

## Chapter DHS 157

### APPENDIX A

Element (atomic number)	Radionuclide	Exempt Concentrations	
		Column I Gas concentration $\mu\text{Ci/ml 1/}$	Column II Liquid and solid concentration $\mu\text{Ci/ml 2/}$
Antimony (51)	Sb-122		$3 \times 10^{-4}$
	Sb-124		$2 \times 10^{-4}$
	Sb-125		$1 \times 10^{-3}$
Argon (18)	Ar-37	$1 \times 10^{-3}$	
	Ar-41	$4 \times 10^{-7}$	
Arsenic (33)	As-73		$5 \times 10^{-3}$
	As-74		$5 \times 10^{-4}$
	As-76		$2 \times 10^{-4}$
	As-77		$8 \times 10^{-4}$
Barium (56)	Ba-131		$2 \times 10^{-3}$
	Ba-140		$3 \times 10^{-4}$
Beryllium (4)	Be-7		$2 \times 10^{-2}$
Bismuth (83)	Bi-206		$4 \times 10^{-4}$
Bromine (35)	Br-82	$4 \times 10^{-7}$	$3 \times 10^{-3}$
Cadmium (48)	Cd-109		$2 \times 10^{-3}$
	Cd-115m		$3 \times 10^{-4}$
	Cd-115		$3 \times 10^{-4}$
Calcium (20)	Ca-45		$9 \times 10^{-5}$
	Ca-47		$5 \times 10^{-4}$
Carbon (6)	C-14	$1 \times 10^{-6}$	$8 \times 10^{-3}$
Cerium (58)	Ce-141		$9 \times 10^{-4}$
	Ce-143		$4 \times 10^{-4}$
	Ce-144		$1 \times 10^{-4}$
Cesium (55)	Cs-131		$2 \times 10^{-2}$
	Cs-134m		$6 \times 10^{-2}$
	Cs-134		$9 \times 10^{-5}$
Chlorine (17)	Cl-38	$9 \times 10^{-7}$	$4 \times 10^{-3}$
Chromium (24)	Cr-51		$2 \times 10^{-2}$
Cobalt (27)	Co-57		$5 \times 10^{-3}$
	Co-58		$1 \times 10^{-3}$
	Co-60		$5 \times 10^{-4}$
Copper (29)	Cu-64		$3 \times 10^{-3}$
Dysprosium (66)	Dy-165		$4 \times 10^{-3}$
	Dy-166		$4 \times 10^{-4}$
Erbium (68)	Er-169		$9 \times 10^{-4}$
	Er-171		$1 \times 10^{-3}$
Europium (63)	Eu-152(9.2 h)		$6 \times 10^{-4}$
	Eu-155		$2 \times 10^{-3}$
Fluorine (9)	F-18	$2 \times 10^{-6}$	$8 \times 10^{-3}$

1/ Values are given in Column I only for those materials normally used as gases.

2/  $\mu\text{Ci/g}$  for solids

Element (atomic number)	Radionuclide	Column I Gas concentration $\mu\text{Ci/ml 1/}$	Column II Liquid and solid concentration $\mu\text{Ci/ml 2/}$
Gadolinium (64)	Gd-153		$2 \times 10^{-3}$
	Gd-159		$8 \times 10^{-4}$
Gallium (31)	Ga-72		$4 \times 10^{-4}$
Germanium (32)	Ge-71		$2 \times 10^{-2}$
Gold (79)	Au-196		$2 \times 10^{-3}$
	Au-198		$5 \times 10^{-4}$
	Au-199		$2 \times 10^{-3}$
Hafnium (72)	Hf-181		$7 \times 10^{-4}$
Hydrogen (1)	H-3	$5 \times 10^{-6}$	$3 \times 10^{-2}$
Indium (49)	In-113m		$1 \times 10^{-2}$
	In-114m		$2 \times 10^{-4}$
Iodine (53)	I-126	$3 \times 10^{-9}$	$2 \times 10^{-5}$
	I-131	$3 \times 10^{-9}$	$2 \times 10^{-5}$
	I-132	$8 \times 10^{-8}$	$6 \times 10^{-4}$
	I-133	$1 \times 10^{-8}$	$7 \times 10^{-5}$
	I-134	$2 \times 10^{-7}$	$1 \times 10^{-3}$
Iridium (77)	Ir-190		$2 \times 10^{-3}$
	Ir-192		$4 \times 10^{-4}$
	Ir-194		$3 \times 10^{-4}$
Iron (26)	Fe-55		$8 \times 10^{-3}$
	Fe-59		$6 \times 10^{-4}$
Krypton (36)	Kr-85m	$1 \times 10^{-6}$	
	Kr-85	$3 \times 10^{-6}$	
Lanthanum (57)	La-140		$2 \times 10^{-4}$
Lead (82)	Pb-203		$4 \times 10^{-3}$
Lutetium (71)	Lu-177		$1 \times 10^{-3}$
Manganese (25)	Mn-52		$3 \times 10^{-4}$
	Mn-54		$1 \times 10^{-3}$
	Mn-56		$1 \times 10^{-3}$
Mercury (80)	Hg-197m		$2 \times 10^{-3}$
	Hg-197		$3 \times 10^{-3}$
	Hg-203		$2 \times 10^{-4}$
Molybdenum (42)	Mo-99		$2 \times 10^{-3}$
Neodymium (60)	Nd-147		$6 \times 10^{-4}$
	Nd-149		$3 \times 10^{-3}$
Nickel (28)	Ni-65		$1 \times 10^{-3}$
Niobium (Columbium) (41)	Nb-95		$1 \times 10^{-3}$
	Nb-97		$9 \times 10^{-3}$
Osmium (76)	Os-185		$7 \times 10^{-4}$
	Os-191m		$3 \times 10^{-2}$
	Os-191		$2 \times 10^{-3}$
Palladium (46)	Os-193		$6 \times 10^{-4}$
	Pd-103		$3 \times 10^{-3}$
Phosphorus (15)	Pd-109		$9 \times 10^{-4}$
	P-32		$2 \times 10^{-4}$
Platinum (78)	Pt-191		$1 \times 10^{-3}$
	Pt-193m		$1 \times 10^{-2}$

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2/  $\mu\text{Ci/g}$  for solids

Element (atomic number)	Radionuclide	Column I Gas concentration $\mu\text{Ci/ml}$ 1/	Column II Liquid and solid concentration $\mu\text{Ci/ml}$ 2/
	Pt-197m		$1 \times 10^{-2}$
	Pt-197		$1 \times 10^{-3}$
Potassium (19)	K-42		$3 \times 10^{-3}$
Praseodymium (59)	Pr-142		$3 \times 10^{-4}$
	Pr-143		$5 \times 10^{-4}$
Promethium (61)	Pm-147		$2 \times 10^{-3}$
	Pm-149		$4 \times 10^{-4}$
Rhenium (75)	Re-183		$6 \times 10^{-3}$
	Re-186		$9 \times 10^{-4}$
	Re-188		$6 \times 10^{-4}$
Rhodium (45)	Rh-103m		$1 \times 10^{-1}$
	Rh-105		$1 \times 10^{-3}$
Rubidium (37)	Rb-86		$7 \times 10^{-4}$
Ruthenium (44)	Ru-97		$4 \times 10^{-3}$
	Ru-103		$8 \times 10^{-4}$
	Ru-105		$1 \times 10^{-3}$
	Ru-106		$1 \times 10^{-4}$
Samarium (62)	Sm-153		$8 \times 10^{-4}$
Scandium (21)	Sc-46		$4 \times 10^{-4}$
	Sc-47		$9 \times 10^{-4}$
	Sc-48		$3 \times 10^{-4}$
Selenium (34)	Se-75		$3 \times 10^{-3}$
Silicon (14)	Si-31		$9 \times 10^{-3}$
Silver (47)	Ag-105		$1 \times 10^{-3}$
	Ag-110m		$3 \times 10^{-4}$
	Ag-111		$4 \times 10^{-4}$
Sodium (11)	Na-24		$2 \times 10^{-3}$
Strontium (38)	Sr-85		$1 \times 10^{-3}$
	Sr-89		$1 \times 10^{-4}$
	Sr-91		$7 \times 10^{-4}$
	Sr-92		$7 \times 10^{-4}$
Sulfur (16)	S-35	$9 \times 10^{-8}$	$6 \times 10^{-4}$
Tantalum (73)	Ta-182		$4 \times 10^{-4}$
Technetium (43)	Tc-96m		$1 \times 10^{-1}$
	Tc-96		$1 \times 10^{-3}$
Tellurium (52)	Te-125m		$2 \times 10^{-3}$
	Te-127m		$6 \times 10^{-4}$
	Te-127		$3 \times 10^{-3}$
	Te-129m		$3 \times 10^{-4}$
	Te-131m		$6 \times 10^{-4}$
	Te-132		$3 \times 10^{-4}$
Terbium (65)	Tb-160		$4 \times 10^{-4}$
Thallium (81)	Tl-200		$4 \times 10^{-3}$
	Tl-201		$3 \times 10^{-3}$

	Tl-202	1X10 <sup>-3</sup>
	Tl-204	1X10 <sup>-3</sup>
Thulium (69)	Tm-170	5X10 <sup>-4</sup>

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Element (atomic number)	Radionuclide	Column I Gas concentration $\mu\text{Ci/ml}$ 1/	Column II Liquid and solid concentration $\mu\text{Ci/ml}$ 2/
	Tm-171		5X10 <sup>-3</sup>
Tin (50)	Sn-113		9X10 <sup>-4</sup>
	Sn-125		2X10 <sup>-4</sup>
Tungsten (Wolfram) (74)	W-181		4X10 <sup>-3</sup>
	W-187		7X10 <sup>-4</sup>
Vanadium (23)	V-48		3X10 <sup>-4</sup>
Xenon (54)	Xe-131m	4X10 <sup>-6</sup>	
	Xe-133	3X10 <sup>-6</sup>	
	Xe-135	1X10 <sup>-6</sup>	
Ytterbium (70)	Yb-175		1X10 <sup>-3</sup>
Yttrium (39)	Y-90		2X10 <sup>-4</sup>
	Y-91m		3X10 <sup>-2</sup>
	Y-91		3X10 <sup>-4</sup>
	Y-92		6X10 <sup>-4</sup>
	Y-93		3X10 <sup>-4</sup>
Zinc (30)	Zn-65		1X10 <sup>-3</sup>
	Zn-69m		7X10 <sup>-4</sup>
	Zn-69		2X10 <sup>-2</sup>
Zirconium (40)	Zr-95		6X10 <sup>-4</sup>
	Zr-97		2X10 <sup>-4</sup>
Beta- and gamma-emitting radioactive material not listed above with half-life of less than 3 years.		1X10 <sup>-10</sup>	1X10 <sup>-6</sup>

**Note 1:** Many radionuclides transform into other radionuclides. In expressing the concentrations in Appendix A, the activity stated is that of the parent radionuclide and takes into account the radioactive decay products.

**Note 2:** For purposes of s. DHS 157.09 (2) where there is involved a combination of radionuclides, the limit for the combination should be derived as follows: Determine for each radionuclide in the product the ratio between the radioactivity concentration present in the product and the exempt radioactivity concentration established in Appendix A for the specific radionuclide when not in combination. The sum of such ratios may not exceed "1".

Example: 
$$\frac{\text{Concentration of Radionuclide A in Product} + \text{Exempt concentration of Radionuclide A}}{\text{Concentration of Radionuclide B in Product} + \text{Exempt concentration of Radionuclide B}} \leq 1$$

**Note 3:** To convert  $\mu\text{Ci/ml}$  to SI units of megabecquerels per liter multiply the above values by 37.

Example: Zirconium (40) Zr-97 (2x10<sup>-4</sup>  $\mu\text{Ci/ml}$ ) multiplied by 37 is equivalent to 74 x 10<sup>-4</sup> MBq/l).

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