

**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.

<b>Radionuclide</b>	<b>Microcuries</b>	<b>Radionuclide</b>	<b>Microcuries</b>
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

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

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

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

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

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

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

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