Chapter DHS 157

APPENDIX F

Quantities of Licensed Material Requiring Labeling (in Atomic Order)

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

Radionuclide	Microcuries	Radionuclide	Microcuries
Hydrogen-3	1,000	Chromium-49	1,000
Beryllium-7	1,000	Chromium-51	1,000
Beryllium-10	1	Manganese-51	1,000
Carbon-11	1,000	Manganese-52m	1,000
Carbon-14	100	Manganese-52	100
Fluorine-18	1,000	Manganese-53	1,000
Sodium-22	10	Manganese-54	100
Sodium-24	100	Manganese-56	1,000
Magnesium-28	100	Iron-52	100
Aluminum-26	10	Iron-55	100
Silicon-31	1,000	Iron-59	10
Silicon-32	1	Iron-60	1
Phosphorus-32	10	Cobalt-55	100
Phosphorus-33	100	Cobalt-56	10
Sulfur-35	100	Cobalt-57	100
Chlorine-36	10	Cobalt-58m	1,000
Chlorine-38	1,000	Cobalt-58	100
Chlorine-39	1,000	Cobalt-60m	1,000
Argon-39	1,000	Cobalt-60	1
Argon-41	1,000	Cobalt-61	1,000
Potassium-40	100	Cobalt-62m	1,000
Potassium-42	1,000	Nickel-56	100
Potassium-43	1,000	Nickel-57	100
Potassium-44	1,000	Nickel-59	100
Potassium-45	1,000	Nickel-63	100
Calcium-41	100	Nickel-65	1,000
Calcium-45	100	Nickel-66	10
Calcium-47	100	Copper-60	1,000
Scandium-43	1,000	Copper-61	1,000
Scandium-44m	100	Copper-64	1,000
Scandium-44	100	Copper-67	1,000
Scandium-46	10	Zinc-62	100
Scandium-47	100	Zinc-63	1,000
Scandium-48	100	Zinc-65	10
Scandium-49	1,000	Zinc-69m	100
Titanium-44	1	Zinc-69	1,000
Titanium-45	1,000	Zinc-71m	1,000
Vanadium-47	1,000	Zinc-72	100
Vanadium-48	100	Gallium-65	1,000
Vanadium-49	1,000	Gallium-66	100
Chromium-48	1,000	Gallium-67	1,000

Gallium-68.....1,000
Gallium-70.....1,000
Gallium-72.....100
Gallium-73.....1,000
Germanium-66.....1,000
Germanium-67.....1,000
Germanium-68.....10
Germanium-69.....1,000
Germanium-71.....1,000
Germanium-75.....1,000
Germanium-77.....1,000
Germanium-78.....1,000
Arsenic-69.....1,000
Arsenic-70.....1,000
Arsenic-71.....100
Arsenic-72.....100
Arsenic-73.....100
Arsenic-74.....100
Arsenic-76.....100
Arsenic-77.....100
Arsenic-78.....1,000
Selenium-70.....1,000
Selenium-73m.....1,000
Selenium-73.....100
Selenium-75.....100
Selenium-79.....100
Selenium-81m.....1,000
Selenium-81.....1,000
Selenium-83.....1,000
Bromine-74m.....1,000
Bromine-74.....1,000
Bromine-75.....1,000
Bromine-76.....100
Bromine-77.....1,000
Bromine-80m.....1,000
Bromine-80.....1,000
Bromine-82.....100
Bromine-83.....1,000
Bromine-84.....1,000
Krypton-74.....1,000
Krypton-76.....1,000
Krypton-77.....1,000
Krypton-79.....1,000
Krypton-81.....1,000
Krypton-83m.....1,000
Krypton-85m.....1,000
Krypton-85.....1,000
Krypton-87.....1,000
Krypton-88.....1,000
Rubidium-79.....1,000
Rubidium-81m.....1,000
Rubidium-81.....1,000
Rubidium-82m.....1,000
Rubidium-83.....100
Rubidium-84.....100
Rubidium-86.....100
Rubidium-87.....100
Rubidium-88.....1,000
Rubidium-89.....1,000
Strontium-80.....100
Strontium-81.....1,000
Strontium-83.....100
Strontium-85m.....1,000
Strontium-85.....100
Strontium-87m.....1,000
Strontium-89.....10
Strontium-90.....0.1
Strontium-91.....100
Strontium-92.....100
Yttrium-86m.....1,000
Yttrium-86.....100
Yttrium-87.....100
Yttrium-88.....10
Yttrium-90m.....1,000
Yttrium-90.....10
Yttrium-91m.....1,000
Yttrium-91.....10
Yttrium-92.....100
Yttrium-93.....100
Yttrium-94.....1,000
Yttrium-95.....1,000
Zirconium-86.....100
Zirconium-88.....10
Zirconium-89.....100
Zirconium-93.....1
Zirconium-95.....10
Zirconium-97.....100
Niobium-88.....1,000
Niobium-89m (66 min).....1,000
Niobium-89 (122 min).....1,000
Niobium-90.....100
Niobium-93m.....10
Niobium-94.....1
Niobium-95m.....100
Niobium-95.....100
Niobium-96.....100
Niobium-97.....1,000
Niobium-98.....1,000
Molybdenum-90.....100
Molybdenum-93m.....100
Molybdenum-93.....10
Molybdenum-99.....100
Molybdenum-101.....1,000
Technetium-93m.....1,000

Technetium-93.....1,000
Technetium-94m.....1,000
Technetium-94.....1,000
Technetium-96m.....1,000
Technetium-96.....100
Technetium-97m.....100
Technetium-97.....1,000
Technetium-98.....10
Technetium-99m.....1,000
Technetium-99.....100
Technetium-101.....1,000
Technetium-104.....1,000
Ruthenium-94.....1,000
Ruthenium-97.....1,000
Ruthenium-103.....100
Ruthenium-105.....1,000
Ruthenium-106.....1
Rhodium-99m.....1,000
Rhodium-99.....100
Rhodium-100.....100
Rhodium-101m.....1,000
Rhodium-101.....10
Rhodium-102m.....10
Rhodium-102.....10
Rhodium-103m.....1,000
Rhodium-105.....100
Rhodium-106m.....1,000
Rhodium-107.....1,000
Palladium-100.....100
Palladium-101.....1,000
Palladium-103.....100
Palladium-107.....10
Palladium-109.....100
Silver-102.....1,000
Silver-103.....1,000
Silver-104m.....1,000
Silver-104.....1,000
Silver-105.....100
Silver-106m.....100
Silver-106.....1,000
Silver-108m.....1
Silver-11Om.....10
Silver-111.....100
Silver-112.....100
Silver-115.....1,000
Cadmium-104.....1,000
Cadmium-107.....1,000
Cadmium-109.....1
Cadmium-113m.....0.1
Cadmium-113.....100
Cadmium-115m.....10
Cadmium-115.....100
Cadmium-117m.....1,000
Cadmium-117.....1,000
Indium-109.....1,000
Indium-110 (69.1 min).....1,000
Indium-110 (4.9 h).....1,000
Indium-111.....100
Indium-112.....1,000
Indium-113m.....1,000
Indium-114m.....10
Indium-115m.....1,000
Indium-115.....100
Indium-116m.....1,000
Indium-117m.....1,000
Indium-117.....1,000
Indium-119m.....1,000
Tin-110.....100
Tin-111.....1,000
Tin-113.....100
Tin-117m.....100
Tin-119m.....100
Tin-121m.....100
Tin-121.....1,000
Tin-123m.....1,000
Tin-123.....10
Tin-125.....10
Tin-126.....10
Tin-127.....1,000
Tin-128.....1,000
Antimony-115.....1,000
Antimony-116m.....1,000
Antimony-116.....1,000
Antimony-117.....1,000
Antimony-118m.....1,000
Antimony-119.....1,000
Antimony-120 (16 min).....1,000
Antimony-120 (5.76 d).....100
Antimony-122.....100
Antimony-124m.....1,000
Antimony-124.....10
Antimony-125.....100
Antimony-126m.....1,000
Antimony-126.....100
Antimony-127.....100
Antimony-128 (10.4 min).....1,000
Antimony-128 (9.01 h).....100
Antimony-129.....100
Antimony-130.....1,000
Antimony-131.....1,000
Tellurium-116.....1,000
Tellurium-121m.....10
Tellurium-121.....100
Tellurium-123m.....10

Tellurium-123.....100
Tellurium-125m.....10
Tellurium-127m.....10
Tellurium-127.....1,000
Tellurium-129m.....10
Tellurium-129.....1,000
Tellurium-131m.....10
Tellurium-131.....100
Tellurium-132.....10
Tellurium-133m.....100
Tellurium-133.....1,000
Tellurium-134.....1,000
Iodine-120m.....1,000
Iodine-120.....100
Iodine-121.....1,000
Iodine-123.....100
Iodine-124.....10
Iodine-125.....1
Iodine-126.....1
Iodine-128.....1,000
Iodine-129.....1
Iodine-130.....10
Iodine-131.....1
Iodine-132m.....100
Iodine-132.....100
Iodine-133.....10
Iodine-134.....1,000
Iodine-135.....100
Xenon-120.....1,000
Xenon-121.....1,000
Xenon-122.....1,000
Xenon-123.....1,000
Xenon-125.....1,000
Xenon-127.....1,000
Xenon-129m.....1,000
Xenon-131m.....1,000
Xenon-133m.....1,000
Xenon-133.....1,000
Xenon-135m.....1,000
Xenon-135.....1,000
Xenon-138.....1,000
Cesium-125.....1,000
Cesium-127.....1,000
Cesium-129.....1,000
Cesium-130.....1,000
Cesium-131.....1,000
Cesium-132.....100
Cesium-134m.....1,000
Cesium-134.....10
Cesium-135m.....1,000
Cesium-135.....100
Cesium-136.....10
Cesium-137.....10
Cesium-138.....1,000
Barium-126.....1,000
Barium-128.....100
Barium-131m.....1,000
Barium-131.....100
Barium-133m.....100
Barium-133.....100
Barium-135m.....100
Barium-139.....1,000
Barium-140.....100
Barium-141.....1,000
Barium-142.....1,000
Lanthanum-131.....1,000
Lanthanum-132.....100
Lanthanum-135.....1,000
Lanthanum-137.....10
Lanthanum-138.....100
Lanthanum-140.....100
Lanthanum-141.....100
Lanthanum-142.....1,000
Lanthanum-143.....1,000
Cerium-134.....100
Cerium-135.....100
Cerium-137m.....100
Cerium-137.....1,000
Cerium-139.....100
Cerium-141.....100
Cerium-143.....100
Cerium-144.....1
Praseodymium-136.....1,000
Praseodymium-137.....1,000
Praseodymium-138m.....1,000
Praseodymium-139.....1,000
Praseodymium-142m.....1,000
Praseodymium-142.....100
Praseodymium-143.....100
Praseodymium-144.....1,000
Praseodymium-145.....100
Praseodymium-147.....1,000
Neodymium-136.....1,000
Neodymium-138.....100
Neodymium-139m.....1,000
Neodymium-139.....1,000
Neodymium-141.....1,000
Neodymium-147.....100
Neodymium-149.....1,000
Neodymium-151.....1,000
Promethium-141.....1,000
Promethium-143.....100
Promethium-144.....10
Promethium-145.....10

Promethium-146.....1
Promethium-147.....10
Promethium-148m.....10
Promethium-148.....10
Promethium-149.....100
Promethium-150.....1,000
Promethium-151.....100
Samarium-141m.....1,000
Samarium-141.....1,000
Samarium-142.....1,000
Samarium-145.....100
Samarium-146.....1
Samarium-147.....100
Samarium-151.....10
Samarium-153.....100
Samarium-155.....1,000
Samarium-156.....1,000
Europium-145.....100
Europium-146.....100
Europium-147.....100
Europium-148.....10
Europium-149.....100
Europium-150 (12.62 h).....100
Europium-150 (34.2 y).....1
Europium-152m.....100
Europium-152.....1
Europium-154.....1
Europium-155.....10
Europium-156.....100
Europium-157.....100
Europium-158.....1,000
Gadolinium-145.....1,000
Gadolinium-146.....10
Gadolinium-147.....100
Gadolinium-148.....0.001
Gadolinium-149.....100
Gadolinium-151.....10
Gadolinium-152.....100
Gadolinium-153.....10
Gadolinium-159.....100
Terbium-147.....1,000
Terbium-149.....100
Terbium-150.....1,000
Terbium-151.....100
Terbium-153.....1,000
Terbium-154.....100
Terbium-155.....1,000
Terbium-156m (5.0 h).....1,000
Terbium-156m (24.4 h).....1,000
Terbium-156.....100
Terbium-157.....10
Terbium-158.....1
Terbium-160.....10
Terbium-161.....100
Dysprosium-155.....1,000
Dysprosium-157.....1,000
Dysprosium-159.....100
Dysprosium-165.....1,000
Dysprosium-166.....100
Holmium-155.....1,000
Holmium-157.....1,000
Holmium-159.....1,000
Holmium-161.....1,000
Holmium-162m.....1,000
Holmium-162.....1,000
Holmium-164m.....1,000
Holmium-164.....1,000
Holmium-166m.....1
Holmium-166.....100
Holmium-167.....1,000
Erbium-161.....1,000
Erbium-165.....1,000
Erbium-169.....100
Erbium-171.....100
Erbium-172.....100
Thulium-162.....1,000
Thulium-166.....100
Thulium-167.....100
Thulium-170.....10
Thulium-171.....10
Thulium-172.....100
Thulium-173.....100
Thulium-175.....1,000
Ytterbium-162.....1,000
Ytterbium-166.....100
Ytterbium-167.....1,000
Ytterbium-169.....100
Ytterbium-175.....100
Ytterbium-177.....1,000
Ytterbium-178.....1,000
Lutetium-169.....100
Lutetium-170.....100
Lutetium-171.....100
Lutetium-172.....100
Lutetium-173.....10
Lutetium-174m.....10
Lutetium-174.....10
Lutetium-176m.....1,000
Lutetium-176.....100
Lutetium-177m.....10
Lutetium-177.....100
Lutetium-178m.....1,000
Lutetium-178.....1,000
Lutetium-179.....1,000

Hafnium-170.....100
Hafnium-172.....1
Hafnium-173.....1,000
Hafnium-175.....100
Hafnium-177m.....1,000
Hafnium-178m.....0.1
Hafnium-179m.....10
Hafnium-180m.....1,000
Hafnium-181.....10
Hafnium-182m.....1,000
Hafnium-182.....0.1
Hafnium-183.....1,000
Hafnium-184.....100
Tantalum-172.....1,000
Tantalum-173.....1,000
Tantalum-174.....1,000
Tantalum-175.....1,000
Tantalum-176.....100
Tantalum-177.....1,000
Tantalum-178.....1,000
Tungsten-188.....10
Rhenium-177.....1,000
Rhenium-178.....1,000
Rhenium-181.....1,000
Rhenium-182 (12.7 h).....1,000
Rhenium-182 (64.0 h).....100
Rhenium-184m.....10
Rhenium-184.....100
Rhenium-186m.....10
Rhenium-186.....100
Rhenium-187.....1,000
Rhenium-188m.....1,000
Rhenium-188.....100
Rhenium-189.....100
Osmium-180.....1,000
Osmium-181.....1,000
Osmium-182.....100
Osmium-185.....100
Osmium-189m.....1,000
Osmium-191m.....1,000
Osmium-191.....100
Osmium-193.....100
Osmium-194.....1
Iridium-182.....1,000
Iridium-184.....1,000
Iridium-185.....1,000
Iridium-186.....100
Iridium-187.....1,000
Iridium-188.....100
Iridium-189.....100
Iridium-190m.....1,000
Iridium-190.....100
Iridium-192m (1.4 min).....10
Iridium-192 (73.8 d).....1
Iridium-194m.....10
Iridium-194.....100
Iridium-195m.....1,000
Iridium-195.....1,000
Platinum-186.....1,000
Platinum-188.....100
Platinum-189.....1,000
Platinum-191.....100
Platinum-193m.....100
Platinum-193.....1,000
Platinum-195m.....100
Platinum-197m.....1,000
Platinum-197.....100
Platinum-199.....1,000
Platinum-200.....100
Gold-193.....1,000
Gold-194.....100
Gold-195.....10
Gold-198m.....100
Gold-198.....100
Gold-199.....100
Gold-200m.....100
Gold-200.....1,000
Gold-201.....1,000
Mercury-193m.....100
Mercury-193.....1,000
Mercury-194.....1
Mercury-195m.....100
Mercury-195.....1,000
Mercury-197m.....100
Mercury-197.....1,000
Mercury-199m.....1,000
Mercury-203.....100
Thallium-194m.....1,000
Thallium-194.....1,000
Thallium-195.....1,000
Thallium-197.....1,000
Thallium-198m.....1,000
Thallium-198.....1,000
Thallium-199.....1,000
Thallium-200.....1,000
Thallium-201.....1,000
Thallium-202.....100
Thallium-204.....100
Lead-195m.....1,000
Lead-198.....1,000
Lead-199.....1,000
Lead-200.....100
Lead-201.....1,000
Lead-202m.....1,000

Lead-202.....10
Lead-203.....1,000
Lead-205.....100
Lead-209.....1,000
Lead-210.....0.01
Lead-211.....100
Lead-212.....1
Lead-214.....100
Bismuth-200.....1,000
Bismuth-201.....1,000
Bismuth-202.....1,000
Bismuth-203.....100
Bismuth-205.....100
Bismuth-206.....100
Bismuth-207.....10
Bismuth-210m.....0.1
Bismuth-210.....1
Bismuth-212.....10
Bismuth-213.....10
Bismuth-214.....100
Polonium-203.....1,000
Polonium-205.....1,000
Polonium-207.....1,000
Polonium-210.....0.1
Astatine-207.....100
Astatine-211.....10
Radon-220.....1
Radon-222.....1
Francium-222.....100
Francium-223.....100
Radium-223.....0.1
Radium-224.....0.1
Radium-225.....0.1
Radium-226.....0.1
Radium-227.....1,000
Radium-228.....0.1
Actinium-224.....1
Actinium-225.....0.01
Actinium-226.....0.1
Actinium-227.....0.001
Actinium-228.....1
Thorium-226.....10
Thorium-227.....0.01
Thorium-228.....0.001
Thorium-229.....0.001
Thorium-230.....0.001
Thorium-231.....100
Thorium-232.....100
Thorium-234.....10
Thorium-natural.....100
Protactinium-227.....10
Protactinium-228.....1
Protactinium-230.....0.1
Protactinium-231.....0.001
Protactinium-232.....1
Protactinium-233.....100
Protactinium-234.....100
Uranium-230.....0.01
Uranium-231.....100
Uranium-232.....0.001
Uranium-233.....0.001
Uranium-234.....0.001
Uranium-235.....0.001
Uranium-236.....0.001
Uranium-237.....100
Uranium-238.....100
Uranium-239.....1,000
Uranium-240.....100
Uranium-natural.....100
Neptunium-232.....100
Neptunium-233.....1,000
Neptunium-234.....100
Neptunium-235.....100
Neptunium-236 (1.15E+5 y).....0.001
Neptunium-236 (22.5 h).....1
Neptunium-237.....0.001
Neptunium-238.....10
Neptunium-239.....100
Neptunium-240.....1,000
Plutonium-234.....10
Plutonium-235.....1,000
Plutonium-236.....0.001
Plutonium-237.....100
Plutonium-238.....0.001
Plutonium-239.....0.001
Plutonium-240.....0.001
Plutonium-241.....0.01
Plutonium-242.....0.001
Plutonium-243.....1,000
Plutonium-244.....0.001
Plutonium-245.....100
Americium-237.....1,000
Americium-238.....100
Americium-239.....1,000
Americium-240.....100
Americium-241.....0.001
Americium-242m.....0.001
Americium-242.....10
Americium-243.....0.001
Americium-244m.....100
Americium-244.....10
Americium-245.....1,000
Americium-246m.....1,000
Americium-246.....1,000

Curium-238	100
Curium-240	0.1
Curium-241	1
Curium-242	0.01
Curium-243	0.001
Curium-244	0.001
Curium-245	0.001
Curium-246	0.001
Curium-247	0.001
Curium-248	0.001
Curium-249	1,000
Berkelium-245	100
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Californium-244	100
Californium-246	1
Californium-248	0.01
Californium-249	0.001
Californium-250	0.001
Californium-251	0.001
Californium-252	0.001
Californium-253	0.1
Californium-254	0.001
Einsteinium-250	100
Einsteinium-251	100
Einsteinium-253	0.1
Einsteinium-254m	1
Einsteinium-254	0.01
Fermium-252	1
Fermium-253	1
Fermium-254	10
Fermium-255	1
Fermium-257	0.01
Mendelevium-257	10
Mendelevium-258	0.01

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. DHS 157.29 (2) (e), (5) (a) and s. DHS 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 microcuries). Values of 3.7 MBq (100 microcuries have been assigned for radionuclides having a radioactive half-life in excess of E+9 years, except rhenium, 37 MBq (1,000 microcuries, to take into account their low specific activity.