide given	
94-Pu			96-Cm-243 α
K ß2	120.540	4.18 ±0.08	
K ß4	120.969	0.13 ±0.06	
K O	121.543	0.99 ±0.10	
K P	121.768	0.157±0.016	
K ß2'	120.974		2.87 ±0.09

A-5: Thermal neutron cross sections, resonance integrals and related parameters

This table contains **thermal neutron cross sections, Westcott g-factors** and **resonance integrals** for **capture** and **fission** (if significant). All data are taken from [1] unless indicated by footnotes, as this source gives uncertainties which are not included in the more recent data files ENDF/B-6 (only sometimes included in the text information) or JENDL-3.

Description of table entries:

The second column describes the thermal neutron cross section of the following type:

σ_o	2200 m/s cross section
σ	Maxwellian average cross section (kT = 0.0253 eV)
σ_r	cross section in a thermal reactor neutron spectrum
m	cross section leading to a metastable state of product
g	cross section leading to ground state of product
m+g	sum cross section
g:	Westcott g-factor for the deviation of the cross section from the 1/v shape for a Maxwellian neutron spectrum with kT = 0.0253 eV

Resonance Integral: Infinite dilution resonance integral including the 1/v part

Source of data:

[1] S.F Mughabghab, Neutron Cross Sections Vol. 1:Resonance Parameters and Thermal Cross Sections, Part B: Z = 61-100; Academic Press, NY, 1984

ENDF/B-6: the US Evaluated Nuclear Data File, version 6

JENDL-3: the Japanese Evaluated Nuclear Data Library,version 3

The data were revised in October 1997. The revised data were taken from the October 1996 revision of the ENDF/B-6 Standards File (NNDC Brookhaven, USA). The evaluated data files of complete $\sigma(E)$ data, ENDF/B-5 and JENDL-3 are available from the 4 Data Centres (see Introduction) upon request.

Table A-5

Nuclide	Thermal Neutron Cross Sections (b)	Westcott g-factor	Resonance Integral (b)
90-Th-232	σ_o-capt 7.37 ± 0.06	0.9982	85. ± 3.
92-U-233	σ_o-capt 45.5 ± 0.7 σ_o-fiss 529.1 ± 1.2	1.0040 [2] 0.9955 ± 0.0015	137. ± 6. 760. ± 17.
92-U-234	σ_o-capt 99.8 ± 1.3	0.9903	660. ± 70.
92-U-235	σ_o-capt 98.59 ± 0.8 σ_o-fiss 584.81 ± 1.11	0.9897 ± 0.0008 0.9786 ± 0.0008	143.4 ± 6.0 277.5 ± 5.0
92-U-236	σ_o-capt 5.11 ± 0.21		360. ± 15.
92-U-237	σ-capt 443. ±167.		1200. ± 200.
92-U-238	σ°-capt 2.680 ± 0.019	1.0009	277. ± 3.
93-Np-237	σ_o-capt 175.9 ± 2.9	0.982	640. ± 50.

Nuclide	Thermal Neutron Cross Sections (b)	Westcott g-factor	Resonance Integral (b)
93-Np-239	σ_r-capt 68. ± 10. [7]		
94-Pu-238	σ_o-capt 540. ± 7.	0.9563	162. ± 15.
94-Pu-238	σ_o-fiss 17.9 ± 0.4	0.9562	33. ± 5.
94-Pu-239	σ_o-capt 271.43 ± 2.14 σ_o-fiss 747.99 ± 1.87	1.1435 [4] 1.0563 ± 0.0022	200. ± 20. 301. ± 10.
94-Pu-240	σ_o-capt 289.5 ± 1.4	1.0264	8100. ± 200.
94-Pu-241	σ_o-capt 361.29 ± 4.95 σ_o-fiss 1012.68 ± 6.58	1.038 1.046 ± 0.006	179.9 [3] 572.6 [3]
94-Pu-242	σ_o-capt 18.5 ± 0.5	1.0096	1115. ± 40.
95-Am-241	σ_o(g)-capt 533. ± 13. σ_o(m)-capt 54. ± 5. σ_o(m+g)-capt 587. ± 12. [5] σ_o-fiss 3.20 ± 0.09	to be computed 1.051 0.996	1230. ± 100. 195. ± 20. 1425. ± 100. 14.4 ± 1.0
95-Am-242g	σ-fiss 2100. ±200. σ_o-capt 5500. [1]		1260. [1] 391. [1]
95-Am-242m	σ-capt 2000. ±600. σ_o-fiss 6950. ±280.	 1.104	246. [6] 1800. ± 65.
95-Am-243	σ_o-capt 75.1 ± 1.8 σ-fiss 0.1983± 0.0043	1.014	1820. ± 70. 9. ± 1.
96-Cm-242	σ-capt 16. ± 5. σ_o-fiss 5.064 [6]		110. ± 20. 20.0 [6]
96-Cm-243	σ_o-capt 130. ± 10. σ_o-fiss 617. ± 20.	1.005 1.0054	215. ± 20. 1570. ± 100.
96-Cm-244	σ_o-capt 15.2 ± 1.2 σ_o-fiss 1.04 ± 0.20	0.999 0.989	650. ± 30. 12.5 ± 2.5

[1] JENDL-3 data are used. There is a discrepancy between ENDF/B-6 and JENDL-3; no value given by Mughabghab [1]

[2] calculated from σ(abs) and g(abs), 574.7 ± 1.0 b and 0.9996 ± 0.0011, respectively

[3] σ_o cross sections for capture and fission taken from ENDF/B-6 standard, RI values taken from JENDL-3

[4] calculated from σ(abs) and g(abs), 1019.42 ± 2.9 b and 1.0768 ± 0.003, respectively

[5] Mughabghab's [1] value not in agreement with ENDF/B-6 (620 ± 13 b)

[6] value from JENDL-3; no values given in [1] and ENDF/B-6

[7] JENDL-3 contains more recent capture data, but without uncertainty: σ_o=37.0 barn, RI=445 barn.

A-6: Average number of neutrons emitted per fission($\bar{\nu}$)

Average number of total and prompt neutrons:

The average numbers of total neutrons for thermal neutron induced fission of U-233,235, Pu-239,241 and spontaneous fission of Cf-252 are taken from the most recent version of the internationally agreed standards file [1]. The prompt neutron data for the same reactions were calculated from the total and delayed neutron data.

For the other nuclides the average numbers of total and prompt neutrons for thermal neutron induced and spontaneous fission, which are identical within their uncertainties, are taken from [2], which is the only and most recent source that contains all these data. In the evaluation [2], all data were normalised to $\bar{\nu}$ of U-235 thermal neutron induced fission and Cf-252 spontaneous fission. The normalisation values used in [2] are almost identical to the standard values from [1]. $\bar{\nu}$ data as a function of incident neutron energy are included in the large data files, (e.g. ENDF/B-6 or JENDL-3). Some formulae of the energy-dependence can be found in [6], e.g. for U-235, U-238 and Pu-239.

No evaluations of total or prompt $\bar{\nu}$ data from fission in a fast reactor or fission neutron spectrum are available.

Average number of delayed neutrons:

The total delayed neutron yield is listed in the last column. A recent OECD/NEA committee meeting recommended [5] the use of delayed neutron yields evaluated from direct measurements rather than those obtained from summation calculations. (In the latter method, delayed neutron yields are derived from individual delayed neutron precursor data and fission yields, and there the charge distribution, which is uncertain in many cases, has a significant effect on the results.) Following this recommendation, the data of Tuttle [3], partially updated [5] by results of new measurements, are chosen for the tables. Recent results from summation calculations [4] are used for nuclides where no data are given in [3,5].

Source of data:

[1] ENDF/B-6 Standards file 1990 (available from Nuclear Data Centres upon request, when requested from NDS: documentation and data are in IAEA-NDS-88 see the help-pages for further informations).

[2] N.E. Holden and M.S. Zucker, Int. Conf. on Nuclear Data for Basic and Applied Science, Santa Fe, New Mexico, USA, 13-17 May 1985, proceedings p.1631.

[3] R.J. Tuttle, INDC(NDS)-107 (1979) 29

[4] R.W. Mills, Thesis, University of Birmingham (UK), March 1995: the most recent UKFY3 fission yields have been used.

[5] J. Blachot et al., "Status of Delayed Neutron Data - 1990", report NEACRP-L-323 (1990)

[6] J.Frehaut, "Coherent Evaluation of $\bar{\nu}_p$ for U-235, U-238 and Pu-239", Report NEANDC(E)238 (INDC(Fr)67), 1986.

ENDF/B-6: the US Evaluated Nuclear Data File, version 6

JENDL-3: the Japanese Evaluated Nuclear Data Library,version 3

The evaluated data files of complete ν data, as part of ENDF/B-6 and JENDL-3, are available from the 4 Data Centres (see Introduction for further information) upon request.

Table A-6.1: Average numbers of total, prompt and delayed neutrons from thermal neutron fission of U-233,5, Pu-239,41, Am-241, Cm-243,5 and spontaneous fission of Cm-242,4, Cf-252

nuclide	total	prompt	delayed
U -233	2.4946 ± 0.0040 [1]	2.4872 ± 0.0040 [1]	0.00667 ± 0.00029 [3]
U -235	2.4320 ± 0.0036 [1]	2.4153 ± 0.0036 [1]	0.0166 ± 0.0005 [5]
Pu-239	2.8815 ± 0.0052 [1]	2.8752 ± 0.0052 [1]	0.00654 ± 0.00026 [5]
Pu-241	2.9453 ± 0.0059 [1]	2.9301 ± 0.0059 [1]	0.0152 ± 0.0011 [3]
Am-241	3.22 ± 0.04 [2]	3.22 ± 0.04 [2]	0.00411 ± 0.00057 [4]
Cm-242	2.54 ± 0.02 [2]	2.54 ± 0.02 [2]	0.00125 ± 0.00033 [4]
Cm-243	3.43 ± 0.14 [2]	3.43 ± 0.14 [2]	0.00222 ± 0.00066 [4]
Cm-244	2.72 ± 0.02 [2]	2.72 ± 0.02 [2]	0.00330 ± 0.00098 [4]
Cm-245	3.75 ± 0.10 [2]	3.75 ± 0.10 [2]	0.00440 ± 0.00122 [4]
Cf-252	3.7676 ± 0.0049 [1]	3.7590 ± 0.0049 [1]	0.0086 ± 0.0010 [3]

Table A-6.2: Average numbers of delayed neutrons from fission in a fast reactor neutron spectrum

nuclide	average number of delayed neutrons
92-Th-232	0.0531 ± 0.0023 [3]
92-U -238	0.0439 ± 0.0010 [3]
94-Pu-240	0.0095 ± 0.0008 [3]
94-Pu-242	0.0221 ± 0.0026 [3]

A-7: Prompt neutron multiplicity distributions P(ν)

There are only 2 sets of evaluated prompt neutron multiplicity distributions for thermal neutron induced and spontaneous fission known to us. The data are reproduced below (no new data since preliminary issue).

Table 7.1: P(ν) values for thermal neutron induced fission (with uncertainties)

	U-233	U-235	Pu-239	Pu-241
0	0.0262 ± 0.0012	0.0317 ± 0.0015	0.0109 ± 0.0001	0.0108 ± 0.0005
1	0.1550 ± 0.0022	0.1720 ± 0.0014	0.0995 ± 0.0028	0.0895 ± 0.0014
2	0.3328 ± 0.0038	0.3363 ± 0.0031	0.2750 ± 0.0003	0.2660 ± 0.0017
3	0.3225 ± 0.0020	0.3038 ± 0.0004	0.3270 ± 0.0041	0.3313 ± 0.0041
4	0.1325 ± 0.0057	0.1268 ± 0.0036	0.2045 ± 0.0087	0.2140 ± 0.0039
5	0.0272 ± 0.0024	0.0266 ± 0.0026	0.0728 ± 0.0133	0.0749 ± 0.0050
6	0.0037 ± 0.0018	0.0026 ± 0.0009	0.0097 ± 0.0027	0.0112 ± 0.0024
7	0.0001 ± 0.0001	0.0002 ± 0.0001	0.0006 ± 0.0009	0.0023 ± 0.0013

<u>Source of data</u>:

N.E. Holden and M.S. Zucker, Nucl.Sci.Eng. 98 (1988) 174

Table 7.2: P(ν) values for spontaneous fission (without uncertainties)

	Cm-242	Cm-244	Cf-252
0	0.02125	0.01501	0.00217
1	0.14674	0.11617	0.02556
2	0.32675	0.29984	0.12541
3	0.32683	0.33316	0.27433
4	0.13751	0.18378	0.30517
5	0.03738	0.04298	0.18523
6	0.00259	0.00879	0.06607
7	0.00076	0.00027	0.01414
8	0.00019		0.00186
9			0.00006

<u>Source of data</u>:

N.E. Holden and M.S. Zucker, Int. Conf. on Nuclear Data for Basic and Applied Science, Santa Fe, New Mexico, USA, 13-17 May 1985; proceedings p. 1631.

A-8: Delayed neutron six-group parameters

An OECD/NEA committee recommended [1] the group parameters from the summation calculations of Brady and England [2] because of the overall consistency of the data and because the overall differences with experimental results (like [3]) were small enough so that the data of [2] can be used without sacrificing accuracy. Following this recommendation and because there was no new evaluation since then, we have adopted the group parameters of [2]. No evaluated group parameters for Cm-242,243,244 are presently available.

<u>Description of table entries</u>:

- λ = delayed neutron group decay constant
- α = ratio (del.neutron group yield)/(total del.neutr. yield)
- yield = delayed neutron group yield (in % per fission)

<u>References</u>:

[1] J. Blachot et al., "Status of Delayed Neutron Data - 1990", report NEACRP-L-323 (1990)
[2] C.M. Brady and T.R. England, Nucl.Sci.Eng. 103 (1989) 135
[3] G.R. Keepin, "Physics of Nuclear Kinetics", Addison-Wesley Publishing Co., Reading, Mass. (1965), tables on pages 86, 87 and 90

Table A-8: Delayed neutron six-group parameters from [2]

group	λ(sec^{-1})	α	yield (%)	λ(sec^{-1})	α	yield (%)
	90-Th-232 fast			**92-U-233 thermal**		
1	0.0131	0.0364	0.1933	0.0129	0.0674	0.0450
2	0.0350	0.1259	0.669	0.0333	0.1927	0.1285
3	0.1272	0.1501	0.797	0.1163	0.1383	0.0922
4	0.3287	0.4406	2.340	0.2933	0.2798	0.1866
5	0.9100	0.1663	0.883	0.7943	0.1128	0.0752
6	2.8206	0.0808	0.429	2.3751	0.2091	0.1395
	90-U-235 thermal			**92-U-238 fast**		
1	0.0133	0.0380	0.0631	0.0136	0.0139	0.0610
2	0.0325	0.1918	0.318	0.0313	0.1128	0.495
3	0.1219	0.1638	0.272	0.1233	0.1310	0.575
4	0.3169	0.3431	0.570	0.3237	0.3851	1.691
5	0.9886	0.1744	0.290	0.9060	0.2540	1.115
6	2.9544	0.0890	0.148	3.0487	0.1031	0.453
	94-Pu-238 fast			**94-Pu-239 thermal**		
1	0.0133	0.0377	0.0177	0.0133	0.0306	0.02001
2	0.0312	0.2390	0.112	0.0301	0.2623	0.1715
3	0.1162	0.1577	0.074	0.1135	0.1828	0.1196
4	0.2888	0.3562	0.167	0.2953	0.3283	0.2147
5	0.8561	0.1590	0.075	0.8537	0.1482	0.0969
6	2.7138	0.0504	0.0237	2.6224	0.0479	0.0313
	94-Pu-240 fast			**94-Pu-241 thermal**		
1	0.0133	0.0320	0.0304	0.0137	0.0167	0.0254
2	0.0305	0.2529	0.240	0.0299	0.2404	0.365
3	0.1152	0.1508	0.143	0.1136	0.1474	0.224
4	0.2974	0.3301	0.314	0.3078	0.3430	0.521
5	0.8477	0.1795	0.171	0.8569	0.1898	0.288
6	2.8796	0.0547	0.0520	3.0800	0.0627	0.095

group	λ(sec^{-1})	α	yield (%)	λ(sec^{-1})	α	yield (%)
	94-Pu-242 fast			95-Am-241 thermal		
1	0.0136	0.0196	0.0433	0.0133	0.0305	0.0118
2	0.0302	0.2314	0.511	0.0300	0.2760	0.1068
3	0.1154	0.1256	0.278	0.1145	0.1531	0.0592
4	0.3042	0.3262	0.721	0.2949	0.3122	0.1208
5	0.8272	0.2255	0.498	0.8818	0.1825	0.0706
6	3.1372	0.0716	0.158	2.6879	0.0457	0.0177
	96-Cm-245 thermal			98-Cf-252 spontaneous		
1	0.0134	0.0222	0.00988	0.0136	0.0124	0.0107
2	0.0307	0.1788	0.0796	0.0291	0.3052	0.262
3	0.1130	0.1672	0.0744	0.1068	0.1813	0.156
4	0.3001	0.3706	0.1649	0.3024	0.2992	0.257
5	0.8340	0.2054	0.0914	0.8173	0.1729	0.149
6	2.7686	0.0559	0.0249	2.6159	0.0290	0.0249

SECTION B: FISSION PRODUCT NUCLEAR DATA

The table below lists the fission products for which half-lives ($T_{1/2}$), γ-ray data and capture cross sections (σ) as well as branching fractions to isomeric states in decay (br) and **neutron capture** (not indicated below) are given in this Section.

nuclide	$T_{1/2}$	br	γ-rays	σ	nuclide	$T_{1/2}$	br	γ-rays	σ
Kr [1]				+	Cs-135				+
Br-85		+			Cs-137	+		+	+
Kr-85m		+			Ba-140	+		+	
Kr-85	+		+	+	La-140	+		+	
Zr [1]				+	Ce-141	+		+	
Zr-95	+	+	+	+	Pr-141				+
Nb-95m	+	+	+		Pr-143				+
Nb-95	+		+		Ce-144	+		+	+
Mo [1]				+	Pr-144	+		+	
Ru [1]				+	Nd [1]				+
Ru-103	+		+	+	Nd-147	+		+	+
Ru-106	+		+		Pm-147	+		+	+
Rh-106	+		+		Pm-148m	+	+	+	+
Sb-125	+		+		Pm-148	+		+	+
Xe [1]				+	Pm-149	+			+
I-131	+	+	+		Pm-151	+			+
Xe-131m	+	+	+		Sm [1]				+
I-133		+			Sm-151	+			+
Xe-133m	+	+			Sm-153	+			+
Xe-133	+		+	+	Eu-151				+
Cs-133				+	Eu-152				+
Cs-134	+	+	+	+	Eu-153				+
I-135	+	+			Eu-154	+	+	+	+
Xe-135m	+	+			Eu-155	+		+	+

[1] Stable isotopes for mass spectrometric measurements

Nuclides with A=147-153 are included for calculating the formation of Eu-154.

B-1: Half-lives and decay branching fractions

Table B-1.1: Half-lives and decay mode branching

Description of table entries:

decay mode: β- beta decay
IT isomeric transition
ec electron capture

units: s second, d day, m minute, y year=365.2422 days, h hour

rel err: relative error (in %)

branching: given for each decay mode (should sum up to 100%)

Source of data:

ENSDF file. Selected nuclides taken from IAEA-TECDOC-619, September, 1991.

nuclide	half-life units	half-life value	rel err	decay mode	braching (percent/decay)
36-Kr- 85	y	10.756 ± 0.018	(0.17)	ß-	100.000
40-Zr- 95	d	64.02 ± 0.04	(0.06)	ß-	100.000
41-Nb- 95m	d	3.608 ± 0.033	(0.92)	IT ß-	94.4 ± 0.6 5.6 ± 0.6
41-Nb- 95	d	34.975 ± 0.007	(0.02)	ß-	100.000
44-Ru-103	d	39.26 ± 0.02	(0.05)	ß-	100.000
44-Ru-106	y	1.0228 ± 0.0004	(0.04)	ß-	100.000
45-Rh-106	s	29.80 ± 0.08	(0.27)	ß-	100.000
51-Sb-125	y	2.7589 ± 0.0016	(0.06)	ß-	100.000
53-I -131	d	8.02070± 0.00011	(0.001)	ß-	100.000
54-Xe-131m	d	11.84 ± 0.07	(0.6)	IT	100.000
54-Xe-133m	d	2.19 ± 0.03	(1.4)	IT	100.000
54-Xe-133	d	5.243 ± 0.001	(0.02)	ß-	100.000
55-Cs-134	y	2.0648 ± 0.0010	(0.05)	ß- ec	99.9997 ± 0.0001 0.0003 ± 0.0001
53-I -135	h	6.57 ± 0.02	(0.3)	ß-	100.000
54-Xe-135m	m	15.29 ± 0.05	(0.33)	IT ß-	99.996 0.004
54-Xe-135	h	9.14 ± 0.02	(0.24)	ß-	100.000
55-Cs-137	y	30.18 ± 0.15	(0.5)	ß-	100.000
56-Ba-140	d	12.752 ± 0.003	(0.02)	ß-	100.000
57-La-140	d	1.6781 ± 0.0003	(0.01)	ß-	100.000

nuclide	half-life units	value	rel err	decay mode	braching (percent/decay)
58-Ce-141	d	32.501 ± 0.005	(0.03)	ß-	100.000
58-Ce-144	d	284.893 ± 0.008	(0.003)	ß-	100.000
59-Pr-144	m	17.28 ± 0.05	(0.29)	ß-	100.000
60-Nd-147	d	10.980 ± 0.010	(0.09)	ß-	100.000
61-Pm-147	y	2.6234 ± 0.0002	(0.01)	ß-	100.000
61-Pm-148m	d	41.29 ± 0.11	(0.27)	ß- IT	95.0 ± 0.4 5.0 ± 0.4
61-Pm-148	d	5.370 ± 0.009	(0.17)	ß-	100.000
61-Pm-149	d	2.2110 ± 0.0020	(0.09)	ß-	100.000
61-Pm-151	d	1.1830 ± 0.0016	(0.14)	ß-	100.000
62-Sm-151	y	90.0 ± 6.0	(6.7)	ß-	100.000
62-Sm-153	d	1.9280 ± 0.0041	(0.21)	ß-	100.000
63-Eu-154	y	8.593 ± 0.004	(0.09)	ß- ec	99.980 ± 0.010 0.020 ± 0.010
63-Eu-155	y	4.7611 ± 0.0013	(0.03)	ß-	100.000

Table B-1.2: Branching to daughters

Branching fractions are given for some important daughter products.

<u>Source of data</u>: ENSDF file

nuclide	daughter	branching (percent/decay)
35-Br- 85	36-Kr- 85	0.18 ± 0.0
36-Kr- 85m	36-Kr- 85	21.4 ± 0.4
40-Zr- 95	41-Nb- 95m	1.13 ± 0.007 [1])
53-I -131	54-Xe-131m	1.10 [1])
53-I -133	54-Xe-133m	2.88 ± 0.03 [1])
53-I -135	54-Xe-135m	15.7 ± 0.3 [1])

[1]) Branching to ground state = 100-branching to metastable state

B-2: Gamma ray energies and emission probabilities

Description of table entries:

1st column: fission product nuclide
2nd column: γ-ray energies and their uncertainties in keV
3rd column: γ-ray emission probabilities and their 1σ uncertainties in percent per decay and relative uncertainties (in %) in brackets.
4th column: systematic (relative) error contributions (in %) from conversion of relative to absolute intensities for each nuclide (included in the errors given in the 3rd column.)

Source of data:

E. Browne, R.B. Firestone: Table of Radioactive Isotopes (V.S. Shirley, ed.), John Wiley & Sons, NY, 1986. Updates to this handbook from the Berkeley decay data file (data derived from ENSDF), E. Browne, private communication, 1986/87.

Note: The data were revised in October 1997. Updated values of energies and emission probabilities were taken from the ENSDF data file as retrieved by MEDLIST program, the version dated May 1997.

Table B-2:

nuclide	**energy (keV)**	**emission probability (percent per decay)**	**syst. err.**
36-Kr-85	513.997 ± 0.005	0.434 ± 0.010 (2.3)	2.27
40-Zr-95	235.680 ± 0.020	0.294 ± 0.016 (5.5)	0.18
	724.1990 ± 0.0050	44.17 ± 0.13 (0.36)	
	756.729 ± 0.012	54.46 ± 0.10 (0.18)	
41-Nb-95m	235.680 ± 0.020	24.9 ± 0.8 (3.2)	0.6
41-Nb-95	765.807 ± 0.006	99.81 ± 0.03 (0.03)	0.03
44-Ru-103	53.2770 ± 0.0087	0.443 ± 0.011 (2.5)	1.12
	294.980 ± 0.019	0.303 ± 0.006 (2.0)	
	443.777 ± 0.012	0.345 ± 0.005 (1.5)	
	497.054 ± 0.010	91.0 ± 1.3 (1.4)	
	557.022 ± 0.014	0.868 ± 0.012 (1.4)	
	610.330 ± 0.02	5.76 ± 0.07 (1.2)	
45-Rh-106	511.8640 ± 0.0031	20.4 ± 0.4 (2.0)	2.9
	616.22 ± 0.09	0.738 ± 0.031 (4.2)	
	621.93 ± 0.06	9.93 ± 0.23 (2.3)	
	873.49 ± 0.05	0.439 ± 0.011 (2.5)	
	1050.360 ± 0.048	1.56 ± 0.05 (3.2)	
	1128.042 ± 0.021	0.404 ± 0.01 (2.5)	
	1562.219 ± 0.048	0.163 ± 0.004 (2.5)	
	1766.25 ± 0.05	0.03427± 0.0013 (3.8)	
	1796.931 ± 0.054	0.02774± 0.0011 (4.0)	
	1927.22 ± 0.09	0.0153 ± 0.0006 (3.9)	
	1988.595 ± 0.093	0.02611± 0.0011 (4.2)	
	2112.599 ± 0.088	0.0340 ± 0.0020 (5.9)	
	2366.04 ± 0.07	0.02326± 0.0012 (5.2)	
	2405.96 ± 0.09	0.0140 ± 0.0008 (6.4)	
51-Sb-125	35.4910 ± 0.0005	4.29 ± 0.18 (4.2)	1.00
	172.626 ± 0.021	0.1820 ± 0.0040 (2.2)	
	176.316 ± 0.010	6.79 ± 0.15 (2.2)	

nuclide	energy (keV)	emission probability (percent per decay)	syst. err.
51-Sb-125	380.452 ± 0.008	1.520 ± 0.034 (2.2)	
	427.875 ± 0.006	29.44 ± 0.66 (2.2)	
	463.365 ± 0.004	10.45 ± 0.23 (2.2)	
	600.600 ± 0.004	17.78 ± 0.40 (2.2)	
	606.718 ± 0.003	5.02 ± 0.11 (2.2)	
	635.954 ± 0.005	11.32 ± 0.25 (2.2)	
	671.445 ± 0.004	1.800 ± 0.044 (2.4)	
53-I -131	80.185 ± 0.002	2.62 ± 0.04 (1.5)	0.99
	284.305 ± 0.005	6.14 ± 0.07 (1.1)	
	364.489 ± 0.005	81.7 ± 0.8 (1.0)	
	636.989 ± 0.004	7.17 ± 0.10 (1.4)	
	642.719 ± 0.005	0.2190 ± 0.0049 (2.2)	
	722.911 ± 0.005	1.77 ± 0.03 (1.7)	
54-Xe-131m	163.9310 ± 0.0068	1.960 ± 0.059 (3.0)	3.0
54-Xe-133	80.997 ± 0.003	38.0 ± 0.7 (1.8)	2.7
55-Cs-134	475.365 ± 0.002	1.486 ± 0.010 (0.7)	1.00
	563.246 ± 0.005	8.35 ± 0.04 (0.5)	
	569.331 ± 0.003	15.38 ± 0.06 (0.4)	
	604.721 ± 0.002	97.62 ± 0.03 (0.03)	
	795.864 ± 0.004	85.53 ± 0.04 (0.05)	
	801.953 ± 0.004	8.69 ± 0.04 (0.5)	
	1038.610 ± 0.007	0.988 ± 0.004 (0.4)	
	1167.968 ± 0.005	1.789 ± 0.007 (0.4)	
	1365.185 ± 0.014	3.014 ± 0.012 (0.4)	
55-Cs-137	661.6600 ± 0.0030	85.1 ± 0.2 (0.24)	0.24
56-Ba-140	29.966 ± 0.001	14.1 ± 0.5 (3.5)	0.90
	132.687 ± 0.001	0.202 ± 0.005 (2.5)	
	162.660 ± 0.001	6.22 ± 0.08 (1.3)	
	304.849 ± 0.003	4.29 ± 0.05 (1.2)	
	423.722 ± 0.001	3.15 ± 0.04 (1.3)	
	437.575 ± 0.002	1.929 ± 0.01 (0.5)	
	537.261 ± 0.009	24.39 ± 0.08 (0.3)	
57-La-140	109.4070 ± 0.0064	0.219 ± 0.004 (1.8)	0.08
	131.1130 ± 0.0072	0.467 ± 0.010 (2.1)	
	173.5290 ± 0.0085	0.127 ± 0.004 (3.1)	
	241.9540 ± 0.0081	0.414 ± 0.008 (1.9)	
	266.5490 ± 0.0080	0.466 ± 0.008 (1.7)	
	328.7570 ± 0.0089	20.3 ± 0.3 (1.5)	
	397.6620 ± 0.0090	0.073 ± 0.005 (6.8)	
	432.493 ± 0.012	2.90 ± 0.03 (1.0)	
	487.026 ± 0.018	45.5 ± 0.6 (1.3)	
	751.637 ± 0.018	4.33 ± 0.04 (0.9)	
	815.783 ± 0.020	23.28 ± 0.2 (0.9)	
	867.846 ± 0.020	5.50 ± 0.07 (1.3)	
	919.550 ± 0.023	2.66 ± 0.03 (1.1)	
	925.189 ± 0.020	6.90 ± 0.07 (1.0)	
	950.99 ± 0.03	0.519 ± 0.007 (1.3)	
	1596.21 ± 0.04	95.400 ± 0.076 (0.08)	
	2347.88 ± 0.05	0.849 ± 0.017 (2.0)	
	2521.40 ± 0.05	3.46 ± 0.04 (1.2)	
	2547.34 ± 0.11	0.1030 ± 0.0028 (2.7)	
	2899.61 ± 0.16	0.0650 ± 0.0019 (2.9)	
	3118.51 ± 0.16	0.0250 ± 0.0009 (3.5)	
58-Ce-141	145.4400 ± 0.0028	48.2 ± 0.3 (0.6)	0.80

nuclide	energy (keV)	emission probability (percent per decay)		syst. err.
58-Ce-144	80.120 ± 0.005	1.36 ± 0.06	(4.4)	1.44
	133.5150 ± 0.002	11.09 ± 0.20	(1.8)	
59-Pr-144	696.510 ± 0.003	1.342 ± 0.014	(1.0)	1.04
	1489.160 ± 0.005	0.278 ± 0.005	(1.8)	
	2185.662 ± 0.007	0.694 ± 0.016	(2.3)	
60-Nd-147	91.105 ± 0.002	27.9 ± 1.1	(3.9)	3.9
	275.385 ± 0.013	0.801 ± 0.059	(7.4)	
	319.414 ± 0.013	1.95 ± 0.14	(6.9)	
	398.155 ± 0.016	0.871 ± 0.065	(7.5)	
	439.910 ± 0.016	1.20 ± 0.10	(8.0)	
	531.013 ± 0.016	13.09 ± 0.89	(6.8)	
61-Pm-147	121.258 ± 0.043	0.0020 ± 0.0001	(3.9)	3.9
61-Pm-148m	75.70 ± 0.10	1.0210 ± 0.0076	(0.75)	0.75
	98.479 ± 0.017	2.473 ± 0.066	(2.7)	
	189.645 ± 0.016	1.091 ± 0.026	(2.4)	
	288.124 ± 0.016	12.51 ± 0.13	(1.0)	
	311.634 ± 0.015	3.90 ± 0.06	(1.5)	
	414.071 ± 0.013	18.59 ± 0.21	(1.1)	
	432.763 ± 0.017	5.33 ± 0.08	(1.5)	
	501.279 ± 0.016	6.72 ± 0.09	(1.3)	
	550.274 ± 0.015	94.5 ± 1.0	(1.0)	
	599.757 ± 0.016	12.49 ± 0.15	(1.2)	
	611.270 ± 0.015	5.46 ± 0.12	(2.1)	
	629.962 ± 0.016	88.63 ± 0.66	(0.75)	
	725.704 ± 0.014	32.7 ± 0.4	(1.2)	
	915.348 ± 0.015	17.10 ± 0.22	(1.3)	
	1013.827 ± 0.015	20.20 ± 0.23	(1.1)	
61-Pm-148	550.274 ± 0.015	22.00 ± 0.66	(3.0)	2.25
	611.270 ± 0.015	1.021 ± 0.031	(3.0)	
	914.850 ± 0.016	11.46 ± 0.34	(3.0)	
	1465.120 ± 0.018	22.20 ± 0.50	(2.3)	
63-Eu-154	123.071 ± 0.001	40.6 ± 0.4	(1.0)	5.6
	188.252 ± 0.008	0.239 ± 0.005	(2.1)	
	247.9670 ± 0.0074	6.91 ± 0.05	(0.7)	
	401.258 ± 0.014	0.209 ± 0.014	(6.6)	
	444.490 ± 0.006	0.562 ± 0.006	(1.0)	
	478.292 ± 0.041	0.217 ± 0.014	(6.5)	
	557.627 ± 0.026	0.268 ± 0.003	(1.1)	
	582.061 ± 0.027	0.889 ± 0.009	(1.0)	
	591.762 ± 0.005	4.96 ± 0.04	(0.8)	
	625.254 ± 0.007	0.318 ± 0.004	(1.2)	
	676.600 ± 0.012	0.157 ± 0.007	(4.5)	
	692.425 ± 0.004	1.792 ± 0.015	(0.8)	
	715.828 ± 0.022	0.188 ± 0.009	(4.8)	
	723.305 ± 0.005	20.11 ± 0.15	(0.7)	
	756.804 ± 0.005	4.54 ± 0.04	(0.9)	
	815.585 ± 0.017	0.513 ± 0.005	(1.0)	
	845.417 ± 0.029	0.588 ± 0.005	(0.9)	
	850.687 ± 0.029	0.242 ± 0.004	(1.6)	
	873.19 ± 0.005	12.20 ± 0.08	(0.7)	
	892.781 ± 0.009	0.515 ± 0.005	(1.0)	
	904.076 ± 0.006	0.893 ± 0.007	(0.8)	
	996.262 ± 0.006	10.53 ± 0.07	(0.7)	
	1004.725 ± 0.007	17.91 ± 0.12	(0.7)	
	1047.370 ± 0.034	0.134 ± 0.015	(10.)	
	1118.293 ± 0.043	0.1030 ± 0.0067	(6.5)	
	1128.560 ± 0.008	0.318 ± 0.004	(1.3)	
	1140.711 ± 0.009	0.216 ± 0.014	(6.4)	

nuclide	energy (keV)	emission probability (percent per decay)	syst. err.
63-Eu-154	1241.393 ± 0.043	0.133 ± 0.005 (3.6)	
	1246.150 ± 0.009	0.864 ± 0.007 (0.8)	
	1274.436 ± 0.006	35.0 ± 0.3 (0.8)	
	1494.048 ± 0.009	0.700 ± 0.008 (1.1)	
	1596.495 ± 0.018	1.788 ± 0.015 (0.8)	
63-Eu-155	45.2972 ± 0.0013	1.33 ± 0.03 (2.3)	6.5
	60.0086 ± 0.0010	1.13 ± 0.05 (4.4)	
	86.0660 ± 0.0047	0.150 ± 0.016 (10.7)	
	86.5420 ± 0.0020	30.7 ± 0.7 (2.3)	
	105.3120 ± 0.0020	21.2 ± 0.5 (2.4)	

B-3: Thermal neutron capture cross sections and resonance integrals

The main reference used for fission product cross section data are the evaluations by Gryntakis [1] and Mughabghab [2,3]. The more recent data files ENDF/B-6 [7] or JENDL-3 [6] were rarely used because they do not contain data uncertainties (except in the text information for some nuclides in ENDF/B-6). The compilation by De Corte [4] was not used (except in one case) because recommended data are not given for all fission products.

The thermal cross sections in [1] agree with those in [2] or [3] in almost all cases, and the values are taken from [1] (more recent) unless indicated by footnotes.

The agreement for resonance integrals is not so good. In cases of differences the data were selected by comparison to ENDF/B-6 and JENDL-3 and/or by one of the following criteria (special cases are indicated by footnotes):

The values of [1] were chosen when:

- no resonance integral is given in [2] or [3], or
- more recent measurements were included in [1], or
- the resonance integral given in [2] or [3] was calculated from resonance parameters, but did not include more recent measurements.

The values of [2] or [3] were chosen when:

- more recent measurements were included, or
- the value in [1] was deduced from old measurements only, and the value in [2] or [3] was calculated from resonance parameters (indicated by "C") which often included more recent measurements.

NOTE: The data were revised in October 1997. Comparison was made with the most recent libraries JEF-2.2 and JENDL-3.2. The changes were made only in cases when new measurements justified them.

<u>Description of table entries</u>:

The second column describes the thermal neutron cross section of the following type:

σ_o	2200 m/s cross section
σ	Maxwellian average cross section (kT = 0.0253 eV)
σ_r	cross section in a thermal reactor neutron spectrum
m	cross section leading to a metastable state of product
g	cross section leading to ground state of product
m+g	sum cross section

Resonance Integral: Infinite dilution resonance integral including the 1/v part, "Ref." gives the source of the tabulated resonance integral, "C" stands for calculation from resonance parameters.

<u>Source of data</u>:

[1] G. Gryntakis et al., Thermal Neutron Cross Sections and Infinite Dilution Resonance Integrals, in "Handbook on Nuclear Activation Data", IAEA Technical Report Series No. 273 (1987), page 199

[2] S.F. Mughabghab et al., Neutron Cross Sections Vol. 1: Resonance Parameters and Thermal Cross Sections, Part A: Z=1-60; Academic Press, NY, 1981

[3] S.F. Mughabghab, Neutron Cross Sections Vol. 1: Resonance Parameters and Thermal Cross Sections, Part B: Z=61-100; Academic Press, NY, 1984

[4] F. De Corte et al., J. Radioanal.Nucl.Chem. 133(1989)53

[5] JEF-2.2: the Joint European File, NEADB, Paris

[6] JENDL-3.2: the Japanese Evaluated Nuclear Data Library

[7] ENDF/B-6: the US Evaluated Nuclear Data File, version 6

The evaluated data files of complete σ(E) data, ENDF/B-6 and JENDL-3.2 are available from the 4 Data Centres (see Introduction) upon request.

Table B-3:

Nuclide	Thermal neutron cross section (b)			Resonance Integral (b)		Ref.
36-Kr-82	σ	30.0 ± 10.0		C	190.0 ± 20.0	[1]
83	σ	180.0 ± 30.0		C	183.0 ± 25.0	[2]
84	σ(m)	0.090 ± 0.013			2.4	[1]
	σ(g)	0.042 ± 0.004			0.8	[1]
	σ(m+g)	0.110 ± 0.015			3.2 ± 0.5	[1]
85	σ	1.66 ± 0.2			1.8 ± 1.0	[1,2]
86	σ	0.003 ± 0.002			0.1 ± 0.04	[1]
40-Zr-90	σ	0.011 ± 0.005		C	0.14	[2]
91	σ	1.24 ± 0.25			6.8 ± 1.3	[1]
92	σ	0.22 ± 0.06			0.63 ± 0.11	[1]
93	σ	2.6 ± 1.4			20.0 ± 10.0	[1]
94	σ	0.0499± 0.0024			0.30 ± 0.07	[1]
95	σ.	0.49			6.5 ± 1.4	[1]
96	σ	0.0229± 0.0010			5.3 ± 0.3	[5]
42-Mo-95	σ	14.0 ± 0.5		C	109.0 ± 5.0	[2]
96	σ	0.5 ± 0.2			24.0 ± 4.0	[1]
97	σ	2.1 ± 0.5		C	14.0 ± 3.0	[2]
98	σ.	0.130 ± 0.006			6.9 ± 0.3	[5]
100	σ	0.199 ± 0.003			3.75 ± 0.15	[2]
44-Ru-100	σ.	5.0 ± 0.6			11.0 ± 0.7	[1]
101	σ.	3.4 ± 0.9			88.0 ± 17.0	[1]
102	σ.	1.21 ± 0.07			4.2 ± 0.1	[2]
103	σ	7.71			60.0 ± 20.0	[1]
104	σ.	0.32 ± 0.02			4.3 ± 0.1	[2]
106	σ	0.146 ± 0.045			1.8 ± 0.4	[1]
54-Xe-130	σ.(m)	0.45 ± 0.10		C	1.17	[1]
	σ.(g)	6.0 ± 1.0		C	13.72	[1]
	σ.(m+g)	6.45 ± 1.0		C	14.89	[1]
131	σ.	85.0 ± 10.0			900.0 ± 100.0	[2]
132	σ.(m)	0.050 ± 0.010			0.9 ± 0.2	[1,2]
	σ.(m+g)	0.450 ± 0.060			4.6 ± 0.6	[1,2]
133g	σ_r	190.0 ± 90.0			134	
	σ.(m)	0.003 ± 0.0003			0.1	[1]
	σ.(m+g)	0.265 ± 0.020			0.3	[1]
	σ.	(2.65 ± 0.11) E+06		C	7600.0 ± 500.	[2]
136	σ.	0.26 ± 0.02			0.74 ± 0.21	[1,2]
55-Cs-133	σ.(m)	2.5 ± 0.2			30.0 ± 6.0	[1]
	σ.(m+g)	29.0 ± 1.5			422.0 ± 23.0	[1]
134g	σ_r	140.0 ± 12.0			106.0	[6]
135	σ	8.7 ± 0.5			66.0 ± 8.0	[1]
137g	σ_r(g)	0.110 ± 0.033			0.35 ± 0.07	[6]
58-Ce-144g	σ	1.0 ± 0.1			2.6 ± 0.3	[1,2]

Nuclide	Thermal neutron cross section (b)	Resonance Integral (b)	Ref.
59-Pr-141	$\sigma_{\cdot}$(m) 3.9 ± 0.3		
143	$\sigma_{\cdot}$(m+g) 11.5 ± 0.3	17.8 ± 3.5	[1]
	σ 90.0 ± 10.0	190.0 ± 25.0	[2]
60-Nd-142	σ 18.7 ± 0.7	8.5 ± 1.0	[1]
143	$\sigma_{\cdot}$ 325.0 ± 10.0	136.0 ± 35.0	[1]
144g	σ 3.6 ± 0.3	5.0 ± 1.0	[1]
145	$\sigma_{\cdot}$ 42.0 ± 2.0	255.0 ± 40.0	[1]
146	$\sigma_{\cdot}$ 1.4 ± 0.1	2.7 ± 0.4	[1]
147	σ 440.0 ± 150.0	540.0 ± 150.0	[1]
148	$\sigma_{\cdot}$ 2.5 ± 0.2	14.0 ± 1.5	[1,2]
150	$\sigma_{\cdot}$ 1.2 ± 0.2	14.5 ± 2.0	[1,2]
61-Pm-147	σ(m) 85.0 ± 5.0	910.0 ± 265.0	[1] 1)
	σ(g) 96.0 ± 2.0	1320.0 ± 85.0	[1]
	σ(m+g) 181.0 ± 7.0	2230.0 ± 70.0	[1] 2)
148m	σ 22000.0 ±2500.0	3600.0 ±2400.0	[1,3]
148g	σ_r 2000.0 ±1000.0	2510.0	[6]
149	σ 1400.0 ± 300.0	825.0 ± 50.0	[1]
151	σ 173.0	1400.0 ± 400.0	[1]
62-Sm-147	σ 64.0 ± 5.0	650.0 ± 50.0	[1]
148	σ 2.7 ± 0.6	27.0 ± 14.0	[1,3]
149	σ 41000.0 ±2000.0	3700.0 ± 400.0	[1]
150	$\sigma_{\cdot}$ 102.0 ± 5.0	358.0 ± 50.	[3]
151	σ 15000.0 ±1800.0	3100.0 ± 500.0	[1]
152	$\sigma_{\cdot}$ 206.0 ± 6.0	2960.0 ± 150.0	[1]
153	$\sigma_{\cdot}$ 420.0 ± 180.0 3)	3700.0 ±2000.0	[1]
154	$\sigma_{\cdot}$ 7.74 ± 0.46 4)	33.3 ± 3.0	[4] 4)
63-Eu-151	σ(m2) 4.2 ± 2.0		
	σ(m1) 3211.0 ± 82.0	1823.0 ± 146.0	[1]
	σ(g) 5935.0 ± 73.0	3552.0 ± 264.0	[1]
	σ(total) 9146.0 ± 109.0	5367.0 ± 263.0	[1]
152	σ 12800.0 ± 600.	2170.0	[6]
153	$\sigma_{\cdot}$ 312.0 ± 7.0 5)	1420.0 ± 100.0	[3] 5)
154g	$\sigma_{\cdot}$ 1500.0 ± 400.0	1500.0 ± 450.0	[1]
155	σ_r 4040.0 ± 125.0 6)	1680.0 ± 300.0	[1]
	σ 3950.0 ± 125.0 6)	C 23200.0 ± 300.0	[3] 6)

1) Original value in [1] = 1045 ± 265 b, adjusted here (within the error limits) to give the correct sum (m+g).

2) Te higher value of [1] is supported by the data from JENDL-3 (2199 b) and ENDF/B-6 (2197 b), whereas [3] gives 2064 ± 100 b.

3) [3] used, as uncertainty is given. Other values: 334.5 b [1], 420.2 b (JENDL-3), 330 b (ENDF/B-6).

4) Taken from [4] because of discrepancies between [1] and [3].

5) [1] gives 603 and 3414 b respectively, but recent evaluations ([4], ENDF/B-6) support the lower values.

6) Both sets of data given for comparison. Other values: ENDF/B-6: same as [3], JENDL-3: 4071 b and 6755 b respectively.

SECTION C: FISSION PRODUCT YIELDS

The tables contain yield sets from the US and UK evaluated fission yield files, which result from the presently largest evaluation efforts. This is in accordance with the recommendations of an IAEA Coordinated Research Programme on the Compilation and Evaluation of Fission Yield Nuclear Data that not a single set of fission yields should be recommended. A third file of fission yield data from China is presently being revised; it is expected that it can be included in the future.

C-1: Chain yields and selected cumulative yields

Fission yields are given for thermal neutron fission of U-233,235, Pu-239,241 and for fast neutron fission of Th-232 and U-238. The Tables contain cumulative and chain yields ≥0.01-0.001 %. In addition, the most important ternary fission yields are presented. Cumulative yields are given seperatly only if they differ significantly from the respective chain yields, or for some important fission products to show the (even small) difference.

Description of table entries:

FP: Chain yields are indicated by "A=". Otherwise the nuclide is listed for which the cumulative yield is given.

The fission yield values are given in percent per fission and tabulated in 2 different representations as extracted from the files:

US file: fixed point numbers and relative errors (in %)
UK file: floating point numbers and absolute errors

Source of data:

US file: ENDF/B-6 Fission Yield File
UK file: R.W. Mills, "UKFY3",the latest update of the UK library of independent and cumulative fission product yields, in ENDF-6 format (1996). The file UKFY3 contains also several other tables of fission yield data and discrepances.

Both the US file and the UK file are available on magnetic tape from the Data Centers.

Table C-1.1: Th-232 fast fission

FP	US file	error (%)	UK file	error
H - 3			7.0030- 3	2.2139- 3
He- 3			7.0081- 3	2.2139- 3
He- 4			1.0164- 1	3.1047- 2
A= 77	0.011765	8.	1.0903- 2	2.6793- 3
A= 78	0.03528	11.	3.2701- 2	1.0566- 2
A= 79	0.076873	11.	8.8309- 2	2.6661- 2
A= 80	0.194213	16.	2.1836- 1	6.5647- 2
A= 81	0.469835	11.	5.0116- 1	1.5023- 1
A= 82	1.075426	16.	1.0746+ 0	3.0393- 1
A= 83	2.169280	2.0	1.9980+ 0	4.2049- 1
A= 84	4.026097	1.4	4.4033+ 0	7.2294- 1
Kr-85	0.8334	1.4	9.9431- 1	2.3040- 1

FP	US file	error (%)	UK file	error
A= 85	4.167428	1.4	4.6596+ 0	8.7907- 1
A= 86	6.587601	2.0	6.9370+ 0	1.1514+ 0
A= 87	7.073593	2.8	6.7234+ 0	1.2404+ 0
A= 88	7.260427	2.0	6.9651+ 0	1.2050+ 0
A= 89	7.467815	2.8	7.3129+ 0	1.0932+ 0
A= 90	7.924058	4.0	8.0327+ 0	1.2038+ 0
A= 91	7.363992	2.0	7.0022+ 0	8.5668- 1
A= 92	6.920399	2.8	7.1301+ 0	1.3574+ 0
A= 93	6.697280	4.0	6.1532+ 0	1.1564+ 0
A= 94	5.562996	4.0	5.5177+ 0	8.8801- 1
A= 95	5.652666	2.0	5.6274+ 0	8.9501- 1
A= 96	4.776764	16.	5.0207+ 0	1.3514+ 0
A= 97	4.425500	2.0	4.3891+ 0	8.6974- 1
A= 98	3.680042	6.	3.5875+ 0	9.7598- 1
A= 99	2.944060	2.0	2.8882+ 0	4.5217- 1
A=100	1.370638	6.	1.6104+ 0	5.1890- 1
A=101	0.713542	11.	8.1881- 1	2.7335- 1
A=102	0.367805	11.	3.6240- 1	9.2444- 2
A=103	0.155461	4.0	1.5417- 1	9.1892- 3
A=104	0.090313	11.	8.7640- 2	2.1156- 2
A=105	0.051481	2.8	7.0452- 2	2.6677- 3
A=106	0.048561	8.	5.4287- 2	6.8126- 3
A=107	0.051075	11.	5.3308- 2	1.4256- 2
A=108	0.061347	16.	5.3368- 2	1.7554- 2
A=109	0.066215	4.0	5.3076- 2	1.6976- 3
A=110	0.070997	16.	5.8727- 2	1.7396- 2
A=111	0.071619	6.	6.4551- 2	1.5117- 2
A=112	0.078263	6.	6.8870- 2	1.6900- 2
A=113	0.078066	4.0	6.8001- 2	2.2248- 2
A=114	0.073423	16.	6.7013- 2	2 2151- 2
A=115	0.077003	2.8	6.5799- 2	1.7689- 2
A=116	0.073801	16.	6.7917- 2	2.1911- 2
A=117	0.073822	2.8	6.8008- 2	2.1907- 2
A=118	0.063281	11.	6.7678- 2	2.1940- 2
A=119	0.057210	16.	6.6878- 2	1.8948- 2
A=120	0.054327	16.	6.5682- 2	1.5725- 2
A=121	0.048821	6.	6.4106- 2	2.0746- 2
A=122	0.036527	16.	6.2161- 2	1.9943- 2
A=123	0.029354	16.	5.9945- 2	1.9410- 2
A=124	0.026475	16.	5.7677- 2	1.8689- 2
A=125	0.032954	11.	5.6283- 2	1.8254- 2
A=126	0.048129	16.	5.9543- 2	1.9303- 2
A=127	0.101355	4.0	8.0179- 2	1.4860- 2
A=128	0.182599	16.	1.7189- 1	5.5112- 2
A=129	0.252076	4.0	4.5684- 1	1.9401- 1
A=130	0.945582	11.	9.0836- 1	2.7901- 1
Xe-131m	0.022692	4.0	1.6682- 2	2.7551- 3
A=131	1.620949	2.0	1.5445+ 0	2.5507- 1
A=132	2.968856	1.4	2.6562+ 0	4.2986- 1
Xe-133m	0.1165	4.0	1.3399- 1	2.1319- 2

FP	US file	error (%)	UK file	error
A=133	4.046220	2.0	4.6516+ 0	7.2172- 1
A=134	5.351795	2.0	5.8608+ 0	8.8907- 1
Xe-135m	0.8187	4.0	8.9306- 1	1.5385- 1
Xe-135	5.5280	2.0	5.7023+ 0	9.9094- 1
A=135	5.528784	2.0	5.7026+ 0	8.8759- 1
A=136	5.621469	2.0	5.6481+ 0	8.1524- 1
A=137	5.839457	4.0	6.5851+ 0	1.2133+ 0
A=138	6.449821	6.	6.3826+ 0	1.0056+ 0
A=139	7.096623	2.0	7.3978+ 0	1.1414+ 0
A=140	7.877878	2.0	7.7204+ 0	1.2160+ 0
A=141	7.463862	2.8	7.0915+ 0	9.7706- 2
A=142	6.540381	2.8	6.3190+ 0	1.3528+ 0
A=143	6.647205	2.0	6.2965+ 0	1.0190+ 0
A=144	7.916097	2.8	7.2697+ 0	1.1770+ 0
A=145	5.338663	2.0	5.1219+ 0	8.8866- 1
A=146	4.554332	2.8	3.6439+ 0	9.8019- 1
A=147	2.978662	2.8	2.8614+ 0	1.6487- 1
A=148	2.005246	2.8	1.8882+ 0	3.5169- 1
A=149	1.083641	4.0	1.1366+ 0	2.7409- 1
A=150	0.561977	23.	8.9271- 1	3.3157- 1
A=151	0.363657	6.	4.0995- 1	8.8839- 2
A=152	0.075545	16.	3.1624- 1	1.0866- 1
A=153	0.031009	11.	2.0441- 1	4.8310- 2
A=154	0.006876	23.	6.3121- 2	2.0881- 2
A=155	0.003617	23.	1.5829- 2	5.1861- 3
A=156	0.002690	8.	2.5201- 3	7.0574- 4
A=157	0.000932	23.	8.6279- 4	3.6382- 4

Table C-1.2: U-233 thermal fission

FP	US file	error (%)	UK file	error
H - 2			8.4660- 4	2.2832- 4
He- 3			9.6910- 3	2.3320- 3
A= 75	0.007981	23.	0.6584- 3	0.1001- 3
A= 76	0.013847	23.	1.7072- 2	2.4978- 3
A= 77	0.025959	16.	4.1328- 2	5.2760- 3
A= 78	0.053838	16.	6.6576- 2	8.6450- 3
A= 79	0.143515	16.	1.3472- 1	1.7242- 2
A= 80	0.234071	16.	2.6259- 1	3.3735- 2
A= 81	0.367786	4.	3.8190- 1	5.0796- 2
A= 82	0.586339	2.8	5.9895- 1	8.0280- 2
A= 83	1.014543	1.0	1.0827+ 0	1.4597- 1
A= 84	1.689426	1.0	1.6937+ 0	2.2116- 1
Kr-85	0.52340	0.35	5.2674- 1	7.2449- 2
A= 85	2.237148	1.0	2.1956+ 0	2.9347- 1
A= 86	2.844415	1.4	3.0777+ 0	4.0054- 1
A= 87	4.018205	1.4	4.0428+ 0	4.8337- 1

FP	US file	error (%)	UK file	error
A= 88	5.465197	1.4	5.5670+ 0	6.8688- 1
A= 89	6.340165	1.4	6.2179+ 0	7.9010- 1
A= 90	6.789072	1.4	6.7451+ 0	8.7165- 1
A= 91	6.485957	1.0	6.5631+ 0	7.7747- 1
A= 92	6.552445	1.0	6.4868+ 0	7.9808- 1
A= 93	6.978996	1.0	6.7946+ 0	8.7873- 1
A= 94	6.831345	1.4	6.7049+ 0	8.8898- 1
Zr-95	6.3490	2.	6.2669+ 0	8.1974- 1
Nb-95m	0.063524	2.	6.9731- 2	9.1198- 3
A= 95	6.349605	1.0	6.2678+ 0	8.4540- 1
A= 96	5.678962	1.0	5.6549+ 0	7.6178- 1
A= 97	5.515746	1.0	5.5004+ 0	6.7437- 1
A= 98	5.189312	1.0	5.1883+ 0	6.6600- 1
A= 99	4.910973	1.4	5.0432+ 0	6.5972- 1
A=100	4.459039	1.4	4.4144+ 0	5.8134- 1
A=101	3.171242	1.4	3.2493+ 0	4.3151- 1
A=102	2.402804	1.0	2.4643+ 0	3.2791- 1
A=103	1.573207	2.	1.4597+ 0	1.9100- 1
A=104	0.980193	2.	9.5898- 1	1.3127- 2
A=105	0.495809	2.8	4.9628- 1	6.5199- 2
A=106	0.246245	2.	2.4968- 1	3.2990- 2
A=107	0.114532	4.	1.1498- 1	1.6312- 2
A=108	0.075767	4.	7.8859- 2	1.1238- 2
A=109	0.039405	16.	4.1746- 2	6.0542- 3
A=110	0.038664	4.	3.9207- 2	5.5531- 3
A=111	0.021600	8.	2.4458- 2	3.5046- 3
A=112	0.013304	8.	1.4221- 2	2.0306- 3
A=113	0.013562	11.	1.5813- 2	2.4853- 3
A=114	0.012860	11.	1.7384- 2	2.7912- 3
A=115	0.014982	6.	1.8971- 2	2.6071- 3
A=116	0.013202	16.	1.7651- 2	2.7065- 3
A=117	0.014124	11.	1.5213- 2	2.1179- 3
A=118	0.015417	11.	1.5681- 2	2.1887- 3
A=119	0.018558	16.	1.5955- 2	2.1935- 3
A=120	0.021829	8.	1.7653- 2	2.3884- 3
A=121	0.023082	8.	1.8586- 2	2.6069- 3
A=122	0.040969	8.	1.9598- 2	2.7501- 3
A=123	0.060415	23.	2.2279- 2	3.4803- 3
A=124	0.074624	16.	3.2291- 2	4.4093- 3
A=125	0.116962	8.	1.1634- 1	1.6378- 2
A=126	0.226118	8.	2.3308- 1	3.6234- 2
A=127	0.555457	11.	4.6784- 1	1.0573- 1
A=128	0.836918	8.	9.2148- 1	1.3405- 1
A=129	1.591337	16.	1.5983+ 0	2.3691- 1
A=130	2.091632	11.	2.5002+ 0	3.7061- 1
Xe-131m	0.050486	2.8	3.8458- 2	5.1343- 3
A=131	3.604300	0.7	3.5522+ 0	4.7420- 1
Te-132	4.7590	2.8	4.6234+ 0	6.0620- 1
A=132	4.953559	0.7	4.8366+ 0	6.2961- 1
Xe-133m	0.2111	23.	2.0210- 1	2.7491- 2

FP	US file	error (%)	UK file	error
Xe-133	5.950	2.	6.0874+ 0	7.6723- 1
A=133	5.950570	1.	6.0875+ 0	7.6965- 1
A=134	6.306880	0.7	6.4101+ 0	8.0917- 1
I -135	5.0320	2.8	4.3758+ 0	6.4814- 1
Xe-135m	1.5460	32.	1.5009+ 0	2.6336- 1
Xe-135	6.2590	2.	5.5384+ 0	7.1027- 1
A=135	6.265223	1.4	5.5546+ 0	7.1527- 1
A=136	6.905353	1.0	7.4858+ 0	8.8505- 1
Cs-137	6.7540	0.7	6.5728+ 0	7.6218- 1
A=137	6.757385	0.7	6.5817+ 0	8.0489- 1
A=138	5.907377	2.	6.1540+ 0	7.7550- 1
A=139	6.305604	2.8	5.8658+ 0	7.5325- 1
Ba-140	6.3980	2.8	6.6076+ 0	7.6218- 1
La-140	6.4250	2.	6.6259+ 0	8.3741- 1
A=140	6.424816	1.4	6.6259+ 0	8.4053- 1
A=141	6.480480	2.8	6.4182+ 0	7.7017- 1
A=142	6.670707	1.4	6.8314+ 0	8.4422- 1
A=143	5.965845	0.7	5.9521+ 0	7.6507- 1
Ce-144	4.7260	2.	4.6524+ 0	6.0243- 1
A=144	4.726134	0.7	4.6535+ 0	6.1579- 1
A=145	3.444062	1.	3.4002+ 0	4.5515- 1
A=146	2.585897	0.7	2.5361+ 0	3.3931- 1
A=147	1.738401	2.8	1.8101+ 0	2.4065- 1
A=148	1.301585	1.	1.2918+ 0	1.7585- 1
A=149	0.778134	2.8	7.6062- 1	1.0506- 1
A=150	0.505712	1.4	4.7745- 1	6.6778- 2
A=151	0.315725	2.	3.1932- 1	4.5602- 2
A=152	0.213639	2.8	1.8370- 1	2.7026- 2
A=153	0.103685	6.	1.1144- 1	1.9513- 2
A=154	0.046690	2.8	4.2773- 2	6.4437- 3
A=155	0.021430	16.	2.1866- 2	3.6923- 3
A=156	0.012794	6.	1.0885- 2	1.5961- 3
A=157	0.006302	8.	6.8821- 3	9.9967- 4
A=158	0.002055	23.	2.6497- 3	4.2155- 4
A=159	0.000886	6.	9.5497- 4	1.3575- 4

Table 1.3: U-235 thermal fission

FP	US file	error (%)	UK file	error
H - 1			1.7110- 3	2.9483- 4
H - 2			8.4000- 4	2.4389- 4
H - 3			9.3140- 3	5.3176- 4
He- 3			9.3140- 3	5.3176- 4
He- 4			1.6990- 1	9.5049- 3
A= 77	0.007961	8.	8.3895- 3	6.0364- 4
A= 78	0.020966	8.	2.0322- 2	9.1351- 4
A= 79	0.044732	6.	4.7151- 2	3.6568- 3

FP	US file	error (%)	UK file	error
A= 80	0.128832	4.	1.2657- 1	5.6480- 3
A= 81	0.203680	2.8	1.9757- 1	9.0481- 3
A= 82	0.324569	2.8	3.2904- 1	1.3406- 2
A= 83	0.536435	0.5	5.5742- 1	2.2571- 2
A= 84	1.002093	0.7	1.0025+ 0	4.7142- 2
Kr-85	0.2834	0.35	2.8728- 1	1.5098- 2
A= 85	1.318713	0.35	1.3287+ 0	6.1233- 2
A= 86	1.965113	0.5	1.9686+ 0	7.6887- 2
A= 87	2.560298	0.5	2.5438+ 0	1.8613- 1
A= 88	3.575006	0.7	3.5088+ 0	1.6668- 1
A= 89	4.733074	1.0	4.7820+ 0	1.9254- 1
A= 90	5.782353	1.0	5.8089+ 0	2.2460- 1
A= 91	5.828245	0.7	5.8951+ 0	5.0951- 1
A= 92	6.021674	0.7	6.0110+ 0	4.7126- 1
A= 93	6.346743	0.7	6.3404+ 0	2.7652- 1
A= 94	6.472653	0.7	6.5010+ 0	2.5392- 1
A= 95	6.503326	0.7	6.5570+ 0	2.5435- 1
A= 96	6.340230	1.0	6.3005+ 0	2.4538- 1
A= 97	5.997223	0.7	5.9378+ 0	4.5412- 1
A= 98	5.790300	0.7	5.7651+ 0	2.7767- 1
A= 99	6.109164	1.0	6.1594+ 0	2.3650- 1
A= 100	6.292781	0.7	6.2316+ 0	2.3674- 1
A=101	5.172919	1.0	5.1492+ 0	1.9908- 1
A=102	4.298778	1.0	4.2701+ 0	1.6691- 1
A=103	3.031149	1.0	3.0802+ 0	1.6023- 1
A=104	1.880825	1.0	1.8685+ 0	7.5748- 2
A=105	0.964228	1.4	9.4711- 1	3.8642- 2
A=106	0.401576	1.0	4.0922- 1	1.7994- 2
A=107	0.146202	2.8	1.3909- 1	6.3035- 3
A=108	0.054129	4.	5.7157- 2	2.8578- 3
A=109	0.031223	6.	2.8444- 2	3.1539- 3
A=110	0.025445	4.	2.5447- 2	1.9026- 3
A=111	0.017432	2.8	1.9700- 2	8.0835- 4
A=112	0.013043	4.	1.1860- 2	6.8785- 4
A=113	0.014205	4.	1.5999- 2	7.8756- 4
A=114	0.011833	4.	1.2909- 2	6.3254- 4
A=115	0.012584	2.8	1.1389- 2	6.3085- 4
A=116	0.013249	4.	1.6099- 2	8.0499- 4
A=117	0.012762	4.	1.2223- 2	1.1609- 3
A=118	0.011346	8.	1.3249- 2	2.0526- 3
A=119	0.012874	8.	1.4904- 2	1.4184- 3
A=120	0.012609	8.	1.4425- 2	1.4517- 3
A=121	0.013047	6.	1.2590- 2	5.1622- 4
A=122	0.015485	8.	1.7992- 2	1.1689- 3
A=123	0.015658	2.8	1.5051- 2	6.1705- 4
A=124	0.026788	8.	3.1551- 2	2.6721- 3
A=125	0.034022	2.0	2.6032- 2	1.3535- 3
A=126	0.058518	8.	5.9471- 2	5.5843- 3
A=127	0.156991	2.8	1.2033- 1	4.9314- 3
A=128	0.348840	2.8	3.3093- 1	1.3531- 2

FP	US file	error (%)	UK file	error
A=129	0.543386	1.	7.0797- 1	3.1635- 2
A=130	1.810633	2.	1.7900+ 0	1.0182- 1
Xe-131m	0.040470	1.4	3.1249- 2	1.2451- 3
A=131	2.890898	0.5	2.8931+ 0	1.1527- 1
A=132	4.313407	0.35	4.3173+ 0	1.6928- 1
Xe-133m	0.1947	2.	1.9070- 1	7.1606- 3
Xe-133	6.6990	0.5	6.5863+ 0	2.4777- 1
A=133	6.699915	0.35	6.5863+ 0	2.4827- 1
A=134	7.872644	0.5	7.7897+ 0	2.8834- 1
I-135	6.2820	1.4	6.3616+ 0	2.6479- 1
Xe-135m	1.1020	1.4	1.1514+ 0	6.1262- 2
Xe-135	6.5380	0.7	6.5948+ 0	2.5532- 1
A=135	6.539455	0.35	6.5957+ 0	2.5370- 1
A=136	6.318709	0.35	6.3071+ 0	2.3901- 1
A=137	6.188944	0.5	6.2462+ 0	2.7549- 1
A=138	6.768035	0.5	6.7518+ 0	2.6046- 1
A=139	6.413852	0.7	6.4024+ 0	2.4944- 1
A=140	6.220169	0.5	6.3758+ 0	2.4785- 1
A=141	5.847414	1.0	5.8208+ 0	4.3696- 1
A=142	5.849283	0.5	5.8209+ 0	2.6528- 1
A=143	5.956198	0.35	5.9659+ 0	2.2744- 1
A=144	5.499964	0.35	5.4759+ 0	2.0968- 1
A=145	3.933647	0.35	3.9510+ 0	1.5557- 1
A=146	2.997113	0.35	2.9834+ 0	1.1884- 1
A=147	2.246885	0.7	2.2211+ 0	1.9120- 1
A=148	1.673660	0.35	1.6802+ 0	6.7209- 2
A=149	1.081705	1.0	1.0488+ 0	4.2532- 2
A=150	0.653325	0.5	6.5019- 1	2.6507- 2
A=151	0.418797	1.0	4.1789- 1	1.7048- 2
A=152	0.266932	1.0	2.5240- 1	1.0322- 2
A=153	0.158290	2.8	1.5106- 1	6.1998- 3
A=154	0.074439	1.0	7.2739- 2	2.9817- 3
A=155	0.032138	4.	3.1017- 2	1.2717- 3
A=156	0.014854	2.8	1.3400- 2	5.4945- 4
A=157	0.006151	8.	6.6337- 3	4.3925- 4
A=158	0.003286	11.	1.9710- 3	2.4649- 4
A=159	0.001009	6.	1.0620- 3	7.0118- 5

Table C-1.4: U-238 fast fission

FP	US file	error (%)	UK file	error
H - 3			1.0262- 2	3.2419- 3
He- 3			1.0262- 2	3.2419- 3
He- 4			1.4880- 1	4.5467- 2
A= 78	0.011222	23.	7.6701- 3	1.9624- 3
A= 79	0.032673	23.	1.7866- 2	4.2626- 3
A= 80	0.042741	16.	3.9122- 2	9.4491- 3

FP	US file	error (%)	UK file	error
A= 81	0.086206	23.	8.1197- 2	2.0204- 2
A= 82	0.213784	16.	1.6063- 1	3.9659- 2
A= 83	0.396237	1.4	3.0375- 1	7.2435- 2
A= 84	0.825770	1.4	5.5427- 1	1.2667- 1
Kr- 85	0.1486	2.	193632- 1	4.5351- 2
A= 85	0.743050	1.0	9.0761- 1	1.8276- 1
A= 86	1.296448	1.0	1.1885+ 0	1.1339- 1
A= 87	1.625506	1.0	1.6507+ 0	2.5987- 1
A= 88	2.028030	1.4	2.1889+ 0	3.0018- 1
A= 89	2.761051	1.4	2.9511+ 0	2.9383- 1
A= 90	3.246924	1.4	3.3527+ 0	3.3442- 1
A= 91	4.039440	2.	4.3157+ 0	4.1110- 1
A= 92	4.312441	2.8	4.4009+ 0	6.5592- 1
A= 93	4.913253	2.	5.2053+ 0	6.9016- 1
A= 94	4.610062	2.8	5.1650+ 0	5.2331- 1
Nb- 95m	0.051405	1.0	5.8435- 2	9.4816- 3
A= 95	5.140443	1.0	5.2644+ 0	4.8831- 1
A= 96	6.017329	4.	6.0618+ 0	7.2568- 1
A= 97	5.562461	0.7	5.6850+ 0	8.5074- 1
A= 98	5.944993	1.0	5.7868+ 0	8.9004- 1
A= 99	6.168192	1.4	6.2038+ 0	7.1091- 1
A=100	6.697326	1.0	6.5601+ 0	6.2165- 1
A=101	6.209007	1.4	6.3796+ 0	6.1062- 1
A=102	6.447346	1.0	5.9350+ 0	4.0079- 1
A=103	6.275279	1.4	5.9570+ 0	9.5226- 1
A=104	5.035980	1.0	4.6340+ 0	9.9407- 1
A=105	4.051243	1.4	3.7088+ 0	6.0340- 1
A=106	2.489722	1.4	2.4774+ 0	2.4567- 1
A=107	1.445866	8.	1.7371+ 0	2.1617- 1
A=108	0.601420	16.	5.7704- 1	1.4617- 1
A=109	0.252140	6.	1.2762- 1	1.9582- 3
A=110	0.140760	16.	1.0027- 1	2.3975- 2
A=111	0.071214	2.	6.7991- 2	1.0353- 2
A=112	0.055901	4.	4.0834- 2	7.0393- 3
A=113	0.046111	11.	3.0942- 2	9.9158- 3
A=114	0.039257	16.	3.4042- 2	9.0068- 3
A=115	0.037548	2.	3.7872- 2	4.6437- 3
A=116	0.039314	11.	3.1076- 2	8.2414- 3
A=117	0.037732	11.	2.7350- 2	7.2175- 3
A=118	0.043176	11.	2.4599- 2	6.6624- 3
A=119	0.039720	11.	2.3282- 2	4.5299- 3
A=120	0.038713	11.	2.1395- 2	3.8861- 3
A=121	0.036927	8.	2.0230- 2	5.0437- 3
A=122	0.041073	11.	1.9304- 2	4.8296- 3
A=123	0.044534	16.	1.9533- 2	4.9769- 3
A=124	0.046461	11.	2.0638- 2	5.2588- 3
A=125	0.048524	6.	2.1184- 2	6.3809- 3
A=126	0.054089	6.	9.6592- 2	3.0877- 2
A=127	0.136294	4.	1.4606- 1	1.4077- 2
A=128	0.286086	6.	2.9689- 1	9.5815- 2

FP	US file	error (%)	UK file	error
A=129	1.011337	6.	6.2464- 1	6.0375- 2
A=130	1.913653	6.	1.6760+ 0	4.2342- 1
Xe-131m	0.046071	1.4	3.7135- 2	3.3995- 3
A=131	3.290794	1.0	3.4381+ 0	3.1473- 1
A=132	5.147494	1.4	4.8484+ 0	4.4053- 1
Xe-133m	0.1908	2.8	1.9713- 1	2.0222- 2
A=133	6.762707	0.5	6.8441+ 0	6.0022- 1
A=134	7.609406	2.8	6.5147+ 0	5.7792- 1
I-135	6.9410	2.	6.6950+ 0	8.1387- 1
Xe-135m	1.0360	2.8	1.0488+ 0	1.2572- 1
A=135	6.967573	0.7	6.7099+ 0	5.9857- 1
A=136	6.979834	2.0	6.7274+ 0	5.6659- 1
A=137	6.052506	0.7	6.2853+ 0	8.5703- 1
A=138	5.762451	1.4	6.1030+ 0	6.0754- 1
A=139	5.670141	1.0	6.0037+ 0	5.4202- 1
A=140	5.81566	0.7	6.0862+ 0	5.4980- 1
A=141	5.336511	2.	5.8580+ 0	5.8322- 2
A=142	4.585776	1.0	4.7945+ 0	7.3957- 1
A=143	4.622060	0.7	4.7807+ 0	5.6021- 1
A=144	4.547939	0.7	4.5543+ 0	4.1453- 1
A=145	3.808983	0.7	3.9097+ 0	3.6825- 1
A=146	3.445628	0.7	3.5216+ 0	3.3323- 1
A=147	2.592719	0.7	2.6361+ 0	113916- 1
A=148	2.112485	0.7	2.2540+ 0	2.5734- 1
A=149	1.625277	1.0	1.6512+ 0	2.9535- 1
A=150	1.273456	1.0	1.2892+ 0	1.2737- 1
A=151	0.799397	1.0	7.9760- 1	8.0774- 2
A=152	0.530227	1.0	5.5069- 1	5.4589- 2
A=153	0.414787	2.	3.5788- 1	4.1342- 2
A=154	0.216281	1.0	2.3728- 1	2.9085- 2
A=155	0.141515	11.	1.2604- 1	3.3532- 2
A=156	0.076033	2.	6.7153- 2	6.9204- 3
A=157	0.041375	16.	3.4374- 2	1.1400- 2
A=158	0.018487	16.	1.7343- 2	4.7529- 3
A=159	0.008619	16.	8.3057- 3	2.9645- 3
A=160	0.003544	23.	3.2833- 3	9.6218- 4

Table C-1.5: Pu-239 thermal fission

FP	US file	error (%)	UK file	error
H - 1			4.0800- 3	7.0527- 4
H - 2			1.3470- 3	2.8929- 4
H - 3			1.4420- 2	1.1431- 3
He- 3			1.4420- 2	1.1431- 3
He- 4			2.0800- 1	9.9813- 3
A= 77	0.007235	11.	7.7041- 3	8.7734- 4
A= 78	0.018776	23.	2.9291- 2	2.6873- 3

FP	US file	error (%)	UK file	error
A= 79	0.043651	2.	5.6471- 2	8.3107- 3
A= 80	0.093888	23.	1.0501- 1	1.5309- 2
A= 81	0.183643	16.	1.8859- 1	2.5226- 2
A= 82	0.229687	23.	2.4865- 1	3.4488- 2
A= 83	0.296793	0.5	2.8224- 1	9.5404- 3
A= 84	0.480359	1.0	4.7244- 1	1.9541- 2
Kr-85	0.1227	1.4	1.3612- 1	6.4821- 3
A= 85	0.574068	0.35	5.9322- 1	2.4855- 2
A= 86	0.766201	0.5	7.6965- 1	1.6597- 2
A= 87	1.003923	0.5	9.5813- 1	4.7591- 2
A= 88	1.329789	1.0	1.2967+ 0	3.6448- 2
A= 89	1.722836	2.	1.6974+ 0	3.6418- 2
A= 90	2.104298	2.	1.9931+ 0	4.5830- 2
A= 91	2.486500	1.	2.4523+ 0	1.9244- 1
A= 92	3.009177	0.7	3.0073+ 0	1.3285- 1
A= 93	3.797575	0.7	3.8749+ 0	1.1842- 1
A= 94	4.321833	1.0	4.3690+ 0	1.1624- 1
Nb-95m	0.04831	2.	5.5193- 2	1.4113- 3
A= 95	4.818517	1.0	4.9652+ 0	9.8005- 2
A= 96	4.893751	1.	4.9436+ 0	1.4430- 1
A= 97	5.414114	1.0	5.2279+ 0	2.2972- 1
A= 98	5.830892	1.0	5.9339+ 0	3.8151- 1
A= 99	6.211806	1.4	6.1803+ 0	1.2324- 1
A=100	6.774621	1.4	6.8555+ 0	4.4710- 1
A=101	6.019171	1.4	6.1756+ 0	2.0719- 1
A=102	6.126339	1.4	6.0734+ 0	2.9261- 1
A=103	6.994895	2.	6.9115+ 0	1.7076- 1
A=104	6.094829	1.0	6.0651+ 0	2.0474- 1
A=105	5.643815	2.	5.7592+ 0	1.4688- 1
Ru-106	4.3500	2.	4.1843+ 0	8.5134- 2
A=106	4.350214	2.	4.1870+ 0	8.3230- 2
A=107	3.330057	4.	3.1717+ 0	1.2795- 1
A=108	2.163956	4.	2.0535+ 0	8.7922- 2
A=109	1.477898	4.	1.7180+ 0	1.3427- 1
A=110	0.645132	6.	6.2441- 1	3.1242- 2
A=111	0.295993	2.	3.0742- 1	7.0801- 3
A=112	0.128506	2.	1.2821- 1	7.3268- 3
A=113	0.081664	2.8	8.1038- 2	3.9137- 3
A=114	0.060254	2.8	5.3920- 2	2.6994- 3
A=115	0.042600	6.	3.6415- 2	1.8402- 3
A=116	0.050678	8.	4.5734- 2	2.2895- 3
A=117	0.044459	8.	4.5731- 2	2.2896- 3
A=118	0.032488	8.	4.5662- 2	3.2049- 3
A=119	0.032249	8.	4.8757- 2	3.4320- 3
A=120	0.030585	11.	4.3373- 2	5.3339- 3
A=121	0.037808	8.	5.5220- 2	8.1445- 3
A=122	0.044695	8.	6.9715- 2	3.4773- 3
A=123	0.044120	16.	8.9202- 2	1.3069- 2
A=124	0.078717	11.	1.2835- 1	6.3339- 3
A=125	0.111659	8.	1.1731- 1	1.3905- 2

FP	US file	error (%)	UK file	error
A=126	0.202324	6.	3.1550- 1	4.5039- 2
A=127	0.506296	6.	4.6206- 1	2.3722- 2
A=128	0.734121	11.	8.3462- 1	4.9365- 2
A=129	1.371454	4.	1.4105+ 0	6.7241- 2
A=130	2.361688	8.	2.8949+ 0	2.6076- 1
Xe-131m	0.054019	2.	4.0313- 2	7.9511- 4
A=131	3.856439	0.5	3.7294+ 0	5.3547- 2
Te-132	5.1390	2.	5.1113+ 0	1.1772- 1
A=132	5.406858	0.5	5.2915+ 0	1.0341- 1
Xe-133m	0.2346	16.	2.1087- 1	6.9941- 3
A=133	7.016466	0.5	6.7685+ 0	1.3091- 1
A=134	7.676881	0.5	6.9055+ 0	2.2748- 1
I=135	6.5420	2.8	6.3506+ 0	3.6663- 1
Xe-135m	1.7140	32.	1.7219+ 0	1.8711- 1
Xe-135	7.66080	1.0	7.3928+ 0	1.7430- 1
A=135	7.621001	0.7	7.4073+ 0	1.7495- 1
A=136	7.143924	1.0	6.8649+ 0	1.8881- 1
Cs-137	6.6070	0.5	6.7235+ 0	5.3918- 1
A=137	6.613842	0.5	6.7290+ 0	1.4120- 1
A=138	6.124533	1.0	6.1310+ 0	1.4121- 1
A=139	5.637200	2.8	5.9952+ 0	1.1654- 1
Ba-140	5.3550	1.4	5.3187+ 0	1.0380- 1
A=140	5.364788	1.0	5.3300+ 0	1.0388- 1
A=141	5.246968	2.	5.2068+ 0	1.7430- 1
A=142	4.928967	0.5	4.9652+ 0	1.0080- 1
A=143	4.413261	0.5	4.4787+ 0	8.7227- 2
A=144	3.739785	0.35	3.7486+ 0	7.3472- 2
A=145	2.986310	0.35	3.0322+ 0	5.9799- 2
A=146	2.458146	0.35	2.4907+ 0	4.9296- 2
A=147	2.002981	1.0	2.0408+ 0	4.1702- 2
A=148	1.642120	0.5	1.6789+ 0	3.3347- 2
A=149	1.216561	0.7	1.2630+ 0	2.7674- 2
A=150	0.967459	0.5	9.7568- 1	1.9447- 2
A=151	0.738426	0.7	7.7758- 1	1.7848- 2
A=152	0.576317	1.0	6.0786- 1	1.6369- 2
A=153	0.361259	6.	3.9953- 1	5.7096- 2
A=154	0.259788	1.4	2.7987- 1	1.1462- 2
A=155	0.165724	11.	1.5937- 1	2.3370- 2
A=156	0.124018	4.	1.1457- 1	4.4704- 3
A=157	0.074152	6.	7.5581- 2	7.5919- 3
A=158	0.041439	16.	4.0766- 2	6.1504- 3
A=159	0.020653	6.	2.1369- 2	1.9363- 3
A=160	0.009681	16.	1.0411- 2	1.5648- 3

Table C-1.6: Pu-241 thermal fission

FP	US file	error (%)	UK file	error
H - 3			1.4100- 2	2.4373- 3
He- 3			1.4100- 2	2.4373- 3
He- 4			2.0150- 1	2.8773- 2
A= 77	0.001896	23.	4.9654- 4	1.1775- 4
A= 78	0.011521	16.	3.2269- 3	1.6954- 3
A= 79	0.014959	16.	9.9117- 3	5.0874- 3
A= 80	0.029235	16.	2.4543- 2	1.2584- 2
A= 81	0.062121	16.	5.4388- 2	2.7624- 2
A= 82	0.136745	8.	1.1250- 1	5.5327- 2
A= 83	0.201544	1.4	1.9983- 1	2.7036- 2
A= 84	0.351325	2.	3.5783- 1	4.7347- 2
Kr- 85	0.083114	2.8	8.5409- 2	1.2529- 2
A= 85	0.406488	1.4	3.9504- 1	5.5741- 2
A= 86	0.594552	2.	6.1450- 1	7.9957- 2
A= 87	0.752828	2.	7.4639- 1	1.1430- 1
A= 88	0.990303	1.4	1.0043+ 0	1.2671- 1
A= 89	1.233109	2.8	1.2301+ 0	1.5814- 1
A= 90	1.535820	1.4	1.5679+ 0	2.0188- 1
A= 91	1.864133	1.4	1.7770+ 0	3.1347- 1
A= 92	2.308494	1.4	2.3477+ 0	3.6721- 1
A= 93	2.978050	1.4	3.0409+ 0	3.6667- 1
A= 94	3.391152	1.4	3.3712+ 0	4.3095- 1
Nb-95m	0.039258	2.8	4.4301- 2	5.8733- 2
A= 95	3.925621	1.4	3.9908+ 0	5.1574- 1
A= 96	4.401147	1.4	4.3143+ 0	5.5549- 1
A= 97	4.801799	1.4	4.6503+ 0	7.2208- 1
A= 98	5.035685	2.	5.1121+ 0	6.7883- 1
A= 99	5.961885	2.	5.6475+ 0	7.4853- 1
A=100	6.254494	2.	6.8781+ 0	9.0679- 1
A=101	6.231942	2.	5.7867+ 0	7.7836- 1
A=102	6.655272	2.	6.2799+ 0	8.3652- 1
A=103	6.776879	2.8	6.8912+ 0	9.1332- 1
A=104	7.179518	2.	6.8932+ 0	8.7550- 1
A=105	6.074350	2.8	5.9518+ 0	7.7390- 1
A=106	6.103987	2.	6.1356+ 0	7.8339- 1
A=107	4.886332	8.	4.9371+ 0	6.8310- 1
A=108	3.769599	8.	3.9155+ 0	5.2877- 1
A=109	2.587597	4.	2.7362+ 0	3.6673- 1
A=110	1.325114	8.	1.3638+ 0	6.2801- 1
A=111	0.585511	2.8	5.8703- 1	2.6784- 1
A=112	0.218486	2.8	1.9329- 1	4.0689- 2
A=113	0.151924	4.	1.8491- 1	5.3551- 2
A=114	0.071086	23.	1.9556- 1	1.0210- 1
A=115	0.038087	11.	1.6397- 1	8.2339- 2
A=116	0.027787	32.	1.2504- 1	6.5970- 2
A=117	0.023626	11.	8.9845- 2	4.7501- 2
A=118	0.023157	32.	6.4049- 2	3.3911- 2

FP	US file	error (%)	UK file	error
A=119	0.023156	32.	5.1725- 2	2.2521- 2
A=120	0.025623	23.	5.8283- 2	2.4206- 2
A=121	0.025882	32.	9.2000- 2	3.2331- 2
A=122	0.025882	32.	1.0580- 1	3.7177- 2
A=123	0.026704	32.	1.3751- 1	4.8466- 2
A=124	0.032352	32.	1.8475- 1	6.5208- 2
A=125	0.046901	8.	2.5873- 1	9.1843- 2
A=126	0.082238	23.	3.7349- 1	1.3356- 1
A=127	0.232387	4.	5.6292- 1	2.0274- 1
A=128	0.379232	23.	8.2962- 1	2.9552- 1
A=129	0.819252	23.	1.3333+ 0	4.6024- 1
A=130	1.818826	11.	2.0717+ 0	6.8752- 1
Xe-131m	0.043412	4.	3.2775- 2	4.4614- 3
A=131	3.100837	1.4	3.0344+ 0	4.1305- 1
Te-132	4.5030	2.8	4.4216+ 0	5.9627- 1
A=132	4.564343	1.4	4.4383+ 0	5.9953- 1
Xe-133m	0.1944	4.	1.8581- 1	2.3936- 2
A=133	6.729190	0.7	6.4310+ 0	8.4628- 1
A=134	7.917365	1.4	7.4213+ 0	9.5689- 1
I -135	6.9430	2.8	6.8359+ 0	8.8839- 1
Xe-135m	1.182	16.	1.1840+ 0	1.6244- 1
Xe-135	7.1701	2.	7.0113+ 0	8.9915- 1
A=135	7.170771	1.0	7.0122+ 0	9.1416- 1
A=136	7.105131	1.4	6.7786+ 0	9.6451- 1
A=137	6.650911	0.7	6.4249+ 0	8.2675- 1
A=138	6.605149	1.0	6.5165+ 0	8.3863- 1
A=139	6.217390	2.	6.3815+ 0	1.6076+ 0
A=140	5.766685	1.4	5.8320+ 0	7.6529- 1
A=141	4.905772	1.4	4.8883+ 0	7.7716- 1
A=142	4.746982	1.0	4.6788+ 0	6.1964- 1
A=143	4.577993	0.7	4.3022+ 0	5.7116- 1
A=144	4.227384	0.7	3.9623+ 0	5.3861- 1
A=145	3.262911	1.0	2.9817+ 0	4.1958- 1
A=146	2.766456	0.7	2.4878+ 0	3.5415- 1
A=147	2.284949	1.4	2.1204+ 0	3.7956- 1
A=148	1.932103	0.7	1.7574+ 0	2.4818- 1
A=149	1.474076	1.4	1.3964+ 0	1.9839- 1
A=150	1.209434	1.0	1.1019+ 0	1.5604- 1
A=151	0.913021	1.4	8.4426- 1	1.1899- 1
A=152	0.717632	1.4	7.1598- 1	1.0067- 1
A=153	0.540584	4.	5.0477- 1	1.3611- 1
A=154	0.379114	2.	4.0419- 1	6.9870- 2
A=155	0.241414	8.	3.9721- 1	1.5862- 1
A=156	0.172125	2.8	3.1887- 1	1.2409- 1
A=157	0.135369	4.	2.5137- 1	9.6873- 2
A=158	0.092244	23.	1.9214- 1	7.2121- 2
A=159	0.048030	4.	1.3487- 1	5.0895- 2
A=160	0.020499	23.	1.0408- 1	3.7957- 2
A=161	0.008468	4.	7.3399- 2	2.9533- 2
A=162			5.0974- 2	1.8554- 2

C-2: Selected independent fission product yields

The table below summarises the yield values (and types) which are significant and included in Tables C-2.1 to C-2.6.

FP	Th-232	U-233	U-235	U238	Pu-239	Pu-241
Kr-82	c	c	c		c	c
Kr-85	i	i	i	i	i	i
Nb-95m					i	
Nb-95					i	
Mo-96	c	c	c		c	c
Xe-130		c	c		c	
Xe-133m		i	i	i	i	i
Xe-133		i	i	i	i	i
Cs-134		i			i	
Xe-135m	i	i	i	i	i	i
Xe-135	i	i	i	i	i	i
Nd-144		c			c	
Sm-150		c	c		c	
Eu-154		i			i	

Description of table entries:

Type: i independent yield of fission product is listed

c cumulative yield of fission product is listed when shielded from beta decay by a stable or long lived precursor; the yield value given is the sum of the independent yields of the nuclide listed and it's short lived precursors which are also shielded (eg.: the cumulative field of Kr-82 is the sum of independent yields of Br-82m, Br-82 and Kr-82, all shielded by stable Se-82).

Only those yield values are listed that exceed 0.01% of the corresponding chain yields in one of the files. According to this criterion, the independent yields of the following fission products, although requested by safeguards experts, are insignificant and not included in any of the tables: Mo-92,94, Xe-128,129, Nd-142, Pm-148m,148, Sm-148, Eu-151, Eu-152.

Source of data:

US file: ENDF/B-6 Fission Yield File.
UK file: R.W. Mills,: "UKFY3",the the latest update of UK library of independent and cumulative fission product yields, in ENDF-6 format (1996).

The file UKFY3 contains also several other tables of fission yield data and discrepances which are available from the author or the Data Centers.Both the US file and the UK file are available on magnetic tape from the Data Centers.

Table C-2.1: Th-232 fast fission

FP	Type	US file %/fission	error abs	UK file %/fission	error abs
Kr- 82	c	9.8798- 5	6.3231-5	8.4515- 5	6.3502- 5
Kr- 85	i	9.9498- 4	6.3679-4	1.5502- 3	1.0902- 3
Mo- 96	c	1.7800- 4	8.0100-5	5.8294- 6	5.2087- 6
Xe-135m	i	7.5508- 3	4.8325-3	1.1571- 2	8.9833- 3
Xe-135	i	2.6529- 3	1.6979-3	4.1357- 3	3.2107- 3

Table C-2.2: U-233 thermal fission

FP	Type	US file %/fission	error abs	UK file %/fission	error abs
Kr- 82	c	8.2998- 4	1.3280-4	7.0101- 3	2.6386- 3
Kr- 85	i	9.5576- 2	2.1982-2	7.4844- 2	2.8763- 2
Mo- 96	c	5.5859- 3	3.5750-3	8.1389- 3	3.2030- 3
Xe-130	c	2.5969- 3	7.2714-5	3.0718- 3	1.2114- 3
Xe-133m	i	4.1321- 2	2.6445-2	2.7917- 2	1.1059- 2
Xe-133	i	1.4667- 2	5.8667-4	1.1564- 2	4.5810- 3
Cs-134	i	1.3400- 4	8.5758-5	9.8285- 4	3.7408- 4
Xe-135m	i	0.8063+ 0	0.5160+0	8.2264- 1	2.5306- 1
Xe-135	i	0.4206+ 0	4.6271-2	3.4076- 1	1.0483- 1
Nd-144	*	2.7558- 4	1.5969-4	1.0683- 3	3.7902- 4
Sm-150	c	4.3699- 4	2.7967-4	1.1306- 3	4.7102- 4
Eu-154	i	1.0400- 6	6.6558-7	3.8653- 6	1.7776- 6

*) Sum of Pr-144 + Nd-144 independent yields.

Table C-2.3: U-235 thermal fission

FP	Type	US file %/fission	error abs	UK file %/fission	error abs
Kr- 82	c	5.4696- 5	6.0166-6	2.8024- 4	9.9192- 5
Kr- 85	i	2.5533- 2	4.0853-3	5.1951- 3	1.9226- 3
Mo- 96	c	5.4396- 4	3.4813-4	4.1961- 4	1.5231- 4
Xe-130	c	2.2198- 4	3.5517-5	3.5329- 5	1.3015- 5
Xe-133m	i	1.8859- 3	1.2070-3	1.0563- 3	3.8000- 4
Xe-133	i	6.6595- 4	3.9957-5	4.3753- 4	1.5743- 4
Xe-135m	i	0.1781+ 0	1.0687-2	1.6532- 1	5.7784- 2
Xe-135	i	7.8513- 2	4.7108-3	6.8480- 2	2.3936- 2
Sm-150	c	2.9998- 5	1.9199-5	6.1426- 5	2.2478- 5

Table C-2.4: U-238 fast fission

FP	Type	US file %/fission	error abs	UK file %/fission	error abs
Kr- 85	i	1.9900- 4	1.2736-4	4.8698- 5	2.8886- 5
Xe-133m	i	1.2210- 3	7.8145-4	1.9489- 5	1.1543- 5
Xe-133	i	4.1800- 4	2.6752-4	6.9656- 6	4.1257- 6
Xe-135m	i	1.5710- 2	1.0055-2	1.1101- 2	6.8002- 2
Xe-135	i	1.1154- 2	7.1386-3	3.9677- 3	2.4304- 3

Table C-2.5: Pu-239 thermal fission

FP	Type	US file %/fission	error abs	UK file %/fission	error abs
Kr- 82	c	1.2890- 3	2.5780-5	1.8558- 3	6.8191- 4
Kr- 85	i	1.0026- 2	6.4166-3	1.2328- 2	4.3574- 3
Nb- 95m	i	1.3200- 4	8.4479-4	8.4180- 5	3.0673- 5
Nb- 95	i	5.6499- 4	3.6160-4	3.6406- 4	1.3266- 4
Mo- 96	c	3.6090- 3	2.3097-3	5.0806- 3	1.8108- 3
Xe-130	c	4.6939- 3	6.5715-5	1.7210- 3	5.1997- 4
Xe-133m	i	3.3799- 2	2.1631-2	1.6608- 2	6.0289- 3
Xe-133	i	9.4479- 3	1.0393-3	6.8793- 3	2.4973- 3
Cs-134	i	3.3500- 4	2.1440-4	5.7351- 4	2.0511- 4
Xe-135m	i	0.7523+ 0	0.4815+0	7.3758- 1	2.3517- 1
Xe-135	i	0.3141+ 0	1.2565-2	3.0552- 1	9.7416- 2
Nd-144	*	3.6574- 4	2.1186-4	1.2372- 3	7.3020- 4
Sm-150	c	1.1520- 3	7.3727-4	2.2585- 3	7.8736- 4
Eu-154	i	1.4000- 5	8.9599-6	2.5155- 5	9.1668- 6

*) Sum of Pr-144 + Nd-144 independent yields.

Table C-2.6: Pu-241 fast fission

FP	Type	US file %/fission	error abs	UK file %/fission	error abs
Kr- 82	c	3.2300- 4	2.0672-4	1.1859- 4	9.0654- 5
Kr- 85	i	2.3780- 3	1.5219-3	1.5451- 3	1.0057- 3
Mo- 96	c	1.2326- 2	5.5467-3	3.3488- 4	2.2303- 4
Xe-133m	i	6.1400- 4	3.9296-4	6.1715- 4	4.0381- 4
Xe-133	i	2.5100- 4	1.6064-4	2.5564- 4	1.6727- 4
Xe-135m	i	0.1614+ 0	0.1033+0	1.2442- 1	8.2420- 2
Xe-135	i	6.5501- 2	5.2401-3	5.1539- 2	3.4140- 2

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