

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 fifty 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									
⁹⁰ Sr	237.4 gm	2.640 M	1.199×10 ⁶	5.051 TBq	β	28.79 y	195.8 keV	37.61 W	158.4 mW	33.57 MSv	141.4 kSv
E ₃₈ Sr	757.5 gm	8.558 M	1.199×10 ⁶	1.583 TBq				37.61 W	49.65 mW	33.57 MSv	44.32 kSv
¹³³ Cs	1.616 kg	12.16 M									
¹³⁴ Cs	11.77 μg	87.90 nM	563.9 MBq	47.91 TBq	β	2.065 y	1.717 MeV	155.1 μW	13.18 W	10.71 Sv	910.3 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	570.0 gm	4.163 M	1.835×10 ⁶	3.219 TBq	β	30.04 y	186.6 keV	54.86 W	96.25 mW	23.85 MSv	41.85 kSv
E ₅₅ Cs	2.806 kg	20.92 M	1.835×10 ⁶	654.1 GBq				54.86 W	19.55 mW	23.86 MSv	8.503 kSv
⁸⁹ Y	676.0 gm	7.604 M									
⁹⁰ Y	59.54 mg	662.2 μM	1.199×10 ⁶	2.014×10 ⁷	β	2.671 d	935.0 keV	179.6 W	3.016 kW	3.237 MSv	54.37 MSv
E ₃₉ Y	676.1 gm	7.604 M	1.199×10 ⁶	1.774 TBq				179.6 W	265.7 mW	3.237 MSv	4.788 kSv
¹⁵⁰ Eu	173.6 ng	1.158 nM	425.5 kBq	2.451 TBq	ε	36.36 y	1.540 MeV	105.0 nW	604.8 mW	553.2 μSv	3.186 kSv
¹⁵¹ Eu	7.313 gm	48.88 mM	380.3 μBq	52.00 μBq	α	≥ 10 ¹⁸ y	1.905 MeV	≤ 1 pW	≤ 1 pW		
¹⁵² Eu	4.929 mg	32.44 μM	31.55 GBq	6.401 TBq	ε	13.52 y	1.276 MeV	6.449 mW	1.308 W	44.17 Sv	8.961 kSv
¹⁵³ Eu	195.8 gm	1.280 M									
¹⁵⁴ Eu	1.172 gm	7.614 mM	11.71 TBq	9.991 TBq	β	8.593 y	1.509 MeV	2.831 W	2.416 W	23.42 kSv	19.98 kSv
¹⁵⁵ Eu	23.82 mg	153.8 μM	410.0 GBq	17.21 TBq	β	4.753 y	122.7 keV	8.061 mW	338.4 mW	131.2 Sv	5.508 kSv
E ₆₃ Eu	204.3 gm	1.337 M	12.15 TBq	59.47 GBq				2.846 W	13.93 mW	23.60 kSv	115.5 Sv
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	≤ 1 pg	≤ 1 pM	144.8 μBq	95.58 TBq	ε	1.267 y	19.60 keV	≤ 1 pW	300.1 mW	≤ 1 pSv	191.2 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	212.4 mg	1.881 mM	3.232 mBq	15.22 mBq	β	7.700 Py	93.30 keV	≤ 1 pW	≤ 1 pW	80.79 pSv	380.4 pSv
^{113m} Cd	41.28 mg	365.6 μM	331.4 GBq	8.028 TBq	β	14.10 y	284.0 keV	15.08 mW	365.3 mW	7.622 kSv	184.6 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		
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	197.7 gm	1.774 M	331.4 GBq	1.676 GBq				15.08 mW	76.27 μW	7.622 kSv	38.55 Sv
¹⁴⁶ Sm	13.66 mg	93.62 μM	17.69 kBq	1.295 MBq	α	100.0 My	2.539 MeV	7.197 nW	526.9 nW	955.3 μSv	69.93 mSv
¹⁴⁷ Sm	243.8 gm	1.659 M	205.1 kBq	841.3 Bq	α	106.0 Gy	2.310 MeV	75.90 nW	311.3 pW	10.05 mSv	41.22 μSv

†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 Sm	309.5 gm	2.092 M	3.458 Bq	11.17 mBq	α	7.000 Py	2.014 MeV	1.116 pW	≤ 1 pW		
¹⁴⁹ Sm	4.616 gm	31.00 mM	205.0 mBq	44.41 mBq	α	2.000 Py	1.870 MeV	≤ 1 pW	≤ 1 pW		
¹⁵⁰ Sm	478.3 gm	3.190 M									
¹⁵¹ Sm	15.53 gm	102.9 mM	15.12 TBq	973.6 GBq	β	90.00 y	19.78 keV	47.92 mW	3.086 mW	1.482 kSv	95.41 Sv
¹⁵² Sm	178.3 gm	1.174 M									
¹⁵⁴ Sm	59.76 gm	388.2 mM									
E ₆₂ Sm	1.290 kg	8.638 M	15.12 TBq	11.72 GBq				47.92 mW	37.15 μ W	1.482 kSv	1.149 Sv
⁹⁸ Tc	10.77 mg	110.0 μ M	346.4 kBq	32.16 MBq	β	4.200 My	1.532 MeV	85.02 nW	7.894 μ W	692.8 μ Sv	64.33 mSv
⁹⁹ Tc	1.136 kg	11.49 M	712.6 GBq	627.3 MBq	β	214.0 ky	84.61 keV	9.659 mW	8.503 μ W	456.1 Sv	401.5 mSv
A ₄₃ Tc	1.136 kg	11.49 M	712.6 GBq	627.3 MBq				9.659 mW	8.503 μ W	456.1 Sv	401.5 mSv
¹¹⁴ Sn	3.852 mg	33.82 μ M									
¹¹⁵ Sn	490.4 mg	4.268 mM									
¹¹⁶ Sn	12.26 gm	105.8 mM									
¹¹⁷ Sn	12.64 gm	108.1 mM									
¹¹⁸ Sn	12.81 gm	108.7 mM									
¹¹⁹ Sn	12.76 gm	107.3 mM									
^{119m} Sn	≤ 1 pg	≤ 1 pM	408.5 pBq	165.8 TBq	γ	293.0 d	87.17 keV	≤ 1 pW	2.315 W	≤ 1 pSv	56.37 kSv
¹²⁰ Sn	12.99 gm	108.3 mM									
^{121m} Sn	2.746 mg	22.71 μ M	6.009 GBq	2.188 TBq	γ	55.00 y	338.0 keV	325.4 μ W	118.5 mW	2.283 Sv	831.5 Sv
¹²² Sn	14.26 gm	117.0 mM									
¹²⁴ Sn	19.24 gm	155.3 mM	20.54 mBq	1.068 mBq	2 β	100.0 Py	2.287 MeV	≤ 1 pW	≤ 1 pW		
¹²⁶ Sn	42.48 gm	337.4 mM	44.62 GBq	1.050 GBq	β	230.0 ky	210.4 keV	1.504 mW	35.40 μ W	209.7 Sv	4.937 Sv
E ₅₀ Sn	139.9 gm	1.152 M	50.63 GBq	361.8 MBq				1.829 mW	13.07 μ W	212.0 Sv	1.515 Sv
¹²⁷ I	84.19 gm	663.4 mM									
¹²⁹ I	273.4 gm	2.121 M	1.786 GBq	6.533 MBq	β	16.10 My	78.04 keV	22.33 μ W	81.68 nW	196.5 Sv	718.6 mSv
E ₅₃ I	357.6 gm	2.784 M	1.786 GBq	4.995 MBq				22.33 μ W	62.45 nW	196.5 Sv	549.4 mSv
⁹⁰ Zr	585.1 gm	6.508 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	2 β	6.000 Py	1.144 MeV	4.839 pW	≤ 1 pW		
⁹⁶ Zr	1.211 kg	12.63 M	4.282 mBq	3.536 μ Bq	2 β	$\geq 10^{18}$ y	3.350 MeV	≤ 1 pW	≤ 1 pW		
A ₄₀ Zr	5.827 kg	62.72 M	99.79 GBq	17.12 MBq				313.3 μ W	53.76 nW	109.8 Sv	18.84 mSv
G ₁ H	5.201 mg	1.724 mM	1.858 TBq	357.2 TBq	β	12.33 y	5.678 keV	1.690 mW	324.9 mW	78.04 Sv	15.00 kSv
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									

†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
⁷⁹ Se	8.865 gm	112.3 mM	22.86 GBq	2.579 GBq	β	377.0 ky	42.00 keV	153.8 μ W	17.35 μ W	66.29 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	22.86 GBq	270.0 MBq				153.8 μ W	1.816 μ W	66.29 Sv	782.9 mSv
¹²¹ Sb	12.21 gm	101.0 mM									
¹²³ Sb	15.25 gm	124.1 mM									
¹²⁵ Sb	72.39 μ g	579.6 nM	2.767 GBq	38.22 TBq	β	2.759 y	527.4 keV	233.8 μ W	3.230 W	3.044 Sv	42.05 kSv
¹²⁶ Sb	2.018 μ g	16.03 nM	6.246 GBq	3.095 $\times 10^6$	β	12.40 d	3.117 MeV	3.119 mW	1.546 kW	14.99 Sv	7.428 MSv
^{126m} Sb	15.35 ng	121.9 pM	44.62 GBq	2.907 $\times 10^9$	β	19.10 m	2.147 MeV	15.35 mW	1.000 MW	1.606 Sv	104.6 MSv
E ₅₁ Sb	27.46 gm	225.1 mM	53.63 GBq	1.953 GBq				18.70 mW	681.1 μ W	19.64 Sv	715.2 mSv
⁹³ Nb	16.90 mg	181.9 μ M									
^{93m} Nb	8.422 mg	90.65 μ M	88.10 GBq	10.46 TBq	γ	16.13 y	29.89 keV	421.9 μ W	50.09 mW	10.57 Sv	1.255 kSv
⁹⁴ Nb	1.180 mg	12.57 μ M	8.184 MBq	6.936 GBq	β	19.99 ky	1.719 MeV	2.254 μ W	1.910 mW	13.91 mSv	11.79 Sv
A ₄₁ Nb	26.50 mg	285.1 μ M	88.11 GBq	3.325 TBq				424.2 μ W	16.00 mW	10.59 Sv	399.4 Sv
¹⁴⁶ Pm	17.21 μ g	117.9 nM	283.6 MBq	16.48 TBq	ϵ	5.531 y	850.7 keV	38.65 μ W	2.246 W	255.2 mSv	14.83 kSv
¹⁴⁷ Pm	283.5 μ g	1.930 μ M	9.727 GBq	34.31 TBq	β	2.623 y	60.51 keV	94.29 μ W	332.6 mW	2.529 Sv	8.921 kSv
E ₆₁ Pm	300.7 μ g	2.048 μ M	10.01 GBq	33.29 TBq				132.9 μ W	442.1 mW	2.784 Sv	9.259 kSv
¹²² Te	1.243 gm	10.20 mM									
¹²³ Te	21.28 mg	173.1 μ M	229.0 mBq	10.76 Bq	ϵ	92.00 Py	17.10 keV	≤ 1 pW	≤ 1 pW	1.008 nSv	47.35 nSv
¹²⁴ Te	963.7 mg	7.778 mM									
¹²⁵ Te	29.08 gm	232.8 mM									
^{125m} Te	1.013 μ g	8.110 nM	674.9 MBq	666.2 TBq	γ	57.40 d	141.9 keV	15.34 μ W	15.14 W	587.2 mSv	579.6 kSv
¹²⁶ Te	1.334 gm	10.60 mM									
¹²⁸ Te	170.8 gm	1.335 M	8.029 nBq	47.01 pBq	2β	$\geq 10^{18}$ y	867.2 keV	≤ 1 pW	≤ 1 pW		
¹³⁰ Te	547.3 gm	4.213 M	70.54 nBq	128.9 pBq	2β	$\geq 10^{18}$ y	2.528 MeV	≤ 1 pW	≤ 1 pW		
E ₅₂ Te	750.7 gm	5.810 M	674.9 MBq	899.0 kBq				15.34 μ W	20.43 nW	587.2 mSv	782.1 μ Sv
¹⁶⁵ Ho	285.7 mg	1.732 mM									
^{166m} Ho	3.425 mg	20.64 μ M	227.5 MBq	66.42 GBq	β	1.200 ky	1.869 MeV	68.12 μ W	19.89 mW	455.0 mSv	132.8 Sv
E ₆₇ Ho	289.1 mg	1.753 mM	227.5 MBq	786.9 MBq				68.12 μ W	235.6 μ W	455.0 mSv	1.574 Sv
¹⁰⁴ Pd	463.0 gm	4.456 M									
¹⁰⁵ Pd	609.7 gm	5.812 M									
¹⁰⁶ Pd	594.1 gm	5.610 M									
¹⁰⁷ Pd	361.2 gm	3.379 M	6.875 GBq	19.03 MBq	β	6.500 My	10.01 keV	11.02 μ W	30.51 nW	254.4 mSv	704.2 μ Sv
¹⁰⁸ Pd	248.7 gm	2.305 M									
¹¹⁰ Pd	82.30 gm	748.8 mM	16.51 mBq	200.6 μ Bq	2β	600.0 Py	2.000 MeV	≤ 1 pW	≤ 1 pW		
A ₄₆ Pd	2.359 kg	22.31 M	6.875 GBq	2.914 MBq				11.02 μ W	4.671 nW	254.4 mSv	107.8 μ Sv

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

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			GBq	GBq/gm	‡			Watts	Watts/gm	Sv	Sv/gm
E $^{14}_6\text{C}$	39.98 μg	2.855 μM	6.597 MBq	165.0 GBq	β	5.700 ky	49.46 keV	52.27 nW	1.307 mW	3.826 mSv	95.70 Sv
^{107}Ag	1.980 mg	18.52 μM									
^{108}Ag	≤ 1 pg	≤ 1 pM	125.4 kBq	2.719×10^{10}	β	2.400 m	628.2 keV	12.62 nW	2.736 MW		
^{108m}Ag	1.461 μg	13.54 nM	1.409 MBq	964.4 GBq	ϵ	418.0 y	1.634 MeV	368.8 nW	252.4 mW	3.241 mSv	2.218 kSv
^{109}Ag	115.4 gm	1.060 M									
^{109m}Ag	≤ 1 pg	≤ 1 pM	144.8 μBq	9.679×10^{10}	γ	39.70 s	86.95 keV	≤ 1 pW	1.348 MW		
^{110}Ag	≤ 1 pg	≤ 1 pM	362.0 pBq	1.543×10^{11}	β	24.56 s	1.212 MeV	≤ 1 pW	29.97 MW		
^{110m}Ag	≤ 1 pg	≤ 1 pM	27.22 nBq	175.8 TBq	β	249.8 d	2.816 MeV	≤ 1 pW	79.33 W	≤ 1 pSv	492.4 kSv
E $_{47}\text{Ag}$	115.4 gm	1.060 M	1.534 MBq	13.30 kBq				381.4 nW	3.305 nW	3.241 mSv	28.08 μSv
^{85}Rb	179.4 gm	2.113 M									
^{87}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 $_{37}\text{Rb}$	541.2 gm	6.276 M	1.172 MBq	2.166 kBq				26.47 nW	48.91 pW	1.758 mSv	3.248 μSv
^{102}Rh	9.937 ng	97.51 pM	444.4 kBq	44.72 TBq	ϵ	2.902 y	2.153 MeV	153.3 nW	15.43 W	533.3 μSv	53.67 kSv
^{103}Rh	611.3 gm	5.940 M									
^{106}Rh	≤ 1 pg	≤ 1 pM	32.40 Bq	1.318×10^{11}	β	30.00 s	1.618 MeV	8.400 pW	34.16 MW		
A $_{45}\text{Rh}$	611.3 gm	5.940 M	444.4 kBq	727.0 Bq				153.3 nW	250.8 pW	533.3 μSv	872.4 nSv
^9Be	29.79 μg	3.306 μM									
^{10}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
^{99}Ru	191.8 mg	1.939 mM									
^{100}Ru	218.3 gm	2.185 M									
^{101}Ru	1.166 kg	11.56 M									
^{102}Ru	1.217 kg	11.94 M									
^{104}Ru	863.0 gm	8.306 M									
^{106}Ru	≤ 1 pg	≤ 1 pM	32.40 Bq	123.9 TBq	β	1.020 y	10.03 keV	≤ 1 pW	199.0 mW	226.8 nSv	867.0 kSv
A $_{44}\text{Ru}$	3.464 kg	33.99 M	32.40 Bq	9.352 mBq				≤ 1 pW	≤ 1 pW	226.8 nSv	65.46 pSv
^{113}In	430.0 mg	3.809 mM									
^{115}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 $_{49}\text{In}$	3.127 gm	27.28 mM	621.2 mBq	198.7 mBq				≤ 1 pW	≤ 1 pW	19.88 nSv	6.357 nSv
^{138}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}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
^{152}Gd	89.89 mg	591.7 μM	72.45 mBq	806.0 mBq	α	108.0 Ty	2.199 MeV	≤ 1 pW	≤ 1 pW	2.970 nSv	33.05 nSv
^{153}Gd	≤ 1 pg	≤ 1 pM	16.96 pBq	130.6 TBq	ϵ	240.4 d	152.4 keV	≤ 1 pW	3.188 W	≤ 1 pSv	35.25 kSv
^{154}Gd	70.81 gm	460.0 mM									
^{155}Gd	26.02 gm	168.0 mM									

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			GBq	GBq/gm	†			Watts	Watts/gm	Sv	Sv/gm
¹⁵⁶ Gd ¹⁵⁷ Gd ¹⁵⁸ Gd ¹⁶⁰ Gd E ₆₄ Gd	125.8 gm 196.7 mg 33.19 gm 2.102 gm 258.2 gm	806.8 mM 1.253 mM 210.2 mM 13.14 mM 1.660 M									
			1.337 mBq 73.79 mBq	636.2 μBq 285.8 μBq	2β	130.0 Py	1.729 MeV	≤ 1 pW ≤ 1 pW	≤ 1 pW ≤ 1 pW	2.970 nSv	11.50 pSv
¹⁶⁹ Tm ¹⁷¹ Tm E ₆₉ Tm	95.30 μg ≤ 1 pg 95.30 μg	564.1 nM ≤ 1 pM 564.1 nM	1.057 Bq 1.057 Bq	40.30 TBq 11.09 kBq	β	1.917 y	26.16 keV	≤ 1 pW ≤ 1 pW	168.9 mW 46.48 pW	116.3 pSv 116.3 pSv	4.433 kSv 1.220 μSv
¹⁴⁰ Ce ¹⁴² Ce ¹⁴⁴ Ce E ₅₈ Ce	1.896 kg 1.711 kg ≤ 1 pg 3.607 kg	13.55 M 12.06 M ≤ 1 pM 25.61 M	3.190 Bq 2.199 mBq 3.192 Bq	1.864 mBq 118.1 TBq 884.9 μBq	2β β	50.00 Py 285.0 d	1.417 MeV 111.9 keV	≤ 1 pW ≤ 1 pW ≤ 1 pW	≤ 1 pW 2.117 W ≤ 1 pW	11.43 pSv 11.43 pSv	614.1 kSv ≤ 1 pSv
¹⁴¹ Pr ¹⁴⁴ Pr ^{144m} Pr E ₅₉ Pr	1.689 kg ≤ 1 pg ≤ 1 pg 1.689 kg	11.99 M ≤ 1 pM ≤ 1 pM 11.99 M	2.199 mBq 26.38 μBq 2.225 mBq	2.797×10 ⁹ 6.712×10 ⁹ 1.318 μBq	β γ	17.28 m 6.900 m	1.240 MeV 57.73 keV	≤ 1 pW ≤ 1 pW ≤ 1 pW	555.5 kW 62.09 kW ≤ 1 pW	≤ 1 pSv ≤ 1 pSv	139.8 MSv ≤ 1 pSv
⁶ Li ⁷ Li E ₃ Li	241.9 μg 15.49 μg 257.4 μg	40.22 μM 2.208 μM 42.42 μM									
⁶⁶ Zn ⁶⁷ Zn ⁶⁸ Zn ⁷⁰ Zn E ₃₀ Zn	53.48 ng 2.226 ng 2.128 mg 7.588 mg 9.716 mg	811.2 pM 33.26 pM 31.33 μM 108.5 μM 139.8 μM									
⁶⁹ Ga ⁷¹ Ga E ₃₁ Ga	5.671 μg 2.257 μg 7.928 μg	82.28 nM 31.82 nM 114.1 nM									
⁷⁰ Ge ⁷² Ge ⁷³ Ge ⁷⁴ Ge ⁷⁶ Ge E ₃₂ Ge	33.14 ng 33.04 mg 66.60 mg 147.3 mg 748.2 mg 995.1 mg	473.9 pM 459.4 μM 913.3 μM 1.993 mM 9.855 mM 13.22 mM	82.50 nBq 82.50 nBq	110.3 nBq 82.91 nBq	2β	≥ 10 ¹⁸ y	2.039 MeV	≤ 1 pW ≤ 1 pW	≤ 1 pW ≤ 1 pW		
E ₃₃ As	⁷⁵ As 298.2 mg	3.980 mM									
⁷⁹ Br ⁸¹ Br	4.918 mg 31.96 gm	62.32 μM 395.0 mM									

†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 ³⁵ Br	31.96 gm	395.0 mM									
⁸⁰ Kr	358.8 μg	4.490 μM									
⁸¹ Kr	42.35 μg	523.4 nM	32.97 kBq	778.5 MBq	ε	210.0 ky	20.81 keV	109.9 pW	2.595 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	1.357 gm	15.98 mM	19.71 TBq	14.52 TBq	β	10.75 y	252.7 keV	797.8 mW	587.9 mW		
⁸⁶ Kr	282.3 gm	3.286 M									
G ³⁶ Kr	516.3 gm	6.084 M	19.71 TBq	38.17 GBq				797.8 mW	1.545 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		
¹⁰⁰ Mo	1.423 kg	14.24 M	19.03 mBq	13.37 μBq	2β	≥ 10 ¹⁸ y	3.034 MeV	≤ 1 pW	≤ 1 pW		
A ₄₂ Mo	5.059 kg	51.89 M	1.673 kBq	330.6 mBq				30.02 pW	≤ 1 pW		
¹²⁸ Xe	7.057 gm	55.17 mM									
¹²⁹ Xe	52.88 mg	410.2 μM									
¹³⁰ Xe	23.11 gm	177.9 mM									
¹³¹ Xe	566.1 gm	4.325 M									
¹³² Xe	1.753 kg	13.29 M									
¹³⁴ Xe	2.246 kg	16.77 M	20.17 Bq	8.980 mBq	2β	11.00 Py	830.0 keV	2.682 pW	≤ 1 pW		
¹³⁶ Xe	3.429 kg	25.23 M	1.589 mBq	463.5 nBq	2β	≥ 10 ¹⁸ y	2.467 MeV	≤ 1 pW	≤ 1 pW		
G ₅₄ Xe	8.024 kg	59.85 M	20.17 Bq	2.514 mBq				2.683 pW	≤ 1 pW		
¹³² Ba	3.142 mg	23.82 μM									
¹³⁴ Ba	342.5 gm	2.558 M									
¹³⁵ Ba	1.057 gm	7.835 mM									
¹³⁶ Ba	42.80 gm	314.9 mM									
¹³⁷ Ba	1.320 kg	9.642 M									
^{137m} Ba	87.20 μg	636.9 nM	1.736×10 ⁶	1.991×10 ¹⁰	γ	2.552 m	662.3 keV	184.2 W	2.112 MW		
¹³⁸ Ba	1.944 kg	14.10 M									
E ₅₆ Ba	3.650 kg	26.62 M	1.736×10 ⁶	475.6 GBq				184.2 W	50.46 mW		
¹⁴² Nd	51.65 gm	364.0 mM									
¹⁴³ Nd	1.116 kg	7.809 M									
¹⁴⁴ Nd	2.072 kg	14.40 M	83.17 Bq	40.14 mBq	α	2.290 Py	1.905 MeV	25.38 pW	≤ 1 pW		
¹⁴⁵ Nd	975.8 gm	6.734 M									
¹⁴⁶ Nd	1.091 kg	7.477 M									
¹⁴⁸ Nd	563.2 gm	3.808 M	18.65 mBq	33.12 μBq	2β	≥ 10 ¹⁸ y	1.929 MeV	≤ 1 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
¹⁵⁰ Nd E ₆₀ Nd	273.6 gm 6.143 kg	1.825 M 42.41 M	1.150 mBq 83.19 Bq	4.201 μ Bq 13.54 mBq	2 β	$\geq 10^{18}$ y	3.368 MeV	≤ 1 pW 25.39 pW	≤ 1 pW ≤ 1 pW		
E ₆₅ ¹⁵⁹ Tb	4.337 gm	27.29 mM									
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 μ M 15.91 mM									
¹⁶⁶ Er ¹⁶⁷ Er ¹⁶⁸ Er ¹⁷⁰ Er E ₆₈ Er	88.64 mg 5.663 mg 11.31 mg 59.35 ng 105.6 mg	534.2 μ M 33.92 μ M 67.35 μ M 349.3 pM 635.5 μ M									
¹⁷⁰ Yb ¹⁷¹ Yb ¹⁷² Yb E ₇₀ Yb	39.44 μ g 3.426 μ g 143.9 ng 43.01 μ g	232.1 nM 20.04 nM 836.9 pM 253.0 nM									
Total	52.18 kg	443.5 M	6.020 $\times 10^6$	115.4 GBq				460.1 W	8.818 mW	60.70 MSv	1.163 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 fifty 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	5.542 ng	23.48 pM	109.0 kBq	19.67 TBq	α	2.858 y	5.870 MeV	102.5 nW	18.50 W	9.483 mSv	1.711 MSv
²³⁸ Pu	219.1 gm	920.4 mM	138.9 TBq	634.0 GBq	α	87.70 y	5.590 MeV	124.4 W	567.8 mW	31.95 MSv	145.8 kSv
²³⁹ Pu	6.177 kg	25.84 M	14.21 TBq	2.300 GBq	α	24.11 ky	5.201 MeV	11.84 W	1.917 mW	3.553 MSv	575.1 Sv
²⁴⁰ Pu	2.989 kg	12.45 M	25.21 TBq	8.434 GBq	α	6.563 ky	5.252 MeV	21.21 W	7.096 mW	6.302 MSv	2.109 kSv
²⁴¹ Pu	161.6 gm	670.4 mM	616.4 TBq	3.814 TBq	β	14.33 y	5.230 keV	516.5 mW	3.196 mW	2.959 MSv	18.31 kSv
²⁴² Pu	873.8 gm	3.610 M	123.5 GBq	141.3 MBq	α	373.5 ky	4.981 MeV	98.56 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	3.603 mBq	1.811×10^6	β	10.85 d	142.0 keV	≤ 1 pW	41.19 W	11.89 pSv	5.975 MSv
C ₉₄ Pu	10.42 kg	43.49 M	794.8 TBq	76.28 GBq				158.1 W	15.17 mW	44.79 MSv	4.298 kSv
²⁴¹ Am	1.601 kg	6.642 M	203.4 TBq	127.0 GBq	α	432.8 y	5.604 MeV	182.6 W	114.1 mW	40.68 MSv	25.41 kSv
²⁴² Am	7.560 μ g	31.23 nM	226.2 GBq	2.992×10^7	β	16.04 h	191.5 keV	6.940 mW	918.0 W	67.86 Sv	8.976 MSv
^{242m} Am	632.0 mg	2.611 mM	227.4 GBq	359.8 GBq	γ	141.0 y	66.62 keV	2.427 mW	3.840 mW	43.21 kSv	68.36 kSv
²⁴³ Am	196.1 gm	806.8 mM	1.447 TBq	7.379 GBq	α	7.365 ky	5.422 MeV	1.257 W	6.410 mW	289.4 kSv	1.476 kSv
²⁴⁵ Am	≤ 1 pg	≤ 1 pM	≤ 1 pBq	2.288×10^8	β	2.050 h	312.9 keV	≤ 1 pW	11.47 kW	≤ 1 pSv	14.19 MSv
²⁴⁶ Am	≤ 1 pg	≤ 1 pM	3.603 mBq	1.132×10^9	β	39.00 m	1.362 MeV	≤ 1 pW	246.9 kW	≤ 1 pSv	65.63 MSv
C ₉₅ Am	1.798 kg	7.451 M	205.3 TBq	114.2 GBq				183.9 W	102.3 mW	41.01 MSv	22.81 kSv
²⁴² Cm	1.529 mg	6.317 μ M	187.1 GBq	122.4 TBq	α	162.9 d	6.215 MeV	186.3 mW	121.8 W	2.245 kSv	1.468 MSv
²⁴³ Cm	221.4 mg	910.9 μ M	422.9 GBq	1.910 TBq	α	30.00 y	6.192 MeV	419.5 mW	1.895 W	63.44 kSv	286.5 kSv
²⁴⁴ Cm	12.53 gm	51.34 mM	37.56 TBq	2.998 TBq	α	18.00 y	5.898 MeV	35.49 W	2.832 W	4.507 MSv	359.7 kSv
²⁴⁵ Cm	5.597 gm	22.84 mM	35.57 GBq	6.355 GBq	α	8.500 ky	5.598 MeV	31.90 mW	5.699 mW	7.470 kSv	1.335 kSv
²⁴⁶ Cm	712.4 mg	2.895 mM	8.099 GBq	11.37 GBq	α	4.730 ky	5.524 MeV	7.167 mW	10.06 mW	1.701 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	4.738 pg	≤ 1 pM	14.41 mBq	3.041 GBq	SF	8.000 ky	123.3 MeV	≤ 1 pW	60.09 mW	63.40 nSv	13.38 kSv
C ₉₆ Cm	19.07 gm	78.03 mM	38.21 TBq	2.004 TBq				36.13 W	1.895 W	4.582 MSv	240.2 kSv
²³² U	273.7 μ g	1.180 μ M	216.9 MBq	792.5 GBq	α	69.80 y	5.416 MeV	188.2 μ W	687.6 mW	71.58 Sv	261.5 kSv
²³³ U	12.89 mg	55.31 μ M	4.618 MBq	358.3 MBq	α	159.3 ky	4.905 MeV	3.629 μ W	281.5 μ W	235.5 mSv	18.27 Sv
²³⁴ U	273.1 gm	1.167 M	63.16 GBq	231.3 MBq	α	245.7 ky	4.859 MeV	49.17 mW	180.0 μ W	3.095 kSv	11.33 Sv
²³⁵ U	7.425 kg	31.59 M	594.2 MBq	80.03 kBq	α	703.8 My	4.417 MeV	420.5 μ W	56.63 nW	27.93 Sv	3.761 mSv
²³⁶ U	5.538 kg	23.46 M	13.26 GBq	2.394 MBq	α	23.70 My	4.571 MeV	9.710 mW	1.753 μ W	623.2 Sv	112.5 mSv
²³⁷ U	5.005 μ g	21.11 nM	15.12 GBq	3.021×10^6	β	6.750 d	319.2 keV	773.3 μ W	154.5 W	11.49 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 μ Sv

†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
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	934.9 kg	3.928 kM	103.8 GBq	111.1 kBq				68.13 mW	72.87 nW	4.345 kSv	4.648 mSv
²³⁶ Np	2.482 mg	10.51 μM	1.210 MBq	487.5 MBq	ε	152.0 ky	340.4 keV	65.98 nW	26.58 μW	20.57 mSv	8.288 Sv
²³⁷ Np	737.7 gm	3.112 M	19.25 GBq	26.09 MBq	α	2.140 My	5.156 MeV	15.90 mW	21.55 μW	2.118 kSv	2.870 Sv
²³⁸ Np	118.5 ng	497.8 pM	1.137 GBq	9.595×10 ⁶	β	2.117 d	808.1 keV	147.2 μW	1.242 kW	1.035 Sv	8.731 MSv
²³⁹ Np	168.6 μg	705.3 nM	1.447 TBq	8.582×10 ⁶	β	2.355 d	407.9 keV	94.55 mW	560.8 W	1.158 kSv	6.866 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	737.7 gm	3.112 M	1.467 TBq	1.989 GBq				110.6 mW	149.9 μW	3.276 kSv	4.441 Sv
²²⁷ Th	872.7 pg	3.844 pM	993.1 kBq	1.138×10 ⁶	α	18.72 d	6.156 MeV	979.4 nW	1.122 kW	8.739 mSv	10.01 MSv
²²⁸ Th	7.343 μg	32.20 nM	222.8 MBq	30.34 TBq	α	1.913 y	5.516 MeV	196.9 μW	26.81 W	16.04 Sv	2.185 MSv
²²⁹ Th	2.438 μg	10.64 nM	19.20 kBq	7.875 GBq	α	7.340 ky	5.159 MeV	15.87 nW	6.509 mW	9.408 mSv	3.859 kSv
²³⁰ Th	32.88 mg	142.9 μM	24.57 MBq	747.3 MBq	α	75.40 ky	4.774 MeV	18.79 μW	571.5 μW	5.160 Sv	156.9 Sv
²³¹ Th	30.19 ng	130.7 pM	594.2 MBq	1.968×10 ⁷	β	1.063 d	94.64 keV	9.009 μW	298.4 W	202.0 mSv	6.692 MSv
²³² Th	8.420 mg	36.29 μM	34.18 Bq	4.059 kBq	α	14.05 Gy	4.083 MeV	22.36 pW	2.656 nW	7.861 μSv	933.7 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	41.32 mg	179.3 μM	12.31 GBq	298.0 GBq				351.4 μW	8.504 mW	60.42 Sv	1.462 kSv
²³¹ Pa	851.6 μg	3.686 μM	1.489 MBq	1.748 GBq	α	32.76 ky	5.085 MeV	1.213 μW	1.424 mW	1.057 Sv	1.241 kSv
²³³ Pa	25.06 μg	107.5 nM	19.25 GBq	768.2 TBq	β	27.00 d	383.0 keV	1.181 mW	47.13 W	16.75 Sv	668.3 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	876.7 μg	3.794 μM	30.74 GBq	35.06 TBq				2.720 mW	3.103 W	17.81 Sv	20.32 kSv
²²³ Ra	531.1 pg	2.381 pM	1.007 MBq	1.896×10 ⁶	α	11.43 d	6.006 MeV	968.9 nW	1.824 kW	100.7 mSv	189.6 MSv
²²⁴ Ra	37.79 ng	168.7 pM	222.8 MBq	5.896×10 ⁶	α	3.640 d	5.791 MeV	206.7 μW	5.470 kW	14.48 Sv	383.2 MSv
²²⁵ Ra	13.23 pg	≤ 1 pM	19.20 kBq	1.451×10 ⁶	β	14.80 d	118.3 keV	363.8 pW	27.50 W	1.901 mSv	143.7 MSv
²²⁶ Ra	7.079 μg	31.32 nM	259.1 kBq	36.60 GBq	α	1.600 ky	4.871 MeV	202.2 nW	28.56 mW	72.55 mSv	10.25 kSv
²²⁸ Ra	3.220 pg	≤ 1 pM	27.89 Bq	8.661 TBq	β	5.750 y	13.00 keV	≤ 1 pW	18.04 mW	19.24 μSv	5.976 MSv
E ₈₈ Ra	7.117 μg	31.49 nM	224.1 MBq	31.48 TBq				207.9 μW	29.21 W	14.66 Sv	2.059 MSv
²⁰⁶ Pb	14.27 ng	69.28 pM									
²⁰⁷ Pb	305.8 ng	1.477 nM									
²⁰⁸ Pb	148.8 μg	715.5 nM									
²⁰⁹ Pb	≤ 1 pg	≤ 1 pM	19.20 kBq	1.683×10 ⁸	β	3.253 h	194.0 keV	596.6 pW	5.229 kW	1.094 μSv	9.592 MSv
²¹⁰ Pb	33.91 ng	161.5 pM	95.83 kBq	2.826 TBq	β	22.16 y	39.08 keV	600.0 pW	17.69 mW	66.12 mSv	1.950 MSv
²¹¹ Pb	1.102 pg	≤ 1 pM	1.007 MBq	9.138×10 ⁸	β	36.10 m	505.4 keV	81.54 nW	73.99 kW	181.3 μSv	164.5 MSv
²¹² Pb	4.332 ng	20.43 pM	222.8 MBq	5.143×10 ⁷	β	10.64 h	321.1 keV	11.46 μW	2.645 kW	1.337 Sv	308.6 MSv
²¹⁴ Pb	≤ 1 pg	≤ 1 pM	259.0 kBq	1.214×10 ⁹	β	26.80 m	537.9 keV	22.32 nW	104.6 kW	36.26 μSv	169.9 MSv
A ₈₂ Pb	149.2 μg	717.2 nM	224.2 MBq	1.503 TBq				11.57 μW	77.54 mW	1.403 Sv	9.407 kSv
²²⁵ Ac	8.935 pg	≤ 1 pM	19.20 kBq	2.149×10 ⁶	α	10.00 d	5.891 MeV	18.12 nW	2.028 kW	460.8 μSv	51.57 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
²²⁷ Ac	375.9 ng	1.656 nM	1.006 MBq	2.676 TBq	β	21.77 y	81.72 keV	13.17 nW	35.04 mW	1.107 Sv	2.944 MSv
²²⁸ Ac	≤ 1 pg	≤ 1 pM	27.89 Bq	8.298×10^7	β	6.150 h	1.458 MeV	6.514 pW	19.38 kW	11.99 nSv	35.68 MSv
E ₈₉ Ac	375.9 ng	1.656 nM	1.025 MBq	2.727 TBq				31.30 nW	83.26 mW	1.107 Sv	2.945 MSv
²⁴⁹ Cf	9.690 μ g	38.90 nM	1.469 MBq	151.6 GBq	α	351.0 y	7.810 MeV	1.838 μ W	189.7 mW	514.2 mSv	53.06 kSv
²⁵⁰ Cf	144.8 ng	579.0 pM	586.1 kBq	4.048 TBq	α	13.08 y	6.265 MeV	588.3 nW	4.063 W	93.78 mSv	647.6 kSv
²⁵¹ Cf	946.9 ng	3.771 nM	55.57 kBq	58.69 GBq	α	898.0 y	6.029 MeV	53.67 nW	56.68 mW	20.01 mSv	21.13 kSv
²⁵² Cf	1.303 pg	≤ 1 pM	25.94 Bq	19.91 TBq	α	2.645 y	12.04 MeV	50.04 pW	38.40 W	2.335 μ Sv	1.792 MSv
C ₉₈ Cf	10.78 μ g	43.25 nM	2.111 MBq	195.8 GBq				2.480 μ W	230.0 mW	627.9 mSv	58.24 kSv
²¹⁰ Po	576.4 pg	2.745 pM	95.83 kBq	166.3 TBq	α	138.4 d	5.408 MeV	83.03 nW	144.0 W	115.0 mSv	199.5 MSv
²¹¹ Po	≤ 1 pg	≤ 1 pM	2.819 kBq	3.534×10^{12}	α	516.0 ms	7.593 MeV	3.429 nW	4.299 GW		
²¹⁵ Po	≤ 1 pg	≤ 1 pM	1.007 MBq	1.091×10^{15}	α	1.780 ms	7.531 MeV	1.215 μ W	1.317×10^{12}		
²¹⁶ Po	≤ 1 pg	≤ 1 pM	222.8 MBq	1.289×10^{13}	α	150.0 ms	6.906 MeV	246.5 μ W	14.26 GW		
²¹⁸ Po	≤ 1 pg	≤ 1 pM	259.1 kBq	1.047×10^{10}	α	3.098 m	6.112 MeV	253.7 nW	10.25 MW		
A ₈₄ Po	576.4 pg	2.745 pM	224.2 MBq	3.889×10^8				248.1 μ W	430.3 kW	115.0 mSv	199.5 MSv
²⁰⁸ Bi	≤ 1 pg	≤ 1 pM	119.3 nBq	172.9 MBq	ϵ	368.0 ky	2.653 MeV	≤ 1 pW	73.50 μ W		
²⁰⁹ Bi	6.495 ng	31.08 pM	≤ 1 pBq	3.331 μ Bq	α	$\geq 10^{18}$ y	3.137 MeV	≤ 1 pW	≤ 1 pW		
²¹⁰ Bi	20.87 pg	≤ 1 pM	95.83 kBq	4.592×10^6	β	5.012 d	389.1 keV	5.973 nW	286.2 W	124.6 μ Sv	5.969 MSv
^{210m} Bi	≤ 1 pg	≤ 1 pM	90.32 nBq	21.00 MBq	α	3.000 My	5.295 MeV	≤ 1 pW	17.82 μ W	≤ 1 pSv	315.1 mSv
²¹¹ Bi	≤ 1 pg	≤ 1 pM	1.007 MBq	1.549×10^{10}	α	2.170 m	6.725 MeV	1.085 μ W	16.69 MW		
²¹² Bi	410.9 pg	1.938 pM	222.8 MBq	5.422×10^8	β	1.009 h	2.869 MeV	102.4 μ W	249.2 kW	57.93 mSv	141.0 MSv
²¹³ Bi	≤ 1 pg	≤ 1 pM	19.20 kBq	7.159×10^8	β	45.59 m	709.1 keV	2.181 nW	81.32 kW	3.840 μ Sv	143.2 MSv
²¹⁴ Bi	≤ 1 pg	≤ 1 pM	259.0 kBq	1.634×10^9	β	19.90 m	2.162 MeV	89.71 nW	566.0 kW	28.49 μ Sv	179.7 MSv
A ₈₃ Bi	6.927 ng	33.12 pM	224.2 MBq	3.236×10^7				103.6 μ W	14.95 kW	58.08 mSv	8.385 MSv
²²¹ Fr	≤ 1 pg	≤ 1 pM	19.20 kBq	6.564×10^9	α	4.900 m	6.509 MeV	20.02 nW	6.844 MW		
²²³ Fr	≤ 1 pg	≤ 1 pM	13.89 kBq	1.432×10^9	β	21.80 m	438.0 keV	974.7 pW	100.5 kW	33.34 μ Sv	3.437 GSv
C ₈₇ Fr	≤ 1 pg	≤ 1 pM	33.09 kBq	2.621×10^9				20.99 nW	1.663 MW	33.34 μ Sv	2.640 GSv
²⁴⁹ Bk	≤ 1 pg	≤ 1 pM	3.680 nBq	60.66 TBq	β	320.0 d	125.0 keV	≤ 1 pW	1.215 W	≤ 1 pSv	58.84 kSv
²⁵⁰ Bk	≤ 1 pg	≤ 1 pM	2.018 mBq	1.440×10^8	β	3.217 h	1.172 MeV	≤ 1 pW	27.04 kW	≤ 1 pSv	20.17 MSv
C ₉₇ Bk	≤ 1 pg	≤ 1 pM	2.018 mBq	1.434×10^8				≤ 1 pW	26.92 kW	≤ 1 pSv	20.08 MSv
C ₉₉ ²⁵⁴ Es	≤ 1 pg	≤ 1 pM	≤ 1 pBq	69.02 TBq	α	275.7 d	6.621 MeV	≤ 1 pW	73.21 W	≤ 1 pSv	1.932 MSv
₀ ²⁵⁰ Sf	110.9 μ g										
G ₂ He	6.185 gm	1.545 M									
²⁰⁷ Tl	≤ 1 pg	≤ 1 pM	1.004 MBq	7.051×10^9	β	4.770 m	495.4 keV	79.68 nW	559.6 kW		
²⁰⁸ Tl	7.344 pg	≤ 1 pM	80.03 MBq	1.090×10^{10}	β	3.053 m	3.971 MeV	50.91 μ W	6.932 MW		
²⁰⁹ Tl	≤ 1 pg	≤ 1 pM	414.8 Bq	1.514×10^{10}	β	2.200 m	2.802 MeV	186.2 pW	6.798 MW		

†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 $_{81}\text{Tl}$	7.486 pg	≤ 1 pM	81.03 MBq	1.082×10^{10}				50.99 μW	6.811 MW		
A $_{85}^{217}\text{At}$	≤ 1 pg	≤ 1 pM	19.20 kBq	5.959×10^{13}	α	32.30 ms	7.198 MeV	22.14 nW	68.72 GW		
^{219}Rn	≤ 1 pg	≤ 1 pM	1.007 MBq	4.816×10^{11}	α	3.960 s	6.998 MeV	1.129 μW	539.9 MW		
^{220}Rn	6.526 pg	≤ 1 pM	222.8 MBq	3.414×10^{10}	α	55.80 s	6.404 MeV	228.6 μW	35.03 MW		
^{222}Rn	45.50 pg	≤ 1 pM	259.1 kBq	5.695×10^6	α	3.823 d	5.589 MeV	232.0 nW	5.099 kW		
G $_{86}\text{Rn}$	52.03 pg	≤ 1 pM	224.1 MBq	4.307×10^9				230.0 μW	4.420 MW		
Total	947.9 kg	3.984 kM	1.040×10^6	1.097 GBq				378.2 W	399.0 μW	90.39 MSv	95.36 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 fifty 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	14.94 GBq	92.97 MBq	β	1.530 My	19.61 keV	46.93 μ W	292.0 nW	16.43 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		
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	14.94 GBq	62.79 kBq				46.93 μ W	197.2 pW	16.43 Sv	69.07 μ Sv
⁹³ Nb	2.509 mg	27.01 μ M									
^{93m} Nb	1.260 mg	13.56 μ M	13.18 GBq	10.46 TBq	γ	16.13 y	29.89 keV	63.12 μ W	50.10 mW	1.582 Sv	1.255 kSv
⁹⁴ Nb	63.32 ng	674.3 pM	439.2 Bq	6.936 GBq	β	19.99 ky	1.718 MeV	120.9 pW	1.909 mW	746.6 nSv	11.79 Sv
A ₄₁ Nb	3.769 mg	40.57 μ M	13.18 GBq	3.497 TBq				63.12 μ W	16.75 mW	1.582 Sv	419.6 Sv
⁸⁷ Sr	3.321 mg	38.21 μ M									
⁸⁸ Sr	325.3 mg	3.701 mM									
⁹⁰ Sr	10.39 μ g	115.6 nM	52.47 MBq	5.050 TBq	β	28.79 y	195.8 keV	1.646 μ W	158.4 mW	1.469 Sv	141.4 kSv
E ₃₈ Sr	328.6 mg	3.739 mM	52.47 MBq	159.7 MBq				1.646 μ W	5.009 μ W	1.469 Sv	4.471 Sv
⁸⁹ Y	24.79 mg	278.8 μ M									
⁹⁰ Y	2.607 ng	29.00 pM	52.50 MBq	2.014×10^7	β	2.671 d	935.0 keV	7.864 μ W	3.016 kW	141.8 mSv	54.37 MSv
E ₃₉ Y	24.79 mg	278.8 μ M	52.50 MBq	2.118 GBq				7.864 μ W	317.2 μ W	141.8 mSv	5.718 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	84.61 keV	9.795 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				9.795 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	≤ 1 pg	≤ 1 pM	153.4 Bq	357.3 TBq	β	12.33 y	5.680 keV	≤ 1 pW	325.2 mW	6.443 nSv	15.01 kSv
G ₁ H	12.74 mg	12.64 mM	153.4 Bq	12.04 kBq				≤ 1 pW	10.96 pW	6.443 nSv	505.7 nSv
¹⁰² Rh	≤ 1 pg	≤ 1 pM	158.4 pBq	44.75 TBq	ϵ	2.902 y	2.152 MeV	≤ 1 pW	15.43 W	≤ 1 pSv	53.69 kSv
¹⁰³ Rh	1.108 pg	≤ 1 pM									
A ₄₅ Rh	1.108 pg	≤ 1 pM	158.4 pBq	143.0 Bq				≤ 1 pW	49.29 pW	≤ 1 pSv	171.6 nSv
³ He	6.745 pg	2.236 pM									
⁴ He	16.30 mg	4.072 mM									
G ₂ He	16.30 mg	4.072 mM									

†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
⁹⁴ Mo	109.9 pg	1.170 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	190.5 ng	1.926 nM									
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	100.1 μg	1.002 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	28.23 GBq	118.6 kBq				119.6 μW	502.5 pW	19.63 Sv	82.47 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											