

§ 173.435

49 CFR Ch. I (10–1–02 Edition)

Thorium and uranium enrichment ¹ (Wt% ²³⁵ U present)	Specific activity			
	TBq/gram	Grams/Tbq	Ci/gram	Grams/Ci
0.45 (depleted)	1.9×10 ⁻⁸	5.4×10 ⁷	5.0×10 ⁻⁷	2.0×10 ⁶
0.72 (natural)	2.6×10 ⁻⁸	3.8×10 ⁷	7.1×10 ⁻⁷	1.4×10 ⁶
1.0	2.8×10 ⁻⁸	3.6×10 ⁷	7.6×10 ⁻⁷	1.3×10 ⁶
1.5	3.7×10 ⁻⁸	2.7×10 ⁷	1.0×10 ⁻⁶	1.0×10 ⁶
5.0	1.0×10 ⁻⁷	1.0×10 ⁷	2.7×10 ⁻⁶	3.7×10 ⁵
10.0	1.8×10 ⁻⁷	5.6×10 ⁶	4.8×10 ⁻⁶	2.1×10 ⁵
20.0	3.7×10 ⁻⁷	2.7×10 ⁶	1.0×10 ⁻⁵	1.0×10 ⁵
35.0	7.4×10 ⁻⁷	1.4×10 ⁶	2.0×10 ⁻⁵	5.0×10 ⁴
50.0	9.3×10 ⁻⁷	1.1×10 ⁶	2.5×10 ⁻⁵	4.0×10 ⁴
90.0	2.1×10 ⁻⁶	4.7×10 ⁵	5.8×10 ⁻⁵	1.7×10 ⁴
93.0	2.6×10 ⁻⁶	3.9×10 ⁵	7.0×10 ⁻⁵	1.4×10 ⁴
95.0	3.4×10 ⁻⁶	3.0×10 ⁵	9.1×10 ⁻⁵	1.1×10 ⁴
Natural thorium	8.1×10 ⁻⁹	1.2×10 ⁸	2.2×10 ⁻⁷	4.6×10 ⁶

¹ The figures for uranium include representative values for the activity of uranium-234 which is concentrated during the enrichment process. The activity for thorium includes the equilibrium concentration of thorium-228.

[Amdt. 173–244, 60 FR 50307, Sept. 28, 1995, as amended by 63 FR 52849, Oct. 1, 1998]

§ 173.435 Table of A₁ and A₂ values for radionuclides.

The table of A₁ and A₂ values for radionuclides is as follows:

Symbol of radionuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Ac-225	Actinium(89)	0.6	16.2	1×10 ⁻²	0.270	2.1×10 ³	5.8×10 ⁴
Ac-227	40	1080	2×10 ⁻⁵	5.41×10 ⁻⁴	2.7	7.2×10 ¹	7.2×10 ¹
Ac-228	0.6	16.2	0.4	10.8	8.4×10 ⁴	2.2×10 ⁶	2.2×10 ⁶
Ag-105	Silver(47)	2	54.1	2	54.1	1.1×10 ³	3.0×10 ⁴
Ag-108m	0.6	16.2	0.6	16.2	9.7×10 ⁻¹	2.6×10 ¹	2.6×10 ¹
Ag-110m	0.4	10.8	0.4	10.8	1.8×10 ²	4.7×10 ³	4.7×10 ³
Ag-111	0.6	16.2	0.5	13.5	5.8×10 ³	1.6×10 ⁵	1.6×10 ⁵
Al-26	Aluminum(13)	0.4	10.8	0.4	10.8	7.0×10 ⁻⁴	1.9×10 ⁻²
Am-241 ...	Americium(95) ...	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	1.3×10 ⁻¹	3.4
Am-242m	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	3.6×10 ⁻¹	1.0×10 ¹	1.0×10 ¹
Am-243 ...	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	7.4×10 ⁻³	2.0×10 ⁻¹	2.0×10 ⁻¹
Ar-37	Argon(18)	40	1080	40	1080	3.7×10 ³	9.9×10 ⁴
Ar-39	20	541	20	541	1.3	3.4×10 ¹	3.4×10 ¹
Ar-41	0.6	16.2	0.6	16.2	1.5×10 ⁶	4.2×10 ⁷	4.2×10 ⁷
Ar-42	0.2	5.41	0.2	5.41	9.6	2.6×10 ²	2.6×10 ²
As-72	Arsenic(33)	0.2	5.41	0.2	5.41	6.2×10 ⁴	1.7×10 ⁶
As-73	40	1080	40	1080	8.2×10 ²	2.2×10 ⁴	2.2×10 ⁴
As-74	1	27.0	0.5	13.5	3.7×10 ³	9.9×10 ⁴	9.9×10 ⁴
As-76	0.2	5.41	0.2	5.41	5.8×10 ⁴	1.6×10 ⁶	1.6×10 ⁶
As-77	20	541	0.5	13.5	3.9×10 ⁴	1.0×10 ⁶	1.0×10 ⁶
At-211	Astatine(85)	30	811	2	54.1	7.6×10 ⁴	2.1×10 ⁶
Au-193	Gold(79)	6	162	6	162	3.4×10 ⁴	9.2×10 ⁵
Au-194	1	27.0	1	27.0	1.5×10 ⁴	4.1×10 ⁵	4.1×10 ⁵
Au-195	10	270	10	270	1.4×10 ²	3.7×10 ³	3.7×10 ³
Au-196	2	54.1	2	54.1	4.0×10 ³	1.1×10 ⁵	1.1×10 ⁵
Au-198	3	81.1	0.5	13.5	9.0×10 ³	2.4×10 ⁵	2.4×10 ⁵
Au-199	10	270	0.9	24.3	7.7×10 ³	2.1×10 ⁵	2.1×10 ⁵
Ba-131	Barium(56)	2	54.1	2	54.1	3.1×10 ³	8.4×10 ⁴
Ba-133m	10	270	0.9	24.3	2.2×10 ⁴	6.1×10 ⁵	6.1×10 ⁵
Ba-133	3	81.1	3	81.1	9.4	2.6×10 ²	2.6×10 ²
Ba-140	0.4	10.8	0.4	10.8	2.7×10 ³	7.3×10 ⁴	7.3×10 ⁴
Be-7	Beryllium(4)	20	541	20	541	1.3×10 ⁴	3.5×10 ⁵
Be-10	20	541	0.5	13.5	8.3×10 ⁻⁴	2.2×10 ⁻²	2.2×10 ⁻²
Bi-205	Bismuth(83)	0.6	16.2	0.6	16.2	1.5×10 ³	4.2×10 ⁴
Bi-206	0.3	8.11	0.3	8.11	3.8×10 ³	1.0×10 ⁵	1.0×10 ⁵
Bi-207	0.7	18.9	0.7	18.9	1.9	5.2×10 ¹	5.2×10 ¹
Bi-210m ...	0.3	8.11	3×10 ⁻²	0.811	2.1×10 ⁻⁵	5.7×10 ⁻⁴	5.7×10 ⁻⁴
Bi-210	0.6	16.2	0.5	13.5	4.6×10 ³	1.2×10 ⁵	1.2×10 ⁵
Bi-212	0.3	8.11	0.3	8.11	5.4×10 ⁵	1.5×10 ⁷	1.5×10 ⁷
Bk-247	Berkelium(97)	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	3.8×10 ⁻²	1.0
Bk-249	40	1080	8×10 ⁻²	2.16	6.1×10 ¹	1.6×10 ³	1.6×10 ³
Br-76	Bromine(35)	0.3	8.11	0.3	8.11	9.4×10 ⁴	2.5×10 ⁶
Br-77	3	81.1	3	81.1	2.6×10 ⁴	7.1×10 ⁵	7.1×10 ⁵

Symbol of radio-nuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Br-82	.....	0.4	10.8	0.4	10.8	4.0×10 ⁴	1.1×10 ⁶
C-11	Carbon(6)	1	27	0.5	13.5	3.1×10 ⁷	8.4×10 ⁸
C-14	.....	40	1080	2	54.1	1.6×10 ⁻¹	4.5
Ca-41	Calcium(20)	40	1080	40	1080	3.1×10 ⁻³	8.5×10 ⁻²
Ca-45	.....	40	1080	0.9	24.3	6.6×10 ²	1.8×10 ⁴
Ca-47	.....	0.9	24.3	0.5	13.5	2.3×10 ⁴	6.1×10 ⁵
Cd-109	Cadmium(48)	40	1080	1	27.0	9.6×10 ¹	2.6×10 ³
Cd-113m	.....	20	541	9×10 ⁻²	2.43	8.3×10 ⁴	2.2×10 ²
Cd-115m	.....	0.3	8.11	0.3	8.11	9.4×10 ²	2.5×10 ⁴
Cd-115	.....	4	108	0.5	13.5	1.9×10 ⁴	5.1×10 ⁵
Ce-139	Cerium(58)	6	162	6	162	2.5×10 ²⁶	.8×10 ⁵
Ce-141	.....	10	270	0.5	13.5	1.1×10 ³	2.8×10 ⁴
Ce-143	.....	0.6	16.2	0.5	13.5	2.5×10 ⁴	6.6×10 ⁵
Ce-144	.....	0.2	5.41	0.2	5.41	1.2×10 ²	3.2×10 ³
Cf-248	Californium (98)	30	811	3×10 ⁻³	8.11×10 ⁻²	5.8×10 ¹	1.6×10 ³
Cf-249	.....	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	1.5×10 ⁻¹	4.1
Cf-250	.....	5	135	5×10 ⁻⁴	1.35×10 ⁻²	4.0	1.1×10 ²
Cf-251	.....	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	5.9×10 ⁻²	1.6
Cf-252	.....	0.1	2.70	1×10 ⁻³	2.70×10 ⁻²	2.0×10 ¹	5.4×10 ²
Cf-253	.....	40	1080	6×10 ⁻²	1.62	1.1×10 ³	2.9×10 ⁴
Cf-254	.....	3×10 ⁻³	8.11×10 ⁻²	6×10 ⁻⁴	1.62×10 ⁻²	3.1×10 ²	8.5×10 ³
Cl-36	Chlorine (17)	20	541	0.5	13.5	1.2×10 ⁻³	3.3×10 ⁻²
Cl-38	.....	0.2	5.41	0.2	5.41	4.9×10 ⁶	1.3×10 ⁸
Cm-240	Curium(96)	40	1080	2×10 ⁻²	0.541	7.5×10 ²	2.0×10 ⁴
Cm-241	.....	2	54.1	0.9	24.3	6.1×10 ²	1.7×10 ⁴
Cm-242	.....	40	1080	1×10 ⁻²	0.270	1.2×10 ²	3.3×10 ³
Cm-243	.....	3	81.1	3×10 ⁻⁴	8.11×10 ⁻³	1.9	5.2×10 ¹
Cm-244	.....	4	108	4×10 ⁻⁴	1.08×10 ⁻²	3.0	8.1×10 ¹
Cm-245	.....	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	6.4×10 ⁻³	1.7×10 ⁻¹
Cm-246	.....	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	1.1×10 ⁻²	3.1×10 ⁻¹
Cm-247	.....	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	3.4×10 ⁻⁶	9.3×10 ⁻⁵
Cm-248	.....	4×10 ⁻²	1.08	5×10 ⁻⁵	1.35×10 ⁻³	1.6×10 ⁻⁴	4.2×10 ⁻³
Co-55	Cobalt(27)	0.5	13.5	0.5	13.5	1.1×10 ⁵	3.1×10 ⁶
Co-56	.....	0.3	8.11	0.3	8.11	1.1×10 ³	3.0×10 ⁴
Co-57	.....	8	216	8	216	3.1×10 ²	8.4×10 ³
Co-58m	.....	40	1080	40	1080	2.2×10 ⁵	5.9×10 ⁶
Co-58	.....	1	27.0	1	27.0	1.2×10 ³	3.2×10 ⁴
Co-60	.....	0.4	10.8	0.4	10.8	4.2×10 ¹	1.1×10 ³
Cr-51	Chromium(24)	30	811	30	811	3.4×10 ³	9.2×10 ⁴
Cs-129	Cesium(55)	4	108	4	108	2.8×10 ⁴	7.6×10 ⁵
Cs-131	.....	40	1080	40	1080	3.8×10 ³	1.0×10 ⁵
Cs-132	.....	1	27.0	1	27.0	5.7×10 ³	1.5×10 ⁵
Cs-134m	.....	40	1080	9	243	3.0×10 ⁵	8.0×10 ⁶
Cs-134	.....	0.6	16.2	0.5	13.5	4.8×10 ¹	1.3×10 ³
Cs-135	.....	40	1080	0.9	24.3	4.3×10 ⁻⁵	1.2×10 ⁻³
Cs-136	.....	0.5	13.5	0.5	13.5	2.7×10 ³	7.3×10 ⁴
Cs-137	.....	2	54.1	0.5	13.5	3.2	8.7×10 ¹
Cu-64	Copper(29)	5	135	0.9	24.3	1.4×10 ⁵	3.9×10 ⁶
Cu-67	.....	9	243	0.9	24.3	2.8×10 ⁴	7.6×10 ⁵
Dy-159	Dysprosium(66)	20	541	20	541	2.1×10 ²	5.7×10 ³
Dy-165	.....	0.6	16.2	0.5	13.5	3.0×10 ⁵	8.2×10 ⁶
Dy-166	.....	0.3	8.11	0.3	8.11	8.6×10 ³	2.3×10 ⁵
Er-169	Erbium(68)	40	1080	0.9	24.3	3.1×10 ³	8.3×10 ⁴
Er-171	.....	0.6	16.2	0.5	13.5	9.0×10 ⁴	2.4×10 ⁶
Es-253	Einsteinium(99) ^a	200	5400	2.1×10 ⁻²	5.4×100 ⁻¹		
Es-254	.....	30	811	3×10 ⁻³	8.11×10 ⁻²		
Es-254m	.....	0.6	16.2	0.4	10.8		
Es-255	.....					
Eu-147	Europium(63)	2	54.1	2	54.1	1.4×10 ³	3.7×10 ⁴
Eu-148	.....	0.5	13.5	0.5	13.5	6.0×10 ²	1.6×10 ⁴
Eu-149	.....	20	541	20	541	3.5×10 ²	9.4×10 ³
Eu-150	.....	0.7	18.9	0.7	18.9	6.1×10 ⁴	1.6×10 ⁶
Eu-152m	.....	0.6	16.2	0.5	13.5	8.2×10 ⁴	2.2×10 ⁶
Eu-152	.....	0.9	24.3	0.9	24.3	6.5	1.8×10 ²
Eu-154	.....	0.8	21.6	0.5	13.5	9.8	2.6×10 ²
Eu-155	.....	20	541	2	54.1	1.8×10 ¹	4.9×10 ²
Eu-156	.....	0.6	16.2	0.5	13.5	2.0×10 ³	5.5×10 ⁴
F-18	Fluorine(9)	1	27.0	0.5	13.5	3.5×10 ⁶	9.5×10 ⁷
Fe-52	Iron(26)	0.2	5.41	0.2	5.41	2.7×10 ⁵	7.3×10 ⁶
Fe-55	.....	40	1080	40	1080	8.8×10 ¹	2.4×10 ³
Fe-59	.....	0.8	21.6	0.8	21.6	1.8×10 ³	5.0×10 ⁴
Fe-60	.....	40	1080	0.2	5.41	7.4×10 ⁻⁴	2.0×10 ⁻²

§ 173.435

49 CFR Ch. I (10–1–02 Edition)

Symbol of radio-nuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Fm-255 ...	Fermium(100) ^b ..	40	1080	0.8	21.6		
Fm-257 ...	.....	10	270	8×10 ⁻³	21.6×10 ⁻¹		
Ga-67 ...	Gallium(31)	6	162	6	162	2.2×10 ⁴	6.0×10 ⁵
Ga-68 .....	.....	0.3	8.11	0.3	8.11	1.5×10 ⁶	4.1×10 ⁷
Ga-72 .....	.....	0.4	10.8	0.4	10.8	1.1×10 ⁵	3.1×10 ⁶
Gd-146 ...	Gadolinium(64) ..	0.4	10.8	0.4	10.8	6.9×10 ²	1.9×10 ⁴
Gd-148 ...	.....	3	81.1	3×10 ⁻⁴	8.11×10 ⁻³	1.2	3.2×10 ¹
Gd-153 ...	.....	10	270	5	135	1.3×10 ²	3.5×10 ³
Gd-159 ...	.....	4	108	0.5	13.5	3.9×10 ⁴	1.1×10 ⁶
Ge-68	Germanium(32)	0.3	8.11	0.3	8.11	2.6×10 ²	7.1×10 ³
Ge-71 .....	.....	40	1080	40	1080	5.8×10 ³	1.6×10 ⁵
Ge-77 .....	.....	0.3	8.11	0.3	8.11	1.3×10 ⁵	3.6×10 ⁶
H-3	Hydrogen(1) SeeT-Tritium.						
Hf-172 ...	Hafnium(72)	0.5	13.5	0.3	8.11	4.1×10 ¹	1.1×10 ³
Hf-175 ...	.....	3	81.1	3	81.1	3.9×10 ²	1.1×10 ⁴
Hf-181 ...	.....	2	54.1	0.9	24.3	6.3×10 ²	1.7×10 ⁴
Hf-182 ...	.....	4	108	3×10 ⁻²	0.811	8.1×10 ⁻⁶	2.2×10 ⁻⁴
Hg-194 ...	Mercury(80)	1	27.0	1	27.0	1.3×10 ⁻¹	3.5
Hg-195m ..	.....	5	135	5	135	1.5×10 ⁴	4.0×10 ⁵
Hg-197m ..	.....	10	270	0.9	24.3	2.5×10 ⁴	6.7×10 ⁵
Hg-197 ...	.....	10	270	10	270	9.2×10 ³	2.5×10 ⁵
Hg-203 ...	.....	4	108	0.9	24.3	5.1×10 ²	1.4×10 ⁴
Ho-163 ...	Holmium(67)	40	1080	40	1080	2.7	7.6×10 ¹
Ho-166m ..	.....	0.6	16.2	0.3	8.11	6.6×10 ⁻²	1.8
Ho-166 ...	.....	0.3	8.11	0.3	8.11	2.6×10 ⁴	7.0×10 ⁵
I-123	Iodine(53)	6	162	6	162	7.1×10 ⁴	1.9×10 ⁶
I-124 .....	.....	0.9	24.3	0.9	24.3	9.3×10 ³	2.5×10 ⁵
I-125 .....	.....	20	541	2	54.1	6.4×10 ²	1.7×10 ⁴
I-126 .....	.....	2	54.1	0.9	24.3	2.9×10 ³	8.0×10 ⁴
I-129 .....	.....	Unlimited	Unlimited	Unlimited	Unlimited	6.5×10 ⁻⁶	1.8×10 ⁻⁴
I-131 .....	.....	3	81.1	0.5	13.5	4.6×10 ³	1.2×10 ⁵
I-132 .....	.....	0.4	10.8	0.4	10.8	3.8×10 ⁵	1.0×10 ⁷
I-133 .....	.....	0.6	16.2	0.5	13.5	4.2×10 ⁴	1.1×10 ⁶
I-134 .....	.....	0.3	8.11	0.3	8.11	9.9×10 ⁵	2.7×10 ⁷
I-135 .....	.....	0.6	16.2	0.5	13.5	1.3×10 ⁵	3.5×10 ⁶
In-111	Indium(49)	2	54.1	2	54.1	1.5×10 ⁴	4.2×10 ⁵
In-113m ...	.....	4	108	4	108	6.2×10 ⁵	1.7×10 ⁷
In-114m ...	.....	0.3	8.11	0.3	8.11	8.6×10 ²	2.3×10 ⁴
In-115m ...	.....	6	162	0.9	24.3	2.2×10 ⁵	6.1×10 ⁶
Ir-189 ...	Iridium(77)	10	270	10	270	1.9×10 ³	5.2×10 ⁴
Ir-190 ...	.....	0.7	18.9	0.7	18.9	2.3×10 ³	6.2×10 ⁴
Ir-192 ...	.....	1	27.0	0.5	13.5	3.4×10 ²	9.2×10 ³
Ir-193m ...	.....	10	270	10	270	2.4×10 ³	6.4×10 ⁴
Ir-194 ...	.....	0.2	5.41	0.2	5.41	3.1×10 ⁴	8.4×10 ⁵
K-40	Potassium(19) ...	0.6	16.2	0.6	16.2	2.4×10 ⁻⁷	6.4×10 ⁻⁶
K-42 .....	.....	0.2	5.41	0.2	5.41	2.2×10 ⁵	6.0×10 ⁶
K-43 .....	.....	1.0	27.0	0.5	13.5	1.2×10 ⁵	3.3×10 ⁶
Kr-81	Krypton(36)	40	1080	40	1080	7.8×10 ⁻⁴	2.1×10 ⁻²
Kr-85m ...	.....	6	162	6	162	3.0×10 ⁵	8.2×10 ⁶
Kr-85 .....	.....	20	541	10	270	1.5×10 ¹	3.9×10 ²
Kr-87 .....	.....	0.2	5.41	0.2	5.41	1.0×10 ⁶	2.8×10 ⁷
La-137 ...	Lanthanum(57) ..	40	1080	2	54.1	1.6×10 ⁻³	4.4×10 ⁻²
La-140 ...	.....	0.4	10.8	0.4	10.8	2.1×10 ⁴	5.6×10 ⁵
Lu-172 ...	Lutetium(71)	0.5	13.5	0.5	13.5	4.2×10 ³	1.1×10 ⁵
Lu-173 ...	.....	8	216	8	216	5.6×10 ¹	1.5×10 ³
Lu-174m ..	.....	20	541	8	216	2.0×10 ²	5.3×10 ³
Lu-74 .....	.....	8	216	4	108	2.3×10 ¹	6.2×10 ²
Lu-177 ...	.....	30	811	0.9	24.3	4.1×10 ³	1.1×10 ⁵
MFP .....	.....	(see § 173.433)		(see § 173.433)			
Mg-28	Magnesium(12)	0.2	5.41	0.2	5.41	2.0×10 ⁵	5.4×10 ⁶
Mn-52	Manganese(25)	0.3	8.11	0.3	8.11	1.6×10 ⁴	4.4×10 ⁵
Mn-53 .....	.....	Unlimited	Unlimited	Unlimited	Unlimited	6.8×10 ⁻⁵	1.8×10 ⁻³
Mn-54 .....	.....	1	27.0	1	27.0	2.9×10 ²	7.7×10 ³
Mn-56 .....	.....	0.2	5.41	0.2	5.41	8.0×10 ⁵	2.2×10 ⁷
Mo-93	Molybdenum(42)	40	1080	7	189	4.1×10 ⁻²	1.1
Mo-99 .....	.....	0.6	16.2	0.5	13.5 ^c	1.8×10 ⁴	4.8×10 ⁵
N-13	Nitrogen(7)	0.6	16.2	0.5	13.5	5.4×10 ⁷	1.5×10 ⁹
Na-22	Sodium(11)	0.5	13.5	0.5	13.5	2.3×10 ²	6.3×10 ³
Na-24	0.2	5.41	0.2	5.41	3.2×10 ⁵	8.7×10 ⁶
Nb-92m ...	Niobium(41)	0.7	18.9	0.7	18.9	5.2×10 ³	1.4×10 ⁵

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						(TBq/g)	(Ci/g)
Nb-93m ...		40	1080	6	162	8.8	2.4×10 ²
Nb-94		0.6	16.2	0.6	16.2	6.9×10 ⁻³	1.9×10 ⁻¹
Nb-95		1	27.0	1	27.0	1.5×10 ³	3.9×10 ⁴
Nb-97		0.6	16.2	0.5	13.5	9.9×10 ⁵	2.7×10 ⁷
Nd-147	Neodymium(60)	4	108	0.5	13.5	3.0×10 ³	8.1×10 ⁴
Nd-149		0.6	16.2	0.5	13.5	4.5×10 ⁵	1.2×10 ⁷
Ni-59	Nickel(28)	40	1080	40	1080	3.0×10 ⁻³	8.0×10 ⁻²
Ni-63		40	1080	30	811	2.1	5.7×10 ¹
Ni-65		0.3	8.11	0.3	8.11	7.1×10 ⁵	1.9×10 ⁷
Np-235	Neptunium(93) ..	40	1080	40	1080	5.2×10 ¹	1.4×10 ³
Np-236		7	189	1×10 ⁻³	2.70×10 ⁻²	4.7×10 ⁻⁴	1.3×10 ⁻²
Np-237		2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	2.6×10 ⁻⁵	7.1×10 ⁻⁴
Np-239		6	162	0.5	13.5	8.6×10 ³	2.3×10 ⁵
Os-185	Osmium(76)	1	27.0	1	27.0	2.8×10 ²	7.5×10 ³
Os-191m ...		40	1080	40	1080	4.6×10 ⁴	1.3×10 ⁶
Os-191		10	270	0.9	24.3	1.6×10 ³	4.4×10 ⁴
Os-193		0.6	16.2	0.5	13.5	2.0×10 ⁴	5.3×10 ⁵
Os-194		0.2	5.41	0.2	5.41	1.1×10 ¹	3.1×10 ²
P-32	Phosphorus(15)	0.3	8.11	0.3	8.11	1.1×10 ⁴	2.9×10 ⁵
P-33		40	1080	0.9	24.3	5.8×10 ³	1.6×10 ⁵
Pa-230	Protactinium(91)	2	54.1	0.1	2.70	1.2×10 ³	3.3×10 ⁴
Pa-231		0.6	16.2	6×10 ⁻⁵	1.62×10 ⁻³	1.7×10 ⁻³	4.7×10 ⁻²
Pa-233		5	135	0.9	24.3	7.7×10 ²	2.1×10 ⁴
Pb-201	Lead(82)	1	27.0	1	27.0	6.2×10 ⁴	1.7×10 ⁶
Pb-202		40	1080	2	54.1	1.2×10 ⁻⁴	3.4×10 ⁻³
Pb-203		3	81.1	3	81.1	1.1×10 ⁴	3.0×10 ⁵
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5×10 ⁻⁶	1.2×10 ⁻⁴
Pb-210		0.6	16.2	9×10 ⁻³	0.243	2.8	7.6×10 ¹
Pb-212		0.3	8.11	0.3	8.11	5.1×10 ⁴	1.4×10 ⁶
Pd-103	Palladium(46)	40	1080	40	1080	2.8×10 ³	7.5×10 ⁴
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9×10 ⁻⁵	5.1×10 ⁻⁴
Pd-109		0.6	16.2	0.5	13.5	7.9×10 ⁴	2.1×10 ⁶
Pm-143	Promethium(61)	3	81.1	3	81.1	1.3×10 ²	3.4×10 ³
Pm-144		0.6	16.2	0.6	16.2	9.2×10 ¹	2.5×10 ³
Pm-145		30	811	7	189	5.2	1.4×10 ²
Pm-147		40	1080	0.9	24.3	3.4×10 ¹	9.3×10 ²
Pm-148m ...		0.5	13.5	0.5	13.5	7.9×10 ²	2.1×10 ⁴
Pm-149		0.6	16.2	0.5	13.5	1.5×10 ⁴	4.0×10 ⁵
Pm-151		3	81.1	0.5	13.5	2.7×10 ⁴	7.3×10 ⁵
Po-208	Polonium(84)	40	1080	2×10 ⁻²	0.541	2.2×10 ¹	5.9×10 ²
Po-209		40	1080	2×10 ⁻²	0.541	6.2×10 ⁻¹	1.7×10 ¹
Po-210		40	1080	2×10 ⁻²	0.541	1.7×10 ²	4.5×10 ³
Pr-142	Praseodymium (59).	0.2	5.41	0.2	5.41	4.3×10 ⁴	1.2×10 ⁶
Pr-143		4	108	0.5	13.5	2.5×10 ³	6.7×10 ⁴
Pt-188	Platinum(78)	0.6	16.2	0.6	16.2	2.5×10 ³	6.8×10 ⁴
Pt-191		3	81.1	3	81.1	8.7×10 ³	2.4×10 ⁵
Pt-193m ..		40	1080	9	243	5.8×10 ³	1.6×10 ⁵
Pt-193		40	1080	40	1080	1.4	3.7×10 ¹
Pt-195m ..		10	270	2	54.1	6.2×10 ³	1.7×10 ⁵
Pt-197m ..		10	270	0.9	24.3	3.7×10 ⁵	1.0×10 ⁷
Pt-197		20	541	0.5	13.5	3.2×10 ⁴	8.7×10 ⁵
Pu-236	Plutonium(94)	7	189	7×10 ⁻⁴	1.89×10 ⁻²	2.0×10 ¹	5.3×10 ²
Pu-237		20	541	20	541	4.5×10 ²	1.2×10 ⁴
Pu-238		2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	6.3×10 ⁻¹	1.7×10 ¹
Pu-239		2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	2.3×10 ⁻³	6.2×10 ⁻²
Pu-240		2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	8.4×10 ⁻³	2.3×10 ⁻¹
Pu-241		40	1080	1×10 ⁻²	0.270	3.8	1.0×10 ²
Pu-242		2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	1.5×10 ⁻⁴	3.9×10 ⁻³
Pu-244		0.3	8.11	2×10 ⁻⁴	5.41×10 ⁻³	6.7×10 ⁻⁷	1.8×10 ⁻⁵
Ra-223	Radium(88)	0.6	16.2	3×10 ⁻²	0.811	1.9×10 ³	5.1×10 ⁴
Ra-224		0.3	8.11	6×10 ⁻²	1.62	5.9×10 ³	1.6×10 ⁵
Ra-225		0.6	16.2	2×10 ⁻²	0.541	1.5×10 ³	3.9×10 ⁴
Ra-226		0.3	8.11	2×10 ⁻²	0.541	3.7×10 ⁻²	1.0
Ra-228		0.6	16.2	4×10 ⁻²	1.08	1.0×10 ¹	2.7×10 ²
Rb-81	Rubidium(37)	2	54.1	0.9	24.3	3.1×10 ⁵	8.4×10 ⁶
Rb-83		2	54.1	2	54.1	6.8×10 ²	1.8×10 ⁴
Rb-84		1	27.0	0.9	24.3	1.8×10 ³	4.7×10 ⁴
Rb-86		0.3	8.11	0.3	8.11	3.0×10 ³	8.1×10 ⁴
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2×10 ⁻⁹	8.6×10 ⁻⁸
Rb (natural).		Unlimited	Unlimited	Unlimited	Unlimited	6.7×10 ⁶	1.8×10 ⁸

Symbol of radio-nuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Re-183	Rhenium(75)	5	135	5	135	3.8×10 ²	1.0×10 ⁴
Re-184m		3	81.1	3	81.1	1.6×10 ²	4.3×10 ³
Re-184		1	27.0	1	27.0	6.9×10 ²	1.9×10 ⁴
Re-186		4	108	0.5	13.5	6.9×10 ³	1.9×10 ⁵
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4×10 ⁻⁹	3.8×10 ⁻⁸
Re-188		0.2	5.41	0.2	5.41	3.6×10 ⁴	9.8×10 ⁵
Re-189		4	108	0.5	13.5	2.5×10 ⁴	6.8×10 ⁵
Re (natural)		Unlimited	Unlimited	Unlimited	Unlimited	—	2.4×10 ⁸
Rh-99	Rhodium(45)	2	54.1	2	54.1	3.0×10 ³	8.2×10 ⁴
Rh-101		4	108	4	108	4.1×10 ¹	1.1×10 ³
Rh-102m		2	54.1	0.9	24.3	2.3×10 ²	6.2×10 ³
Rh-102		0.5	13.5	0.5	13.5	4.5×10 ¹	1.2×10 ³
Rh-103m		40	1080	40	1080	1.2×10 ⁶	3.3×10 ⁷
Rh-105		10	270	0.9	24.3	3.1×10 ⁴	8.4×10 ⁵
Rn-222	Radon(86)	0.2	5.41	4×10 ⁻³	0.108	5.7×10 ³	1.5×10 ⁵
Ru-97	Ruthenium(44)	4	108	4	108	1.7×10 ⁴	4.6×10 ⁵
Ru-103		2	54.1	0.9	24.3	1.2×10 ³	3.2×10 ⁴
Ru-105		0.6	16.2	0.5	13.5	2.5×10 ⁵	6.7×10 ⁶
Ru-106		0.2	5.41	0.2	5.41	1.2×10 ²	3.3×10 ³
S-35	Sulfur(16)	40	1080	2	54.1	1.6×10 ³	4.3×10 ⁴
Sb-122	Antimony(51)	0.3	8.11	0.3	8.11	1.5×10 ⁴	4.0×10 ⁵
Sb-124		0.6	16.2	0.5	13.5	6.5×10 ²	1.7×10 ⁴
Sb-125		2	54.1	0.9	24.3	3.9×10 ¹	1.0×10 ³
Sb-126		0.4	10.8	0.4	10.8	3.1×10 ³	8.4×10 ⁴
Sc-44	Scandium(21)	0.5	13.5	0.5	13.5	6.7×10 ⁵	1.8×10 ⁷
Sc-46		0.5	13.5	0.5	13.5	1.3×10 ³	3.4×10 ⁴
Sc-47		9	243	0.9	24.3	3.1×10 ⁴	8.3×10 ⁵
Sc-48		0.3	8.11	0.3	8.11	5.5×10 ⁴	1.5×10 ⁶
Se-75	Selenium(34)	3	81.1	3	81.1	5.4×10 ²	1.5×10 ⁴
Se-79		40	1080	2	54.1	2.6×10 ⁻³	7.0×10 ⁻²
Si-31	Silicon(14)	0.6	16.2	0.5	13.5	1.4×10 ⁶	3.9×10 ⁷
Si-32		40	1080	0.2	5.41	3.9	1.1×10 ²
Sm-145	Samarium(62)	20	541	20	541	9.8×10 ¹	2.610 ³
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5×10 ⁻¹⁰	2.3×10 ⁻⁸
Sm-151		40	1080	4	108	9.7×10 ⁻¹	2.6×10 ¹
Sm-153		4	108	0.5	13.5	1.6×10 ⁴	4.4×10 ⁵
Sn-113	Tin(50)	4	108	4	108	3.7×10 ²	1.0×10 ⁴
Sn-117m		6	162	2	54.1	3.0×10 ³	8.2×10 ⁴
Sn-119m		40	1080	40	1080	1.4×10 ²	3.7×10 ³
Sn-121m		40	1080	0.9	24.3	2.0	5.4×10 ¹
Sn-123		0.6	16.2	0.5	13.5	3.0×10 ²	8.2×10 ³
Sn-125		0.2	5.41	0.2	5.41	4.0×10 ³	1.1×10 ⁵
Sn-126		0.3	8.11	0.3	8.11	1.0×10 ⁻³	2.8×10 ⁻²
Sr-82	Strontium(38)	0.2	5.41	0.2	5.41	2.3×10 ³	6.2×10 ⁴
Sr-85m		5	135	5	135	1.2×10 ⁶	3.3×10 ⁷
Sr-85		2	54.1	2	54.1	8.8×10 ²	2.4×10 ⁴
Sr-87m		3	81.1	3	81.1	4.8×10 ⁵	1.3×10 ⁷
Sr-89		0.6	16.2	0.5	13.5	1.1×10 ³	2.9×10 ⁴
Sr-90		0.2	5.41	0.1	2.70	5.1	1.4×10 ²
Sr-91		0.3	8.11	0.3	8.11	1.3×10 ⁵	3.6×10 ⁶
Sr-92		0.8	21.6	0.5	13.5	4.7×10 ⁵	1.3×10 ⁷
T	Tritium(1)	40	1080	40	1080	3.6×10 ²	9.7×10 ³
Ta-178	Tantalum(73)	1	27.0	1	27.0	4.2×10 ⁶	1.1×10 ⁸
Ta-179		30	811	30	811	4.1×10 ¹	1.1×10 ³
Ta-182		0.8	21.6	0.5	13.5	2.3×10 ²	6.2×10 ³
Tb-157	Terbium(65)	40	1080	10	270	5.6×10 ⁻¹	1.5×10 ¹
Tb-158		1	27.0	0.7	18.9	5.6×10 ⁻¹	1.5×10 ¹
Tb-160		0.9	24.3	0.5	13.5	4.2×10 ²	1.1×10 ⁴
Tc-95m	Technetium(43)	2	54.1	2	54.1	8.3×10 ²	2.2×10 ⁴
Tc-96m		0.4	10.8	0.4	10.8	1.4×10 ⁶	3.8×10 ⁷
Tc-96		0.4	10.8	0.4	10.8	1.2×10 ⁴	3.2×10 ⁵
Tc-97m		40	1080	40	1080	5.6×10 ²	1.5×10 ⁴
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2×10 ⁻⁵	1.4×10 ⁻³
Tc-98		0.7	18.9	0.7	18.9	3.2×10 ⁻⁵	8.7×10 ⁻⁴
Tc-99m		8	216	8	216	1.9×10 ⁵	5.3×10 ⁶
Tc-99		40	1080	0.9	24.3	6.3×10 ⁻⁴	1.7×10 ⁻²
Te-118	Tellurium(52)	0.2	5.41	0.2	5.41	6.8×10 ³	1.8×10 ⁵
Te-121m		5	135	5	135	2.6×10 ²	7.0×10 ³
Te-121		2	54.1	2	54.1	2.4×10 ³	6.4×10 ⁴
Te-123m		7	189	7	189	3.3×10 ²	8.9×10 ³
Te-125m		30	811	9	243	6.7×10 ²	1.8×10 ⁴

Symbol of radio-nuclide	Element and atomic number	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific activity	
						(TBq/g)	(Ci/g)
Te-127m	20	541	0.5	13.5	3.5×10 ²	9.4×10 ³
Te-127	20	541	0.5	13.5	9.8×10 ⁴	2.6×10 ⁶
Te-129m	0.6	16.2	0.5	13.5	1.1×10 ³	3.0×10 ⁴
Te-129	0.6	16.2	0.5	13.5	7.7×10 ⁵	2.1×10 ⁷
Te-131m	0.7	18.9	0.5	13.5	3.0×10 ⁴	8.0×10 ⁵
Te-132	0.4	10.8	0.4	10.8	1.1×10 ⁴	3.0×10 ⁵
Th-227	Thorium(90)	9	243	1×10 ⁻²	0.270	1.1×10 ³	3.1×10 ⁴
Th-228	0.3	8.11	4×10 ⁻⁴	1.08×10 ⁻²	3.0×10 ¹	8.2×10 ²
Th-229	0.3	8.11	3×10 ⁻⁵	8.11×10 ⁻⁴	7.9×10 ⁻³	2.1×10 ⁻¹
Th-230	2	54.1	2×10 ⁻⁴	5.41×10 ⁻³	7.6×10 ⁻⁴	2.1×10 ⁻²
Th-231	40	1080	0.9	24.3	2.0×10 ⁴	5.3×10 ⁵
Th-232	Unlimited	Unlimited	Unlimited	Unlimited	4.0×10 ⁻⁹	1.1×10 ⁻⁷
Th-234	0.2	5.41	0.2	5.41	8.6×10 ²	2.3×10 ⁴
Th (natural)	Unlimited	Unlimited	Unlimited	Unlimited	8.1×10 ⁻⁹	2.2×10 ⁻⁷
Ti-44	Titanium(22)	0.5	13.5	0.2	5.41	6.4	1.7×10 ²
Tl-200	Thallium(81.1) ...	0.8	21.6	0.8	21.6	2.2×10 ⁴	6.0×10 ⁵
Tl-201	10	270	10	270	7.9×10 ³	2.1×10 ⁵
Tl-202	2	54.1	2	54.1	2.0×10 ³	5.3×10 ⁴
Tl-204	4	108	0.5	13.5	1.7×10 ¹	4.6×10 ²
Tm-167	Thulium(69)	7	189	7	189	3.1×10 ³	8.5×10 ⁴
Tm-168	0.8	21.6	0.8	21.6	3.1×10 ²	8.3×10 ³
Tm-170	4	108	0.5	13.5	2.2×10 ²	6.0×10 ³
Tm-171	40	1080	10	270	4.0×10 ¹	1.1×10 ³
U-230	Uranium(92)	40	1080	1×10 ⁻²	0.270	1.0×10 ³	2.7×10 ⁴
U-232	3	81.1	3×10 ⁻⁴	8.11×10 ⁻³	8.3×10 ⁻¹	2.2×10 ¹
U-233	10	270	1×10 ⁻³	2.70×10 ⁻²	3.6×10 ⁻⁴	9.7×10 ⁻³
U-234	10	270	1×10 ⁻³	2.70×10 ⁻²	2.3×10 ⁻⁴	6.2×10 ⁻³
U-235	Unlimited	Unlimited	Unlimited	Unlimited	8.0×10 ⁻⁸	2.2×10 ⁻⁶
U-236	10	270	1×10 ⁻³	2.70×10 ⁻²	2.4×10 ⁻⁶	6.5×10 ⁻⁵
U-238	Unlimited	Unlimited	Unlimited	Unlimited	1.2×10 ⁻⁸	3.4×10 ⁻⁷
U (natural)	Unlimited	Unlimited	Unlimited	Unlimited	2.6×10 ⁻⁸	7.1×10 ⁻⁷
U (enriched 5% or less)	Unlimited	Unlimited	Unlimited	Unlimited	—	(see § 173.434)
U (enriched more than 5%)	10	270	1×10 ⁻³	2.70×10 ⁻²	—	(see § 173.434)
U (depleted)	Unlimited	Unlimited	Unlimited	Unlimited	—	(see § 173.434)
V-48	Vanadium(23)	0.3	8.11	0.3	8.11	6.3×10 ³	1.7×10 ⁵
V-49	40	1080	40	1080	3.0×10 ²	8.1×10 ³
W-178	Tungsten(74)	1	27.0	1	27.0	1.3×10 ⁻³	3.4×10 ⁴
W-181	30	811	30	811	2.2×10 ²	6.0×10 ³
W-185	40	1080	0.9	24.3	3.5×10 ²	9.4×10 ³
W-187	2	54.1	0.5	13.5	2.6×10 ⁴	7.0×10 ⁵
W-188	0.2	5.41	0.2	5.41	3.7×10 ²	1.0×10 ⁴
Xe-122	Xenon(54)	0.2	5.41	0.2	5.41	4.8×10 ⁴	1.3×10 ⁶
Xe-123	0.2	5.41	0.2	5.41	4.4×10 ⁵	1.2×10 ⁷
Xe-127	4	108	4	108	1.0×10 ³	2.8×10 ⁴
Xe-131m	40	1080	40	1080	3.1×10 ³	8.4×10 ⁴
Xe-133	20	541	20	541	6.9×10 ³	1.9×10 ⁵
Xe-135	4	108	4	108	9.5×10 ⁴	2.6×10 ⁶
Y-87	Yttrium(39)	2	54.1	2	54.1	1.7×10 ⁴	4.5×10 ⁵
Y-88	0.4	10.8	0.4	10.8	5.2×10 ²	1.4×10 ⁴
Y-90	0.2	5.41	0.2	5.41	2.0×10 ⁴	5.4×10 ⁵
Y-91m	2	54.1	2	54.1	1.5×10 ⁶	4.2×10 ⁷
Y-91	0.3	8.11	0.3	8.11	9.1×10 ²	2.5×10 ⁴
Y-92	0.2	5.41	0.2	5.41	3.6×10 ⁵	9.6×10 ⁶
Y-93	0.2	5.41	0.2	5.41	1.2×10 ⁵	3.3×10 ⁶
Yb-169	Ytterbium(70)	3	81.1	3	81.1	8.9×10 ²	2.4×10 ⁴
Yb-175	30	811	0.9	24.3	6.6×10 ³	1.8×10 ⁵
Zn-65	Zinc(30)	2	54.1	2	54.1	3.0×10 ²	8.2×10 ³
Zn-69m	2	54.1	0.5	13.5	1.2×10 ⁵	3.3×10 ⁶
Zn-69	4	108	0.5	13.5	1.8×10 ⁶	4.9×10 ⁷
Zr-88	Zirconium(40)	3	81.1	3	81.1	6.6×10 ²	1.8×10 ⁴
Zr-93	40	1080	0.2	5.41	9.3×10 ⁻⁵	2.5×10 ⁻³
Zr-95	1	27.0	0.9	24.3	7.9×10 ²	2.1×10 ⁴
Zr-97	0.3	8.11	0.3	8.11	7.1×10 ⁴	1.9×10 ⁶

^aInternational shipments of Einsteinium require multilateral approval of A₁ and A₂ values.

^b International shipments of Fermium require multilateral approval of A₁ and A₂ values.

^c 20 Ci for Mo⁹⁹ for domestic use.

MFP: For mixed fission products, use formula for mixtures or table 10 in § 173.433.

Note: The activity per gram of radionuclide quantities are technical information that might not provide a direct relationship between the activity and total mass of material contained in a package.

[Amdt. 173–244, 60 FR 50307, Sept. 28, 1995, as amended by Amdt. 173–244, 61 FR 20752, May 8, 1996; Amdt. 173–253, 61 FR 27175, May 30, 1996; 65 FR 58630, Sept. 29, 2000; 66 FR 45184, Aug. 28, 2001]

§ 173.441 Radiation level limitations.

(a) Except as provided in paragraph (b) of this section, each package of Class 7 (radioactive) materials offered for transportation must be designed and prepared for shipment, so that under conditions normally incident to transportation, the radiation level does not exceed 2 mSv/hour (200 mrem/hour) at any point on the external surface of the package, and the transport index does not exceed 10.

(b) A package which exceeds the radiation level limits specified in paragraph (a) of this section must be transported by exclusive use shipment, and the radiation levels for such shipment may not exceed the following during transportation:

(1) 2 mSv/h (200 mrem/h) on the external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1000 mrem/h):

(i) The shipment is made in a closed transport vehicle;

(ii) The package is secured within the vehicle so that its position remains fixed during transportation; and

(iii) There are no loading or unloading operations between the beginning and end of the transportation;

(2) 2 mSv/h (200 mrem/h) at any point on the outer surfaces of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure if used, and on the lower external surface of the vehicle;

(3) 0.1 mSv/h (10 mrem/h) at any point 2 m (6.6 feet) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 m (6.6 feet) from the vertical planes projected by the outer

edges of the vehicle (excluding the top and underside of the vehicle); and

(4) 0.02 mSv/h (2mrem/h) in any normally occupied space, except that this provision does not apply to carriers if they operate under the provisions of a State or federally regulated radiation protection program and if personnel under their control who are in such an occupied space wear radiation dosimetry devices.

(c) For shipments made under the provisions of paragraph (b) of this section, the offeror shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions must be included with the shipping paper information. The instructions must be sufficient so that, when followed, they will cause the carrier to avoid actions that will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.

(d) Packages exceeding the radiation level or transport index prescribed in paragraph (a) of this section may not be transported by aircraft.

[Amdt. 173–244, 60 FR 50307, Sept. 28, 1995, as amended at 63 FR 48568, Sept. 10, 1998; 66 FR 45380, Aug. 28, 2001]

§ 173.442 Thermal limitations.

A package of Class 7 (radioactive) material must be designed, constructed, and loaded so that—

(a) The heat generated within the package by the radioactive contents will not, during conditions normally incident to transport, affect the integrity of the package; and

(b) The temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade at an ambient temperature of 38 °C (100 °F), exceed either—

(1) 50 °C (122 °F) in other than an exclusive use shipment; or