

TABLE 7. IRDF-II recommended (recomm.) nuclear decay data for pure beta emitters. (DD eval.) refers to the latest Chechev compilation at <https://www-nds.iaea.org/IRDFtest/RCM3/Chechev-RCM3.pdf>. New DDEP evaluations undertaken within this project are highlighted in blue. Numbers in parentheses indicate the absolute uncertainties, *e.g.*, 12.312(25) \equiv 12.312 \pm 0.025.

Reaction Product	Half-life (recomm.)	Half-life (DD eval.)	Time unit	Beta Data	
				Aver. E_β [keV]	Emiss. Prob. [%]
^3H	12.32(2)	12.312(25)	a	5.68(1)	100.
^{32}P	14.263(36)	14.284(36)	d	695.5(3)	100.
^{106}Ru	371.8(18)	371.5(21)	d	10.03(6)	100.

C. Nuclear Decay Data

This Sec. addresses the IRDF-II nuclear decay data used in reaction evaluations for activation and fission products. Tables 7 (beta emitters) and 8 (gamma emit-

ters) give the recommended half-lives and emission probabilities associated with the residual nuclei (activation products) for all of the library radionuclides according to the detected decay radiation. Those recommended values (recomm.) were used in reaction evaluations. It also shows the most recently evaluated gamma and beta decay data, namely the emission energies and emission probabilities for all of the residual nuclei associated with the reactions addressed within IRDF-II.

Note that recommended data usually agree within uncertainties with the latest decay data evaluations (labelled **DD eval.** in Table headers). The only discrepant data at the three sigma level is the half-life of ^{24}Na , users should exercise special care when using this radionuclide for dosimetry. The latest decay data evaluations have been compiled into associated IRDF-II decay data file that is released together with the IRDF-II neutron metrology library.

TABLE 8: IRDF-II recommended nuclear decay data content for gamma emitters. (DD eval.) refers to the latest Chechev compilation at <https://www-nds.iaea.org/IRDFtest/RCM3/Chechev-RCM3.pdf>. (*) indicates data taken from ENSDF. New DDEP evaluations undertaken within this project are highlighted in blue. Numbers in parentheses indicate the absolute uncertainties, *e.g.*, 109.734(14) \equiv 109.734 \pm 0.014.

Reaction Product	Half-life (recomm.)	Half-life (DD eval.)	Time unit	Gamma/X-ray Energy [keV]	Gamma/X-ray		Source Document
					Emiss. Prob. [%] (recomm.)	Emiss. Prob. [%] (DD eval.)	
^{18}F	109.77(5)	109.734(14)	m	511. 0.525 $XK_\alpha 1$ 0.525 $XK_\alpha 2$	193.72(38) 0.013(4) 0.007(2)		BIPM
^{22}Na	2.6018(22)	2.6020	a	1274.537(7) 511.	99.94(13) 180.7(2)	99.940(14) 180.76(4)	BIPM
^{24}Na	14.997(12)	14.958(2)	h	1368.630(5) 2754.049(13)	99.9934(5) 99.862(3)	99.9936(15) 99.855(5)	BIPM
^{27}Mg	9.458(12)		m	843.76(10) 1014.52(10)	71.800(20) 28.200(20)	71.8(4) 28.0(4)	ENSDF
^{26g}Al	717 000(24)		a	11129.67(10) 1808.65(7) 511.0	2.5(2) 99.76(4) 163.5(4)		ENSDF
^{28}Al	(*)2.245(2)	2.245(2)	m	1778.987(15)	100.0		ENSDF
^{31}Si	(*)157.36(26)		m	1266.2(14)	0.0554(7)		ENSDF
^{46}Sc	83.787(16)	83.787(16)	d	889.271(2) 1120.537(3)	99.98374(25) 99.97(2)		BIPM
^{47}Sc	3.3485(9)	3.3485(9)	d	159.373(12)	68.1(5)		BIPM
^{48}Sc	(*)43.67(9)	43.70	h	983.526(12) 1037.522(12) 1312.120(12)	100.1(6) 97.6(7) 100.1(7)		ENSDF
^{45}Ti	(*)184.8(5)	184.8	m	511.0	169.6(3)		ENSDF
^{51}Cr	27.704	27.704	d	320.0835(4)	9.89(2)		BIPM
^{54}Mn	312.12(10)	312.19(3)	d	834.855(3)	99.9997(3)	99.976(1)	BIPM
^{56}Mn	2.5785(2)	2.57878(46)	h	846.7638(19) 1810.726(4) 2113.092(6)	98.85(3) 26.9(4) 14.2(3)	98.87(30) 27.189(791) 14.336(395)	BIPM
^{53}Fe	(*)8.51(2)		m				ENSDF
^{59}Fe	44.495(9)	44.494(12)	d	1099.245(3) 1291.590(6)	56.51(31) 43.23(33)	56.6(18) 43.2(14)	BIPM
^{57}Co	(*)271.74(6)	271.81	d	14.41295(31) 122.06065(12) 136.47356(29)	9.18(12) 85.49(14) 10.71(15)		BIPM
^{58}Co	70.86(6)	70.85(3)	d	810.7602(20)	99.44(2)	85.60(17) 10.68(8)	BIPM
^{60}Co	5.2711(8)	5.2711(8)	a	1173.228(3) 1332.492(4)	99.85(3) 99.9826(6)	99.450(10)	BIPM
^{57}Ni	35.60(6)	35.60(6)	h	127.164(3)	16.0(5)		BIPM

TABLE 8: (continued). IRDF-II recommended nuclear decay data content for gamma emitters. (DD eval.) refers to the latest Chechev compilation at <https://www-nds.iaea.org/IRDFtest/RCM3/Chechev-RCM3.pdf>. (*) indicates data taken from ENSDF. New DDEP evaluations undertaken within this project are highlighted in blue.

Reaction Product	Half-life (recomm.)	Half-life (DD eval.)	Time unit	Gamma/Xray		Source Document
				Gamma/X-ray Energy[keV]	Emiss.Prob. [%] (recomm.)	
⁶² Cu	9.73(3)	9.67(3)	m	1377.62(4)	81.2(6)	81.7(24)
				1757.55(3)	6.1(4)	
				1919.62(14)	12.5(5)	12.3(4)
				1172.97(10)	0.342	
⁶⁴ Cu	12.701(2)	12.7004(20)	h	511.0	195.66(5)	2 x 94.86(5)
				1345.77(6)	0.4748(34)	
⁶⁷ Cu	(*)61.83(12)	61.86	h	511.	35.2(4)	34.8(4)
				184.577(10)	48.7(3)	
⁷⁴ As	(*)17.77(2)		d	595.83(8)	59(3)	ENSDF
⁸⁸ Y	(*)106.626(21)	106.63	d	1836.070(8)	99.346(25)	99.2(3)
				898.042(11)	93.7(3)	
⁸⁹ Zr	78.41(12)	78.42(13)	h	908.97(3)	99.03(2)	99.04(1)
				511.	45.6(6)	45.5(5)
⁹⁵ Zr	64.032(6)	64.032(6)	d	756.729(12)	54.38(22)	
				724.193(3)	44.27(22)	
⁹⁵ Nb	34.991(6)	34.991(6)	d	765.803(6)	99.808(7)	BIPM
⁹⁴ Nb	20 300(16)	20 200	a	871.091(18)	99.892(0)	ENSDF
				702.65(6)	99.814(0)	
^{94m} Nb	(*)6.263(4)		m	871	0.50(6)	ENSDF
^{93m} Nb	16.1(2)	16.12(15)	a	30.77(2)	0.000591(9)	BIPM
				16.5213 XK _α 2	3.32(8)	
				16.6152 XK _α 1	6.34(15)	
				18.67 XK _β 1	1.64(4)	
				18.967 XK _β 2	0.246(11)	
				934.44(10)	99.15(4)	99.07(4)
^{92m} Nb	10.15(2)		d	934.44(10)	99.15(4)	ENSDF
⁹⁹ Mo	(*)65.924(6)		h	739.500(17)	12.20	ENSDF
¹⁰³ Ru	(*)39.247(13)		d	610.333(10)	5.76(6)	ENSDF
				497.085(10)	91.0(12)	
^{103m} Rh	(*)56.114(9)		m	39.755(12)	0.068(5)	ENSDF
				20.073 XK - L ₂	2.00(18)	
				20.215 XK - L ₃	3.8(3)	
				22.699-22.912 XK - M _{2,3,4}	1.03(9)	
				22.699-23.215 XK - MN	1.20(11)	
				23.167-23.172 XK - N _{2,3,4,5} O _{2,3}	0.171(16)	
				1505.028(2)	13.16(16)	
^{110m} Ag	249.78(2)		d	1384.2931(20)	24.7(5)	BIPM
				937.485(3)	34.51(27)	
				884.6781(13)	74.0(12)	
				763.9424(17)	22.31(9)	
				706.6760(15)	16.48(8)	
				657.7600(11)	94.38(8)	
^{113m} In	(*)99.476(23)	99.48	m	391.698(3)	64.94(17)	ENSDF
^{114m} In	(*)49.51(1)	49.51	d	190.27(3)	15.56(15)	ENSDF
				24.002	9.8(3)	
				24.21	18.2(6)	
^{115m} In	4.486(4)		h	336.244(17)	45.9(1)	ENSDF
^{116m} In	54.29(17)		m	1293.56(2)	84.8(12)	ENSDF
				1097.28(2)	58.5(8)	
¹²⁶ I	(*)12.93(5)	12.93	d	666.331(12)	32.9(7)	ENSDF
^{137m} Ba	(*)2.552(1)	2.552	m	388.633(11)	35.6(6)	
				661.657(3)	90.07(20)	BIPM
¹³⁷ Cs	(*)30.08(9)		a	661.657(3)	84.99(20)	BIPM
¹⁴⁰ La	1.6781(3)	1.67855(12)	d	1596.203(13)	95.40(5)	95.40(8)
				815.784(6)	23.72(20)	
				328.761(4)	20.8(3)	
¹⁴⁰ Ba	(*)12.7527(23)	12.7527	d	537.261(25)	24.6(5)	BIPM
¹⁴⁴ Ce	(*)284.91(5)		d	133.5152(20)	10.83(12)	BIPM

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Reaction Product	Half-life (recomm.)	Half-life (DD eval.)	Time unit	Gamma/Xray		Source Document
				Gamma/X-ray Energy[keV]	Emiss.Prob. [%] (recomm.)	
¹⁴⁰ Pr	(*)3.39(1)	3.39	m	1596.1(2)	0.49	ENSDF
				511.0	102.0(6)	
				39.258	3.68(8)	
¹⁶⁷ Tm	(*)9.25(2)	9.25	d	207.801(5)	42(8)	BIPM
¹⁶⁸ Tm	(*)93.1(2)		d	815.89(5)	50.95(16)	ENSDF
				447.515(3)	23.98(11)	
				198.251 (2)	54.49(16)	
¹⁸² Ta	114.43	114.74(12)	d	1221.395(3)	27.35(27)	BIPM
				1189.040(3)	16.66(16)	
				1121.290(3)	35.30(33)	
¹⁸⁷ W	23.72(6)	24.00	h	685.81(1)	33.2(5)	ENSDF
				551.55(1)	6.14(10)	
				479.53(1)	26.6(4)	
¹⁹⁶ Au	6.183(10)	6.1669(6)	d	333.03(5)	22.9(9)	ENSDF
				355.73(5)	87.	
				426.10(6)	6.6	
¹⁹⁸ Au	2.6943(8)	2.6943(3)	d	411.80205(17)	95.62(6)	BIPM
				675.8836(7)	0.804(7)	
				1087.6842(7)	0.1591(21)	
^{199m} Hg	42.6(2)	42.67(9)	m	158.3(1)	52.3	ENSDF
				374.1(1)	13.8(11)	
^{204m} Pb	67.2(3)	66.93(10)	m	374.76(7)	94.20(14)	ENSDF
				911.74(15)	91.5(13)	
²⁰⁴ Bi	11.22(10)	11.28	h	1755.28(6)	1.23(16)	ENSDF
				1703.27(5)	2.00(24)	
				983.98(3)	59(6)	
				899.15(3)	99(12)	
				670.72(3)	11.4(13)	
²⁰⁵ Bi	15.31(4)	15.11	d	703.45(5)	31.1	ENSDF
				987.66(5)	16.1(3)	
				1764.30(10)	32.5(7)	
²⁰⁶ Bi	6.243(3)		d	803.10(5)	99.0(14)	ENSDF
				537.45(4)	30.5(4)	
				343.51(3)	23.5(4)	
²⁰⁷ Bi	32.9(14)	31.55(4)	a	1063.656(3)	74.58(22)	BIPM
				1770.228(9)	6.871(26)	
				569.698(2)	97.76(3)	
²⁰⁸ Bi	(*)368 000(4)		a	2614.5	99.785	ENSDF
²³³ Th	(*)21.83(4)	22.15(8)	m	595.39(6)	0.1178(16)	BIPM
				170.60(6)	0.507(9)	
				86.477(10)	1.843(22)	
²³³ Pa	(*)26.975(13)	26.98(2)	d	415.764(5)	1.97(12)	BIPM
				311.904(5)	68.9(12)	
				300.129(5)	12.3(4)	
²³⁷ U	(*)6.752(2)	6.749(16)	d	332.376(16)	1.199(16)	BIPM
				208.00(1)	21.3(3)	
				59.54091(10)	34.1(9)	
²³⁹ U	23.46		m	844.10(3)	0.139(3)	BIPM
				662.28(2)	0.170(5)	
				74.664(1)	51.6(13)	
²³⁹ Np	2.356(3)		d	106.125(2)	25.9(3)	BIPM
				228.183(1)	11.32(22)	
				334.310(3)	2.04(2)	

[1] International Reactor Dosimetry File 2002 (IRDF-2002), TECHNICAL REPORT SERIES 452, IAEA, (2006); nu-

merical data: <https://www-nds.iaea.org/irdf2002/>.