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APPENDIX F

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Hydrogen–3	1,000	Scandium–47	100
Beryllium–7	1,000	Scandium–48	100
Beryllium–10	1	Scandium–49	1,000
Carbon–11	1,000	Titanium–44	1
Carbon–14	100	Titanium–45	1,000
Fluorine–18	1,000	Vanadium–47	1,000
Sodium–22	10	Vanadium–48	100
Sodium–24	100	Vanadium–49	1,000
Magnesium–28	100	Chromium–48	1,000
Aluminum–26	10	Chromium–49	1,000
Silicon–31	1,000	Chromium–51	1,000
Silicon–32	1	Manganese–51	1,000
Phosphorus–32	10	Manganese–52m	1,000
Phosphorus–33	100	Manganese–52	100
Sulfur–35	100	Manganese–53	1,000
Chlorine–36	10	Manganese–54	100
Chlorine–38	1,000	Manganese–56	1,000
Chlorine–39	1,000	Iron–52	100
Argon–39	1,000	Iron–55	100
Argon–41	1,000	Iron–59	10
Potassium–40	100	Iron–60	1
Potassium–42	1,000	Cobalt–55	100
Potassium–43	1,000	Cobalt–56	10
Potassium–44	1,000	Cobalt–57	100
Potassium–45	1,000	Cobalt–58m	1,000
Calcium–41	100	Cobalt–58	100
Calcium–45	100	Cobalt–60m	1,000
Calcium–47	100	Cobalt–60	1
Scandium–43	1,000	Cobalt–61	1,000
Scandium–44m	100	Cobalt–62m	1,000
Scandium–44	100	Nickel–56	100
Scandium–46	10	Nickel–57	100

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37.			
Nickel–59	100	Arsenic–74	100
Nickel–63	100	Arsenic–76	100
Nickel–65	1,000	Arsenic–77	100
Nickel–66	10	Arsenic–78	1,000
Copper–60	1,000	Selenium–70	1,000
Copper–61	1,000	Selenium–73m	1,000
Copper–64	1,000	Selenium–73	100
Copper–67	1,000	Selenium–75	100
Zinc–62	100	Selenium–79	100
Zinc–63	1,000	Selenium–81m	1,000
Zinc–65	10	Selenium–81	1,000
Zinc–69m	100	Selenium–83	1,000
Zinc–69	1,000	Bromine–74m	1,000
Zinc–71m	1,000	Bromine–74	1,000
Zinc–72	100	Bromine–75	1,000
Gallium–65	1,000	Bromine–76	100
Gallium–66	100	Bromine–77	1,000
Gallium–67	1,000	Bromine–80m	1,000
Gallium–68	1,000	Bromine–80	1,000
Gallium–70	1,000	Bromine–82	100
Gallium–72	100	Bromine–83	1,000
Gallium–73	1,000	Bromine–84	1,000
Germanium–66	1,000	Krypton–74	1,000
Germanium–67	1,000	Krypton–76	1,000
Germanium–68	10	Krypton–77	1,000
Germanium–69	1,000	Krypton–79	1,000
Germanium–71	1,000	Krypton–81	1,000
Germanium–75	1,000	Krypton–83m	1,000
Germanium–77	1,000	Krypton–85m	1,000
Germanium–78	1,000	Krypton–85	1,000
Arsenic–69	1,000	Krypton–87	1,000
Arsenic–70	1,000	Krypton–88	1,000
Arsenic–71	100	Rubidium–79	1,000
Arsenic–72	100	Rubidium–81m	1,000
Arsenic–73	100	Rubidium–81	1,000

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Rubidium–82m	1,000	Niobium–88	1,000
Rubidium–83	100	Niobium–89m (66 min)	1,000
Rubidium–84	100	Niobium–89 (122 min)	1,000
Rubidium–86	100	Niobium–90	100
Rubidium–87	100	Niobium–93m	10
Rubidium–88	1,000	Niobium–94	1
Rubidium–89	1,000	Niobium–95m	100
Strontium–80	100	Niobium–95	100
Strontium–81	1,000	Niobium–96	100
Strontium–83	100	Niobium–97	1,000
Strontium–85m	1,000	Niobium–98	1,000
Strontium–85	100	Molybdenum–90	100
Strontium–87m	1,000	Molybdenum–93m	100
Strontium–89	10	Molybdenum–93	10
Strontium–90	0.1	Molybdenum–99	100
Strontium–91	100	Molybdenum–101	1,000
Strontium–92	100	Technetium–93m	1,000
Yttrium–86m	1,000	Technetium–93	1,000
Yttrium–86	100	Technetium–94m	1,000
Yttrium–87	100	Technetium–94	1,000
Yttrium–88	10	Technetium–96m	1,000
Yttrium–90m	1,000	Technetium–96	100
Yttrium–90	10	Technetium–97m	100
Yttrium–91m	1,000	Technetium–97	1,000
Yttrium–91	10	Technetium–98	10
Yttrium–92	100	Technetium–99m	1,000
Yttrium–93	100	Technetium–99	100
Yttrium–94	1,000	Technetium–101	1,000
Yttrium–95	1,000	Technetium–104	1,000
Zirconium–86	100	Ruthenium–94	1,000
Zirconium–88	10	Ruthenium–97	1,000
Zirconium–89	100	Ruthenium–103	100
Zirconium–93	1	Ruthenium–105	1,000
Zirconium–95	10	Ruthenium–106	1
Zirconium–97	100	Rhodium–99m	1,000

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Rhodium–99	100	Cadmium–117	1,000
Rhodium–100	100	Indium–109	1,000
Rhodium–101m	1,000	Indium–110 (69.1 min)	1,000
Rhodium–101	10	Indium–110 (4.9 h)	1,000
Rhodium–102m	10	Indium–111	100
Rhodium–102	10	Indium–112	1,000
Rhodium–103m	1,000	Indium–113m	1,000
Rhodium–105	100	Indium–114m	10
Rhodium–106m	1,000	Indium–115m	1,000
Rhodium–107	1,000	Indium–115	100
Palladium–100	100	Indium–116m	1,000
Palladium–101	1,000	Indium–117m	1,000
Palladium–103	100	Indium–117	1,000
Palladium–107	10	Indium–119m	1,000
Palladium–109	100	Tin–110	100
Silver–102	1,000	Tin–111	1,000
Silver–103	1,000	Tin–113	100
Silver–104m	1,000	Tin–117m	100
Silver–104	1,000	Tin–119m	100
Silver–105	100	Tin–121m	100
Silver–106m	100	Tin–121	1,000
Silver–106	1,000	Tin–123m	1,000
Silver–108m	1	Tin–123	10
Silver–11Om	10	Tin–125	10
Silver–111	100	Tin–126	10
Silver–112	100	Tin–127	1,000
Silver–115	1,000	Tin–128	1,000
Cadmium–104	1,000	Antimony–115	1,000
Cadmium–107	1,000	Antimony–116m	1,000
Cadmium–109	1	Antimony–116	1,000
Cadmium–113m	0.1	Antimony–117	1,000
Cadmium–113	100	Antimony–118m	1,000
Cadmium–115m	10	Antimony–119	1,000
Cadmium–115	100	Antimony–120 (16 min)	1,000
Cadmium–117m	1,000	Antimony–120 (5.76 d)	100

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Antimony–122	100	Iodine–128	1,000
Antimony–124m	1,000	Iodine–129	1
Antimony–124	10	Iodine–130	10
Antimony–125	100	Iodine–131	1
Antimony–126m	1,000	Iodine–132m	100
Antimony–126	100	Iodine–132	100
Antimony–127	100	Iodine–133	10
Antimony–128 (10.4 min)	1,000	Iodine–134	1,000
Antimony–128 (9.01 h)	100	Iodine–135	100
Antimony–129	100	Xenon–120	1,000
Antimony–130	1,000	Xenon–121	1,000
Antimony–131	1,000	Xenon–122	1,000
Tellurium–116	1,000	Xenon–123	1,000
Tellurium–121m	10	Xenon–125	1,000
Tellurium–121	100	Xenon–127	1,000
Tellurium–123m	10	Xenon–129m	1,000
Tellurium–123	100	Xenon–131m	1,000
Tellurium–125m	10	Xenon–133m	1,000
Tellurium–127m	10	Xenon–133	1,000
Tellurium–127	1,000	Xenon–135m	1,000
Tellurium–129m	10	Xenon–135	1,000
Tellurium–129	1,000	Xenon–138	1,000
Tellurium–131m	10	Cesium–125	1,000
Tellurium–131	100	Cesium–127	1,000
Tellurium–132	10	Cesium–129	1,000
Tellurium–133m	100	Cesium–130	1,000
Tellurium–133	1,000	Cesium–131	1,000
Tellurium–134	1,000	Cesium–132	100
Iodine–120m	1,000	Cesium–134m	1,000
Iodine–120	100	Cesium–134	10
Iodine–121	1,000	Cesium–135m	1,000
Iodine–123	100	Cesium–135	100
Iodine–124	10	Cesium–136	10
Iodine–125	1	Cesium–137	10
Iodine–126	1	Cesium–138	1,000

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Barium–126	1,000	Praseodymium–144	1,000
Barium–128	100	Praseodymium–145	100
Barium–131m	1,000	Praseodymium–147	1,000
Barium–131	100	Neodymium–136	1,000
Barium–133m	100	Neodymium–138	100
Barium–133	100	Neodymium–139m	1,000
Barium–135m	100	Neodymium–139	1,000
Barium–139	1,000	Neodymium–141	1,000
Barium–140	100	Neodymium–147	100
Barium–141	1,000	Neodymium–149	1,000
Barium–142	1,000	Neodymium–151	1,000
Lanthanum–131	1,000	Promethium–141	1,000
Lanthanum–132	100	Promethium–143	100
Lanthanum–135	1,000	Promethium–144	10
Lanthanum–137	10	Promethium–145	10
Lanthanum–138	100	Promethium–146	1
Lanthanum–140	100	Promethium–147	10
Lanthanum–141	100	Promethium–148m	10
Lanthanum–142	1,000	Promethium–148	10
Lanthanum–143	1,000	Promethium–149	100
Cerium–134	100	Promethium–150	1,000
Cerium–135	100	Promethium–151	100
Cerium–137m	100	Samarium–141m	1,000
Cerium–137	1,000	Samarium–141	1,000
Cerium–139	100	Samarium–142	1,000
Cerium–141	100	Samarium–145	100
Cerium–143	100	Samarium–146	1
Cerium–144	1	Samarium–147	100
Praseodymium–136	1,000	Samarium–151	10
Praseodymium–137	1,000	Samarium–153	100
Praseodymium–138m	1,000	Samarium–155	1,000
Praseodymium–139	1,000	Samarium–156	1,000
Praseodymium–142m	1,000	Europium–145	100
Praseodymium–142	100	Europium–146	100
Praseodymium–143	100	Europium–147	100

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37.			
Europium–148	10	Dysprosium–157	1,000
Europium–149	100	Dysprosium–159	100
Europium–150 (12.62 h)	100	Dysprosium–165	1,000
Europium–150 (34.2 y)	1	Dysprosium–166	100
Europium–152m	100	Holmium–155	1,000
Europium–152	1	Holmium–157	1,000
Europium–154	1	Holmium–159	1,000
Europium–155	10	Holmium–161	1,000
Europium–156	100	Holmium–162m	1,000
Europium–157	100	Holmium–162	1,000
Europium–158	1,000	Holmium–164m	1,000
Gadolinium–145	1,000	Holmium–164	1,000
Gadolinium–146	10	Holmium–166m	1
Gadolinium–147	100	Holmium–166	100
Gadolinium–148	0.001	Holmium–167	1,000
Gadolinium–149	100	Erbium–161	1,000
Gadolinium–151	10	Erbium–165	1,000
Gadolinium–152	100	Erbium–169	100
Gadolinium–153	10	Erbium–171	100
Gadolinium–159	100	Erbium–172	100
Terbium–147	1,000	Thulium–162	1,000
Terbium–149	100	Thulium–166	100
Terbium–150	1,000	Thulium–167	100
Terbium–151	100	Thulium–170	10
Terbium–153	1,000	Thulium–171	10
Terbium–154	100	Thulium–172	100
Terbium–155	1,000	Thulium–173	100
Terbium–156m (5.0 h)	1,000	Thulium–175	1,000
Terbium–156m (24.4 h)	1,000	Ytterbium–162	1,000
Terbium–156	100	Ytterbium–166	100
Terbium–157	10	Ytterbium–167	1,000
Terbium–158	1	Ytterbium–169	100
Terbium–160	10	Ytterbium–175	100
Terbium–161	100	Ytterbium–177	1,000
Dysprosium–155	1,000	Ytterbium–178	1,000

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Lutetium–169	100	Tantalum–180m	1,000
Lutetium–170	100	Tantalum–180	100
Lutetium–171	100	Tantalum–182m	1,000
Lutetium–172	100	Tantalum–182	10
Lutetium–173	10	Tantalum–183	100
Lutetium–174m	10	Tantalum–184	100
Lutetium–174	10	Tantalum–185	1,000
Lutetium–176m	1,000	Tantalum–186	1,000
Lutetium–176	100	Tungsten–176	1,000
Lutetium–177m	10	Tungsten–177	1,000
Lutetium–177	100	Tungsten–178	1,000
Lutetium–178m	1,000	Tungsten–179	1,000
Lutetium–178	1,000	Tungsten–181	1,000
Lutetium–179	1,000	Tungsten–185	100
Hafnium–170	100	Tungsten–187	100
Hafnium–172	1	Tungsten–188	10
Hafnium–173	1,000	Rhenium–177	1,000
Hafnium–175	100	Rhenium–178	1,000
Hafnium–177m	1,000	Rhenium–181	1,000
Hafnium–178m	0.1	Rhenium–182 (12.7 h)	1,000
Hafnium–179m	10	Rhenium–182 (64.0 h)	100
Hafnium–180m	1,000	Rhenium–184m	10
Hafnium–181	10	Rhenium–184	100
Hafnium–182m	1,000	Rhenium–186m	10
Hafnium–182	0.1	Rhenium–186	100
Hafnium–183	1,000	Rhenium–187	1,000
Hafnium–184	100	Rhenium–188m	1,000
Tantalum–172	1,000	Rhenium–188	100
Tantalum–173	1,000	Rhenium–189	100
Tantalum–174	1,000	Osmium–180	1,000
Tantalum–175	1,000	Osmium–181	1,000
Tantalum–176	100	Osmium–182	100
Tantalum–177	1,000	Osmium–185	100
Tantalum–178	1,000	Osmium–189m	1,000
Tantalum–179	100	Osmium–191m	1,000

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37.			
Osmium–191	100	Gold–200m	100
Osmium–193	100	Gold–200	1,000
Osmium–194	1	Gold–201	1,000
Iridium–182	1,000	Mercury–193m	100
Iridium–184	1,000	Mercury–193	1,000
Iridium–185	1,000	Mercury–194	1
Iridium–186	100	Mercury–195m	100
Iridium–187	1,000	Mercury–195	1,000
Iridium–188	100	Mercury–197m	100
Iridium–189	100	Mercury–197	1,000
Iridium–190m	1,000	Mercury–199m	1,000
Iridium–190	100	Mercury–203	100
Iridium–192m (1.4 min)	10	Thallium–194m	1,000
Iridium–192 (73.8 d)	1	Thallium–194	1,000
Iridium–194m	10	Thallium–195	1,000
Iridium–194	100	Thallium–197	1,000
Iridium–195m	1,000	Thallium–198m	1,000
Iridium–195	1,000	Thallium–198	1,000
Platinum–186	1,000	Thallium–199	1,000
Platinum–188	100	Thallium–201	1,000
Platinum–189	1,000	Thallium–200	1,000
Platinum–191	100	Thallium–202	100
Platinum–193m	100	Thallium–204	100
Platinum–193	1,000	Lead–195m	1,000
Platinum–195m	100	Lead–198	1,000
Platinum–197m	1,000	Lead–199	1,000
Platinum–197	100	Lead–200	100
Platinum–199	1,000	Lead–201	1,000
Platinum–200	100	Lead–202m	1,000
Gold–193	1,000	Lead–202	10
Gold–194	100	Lead–203	1,000
Gold–195	10	Lead–205	100
Gold–198m	100	Lead–209	1,000
Gold–198	100	Lead–210	0.01
Gold–199	100	Lead–211	100

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Lead–212	1	Thorium–226	10
Lead–214	100	Thorium–227	0.01
Bismuth–200	1,000	Thorium–228	0.001
Bismuth–201	1,000	Thorium–229	0.001
Bismuth–202	1,000	Thorium–230	0.001
Bismuth–203	100	Thorium–231	100
Bismuth–205	100	Thorium–232	100
Bismuth–206	100	Thorium–234	10
Bismuth–207	10	Thorium–natural	100
Bismuth–210m	0.1	Protactinium–227	10
Bismuth–210	1	Protactinium–228	1
Bismuth–212	10	Protactinium–230	0.1
Bismuth–213	10	Protactinium–231	0.001
Bismuth–214	100	Protactinium–232	1
Polonium–203	1,000	Protactinium–233	100
Polonium–205	1,000	Protactinium–234	100
Polonium–207	1,000	Uranium–230	0.01
Polonium–210	0.1	Uranium–231	100
Astatine–207	100	Uranium–232	0.001
Astatine–211	10	Uranium–233	0.001
Radon–220	1	Uranium–234	0.001
Radon–222	1	Uranium–235	0.001
Francium–222	100	Uranium–236	0.001
Francium–223	100	Uranium–237	100
Radium–223	0.1	Uranium–238	100
Radium–224	0.1	Uranium–239	1,000
Radium–225	0.1	Uranium–240	100
Radium–226	0.1	Uranium–natural	100
Radium–227	1,000	Neptunium–232	100
Radium–228	0.1	Neptunium–233	1,000
Actinium–224	1	Neptunium–234	100
Actinium–225	0.01	Neptunium–235	100
Actinium–226	0.1	Neptunium–236 (1.15E+5 y)	0.001
Actinium–227	0.001	Neptunium–236 (22.5 h)	1
Actinium–228	1	Neptunium–237	0.001

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37.			
Neptunium–238	10	Curium–244	0.001
Neptunium–239	100	Curium–245	0.001
Neptunium–240	1,000	Curium–246	0.001
Plutonium–234	10	Curium–247	0.001
Plutonium–235	1,000	Curium–248	0.001
Plutonium–236	0.001	Curium–249	1,000
Plutonium–237	100	Berkelium–245	100
Plutonium–238	0.001	Berkelium–246	100
Plutonium–239	0.001	Berkelium–247	0.001
Plutonium–240	0.001	Berkelium–249	0.1
Plutonium–241	0.01	Berkelium–250	10
Plutonium–242	0.001	Californium–244	100
Plutonium–243	1,000	Californium–246	1
Plutonium–244	0.001	Californium–248	0.01
Plutonium–245	100	Californium–249	0.001
Americium–237	1,000	Californium–250	0.001
Americium–238	100	Californium–251	0.001
Americium–239	1,000	Californium–252	0.001
Americium–240	100	Californium–253	0.1
Americium–241	0.001	Californium–254	0.001
Americium–242m	0.001	Einsteinium–250	100
Americium–242	10	Einsteinium–251	100
Americium–243	0.001	Einsteinium–253	0.1
Americium–244m	100	Einsteinium–254m	1
Americium–244	10	Einsteinium–254	0.01
Americium–245	1,000	Fermium–252	1
Americium–246m	1,000	Fermium–253	1
Americium–246	1,000	Fermium–254	10
Curium–238	100	Fermium–255	1
Curium–240	0.1	Fermium–257	0.01
Curium–241	1	Mendelevium–257	10
Curium–242	0.01	Mendelevium–258	0.01
Curium–243	0.001		

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING (Continued)
(In Atomic Number Order)

Radionuclide	Quantity (uCi)

Note: To convert uCi to kBq, multiply the uCi value by 37.

Any alpha−emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Any radionuclide other than alpha−emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01

Note: For purposes of s. HFS 157.29 (1) (e), (5) (a) and s. HFS 157.32 (1) (a) where there is involved a combination of radionuclides in known amounts, the limit for the combination shall be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" −− that is, unity.

Note: The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in Table I, Columns 1 and 2, of Appendix E, rounding to the nearest factor of 10 and constraining the values listed between 37 Bq and 37 MBq (0.001 and 1,000 μCi). Values of 3.7 MBq (100 μCi) have been assigned for radionuclides having a radioactive half−life in excess of E+9 years, except rhenium, 37 MBq (1,000 μCi), to take into account their low specific activity.