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Recommended Nuclear Decay Data

D Smith and S A Woods

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ABSTRACT

Databases and other sources of evaluated nuclear decay data have been studied and half-life and P_γ values for 53 selected radionuclides recommended.

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Approved on behalf of Director and Chief Executive, NPL,
by Dr P Christmas, Acting Head, Division of Radiation Science and Acoustics

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TABLES

1 INTRODUCTION

As a result of an IAEA Coordinated Research Programme (1986-1990) [1], values of decay parameters of 36 radionuclides commonly used for γ- and X-ray detector calibration were recommended. Further to this work, NPL have studied evaluated decay data for another 53 radionuclides, primarily those which have been standardised at NPL, and this report recommends values for their decay parameters.

2 METHODOLOGY

The listing of half-lives and γ-ray emission probabilities was compiled, with few exceptions, by taking data, with permission, from

a) the UK data file UKPADD2,
b) the international data file JEF (currently at version 2.2),
c) the international ENSDF data file as implemented for PC use.

The use of evaluated data, which take account of a range of measurements from different authors, was regarded as preferable to sources which sometimes contain only data from a limited number (often one) author. Thus data from JEF2.2 and UKPADD2 were used, where possible. It is expected that many of the UKPADD2 data will eventually be incorporated into JEF. For a few nuclides, the ENSDF data were preferred, usually either because the data was not present (UKPADD2) or a small inconsistency was found (JEF2.2). In the case of an inconsistency, the relevant author was notified and has undertaken the necessary amendment to their database for subsequent releases.

3 RECOMMENDED DATA

Table 1 gives the NPL recommended nuclear decay data for the 53 selected radionuclides. The first line associated with each radionuclide gives the half-life, mode(s) of decay and the reference to the data source. A table of γ-ray energies and emission probabilities is then given. All uncertainties are given at the one-sigma level. For the half-lives, base 10 is denoted by the letter 'E'.

For data taken from JEF2.2, the reference to the data source is further annotated to indicate its original origin and year of inclusion (xx) in that database:

ENxx - Data taken from ENSDF.
FRxx - Data taken from the French Decay Data Library.
UKxx - Data taken from the UK Decay Data Library.

For some radionuclides, where many weak γ-ray transitions were confirmed in the original JEF2.2 or UKPADD2 data, the present list has been limited to γ-ray transitions above 0.000010 (or 0.001%) probability. Each such case is noted in Table 1.

4 ACKNOWLEDGEMENTS

The authors wish to thank the following people and authorities for permission to quote data from their databases:

JEF2.2 The NEA Data Bank coordinates the work of the Joint Evaluated File (JEF) project, which has led to JEF2.2, which was "frozen" and released in mid-1993. The data are available from

Dr M Konieczny
OECD Nuclear Safety Agency
La Seine St Germain
12 Boulevard des Iles
92130 Issy les Moulineaux
France.

UKPADD2 Assembled by AEA Technology with funding from BNFL plc and AEA Reactor Services. The UKPADD2 data is under the co-ownership of BNFL plc and AEA Reactor Services. Further information on UKPADD2 is available from

Dr A L Nichols
Environmental and Process Engineering
Building 353
AEA Technology
Harwell
Oxfordshire
OX11 ORA.

ENSDF-PC This database was assembled for PC use, from ENSDF (27 February 1990) by

Dr P Ekstrom et al
Department of Physics
Solvegatan 14
S-232 62 Lund
Sweden.

The Evaluated Nuclear Structure Data File (ENSDF) is produced by an international collaboration under the auspices of the IAEA, and is edited and maintained by the National Nuclear Data Center, Brookhaven National Laboratory, USA. Permission to use data from the PC database was given by Dr Ekstrom.

The authors would also like to thank J A Shannon, P de Lavison and Mrs M T Curry for their assistance in producing this report, and are grateful to members of the UK Nuclear Forum for their comments upon an earlier draft of the report

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[1] IAEA TECDOC-619, *X-ray & Gamma-ray Standards for Dectector Calibration* (IAEA, Vienna 1991).

[2] Y Kawada, Appl. Radiat. Isot. 37 (1986) 7.

[3] P Christmas, S M Judge, T B Ryves and D Smith, Nucl. Instr. and Meth. 215 (1983) 397.

[4] R W P Drever, A Moljk and J Scobe, Phil. Mag. 1 (1956) 942.

[5] E Browne and R B Firestone, *Table of Radioactive Isotopes* (John Wiley, New York, 1986).

Table 1: Recommended radionuclide decay data.

^{7}Be

53.24(4) days	EC decay	[UKPADD2]
photon energy(keV)		emission probability
477.6		0.103(2)

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^{14}C

2.093(15) E6 days	β^- decay	[JEF2.2, UK82]
photon energy(keV)		emission probability
none		none

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^{18}F

1.828(2) hours	β^+ decay	[JEF2.2, UK82]
photon energy(keV)		emission probability
511.0 (annihilation)		1.936(4) **

** from Drever et al [4].

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^{32}P

14.27(4) days	β^- decay	[UKPADD2]
photon energy(keV)		emission probability
none		none

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^{33}P

25.4(1) days	β^- decay	[JEF2.2, UK82]
photon energy(keV)		emission probability
none		none

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^{35}S

87.5(4) days	β^- decay	[JEF2.2, UK82]
photon energy(keV)		emission probability
none		none

Table 1 (continued).

^{41}Ar

1.827(7) hours	β^- decay	[UKPADD2]
photon energy(keV)		emission probability
1293.7		0.9916(6)
1677.2		0.00052(5)

---

^{42}K

12.37(2) hours	β^- decay	[JEF2.2, UK83]
photon energy(keV)		emission probability
312.6		0.00352(26)
694.0		0.000034(8)
899.0		0.000548(44)
1022.0		0.000210(18)
1228.0		0.000034(17)
1524.6		0.1890(80)
1921.0		0.000431(45)
2424.0		0.000208(31)

---

^{43}K

22.2(2) hours	β^- decay	[JEF2.2, UK82]
photon energy(keV)		emission probability
220.6		0.0409(20)
372.8		0.871(19)
396.9		0.1141(27)
404.0		0.001132(91)
593.4		0.1097(36)
617.5		0.804(22)
801.0		0.001481(93)
990.0		0.00331(62)
1022.0		0.01873(81)
1394.0		0.00105(18)

Table 1 (continued).

^{47}Ca

4.538(2) days | β^- decay | [UKPADD2]

photon energy(keV)	emission probability
41.1	0.000064(7)
489.2	0.065(4)
530.3	0.00095(10)
766.8	0.00193(14)
807.9	0.065(4)
1297.1	0.750(20)
1878.2	0.00029(3)

---

^{47}Sc

3.346(2) days | β^- decay | [UKPADD2]

photon energy(keV)	emission probability
159.4	0.681(6)

---

^{56}Mn

2.579(3) hours | β^- decay | [UKPADD2]

photon energy(keV)	emission probability
846.7	0.9887(4)
1037.8	0.00042(8)
1238.3	0.001186(99)
1810.8	0.2749(59)
2113.1	0.1434(30)
2523.0	0.0103(4)
2598.5	0.00022(3)
2657.5	0.00672(20)
2959.9	0.00297(10)
3369.7	0.00158(10)

Table 1 (continued).

^{59}Fe

44.502(5) days	β^- decay	[UKPADD2]
photon energy(keV)		emission probability
142.6		0.0102(4)
190.0		0.000130(20)
192.3		0.0310(9)
335.0		0.00270(10)
382.3		0.00018(3)
1099.2		0.567(13)
1291.6		0.431(10)
1481.6		0.00056(4)

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^{64}Cu

12.702 hours	β^- and β^+ decay	[UKPADD2]
photon energy(keV)		emission probability
511.0 (annihilation)		0.3576(23)**
1345.79		0.00479

** the uncertainty in the annihilation emission probability is taken from two recent references (Kawada et al [2] and Christmas et al [3]).

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^{67}Cu

2.578(5) days	β^- decay	[JEF2.2, FR84]
photon energy(keV)		emission probability
91.3		0.0701(11)
93.3		0.1612(22)
184.6		0.4870(42)
209.0		0.001149(49)
300.2		0.00797(13)
393.5		0.002201(79)

Table 1 (continued).

^{67}Ga

3.261(1) days | EC decay | [JEF2.2, EN88]

photon energy(keV)	emission probability
91.3	0.0296(45)
93.3	0.370(56)
184.6	0.204(31)
209.0	0.0233(36)
300.2	0.166(25)
393.5	0.0464(70)
494.2	0.00068(11)
703.1	0.000108(18)
794.4	0.000509(78)
887.7	0.00144(22)

^{68}Ga

67.628(25) minutes | β^+ and EC decay | [JEF2.2, EN93]

photon energy(keV)	emission probability (*0.000010 limit*)
578.4	0.00030(5)
805.9	0.00089(10)
1077.4	0.030(3)
1261.3	0.0090(10)
1744.8	0.000090(15)
1883.2	0.00130(14)
2338.0	0.0000150(24)

Table 1 (continued).

^{82}Br

1.472(1) days | β⁻ decay | [UKPADD2]

photon energy(keV)	emission probability (*0.000010 limit*)
92.2	0.00718(36)
100.6	0.00070(7)
129.3	0.00030(6)
137.4	0.00152(3)
179.8	0.00010(8)
221.5	0.0226(8)
273.5	0.0080(3)
332.9	0.00090(5)
401.2	0.00091(8)
554.3	0.707(14)
599.4	0.00013(7)
606.4	0.0121(6)
619.1	0.434(9)
698.4	0.285(6)
734.1	0.000050(25)
735.6	0.00075(9)
776.5	0.835(15)
827.8	0.240(5)
952.0	0.00367(18)
1007.6	0.01271(26)
1044.0	0.272(6)
1072.9	0.00079(13)
1081.3	0.00618(20)
1099.2	0.000058(25)
1173.5	0.00017(7)
1180.3	0.00086(8)
1317.5	0.265(5)
1474.9	0.163(3)
1650.3	0.00742(15)
1771.2	0.000032(5)
1779.7	0.001136(26)
1871.8	0.00025(8)
1956.8	0.00391(13)

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^{86}Rb

18.660(20) days | β⁻ decay | [JEF2.2, FR84]

photon energy(keV)	emission probability
1076.6	0.0878(8)

Table 1 (continued).

^{87m}Sr	2.810(10) hours	IT and EC decay	[JEF2.2, FR84]
	photon energy(keV)	emission probability	
	388.4	0.8226(14)	
^{89}Sr	50.52(8) days	β^- decay	[UKPADD2]
	photon energy(keV)	emission probability	
	none	none	
^{90}Sr	10460(60)days	β^- decay	[UKPADD2]
	photon energy(keV)	emission probability	
	none	none	
^{90}Y	2.6713(25) days	β^- decay	[UKPADD2]
	photon energy(keV)	emission probability	
	none	none	

Table 1 (continued).

^{99}Mo

65.95(2) hours | β decay | [UKPADD2]

photon energy(keV)	emission probability (*0.000010 limit*)
38.4	0.000026(2)
40.6	0.0104(4)
140.5	0.045(4)
158.9	0.000119(24)
181.1	0.0596(13)
249.2	0.000048(12)
320.0	0.000062(3)
353.0	0.000025(10)
366.4	0.0119(4)
380.3	0.000083(12)
391.4	0.000019(5)
409.0	0.000012(5)
471.6	0.000179(24)
458.1	0.000060(12)
528.8	0.00052(4)
538.4	0.000012(2)
580.7	0.000029(6)
620.5	0.000032(5)
621.2	0.000238(24)
739.6	0.119(2)
761.8	0.000023(6)
778.0	0.0420(12)
823.0	0.00129(4)
961.0	0.00096(4)
987.0	0.000017(4)
1001.6	0.000049(7)
1072.5	0.000012(5)

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^{99}Tc

7.718(40) E7 days | β^- decay | [UKPADD2]

photon energy(keV)	emission probability
none	none

Table 1 (continued).

^{99m}Tc

6.01(1) hours | β^- decay | [UKPADD2]

photon energy(keV)	emission probability
89.7	0.000010(2)
140.5	0.890(5)
142.7	0.000190(10)

^{103}Ru

39.26(2) days | β^- decay | [UKPADD2]

photon energy(keV)	emission probability *(0.000010 limit)*
42.6	0.000011(2)
53.3	0.00374(21)
113.3	0.000037(7)
114.9	0.000081(8)
241.9	0.000151(16)
292.7	0.000027(27)
295.0	0.00265(20)
357.4	0.000091(28)
443.8	0.00374(38)
497.1	0.913(39)
514.4	0.000049(14)
557.0	0.00849(37)
567.7	0.000016(7)
610.3	0.0584(20)
612.0	0.00081(9)

Table 1 (continued).

^{106}Ru-^{106}Rh

368.2(12) days | β^- decay | [JEF2.2, UK80]

photon energy(keV)	emission probability (*0.000010 limit*)
333.5	0.000050(21)
428.4	0.000745(86)
429.6	0.000023(1)
434.2	0.000186(42)
439.5	0.000095(41)
511.9	0.2070(60)
578.4	0.000095(7)
616.2	0.0075(15)
621.8	0.0981(58)
680.2	0.000093(13)
684.7	0.000050(8)
715.9	0.000099(17)
717.3	0.000068(15)
873.5	0.00433(30)
1045.8	0.000050(1)
1050.4	0.0150(11)
1062.2	0.000296(12)
1108.7	0.000050(15)
1114.5	0.000106(19)
1128.1	0.00397(15)
1133.7	0.00280(32)
1150.2	0.000027(2)
1180.8	0.000141(9)
1194.6	0.000546(26)
1266.1	0.000012(2)
1305.3	0.000011(1)
1315.7	0.000034(3)
1360.1	0.000016(1)
1372.3	0.000019(2)
1397.7	0.000025(2)
1489.7	0.000018(3)
1496.6	0.000269(18)
1562.2	0.001586(91)
1572.3	0.000017(2)
1730.5	0.000019(2)
1766.2	0.000277(26)
1796.9	0.000253(16)
1927.3	0.000137(9)
1988.6	0.000244(16)
2112.6	0.000350(21)
2193.3	0.000047(3)
2242.4	0.000018(1)
2271.8	0.000011(1)
2308.8	0.000027(1)
2309.3	0.000025(1)

Table 1 (continued).

photon energy(keV)	emission probability
2316.5	0.000059(4)
2366.1	0.000224(14)
2390.6	0.000062(5)
2406.0	0.000141(9)
2439.1	0.000044(3)
2542.8	0.000029(2)
2571.2	0.000014(1)
2705.3	0.000026(4)
2709.6	0.000038(4)
2821.3	0.000012(1)
3037.3	0.000011(1)

Table 1 (continued).

^{110m}Ag

249.79(18) days β⁻ and IT decay [UKPADD2]

photon energy(keV)	emission probability
1.1	0.000032(3)
116.5	0.000076(2)
120.2	0.000170(9)
133.3	0.000767(47)
219.4	0.000737(38)
221.1	0.000709(47)
229.4	0.000104(19)
266.9	0.000350(19)
341.2	0.000057(28)
360.2	0.000132(19)
365.4	0.00086(18)
387.1	0.0007(3)
396.9	0.00057(28)
409.30	0.000066(9)
409.32	0.000066(9)
446.8	0.0384(8)
467.0	0.000246(19)
493.5	0.00011(4)
544.6	0.000180(9)
573.3	0.000180(9)
603.1	0.000189(28)
620.4	0.02788(29)
626.3	0.00215(8)
630.6	0.000284(19)
649.7	0.00018(4)
657.8	0.9450(20)
677.6	0.1049(10)
687.0	0.0671(28)
706.7	0.1644(19)
708.1	0.00189(19)
714.6	0.000085(19)
744.3	0.0482(9)
763.9	0.2268(29)
774.8	0.000028(19)
818.0	0.0733(4)
884.7	0.747(19)
937.5	0.3431(13)
957.4	0.000104(9)
997.2	0.00134(5)
1018.9	0.000142(9)
1085.5	0.00062(11)
1117.4	0.00039(6)
1125.7	0.00036(8)
1163.2	0.00045(8)
1165.0	0.00029(4)

Table 1 (continued).

photon energy(keV)	emission probability
1186.6	0.000047(19)
1251.0	0.00023(7)
1300.0	0.00024(8)
1334.4	0.00141(6)
1384.3	0.2425(9)
1421.1	0.00037(3)
1475.8	0.03988(21)
1505.0	0.1302(5)
1562.3	0.0103(10)
1592.8	0.000209(12)
1629.7	0.000058(10)
1698.6	0.000018(2)
1775.4	0.000063(10)
1783.5	0.000097(10)
1903.5	0.000149(14)
2004.6	0.000011(1)

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^{113m}In

1.658(1) hours IT decay [UKPADD2]

photon energy(keV)	emission probability
391.7	0.6489(15)

Table 1 (continued).

^{123}I

13.2(1) hours	EC decay	[ENSDF-PC]
photon energy(keV)		emission probability (*0.000010 limit*)
159.0		0.833(4)
182.6		0.000129(6)
192.2		0.000198(10)
198.2		0.000033(9)
206.8		0.000033(9)
207.8		0.000011(4)
248.0		0.00071(3)
257.5		0.000015(5)
278.4		0.000022(5)
281.0		0.00079(3)
285.3		0.000042(5)
295.2		0.00001583(8)
329.4		0.000026(6)
330.7		0.000116(6)
343.7		0.000042(5)
346.4		0.00126(5)
405.0		0.000029(6)
440.0		0.00428(15)
454.8		0.000039(5)
505.3		0.00316(11)
529.0		0.0139(5)
538.5		0.00382(13)
556.0		0.000031(5)
562.8		0.000011(5)
578.3		0.000015(5)
599.7		0.000026(10)
610.1		0.000011(4)
624.6		0.00083(3)
628.3		0.000016(3)
688.0		0.000267(15)
735.8		0.000616(22)
783.6		0.000594(22)
877.5		0.000011(7)
909.1		0.0000133(25)
1068.1		0.0000142(9)

Table 1 (continued).

^{124}I

4.181(21) days EC decay [JEF2.2, EN88]*

* JEF2.2 does not give an uncertainty on the gamma intensity normalisation. However, a value of 8% (as used by Browne & Firestone [5]) has been incorporated below.

photon energy(keV)	emission probability
307.2	0.000182(92)
336.0	0.000175(92)
381.7	0.000169(18)
444.1	0.000333(95)
478.7	0.000260(32)
526.0	0.00036(19)
541.2	0.00188(17)
553.8	0.000605(48)
592.4	0.000405(91)
602.7	0.605(49)
631.5	0.000061(5)
645.8	0.00944(82)
662.4	0.000545(57)
695.0	0.001210(97)
707.5	0.00067(31)
709.2	0.0042(19)
713.8	0.00109(15)
722.8	0.0998(82)
743.2	0.000163(44)
775.1	0.000133(38)
790.7	0.000278(82)
795.3	0.000436(46)
846.6	0.000024(12)
876.5	0.000260(64)
899.0	0.00030(19)
928.0	0.000021(09)
961.8	0.000224(30)
968.2	0.000411(34)
976.3	0.00103(15)
984.4	0.000139(32)
1000.0	0.000242(19)
1045.0	0.00424(46)
1054.0	0.00121(12)
1086.6	0.000182(62)
1128.1	0.000436(35)
1195.7	0.000188(68)
1204.9	0.000188(16)
1236.0	0.000054(31)
1315.2	0.000345(51)
1325.5	0.0143(13)
1355.1	0.000424(75)

Table 1 (continued).

photon energy(keV)	emission probability
1357.0	0.00073(25)
1368.2	0.00284(30)
1376.0	0.01664(14)
1433.5	0.000061(5)
1436.5	0.00067(19)
1444.9	0.00033(12)
1488.9	0.00182(16)
1509.5	0.0299(24)
1559.8	0.00163(28)
1621.7	0.0005687(15)
1637.7	0.00194(20)
1662.0	0.000605(48)
1675.8	0.00109(26)
1691.0	0.1041(85)
1705.5	0.000139(27)
1720.4	0.00169(19)
1739.5	0.000242(64)
1752.2	0.000496(72)
1851.4	0.00206(30)
1918.6	0.00157(23)
2021.0	0.000030(30)
2038.3	0.00339(33)
2078.9	0.00345(31)
2091.0	0.00569(46)
2092.0	0.00019(19)
2099.1	0.00139(13)
2144.3	0.00109(11)
2214.6	0.000103(49)
2232.3	0.00569(48)
2275.8	0.000061(31)
2283.3	0.00660(61)
2294.4	0.000103(20)
2385.4	0.000194(29)
2453.9	0.00067(19)
2485.0	0.000242(19)
2641.0	0.000054(4)
2681.5	0.00030(13)
2693.0	0.000157(80)
2746.9	0.00460(41)
2837.0	0.000048(4)
2987.6	0.000079(37)
3000.0	0.000054(4)

Table 1 (continued).

^{124}Sb

60.24(9) days | β^- decay | [UKPADD2]

photon energy(keV)	emission probability (*0.000010 limit*)
254.4	0.00016(3)
335.8	0.00077(10)
370.4	0.00027(4)
400.2	0.0018(4)
444.0	0.00220(20)
468.7	0.00049(9)
476.7	0.00035(5)
481.3	0.00020(10)
525.4	0.00140(10)
602.7	0.9780(10)
632.4	0.00120(10)
645.9	0.0740(7)
662.4	0.000150(20)
709.3	0.01400(20)
713.8	0.02340(30)
722.8	0.1097(12)
735.8	0.00137(4)
766.1	0.0000090(20)
790.7	0.00743(6)
817.1	0.00077(4)
857.0	0.000260(20)
899.4	0.00017(4)
968.2	0.0192(4)
976.4	0.00090(4)
997.8	0.000060(20)
1045.1	0.01860(20)
1053.9	0.00009(4)
1086.6	0.00038(4)
1197.0	0.00006(3)
1234.7	0.00009(4)
1263.1	0.00043(7)
1301.2	0.00040(3)
1325.5	0.0155(5)
1355.2	0.0106(5)
1368.2	0.0260(8)
1376.2	0.0050(3)
1385.3	0.00047(6)
1436.6	0.0122(7)
1445.1	0.0032(5)
1453.1	0.00012(5)
1488.9	0.0070(5)
1526.4	0.00430(20)
1579.8	0.0029(8)
1622.2	0.00036(6)

Table 1 (continued).

photon energy(keV)	emission probability
1691.0	0.484(6)
1720.6	0.00097(3)
1732.5	0.00008(4)
1851.6	0.000015(5)
1919.8	0.000560(20)
2015.0	0.000098(9)
2039.3	0.000620(20)
2078.8	0.000160(20)
2091.0	0.0557(6)
2099.0	0.00042(4)
2108.1	0.000450(20)
2172.3	0.000013(3)
2182.5	0.000410(10)
2204.0	0.000071(5)
2254.0	0.000012(5)
2283.2	0.000064(10)
2293.7	0.00043(8)
2323.3	0.000018(4)
2681.5	0.000018(3)
2693.7	0.000025(3)

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^{129}I

5.73(15) E9 days β^- decay [JEF2.2, FR84]

photon energy(keV)	emission probability
39.6	0.075(2)

Table 1 (continued).

^{131}I

8.04(1) days β⁻ decay [JEF2.2, UK83]

photon energy(keV)	emission probability (*0.000010 limit*)
80.2	0.02621(67)
177.2	0.002651(57)
232.2	0.000014(8)
272.5	0.000565(16)
284.3	0.0606(13)
302.4	0.000045(10)
318.1	0.000796(38)
324.6	0.000222(43)
325.8	0.002510(76)
358.4	0.000092(3)
364.5	0.812(17)
404.8	0.000565(26)
503.0	0.003609(86)
637.0	0.0727(16)
642.7	0.002197(52)
722.9	0.01804(39)

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^{132}I

2.30(3) hours β⁻ decay [JEF2.2, UK83]

photon energy(keV)	emission probability (*0.000010 limit*)
136.6	0.00079(10)
147.2	0.00237(21)
183.3	0.001579(3)
254.8	0.00188(30)
262.7	0.01441(92)
278.9	0.00040(20)
284.8	0.00790(71)
302.0	0.000049(0)
306.6	0.001086(2)
310.0	0.00089(40)
316.5	0.00158(40)
343.6	0.00099(20)
351.8	0.00079(20)
363.5	0.0049(10)
387.8	0.00168(30)
416.8	0.00464(90)
431.9	0.00454(90)
446.0	0.00671(81)
473.4	0.00267(50)

Table 1 (continued).

photon energy(keV)	emission probability
477.9	0.00099(40)
487.5	0.00178(50)
505.9	0.0503(21)
522.7	0.1609(63)
535.5	0.00523(80)
547.1	0.01253(92)
590.9	0.00059(40)
600.5	0.000888(2)
620.8	0.003948(8)
621.2	0.015790(32)
630.2	0.1372(62)
650.6	0.0267(21)
667.7	0.9870(20)
669.8	0.0494(80)
671.6	0.0523(41)
727.0	0.0217(60)
727.2	0.0316(60)
729.5	0.0109(30)
771.7	0.00020(20)
772.6	0.762(20)
780.2	0.01234(62)
784.5	0.00424(51)
792.1	0.00089(30)
809.8	0.0286(31)
812.2	0.0563(51)
863.3	0.00592(51)
876.8	0.01076(52)
889.0	0.00040(30)
910.3	0.00918(52)
927.6	0.00444(80)
948.6	0.00079(50)
954.6	0.1806(63)
984.5	0.00563(61)
1002.1	0.000395(1)
1009.8	0.000790(2)
1016.2	0.00049(30)
1034.7	0.00573(51)
1049.9	0.00044(15)
1086.3	0.00069(30)
1096.8	0.00035(12)
1112.5	0.00059(20)
1126.6	0.00051(24)
1136.0	0.0296(21)
1138.0	0.002961(6)
1143.4	0.0138(11)
1148.2	0.00207(50)
1173.2	0.0109(11)
1254.1	0.00049(30)

Table 1 (continued).

photon energy(keV)	emission probability
1263.7	0.00023(12)
1272.7	0.00148(30)
1290.7	0.01135(62)
1295.3	0.0197(11)
1298.2	0.0089(11)
1314.3	0.00059(20)
1317.1	0.00118(20)
1372.1	0.0247(11)
1398.6	0.0711(32)
1410.5	0.00059(20)
1442.6	0.01421(63)
1456.5	0.00048(10)
1476.8	0.00138(20)
1519.7	0.000513(60)
1542.2	0.000099(50)
1593.1	0.000444(60)
1618.5	0.000148(30)
1620.0	0.000079(30)
1637.8	0.000168(40)
1661.6	0.000168(40)
1671.6	0.000178(0)
1715.5	0.000523(50)
1727.3	0.000622(90)
1752.5	0.000296(99)
1757.5	0.00375(31)
1760.8	0.000197(99)
1778.4	0.00059(15)
1786.8	0.000079(40)
1814.4	0.000099(40)
1879.2	0.000158(30)
1985.5	0.000079(20)
2002.3	0.0109(11)
2086.8	0.00247(40)
2172.7	0.00188(30)
2186.9	0.000069(30)
2223.2	0.00118(20)
2249.1	0.000296(99)
2290.4	0.000039(0)
2390.5	0.00168(21)
2408.9	0.000099(30)
2444.1	0.000039(20)
2455.2	0.000030(20)
2487.0	0.000020(0)
2525.1	0.000365(70)
2546.6	0.000020(10)
2569.7	0.000030(10)
2717.4	0.000030(10)

Table 1 (continued).

^{144}Ce

284.9(2) days | β^- decay | [ENSDF-PC]

The 17.28(5) minute daughter ^{144}Pr is taken to be in equilibrium with ^{144}Ce.

photon energy(keV)	emission probability (*0.000010 limit*)
33.6	0.00200(23)
41.0	0.00257(16)
53.4	0.00100(8)
80.1	0.0136(6)
100.0	0.00040(5)
133.5	0.1109(20)
624.7	0.0000113(3)
675.0	0.000030(3)
696.5	0.01342(14)
814.1	0.000032(3)
864.5	0.000024(3)
1388.0	0.0000672(9)
1489.2	0.00278(5)
2185.7	0.00694(16)

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^{144}Pm

363(14) days | EC decay | [ENSDF-PC]

photon energy(keV)	emission probability (*0.000010 limit*)
301.7	0.0018(4)
476.8	0.420(8)
582.4	0.00189(20)
618.0	0.986(10)
694.0	0.0055(10)
696.5	0.99490(20)
778.6	0.0151(5)
814.1	0.0055(3)
890.1	0.00040(10)

Table 1 (continued).

^{160}Tb

72.3(2) days | β^- decay | [JEF2.2, FR84]

photon energy(keV)	emission probability
86.8	0.1316(62)
93.9	0.000560(52)
176.5	0.000049(10)
197.0	0.0515(19)
215.7	0.0395(15)
230.6	0.000727(62)
237.6	0.000079(30)
242.5	0.000098(3)
246.5	0.000226(40)
298.6	0.269(11)
309.6	0.00854(32)
337.3	0.00324(14)
349.9	0.000147(30)
379.4	0.000147(30)
392.5	0.01336(49)
432.7	0.000167(30)
486.1	0.000845(55)
682.3	0.00570(34)
765.3	0.02003(76)
872.0	0.00206(30)
879.4	0.2946(84)
962.3	0.0982(41)
966.2	0.2504(87)
1002.9	0.01021(42)
1005.0	0.000982(28)
1069.1	0.00092(13)
1102.6	0.00530(25)
1115.1	0.01532(53)
1177.9	0.1522(53)
1199.9	0.02318(83)
1251.3	0.00098(11)
1271.9	0.0746(29)
1285.6	0.000137(20)
1299.3	0.000049(29)
1312.1	0.02917(11)

Table 1 (continued).

^{169}Yb

32.010(20) days	EC decay	[JEF2.2, FR84]
photon energy(keV)		emission probability (*0.000010 limit*)
8.4		0.00352(30)
20.8		0.00237(16)
63.1		0.416(24)
93.6		0.0255(16)
109.8		0.1741(70)
117.3		0.000388(20)
118.2		0.01906(75)
130.5		0.1149(47)
156.7		0.000083(15)
177.2		0.2233(89)
198.0		0.359(14)
240.4		0.001221(78)
261.1		0.01684(66)
307.7		0.0987(38)
333.9		0.000016(2)
336.4		0.000101(4)
594.2		0.000015(1)
514.9		0.000042(2)
570.5		0.000013(1)
579.4		0.000019(1)
600.2		0.000011(1)
624.6		0.000049(2)

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^{170}Tm

128.6(3) days	β^- and EC decay	[ENSDF-PC]
photon energy(keV)		emission probability
78.7		0.000039(9)
84.3		0.0326(16)

Table 1 (continued).

^{187}W

23.85(8) hours	β^- decay	[UKPADD2]
photon energy(keV)		emission probability (*0.000010 limit*)
7.2		0.000049(6)
29.3		0.000038(8)
36.5		0.000038(6)
43.7		0.000016(8)
72.0		0.110(4)
77.3		0.000078(11)
106.6		0.000162(28)
106.7		0.000135(27)
113.8		0.00078(4)
134.3		0.087(4)
168.5		0.000024(8)
198.3		0.000016(5)
206.2		0.00130(12)
239.1		0.00084(4)
246.3		0.00113(9)
275.6		0.000024(5)
352.9		0.000015(6)
454.7		0.000316(22)
479.5		0.217(8)
484.0		0.000170(10)
511.6		0.00637(25)
551.5		0.0505(20)
564.9		0.00012(4)
576.9		0.000065(8)
589.0		0.00130(7)
612.2		0.000022(11)
618.3		0.0621(23)
625.5		0.0108(4)
638.5		0.000016(5)
638.7		0.000016(5)
682.3		0.00007(7)
685.7		0.270(10)
692.4		0.000016(8)
745.4		0.00300(14)
772.9		0.0410(16)
816.6		0.000100(7)
864.6		0.00335(14)
879.6		0.00140(6)
960.2		0.000013(1)
1230.5		0.000013(1)

Table 1 (continued).

^{192}Ir

73.831(8) days	β^- and EC decay	[JEF2.2, EN88]
photon energy(keV)	emission probability	
136.3	0.001810(90)	
177.0	0.000100(50)	
201.3	0.00454(18)	
205.8	0.0318(12)	
214.7	0.000013(13)	
280.0	0.000017(17)	
283.3	0.00249(20)	
296.0	0.2873(20)	
308.5	0.2975(21)	
314.8	0.00040(40)	
314.8	0.00040(40,	
316.5	0.8300(60)	
374.5	0.00709(23)	
415.4	0.000050(50)	
416.5	0.006640(90)	
420.5	0.000640(80)	
468.1	0.4770(30)	
476.5	0.000029(13)	
484.6	0.0314(10)	
485.0	0.000022(0)	
489.1	0.00432(16)	
588.6	0.04480(30)	
593.4	0.000432(25)	
604.4	0.08090(50)	
612.5	0.05260(40)	
884.5	0.002839(24)	
1061.5	0.000524(10)	
1089.0	0.000011(5)	
1378.0	0.000013(5)	

^{195}Au

186.09(2) days	EC decay	[ENSDF-PC]
photon energy(keV)	emission probability	
30.9	0.0075(6)	
98.9	0.109(9)	
129.9	0.0082(5)	
199.5	0.000086(8)	
211.4	0.000109(13)	

Table 1 (continued).

^{197}Hg

64.6(6) hours | EC decay | [UKPADD2]

photon energy(keV)	emission probability
77.4	0.179(5)
191.4	0.00609(26)
268.8	0.000376(21)

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^{199}Au

3.139(7) days | β^- decay | [JEF2.2, FR84]

photon energy(keV)	emission probability
49.8	0.00328(12)
158.4	0.3690(74)
208.2	0.0838(26)

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^{201}Tl

72.912(17) hours | EC decay | [ENSDF-PC]

JEF2.2 not quoted, as the normalisation factor is missing.

photon energy(keV)	emission probability
26.3	0.000091(11)
30.6	0.00272(13)
32.2	0.00276(15)
135.3	0.0280(11)
141.1	0.0000604(23)
165.9	0.00166(13)
167.4	0.106(5)

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^{203}Pb

51.873(9) hours | EC decay | [ENSDF-PC]

photon energy(keV)	emission probability
279.2	0.8080(20)
401.3	0.0347(17)
680.5	0.0070(8)

Table 1 (continued).

^{231}Pa

1.201(4) E7 days α decay [JEF2.2, UK91]

photon energy(keV)	emission probability (*0.000010 limit*)
16.4	0.00220(10)
19.0	0.003540(70)
23.6	0.000044(5)
24.5	0.000035(1)
25.4	0.000950(30)
27.4	0.1110(40)
30.0	0.000950(60)
31.5	0.000076(7)
35.9	0.000160(20)
38.2	0.001430(90)
42.3	0.000054(10)
44.2	0.000560(70)
46.4	0.002230(60)
51.0	0.000014(4)
52.7	0.00090(11)
54.6	0.000770(60)
56.9	0.000048(6)
57.2	0.000400(30)
60.5	0.000055(9)
63.6	0.000460(30)
70.6	0.000058(10)
71.9	0.000015(2)
72.6	0.000035(6)
74.1	0.000220(10)
77.4	0.000570(40)
96.9	0.000820(30)
100.9	0.000230(20)
102.8	0.000150(40)
124.6	0.000039(7)
144.5	0.000110(10)
199.0	0.000043(6)
242.8	0.000110(20)
243.2	0.000320(20)
245.5	0.000068(6)
255.9	0.001070(30)
260.3	0.001820(50)
273.2	0.000590(20)
277.3	0.000690(20)
283.7	0.01650(40)
286.6	0.000104(7)
300.1	0.02410(60)
302.7	0.02470(60)
310.0	0.000010(2)
313.0	0.000990(20)

Table 1 (continued).

photon energy(keV)	emission probability
327.1	0.000350(10)
330.1	0.01360(30)
340.8	0.001780(40)
351.6	0.000016(2)
354.5	0.000970(30)
357.2	0.001690(50)
359.5	0.000086(4)
364.0	0.000080(4)
375.4	0.000047(3)
379.3	0.000500(10)
884.9	0.000039(4)
391.8	0.000068(3)
395.7	0.000025(2)
398.3	0.000096(4)
407.8	0.000360(10)
410.8	0.000017(2)
435.1	0.000030(2)
438.1	0.000046(3)
438.8	0.000013(3)
486.8	0.000015(2)
516.4	0.000015(2)

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^{233}Pa

27.00(10) days β^- decay [JEF2.2, UK91]

photon energy(keV)	emission probability
17.3	0.000037(9)
28.5	0.00151(12)
40.4	0.000386(77)
41.7	0.000135(39)
57.9	0.000019(19)
75.3	0.01320(43)
86.6	0.0197(12)
92.0	0.000019(19)
103.9	0.00869(33)
248.5	0.000579(39)
258.5	0.000039(15)
271.5	0.00320(13)
298.9	0.000347(77)
300.1	0.0664(12)
312.0	0.3860(50)
340.5	0.04516(97)
375.5	0.00695(40)
398.6	0.01409(27)
415.8	0.01737(45)

Table 1 (continued).

^{237}Np

7.82(4) E8 days α decay [JEF2.2, UK91]

photon energy(keV)	emission probability (*0.000010 limit*)
5.3	0.000023(3)
17.3	0.000013(3)
29.4	0.152(35)
46.5	0.00106(13)
57.1	0.00382(41)
62.5	0.000063(63)
63.9	0.000164(21)
74.7	0.000050(14)
86.5	0.123(13)
88.0	0.00139(15)
94.7	0.00635(79)
106.1	0.00045(10)
108.6	0.00077(16)
115.5	0.000026(8)
117.7	0.00173(18)
131.0	0.000857(92)
134.2	0.000706(77)
140.6	0.000189(54)
143.2	0.00432(46)
151.4	0.00234(25)
153.5	0.000073(18)
155.2	0.000920(98)
162.5	0.000416(87)
169.2	0.000706(74)
170.6	0.000168(31)
172.6	0.000072(20)
176.1	0.000175(40)
180.8	0.000227(56)
186.8	0.000033(33)
191.5	0.000290(50)
193.3	0.000441(63)
194.7	0.000120(36)
195.1	0.00185(20)
196.8	0.000234(42)
200.2	0.000037(14)
201.7	0.000454(69)
202.7	0.000049(20)
209.2	0.000198(29)
212.4	0.0015[illegible]16)
214.1	0.000[illegible]79(62)
222.5	0.000018(18)

Table 1 (continued).

230.0	0.000117(31)
238.0	0.000592(62)
248.9	0.000049(22)
257.2	0.000067(36)
262.4	0.000078(24)
279.4	0.000018(18)

^{237}U

6.75(1) days β⁻ decay [JEF2.2, UK91]

photon energy(keV)	emission probability (*0.000010 limit*)
13.8	0.000610(60)
26.3	0.0222(23)
33.2	0.00112(48)
43.4	0.000240(17)
51.0	0.004500(60)
59.5	0.3450(80)
64.8	0.01310(30)
69.8	0.000100(10)
103.0	0.000082(4)
164.6	0.01870(50)
208.0	0.2160(50)
221.7	0.000205(8)
234.2	0.000205(8)
267.5	0.00730(18)
292.8	0.000025(2)
332.4	0.01210(30)
335.4	0.000970(3)
337.8	0.000089(5)
368.6	0.000420(20)
370.9	0.001100(40)

^{239}Pu

8.807(15) E6 days α decay [JEF2.2,UK91]

photon energy(keV)	emission probability (*0.000010 limit*)
38.7	0.000105(2)
51.6	0.000271(5)
56.8	0.000011(0)
98.8	0.000012(0)
111.3	0.000016(0)
129.3	0.000063(1)
375.1	0.000016(0)
413.7	0.000015(0)