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Naturally-Occurring and Accelerator-Produced Radioactive Materials

Comment On: NRC-2017-0159-0002

Naturally Occurring and Accelerator-Produced Radioactive Materials; Petition for Rulemaking; Notice of Docketing and Request for Comment

Document: NRC-2017-0159-DRAFT-0005

Comment on FR Doc # 2017-17690

Submitter Information

Name: Catherine Ribaud

General Comment

Please find, attached, a response to this Request for Comment on behalf of the National Institutes of Health. Thank you.

Attachments

Comparison of 10CFR30 appB to 10CFR20

Comment Submission re OAS Petition Part 30 Appendix B



October 31, 2017

U.S. Nuclear Regulatory Commission
Office of Administration
Ms. Cindy Bladey
Mail Stop: OWFN-12-H08
Washington DC 20555-0001

Dear Ms. Bladey:

This is a submittal of comments following the NRC public request for comment on a petition for rulemaking by the Organization of Agreement States (Docket ID: NRC-2017-0159). Specific questions posed by the NRC have been addressed below:

1. What products or technologies, other than the germanium-68 generators cited in the petition, are being or could be negatively affected because the radioactive materials required for these products or technologies are not currently listed on the table in appendix B of 10 CFR part 30?

NIH staff compared radionuclides from appendix B of 10 CFR part 30 to appendix C of 10 CFR part 20 and discovered there are about 45 radionuclides with half-life > 120 days in appendix B of 10 CFR part 30 compared to about 150 in 10 CFR part 20. See attached spreadsheet. We believe appendix B of 10 CFR part 30 is an incomplete list that could negatively affect licensees. While we do not know a specific product or technology (other than the Ge-68 generators) to use as an example, this response is intended to serve as an overall indication that a negative impact to licensees could occur unwittingly, unless appendix B of 10 CFR part 30 is expanded. For example, a standard dose of 200 mCi Lu-177 is administered to clinical patients in the form of Lutathera. Despite being advertised as "just" 0.05% of the Lu-177 in Lutathera, Lu-177m is present in quantities of 100 uCi. This radioisotope is not listed in the part 30 table and is thus subject to 0.1 uCi constraint, presenting a waste disposal issue and a potential decommissioning concern; note that this quantity of Lu-177m exceeds even the part 20 value for this radionuclide. The attached spreadsheet highlights, for radionuclides with half-life > 120 days, the differing values between the two tables for the same radionuclide; both tables have identical titles, which implies some similarity of purpose.

2. Please provide specific examples of how the current NRC regulatory framework for decommissioning financial assurance has put an undue hardship on potential license applicants. Explain how this hardship has discouraged the development of beneficial new products, or otherwise imposed unnecessarily burdensome requirements on licensees or members of the public (e.g., users of medical diagnostic or therapeutic technologies) that depend on naturally-occurring or accelerator-produced radioactive materials (NARM).

NIH tends to agree with the petitioners that as a result of appendix B of 10 CFR part 30 being an incomplete list, licensees could face the additional administrative burden of requesting case-by-case exemptions for unlisted radionuclides, or an unnecessary high financial assurance burden caused by extremely low activity values for radionuclides not listed in appendix B of 10 CFR part 30.

3. Given NRC's current regulatory authority over the radiological safety and security of NARM, what factors should the NRC take into account in establishing possession limits for any of these materials that should be listed in appendix B of 10 CFR part 30?

NIH believes the NRC could use possession limits from appendix C of 10 CFR part 20 for use in appendix B of 10 CFR part 30 for radionuclides that require a decommissioning funding plan.

4. Does this petition raise other issues not addressed by the questions above about labelling or decommissioning financial assurance for radioactive materials? Must these issues be addressed by a rulemaking, or are there other regulatory solutions that NRC should consider?

NIH has no further issues or comments.

I hope the NRC finds these comments useful. If you have any questions or need additional clarification on our submittal, please contact me at 301-594-1303 or via e-mail at cribaudo@nih.gov.



Catherine Ribaldo
NIH Radiation Safety Officer

Attachment

cc: Dr. Bradford Wood, Chair, RSC, NIH

Appendix B to Part 30--Quantities1 of Licensed Material Requiring Labeling		Appendix C to Part 20: Quantities of Licensed Material Requiring Labeling		Ratio: Part 30/Part 20
Americium-241	0.01	Americium-241	0.001	10
Barium-133	10.00	Barium-133	100	0.1
Cadmium-109	10.00	Cadmium-109	1	10
Calcium-45	10.00	Calcium-45	100	0.1
Carbon-14	100.00	Carbon-14	100	1
Cerium-144	1.00	Cerium-144	1	1
Cesium-134	1.00	Cesium-134	10	0.1
Cesium-135	10.00	Cesium-135	100	0.1
Cesium-137	10.00	Cesium-137	10	1
Chlorine-36	10.00	Chlorine-36	10	1
Cobalt-60	1.00	Cobalt-60	1	1
Europium-152 (9.2h)	1.00	Europium-152	1	1
Europium-154	1.00	Europium-154	1	1
Europium-155	10.00	Europium-155	10	1
Gadolinium-153	10.00	Gadolinium-153	10	1
Hydrogen-3	1000.00	Hydrogen-3	1,000	1
Indium-115	10.00	Indium-115	100	0.1
Iodine-129	0.10	Iodine-129	1	0.1
Iron-55	100.00	Iron-55	100	1
Krypton-85	100.00	Krypton-85	1,000	0.1
Manganese-54	10.00	Manganese-54	100	0.1
Nickel-59	100.00	Nickel-59	100	1
Nickel-63	10.00	Nickel-63	100	0.1
Niobium-93m	10.00	Niobium-93m	10	1
Plutonium-239	0.01	Plutonium-239	0.001	10
Promethium-147	10.00	Promethium-147	10	1
Radium-226	0.01	Radium-226	0.1	0.1
Rubidium-87	10.00	Rubidium-87	100	0.1
Samarium-151	10.00	Samarium-151	10	1
Selenium-75	10.00	Selenium-75	100	0.1
Silver-110m	1.00	Silver-110m	10	0.1
Strontium-90	0.10	Strontium-90	0.1	1
Technetium-97	100.00	Technetium-97	1,000	0.1
Technetium-99	10.00	Technetium-99	100	0.1
Thallium-204	10.00	Thallium-204	100	0.1
Thorium (natural) ₁	100.00	Thorium-natural	100	1

Thulium-170	10.00	Thulium-170	10	1
Thulium-171	10.00	Thulium-171	10	1
Tungsten-181	10.00	Tungsten-181	1,000	0.01
Uranium (natural) ₂	100.00	Uranium-natural	100	1
Uranium-233	0.01	Uranium-233	0.001	10
Uranium-234--Uranium-235	0.01	Uranium-234	0.001	10
Uranium-234--Uranium-235	0.01	Uranium-235	0.001	10
Zinc-65	10.00	Zinc-65	10	1
Zirconium-93	10.00	Zirconium-93	1	10
		Actinium-227	0.001	0
		Aluminium-26	10	0
		Americium-242m	0.001	0
		Americium-243	0.001	0
		Antimony-125	100	0
		Argon-39	1,000	0
		Berkelium-247	0.001	0
		Berkelium-249	0.1	0
		Beryllium-10	1	0
		Bismuth-207	10	0
		Bismuth-210m	0.1	0
		Cadmium-113	100	0
		Cadmium-113m	0.1	0
		Calcium-41	100	0
		Californium-248	0.01	0
		Californium-249	0.001	0
		Californium-250	0.001	0
		Californium-251	0.001	0
		Californium-252	0.001	0
		Cobalt-57	100	0
		Curium-242	0.01	0
		Curium-243	0.001	0
		Curium-244	0.001	0
		Curium-245	0.001	0
		Curium-246	0.001	0
		Curium-247	0.001	0
		Curium-248	0.001	0
		Dysprosium-159	100	0
		Einsteinium-254	0.01	0
		Europium-150 (34.2y)	1	0
		Gadolinium-148	0.001	0

		Gadolinium-151	10	0
		Gadolinium-152	100	0
		Germanium-68	10	0
		Gold-195	10	0
		Hafnium-172	1	0
		Hafnium-178m	0.1	0
		Hafnium-182	0.1	0
		Holmium-166m	1	0
		Iridium-194m	10	0
		Iron-60	1	0
		Krypton-81	1,000	0
		Lanthanum-137	10	0
		Lanthanum-138	100	0
		Lead-202	10	0
		Lead-205	100	0
		Lead-210	0.01	0
		Lutetium-173	10	0
		Lutetium-174	10	0
		Lutetium-174m	10	0
		Lutetium-176	100	0
		Lutetium-177m	10	0
		Manganese-53	1,000	0
		Mercury-194	1	0
		Molybdenum-93	10	0
		Neptunium-236 (1.15x)	0.001	0
		Neptunium-236 (22.5h)	1	0
		Neptunium-237	0.001	0
		Niobium-94	1	0
		Osmium-194	1	0
		Palladium-107	10	0
		Platinum-193	1,000	0
		Plutonium-236	0.001	0
		Plutonium-238	0.001	0
		Plutonium-240	0.001	0
		Plutonium-241	0.01	0
		Plutonium-242	0.001	0
		Plutonium-244	0.001	0
		Potassium-40	100	0
		Promethium-143	100	0
		Promethium-144	10	0

Hydrogen-3	H-3	1,000
Actinium-224	Ac-224	1
Actinium-225	Ac-225	0.01
Actinium-226	Ac-226	0.1
Actinium-227	Ac-227	0.001
Actinium-228	Ac-228	1
Aluminum-26	Al-26	10
Americium-237	Am-237	1,000
Americium-238	Am-238	100
Americium-239	Am-239	1,000
Americium-240	Am-240	100
Americium-241	Am-241	0.001
Americium-242	Am-242	10
Americium-242m	Am-242m	0.001
Americium-243	Am-243	0.001
Americium-244	Am-244	10
Americium-244m	Am-244m	100
Americium-245	Am-245	1,000
Americium-246	Am-246	1,000
Americium-246m	Am-246	1,000
Antimony-115	Sb-115	1,000
Antimony-116	Sb-116	1,000
Antimony-116m	Sb-116m	1,000
Antimony-117	Sb-117	1,000
Antimony-118m	Sb-118m	1,000
Antimony-119	Sb-119	1,000
Antimony-120 (16 mi	Sb-120	1,000
Antimony-120 (5.76d	Sb-120	100
Antimony-122	Sb-122	100
Antimony-124	Sb-124	10
Antimony-124m	Sb-124m	1,000
Antimony-125	Sb-125	100
Antimony-126	Sb-126	100
Antimony-126m	Sb-126m	1,000
Antimony-127	Sb-127	100
Antimony-128 (10.4 r	Sb-128	1,000
Antimony-128 (9.01h	Sb-128	100
Antimony-129	Sb-129	100
Antimony-130	Sb-130	1,000
Antimony-131	Sb-131	1,000
Any alpha emitting radionuclide not listed		0.001
Any radionuclide other than alpha emitter		0.01
Argon-39	Ar-39	1,000
Argon-41	Ar-41	1,000
Arsenic-69	As-69	1,000
Arsenic-70	As-70	1,000
Arsenic-71	As-71	100
Arsenic-72	As-72	100
Arsenic-73	As-73	100

Arsenic-74	As-74	100
Arsenic-76	As-76	100
Arsenic-77	As-77	100
Arsenic-78	As-78	1,000
Astatine-207	At-207	100
Astatine-211	At-211	10
Barium-126	Ba-126	1,000
Barium-128	B-128	100
Barium-131	Ba-131	100
Barium-131m	Ba-131m	1,000
Barium-133	Ba-133	100
Barium-133m	Ba-133m	100
Barium-135m	Ba-135m	100
Barium-139	Ba-139	1,000
Barium-140	Ba-140	100
Barium-141	Ba-141	1,000
Barium-142	Ba-142	1,000
Berkelium-245	Bk-245	100
Berkelium-246	Bk-246	100
Berkelium-247	Bk-247	0.001
Berkelium-249	Bk-249	0.1
Berkelium-250	Bk-250	10
Beryllium-10	Be-10	1
Beryllium-7	Be-7	1,000
Bismuth-200	Bi-200	1,000
Bismuth-201	Bi-201	1,000
Bismuth-202	Bi-202	1,000
Bismuth-203	Bi-203	100
Bismuth-205	Bi-205	100
Bismuth-206	Bi-206	100
Bismuth-207	Bi-207	10
Bismuth-210	Bi-210	1
Bismuth-210m	Bi-210m	0.1
Bismuth-212	Bi-212	10
Bismuth-213	Bi-213	10
Bismuth-214	Bi-214	100
Bromine-74	Br-74	1,000
Bromine-74m	Br-74m	1,000
Bromine-75	Br-75	1,000
Bromine-76	Br-76	100
Bromine-77	Br-77	1,000
Bromine-80	Br-80	1,000
Bromine-80m	Br-80m	1,000
Bromine-82	Br-82	100
Bromine-83	Br-83	1,000
Bromine-84	Br-84	1,000
Cadmium-104	Cd-104	1,000
Cadmium-107	Cd-107	1,000
Cadmium-109	Cd-109	1

Cadmium-113	Cd-113	100
Cadmium-113m	Cd-113m	0.1
Cadmium-115	Cd-115	100
Cadmium-115m	Cd-115m	10
Cadmium-117	Cd-117	1,000
Cadmium-117m	Cd-117m	1,000
Calcium-41	Ca-41	100
Calcium-45	Ca-45	100
Calcium-47	Ca-47	100
Californium-244	Cf-244	100
Californium-246	Cf-246	1
Californium-248	Cf-248	0.01
Californium-249	Cf-249	0.001
Californium-250	Cf-250	0.001
Californium-251	Cf-251	0.001
Californium-252	Cf-252	0.001
Californium-253	Cf-253	0.1
Californium-254	Cf-254	0.001
Carbon-11	C-11	1,000
Carbon-14	C-14	100
Cerium-134	Ce-134	100
Cerium-135	Ce-135	100
Cerium-137	Ce-137	1,000
Cerium-137m	Ce-137m	100
Cerium-139	Ce-139	100
Cerium-141	Ce-141	100
Cerium-143	Ce-143	100
Cerium-144	Ce-144	1
Cesium-125	Cs-125	1,000
Cesium-127	Cs-127	1,000
Cesium-129	Cs-129	1,000
Cesium-130	Cs-130	1,000
Cesium-131	Cs-131	1,000
Cesium-132	Cs-132	100
Cesium-134	Cs-134	10
Cesium-134m	Cs-134m	1,000
Cesium-135	Cs-135	100
Cesium-135m	Cs-135m	1,000
Cesium-136	Cs-136	10
Cesium-137	Cs-137	10
Cesium-138	Cs-138	1,000
Chlorine-36	Cl-36	10
Chlorine-38	Cl-38	1,000
Chlorine-39	Cl-39	1,000
Chromium-48	Cr-48	1,000
Chromium-49	Cr-49	1,000
Chromium-51	Cr-51	1,000
Cobalt-55	Co-55	100
Cobalt-56	Co-56	10

Cobalt-57	Co-57	100
Cobalt-58	Co-58	100
Cobalt-58m	Co-58m	1,000
Cobalt-60	Co-60	1
Cobalt-60m	Co-60m	1,000
Cobalt-61	Co-61	1,000
Cobalt-62m	Co-62m	1,000
Copper-60	Cu-60	1,000
Copper-61	Cu-61	1,000
Copper-64	Cu-64	1,000
Copper-67	Cu-67	1,000
Curium-238	Cm-238	100
Curium-240	Cm-240	0.1
Curium-241	Cm-241	1
Curium-242	Cm-242	0.01
Curium-243	Cm-243	0.001
Curium-244	Cm-244	0.001
Curium-245	Cm-245	0.001
Curium-246	Cm-246	0.001
Curium-247	Cm-247	0.001
Curium-248	Cm-248	0.001
Curium-249	Cm-249	1,000
Dysprosium-155	Dy-155	1,000
Dysprosium-157	Dy-157	1,000
Dysprosium-159	Dy-159	100
Dysprosium-165	Dy-165	1,000
Dysprosium-166	Dy-166	100
Einsteinium-250	Es-250	100
Einsteinium-251	Es-251	100
Einsteinium-253	Es-253	0.1
Einsteinium-254	Es-254	0.01
Einsteinium-254m	Es-254m	1
Erbium-161	Er-161	1,000
Erbium-165	Er-165	1,000
Erbium-169	Er-169	100
Erbium-171	Er-171	100
Erbium-172	Er-172	100
Europium-145	Eu-145	100
Europium-146	Eu-146	100
Europium-147	Eu-147	100
Europium-148	Eu-148	10
Europium-149	Eu-149	100
Europium-150 (12.62 y)	Eu-150	100
Europium-150 (34.2y)	Eu-150	1
Europium-152	Eu-152	1
Europium-152m	Eu-152m	100
Europium-154	Eu-154	1
Europium-155	Eu-155	10
Europium-156	Eu-156	100

Europium-157	Eu-157	100
Europium-158	Eu-158	1,000
Fermium-252	Fm-252	1
Fermium-253	Fm-253	1
Fermium-254	Fm-254	10
Fermium-255	Fm-255	1
Fermium-257	Fm-257	0.01
Fluorine-18	F-18	1,000
Francium-222	Fr-222	100
Francium-223	Fr-223	100
Gadolinium-145	Gd-145	1,000
Gadolinium-146	Gd-146	10
Gadolinium-147	Gd-147	100
Gadolinium-148	Gd-148	0.001
Gadolinium-149	Gd-149	100
Gadolinium-151	Gd-151	10
Gadolinium-152	Gd-152	100
Gadolinium-153	Gd-153	10
Gadolinium-159	Gd-159	100
Gallium-65	Ga-65	1,000
Gallium-66	Ga-66	100
Gallium-67	Ga-67	1,000
Gallium-68	Ga-68	1,000
Gallium-70	Ga-70	1,000
Gallium-72	Ga-72	100
Gallium-73	Ga-73	1,000
Germanium-66	Ge-66	1,000
Germanium-67	Ge-67	1,000
Germanium-68	Ge-68	10
Germanium-69	Ge-69	1,000
Germanium-71	Ge-71	1,000
Germanium-75	Ge-75	1,000
Germanium-77	Ge-77	1,000
Germanium-78	Ge-78	1,000
Gold-193	Au-193	1,000
Gold-194	Au-194	100
Gold-195	Au-195	10
Gold-198	Au-198	100
Gold-198m	Au-198m	100
Gold-199	Au-199	100
Gold-200	Au-200	1,000
Gold-200m	Au-200m	100
Gold-201	Au-201	1,000
Hafnium-170	Hf-170	100
Hafnium-172	Hf-172	1
Hafnium-173	Hf-173	1,000
Hafnium-175	Hf-175	100
Hafnium-177m	Hf-177m	1,000
Hafnium-178m	Hf-178m	0.1

Hafnium-179m	Hf-179m	10
Hafnium-180m	Hf-180m	1,000
Hafnium-181	Hf-181	10
Hafnium-182	Hf-182	0.1
Hafnium-182m	Hf-182m	1,000
Hafnium-183	Hf-183	1,000
Hafnium-184	Hf-184	100
Holmium-155	Ho-155	1,000
Holmium-157	Ho-157	1,000
Holmium-159	Ho-159	1,000
Holmium-161	Ho-161	1,000
Holmium-162	Ho-162	1,000
Holmium-162m	Ho-162m	1,000
Holmium-164	Ho-164	1,000
Holmium-164m	Ho-164m	1,000
Holmium-166	Ho-166	100
Holmium-166m	Ho-166m	1
Holmium-167	Ho-167	1,000
Indium-109	In-109	1,000
Indium-110 (4.9h)	In-110	1,000
Indium-110 (69.1 min)	In-110	1,000
Indium-111	In-111	100
Indium-112	In-112	1,000
Indium-113m	In-113m	1,000
Indium-114m	In-114m	10
Indium-115	In-115	100
Indium-115m	In-115m	1,000
Indium-116m	In-116m	1,000
Indium-117	In-117	1,000
Indium-117m	In-117m	1,000
Indium-119m	In-119m	1,000
Iodine-120	I-120	100
Iodine-120m	I-120m	1,000
Iodine-121	I-121	1,000
Iodine-123	I-123	100
Iodine-124	I-124	10
Iodine-125	I-125	1
Iodine-126	I-126	1
Iodine-128	I-128	1,000
Iodine-129	I-129	1
Iodine-130	I-130	10
Iodine-131	I-131	1
Iodine-132	I-132	100
Iodine-132m	I-132m	100
Iodine-133	I-133	10
Iodine-134	I-134	1,000
Iodine-135	I-135	100
Iridium-182	Ir-182	1,000
Iridium-184	Ir-184	1,000

Iridium-185	Ir-185	1,000
Iridium-186	Ir-186	100
Iridium-187	Ir-187	1,000
Iridium-188	Ir-188	100
Iridium-189	Ir-189	100
Iridium-190	Ir-190	100
Iridium-190m	Ir-190m	1,000
Iridium-192 (73.8d)	Ir-192	1
Iridium-192m (1.4 mi	Ir-192m	10
Iridium-194	Ir-194	100
Iridium-194m	Ir-194m	10
Iridium-195	Ir-95	1,000
Iridium-195m	Ir-195m	1,000
Iron-52	Fe-52	100
Iron-55	Fe-55	100
Iron-59	Fe-59	10
Iron-60	Fe-60	1
Krypton-74	Kr-74	1,000
Krypton-76	Kr-76	1,000
Krypton-77	Kr-77	1,000
Krypton-79	Kr-79	1,000
Krypton-81	Kr-81	1,000
Krypton-83m	Kr-83m	1,000
Krypton-85	Kr-85	1,000
Krypton-85m	Kr-85m	1,000
Krypton-87	Kr-87	1,000
Krypton-88	Kr-88	1,000
Lanthanum-131	La-131	1,000
Lanthanum-132	La-132	100
Lanthanum-135	La-135	1,000
Lanthanum-137	La-137	10
Lanthanum-138	La-138	100
Lanthanum-140	La-140	100
Lanthanum-141	La-141	100
Lanthanum-142	La-142	1,000
Lanthanum-143	La-143	1,000
Lead-195m	Pb-195m	1,000
Lead-198	Pb-198	1,000
Lead-199	Pb-199	1,000
Lead-200	Pb-200	100
Lead-201	Pb-201	1,000
Lead-202	Pb-202	10
Lead-202m	Pb-202m	1,000
Lead-203	Pb-2023	1,000
Lead-205	Pb-205	100
Lead-209	Pb-209	1,000
Lead-210	Pb-210	0.01
Lead-211	Pb-211	100
Lead-212	Pb-212	1

Lead-214	Pb-214	100
Lutetium-169	Lu-169	100
Lutetium-170	Lu-170	100
Lutetium-171	Lu-171	100
Lutetium-172	Lu-172	100
Lutetium-173	Lu-173	10
Lutetium-174	Lu-174	10
Lutetium-174m	Lu-174m	10
Lutetium-176	Lu-176	100
Lutetium-176m	Lu-176m	1,000
Lutetium-177	Lu-177	100
Lutetium-177m	Lu-177m	10
Lutetium-178	Lu-178	1,000
Lutetium-178m	Lu-178m	1,000
Lutetium-179	Lu-179	1,000
Magnesium-28	Mg-28	100
Manganese-51	Mn-51	1,000
Manganese-52	Mn-52	100
Manganese-52m	Mn-52m	1,000
Manganese-53	Mn-53	1,000
Manganese-54	Mn-54	100
Manganese-56	Mn-56	1,000
Mendelevium-257	Md-257	10
Mendelevium-258	Md-258	0.01
Mercury-193	Hg-193	1,000
Mercury-193m	Hg-193m	100
Mercury-194	Hg-194	1
Mercury-195	Hg-195	1,000
Mercury-195m	Hg-195m	100
Mercury-197	Hg-197	1,000
Mercury-197m	Hg-197m	100
Mercury-199m	Hg-199m	1,000
Mercury-203	Hg-203	100
Molybdenum-101	Mo-101	1,000
Molybdenum-90	Mo-90	100
Molybdenum-93	Mo-93	10
Molybdenum-93m	Mo-93m	100
Molybdenum-99	Mo-99	100
Neodymium-136	Nd-136	1,000
Neodymium-138	Nd-138	100
Neodymium-139	Nd-139	1,000
Neodymium-139m	Nd-139m	1,000
Neodymium-141	Nd-141	1,000
Neodymium-147	Nd-147	100
Neodymium-149	Nd-149	1,000
Neodymium-151	Nd-151	1,000
Neptunium-232	Np-232	100
Neptunium-233	Np-233	1,000
Neptunium-234	Np-234	100

Neptunium-235	Np-235	100
Neptunium-236 (1.15 min)	Np-236	0.001
Neptunium-236 (22.5 min)	Np-236	1
Neptunium-237	Np-237	0.001
Neptunium-238	Np-238	10
Neptunium-239	Np-239	100
Neptunium-240	Np-240	1,000
Nickel-56	Ni-56	100
Nickel-57	Ni-57	100
Nickel-59	Ni-59	100
Nickel-63	Ni-63	100
Nickel-65	Ni-65	1,000
Nickel-66	Ni-66	10
Niobium-88	Nb-88	1,000
Niobium-89	Nb-89	1,000
Niobium-89 (122 min)	Nb-89	1,000
Niobium-89m (66 min)	Nb-89m	1,000
Niobium-90	Nb-90	100
Niobium-93m	Nb-93m	10
Niobium-94	Nb-94	1
Niobium-95	Nb-95	100
Niobium-95m	Nb-95m	100
Niobium-96	Nb-96	100
Niobium-97	Nb-97	1,000
Niobium-98	Nb-98	1,000
Osmium-180	Os-180	1,000
Osmium-181	Os-181	1,000
Osmium-182	Os-182	100
Osmium-185	Os-185	100
Osmium-189m	Os-189m	1,000
Osmium-191	Os-191	100
Osmium-191m	Os-191m	1,000
Osmium-193	Os-193	100
Osmium-194	Os-194	1
Palladium-100	Pd-100	100
Palladium-101	Pd-101	1,000
Palladium-103	Pd-103	100
Palladium-107	Pd-107	10
Palladium-109	Pd-109	100
Phosphorus-32	P-32	10
Phosphorus-33	P-33	100
Platinum-186	Pt-186	1,000
Platinum-188	Pt-188	100
Platinum-189	Pt-189	1,000
Platinum-191	Pt-191	100
Platinum-193	Pt-193	1,000
Platinum-193m	Pt-193m	100
Platinum-195m	Pt-195m	100
Platinum-197	Pt-197	100

Platinum-197m	Pt-197m	1,000
Platinum-199	Pt-199	1,000
Platinum-200	Pt-200	100
Plutonium-234	Pu-234	10
Plutonium-235	Pu-235	1,000
Plutonium-236	Pu-236	0.001
Plutonium-237	Pu-237	100
Plutonium-238	Pu-238	0.001
Plutonium-239	Pu-239	0.001
Plutonium-240	Pu-240	0.001
Plutonium-241	Pu-241	0.01
Plutonium-242	Pu-242	0.001
Plutonium-243	Pu-243	1,000
Plutonium-244	Pu-244	0.001
Plutonium-245	Pu-245	100
Polonium-203	Po-203	1,000
Polonium-205	Po-205	1,000
Polonium-207	Po-207	1,000
Polonium-210	Po-210	0.1
Potassium-40	K-40	100
Potassium-42	K-42	1,000
Potassium-43	K-43	1,000
Potassium-44	K-44	1,000
Potassium-45	K-45	1,000
Praseodymium-136	Pr-136	1,000
Praseodymium-137	Pr-137	1,000
Praseodymium-138m	Pr-138m	1,000
Praseodymium-139	Pr-139	1,000
Praseodymium-142	Pr-142	100
Praseodymium-142m	Pr-142m	1,000
Praseodymium-143	Pr-143	100
Praseodymium-144	Pr-144	1,000
Praseodymium-145	Pr-145	100
Praseodymium-147	Pr-147	1,000
Promethium-141	Pm-141	1,000
Promethium-143	Pm-143	100
Promethium-144	Pm-144	10
Promethium-145	Pm-145	10
Promethium-146	Pm-146	1
Promethium-147	Pm-147	10
Promethium-148	Pm-148	10
Promethium-148m	Pm-148m	10
Promethium-149	Pm-149	100
Promethium-150	Pm-150	1,000
Promethium-151	Pm-151	100
Protactinium-227	Pa-227	10
Protactinium-228	Pa-228	1
Protactinium-230	Pa-230	0.01
Protactinium-231	Pa-231	0.001

Protactinium-232	Pa-232	1
Protactinium-233	Pa-233	100
Protactinium-234	Pa-234	100
Radium-223	Ra-223	0.1
Radium-224	Ra-224	0.1
Radium-225	Ra-225	0.1
Radium-226	Ra-226	0.1
Radium-227	Ra-227	1,000
Radium-228	Ra-228	0.1
Radon-220	Rn-220	1
Radon-222	Rn-222	1
Rhenium-177	Re-177	1,000
Rhenium-178	Re-178	1,000
Rhenium-181	Re-181	1,000
Rhenium-182 (12.7h)	Re-182	1,000
Rhenium-182 (64.0h)	Re-182	100
Rhenium-184	Re-184	100
Rhenium-184m	Re-184m	10
Rhenium-186	Re-186	100
Rhenium-186m	Re-186m	10
Rhenium-187	Re-187	1,000
Rhenium-188	Re-188	100
Rhenium-188m	Re-188m	1,000
Rhenium-189	Re-189	100
Rhodium-100	Rh-100	100
Rhodium-101	Rh-101	10
Rhodium-101m	Rh-101m	1,000
Rhodium-102	Rh-102	10
Rhodium-102m	Rh-102m	10
Rhodium-103m	Rh-103m	1,000
Rhodium-105	Rh-105	100
Rhodium-106m	Rh-106m	1,000
Rhodium-107	Rh-107	1,000
Rhodium-99	Rh-99	100
Rhodium-99m	Rh-99m	1,000
Rubidium-79	Rb-79	1,000
Rubidium-81	Rb-81	1,000
Rubidium-81m	Rb-81m	1,000
Rubidium-82m	Rb-82m	1,000
Rubidium-83	Rb-83	100
Rubidium-84	Rb-84	100
Rubidium-86	Rb-86	100
Rubidium-87	Rb-87	100
Rubidium-88	Rb-88	1,000
Rubidium-89	Rb-89	1,000
Ruthenium-103	Ru-103	100
Ruthenium-105	Ru-105	1,000
Ruthenium-106	Ru-106	1
Ruthenium-94	Ru-94	1,000

Ruthenium-97	Ru-97	1,000
Samarium-141	Sm-141	1,000
Samarium-141m	Sm-141m	1,000
Samarium-142	Sm-142	1,000
Samarium-145	Sm-145	100
Samarium-146	Sm-146	1
Samarium-147	Sm-147	100
Samarium-151	Sm-151	10
Samarium-153	Sm-153	100
Samarium-155	Sm-155	1,000
Samarium-156	Sm-156	1,000
Scandium-43	Sc-43	1,000
Scandium-44	Sc-44	100
Scandium-44m	Sc-44m	100
Scandium-46	Sc-46	10
Scandium-47	Sc-47	100
Scandium-48	Sc-48	100
Scandium-49	Sc-49	1,000
Selenium-70	Se-70	1,000
Selenium-73	Se-73	100
Selenium-73m	Se-73m	1,000
Selenium-75	Se-75	100
Selenium-79	Se-79	100
Selenium-81	Se-81	1,000
Selenium-81m	Se-81m	1,000
Selenium-83	Se-83	1,000
Silicon-31	Si-31	1,000
Silicon-32	Si-32	1
Silver-102	Ag-102	1,000
Silver-103	Ag-103	1,000
Silver-104	Ag-104	1,000
Silver-104m	Ag-104m	1,000
Silver-105	Ag-105	100
Silver-106	Ag-106	1,000
Silver-106m	Ag-106m	100
Silver-108m	Ag-108m	1
Silver-110m	Ag-110m	10
Silver-111	Ag-111	100
Silver-112	Ag-112	100
Silver-115	Ag-115	1,000
Sodium-22	Na-22	10
Sodium-24	Na-24	100
Strontium-80	Sr-80	100
Strontium-81	Sr-81	1,000
Strontium-83	Sr-83	100
Strontium-85	Sr-85	100
Strontium-85m	Sr-85m	1,000
Strontium-87m	Sr-87m	1,000
Strontium-89	Sr-89	10

Strontium-90	Sr-90	0.1
Strontium-91	Sr-91	100
Strontium-92	Sr-92	100
Sulfur-35	S-35	100
Tantalum-172	Ta-172	1,000
Tantalum-173	Ta-173	1,000
Tantalum-174	Ta-174	1,000
Tantalum-175	Ta-175	1,000
Tantalum-176	Ta-176	100
Tantalum-177	Ta-177	1,000
Tantalum-178	Ta-178	1,000
Tantalum-179	Ta-179	100
Tantalum-180	Ta-180	100
Tantalum-180m	Ta-180m	1,000
Tantalum-182	Ta-182	10
Tantalum-182m	Ta-182m	1,000
Tantalum-183	Ta-183	100
Tantalum-184	Ta-184	100
Tantalum-185	Ta-185	1,000
Tantalum-186	Ta-186	1,000
Technetium-101	Tc-101	1,000
Technetium-104	Tc-104	1,000
Technetium-93	Tc-93	1,000
Technetium-93m	Tc-93m	1,000
Technetium-94	Tc-94	1,000
Technetium-94m	Tc-94m	1,000
Technetium-96	Tc-96	100
Technetium-96m	Tc-96	1,000
Technetium-97	Tc-97	1,000
Technetium-97m	Tc-97m	100
Technetium-98	Tc-98	10
Technetium-99	Tc-99	100
Technetium-99m	Tc-99m	1,000
Tellurium-116	Te-116	1,000
Tellurium-121	Te-121	100
Tellurium-121m	Te-121m	10
Tellurium-123	Te-123	100
Tellurium-123m	Te-123m	10
Tellurium-125m	Te-125m	10
Tellurium-127	Te-127	1,000
Tellurium-127m	Te-127m	10
Tellurium-129	Te-129	1,000
Tellurium-129m	Te-129m	10
Tellurium-131	Te-131	100
Tellurium-131m	Te-131m	10
Tellurium-132	Te-132	10
Tellurium-133	Te-133	1,000
Tellurium-133m	Te-133m	100
Tellurium-134	Te-134	1,000

Terbium-147	Tb-147	1,000
Terbium-149	Tb-149	100
Terbium-150	Tb-150	1,000
Terbium-151	Tb-151	100
Terbium-153	Tb-153	1,000
Terbium-154	Tb-154	100
Terbium-155	Tb-155	1,000
Terbium-156	Tb-156	100
Terbium-156m (24.4h)	Tb-156m	1,000
Terbium-156m (5.0h)	Tb-156m	1,000
Terbium-157	Tb-157	10
Terbium-158	Tb-158	1
Terbium-160	Tb-160	10
Terbium-161	Tb-161	100
Thallium-194	Tl-194	1,000
Thallium-194m	Tl-194m	1,000
Thallium-195	Tl-195	1,000
Thallium-197	Tl-197	1,000
Thallium-198	Tl-198	1,000
Thallium-198m	Tl-198m	1,000
Thallium-199	Tl-199	1,000
Thallium-200	Tl-200	1,000
Thallium-201	Tl-201	1,000
Thallium-202	Tl-202	100
Thallium-204	Tl-204	100
Thorium-226	Th-226	10
Thorium-227	Th-227	0.01
Thorium-228	Th-228	0.001
Thorium-229	Th-229	0.001
Thorium-230	Th-230	0.001
Thorium-231	Th-231	100
Thorium-232	Th-232	100
Thorium-234	Th-234	10
Thorium-natural		100
Thulium-162	Tm-162	1,000
Thulium-166	Tm-166	100
Thulium-167	Tm-167	100
Thulium-170	Tm-170	10
Thulium-171	Tm-171	10
Thulium-172	Tm-172	100
Thulium-173	Tm-173	100
Thulium-175	Tm-175	1,000
Tin-110	Sn-110	100
Tin-111	Sn-111	1,000
Tin-113	Sn-113	100
Tin-117m	Sn-117m	100
Tin-119m	Sn-119m	100
Tin-121	Sn-121	1,000
Tin-121m	Sn-121m	100

Tin-123	Sn-123	10
Tin-123m	Sn-123m	1,000
Tin-125	Sn-125	10
Tin-126	Sn-126	10
Tin-127	Sn-127	1,000
Tin-128	Sn-128	1,000
Titanium-44	Ti-44	1
Titanium-45	Ti-45	1,000
Tungsten-176	W-176	1,000
Tungsten-177	W-177	1,000
Tungsten-178	W-178	1,000
Tungsten-179	W-179	1,000
Tungsten-181	W-181	1,000
Tungsten-185	W-185	100
Tungsten-187	W-187	100
Tungsten-188	W-188	10
Uranium-230	U-230	0.01
Uranium-231	U-231	100
Uranium-232	U-232	0.001
Uranium-233	U-233	0.001
Uranium-234	U-234	0.001
Uranium-235	U-235	0.001
Uranium-236	U-236	0.001
Uranium-237	U-237	100
Uranium-238	U-238	100
Uranium-239	U-239	1,000
Uranium-240	U-240	100
Uranium-natural		100
Vanadium-47	V-47	1,000
Vanadium-48	V-48	100
Vanadium-49	V-49	1,000
Xenon-120	Xe-120	1,000
Xenon-121	Xe-121	1,000
Xenon-122	Xe-122	1,000
Xenon-123	Xe-123	1,000
Xenon-125	Xe-125	1,000
Xenon-127	Xe-127	1,000
Xenon-129m	Xe-129m	1,000
Xenon-131m	Xe-131m	1,000
Xenon-133	Xe-133	1,000
Xenon-133m	Xe-133m	1,000
Xenon-135	Xe-135	1,000
Xenon-135m	Xe-135m	1,000
Xenon-138	Xe-138	1,000
Ytterbium-162	Yb-162	1,000
Ytterbium-166	Yb-166	100
Ytterbium-167	Yb-167	1,000
Ytterbium-169	Yb-169	100
Ytterbium-175	Yb-175	100

Ytterbium-177	Yb-177	1,000
Ytterbium-178	Yb-178	1,000
Yttrium-86	Y-86	100
Yttrium-86m	Y-86m	1,000
Yttrium-87	Y-87	100
Yttrium-88	Y-88	10
Yttrium-90	Y-90	10
Yttrium-90m	Y-90m	1,000
Yttrium-91	Y-91	10
Yttrium-91m	Y-91m	1,000
Yttrium-92	Y-92	100
Yttrium-93	Y-93	100
Yttrium-94	Y-94	1,000
Yttrium-95	Y-95	1,000
Zinc-62	Zn-62	100
Zinc-63	Zn-63	1,000
Zinc-65	Zn-65	10
Zinc-69	Zn-69	1,000
Zinc-69m	Zn-69m	100
Zinc-71m	Zn-71m	1,000
Zinc-72	Zn-72	100
Zirconium-86	Zr-86	100
Zirconium-88	Zr-88	10
Zirconium-89	Zr-89	100
Zirconium-93	Zr-93	1
Zirconium-95	Zr-95	10
Zirconium-97	Zr-97	100

Americium-241	0.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-133	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.2h	100
Europium-152 13 yr	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000

Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molbdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10

Promethium-149	10
Radium-226	0.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Seleium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulphur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium127m	10
Tellurium-127	100
Tellurium129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
Thorium (natural) 1	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10

Tungsten-185	10
Tungsten-187	100
Uranium (natural)²	100
Uranium-233	0.01
Uranium-234--Uranium-235	0.01
Vandium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.01
Any radionuclide other than alpha emitting radio-nuclides, not listed above or mixtures of beta emitters of unknown composition	0.1