

APPENDIX T

List of Some Major Uses of Radioisotopes in the United States

A radioisotope is an unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified. Radioisotopes come from three sources: from nature, such as radon in the air or radium in the soil; from machine-produced nuclear interactions in devices, such as linear accelerators and cyclotrons; or from nuclear reactors.

The licensing and regulation of radioisotopes in the United States are shared by the NRC, the U.S. Environmental Protection Agency (EPA), and many State governments. The EPA is also responsible for, among other things, setting air emission and drinking water standards for radionuclides. The States regulate radioactive substances that occur naturally or are produced by machines, such as linear accelerators or cyclotrons. The Food and Drug Administration (FDA) regulates the manufacture and use of linear accelerators; the States regulate their operation.

Americium-241

Used in many smoke detectors for homes and businesses; to measure levels of toxic lead in dried paint samples; to ensure uniform thickness in rolling processes like steel and paper production; and to help determine where oil wells should be drilled.

Cadmium-109

Used to analyze metal alloys for checking stock, scrap sorting.

Calcium-47

Important aid to biomedical researchers studying the cellular functions and bone formation in mammals.

Californium-252

Used to inspect airline luggage for hidden explosives, to gauge the moisture content of soil in the road construction and building industries, and to measure the moisture of materials stored in soils.

Carbon-14

Major research tool. Helps ensure potential new drugs are metabolized without forming harmful byproducts. Used in biological research, agriculture, pollution control, and archeology.

Cesium-137

Used to measure correct patient dosages of radioactive pharmaceuticals; to measure and control the liquid flow in oil pipelines; to tell researchers whether oil wells are plugged by sand; and to ensure the right fill level for packages of food, drugs, and other products. (The products in these packages do not become radioactive.)

Chromium-51

Used in research in red blood cell survival studies.

Cobalt-57

Used as a tracer to diagnose pernicious anemia.

Cobalt-60

Used to sterilize surgical instruments and to improve the safety and reliability of industrial fuel oil burners. Used in cancer treatment, food irradiation, gauges, and radiography.

Curium-244

Used in mining to analyze material excavated from pits and slurries from drilling operations.

Fluorine-18

Used for positron emission imaging in medical diagnosis.

Gallium-68

Used for positron emission imaging in medical diagnosis.

Iodine-123

Widely used to diagnose thyroid disorders and other metabolic disorders including brain function.

Iodine-125

Major diagnostic tool used in clinical tests and to diagnose thyroid disorders. Also used in biomedical research.

Iodine-129

Used to check some radioactivity counters at in vitro diagnostic testing laboratories.

Iodine-131

Used to treat thyroid disorders.

Iridium-192

Used to test the integrity of pipeline welds, boilers, and aircraft parts and in brachytherapy/tumor irradiation.

Iron-55

Used to analyze electroplating solutions and to detect the presence of sulphur in the air. Used in metabolism research.

Krypton-85

Used in indicator lights in appliances such as clothes washers and dryers, stereos, and coffee makers; to gauge the thickness of thin plastics and sheet metal, rubber, textiles, and paper; and to measure dust and pollutant levels.

Lutecium-177

Used as part of radiopharmaceuticals for treatment of cancer.

Nickel-63

Used to detect explosives, in voltage regulators and current surge protectors in electronic devices, and in electron capture detectors for gas chromatographs.

Phosphorus-32

Used in molecular biology and genetics research.

Phosphorus-33

Used in molecular biology and genetics research.

Plutonium-238

Has powered more than 20 NASA spacecraft since 1972. (The most common radioisotopes of plutonium are Pu-238, Pu-239, and Pu-240.)

Polonium-210

Reduces the static charge in production of photographic film and other materials.

Promethium-147

Used in electric blanket thermostats and to gauge the thickness of thin plastics, thin sheet metal, rubber, textiles, and paper.

Radium-226

Makes lighting rods more effective. (The most common isotopes of radium are Ra-226 and Ra-228. Radium-226 is part of the uranium decay series. Radium-228 and Ra-224 are part of the thorium decay series. All isotopes of radium are radioactive. Radium decays to produce radon gas.)

Selenium-75

Used in protein studies in life science research.

Sodium-24

Used to locate leaks in industrial pipe lines and in oil well studies.

Strontium-85

Used to study bone formation and metabolism.

Strontium-90

Used in survey meters by schools, the military, and emergency management authorities. Also used in cigarette manufacturing sensors and medical treatment.

Sulphur-35

Used in genetics and molecular biology research.

Technetium-99m

The most widely used radioactive pharmaceutical for diagnostic studies in nuclear medicine. Different chemical forms are used for brain, bone, liver, spleen, and kidney imaging and also for blood flow studies.

Thallium-201

Used in nuclear medicine for nuclear cardiology and tumor detection.

Thallium-204

Used to measure dust and pollutant levels on filter paper and to gauge the thickness of plastics, sheet metal, rubber, textiles, and paper.

Thorium-229

Helps fluorescent lights last longer.

Thorium-232

As thoriated tungsten, used in electric arc welding rods in construction, aircraft, petrochemical, and food processing equipment industries.

Thorium-230

Provides coloring and fluorescence in colored glazes and glassware.

Tritium

Major tool for biomedical research. Used for life science and drug metabolism studies to ensure the safety of potential new drugs; for luminous exit signs; for luminous dials, gauges, and wrist watches; to produce luminous paint; and for geological prospecting and hydrology.

Uranium-235

Fuel for nuclear power plants and naval nuclear propulsion systems; previously used to produce fluorescent glassware, a variety of colored glazes, and wall tiles.

Xenon-133

Used in nuclear medicine for lung ventilation and blood flow studies.

Yttrium-90

Used as microsphere brachytherapy for treatment of liver cancers.

Source: [NUREG/BR-0217, Revision 1, "The Regulation and Use of Radioisotopes in Today's World," April 2000.](#) For more information visit the following web pages:
 EPA at <https://www.epa.gov/radiation/radionuclides>
 FDA at <https://www.fda.gov/radiation-emitting-products>
 National Nuclear Data Center at <https://www.nndc.bnl.gov/>

PERIODIC TABLE OF ELEMENTS																					
1 H Hydrogen																	2 He Helium				
3 Li Lithium	4 Be Beryllium															5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium															13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton				
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon				
55 Cs Caesium	56 Ba Barium	57 La [*] Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon				
87 Fr Francium	88 Ra Radium	89 Ac ^{**} Actinium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson				

RADIOACTIVE ELEMENTS
 Radioactive elements have no stable isotopes.

[*] 58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
^{**} 90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium