

Fission Products Per Tonne of Fuel

used for 50.68 GW-day LWR burnup at power of 36.5 MW and $3.14 \times 10^{14} N/cm^2/s$ neutron flux,
after ten years' storage, as calculated by ORIGEN2 version 2.1 on 9 October 2013.

Radiotoxicity in Sieverts computed for adult ingestion using dose factors from ICRP publication 119

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
⁸⁶ Sr	923.6 mg	10.75 mM									
⁸⁷ Sr	7.616 mg	87.63 μM									
⁸⁸ Sr	519.2 gm	5.906 M									
⁸⁹ Sr	≤ 1 pg	≤ 1 pM	4.803 μBq	1.076×10 ⁶	β	50.57 d	583.0 keV	≤ 1 pW	100.5 W	≤ 1 pSv	2.797 MSv
⁹⁰ Sr	615.2 gm	6.843 M	3.106×10 ⁶	5.049 TBq	β	28.79 y	195.8 keV	97.44 W	158.4 mW	86.97 MSv	141.4 kSv
E ₃₈ Sr	1.135 kg	12.76 M	3.106×10 ⁶	2.736 TBq				97.44 W	85.83 mW	86.97 MSv	76.60 kSv
¹³³ Cs	1.616 kg	12.16 M									
¹³⁴ Cs	8.139 gm	60.78 mM	390.0 TBq	47.92 TBq	β	2.065 y	1.716 MeV	107.2 W	13.17 W	7.410 MSv	910.4 kSv
¹³⁵ Cs	619.6 gm	4.593 M	26.41 GBq	42.62 MBq	β	2.300 My	56.30 keV	238.2 μW	384.4 nW	52.82 Sv	85.25 mSv
¹³⁷ Cs	1.436 kg	10.49 M	4.625×10 ⁶	3.221 TBq	β	30.04 y	186.7 keV	138.3 W	96.31 mW	60.13 MSv	41.87 kSv
E ₅₅ Cs	3.680 kg	27.30 M	5.015×10 ⁶	1.363 TBq				245.5 W	66.72 mW	67.54 MSv	18.35 kSv
⁸⁹ Y	676.0 gm	7.604 M									
⁹⁰ Y	154.3 mg	1.716 mM	3.107×10 ⁶	2.014×10 ⁷	β	2.671 d	935.0 keV	465.4 W	3.016 kW	8.389 MSv	54.37 MSv
⁹¹ Y	≤ 1 pg	≤ 1 pM	6.161 mBq	907.6 TBq	β	58.51 d	606.1 keV	≤ 1 pW	88.13 W	14.79 pSv	2.178 MSv
E ₃₉ Y	676.2 gm	7.605 M	3.107×10 ⁶	4.595 TBq				465.4 W	688.3 mW	8.389 MSv	12.41 kSv
¹⁵⁰ Eu	375.0 ng	2.501 nM	919.1 kBq	2.451 TBq	ε	36.36 y	1.540 MeV	226.7 nW	604.5 mW	1.195 mSv	3.186 kSv
¹⁵¹ Eu	1.710 gm	11.43 mM	88.93 μBq	52.00 μBq	α	≥ 10 ¹⁸ y	1.905 MeV	≤ 1 pW	≤ 1 pW		
¹⁵² Eu	37.85 mg	249.1 μM	242.3 GBq	6.402 TBq	ε	13.52 y	1.276 MeV	49.53 mW	1.309 W	339.2 Sv	8.962 kSv
¹⁵³ Eu	195.8 gm	1.280 M									
¹⁵⁴ Eu	29.45 gm	191.3 mM	294.3 TBq	9.993 TBq	β	8.593 y	1.509 MeV	71.14 W	2.416 W	588.6 kSv	19.99 kSv
¹⁵⁵ Eu	6.383 gm	41.20 mM	109.9 TBq	17.22 TBq	β	4.753 y	122.7 keV	2.160 W	338.4 mW	35.17 kSv	5.510 kSv
E ₆₃ Eu	233.4 gm	1.525 M	404.4 TBq	1.733 TBq				73.35 W	314.3 mW	624.1 kSv	2.674 kSv
⁹⁹ Ru	43.95 mg	444.4 μM									
¹⁰⁰ Ru	218.3 gm	2.185 M									
¹⁰¹ Ru	1.166 kg	11.56 M									
¹⁰² Ru	1.217 kg	11.94 M									
¹⁰³ Ru	≤ 1 pg	≤ 1 pM	6.353 pBq	1.194×10 ⁶	β	39.26 d	564.5 keV	≤ 1 pW	108.0 W	≤ 1 pSv	871.9 kSv
¹⁰⁴ Ru	863.0 gm	8.306 M									
¹⁰⁶ Ru	231.6 mg	2.187 mM	28.69 TBq	123.9 TBq	β	1.020 y	10.03 keV	46.10 mW	199.1 mW	200.8 kSv	867.1 kSv
A ₄₄ Ru	3.465 kg	33.99 M	28.69 TBq	8.281 GBq				46.10 mW	13.31 μW	200.8 kSv	57.97 Sv
¹⁴⁶ Pm	2.661 mg	18.24 μM	43.84 GBq	16.48 TBq	ε	5.531 y	851.0 keV	5.977 mW	2.246 W	39.46 Sv	14.83 kSv
¹⁴⁷ Pm	11.02 gm	75.01 mM	378.1 TBq	34.31 TBq	β	2.623 y	60.54 keV	3.667 W	332.8 mW	98.31 kSv	8.921 kSv

†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
¹⁴⁸ Pm	≤ 1 pg	≤ 1 pM	≤ 1 pBq	6.083×10 ⁶	β	5.368 d	1.299 MeV	≤ 1 pW	1.266 kW	≤ 1 pSv	16.42 MSv
^{148m} Pm	≤ 1 pg	≤ 1 pM	2.955 pBq	790.7 TBq	β	41.05 d	2.140 MeV	≤ 1 pW	271.1 W	≤ 1 pSv	1.344 MSv
E ₆₁ Pm	11.02 gm	75.03 mM	378.1 TBq	34.31 TBq				3.673 W	333.2 mW	98.35 kSv	8.922 kSv
¹²¹ Sb	12.20 gm	100.9 mM									
¹²³ Sb	15.25 gm	124.1 mM									
¹²⁴ Sb	≤ 1 pg	≤ 1 pM	45.21 μBq	647.7 TBq	β	60.20 d	2.239 MeV	≤ 1 pW	232.4 W	≤ 1 pSv	1.619 MSv
¹²⁵ Sb	1.610 gm	12.89 mM	61.53 TBq	38.22 TBq	β	2.759 y	527.5 keV	5.200 W	3.230 W	67.68 kSv	42.04 kSv
¹²⁶ Sb	2.019 μg	16.04 nM	6.249 GBq	3.095×10 ⁶	β	12.40 d	3.117 MeV	3.120 mW	1.545 kW	15.00 Sv	7.428 MSv
^{126m} Sb	15.35 ng	121.9 pM	44.62 GBq	2.907×10 ⁹	β	19.10 m	2.149 MeV	15.36 mW	1.001 MW	1.606 Sv	104.6 MSv
E ₅₁ Sb	29.06 gm	237.9 mM	61.58 TBq	2.119 TBq				5.218 W	179.6 mW	67.70 kSv	2.330 kSv
¹⁰⁸ Cd	694.2 μg	6.434 μM	207.6 nBq	299.0 μBq	ε	410.0 Py	272.0 keV	≤ 1 pW	≤ 1 pW		
¹⁰⁹ Cd	4.558 ng	41.85 pM	435.5 kBq	95.55 TBq	ε	1.267 y	19.61 keV	1.368 nW	300.1 mW	871.0 μSv	191.1 kSv
¹¹⁰ Cd	77.24 gm	702.8 mM									
¹¹¹ Cd	45.72 gm	412.3 mM									
¹¹² Cd	26.97 gm	241.0 mM									
¹¹³ Cd	212.2 mg	1.879 mM	3.229 mBq	15.22 mBq	β	7.700 Py	93.30 keV	≤ 1 pW	≤ 1 pW	80.72 pSv	380.4 pSv
^{113m} Cd	276.1 mg	2.445 mM	2.217 TBq	8.030 TBq	β	14.10 y	283.8 keV	100.8 mW	365.1 mW	50.99 kSv	184.7 kSv
¹¹⁴ Cd	34.99 gm	307.2 mM	6.772 mBq	193.5 μBq	2β	600.0 Py	536.0 keV	≤ 1 pW	≤ 1 pW		
^{115m} Cd	≤ 1 pg	≤ 1 pM	16.49 pBq	942.8 TBq	β	44.60 d	629.1 keV	≤ 1 pW	95.03 W	≤ 1 pSv	3.111 MSv
¹¹⁶ Cd	12.55 gm	108.3 mM	42.12 μBq	3.357 μBq	2β	≥ 10 ¹⁸ y	2.804 MeV	≤ 1 pW	≤ 1 pW		
A ₄₈ Cd	198.0 gm	1.776 M	2.217 TBq	11.20 GBq				100.8 mW	509.2 μW	50.99 kSv	257.6 Sv
¹⁴⁰ Ce	1.896 kg	13.55 M									
¹⁴¹ Ce	≤ 1 pg	≤ 1 pM	≤ 1 pBq	1.055×10 ⁶	β	32.50 d	247.0 keV	≤ 1 pW	41.72 W	≤ 1 pSv	748.7 kSv
¹⁴² Ce	1.711 kg	12.06 M	3.190 Bq	1.864 mBq	2β	50.00 Py	1.417 MeV	≤ 1 pW	≤ 1 pW		
¹⁴⁴ Ce	55.20 mg	383.6 μM	6.519 TBq	118.1 TBq	β	285.0 d	111.9 keV	116.9 mW	2.118 W	33.90 kSv	614.1 kSv
E ₅₈ Ce	3.607 kg	25.61 M	6.519 TBq	1.807 GBq				116.9 mW	32.41 μW	33.90 kSv	9.398 Sv
¹²² Te	1.243 gm	10.20 mM									
¹²³ Te	21.28 mg	173.1 μM	229.0 mBq	10.76 Bq	ε	92.00 Py	17.10 keV	≤ 1 pW	≤ 1 pW	1.008 nSv	47.35 nSv
^{123m} Te	2.644 pg	≤ 1 pM	868.0 Bq	328.3 TBq	γ	119.5 d	245.7 keV	34.17 pW	12.92 W	1.215 μSv	459.6 kSv
¹²⁴ Te	963.7 mg	7.778 mM									
¹²⁵ Te	27.45 gm	219.8 mM									
^{125m} Te	22.52 mg	180.3 μM	15.02 TBq	667.0 TBq	γ	57.40 d	141.8 keV	341.1 mW	15.15 W	13.07 kSv	580.3 kSv
¹²⁶ Te	1.322 gm	10.50 mM									
¹²⁷ Te	≤ 1 pg	≤ 1 pM	48.91 kBq	9.766×10 ⁷	β	9.350 h	227.8 keV	1.785 nW	3.564 kW	8.315 μSv	16.60 MSv
^{127m} Te	143.0 pg	1.127 pM	49.95 kBq	349.3 TBq	γ	109.0 d	90.72 keV	726.0 pW	5.077 W	114.9 μSv	803.4 kSv
¹²⁸ Te	170.8 gm	1.335 M	8.029 nBq	47.01 pBq	2β	≥ 10 ¹⁸ y	867.2 keV	≤ 1 pW	≤ 1 pW		
^{129m} Te	≤ 1 pg	≤ 1 pM	≤ 1 pBq	1.115×10 ⁶	γ	33.60 d	295.8 keV	≤ 1 pW	52.85 W	≤ 1 pSv	3.345 MSv

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Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
¹³⁰ Te E ₅₂ Te	547.3 gm 749.1 gm	4.213 M 5.797 M	70.54 nBq 15.02 TBq	128.9 pBq 20.05 GBq	2β	≥ 10 ¹⁸ y	2.528 MeV	≤ 1 pW 341.1 mW	≤ 1 pW 455.3 μW	13.07 kSv	17.44 Sv
¹⁴⁶ Sm ¹⁴⁷ Sm ¹⁴⁸ Sm ¹⁴⁹ Sm ¹⁵⁰ Sm ¹⁵¹ Sm ¹⁵² Sm ¹⁵⁴ Sm E ₆₂ Sm	12.68 mg 232.8 gm 309.5 gm 4.616 gm 478.3 gm 21.13 gm 178.3 gm 59.76 gm 1.284 kg	86.90 μM 1.585 M 2.092 M 31.00 mM 3.190 M 140.0 mM 1.174 M 388.2 mM 8.600 M	16.42 kBq 195.8 kBq 3.458 Bq 205.0 mBq 20.58 TBq 20.58 TBq	1.295 MBq 841.1 Bq 11.17 mBq 44.41 mBq 974.0 GBq 16.02 GBq	α α α α β	100.0 My 106.0 Gy 7.000 Py 2.000 Py 90.00 y	2.540 MeV 2.310 MeV 2.014 MeV 1.870 MeV 19.78 keV	6.681 nW 72.47 nW 1.116 pW ≤ 1 pW 65.21 mW 65.21 mW	526.9 nW 311.3 pW ≤ 1 pW ≤ 1 pW 3.086 mW 50.77 μW	886.7 μSv 9.594 mSv 2.017 kSv 2.017 kSv	69.93 mSv 41.21 μSv 95.45 Sv 1.570 Sv
G ₁ ³ H	49.11 mg	16.28 mM	17.54 TBq	357.2 TBq	β	12.33 y	5.680 keV	15.96 mW	325.0 mW	736.7 Sv	15.00 kSv
⁹⁸ Tc ⁹⁹ Tc A ₄₃ Tc	10.77 mg 1.136 kg 1.136 kg	110.0 μM 11.49 M 11.49 M	346.4 kBq 712.6 GBq 712.6 GBq	32.16 MBq 627.3 MBq 627.3 MBq	β β	4.200 My 214.0 ky	1.532 MeV 84.62 keV	85.02 nW 9.660 mW 9.660 mW	7.894 μW 8.504 μW 8.504 μW	692.8 μSv 456.1 Sv 456.1 Sv	64.33 mSv 401.5 mSv 401.5 mSv
¹⁴¹ Pr ¹⁴⁴ Pr ^{144m} Pr E ₅₉ Pr	1.689 kg 2.331 μg 11.65 ng 1.689 kg	11.99 M 16.20 nM 80.95 pM 11.99 M	6.519 TBq 78.22 GBq 6.597 TBq	2.797×10 ⁹ 6.714×10 ⁹ 3.906 GBq	β γ	17.28 m 6.900 m	1.240 MeV 57.72 keV	1.295 W 723.3 μW 1.296 W	555.6 kW 62.09 kW 767.2 μW	326.0 Sv 326.0 Sv	139.8 MSv 193.0 mSv
¹¹⁴ Sn ¹¹⁵ Sn ¹¹⁶ Sn ¹¹⁷ Sn ¹¹⁸ Sn ¹¹⁹ Sn ^{119m} Sn ¹²⁰ Sn ^{121m} Sn ¹²² Sn ¹²³ Sn ¹²⁴ Sn ¹²⁶ Sn E ₅₀ Sn	3.852 mg 490.4 mg 12.26 gm 12.64 gm 12.81 gm 12.76 gm 2.193 μg 12.99 gm 4.782 mg 14.26 gm 1.506 ng 19.24 gm 42.49 gm 139.9 gm	33.82 μM 4.268 mM 105.8 mM 108.1 mM 108.7 mM 107.3 mM 18.44 nM 108.3 mM 39.55 μM 117.0 mM 12.25 pM 155.3 mM 337.5 mM 1.152 M	363.6 MBq 10.46 GBq 55.44 GBq	165.8 TBq 2.187 TBq 396.2 MBq	γ γ β 2β β	293.0 d 55.00 y 129.2 d 100.0 Py 230.0 ky	87.19 keV 338.2 keV 526.9 keV 2.287 MeV 210.4 keV	5.079 μW 566.7 μW 38.67 nW ≤ 1 pW 1.504 mW 2.076 mW	2.316 W 118.5 mW 25.68 W ≤ 1 pW 35.40 μW 14.83 μW	123.6 mSv 3.975 Sv 962.0 μSv 209.7 Sv 213.8 Sv	56.37 kSv 831.2 Sv 638.8 kSv 4.936 Sv 1.528 Sv
¹²⁷ I ¹²⁹ I E ₅₃ I	84.19 gm 273.4 gm 357.6 gm	663.4 mM 2.121 M 2.784 M	1.786 GBq 1.786 GBq	6.533 MBq 4.995 MBq	β	16.10 My	78.04 keV	22.33 μW 22.33 μW	81.68 nW 62.45 nW	196.5 Sv 196.5 Sv	718.6 mSv 549.4 mSv

‡First emission from decay with highest branching ratio; †Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
⁹⁰ Zr	207.2 gm	2.305 M									
⁹¹ Zr	876.9 gm	9.646 M									
⁹² Zr	956.3 gm	10.41 M									
⁹³ Zr	1.073 kg	11.55 M	99.79 GBq	93.00 MBq	β	1.530 My	19.60 keV	313.3 μ W	292.0 nW	109.8 Sv	102.3 mSv
⁹⁴ Zr	1.125 kg	11.98 M	26.41 Bq	23.48 mBq	2β	6.000 Py	1.144 MeV	4.839 pW	≤ 1 pW		
⁹⁵ Zr	≤ 1 pg	≤ 1 pM	374.4 mBq	794.7 TBq	β	64.03 d	854.9 keV	≤ 1 pW	108.9 W	355.7 pSv	755.0 kSv
⁹⁶ Zr	1.211 kg	12.63 M	4.282 mBq	3.536 μ Bq	2β	$\geq 10^{18}$ y	3.350 MeV	≤ 1 pW	≤ 1 pW		
A ₄₀ Zr	5.449 kg	58.51 M	99.79 GBq	18.31 MBq				313.3 μ W	57.49 nW	109.8 Sv	20.14 mSv
⁷⁶ Se	12.23 mg	161.1 μ M									
⁷⁷ Se	1.515 gm	19.70 mM									
⁷⁸ Se	3.687 gm	47.32 mM									
⁷⁹ Se	8.869 gm	112.4 mM	22.87 GBq	2.579 GBq	β	377.0 ky	42.00 keV	153.9 μ W	17.35 μ W	66.32 Sv	7.478 Sv
⁸⁰ Se	20.17 gm	252.4 mM									
⁸² Se	50.43 gm	615.6 mM	67.30 μ Bq	1.334 μ Bq	2β	$\geq 10^{18}$ y	2.995 MeV	≤ 1 pW	≤ 1 pW		
E ₃₄ Se	84.68 gm	1.048 M	22.87 GBq	270.1 MBq				153.9 μ W	1.817 μ W	66.32 Sv	783.2 mSv
¹⁰⁷ Ag	438.3 μ g	4.100 μ M									
¹⁰⁸ Ag	≤ 1 pg	≤ 1 pM	156.0 kBq	2.719×10^{10}	β	2.400 m	628.2 keV	15.70 nW	2.737 MW		
^{108m} Ag	1.817 μ g	16.84 nM	1.753 MBq	964.8 GBq	ϵ	418.0 y	1.634 MeV	458.8 nW	252.5 mW	4.032 mSv	2.219 kSv
¹⁰⁹ Ag	115.4 gm	1.060 M									
^{109m} Ag	≤ 1 pg	≤ 1 pM	435.5 kBq	9.673×10^{10}	γ	39.70 s	86.99 keV	6.069 nW	1.348 MW		
¹¹⁰ Ag	≤ 1 pg	≤ 1 pM	144.2 MBq	1.543×10^{11}	β	24.56 s	1.212 MeV	28.01 μ W	29.97 MW		
^{110m} Ag	61.68 μ g	561.2 nM	10.84 GBq	175.7 TBq	β	249.8 d	2.818 MeV	4.894 mW	79.35 W	30.35 Sv	492.1 kSv
E ₄₇ Ag	115.4 gm	1.060 M	10.99 GBq	95.20 MBq				4.922 mW	42.66 μ W	30.36 Sv	263.0 mSv
¹⁰² Rh	141.1 μ g	1.385 μ M	6.312 GBq	44.73 TBq	ϵ	2.902 y	2.152 MeV	2.176 mW	15.42 W	7.574 Sv	53.68 kSv
¹⁰³ Rh	611.3 gm	5.940 M									
^{103m} Rh	≤ 1 pg	≤ 1 pM	5.728 pBq	1.204×10^9	γ	56.11 m	38.83 keV	≤ 1 pW	7.490 kW	≤ 1 pSv	4.576 MSv
¹⁰⁶ Rh	217.7 ng	2.056 nM	28.69 TBq	1.318×10^{11}	β	30.00 s	1.618 MeV	7.437 W	34.16 MW		
A ₄₅ Rh	611.3 gm	5.940 M	28.70 TBq	46.94 GBq				7.439 W	12.17 mW	7.574 Sv	12.39 mSv
⁹³ Nb	1.725 mg	18.57 μ M									
^{93m} Nb	4.153 mg	44.70 μ M	43.44 GBq	10.46 TBq	γ	16.13 y	29.90 keV	208.1 μ W	50.11 mW	5.213 Sv	1.255 kSv
⁹⁴ Nb	1.182 mg	12.59 μ M	8.195 MBq	6.933 GBq	β	19.99 ky	1.719 MeV	2.257 μ W	1.909 mW	13.93 mSv	11.79 Sv
⁹⁵ Nb	≤ 1 pg	≤ 1 pM	831.8 mBq	1.448×10^6	β	34.99 d	809.0 keV	≤ 1 pW	187.6 W	482.4 pSv	839.6 kSv
^{95m} Nb	≤ 1 pg	≤ 1 pM	2.779 mBq	1.410×10^7	γ	3.608 d	234.5 keV	≤ 1 pW	529.7 W	1.556 pSv	7.896 MSv
A ₄₁ Nb	7.060 mg	75.85 μ M	43.45 GBq	6.154 TBq				210.4 μ W	29.80 mW	5.227 Sv	740.3 Sv
¹⁶⁵ Ho	285.7 mg	1.732 mM									
^{166m} Ho	3.505 mg	21.12 μ M	232.8 MBq	66.42 GBq	β	1.200 ky	1.869 MeV	69.71 μ W	19.89 mW	465.6 mSv	132.8 Sv

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			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
E ${}_{67}\text{Ho}$	289.2 mg	1.753 mM	232.8 MBq	805.0 MBq				69.71 μW	241.0 μW	465.6 mSv	1.610 Sv
${}^{104}\text{Pd}$	463.0 gm	4.456 M									
${}^{105}\text{Pd}$	609.7 gm	5.812 M									
${}^{106}\text{Pd}$	593.8 gm	5.607 M									
${}^{107}\text{Pd}$	361.2 gm	3.379 M	6.875 GBq	19.03 MBq	β	6.500 My	10.01 keV	11.02 μW	30.51 nW	254.4 mSv	704.2 μSv
${}^{108}\text{Pd}$	248.7 gm	2.305 M									
${}^{110}\text{Pd}$	82.30 gm	748.8 mM	16.51 mBq	200.6 μBq	2β	600.0 Py	2.000 MeV	≤ 1 pW	≤ 1 pW		
A ${}_{46}\text{Pd}$	2.359 kg	22.31 M	6.875 GBq	2.915 MBq				11.02 μW	4.672 nW	254.4 mSv	107.8 μSv
${}^{152}\text{Gd}$	80.72 mg	531.3 μM	65.08 mBq	806.2 mBq	α	108.0 Ty	2.197 MeV	≤ 1 pW	≤ 1 pW	2.668 nSv	33.06 nSv
${}^{153}\text{Gd}$	193.4 ng	1.265 nM	25.25 MBq	130.6 TBq	ϵ	240.4 d	152.4 keV	616.4 nW	3.187 W	6.818 mSv	35.25 kSv
${}^{154}\text{Gd}$	42.53 gm	276.3 mM									
${}^{155}\text{Gd}$	19.66 gm	126.9 mM									
${}^{156}\text{Gd}$	125.8 gm	806.8 mM									
${}^{157}\text{Gd}$	196.7 mg	1.253 mM									
${}^{158}\text{Gd}$	33.19 gm	210.2 mM									
${}^{160}\text{Gd}$	2.102 gm	13.14 mM	1.337 mBq	636.2 μBq	2β	130.0 Py	1.729 MeV	≤ 1 pW	≤ 1 pW		
E ${}_{64}\text{Gd}$	223.6 gm	1.435 M	25.25 MBq	112.9 kBq				616.4 nW	2.757 nW	6.818 mSv	30.50 μSv
E ${}_{6}^{14}\text{C}$	40.17 μg	2.869 μM	6.627 MBq	165.0 GBq	β	5.700 ky	49.48 keV	52.53 nW	1.308 mW	3.844 mSv	95.68 Sv
${}^{85}\text{Rb}$	162.7 gm	1.916 M									
${}^{87}\text{Rb}$	361.8 gm	4.163 M	1.172 MBq	3.239 kBq	β	48.10 Gy	141.0 keV	26.47 nW	73.16 pW	1.758 mSv	4.859 μSv
E ${}_{37}\text{Rb}$	524.5 gm	6.079 M	1.172 MBq	2.235 kBq				26.47 nW	50.47 pW	1.758 mSv	3.352 μSv
${}^{169}\text{Tm}$	95.30 μg	564.1 nM									
${}^{170}\text{Tm}$	≤ 1 pg	≤ 1 pM	9.923 Bq	221.1 TBq	β	128.6 d	334.7 keV	≤ 1 pW	11.86 W	12.90 nSv	287.4 kSv
${}^{171}\text{Tm}$	49.01 ng	286.7 pM	1.975 MBq	40.30 TBq	β	1.917 y	26.16 keV	8.278 nW	168.9 mW	217.3 μSv	4.433 kSv
E ${}_{69}\text{Tm}$	95.35 μg	564.4 nM	1.975 MBq	20.71 GBq				8.279 nW	86.82 μW	217.3 μSv	2.279 Sv
${}^9\text{Be}$	29.79 μg	3.306 μM									
${}^{10}\text{Be}$	198.9 μg	19.86 μM	164.5 kBq	827.0 MBq	β	1.600 My	202.6 keV	5.338 nW	26.84 μW	180.9 μSv	909.8 mSv
E ${}_{4}\text{Be}$	228.7 μg	23.17 μM	164.5 kBq	719.3 MBq				5.338 nW	23.34 μW	180.9 μSv	791.2 mSv
${}^{113}\text{In}$	195.4 mg	1.731 mM									
${}^{114}\text{In}$	≤ 1 pg	≤ 1 pM	13.55 pBq	5.096×10^{10}	β	1.198 m	803.4 keV	≤ 1 pW	6.559 MW		
${}^{114m}\text{In}$	≤ 1 pg	≤ 1 pM	14.16 pBq	856.6 TBq	γ	50.00 d	239.3 keV	≤ 1 pW	32.84 W	≤ 1 pSv	3.512 MSv
${}^{115}\text{In}$	2.697 gm	23.47 mM	621.2 mBq	230.3 mBq	β	441.0 Ty	242.0 keV	≤ 1 pW	≤ 1 pW	19.88 nSv	7.371 nSv
E ${}_{49}\text{In}$	2.892 gm	25.20 mM	621.2 mBq	214.8 mBq				≤ 1 pW	≤ 1 pW	19.88 nSv	6.873 nSv
${}^{138}\text{La}$	7.637 mg	55.38 μM	5.424 Bq	710.2 Bq	ϵ	102.0 Gy	1.237 MeV	1.075 pW	140.8 pW	5.966 nSv	781.2 nSv
${}^{139}\text{La}$	1.849 kg	13.31 M									
E ${}_{57}\text{La}$	1.849 kg	13.31 M	5.424 Bq	2.933 mBq				1.075 pW	≤ 1 pW	5.966 nSv	3.227 pSv

‡First emission from decay with highest branching ratio; †Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
¹⁵⁹ Tb	4.337 gm	27.29 mM									
¹⁶⁰ Tb	≤ 1 pg	≤ 1 pM	41.74 mBq	418.0 TBq	β	72.30 d	1.373 MeV	≤ 1 pW	91.97 W	66.78 pSv	668.8 kSv
E ₆₅ Tb	4.337 gm	27.29 mM	41.74 mBq	9.624 mBq				≤ 1 pW	≤ 1 pW	66.78 pSv	15.40 pSv
⁶ Li	241.9 μg	40.22 μM									
⁷ Li	15.49 μg	2.208 μM									
E ₃ Li	257.4 μg	42.42 μM									
⁶⁶ Zn	53.48 ng	811.2 pM									
⁶⁷ Zn	2.226 ng	33.26 pM									
⁶⁸ Zn	2.128 mg	31.33 μM									
⁷⁰ Zn	7.588 mg	108.5 μM									
E ₃₀ Zn	9.716 mg	139.8 μM									
⁶⁹ Ga	5.671 μg	82.28 nM									
⁷¹ Ga	2.257 μg	31.82 nM									
E ₃₁ Ga	7.928 μg	114.1 nM									
⁷⁰ Ge	33.14 ng	473.9 pM									
⁷² Ge	33.04 mg	459.4 μM									
⁷³ Ge	66.60 mg	913.3 μM									
⁷⁴ Ge	147.3 mg	1.993 mM									
⁷⁶ Ge	748.2 mg	9.855 mM	82.50 nBq	110.3 nBq	2β	≥ 10 ¹⁸ y	2.039 MeV	≤ 1 pW	≤ 1 pW		
E ₃₂ Ge	995.1 mg	13.22 mM	82.50 nBq	82.91 nBq				≤ 1 pW	≤ 1 pW		
E ₃₃ As	298.2 mg	3.980 mM									
⁷⁹ Br	1.133 mg	14.36 μM									
⁸¹ Br	31.96 gm	395.0 mM									
E ₃₅ Br	31.96 gm	395.0 mM									
⁸⁰ Kr	358.8 μg	4.490 μM									
⁸¹ Kr	42.36 μg	523.5 nM	32.97 kBq	778.3 MBq	ε	210.0 ky	20.81 keV	109.9 pW	2.594 μW		
⁸² Kr	2.022 gm	24.68 mM									
⁸³ Kr	57.85 gm	697.7 mM									
⁸⁴ Kr	172.8 gm	2.059 M									
⁸⁵ Kr	18.02 gm	212.2 mM	261.7 TBq	14.52 TBq	β	10.75 y	252.8 keV	10.60 W	588.2 mW		
⁸⁶ Kr	282.3 gm	3.286 M									
G ₃₆ Kr	533.0 gm	6.280 M	261.7 TBq	491.0 GBq				10.60 W	19.89 mW		
⁹⁵ Mo	1.116 kg	11.76 M									
⁹⁶ Mo	80.49 gm	839.3 mM									
⁹⁷ Mo	1.202 kg	12.40 M									
⁹⁸ Mo	1.238 kg	12.64 M	1.673 kBq	1.351 Bq	2β	100.0 Ty	112.0 keV	30.01 pW	≤ 1 pW		

‡First emission from decay with highest branching ratio; †Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
¹⁰⁰ Mo A ₄₂ Mo	1.423 kg 5.059 kg	14.24 M 51.89 M	19.03 mBq 1.673 kBq	13.37 μBq 330.6 mBq	2β	≥ 10 ¹⁸ y	3.034 MeV	≤ 1 pW 30.02 pW	≤ 1 pW ≤ 1 pW		
¹²⁷ Xe ¹²⁸ Xe ¹²⁹ Xe ¹³⁰ Xe ¹³¹ Xe ¹³² Xe ¹³⁴ Xe ¹³⁶ Xe G ₅₄ Xe	≤ 1 pg 7.057 gm 52.40 mg 23.11 gm 566.1 gm 1.753 kg 2.246 kg 3.429 kg 8.024 kg	≤ 1 pM 55.17 mM 406.5 μM 177.9 mM 4.325 M 13.29 M 16.77 M 25.23 M 59.85 M	≤ 1 pBq	1.045×10 ⁶	ε	36.40 d	309.1 keV	≤ 1 pW	51.75 W		
¹³² Ba ¹³⁴ Ba ¹³⁵ Ba ¹³⁶ Ba ¹³⁷ Ba ^{137m} Ba ¹³⁸ Ba E ₅₆ Ba	3.142 mg 334.3 gm 1.050 gm 42.80 gm 453.5 gm 219.7 μg 1.944 kg 2.776 kg	23.82 μM 2.497 M 7.783 mM 314.9 mM 3.312 M 1.605 μM 14.10 M 20.23 M									
¹⁴² Nd ¹⁴³ Nd ¹⁴⁴ Nd ¹⁴⁵ Nd ¹⁴⁶ Nd ¹⁴⁸ Nd ¹⁵⁰ Nd E ₆₀ Nd	51.65 gm 1.116 kg 2.072 kg 975.8 gm 1.091 kg 563.2 gm 273.6 gm 6.143 kg	364.0 mM 7.809 M 14.40 M 6.734 M 7.477 M 3.808 M 1.825 M 42.41 M									
¹⁴² Nd ¹⁴³ Nd ¹⁴⁴ Nd ¹⁴⁵ Nd ¹⁴⁶ Nd ¹⁴⁸ Nd ¹⁵⁰ Nd E ₆₀ Nd	51.65 gm 1.116 kg 2.072 kg 975.8 gm 1.091 kg 563.2 gm 273.6 gm 6.143 kg	364.0 mM 7.809 M 14.40 M 6.734 M 7.477 M 3.808 M 1.825 M 42.41 M	83.17 Bq	40.14 mBq	α	2.290 Py	1.905 MeV	25.38 pW	≤ 1 pW		
¹⁴² Nd ¹⁴³ Nd ¹⁴⁴ Nd ¹⁴⁵ Nd ¹⁴⁶ Nd ¹⁴⁸ Nd ¹⁵⁰ Nd E ₆₀ Nd	51.65 gm 1.116 kg 2.072 kg 975.8 gm 1.091 kg 563.2 gm 273.6 gm 6.143 kg	364.0 mM 7.809 M 14.40 M 6.734 M 7.477 M 3.808 M 1.825 M 42.41 M	18.65 mBq 1.150 mBq 83.19 Bq	33.12 μBq 4.201 μBq 13.54 mBq	2β 2β	≥ 10 ¹⁸ y ≥ 10 ¹⁸ y	1.929 MeV 3.368 MeV	≤ 1 pW ≤ 1 pW 25.39 pW	≤ 1 pW ≤ 1 pW ≤ 1 pW		
¹⁶⁰ Dy ¹⁶¹ Dy ¹⁶² Dy ¹⁶³ Dy ¹⁶⁴ Dy E ₆₆ Dy	612.8 mg 712.4 mg 572.7 mg 537.5 mg 133.0 mg 2.568 gm	3.832 mM 4.427 mM 3.537 mM 3.299 mM 811.3 μM 15.91 mM									
¹⁶⁶ Er ¹⁶⁷ Er ¹⁶⁸ Er ¹⁷⁰ Er	88.56 mg 5.663 mg 11.31 mg 59.35 ng	533.7 μM 33.92 μM 67.35 μM 349.3 pM									

†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
E ₆₈ Er	105.5 mg	635.0 μM									
¹⁷⁰ Yb	39.44 μg	232.1 nM									
¹⁷¹ Yb	3.377 μg	19.76 nM									
¹⁷² Yb	143.9 ng	836.9 pM									
E ₇₀ Yb	42.96 μg	252.7 nM									
Total	52.18 kg	443.5 M	1.684×10 ⁷	322.7 GBq				1.375 kW	26.35 mW	164.0 MSv	3.143 kSv
ICRP Publication 119 does not report dose factors for isotopes with half lives less than ten minutes or greater than 10 ⁹ years. Dose factors for gases are given as Sv/day per Bq/m ³ . Radiotoxicity is not computed for gases.											
‡First emission from decay with highest branching ratio; †Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas											

Actinides and Daughters Per Tonne of Fuel

used for 50.68 GW-day LWR burnup at power of 36.5 MW and $3.14 \times 10^{14} N/cm^2/s$ neutron flux,
after ten years' storage, as calculated by ORIGEN2 version 2.1 on 9 October 2013.

Radiotoxicity in Sieverts computed for adult ingestion using dose factors from ICRP publication 119

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
²³⁶ Pu	5.150 ng	21.82 pM	101.3 kBq	19.67 TBq	α	2.858 y	5.870 MeV	95.27 nW	18.50 W	8.813 mSv	1.711 MSv
²³⁷ Pu	≤ 1 pg	≤ 1 pM	≤ 1 pBq	447.2 TBq	ϵ	45.30 d	62.20 keV	≤ 1 pW	4.457 W	≤ 1 pSv	44.72 kSv
²³⁸ Pu	300.4 gm	1.262 M	190.4 TBq	633.8 GBq	α	87.70 y	5.590 MeV	170.5 W	567.6 mW	43.79 MSv	145.8 kSv
²³⁹ Pu	6.183 kg	25.86 M	14.23 TBq	2.301 GBq	α	24.11 ky	5.198 MeV	11.85 W	1.917 mW	3.557 MSv	575.4 Sv
²⁴⁰ Pu	2.957 kg	12.32 M	24.94 TBq	8.434 GBq	α	6.563 ky	5.253 MeV	20.99 W	7.098 mW	6.235 MSv	2.109 kSv
²⁴¹ Pu	1.109 kg	4.601 M	4.229×10 ⁶	3.813 TBq	β	14.33 y	5.228 keV	3.542 W	3.194 mW	20.30 MSv	18.30 kSv
²⁴² Pu	873.8 gm	3.610 M	123.5 GBq	141.3 MBq	α	373.5 ky	4.982 MeV	98.57 mW	112.8 μ W	29.64 kSv	33.92 Sv
²⁴³ Pu	≤ 1 pg	≤ 1 pM	33.76 kBq	9.635×10 ⁷	β	4.956 h	194.7 keV	1.053 nW	3.005 kW	2.870 μ Sv	8.189 MSv
²⁴⁴ Pu	31.02 mg	127.1 μ M	20.36 kBq	656.4 kBq	α	80.00 My	4.893 MeV	15.96 nW	514.5 nW	4.886 mSv	157.5 mSv
²⁴⁶ Pu	≤ 1 pg	≤ 1 pM	3.609 mBq	1.811×10 ⁶	β	10.85 d	142.0 keV	≤ 1 pW	41.19 W	11.91 pSv	5.976 MSv
C ₉₄ Pu	11.42 kg	47.66 M	4.459×10 ⁶	390.3 GBq				207.0 W	18.12 mW	73.91 MSv	6.470 kSv
²⁴¹ Cm	≤ 1 pg	≤ 1 pM	≤ 1 pBq	557.1 TBq	ϵ	32.80 d	693.3 keV	≤ 1 pW	61.88 W	≤ 1 pSv	507.0 kSv
²⁴² Cm	1.843 mg	7.614 μ M	225.6 GBq	122.4 TBq	α	162.9 d	6.214 MeV	224.6 mW	121.9 W	2.707 kSv	1.469 MSv
²⁴³ Cm	585.7 mg	2.410 mM	1.119 TBq	1.911 TBq	α	30.00 y	6.192 MeV	1.110 W	1.895 W	167.9 kSv	286.6 kSv
²⁴⁴ Cm	57.94 gm	237.4 mM	173.5 TBq	2.994 TBq	α	18.00 y	5.900 MeV	164.0 W	2.831 W	20.82 MSv	359.3 kSv
²⁴⁵ Cm	5.615 gm	22.91 mM	35.69 GBq	6.356 GBq	α	8.500 ky	5.598 MeV	32.01 mW	5.701 mW	7.495 kSv	1.335 kSv
²⁴⁶ Cm	716.6 mg	2.912 mM	8.147 GBq	11.37 GBq	α	4.730 ky	5.523 MeV	7.209 mW	10.06 mW	1.711 kSv	2.387 kSv
²⁴⁷ Cm	9.829 mg	39.78 μ M	33.76 kBq	3.435 MBq	α	16.00 My	5.390 MeV	29.15 nW	2.966 μ W	6.414 mSv	652.6 mSv
²⁴⁸ Cm	760.1 μ g	3.064 μ M	119.6 kBq	157.3 MBq	α	340.0 ky	21.00 MeV	402.4 nW	529.4 μ W	92.09 mSv	121.2 Sv
²⁵⁰ Cm	4.745 pg	≤ 1 pM	14.43 mBq	3.041 GBq	SF	8.000 ky	123.3 MeV	≤ 1 pW	60.08 mW	63.49 nSv	13.38 kSv
C ₉₆ Cm	64.87 gm	265.7 mM	174.9 TBq	2.696 TBq				165.4 W	2.549 W	21.00 MSv	323.7 kSv
²⁴¹ Am	738.5 gm	3.064 M	93.83 TBq	127.1 GBq	α	432.8 y	5.603 MeV	84.23 W	114.1 mW	18.77 MSv	25.41 kSv
²⁴² Am	9.073 μ g	37.48 nM	271.5 GBq	2.992×10 ⁷	β	16.04 h	191.5 keV	8.329 mW	918.0 W	81.45 Sv	8.977 MSv
^{242m} Am	758.5 mg	3.134 mM	272.8 GBq	359.7 GBq	γ	141.0 y	66.65 keV	2.913 mW	3.840 mW	51.83 kSv	68.33 kSv
²⁴³ Am	196.9 gm	810.1 mM	1.453 TBq	7.379 GBq	α	7.365 ky	5.421 MeV	1.262 W	6.409 mW	290.6 kSv	1.476 kSv
²⁴⁵ Am	≤ 1 pg	≤ 1 pM	2.953 Bq	2.287×10 ⁸	β	2.050 h	313.1 keV	≤ 1 pW	11.47 kW	183.1 pSv	14.18 MSv
²⁴⁶ Am	≤ 1 pg	≤ 1 pM	3.609 mBq	1.132×10 ⁹	β	39.00 m	1.362 MeV	≤ 1 pW	246.9 kW	≤ 1 pSv	65.64 MSv
C ₉₅ Am	936.2 gm	3.877 M	95.83 TBq	102.4 GBq				85.50 W	91.33 mW	19.11 MSv	20.41 kSv
²³² U	402.3 μ g	1.734 μ M	318.7 MBq	792.2 GBq	α	69.80 y	5.415 MeV	276.5 μ W	687.3 mW	105.2 Sv	261.4 kSv
²³³ U	4.079 mg	17.50 μ M	1.461 MBq	358.2 MBq	α	159.3 ky	4.905 MeV	1.148 μ W	281.4 μ W	74.51 mSv	18.27 Sv
²³⁴ U	193.1 gm	825.1 mM	44.66 GBq	231.3 MBq	α	245.7 ky	4.860 MeV	34.77 mW	180.1 μ W	2.188 kSv	11.33 Sv
²³⁵ U	7.418 kg	31.56 M	593.5 MBq	80.01 kBq	α	703.8 My	4.418 MeV	420.1 μ W	56.63 nW	27.89 Sv	3.760 mSv
²³⁶ U	5.526 kg	23.41 M	13.23 GBq	2.394 MBq	α	23.70 My	4.571 MeV	9.688 mW	1.753 μ W	621.8 Sv	112.5 mSv

†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
²³⁷ U	34.33 μg	144.8 nM	103.7 GBq	3.021×10 ⁶	β	6.750 d	319.3 keV	5.304 mW	154.5 W	78.81 Sv	2.296 MSv
²³⁸ U	921.7 kg	3.872 kM	11.47 GBq	12.44 kBq	α	4.468 Gy	4.279 MeV	7.863 mW	8.531 nW	516.2 Sv	560.0 μSv
²⁴⁰ U	≤ 1 pg	≤ 1 pM	20.34 kBq	3.428×10 ⁷	β	14.10 h	138.4 keV	450.9 pW	760.0 W	22.37 μSv	37.71 MSv
C ₉₂ U	934.8 kg	3.928 kM	174.0 GBq	186.1 kBq				58.32 mW	62.39 nW	3.538 kSv	3.785 mSv
²³⁶ Np	2.483 mg	10.52 μM	1.211 MBq	487.7 MBq	ε	152.0 ky	340.2 keV	66.00 nW	26.58 μW	20.59 mSv	8.291 Sv
²³⁷ Np	654.6 gm	2.761 M	17.08 GBq	26.09 MBq	α	2.140 My	5.157 MeV	14.11 mW	21.56 μW	1.879 kSv	2.870 Sv
²³⁸ Np	142.2 ng	597.4 pM	1.364 GBq	9.592×10 ⁶	β	2.117 d	808.2 keV	176.6 μW	1.242 kW	1.241 Sv	8.729 MSv
²³⁹ Np	169.2 μg	707.8 nM	1.453 TBq	8.587×10 ⁶	β	2.355 d	407.7 keV	94.91 mW	560.9 W	1.162 kSv	6.870 MSv
^{240m} Np	≤ 1 pg	≤ 1 pM	20.34 kBq	3.919×10 ⁹	β	7.400 m	977.4 keV	3.185 nW	613.7 kW		
C ₉₃ Np	654.6 gm	2.761 M	1.471 TBq	2.248 GBq				109.2 mW	166.8 μW	3.042 kSv	4.648 Sv
²²⁷ Th	239.9 pg	1.057 pM	273.0 kBq	1.138×10 ⁶	α	18.72 d	6.157 MeV	269.3 nW	1.123 kW	2.402 mSv	10.01 MSv
²²⁸ Th	10.55 μg	46.27 nM	320.2 MBq	30.35 TBq	α	1.913 y	5.517 MeV	283.0 μW	26.82 W	23.05 Sv	2.185 MSv
²²⁹ Th	998.6 ng	4.360 nM	7.862 kBq	7.873 GBq	α	7.340 ky	5.161 MeV	6.501 nW	6.510 mW	3.852 mSv	3.858 kSv
²³⁰ Th	6.672 mg	29.00 μM	4.984 MBq	747.0 MBq	α	75.40 ky	4.775 MeV	3.813 μW	571.5 μW	1.047 Sv	156.9 Sv
²³¹ Th	30.16 ng	130.5 pM	593.5 MBq	1.968×10 ⁷	β	1.063 d	94.67 keV	9.001 μW	298.4 W	201.8 mSv	6.691 MSv
²³² Th	1.981 mg	8.537 μM	8.040 Bq	4.059 kBq	α	14.05 Gy	4.084 MeV	5.261 pW	2.656 nW	1.849 μSv	933.5 μSv
²³⁴ Th	13.38 μg	57.17 nM	11.47 GBq	857.2 TBq	β	24.09 d	68.41 keV	125.7 μW	9.395 W	39.00 Sv	2.915 MSv
C ₉₀ Th	8.678 mg	37.65 μM	12.39 GBq	1.428 TBq				421.8 μW	48.60 mW	63.31 Sv	7.295 kSv
²²³ Ra	146.0 pg	≤ 1 pM	276.8 kBq	1.896×10 ⁶	α	11.43 d	6.007 MeV	266.4 nW	1.825 kW	27.68 mSv	189.6 MSv
²²⁴ Ra	54.39 ng	242.8 pM	320.7 MBq	5.896×10 ⁶	α	3.640 d	5.790 MeV	297.5 μW	5.470 kW	20.85 Sv	383.3 MSv
²²⁵ Ra	5.418 pg	≤ 1 pM	7.862 kBq	1.451×10 ⁶	β	14.80 d	118.3 keV	149.0 pW	27.50 W	778.3 μSv	143.7 MSv
²²⁶ Ra	395.2 ng	1.748 nM	14.46 kBq	36.59 GBq	α	1.600 ky	4.874 MeV	11.29 nW	28.57 mW	4.049 mSv	10.24 kSv
²²⁸ Ra	≤ 1 pg	≤ 1 pM	3.505 Bq	8.661 TBq	β	5.750 y	13.00 keV	≤ 1 pW	18.04 mW	2.418 μSv	5.976 MSv
E ₈₈ Ra	449.7 ng	1.992 nM	321.0 MBq	713.7 TBq				297.8 μW	662.1 W	20.88 Sv	46.42 MSv
²³¹ Pa	564.8 μg	2.445 μM	987.5 kBq	1.748 GBq	α	32.76 ky	5.083 MeV	804.1 nW	1.424 mW	701.1 mSv	1.241 kSv
²³³ Pa	22.23 μg	95.39 nM	17.08 GBq	768.3 TBq	β	27.00 d	383.0 keV	1.048 mW	47.14 W	14.86 Sv	668.4 kSv
²³⁴ Pa	201.5 pg	≤ 1 pM	14.91 MBq	7.400×10 ⁷	β	6.780 h	2.423 MeV	5.788 μW	28.72 kW	7.604 mSv	37.74 MSv
^{234m} Pa	451.2 pg	1.928 pM	11.47 GBq	2.542×10 ¹⁰	β	1.170 m	833.7 keV	1.532 mW	3.395 MW		
C ₉₁ Pa	587.0 μg	2.540 μM	28.57 GBq	48.66 TBq				2.587 mW	4.406 W	15.57 Sv	26.52 kSv
²⁰⁶ Pb	71.93 pg	≤ 1 pM									
²⁰⁷ Pb	17.43 ng	84.21 pM									
²⁰⁸ Pb	30.50 μg	146.7 nM									
²⁰⁹ Pb	≤ 1 pg	≤ 1 pM	7.862 kBq	1.682×10 ⁸	β	3.253 h	194.0 keV	244.4 pW	5.228 kW	448.1 nSv	9.586 MSv
²¹⁰ Pb	685.2 pg	3.263 pM	1.936 kBq	2.825 TBq	β	22.16 y	39.08 keV	12.12 pW	17.69 mW	1.336 mSv	1.950 MSv
²¹¹ Pb	≤ 1 pg	≤ 1 pM	276.8 kBq	9.138×10 ⁸	β	36.10 m	505.6 keV	22.42 nW	74.02 kW	49.82 μSv	164.5 MSv
²¹² Pb	6.236 ng	29.42 pM	320.7 MBq	5.143×10 ⁷	β	10.64 h	321.2 keV	16.50 μW	2.646 kW	1.924 Sv	308.6 MSv
²¹⁴ Pb	≤ 1 pg	≤ 1 pM	14.46 kBq	1.213×10 ⁹	β	26.80 m	537.9 keV	1.246 nW	104.5 kW	2.024 μSv	169.8 MSv

†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
A $_{82}\text{Pb}$	30.52 μg	146.8 nM	321.0 MBq	10.52 TBq				16.52 μW	541.3 mW	1.926 Sv	63.08 kSv
^{249}Cf	10.48 μg	42.08 nM	1.590 MBq	151.7 GBq	α	351.0 y	7.804 MeV	1.988 μW	189.7 mW	556.5 mSv	53.10 kSv
^{250}Cf	1.206 μg	4.823 nM	4.880 MBq	4.046 TBq	α	13.08 y	6.266 MeV	4.899 μW	4.062 W	780.8 mSv	647.4 kSv
^{251}Cf	976.6 ng	3.890 nM	57.31 kBq	58.68 GBq	α	898.0 y	6.030 MeV	55.36 nW	56.69 mW	20.63 mSv	21.13 kSv
^{252}Cf	47.81 ng	189.7 pM	951.6 kBq	19.90 TBq	α	2.645 y	12.04 MeV	1.836 μW	38.40 W	85.64 mSv	1.791 MSv
^{254}Cf	≤ 1 pg	≤ 1 pM	≤ 1 pBq	314.4 TBq	SF	60.50 d	199.5 MeV	≤ 1 pW	10.05 kW	≤ 1 pSv	125.8 MSv
C $_{98}\text{Cf}$	12.71 μg	50.98 nM	7.479 MBq	588.4 GBq				8.778 μW	690.6 mW	1.444 Sv	113.6 kSv
^{225}Ac	3.660 pg	≤ 1 pM	7.862 kBq	2.148×10^6	α	10.00 d	5.893 MeV	7.423 nW	2.028 kW	188.7 μSv	51.55 MSv
^{227}Ac	103.2 ng	454.6 pM	276.4 kBq	2.678 TBq	β	21.77 y	81.68 keV	3.617 nW	35.05 mW	304.0 mSv	2.946 MSv
^{228}Ac	≤ 1 pg	≤ 1 pM	3.506 Bq	8.300×10^7	β	6.150 h	1.458 MeV	≤ 1 pW	19.39 kW	1.508 nSv	35.69 MSv
E $_{89}\text{Ac}$	103.2 ng	454.6 pM	284.3 kBq	2.754 TBq				11.04 nW	107.0 mW	304.2 mSv	2.948 MSv
^{208}Bi	≤ 1 pg	≤ 1 pM	119.3 nBq	172.9 MBq	ϵ	368.0 ky	2.653 MeV	≤ 1 pW	73.51 μW		
^{209}Bi	1.009 ng	4.828 pM	≤ 1 pBq	3.331 μBq	α	$\geq 10^{18}$ y	3.137 MeV	≤ 1 pW	≤ 1 pW		
^{210}Bi	≤ 1 pg	≤ 1 pM	1.937 kBq	4.593×10^6	β	5.012 d	389.0 keV	120.7 pW	286.2 W	2.518 μSv	5.971 MSv
^{210m}Bi	≤ 1 pg	≤ 1 pM	90.32 nBq	21.00 MBq	α	3.000 My	5.296 MeV	≤ 1 pW	17.82 μW	≤ 1 pSv	315.1 mSv
^{211}Bi	≤ 1 pg	≤ 1 pM	276.8 kBq	1.549×10^{10}	α	2.170 m	6.729 MeV	298.4 nW	16.70 MW		
^{212}Bi	591.5 pg	2.790 pM	320.7 MBq	5.422×10^8	β	1.009 h	2.869 MeV	147.4 μW	249.2 kW	83.38 mSv	141.0 MSv
^{213}Bi	≤ 1 pg	≤ 1 pM	7.862 kBq	7.160×10^8	β	45.59 m	709.2 keV	893.3 pW	81.36 kW	1.572 μSv	143.2 MSv
^{214}Bi	≤ 1 pg	≤ 1 pM	14.46 kBq	1.634×10^9	β	19.90 m	2.162 MeV	5.009 nW	566.1 kW	1.591 μSv	179.7 MSv
A $_{83}\text{Bi}$	1.601 ng	7.621 pM	321.0 MBq	2.005×10^8				147.7 μW	92.26 kW	83.39 mSv	52.09 MSv
^{210}Po	10.40 pg	≤ 1 pM	1.729 kBq	166.3 TBq	α	138.4 d	5.408 MeV	1.498 nW	144.0 W	2.075 mSv	199.5 MSv
^{211}Po	≤ 1 pg	≤ 1 pM	775.2 Bq	3.535×10^{12}	α	516.0 ms	7.591 MeV	942.7 pW	4.299 GW		
^{215}Po	≤ 1 pg	≤ 1 pM	276.8 kBq	1.091×10^{15}	α	1.780 ms	7.532 MeV	334.0 nW	1.317×10^{12}		
^{216}Po	≤ 1 pg	≤ 1 pM	320.7 MBq	1.289×10^{13}	α	150.0 ms	6.906 MeV	354.8 μW	14.26 GW		
^{218}Po	≤ 1 pg	≤ 1 pM	14.46 kBq	1.046×10^{10}	α	3.098 m	6.117 MeV	14.17 nW	10.25 MW		
A $_{84}\text{Po}$	10.43 pg	≤ 1 pM	321.0 MBq	3.079×10^{10}				355.2 μW	34.06 MW	2.075 mSv	199.0 MSv
^{249}Bk	3.356 ng	13.47 pM	203.6 kBq	60.67 TBq	β	320.0 d	125.0 keV	4.077 nW	1.215 W	197.5 μSv	58.85 kSv
^{250}Bk	≤ 1 pg	≤ 1 pM	1.108 Bq	1.440×10^8	β	3.217 h	1.172 MeV	≤ 1 pW	27.04 kW	155.1 pSv	20.16 MSv
C $_{97}\text{Bk}$	3.356 ng	13.47 pM	203.6 kBq	60.67 TBq				4.077 nW	1.215 W	197.5 μSv	58.85 kSv
^{221}Fr	≤ 1 pg	≤ 1 pM	7.862 kBq	6.563×10^9	α	4.900 m	6.511 MeV	8.201 nW	6.846 MW		
^{223}Fr	≤ 1 pg	≤ 1 pM	3.815 kBq	1.432×10^9	β	21.80 m	438.0 keV	267.7 pW	100.5 kW	9.156 μSv	3.437 GSv
C $_{87}\text{Fr}$	≤ 1 pg	≤ 1 pM	11.68 kBq	3.024×10^9				8.469 nW	2.193 MW	9.156 μSv	2.371 GSv
C $^{254}_{99}\text{Es}$	≤ 1 pg	≤ 1 pM	1.106 Bq	69.04 TBq	α	275.7 d	6.620 MeV	1.173 pW	73.22 W	30.97 nSv	1.933 MSv
$^{250}_{0}\text{Sf}$	45.96 μg										
G ^4_2He	2.317 gm	578.9 mM									
^{207}Tl	≤ 1 pg	≤ 1 pM	276.0 kBq	7.048×10^9	β	4.770 m	495.5 keV	21.91 nW	559.5 kW		

†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity		
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm	
A ₈₁ Tl	²⁰⁸ Tl	10.57 pg	≤ 1 pM	115.2 MBq	1.090×10 ¹⁰	β	3.053 m	3.971 MeV	73.29 μW	6.934 MW		
	²⁰⁹ Tl	≤ 1 pg	≤ 1 pM	169.8 Bq	1.513×10 ¹⁰	β	2.200 m	2.803 MeV	76.26 pW	6.797 MW		
		10.61 pg	≤ 1 pM	115.5 MBq	1.088×10 ¹⁰				73.31 μW	6.910 MW		
A ₈₅ At	²¹⁷ At	≤ 1 pg	≤ 1 pM	7.862 kBq	5.956×10 ¹³	α	32.30 ms	7.199 MeV	9.068 nW	68.70 GW		
G ₈₆ Rn	²¹⁹ Rn	≤ 1 pg	≤ 1 pM	276.8 kBq	4.816×10 ¹¹	α	3.960 s	7.000 MeV	310.4 nW	540.0 MW		
	²²⁰ Rn	9.394 pg	≤ 1 pM	320.7 MBq	3.414×10 ¹⁰	α	55.80 s	6.405 MeV	329.1 μW	35.03 MW		
	²²² Rn	2.541 pg	≤ 1 pM	14.46 kBq	5.691×10 ⁶	α	3.823 d	5.590 MeV	12.95 nW	5.096 kW		
		11.94 pg	≤ 1 pM	321.0 MBq	2.689×10 ¹⁰				329.4 μW	27.60 MW		
Total	947.9 kg	3.983 kM	4.729×10 ⁶	4.989 GBq					458.1 W	483.3 μW	114.0 MSv	120.3 Sv
ICRP Publication 119 does not report dose factors for isotopes with half lives less than ten minutes or greater than 10 ⁹ years. Dose factors for gases are given as Sv/day per Bq/m ³ . Radiotoxicity is not computed for gases.												
†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas												

Activation Products Per Tonne of Fuel

used for 50.68 GW-day LWR burnup at power of 36.5 MW and $3.14 \times 10^{14} N/cm^2/s$ neutron flux,
after ten years' storage, as calculated by ORIGEN2 version 2.1 on 9 October 2013.
Radiotoxicity in Sieverts computed for adult ingestion using dose factors from ICRP publication 119

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
⁹⁰ Zr	120.7 kg	1.343 kM									
⁹¹ Zr	26.41 kg	290.5 M									
⁹² Zr	41.10 kg	447.2 M									
⁹³ Zr	160.7 gm	1.730 M	14.95 GBq	93.03 MBq	β	1.530 My	19.59 keV	46.93 μ W	292.0 nW	16.44 Sv	102.3 mSv
⁹⁴ Zr	42.60 kg	453.6 M	1.000 kBq	23.48 mBq	2β	6.000 Py	1.144 MeV	183.2 pW	≤ 1 pW		
⁹⁵ Zr	≤ 1 pg	≤ 1 pM	12.72 mBq	795.5 TBq	β	64.03 d	854.3 keV	≤ 1 pW	108.9 W	12.08 pSv	755.7 kSv
⁹⁶ Zr	6.957 kg	72.54 M	24.60 mBq	3.536 μ Bq	2β	$\geq 10^{18}$ y	3.350 MeV	≤ 1 pW	≤ 1 pW		
A ₄₀ Zr	237.9 kg	2.608 kM	14.95 GBq	62.83 kBq				46.93 μ W	197.2 pW	16.44 Sv	69.12 μ Sv
⁸⁷ Sr	3.321 mg	38.21 μ M									
⁸⁸ Sr	325.3 mg	3.701 mM									
⁸⁹ Sr	≤ 1 pg	≤ 1 pM	283.4 pBq	1.076×10^6	β	50.57 d	583.2 keV	≤ 1 pW	100.5 W	≤ 1 pSv	2.796 MSv
⁹⁰ Sr	26.93 μ g	299.5 nM	136.0 MBq	5.050 TBq	β	28.79 y	195.8 keV	4.266 μ W	158.4 mW	3.808 Sv	141.4 kSv
E ₃₈ Sr	328.6 mg	3.739 mM	136.0 MBq	413.8 MBq				4.266 μ W	12.98 μ W	3.808 Sv	11.59 Sv
⁹³ Nb	245.6 μ g	2.644 μ M									
^{93m} Nb	610.9 μ g	6.575 μ M	6.394 GBq	10.47 TBq	γ	16.13 y	29.88 keV	30.61 μ W	50.11 mW	767.3 mSv	1.256 kSv
⁹⁴ Nb	63.41 ng	675.2 pM	439.6 Bq	6.933 GBq	β	19.99 ky	1.720 MeV	121.1 pW	1.910 mW	747.3 nSv	11.79 Sv
⁹⁵ Nb	≤ 1 pg	≤ 1 pM	28.23 mBq	1.448×10^6	β	34.99 d	809.3 keV	≤ 1 pW	187.7 W	16.37 pSv	839.7 kSv
^{95m} Nb	≤ 1 pg	≤ 1 pM	94.31 μ Bq	1.410×10^7	γ	3.608 d	234.4 keV	≤ 1 pW	529.4 W	≤ 1 pSv	7.893 MSv
A ₄₁ Nb	856.6 μ g	9.220 μ M	6.394 GBq	7.465 TBq				30.61 μ W	35.74 mW	767.3 mSv	895.8 Sv
⁸⁹ Y	24.79 mg	278.8 μ M									
⁹⁰ Y	6.754 ng	75.12 pM	136.0 MBq	2.014×10^7	β	2.671 d	935.4 keV	20.38 μ W	3.017 kW	367.2 mSv	54.37 MSv
⁹¹ Y	≤ 1 pg	≤ 1 pM	686.0 nBq	907.6 TBq	β	58.51 d	606.0 keV	≤ 1 pW	88.12 W	≤ 1 pSv	2.178 MSv
E ₃₉ Y	24.79 mg	278.8 μ M	136.0 MBq	5.486 GBq				20.38 μ W	822.1 μ W	367.2 mSv	14.81 Sv
⁹⁸ Tc	4.887 ng	49.91 pM	157.2 mBq	32.17 MBq	β	4.200 My	1.532 MeV	≤ 1 pW	7.892 μ W	314.4 pSv	64.33 mSv
⁹⁹ Tc	1.152 mg	11.65 μ M	722.6 kBq	627.3 MBq	β	214.0 ky	84.62 keV	9.796 nW	8.503 μ W	462.5 μ Sv	401.4 mSv
A ₄₃ Tc	1.152 mg	11.65 μ M	722.6 kBq	627.3 MBq				9.796 nW	8.503 μ W	462.5 μ Sv	401.4 mSv
¹ H	12.73 mg	12.63 mM									
² H	10.72 μ g	5.322 μ M									
³ H	4.054 pg	1.344 pM	1.448 kBq	357.2 TBq	β	12.33 y	5.682 keV	1.318 pW	325.1 mW	60.82 nSv	15.00 kSv
G ₁ H	12.74 mg	12.64 mM	1.448 kBq	113.7 kBq				1.318 pW	103.4 pW	60.82 nSv	4.773 μ Sv
¹⁰² Rh	≤ 1 pg	≤ 1 pM	2.250 μ Bq	44.74 TBq	ϵ	2.902 y	2.152 MeV	≤ 1 pW	15.42 W	≤ 1 pSv	53.69 kSv
¹⁰³ Rh	1.108 pg	≤ 1 pM									

†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas

Isotope ‡	Mass grams	Moles	Radioactivity			Half Life	Energy per Bq-s	Thermal Power		Radiotoxicity	
			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
A ₄₅ Rh	1.108 pg	≤ 1 pM	2.250 μBq	2.031 MBq				≤ 1 pW	700.1 nW	≤ 1 pSv	2.437 mSv
³ He	3.120 pg	1.034 pM									
⁴ He	16.30 mg	4.072 mM									
G ₂ He	16.30 mg	4.072 mM									
⁹⁴ Mo	23.39 pg	≤ 1 pM									
⁹⁵ Mo	29.03 gm	305.9 mM									
⁹⁶ Mo	1.824 gm	19.02 mM									
⁹⁷ Mo	48.80 gm	503.6 mM									
⁹⁸ Mo	616.9 mg	6.301 mM	833.5 mBq	1.351 Bq	2β	100.0 Ty	112.0 keV	≤ 1 pW	≤ 1 pW		
¹⁰⁰ Mo	1.234 μg	12.35 nM	16.50 pBq	13.37 μBq	2β	≥ 10 ¹⁸ y	3.034 MeV	≤ 1 pW	≤ 1 pW		
A ₄₂ Mo	80.27 gm	834.8 mM	833.5 mBq	10.38 mBq				≤ 1 pW	≤ 1 pW		
⁹⁸ Ru	≤ 1 pg	≤ 1 pM									
⁹⁹ Ru	40.54 ng	409.9 pM									
¹⁰⁰ Ru	99.42 μg	995.2 nM									
¹⁰¹ Ru	500.4 ng	4.959 nM									
¹⁰² Ru	9.511 ng	93.33 pM									
¹⁰⁴ Ru	≤ 1 pg	≤ 1 pM									
A ₄₄ Ru	99.97 μg	1.001 μM									
¹⁰⁴ Pd	≤ 1 pg	≤ 1 pM									
¹⁰⁵ Pd	≤ 1 pg	≤ 1 pM									
¹⁰⁶ Pd	≤ 1 pg	≤ 1 pM									
A ₄₆ Pd	≤ 1 pg	≤ 1 pM									
Total	238.0 kg	2.609 kM	21.61 GBq	90.80 kBq				102.2 μW	429.4 pW	21.39 Sv	89.87 μSv
ICRP Publication 119 does not report dose factors for isotopes with half lives less than ten minutes or greater than 10 ⁹ years. Dose factors for gases are given as Sv/day per Bq/m ³ . Radiotoxicity is not computed for gases.											
†First emission from decay with highest branching ratio; ‡Electrorefiner destination: A = anode, C = cathode, E = electrolyte, G = gas											