The repeal, subchapters I, III, IV, V, VIII through XV and all Appendices contained in this chapter shall take effect on the first day of the month following publication in the Wisconsin Administrative Register, as provided in s. 227.22 (2), Stats. Subchapters II, VI and VII shall take effect 30 days after signature by the Governor of an agreement transferring regulatory authority over byproduct, source and special nuclear material to the State of Wisconsin.

Wisconsin Department of Health
and Family Services

Dated:

By: _____
Phyllis J. Dubé
Secretary

SEAL:

APPENDIX A

EXEMPT CONCENTRATIONS

Element (atomic number)	Radionuclide	Column I Gas concentration µCi/ml 1/	Column II Liquid and solid concentration µCi/ml 2/
Antimony (51)	Sb-122		$3X10^{-4}$
	Sb-124		$2X10^{-4}$
	Sb-125		$1X10^{-3}$
Argon (18)	Ar-37	$1X10^{-3}$	
	Ar-41	$4X10^{-7}$	
Arsenic (33)	As-73		$5X10^{-3}$
	As-74		$5X10^{-4}$
	As-76		$2X10^{-4}$
	As-77		$8X10^{-4}$
Barium (56)	Ba-131		$2X10^{-3}$
	Ba-140		$3X10^{-4}$
Beryllium (4)	Be-7		$2X10^{-2}$
Bismuth (83)	Bi-206		$4X10^{-4}$
Bromine (35)	Br-82	$4X10^{-7}$	$3X10^{-3}$
Cadmium (48)	Cd-109		$2X10^{-3}$
	Cd-115m		$3X10^{-4}$
	Cd-115		$3X10^{-4}$
Calcium (20)	Ca-45		$9X10^{-5}$
	Ca-47		$5X10^{-4}$
Carbon (6)	C-14	$1X10^{-6}$	$8X10^{-3}$
Cerium (58)	Ce-141		$9X10^{-4}$
	Ce-143		$4X10^{-4}$
	Ce-144		$1X10^{-4}$
Cesium (55)	Cs-131		$2X10^{-2}$
	Cs-134m		$6X10^{-2}$
	Cs-134		$9X10^{-5}$
Chlorine (17)	Cl-38	$9X10^{-7}$	$4X10^{-3}$
Chromium (24)	Cr-51		$2X10^{-2}$
Cobalt (27)	Co-57		$5X10^{-3}$
	Co-58		$1X10^{-3}$
	Co-60		$5X10^{-4}$

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

Element (atomic number)	Radionuclide	Column I Gas concentration µCi/ml 1/	Column II Liquid and solid concentration µCi/ml 2/
Copper (29)	Cu-64		$3X10^{-3}$
Dysprosium (66)	Dy-165		$4X10^{-3}$
	Dy-166		$4X10^{-4}$
Erbium (68)	Er-169		$9X10^{-4}$
	Er-171		$1X10^{-3}$
Europium (63)	Eu-152(9.2 h)		$6X10^{-4}$
	Eu-155		$2X10^{-3}$
Fluorine (9)	F-18	$2X10^{-6}$	$8X10^{-3}$
Gadolinium (64)	Gd-153		$2X10^{-3}$
	Gd-159		$8X10^{-4}$
Gallium (31)	Ga-72		$4X10^{-4}$
Germanium (32)	Ge-71		$2X10^{-2}$
Gold (79)	Au-196		$2X10^{-3}$
	Au-198		$5X10^{-4}$
	Au-199		$2X10^{-3}$
Hafnium (72)	Hf-181		$7X10^{-4}$
Hydrogen (1)	H-3	$5X10^{-6}$	$3X10^{-2}$
Indium (49)	In-113m		$1X10^{-2}$
	In-114m		$2X10^{-4}$
Iodine (53)	I-126	$3X10^{-9}$	$2X10^{-5}$
	I-131	$3X10^{-9}$	$2X10^{-5}$
	I-132	$8X10^{-8}$	$6X10^{-4}$
	I-133	$1X10^{-8}$	$7X10^{-5}$
	I-134	$2X10^{-7}$	$1X10^{-3}$
Iridium (77)	Ir-190		$2X10^{-3}$
	Ir-192		$4X10^{-4}$
	Ir-194		$3X10^{-4}$
Iron (26)	Fe-55		$8X10^{-3}$
	Fe-59		$6X10^{-4}$
Krypton (36)	Kr-85m	$1X10^{-6}$	
	Kr-85	$3X10^{-6}$	
Lanthanum (57)	La-140		$2X10^{-4}$
Lead (82)	Pb-203		$4X10^{-3}$
Lutetium (71)	Lu-177		$1X10^{-3}$

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

Element (atomic number)	Radionuclide	Column I Gas concentration µCi/ml 1/	Column II Liquid and solid concentration µCi/ml 2/
Manganese (25)	Mn-52		$3X10^{-4}$
	Mn-54		$1X10^{-3}$
	Mn-56		$1X10^{-3}$
Mercury (80)	Hg-197m		$2X10^{-3}$
	Hg-197		$3X10^{-3}$
	Hg-203		$2X10^{-4}$
Molybdenum (42)	Mo-99		$2X10^{-3}$
Neodymium (60)	Nd-147		$6X10^{-4}$
	Nd-149		$3X10^{-3}$
Nickel (28)	Ni-65		$1X10^{-3}$
Niobium (Columbium) (41)	Nb-95		$1X10^{-3}$
	Nb-97		$9X10^{-3}$
Osmium (76)	Os-185		$7X10^{-4}$
	Os-191m		$3X10^{-2}$
	Os-191		$2X10^{-3}$
	Os-193		$6X10^{-4}$
Palladium (46)	Pd-103		$3X10^{-3}$
	Pd-109		$9X10^{-4}$
Phosphorus (15)	P-32		$2X10^{-4}$
Platinum (78)	Pt-191		$1X10^{-3}$
	Pt-193m		$1X10^{-2}$
	Pt-197m		$1X10^{-2}$
	Pt-197		$1X10^{-3}$
Potassium (19)	K-42		$3X10^{-3}$
Praseodymium (59)	Pr-142		$3X10^{-4}$
	Pr-143		$5X10^{-4}$
Promethium (61)	Pm-147		$2X10^{-3}$
	Pm-149		$4X10^{-4}$
Rhenium (75)	Re-183		$6X10^{-3}$
	Re-186		$9X10^{-4}$
	Re-188		$6X10^{-4}$
Rhodium (45)	Rh-103m		$1X10^{-1}$
	Rh-105		$1X10^{-3}$
Rubidium (37)	Rb-86		$7X10^{-4}$

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

Element (atomic number)	Radionuclide	Column I Gas concentration µCi/ml 1/	Column II Liquid and solid concentration µCi/ml 2/
Ruthenium (44)	Ru-97		$4X10^{-3}$
	Ru-103		$8X10^{-4}$
	Ru-105		$1X10^{-3}$
	Ru-106		$1X10^{-4}$
Samarium (62)	Sm-153		$8X10^{-4}$
Scandium (21)	Sc-46		$4X10^{-4}$
	Sc-47		$9X10^{-4}$
	Sc-48		$3X10^{-4}$
Selenium (34)	Se-75		$3X10^{-3}$
Silicon (14)	Si-31		$9X10^{-3}$
Silver (47)	Ag-105		$1X10^{-3}$
	Ag-110m		$3X10^{-4}$
	Ag-111		$4X10^{-4}$
Sodium (11)	Na-24		$2X10^{-3}$
Strontium (38)	Sr-85		$1X10^{-3}$
	Sr-89		$1X10^{-4}$
	Sr-91		$7X10^{-4}$
	Sr-92		$7X10^{-4}$
Sulfur (16)	S-35	$9X10^{-8}$	$6X10^{-4}$
Tantalum (73)	Ta-182		$4X10^{-4}$
Technetium (43)	Tc-96m		$1X10^{-1}$
	Tc-96		$1X10^{-3}$
Tellurium (52)	Te-125m		$2X10^{-3}$
	Te-127m		$6X10^{-4}$
	Te-127		$3X10^{-3}$
	Te-129m		$3X10^{-4}$
	Te-131m		$6X10^{-4}$
	Te-132		$3X10^{-4}$
Terbium (65)	Tb-160		$4X10^{-4}$
Thallium (81)	Tl-200		$4X10^{-3}$
	Tl-201		$3X10^{-3}$
	Tl-202		$1X10^{-3}$
	Tl-204		$1X10^{-3}$
Thulium (69)	Tm-170		$5X10^{-4}$
	Tm-171		$5X10^{-3}$

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

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

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. HFS 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".

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

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

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

Note 3: To convert μCi/ml to SI units of megabecquerels per liter multiply the above values by 37.

Example: Zirconium (40) Zr-97 (2×10^{-4} μCi/ml multiplied by 37 is equivalent to 74×10^{-4} MBq/l).

APPENDIX B

EXEMPT QUANTITIES

Radioactive Material	Microcuries
Antimony-122 (Sb 122)	100
Antimony-124 (Sb 124)	10
Antimony-125 (Sb 125)	10
Arsenic-73 (As 73)	100
Arsenic-74 (As 74)	10
Arsenic-76 (As 76)	10
Arsenic-77 (As 77)	100
Barium-131 (Ba 131)	10
Barium-133 (Ba 133)	10
Barium-140 (Ba 140)	10
Bismuth-210 (Bi 210)	1
Bromine-82 (Br 82)	10
Cadmium-109 (Cd 109)	10
Cadmium-115m (Cd 115m)	10
Cadmium-115 (Cd 115)	100
Calcium-45 (Ca 45)	10
Calcium-47 (Ca 47)	10
Carbon-14 (C 14)	100
Cerium-141 (Ce 141)	100
Cerium-143 (Ce 143)	100
Cerium-144 (Ce 144)	1
Cesium-129 (Cs 129)	100
Cesium-131 (Cs 131)	1,000
Cesium-134m (Cs 134m)	100
Cesium-134 (Cs 134)	1
Cesium-135 (Cs 135)	10
Cesium-136 (Cs 136)	10
Cesium-137 (Cs 137)	10
Chlorine-36 (Cl 36)	10
Chlorine-38 (Cl 38)	10
Chromium-51 (Cr 51)	1,000
Cobalt-57 (Co 57)	100
Cobalt-58m (Co 58m)	10
Cobalt-58 (Co 58)	10
Cobalt-60 (Co 60)	1
Copper-64 (Cu 64)	100
Dysprosium-165 (Dy 165)	10
Dysprosium-166 (Dy 166)	100
Erbium-169 (Er 169)	100
Erbium-171 (Er 171)	100

Radioactive Material	Microcuries
Europium-152 (Eu 152)9.2h	100
Europium-152 (Eu 152)13 yr	1
Europium-154 (Eu 154)	1
Europium-155 (Eu 155)	10
Fluorine-18 (F 18)	1,000
Gadolinium-153 (Gd 153)	10
Gadolinium-159 (Gd 159)	100
Gallium-67 (Ga 67)	100
Gallium-72 (Ga 72)	10
Germanium-68 (Ge 68)	10
Germanium-71 (Ge 71)	100
Gold-195 (Au 195)	10
Gold-198 (Au 198)	100
Gold-199 (Au 199)	100
Hafnium-181 (Hf 181)	10
Holmium-166 (Ho 166)	100
Hydrogen-3 (H 3)	1,000
Indium-111 (In 111)	100
Indium-113m (In 113m)	100
Indium-114m (In 114m)	10
Indium-115m (In 115m)	100
Indium-115 (In 115)	10
Iodine-123 (I 123)	100
Iodine-125 (I 125)	1
Iodine-126 (I 126)	1
Iodine-129 (I 129)	0.1
Iodine-131 (I 131)	1
Iodine-132 (I 132)	10
Iodine-133 (I 133)	1
Iodine-134 (I 134)	10
Iodine-135 (I 135)	10
Iridium-192 (Ir 192)	10
Iridium-194 (Ir 194)	100
Iron-52 (Fe 52)	10
Iron-55 (Fe 55)	100
Iron-59 (Fe 59)	10
Krypton-85 (Kr 85)	100
Krypton-87 (Kr 87)	10
Lanthanum-140 (La 140)	10
Lutetium-177 (Lu 177)	100
Manganese-52 (Mn 52)	10
Manganese-54 (Mn 54)	10
Manganese-56 (Mn 56)	10
Mercury-197m (Hg 197m)	100

Radioactive Material	Microcuries
Mercury-197 (Hg 197)	100
Mercury-203 (Hg 203)	10
Molybdenum-99 (Mo 99)	100
Neodymium-147 (Nd 147)	100
Neodymium-149 (Nd 149)	100
Nickel-59 (Ni 59)	100
Nickel-63 (Ni 63)	10
Nickel-65 (Ni 65)	100
Niobium-93m (Nb 93m)	10
Niobium-95 (Nb 95)	10
Niobium-97 (Nb 97)	10
Osmium-185 (Os 185)	10
Osmium-191m (Os 191m)	100
Osmium-191 (Os 191)	100
Osmium-193 (Os 193)	100
Palladium-103 (Pd 103)	100
Palladium-109 (Pd 109)	100
Phosphorus-32 (P 32)	10
Platinum-191 (Pt 191)	100
Platinum-193m (Pt 193m)	100
Platinum-193 (Pt 193)	100
Platinum-197m (Pt 197m)	100
Platinum-197 (Pt 197)	100
Polonium-210 (Po 210)	0.1
Potassium-42 (K 42)	10
Potassium-43 (K 43)	10
Praseodymium-142 (Pr 142)	100
Praseodymium-143 (Pr 143)	100
Promethium-147 (Pm 147)	10
Promethium-149 (Pm 149)	10
Rhenium-186 (Re 186)	100
Rhenium-188 (Re 188)	100
Rhodium-103m (Rh 103m)	100
Rhodium-105 (Rh 105)	100
Rubidium-81 (Rb 81)	10
Rubidium-86 (Rb 86)	10
Rubidium-87 (Rb 87)	10
Ruthenium-97 (Ru 97)	100
Ruthenium-103 (Ru 103)	10
Ruthenium-105 (Ru 105)	10
Ruthenium-106 (Ru 106)	1
Samarium-151 (Sm 151)	10
Samarium-153 (Sm 153)	100
Scandium-46 (Sc 46)	10

Radioactive Material	Microcuries
Scandium-47 (Sc 47)	100
Scandium-48 (Sc 48)	10
Selenium-75 (Se 75)	10
Silicon-31 (Si 31)	100
Silver-105 (Ag 105)	10
Silver-110m (Ag 110m)	1
Silver-111 (Ag 111)	100
Sodium-22 (Na 22)	10
Sodium-24 (Na 24)	10
Strontium-85 (Sr 85)	10
Strontium-89 (Sr 89)	1
Strontium-90 (Sr 90)	0.1
Strontium-91 (Sr 91)	10
Strontium-92 (Sr 92)	10
Sulphur-35 (S 35)	100
Tantalum-182 (Ta 182)	10
Technetium-96 (Tc 96)	10
Technetium-97m (Tc 97m)	100
Technetium-97 (Tc 97)	100
Technetium-99m (Tc 99m)	100
Technetium-99 (Tc 99)	10
Tellurium-125m (Te 125m)	10
Tellurium-127m (Te 127m)	10
Tellurium-127 (Te 127)	100
Tellurium-129m (Te 129m)	10
Tellurium-129 (Te 129)	100
Tellurium-131m (Te 131m)	10
Tellurium-132 (Te 132)	10
Terbium-160 (Tb 160)	10
Thallium-200 (Tl 200)	100
Thallium-201 (Tl 201)	100
Thallium-202 (Tl 202)	100
Thallium-204 (Tl 204)	10
Thulium-170 (Tm 170)	10
Thulium-171 (Tm 171)	10
Tin-113 (Sn 113)	10
Tin-125 (Sn 125)	10
Tungsten-181 (W 181)	10
Tungsten-185 (W 185)	10
Tungsten-187 (W 187)	100
Vanadium-48 (V 48)	10
Xenon-131m (Xe 131m)	1,000
Xenon-133 (Xe 133)	100
Xenon-135 (Xe 135)	100

Radioactive Material	Microcuries
Ytterbium-175 (Yb 175)	100
Yttrium-87 (Y 87)	10
Yttrium-88 (Y 88)	10
Yttrium-90 (Y 90)	10
Yttrium-91 (Y 91)	10
Yttrium-92 (Y 92)	100
Yttrium-93 (Y 93)	100
Zinc-65 (Zn 65)	10
Zinc-69m (Zn 69m)	100
Zinc-69 (Zn 69)	1,000
Zirconium-93 (Zr 93)	10
Zirconium-95 (Zr 95)	10
Zirconium-97 (Zr 97)	10
Any radioactive material not listed above other than alpha-emitting radioactive material	0.1

Note 1: Where there is a combination of radionuclides, the limit for the combination should be derived as follows:

Determine the amount of each radionuclide possessed and 1,000 times the amount in Appendix B for each of those radionuclides when not in combination. The sum of the ratios of those quantities may not exceed 1.

Example:

$$\frac{\text{Amt. of Radionuclide A possessed}}{\text{1000 x Appendix B quantity for Radionuclide A}} + \frac{\text{Amt. of Radionuclide B possessed}}{\text{1000 x Appendix B quantity for Radionuclide B}} \leq 1$$

Note 2: To convert microcuries (μCi) to SI units of kilobecquerels (kBq), multiply the above values by 37.

Example: Zirconium-97 (10 μCi multiplied by 37 is equivalent to 370 kBq).

APPENDIX C

LIMITS FOR BROAD LICENSES

Radioactive Material	Type B License Column I curies	Type C License Column II curies
Antimony-122	1	0.01
Antimony-124	1	0.01
Antimony-125	1	0.01
Arsenic-73	10	0.1
Arsenic-74	1	0.01
Arsenic-76	1	0.01
Arsenic-77	10	0.1
Barium-131	10	0.1
Barium-140	1	0.01
Beryllium-7	10	0.1
Bismuth-210	0.1	0.001
Bromine-82	10	0.1
Cadmium-109	1	0.01
Cadmium-115m	1	0.01
Cadmium-115	10	0.1
Calcium-45	1	0.01
Calcium-47	10	0.1
Carbon-14	100	1.
Cerium-141	10	0.1
Cerium-143	10	0.1
Cerium-144	0.1	0.001
Cesium-131	100	1.
Cesium-134m	100	1.
Cesium-134	0.1	0.001
Cesium-135	1	0.01
Cesium-136	10	0.1
Cesium-137	0.1	0.001
Chlorine-36	1	0.01
Chlorine-38	100	1.
Chromium-51	100	1.
Cobalt-57	10	0.1
Cobalt-58m	100	1.
Cobalt-58	1	0.01
Cobalt-60	0.1	0.001
Copper-64	10	0.1
Dysprosium-165	100	1.
Dysprosium-166	10	0.1

Radioactive Material	Type B License Column I curies	Type C License Column II curies
Erbium-169	10	0.1
Erbium-171	10	0.1
Europium-152 (9.2 h)	10	0.1
Europium-152 (13 y)	0.1	0.001
Europium-154	0.1	0.001
Europium-155	1	0.01
Fluorine-18	100	1.
Gadolinium-153	1	0.01
Gadolinium-159	10	0.1
Gallium-72	10	0.1
Germanium-71	100	1.
Gold-198	10	0.1
Gold-199	10	0.1
Hafnium-181	1	0.01
Holmium-166	10	0.1
Hydrogen-3	100	1.
Indium-113m	100	1.
Indium-114m	1	0.01
Indium-115m	100	1.
Indium-115	1	0.01
Iodine-125	0.1	0.001
Iodine-126	0.1	0.001
Iodine-129	0.1	0.001
Iodine-131	0.1	0.001
Iodine-132	10	0.1
Iodine-133	1	0.01
Iodine-134	10	0.1
Iodine-135	1	0.01
Iridium-192	1	0.01
Iridium-194	10	0.1
Iron-55	10	0.1
Iron-59	1	0.01
Krypton-85	100	1.
Krypton-87	10	0.1
Lanthanum-140	1	0.01
Lutetium-177	10	0.1
Manganese-52	1	0.01
Manganese-54	1	0.01
Manganese-56	10	0.1
Mercury-197m	10	0.1
Mercury-197	10	0.1
Mercury-203	1	0.01

Radioactive Material	Type B License Column I curies	Type C License Column II curies
Molybdenum-99	10	0.1
Neodymium-147	10	0.1
Neodymium-149	10	0.1
Nickel-59	10	0.1
Nickel-63	1	0.01
Nickel-65	10	0.1
Niobium-93m	1	0.01
Niobium-95	1	0.01
Niobium-97	100	1.
Osmium-185	1	0.01
Osmium-191m	100	1.
Osmium-191	10	0.1
Osmium-193	10	0.1
Palladium-103	10	0.1
Palladium-109	10	0.1
Phosphorus-32	1	0.01
Platinum-191	10	0.1
Platinum-193m	100	1.
Platinum-193	10	0.1
Platinum-197m	100	1.
Platinum-197	10	0.1
Polonium-210	0.01	0.0001
Potassium-42	1	0.01
Praseodymium-142	10	0.1
Praseodymium-143	10	0.1
Promethium-147	1	0.01
Promethium-149	10	0.1
Radium-226	0.01	0.0001
Rhenium-186	10	0.1
Rhenium-188	10	0.1
Rhodium-103m	1,000	10.
Rhodium-105	10	0.1
Rubidium-86	1	0.01
Rubidium-87	1	0.01
Ruthenium-97	100	1.
Ruthenium-103	1	0.01
Ruthenium-105	10	0.1
Ruthenium-106	0.1	0.001
Samarium-151	1	0.01
Samarium-153	10	0.1
Scandium-46	1	0.01
Scandium-47	10	0.1

Radioactive Material	Type B License Column I curies	Type C License Column II curies
Scandium-48	1	0.01
Selenium-75	1	0.01
Silicon-31	10	0.1
Silver-105	1	0.01
Silver-110m	0.1	0.001
Silver-111	10	0.1
Sodium-22	0.1	0.001
Sodium-24	1	0.01
Strontium-85m	1,000	10.
Strontium-85	1	0.01
Strontium-89	1	0.01
Strontium-90	0.01	0.0001
Strontium-91	10	0.1
Strontium-92	10	0.1
Sulphur-35	10	0.1
Tantalum-182	1	0.01
Technetium-96	10	0.1
Technetium-97m	10	0.1
Technetium-97	10	0.1
Technetium-99m	100	1.
Technetium-99	1	0.01
Tellurium-125m	1	0.01
Tellurium-127m	1	0.01
Tellurium-127	10	0.1
Tellurium-129m	1	0.01
Tellurium-129	100	1.
Tellurium-131m	10	0.1
Tellurium-132	1	0.01
Terbium-160	1	0.01
Thallium-200	10	0.1
Thallium-201	10	0.1
Thallium-202	10	0.1
Thallium-204	1	0.01
Thulium-170	1	0.01
Thulium-171	1	0.01
Tin-113	1	0.01
Tin-125	1	0.01
Tungsten-181	1	0.01
Tungsten-185	1	0.01
Tungsten-187	10	0.1
Vanadium-48	1	0.01
Xenon-131m	1,000	10.
Xenon-133	100	1.
Xenon-135	100	1.

Radioactive Material	Type B License Column I curies	Type C License Column II curies
Ytterbium-175	10	0.1
Yttrium-90	1	0.01
Yttrium-91	1	0.01
Yttrium-92	10	0.1
Yttrium-93	1	0.01
Zinc-65	1	0.01
Zinc-69m	10	0.1
Zinc-69	100	1
Zirconium-93	1	0.01
Zirconium-95	1	0.01
Zirconium-97	1	0.01
Any radioactive material other than source material, special nuclear material, or alpha emitting radioactive material not listed above.	0.1	0.001

Note 1: To convert curies (Ci) to SI units of gigabecquerels (GBq), multiply the above values by 37.

Example: Zirconium-97 (Col. II) (0.01 Ci multiplied by 37 is equivalent to 0.37 GBq).

APPENDIX D
ASSIGNED PROTECTION FACTORS FOR RESPIRATORS[a]

	Operating mode	Assigned Protection Factors
I. Air Purifying Respirators [Particulate1A[b] only]1A[c]:		
Filtering facepiece disposabled	Negative Pressure	([d])
Facepiece, half [e]	Negative Pressure	10
Facepiece, full	Negative Pressure	100
Facepiece, half	Powered air-purifying respirators	50
Facepiece, full	Powered air-purifying respirators	1000
Helmet/hood	Powered air-purifying respirators	1000
Facepiece, loose-fitting	Powered air-purifying respirators	25
II. Atmosphere supplying respirators [particulate, gases and vapors1A[f]]:		
1. Air-line respirator:		
Facepiece, half	Demand	10
Facepiece, half	Continuous Flow	50
Facepiece, half	Pressure Demand	50
Facepiece, full	Demand	100
Facepiece, full	Continuous Flow	1000
Facepiece, full	Pressure Demand	1000
Helmet/hood	Continuous Flow	1000
Facepiece, loose-fitting	Continuous Flow	25
Suit	Continuous Flow	([g])
2. Self-contained breathing Apparatus (SCBA):		
Facepiece, full	Demand	100
Facepiece, full	Pressure Demand	10,000
Facepiece, full	Demand, Recirculating	100
Facepiece, full	Positive Pressure Recirculating	10,000
III. Combination Respirators:		
Any combination of air-purifying and atmosphere-supplying respirators	(1) Assigned protection factor for type and mode of operation as listed above.	

[a] These assigned protection factors apply only in a respiratory protection program that meets the requirements of subchapter III of this chapter. The protection factors are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances must also comply with U.S. Department of Labor regulations.

Radioactive contaminants for which the concentration values in Column 3 of Appendix E are based on internal dose due to inhalation may, in addition, present external exposure hazards at

higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

[b] Air purifying respirators with APF <100 must be equipped with particulate filters that are at least 95 percent efficient. Air purifying respirators with APF = 100 must be equipped with particulate filters that are at least 99 percent efficient. Air purifying respirators with APFs >100 must be equipped with particulate filters that are at least 99.97 percent efficient.

[c] A licensee may apply to the department for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors, for example, radioiodine.

[d] A licensee may permit individuals who have not been medically screened or fit tested on the device to use this type of respirator, provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use user seal check on this type of device. All other respiratory protection program requirements listed in s. HFS 157.27 (3) apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to 10 may be used if the licensee demonstrates a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

[e] Under-chin type only. No distinction is made in this Appendix between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece, for example, disposable or reusable disposable. Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the 2 or more suspension straps are adjustable, the filter medium is at least 95 percent efficient and all other requirements of subchapter III of this chapter are met.

[f] The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external submersion dose considerations.

[g] No National Institute of Occupational Safety and Health approval schedule is currently available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met.

Note: See s. HFS 157.27 (3).

[h] A licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health.

[i] This type of respirator may be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure such as skin absorption shall be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

APPENDIX E

ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS (DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE

Introduction

For each radionuclide, Table I indicates the chemical form which is to be used for selecting the appropriate ALI or DAC value. The ALIs and DACs for inhalation are given for an aerosol with an activity median aerodynamic diameter (AMAD) of 1 μ(micron), and for the D, W and Y classes of radioactive material, which refer to their retention in the pulmonary region of the lung. This classification applies to a range of clearance half-times for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. The D, W or Y class given in the column headed "Class" applies only to the inhalation ALIs and DACs given in Table I, column 2 and 3. Table II provides concentration limits for airborne and liquid effluents released to the general environment. Table III provides concentration limits for discharges to sanitary sewerage.

Note: The values in Tables I, II, and III are presented in the computer "E" notation. In this notation a value of 6E-02 represents a value of 6×10^{-2} or 0.06, 6E+2 represents 6×10^{2} or 600, and 6E+0 represents 6×10^{0} or 6.

Table I "Occupational Values"

Note that the columns in Table I of this appendix captioned "Oral Ingestion ALI," "Inhalation ALI" and "DAC" are applicable to occupational exposure to radioactive material.

The ALIs in this appendix are the annual intakes of given radionuclide by "reference man" which would result in either (1) a committed effective dose equivalent of 0.05 Sv (5 rem), stochastic ALI, or (2) a committed dose equivalent of 0.5 Sv (50 rem) to an organ or tissue, non-stochastic ALI. The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of 0.05 Sv (5 rem). The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w_T. This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of w_T are listed under the definition of weighting factor in s. HFS 157.03. The non-stochastic ALIs were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

Note: A description of the reference man is contained in the International Commission on Radiological Protection report, ICRP Publication 23, Reference Man: Anatomical Physiological and Metabolic Characteristics, Pergamon Press, Oxford (1975). The publication may be ordered from the web-site http://www.icrp.org/ordering.htm.

A value of $w_T = 0.06$ is applicable to each of the 5 organs or tissues in the "remainder" category receiving the highest dose equivalents, and the dose equivalents of all other remaining tissues may be disregarded. The following portions of the GI tract -- stomach, small intestine, upper large intestine, and lower large intestine -- are to be treated as 4 separate organs.

Note that the dose equivalents for an extremity, skin and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses. Abbreviated organ or tissue designations are used:

LLI wall = lower large intestine wall;
St wall = stomach wall;
Blad wall = bladder wall; and
Bone surf = bone surface.

The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure that non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low value. If, in a particular situation involving a radionuclide for which the non-stochastic ALI is limiting, use of that non-stochastic ALI is considered unduly conservative, the licensee may use the stochastic ALI to determine the committed effective dose equivalent. However, the licensee shall also ensure that the 0.5 Sv (50 rem) dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the nonstochastic ALIs that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is, intake of each radionuclide/$ALI_{ns} \leq 1.0$. If there is an external deep dose equivalent contribution of H_d, then this sum must be less than $1 - (H_d/50)$, instead of ≤ 1.0.

Note that the dose equivalents for an extremity, skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

The derived air concentration (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by:

$$DAC = ALI \text{ in :Ci}/(2000 \text{ hours per working year} \times 60 \text{ minutes/hour} \times 2 \times 10^4 \text{ ml per minute}) = [ALI/2.4 \times 10^9] \text{ :Ci/ml},$$

where 2×10^4 ml is the volume of air breathed per minute at work by reference man under working conditions of light work.

The DAC values relate to 1 of 2 modes of exposure: either external submersion or the internal committed dose equivalents resulting from inhalation of radioactive materials. DACs based upon submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each radionuclide separately.

The ALI and DAC values include contributions to exposure by the single radionuclide named and any in-growth of daughter radionuclides produced in the body by decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

The values of ALI and DAC do not apply directly when the individual both ingests and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both or when the individual is exposed to both internal and external irradiation. See s. HFS 157.22 (2). When an individual is exposed to radioactive materials that fall under several of the translocation classifications of the same radionuclide, such as Class D, Class W or Class Y, the exposure may be evaluated as if it were a mixture of different radionuclides.

It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical form of the compound and does not take into account the radiological half-life of different radionuclides. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table II "Effluent Concentrations"

The columns in Table II of this appendix captioned "Effluents," "Air" and "Water" are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of s. HFS 157.23 (2). The concentration values given in Columns 1 and 2 of Table II are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.5 mSv (0.05 rem).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to occur at or below the dose levels established for individual members of the public. For radionuclides, where the non-stochastic limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in Table II. For this reason, the DAC and airborne effluent limits are not always proportional.

The air concentration values listed in Table II, Column 1 were derived by one of 2 methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by 2.4×10^9 ml, relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 0.05 Sv (5 rem) annual occupational dose limit to the 1 mSv (0.1 rem) limit for members of the public, a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values, derived for adults, so that they are applicable to other age groups.

For those radionuclides for which submersion, that is external dose, is limiting, the occupational DAC in Table I, Column 3 was divided by 219. The factor of 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2,000 hours of a 8,760 hour full-time exposure per year. Note that an additional factor of 2 for age considerations is not warranted in the submersion case.

The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^7. The factor of 7.3×10^7 ml includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^5 ml which is the annual water intake of reference man.

Note 2 of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings, including occupational inhalation ALIs and DACs, air and water effluent concentrations and releases to sewer, require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of one of the listed radionuclides cannot be definitely excluded as being present either from knowledge of the radionuclide composition of the source or from actual measurements.

Table III "Releases to Sewers"

The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in s. HFS 157.30 (3). The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^6 ml. The factor of 7.3×10^6 ml is composed of a factor of 7.3×10^5 ml, the annual water intake by reference man, and a factor of 10, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a reference man during a year, would result in a committed effective dose equivalent of 5 mSv (0.5 rem).

List of Elements

Name	Symbol	Atomic Number	Name	Symbol	Atomic Number
Actinium	Ac	89	Copper	Cu	29
Aluminum	A	13	Curium	Cm	96
Americium	Am	95	Dysprosium	Dy	66
Antimony	Sb	51	Einsteinium	Es	99
Argon	Ar	18	Erbium	Er	68
Arsenic	As	33	Europium	Eu	63
Astatine	At	85	Fermium	Fm	100
Barium	Ba	56	Fluorine	F	9
Berkelium	Bk	97	Francium	Fr	87
Beryllium	Be	4	Gadolinium	Gd	64
Bismuth	Bi	83	Gallium	Ga	31
Bromine	Br	35	Germanium	Ge	32
Cadmium	Cd	48	Gold	Au	79
Calcium	Ca	20	Hafnium	Hf	72
Californium	Cf	98	Holmium	Ho	67
Carbon	C	6	Hydrogen	H	1

List of Elements *(Continued)*

Name	Symbol	Atomic Number	Name	Symbol	Atomic Number
Cerium	Ce	58	Tantalum	Ta	73
Cesium	Cs	55	Technetium	Tc	43
Chlorine	Cl	17	Tellurium	Te	52
Chromium	Cr	24	Terbium	Tb	65
Cobalt	Co	27	Thallium	Tl	81
Lanthanum	La	57	Thorium	Th	90
Lead	Pb	82	Thulium	Tm	69
Lutetium	Lu	71	Tin	Sn	50
Magnesium	Mg	12	Indium	In	49
Manganese	Mn	25	Iodine	I	53
Mendelevium	Md	101	Iridium	Ir	77
Mercury	Hg	80	Iron	Fe	26
Molybdenum	Mo	42	Krypton	Kr	36
Neodymium	Nd	60	Titanium	Ti	22
Neptunium	Np	93	Tungsten	W	74
Nickel	Ni	28	Uranium	U	92
Niobium	Nb	41	Vanadium	V	23
Osmium	Os	76	Xenon	Xe	54
Palladium	Pd	46	Ytterbium	Yb	70
Phosphorus	P	15	Yttrium	Y	39
Platinum	Pt	78	Zinc	Zn	30
Plutonium	Pu	94			
Polonium	Po	84			
Potassium	K	19			
Praseodymium	Pr	59			
Promethium	Pm	61			
Protactinium	Pa	91			
Radium	Ra	88			
Radon	Rn	86			
Rhenium	Re	75			
Rhodium	Rh	45			
Rubidium	Rb	37			
Ruthenium	Ru	44			
Samarium	Sm	62			
Scandium	Sc	21			
Selenium	Se	34			
Silicon	Si	14			
Silver	Ag	47			
Sodium	Na	11			
Strontium	Sr	38			
Sulfur	S	16			

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col. 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
1	Hydrogen-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
		Gas (HT or T_2) Submersion[a] Use above values as HT and T_2 oxidize in air and in the body to HTO						
4	Beryllium-7	W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
		Y, oxides, halides, and nitrates	-	2E+4	8E-6	3E-8	-	-
4	Beryllium-10	W, see ^{7}Be	1E+3	2E+2	6E-8	2E-10	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{7}Be	-	1E+1	6E-9	2E-11	-	-
6	Carbon-11[b]	Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
		Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
9	Fluorine-18[b]	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4	7E+4	3E-5	1E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		W, fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re	-	9E+4	4E-5	1E-7	-	-
		Y, lanthanum fluoride	-	8E+4	3E-5	1E-7	-	-
11	Sodium-22	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	1E+3	5E-7	2E-9	-	-
13	Aluminum-26	D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	9E+1	4E-8	1E-10	-	-
14	Silicon-31	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and nitrates	-	3E+4	1E-5	5E-8	-	-
		Y, aluminosilicate glass	-	3E+4	1E-5	4E-8	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col. 2 Inhalation	Col 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
14	Silicon-32	D, see ^{31}Si	2E+3	2E+2	1E-7	3E-10	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		W, see ^{31}Si-	1E+2	5E-8	2E-10	-	-	-
		Y, see ^{31}Si	-	5E+0	2E-9	7E-12	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+}, S^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+}, and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
		W, see ^{32}P	-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4	2E+4	7E-6	2E-8	-	-
			LLI wall (8E+3)	-	-	-	1E-4	1E-3
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3 -	2E+3	9E-7	3E-9	-	-
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	-	2E+2	1E-7	3E-10	-	-
17	Chlorine-38[b]	D, see ^{36}Cl	2E+4	4E+4	2E-5	6E-8	-	-
			St wall (3E+4)	-	-	-	3E-4	3E-3
		W, see ^{36}Cl	-	5E+4	2E-5	6E-8	-	-
17	Chlorine-39[b]	D, see ^{36}Cl	2E+4	5E+4	2E-5	7E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{36}Cl	-	6E+4	2E-5	8E-8	-	-
18	Argon-37	Submersion[g]	-	-	1E+0	6E-3	-	-
18	Argon-39	Submersion[g]	-	-	2E-4	8E-7	-	-
18	Argon-41	Submersion[g]	-	-	3E-6	1E-8	-	-
19	Potassium-40	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
19	Potassium-42	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
19	Potassium-43	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	Potassium-44[b]	D, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
19	Potassium-45[b]	D, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3	4E+3	2E-6	-	-	-
			Bone surf (4E+3)	Bone surf (4E+3)	-	5E-9	6E-5	6E-4
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
21	Scandium-43	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Scandium-44m	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49[b]	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E+1	1E-8	4E-11	-	-
		Y, SrTiO	-	6E+0	2E-9	8E-12	-	-
22	Titanium-45	D, see ^{44}Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{44}Ti	-	4E+4	1E-5	5E-8	-	-
		Y, see ^{44}Ti	-	3E+4	1E-5	4E-8	-	-
23	Vanadium-47[b]	D, all compounds except those given for W	3E+4	8E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see ^{47}V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
		W, see ^{47}V	-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ^{47}V	7E+4	3E+4	1E-5	-	-	-
			LLI wall (9E+4)	Bone surf (3E+4)	-	5E-8	1E-3	1E-2
		W, see ^{47}V	-	2E+4	8E-6	2E-8	-	-
24	Chromium-48	D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
		Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49[b]	D, see ^{48}Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{48}Cr	-	1E+5	4E-5	1E-7	-	-
		Y, see ^{48}Cr	-	9E+4	4E-5	1E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
24	Chromium-51	D, see ^{48}Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
		W, see ^{48}Cr	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{48}Cr	-	2E+4	8E-6	3E-8	-	-
25	Manganese-51[b]	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
25	Manganese-52m[b]	D, see ^{51}Mn	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{51}Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see ^{51}Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
		W, see ^{51}Mn	-	9E+2	4E-7	1E-9	-	-
25	Manganese-53	D, see ^{51}Mn	5E+4	1E+4	5E-6	-	7E-4	7E-3
			-	Bone surf (2E+4)	-	3E-8	-	-
		W, see ^{51}Mn	-	1E+4	5E-6	2E-8	-	-
25	Manganese-54	D, see ^{51}Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
		W, see ^{51}Mn	-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see ^{51}Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{51}Mn	-	2E+4	9E-6	3E-8	-	-
26	Iron-52	D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		W, oxides, hydroxides, and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ^{52}Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
		W, see ^{52}Fe	-	4E+3	2E-6	6E-9	-	-
26	Iron-59	D, see ^{52}Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		W, see ^{52}Fe	-	5E+2	2E-7	7E-10	-	-
26	Iron-60	D, see ^{52}Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
		W, see ^{52}Fe	-	2E+1	8E-9	3E-11	-	-
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
27	Cobalt-56	W, see ^{55}Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ^{55}Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ^{55}Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ^{55}Co	4E+3	7E+2	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ^{55}Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ^{55}Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ^{55}Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ^{55}Co	1E+3	7E+2	3E-7	1E-9	-	-
27	Cobalt-60m[b]	W, see ^{55}Co	1E+6	4E+6	2E-3	6E-6	-	-
			St wall (1E+6)	-	-	-	2E-2	2E-1
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
27	Cobalt-60	W, see ^{55}Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ^{55}Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-61[b]	W, see ^{55}Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{55}Co	2E+4	6E+4	2E-5	8E-8	-	-
27	Cobalt-62m[b]	W, see ^{55}Co	4E+4	2E+5	7E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	-	-
28	Nickel-56	D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		W, oxides, hydroxides, and carbides	-	1E+3	5E-7	2E-9	-	-
		Vapor	-	1E+3	5E-7	2E-9	-	-
28	Nickel-57	D, see ^{56}Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	6E+3	3E-6	9E-9	-	-
28	Nickel-59	D, see ^{56}Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
		W, see ^{56}Ni	-	7E+3	3E-6	1E-8	-	-
		Vapor	-	2E+3	8E-7	3E-9	-	-
28	Nickel-63	D, see ^{56}Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	8E+2	3E-7	1E-9	-	-
28	Nickel-65	D, see ^{56}Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{56}Ni	-	3E+4	1E-5	4E-8	-	-
		Vapor	-	2E+4	7E-6	2E-8	-	-
28	Nickel-66	D, see ^{56}Ni	4E+2	2E+3	7E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
		W, see ^{56}Ni	-	6E+2	3E-7	9E-10	-	-
		Vapor	-	3E+3	1E-6	4E-9	-	-
29	Copper-60[b]	D, all compounds except those given for W and Y	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	4E-5	1E-7	-	-
29	Copper-61	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	4E+4	2E-5	6E-8	-	-
		Y, see ^{60}Cu	-	4E+4	1E-5	5E-8	-	-
29	Copper-64	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{60}Cu	-	2E+4	9E-6	3E-8	-	-
29	Copper-67	D, see ^{60}Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
		W, see ^{60}Cu	-	5E+3	2E-6	7E-9	-	-
		Y, see ^{60}Cu	-	5E+3	2E-6	6E-9	-	-
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63[b]	Y, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
			St wall (3E+4)	-	-	-	3E-4	3E-3

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
30	Zinc-69[b/]	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
31	Gallium-65[b/]	D, all compounds except those given for W	5E+4	2E+5	7E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	-	-
31	Gallium-66	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-67	D, see ^{65}Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
		W, see ^{65}Ga	-	1E+4	4E-6	1E-8	-	-
31	Gallium-68[b/]	D, see ^{65}Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{65}Ga	-	5E+4	2E-5	7E-8	-	-
31	Gallium-70[b/]	D, see ^{65}Ga	5E+4	2E+5	7E-5	2E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		W, see ^{65}Ga	-	2E+5	8E-5	3E-7	-	-
31	Gallium-72	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-73	D, see ^{65}Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{65}Ga	-	2E+4	6E-6	2E-8	-	-
32	Germanium-66	D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
		W, oxides, sulfides, and halides	-	2E+4	8E-6	3E-8	-	-
32	Germanium-67[b/]	D, see ^{66}Ge	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		W, see ^{66}Ge	-	1E+5	4E-5	1E-7	-	-
32	Germanium-68	D, see ^{66}Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
		W, see ^{66}Ge	-	1E+2	4E-8	1E-10	-	-
32	Germanium-69	D, see ^{66}Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
		W, see ^{66}Ge	-	8E+3	3E-6	1E-8	-	-
32	Germanium-71	D, see ^{66}Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
		W, see ^{66}Ge	-	4E+4	2E-5	6E-8	-	-
32	Germanium-75[b/]	D, see ^{66}Ge	4E+4	8E+4	3E-5	1E-7	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{66}Ge	-	8E+4	4E-5	1E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col. 1	Col 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
32	Germanium-77	D, see ^{66}Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
		W, see ^{66}Ge	-	6E+3	2E-6	8E-9	-	-
32	Germanium-78[b]	D, see ^{66}Ge	2E+4	2E+4	9E-6	3E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, see ^{66}Ge	-	2E+4	9E-6	3E-8	-	-
33	Arsenic-69[b]	W, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
33	Arsenic-70[b]	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	Arsenic-71	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds	4E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	6E-5	6E-4
33	Arsenic-78[b]	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Selenium-70[b]	D, all compounds except those given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	-	-
34	Selenium-73m[b]	D, see ^{70}Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	6E-5	2E-7	-	-
34	Selenium-73	D, see ^{70}Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
		W, see ^{70}Se	-	2E+4	7E-6	2E-8	-	-
34	Selenium-75	D, see ^{70}Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
		W, see ^{70}Se	-	6E+2	3E-7	8E-10	-	-
34	Selenium-79	D, see ^{70}Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
		W, see ^{70}Se	-	6E+2	2E-7	8E-10	-	-
34	Selenium-81m[b]	D, see ^{70}Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{70}Se	2E+4	7E+4	3E-5	1E-7	-	-
34	Selenium-81[b]	D, see ^{70}Se	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
		W, see ^{70}Se	-	2E+5	1E-4	3E-7	-	-
34	Selenium-83[b]	D, see ^{70}Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	5E-5	2E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col. 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
35	Bromine-74m[b]	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74[b]	D, see ^{74m}Br	2E+4	7E+4	3E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	8E+4	4E-5	1E-7	-	-
35	Bromine-75[b]	D, see ^{74m}Br	3E+4	5E+4	2E-5	7E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	5E+4	2E-5	7E-8	-	-
35	Bromine-76	D, see ^{74m}Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
		W, see ^{74m}Br	-	4E+3	2E-6	6E-9	-	-
35	Bromine-77	D, see ^{74m}Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
		W, see ^{74m}Br	-	2E+4	8E-6	3E-8	-	-
35	Bromine-80m	D, see ^{74m}Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
		W, see ^{74m}Br	-	1E+4	6E-6	2E-8	-	-
35	Bromine-80[b]	D, see ^{74m}Br	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{74m}Br	-	2E+5	9E-5	3E-7	-	-
35	Bromine-82	D, see ^{74m}Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{74m}Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m}Br	5E+4	6E+4	3E-5	9E-8	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
35	Bromine-84[b]	D, see ^{74m}Br	2E+4	6E+4	2E-5	8E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
36	Krypton-74[b]	Submersion[a]	-	-	3E-6	1E-8	-	-
36	Krypton-76	Submersion[a]	-	-	9E-6	4E-8	-	-
36	Krypton-77[b]	Submersion[a]	-	-	4E-6	2E-8	-	-
36	Krypton-79	Submersion[a]	-	-	2E-5	7E-8	-	-
36	Krypton-81	Submersion[a]	-	-	7E-4	3E-6	-	-
36	Krypton-83m[b]	Submersion[a]	-	-	1E-2	5E-5	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
36	Krypton-85m	Submersion[a]	-	-	2E-5	1E-7	-	-
36	Krypton-85	Submersion[a]	-	-	1E-4	7E-7	-	-
36	Krypton-87[b]	Submersion[a]	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion[a]	-	-	2E-6	9E-9	-	-
37	Rubidium-79[b]	D, all compounds	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
37	Rubidium-81m[b]	D, all compounds	2E+5	3E+5	1E-4	5E-7	-	-
			St wall (3E+5)	-	-	-	4E-3	4E-2
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88[b]	D, all compounds	2E+4	6E+4	3E-5	9E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89[b]	D, all compounds	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
38	Strontium-80[b]	D, all soluble compounds except $SrTiO_3$	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and $SrTiO_3$	-	1E+4	5E-6	2E-8	-	-
38	Strontium-81[b]	D, see ^{80}Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{80}Sr	2E+4	8E+4	3E-5	1E-7	-	-
38	Strontium-82	D, see ^{80}Sr	3E+2	4E+2	2E-7	6E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		Y, see ^{80}Sr	2E+2	9E+1	4E-8	1E-10	-	-
38	Strontium-83	D, see ^{80}Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{80}Sr	2E+3	4E+3	1E-6	5E-9	-	-
38	Strontium-85m[b]	D, see ^{80}Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
		Y, see ^{80}Sr	-	8E+5	4E-4	1E-6	-	-
38	Strontium-85	D, see ^{80}Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see ^{80}Sr	-	2E+3	6E-7	2E-9	-	-
38	Strontium-87m	D, see ^{80}Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{80}Sr	4E+4	2E+5	6E-5	2E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col 3	Col 1	Col 2	
			Oral Ingestion	Inhalation				
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
38	Strontium-89	D, see ^{80}Sr	6E+2	8E+2	4E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see ^{80}Sr	5E+2	1E+2	6E-8	2E-10	-	-
38	Strontium-90	D, see ^{80}Sr	3E+1	2E+1	8E-9	-	-	-
			Bone surf (4E+1)	Bone surf (2E+1)	-	3E-11	5E-7	5E-6
		Y, see ^{80}Sr	-	4E+0	2E-9	6E-12	-	-
38	Strontium-91	D, see ^{80}Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
		Y, see ^{80}Sr	-	4E+3	1E-6	5E-9	-	-
38	Strontium-92	D, see ^{80}Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{80}Sr	-	7E+3	3E-6	9E-9	-	-
39	Yttrium-86m[b]	W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
39	Yttrium-86	W, see ^{86m}Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-87	W, see ^{86m}Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-88	W, see ^{86m}Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
		Y, see ^{86m}Y	-	2E+2	1E-7	3E-10	-	-
39	Yttrium-90m	W, see ^{86m}Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
		Y, see ^{86m}Y	-	1E+4	5E-6	2E-8	-	-
39	Yttrium-90	W, see ^{86m}Y	4E+2	7E+2	3E-7	9E-10	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{86m}Y	-	6E+2	3E-7	9E-10	-	-
39	Yttrium-91m[b]	W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
		Y, see ^{86m}Y	-	2E+5	7E-5	2E-7	-	-
39	Yttrium-91	W, see ^{86m}Y	5E+2	2E+2	7E-8	2E-10	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see ^{86m}Y	-	1E+2	5E-8	2E-10	-	-
39	Yttrium-92	W, see ^{86m}Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{86m}Y	-	8E+3	3E-6	1E-8	-	-
39	Yttrium-93	W, see ^{86m}Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	2E+3	1E-6	3E-9	-	-
39	Yttrium-94[b]	W, see ^{86m}Y	2E+4	8E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		Y, see ^{86m}Y	-	8E+4	3E-5	1E-7	-	-
39	Yttrium-95[b]	W, see ^{86m}Y	4E+4	2E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{86m}Y	-	1E+5	6E-5	2E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
40	Zirconium-86	D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
		Y, carbide	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-88	D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
		W, see ^{86}Zr	-	5E+2	2E-7	7E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-89	D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-93	D, see ^{86}Zr	1E+3	6E+0	3E-9	-	-	-
			Bone surf (3E+3)	Bone surf (2E+1)	-	2E-11	4E-5	4E-4
		W, see ^{86}Zr	-	2E+1	1E-8	□	□	□
			-	Bone surf (6E+1)	-	9E-11	-	-
		Y, see ^{86}Zr	-	6E+1	2E-8	-	-	-
			-	Bone surf (7E+1)	-	9E-11	-	-
40	Zirconium-95	D, see ^{86}Zr	1E+3	1E+2	5E-8	-	2E-5	2E-4
			-	Bone surf (3E+2)	-	4E-10	-	-
		W, see ^{86}Zr	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-97	D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ^{86}Zr	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{86}Zr	-	1E+3	5E-7	2E-9	-	-
41	Niobium-88[b]	W, all compounds except those given for Y	5E+4	2E+5	9E-5	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89[b] (66 min)	W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
		Y, see ^{88}Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-89 (122 min)	W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{88}Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-90	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-93m	W, see ^{88}Nb	9E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+4)	-	-	-	2E-4	2E-3
		Y, see ^{88}Nb	-	2E+2	7E-8	2E-10	-	-
41	Niobium-94	W, see ^{88}Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+1	6E-9	2E-11	-	-
41	Niobium-95m	W, see ^{88}Nb	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{88}Nb	-	2E+3	9E-7	3E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
41	Niobium-95	W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		Y, see ^{88}Nb	-	1E+3	5E-7	2E-9	-	-
41	Niobium-96	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-97[b]	W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{88}Nb	-	7E+4	3E-5	1E-7	-	-
41	Niobium-98[b]	W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
		Y, see ^{88}Nb	-	5E+4	2E-5	7E-8	-	-
42	Molybdenum-90	D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, oxides, hydroxides, and MoS_2	2E+3	5E+3	2E-6	6E-9	-	-
42	Molybdenum-93m	D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
		Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	-	-
42	Molybdenum-93	D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	-	-
42	Molybdenum-99	D, see ^{90}Mo	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	-	-
42	Molybdenum-101[b]	D, see ^{90}Mo	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{90}Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m[b]	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m}Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		W, see ^{93m}Tc	-	1E+5	4E-5	1E-7	-	-
43	Technetium-94m[b]	D, see ^{93m}Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{93m}Tc	-	6E+4	2E-5	8E-8	-	-
43	Technetium-94	D, see ^{93m}Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	1E-5	3E-8	-	-
43	Technetium-95m	D, see ^{93m}Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		W, see ^{93m}Tc	-	2E+3	8E-7	3E-9	-	-
43	Technetium-95	D, see ^{93m}Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	8E-6	3E-8	-	-
43	Technetium-96m[b]	D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-96	D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{93m}Tc	-	2E+3	9E-7	3E-9	-	-
43	Technetium-97m	D, see ^{93m}Tc	5E+3	7E+3	3E-6	-	6E-5	6E-4
			-	St wall (7E+3)	-	1E-8	-	-
		W, see ^{93m}Tc	-	1E+3	5E-7	2E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col. 2	Col 3	Col 1	Col 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
43	Technetium-97	D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		W, see ^{93m}Tc	-	6E+3	2E-6	8E-9	-	-
43	Technetium-98	D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{93m}Tc	-	3E+2	1E-7	4E-10	-	-
43	Technetium-99m	D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-99	D, see ^{93m}Tc	4E+3	5E+3	2E-6	-	6E-5	6E-4
			-	St wall (6E+3)	-	8E-9	-	-
		W, see ^{93m}Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101[b]	D, see ^{93m}Tc	9E+4	3E+5	1E-4	5E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
		W, see ^{93m}Tc	-	4E+5	2E-4	5E-7	-	-
43	Technetium-104[b]	D, see ^{93m}Tc	2E+4	7E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{93m}Tc	-	9E+4	4E-5	1E-7	-	-
44	Ruthenium-94[b]	D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, halides	-	6E+4	3E-5	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	2E-5	8E-8	-	-
44	Ruthenium-97	D, see ^{94}Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-103	D, see ^{94}Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ^{94}Ru	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{94}Ru	-	6E+2	3E-7	9E-10	-	-
44	Ruthenium-105	D, see ^{94}Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{94}Ru	-	1E+4	6E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-106	D, see ^{94}Ru	2E+2	9E+1	4E-8	1E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		W, see ^{94}Ru	-	5E+1	2E-8	8E-11	-	-
		Y, see ^{94}Ru	-	1E+1	5E-9	2E-11	-	-
45	Rhodium-99m	D, all compounds except those given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		W, halides	-	8E+4	3E-5	1E-7	-	-
		Y, oxides and hydroxides	-	7E+4	3E-5	9E-8	-	-
45	Rhodium-101m	D, see ^{99m}Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{99m}Rh	-	8E+3	4E-6	1E-8	-	-
		Y, see ^{99m}Rh	-	8E+3	3E-6	1E-8	-	-
45	Rhodium-101	D, see ^{99m}Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{99m}Rh	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{99m}Rh	-	2E+2	6E-8	2E-10	-	-
45	Rhodium-99	D, see ^{99m}Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{99m}Rh	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{99m}Rh	-	2E+3	8E-7	3E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
45	Rhodium-100	D, see ^{99m}Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{99m}Rh	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{99m}Rh	-	4E+3	2E-6	5E-9	-	-
45	Rhodium-102m	D, see ^{99m}Rh	1E+3	5E+2	2E-7	7E-10	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		W, see ^{99m}Rh	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{99m}Rh	-	1E+2	5E-8	2E-10	-	-
45	Rhodium-102	D, see ^{99m}Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
		W, see ^{99m}Rh	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{99m}Rh	-	6E+1	2E-8	8E-11	-	-
45	Rhodium-103m[b]	D, see ^{99m}Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
		W, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
		Y, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
45	Rhodium-105	D, see ^{99m}Rh	4E+3	1E+4	5E-6	2E-8	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
		W, see ^{99m}Rh	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{99m}Rh	-	6E+3	2E-6	8E-9	-	-
45	Rhodium-106m	D, see ^{99m}Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{99m}Rh	-	4E+4	2E-5	5E-8	-	-
		Y, see ^{99m}Rh	-	4E+4	1E-5	5E-8	-	-
45	Rhodium-107[b]	D, see ^{99m}Rh	7E+4	2E+5	1E-4	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{99m}Rh	-	3E+5	1E-4	4E-7	-	-
		Y, see ^{99m}Rh	-	3E+5	1E-4	3E-7	-	-
46	Palladium-100	D, all compound44s except those given for W and4 Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
		W, nitrates	-	1E+3	5E-7	2E-9	-	-
		Y, oxides and hydroxides	-	1E+3	6E-7	2E-9	-	-
46	Palladium-101	D, see ^{100}Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{100}Pd	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{100}Pd	-	3E+4	1E-5	4E-8	-	-
46	Palladium-103	D, see ^{100}Pd	6E+3	6E+3	3E-6	9E-9	-	-
			LLI wall (7E+3)	-	-	-	1E-4	1E-3
		W, see ^{100}Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{100}Pd	-	4E+3	1E-6	5E-9	-	-
46	Palladium-107	D, see ^{100}Pd	3E+4	2E+4	9E-6	-	-	-
			LLI wall (4E+4)	Kidneys (2E+4)	-	3E-8	5E-4	5E-3
		W, see ^{100}Pd	-	7E+3	3E-6	1E-8	-	-
		Y, see ^{100}Pd	-	4E+2	2E-7	6E-10	-	-
46	Palladium-109	D, see ^{100}Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{100}Pd	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{100}Pd	-	5E+3	2E-6	6E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
47	Silver-102[b]	D, all compounds except those given for W and Y	5E+4	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, nitrates and sulfides	-	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	-	2E+5	8E-5	3E-7	-	-
47	Silver-103[b]	D, see ^{102}Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104m[b]	D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104[b]	D, see ^{102}Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
47	Silver-105	D, see ^{102}Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
		W, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	D, see ^{102}Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-106[b]	D, see ^{102}Ag	6E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, see ^{102}Ag	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{102}Ag	-	2E+5	8E-5	3E-7	-	-
47	Silver-108m	D, see ^{102}Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
		W, see ^{102}Ag	-	3E+2	1E-7	4E-10	-	-
		Y, see ^{102}Ag	-	2E+1	1E-8	3E-11	-	-
47	Silver-110m	D, see ^{102}Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
		W, see ^{102}Ag	-	2E+2	8E-8	3E-10	-	-
		Y, see ^{102}Ag	-	9E+1	4E-8	1E-10	-	-
47	Silver-111	D, see ^{102}Ag	9E+2	2E+3	6E-7	-	-	-
			LLI wall (1E+3)	Liver (2E+3)	-	2E-9	2E-5	2E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-112	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{102}Ag	-	1E+4	4E-6	1E-8	-	-
		Y, see ^{102}Ag	-	9E+3	4E-6	1E-8	-	-
47	Silver-115[b]	D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{102}Ag	-	9E+4	4E-5	1E-7	-	-
		Y, see ^{102}Ag	-	8E+4	3E-5	1E-7	-	-
48	Cadmium-104[b]	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col 2	Col 3	Col 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
48	Cadmium-107	D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{104}Cd	-	6E+4	2E-5	8E-8	-	-
		Y, see ^{104}Cd	-	5E+4	2E-5	7E-8	-	-
48	Cadmium-109	D, see ^{104}Cd	3E+2	4E+1	1E-8	-	-	-
			Kidneys (4E+2)	Kidneys (5E+1)	-	7E-11	6E-6	6E-5
		W, see ^{104}Cd	-	1E+2	5E-8	-	-	-
			-	Kidneys (1E+2)	-	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
48	Cadmium-113m	D, see ^{104}Cd	2E+1	2E+0	1E-9	-	-	-
			Kidneys (4E+1)	Kidneys (4E+0)	-	5E-12	5E-7	5E-6
		W, see ^{104}Cd	-	8E+0	4E-9	-	-	-
			-	Kidneys (1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-
48	Cadmium-113	D, see ^{104}Cd	2E+1	2E+0	9E-10	-	-	-
			Kidneys (3E+1)	Kidneys (3E+0)	-	5E-12	4E-7	4E-6
		W, see ^{104}Cd	-	8E+0	3E-9	-	-	-
			-	Kidneys (1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1	2E-8	-	4E-6	4E-5
			-	Kidneys (8E+1)	-	1E-10	-	-
		W, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	6E-8	2E-10	-	-
48	Cadmium-115	D, see ^{104}Cd	9E+2	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
		W, see ^{104}Cd	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
48	Cadmium-117m	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
48	Cadmium-117	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	9E-8	-	-
49	Indium-110[b] (69 1 min)	D, see ^{109}In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	6E+4	2E-5	8E-8	-	-
49	Indium-110 (4 9 h)	D, see ^{109}In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		W, see ^{109}In	-	2E+4	8E-6	3E-8	-	-
49	Indium-111	D, see ^{109}In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
		W, see ^{109}In	-	6E+3	3E-6	9E-9	-	-
49	Indium-112[b]	D, see ^{109}In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
		W, see ^{109}In	-	7E+5	3E-4	1E-6	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
49	Indium-113m[b]	D, see ^{109}In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		W, see ^{109}In	-	2E+5	8E-5	3E-7	-	-
49	Indium-114m	D, see ^{109}In	3E+2	6E+1	3E-8	9E-11	-	-
			LLI wall (4E+2)	-	-	-	5E-6	5E-5
		W, see ^{109}In	-	1E+2	4E-8	1E-10	-	-
49	Indium-115m	D, see ^{109}In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	5E+4	2E-5	7E-8	-	-
49	Indium-115	D, see ^{109}In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
		W, see ^{109}In	-	5E+0	2E-9	8E-12	-	-
49	Indium-116m[b]	D, see ^{109}In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{109}In	-	1E+5	5E-5	2E-7	-	-
49	Indium-117m[b]	D, see ^{109}In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{109}In	-	4E+4	2E-5	6E-8	-	-
49	Indium-117[b]	D, see ^{109}In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
		W, see ^{109}In	-	2E+5	9E-5	3E-7	-	-
49	Indium-119m[b]	D, see ^{109}In	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		W, see ^{109}In	-	1E+5	6E-5	2E-7	-	-
50	Tin-110	D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	-	1E+4	5E-6	2E-8	-	-
50	Tin-111[b]	D, see ^{110}Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
		W, see ^{110}Sn	-	3E+5	1E-4	4E-7	-	-
50	Tin-113	D, see ^{110}Sn	2E+3	1E+3	5E-7	2E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ^{110}Sn	2E+3	1E+3	5E-7	-	-	-
			LLI wall (2E+3)	Bone surf (2E+3)	-	3E-9	3E-5	3E-4
		W, see ^{110}Sn	-	1E+3	6E-7	2E-9	-	-
50	Tin-119m	D, see ^{110}Sn	3E+3	2E+3	1E-6	3E-9	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ^{110}Sn	-	1E+3	4E-7	1E-9	-	-
50	Tin-121m	D, see ^{110}Sn	3E+3	9E+2	4E-7	1E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-121	D, see ^{110}Sn	6E+3	2E+4	6E-6	2E-8	-	-
			LLI wall (6E+3)	-	-	-	8E-5	8E-4
		W, see ^{110}Sn	-	1E+4	5E-6	2E-8	-	-
50	Tin-123m[b]	D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
		W, see ^{110}Sn	-	1E+5	6E-5	2E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
50	Tin-123	D, see ^{110}Sn	5E+2	6E+2	3E-7	9E-10	-	-
			LLI wall (6E+2)	-	-	-	9E-6	9E-5
		W, see ^{110}Sn	-	2E+2	7E-8	2E-10	-	-
50	Tin-125	D, see ^{110}Sn	4E+2	9E+2	4E-7	1E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
		W, see ^{110}Sn	-	4E+2	1E-7	5E-10	-	-
50	Tin-126	D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
		W, see ^{110}Sn	-	7E+1	3E-8	9E-11	-	-
50	Tin-127	D, see ^{110}Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		W, see ^{110}Sn	-	2E+4	8E-6	3E-8	-	-
50	Tin-128[b]	D, see ^{110}Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{110}Sn	-	4E+4	1E-5	5E-8	-	-
51	Antimony-115[b]	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-	-
51	Antimony-116m[b]	D, see ^{115}Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{115}Sb	-	1E+5	6E-5	2E-7	-	-
51	Antimony-116[b]	D, see ^{115}Sb	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	3E+5	1E-4	5E-7	-	-
51	Antimony-117	D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
		W, see ^{115}Sb	-	3E+5	1E-4	4E-7	-	-
51	Antimony-118m	D, see ^{115}Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	-	-
51	Antimony-119	D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	-	-
51	Antimony-120[b] (16 min)	D, see ^{115}Sb	1E+5	4E+5	2E-4	6E-7	-	-
			St wall (2E+5)	-	-	-	2E-3	2E-2
		W, see ^{115}Sb	-	5E+5	2E-4	7E-7	-	-
51	Antimony-120 (5 76 d)	D, see ^{115}Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		W, see ^{115}Sb	9E+2	1E+3	5E-7	2E-9	-	-
51	Antimony-122	D, see ^{115}Sb	8E+2	2E+3	1E-6	3E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
		W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	-	-
51	Antimony-124m[b]	D, see ^{115}Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
		W, see ^{115}Sb	2E+5	6E+5	2E-4	8E-7	-	-
51	Antimony-124	D, see ^{115}Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	2E+2	1E-7	3E-10	-	-
51	Antimony-125	D, see ^{115}Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
		W, see ^{115}Sb	-	5E+2	2E-7	7E-10	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
51	Antimony-126m[b]	D, see ^{115}Sb	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{115}Sb	-	2E+5	8E-5	3E-7	-	-
51	Antimony-126	D, see ^{115}Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	5E+2	2E-7	7E-10	-	-
51	Antimony-127	D, see ^{115}Sb	8E+2	2E+3	9E-7	3E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
		W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	-	-
51	Antimony-128[b] (10 4 min)	D, see ^{115}Sb	8E+4	4E+5	2E-4	5E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	4E+5	2E-4	6E-7	-	-
51	Antimony-128 (9 01 h)	D, see ^{115}Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, see ^{115}Sb	-	3E+3	1E-6	5E-9	-	-
51	Antimony-129	D, see ^{115}Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, see ^{115}Sb	-	9E+3	4E-6	1E-8	-	-
51	Antimony-130[b]	D, see ^{115}Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{115}Sb	-	8E+4	3E-5	1E-7	-	-
51	Antimony-131[b]	D, see ^{115}Sb	1E+4	2E+4	1E-5	-	-	-
			Thyroid (2E+4)	Thyroid (4E+4)	-	6E-8	2E-4	2E-3
		W, see ^{115}Sb	-	2E+4	1E-5		-	-
			-	Thyroid (4E+4)	-	6E-8	-	-
52	Tellurium-116	D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ^{116}Te	5E+2	2E+2	8E-8	-	-	-
			Bone surf (7E+2)	Bone surf (4E+2)	-	5E-10	1E-5	1E-4
		W, see ^{116}Te	-	4E+2	2E-7	6E-10	-	-
52	Tellurium-121	D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{116}Te	-	3E+3	1E-6	4E-9	-	-
52	Tellurium-123m	D, see ^{116}Te	6E+2	2E+2	9E-8	-	-	-
			Bone surf (1E+3)	Bone surf (5E+2)	-	8E-10	1E-5	1E-4
		W, see ^{116}Te	-	5E+2	2E-7	8E-10	-	-
52	Tellurium-123	D, see ^{116}Te	5E+2	2E+2	8E-8	-	-	-
			Bone surf (1E+3)	Bone surf (5E+2)	-	7E-10	2E-5	2E-4
		W, see ^{116}Te	-	4E+2	2E-7	-	-	-
			-	Bone surf (1E+3)	-	2E-9	-	-
52	Tellurium-125m	D, see ^{116}Te	1E+3	4E+2	2E-7	-	-	-
			Bone surf (1E+3)	Bone surf (1E+3)	-	1E-9	2E-5	2E-4
		W, see ^{116}Te	-	7E+2	3E-7	1E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
52	Tellurium-127m	D, see ^{116}Te	6E+2	3E+2	1E-7	-	9E-6	9E-5
			-	Bone surf (4E+2)	-	6E-10	-	-
		W, see ^{116}Te	-	3E+2	1E-7	4E-10	-	-
52	Tellurium-127	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{116}Te	-	2E+4	7E-6	2E-8	-	-
52	Tellurium-129m	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
		W, see ^{116}Te	-	2E+2	1E-7	3E-10	-	-
52	Tellurium-129[b]	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{116}Te	-	7E+4	3E-5	1E-7	-	-
52	Tellurium-131m	D, see ^{116}Te	3E+2	4E+2	2E-7	-	-	-
			Thyroid (6E+2)	Thyroid (1E+3)	-	2E-9	8E-6	8E-5
		W, see ^{116}Te	-	4E+2	2E-7	-	-	-
			-	Thyroid (9E+2)	-	1E-9	-	-
52	Tellurium-131[b]	D, see ^{116}Te	3E+3	5E+3	2E-6	-	-	-
			Thyroid (6E+3)	Thyroid (1E+4)	-	2E-8	8E-5	8E-4
		W, see ^{116}Te	-	5E+3	2E-6	-	-	-
			-	Thyroid (1E+4)	-	2E-8	-	-
52	Tellurium-132	D, see ^{116}Te	2E+2	2E+2	9E-8	-	-	-
			Thyroid (7E+2)	Thyroid (8E+2)	-	1E-9	9E-6	9E-5
		W, see ^{116}Te	-	2E+2	9E-8	-	-	-
			-	Thyroid (6E+2)	-	9E-10	-	-
52	Tellurium-133m[b]	D, see ^{116}Te	3E+3	5E+3	2E-6	-	-	-
			Thyroid (6E+3)	Thyroid (1E+4)	-	2E-8	9E-5	9E-4
		W, see ^{116}Te	-	5E+3	2E-6	-	-	-
			-	Thyroid (1E+4)	-	2E-8	-	-
52	Tellurium-133[b]	D, see ^{116}Te	1E+4	2E+4	9E-6	-	-	-
			Thyroid (3E+4)	Thyroid (6E+4)	-	8E-8	4E-4	4E-3
		W, see ^{116}Te	-	2E+4	9E-6	-	-	-
			-	Thyroid (6E+4)	-	8E-8	-	-
52	Tellurium-134[b]	D, see ^{116}Te	2E+4	2E+4	1E-5	-	-	-
			Thyroid (2E+4)	Thyroid (5E+4)	-	7E-8	3E-4	3E-3
		W, see ^{116}Te	-	2E+4	1E-5	-	-	-
			-	Thyroid (5E+4)	-	7E-8	-	-
53	Iodine-120m[b]	D, all compounds	1E+4	2E+4	9E-6	3E-8	-	-
			Thyroid (1E+4)	-	-	-	2E-4	2E-3
53	Iodine-120[b]	D, all compounds	4E+3	9E+3	4E-6	-	-	-
			Thyroid (8E+3)	Thyroid (1E+4)	-	2E-8	1E-4	1E-3

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col. 3	Col 1	Col 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6 -	7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6 -	2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8 -	4E-10	2E-6	2E-5
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8 -	3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8 -	2E-10	1E-6	1E-5
53	Iodine-128[b]	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	5E-5 -	2E-7 -	8E-4	8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9 -	4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7 -	3E-9	2E-5	2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8 -	2E-10	1E-6	1E-5
53	Iodine-132m[b]	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6 -	3E-8	1E-4	1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6 -	2E-8	1E-4	1E-3
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7 -	1E-9	7E-6	7E-5
53	Iodine-134[b]	D, all compounds	2E+4 Thyroid (3E+4)	5E+4 -	2E-5 -	6E-8 -	4E-4	4E-3
53	Iodine-135	D, all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7 -	6E-9	3E-5	3E-4
54	Xenon-120[b]	Submersion[a]	-	-	1E-5	4E-8	-	-
54	Xenon-121[b]	Submersion[a]	-	-	2E-6	1E-8	-	-
54	Xenon-122	Submersion[a]	-	-	7E-5	3E-7	-	-
54	Xenon-123	Submersion[a]	-	-	6E-6	3E-8	-	-
54	Xenon-125	Submersion[a]	-	-	2E-5	7E-8	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average Concentration
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	(μCi/ml)
54	Xenon-127	Submersion[a]	-	-	1E-5	6E-8	-	-
54	Xenon-129m	Submersion[a]	-	-	2E-4	9E-7	-	-
54	Xenon-131m	Submersion[a]	-	-	4E-4	2E-6	-	-
54	Xenon-133m	Submersion[a]	-	-	1E-4	6E-7	-	-
54	Xenon-133	Submersion[a]	-	-	1E-4	5E-7	-	-
54	Xenon-135m[b]	Submersion[a]	-	-	9E-6	4E-8	-	-
54	Xenon-135	Submersion[a]	-	-	1E-5	7E-8	-	-
54	Xenon-138[b]	Submersion[a]	-	-	4E-6	2E-8	-	-
55	Cesium-125[b]	D, all compounds	5E+4	1E+5	6E-5	2E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130[b]	D, all compounds	6E+4	2E+5	8E-5	3E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
55	Cesium-132	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds	1E+5	1E+5	6E-5	2E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
55	Cesium-134	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
55	Cesium-135m[b]	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
55	Cesium-137	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
55	Cesium-138[b]	D, all compounds	2E+4	6E+4	2E-5	8E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
56	Barium-126[b]	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
56	Barium-128	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
56	Barium-131m[b]	D, all compounds	4E+5	1E+6	6E-4	2E-6	-	-
			St wall (5E+5)	-	-	-	7E-3	7E-2
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds	2E+3	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
56	Barium-133	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
56	Barium-139[b]	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds	5E+2	1E+3	6E-7	2E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
56	Barium-141[b]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
56	Barium-142[b]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	Lanthanum-131[b]	D, all compounds except those given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-
57	Lanthanum-132	D, see ^{131}La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-135	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
57	Lanthanum-137	D, see ^{131}La	1E+4	6E+1	3E-8	-	2E-4	2E-3
			-	Liver (7E+1)	-	1E-10	-	-
		W, see ^{131}La	-	3E+2	1E-7	-	-	-
			-	Liver (3E+2)	-	4E-10	-	-
57	Lanthanum-138	D, see ^{131}La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
		W, see ^{131}La	-	1E+1	6E-9	2E-11	-	-
57	Lanthanum-140	D, see ^{131}La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{131}La	-	1E+3	5E-7	2E-9	-	-
57	Lanthanum-141	D, see ^{131}La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-142[b]	D, see ^{131}La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{131}La	-	3E+4	1E-5	5E-8	-	-
57	Lanthanum-143[b]	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
58	Cerium-134	W, all compounds except those given for Y	5E+2	7E+2	3E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	-	-
58	Cerium-135	W, see ^{134}Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		Y, see ^{134}Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137m	W, see ^{134}Ce	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	4E+3	2E-6	5E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
58	Cerium-137	W, see ^{134}Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		Y, see ^{134}Ce	-	1E+5	5E-5	2E-7	-	-
58	Cerium-139	W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
		Y, see ^{134}Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-141	W, see ^{134}Ce	2E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	6E+2	2E-7	8E-10	-	-
58	Cerium-143	W, see ^{134}Ce	1E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{134}Ce	-	2E+3	7E-7	2E-9	-	-
58	Cerium-144	W, see ^{134}Ce	2E+2	3E+1	1E-8	4E-11	-	-
			LLI wall (3E+2)	-	-	-	3E-6	3E-5
		Y, see ^{134}Ce	-	1E+1	6E-9	2E-11	-	-
59	Praseodymium-136[b]	W, all compounds except those given for Y	5E+4	2E+5	1E-4	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	-	-
59	Praseodymium-137[b]	W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-138m	W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
		Y, see ^{136}Pr	-	4E+4	2E-5	6E-8	-	-
59	Praseodymium-139	W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-142m[b]	W, see ^{136}Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-142	W, see ^{136}Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		Y, see ^{136}Pr	-	2E+3	8E-7	3E-9	-	-
59	Praseodymium-143	W, see ^{136}Pr	9E+2	8E+2	3E-7	1E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Pr	-	7E+2	3E-7	9E-10	-	-
59	Praseodymium-144[b]	W, see ^{136}Pr	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-145	W, see ^{136}Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{136}Pr	-	8E+3	3E-6	1E-8	-	-
60	Neodymium-136[b]	W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
60	Neodymium-138	W, see ^{136}Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		Y, see ^{136}Nd	-	5E+3	2E-6	7E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
59	Praseodymium-147[b]	W, see ^{136}Pr	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
		Y, see ^{136}Pr	-	2E+5	8E-5	3E-7	-	-
60	Neodymium-139m	W, see ^{136}Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		Y, see ^{136}Nd	-	1E+4	6E-6	2E-8	-	-
60	Neodymium-139[b]	W, see ^{136}Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
		Y, see ^{136}Nd	-	3E+5	1E-4	4E-7	-	-
60	Neodymium-141	W, see ^{136}Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
		Y, see ^{136}Nd	-	6E+5	3E-4	9E-7	-	-
60	Neodymium-147	W, see ^{136}Nd	1E+3	9E+2	4E-7	1E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Nd	-	8E+2	4E-7	1E-9	-	-
60	Neodymium-149[b]	W, see ^{136}Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
		Y, see ^{136}Nd	-	2E+4	1E-5	3E-8	-	-
60	Neodymium-151[b]	W, see ^{136}Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		Y, see ^{136}Nd	-	2E+5	8E-5	3E-7	-	-
61	Promethium-141[b]	W, all compounds except those given for Y	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-5	2E-7	-	-
61	Promethium-143	W, see ^{141}Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	7E+2	3E-7	1E-9	-	-
61	Promethium-144	W, see ^{141}Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		Y, see ^{141}Pm	-	1E+2	5E-8	2E-10	-	-
61	Promethium-145	W, see ^{141}Pm	1E+4	2E+2	7E-8	-	1E-4	1E-3
			-	Bone surf (2E+2)	-	3E-10	-	-
		Y, see ^{141}Pm	-	2E+2	8E-8	3E-10	-	-
61	Promethium-146	W, see ^{141}Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
		Y, see ^{141}Pm	-	4E+1	2E-8	6E-11	-	-
61	Promethium-147	W, see ^{141}Pm	4E+3	1E+2	5E-8	-	-	-
			LLI wall (5E+3)	Bone surf (2E+2)	-	3E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	1E+2	6E-8	2E-10	-	-
61	Promethium-148m	W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		Y, see ^{141}Pm	-	3E+2	1E-7	5E-10	-	-
61	Promethium-148	W, see ^{141}Pm	4E+2	5E+2	2E-7	8E-10	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{141}Pm	-	5E+2	2E-7	7E-10	-	-
61	Promethium-149	W, see ^{141}Pm	1E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{141}Pm	-	2E+3	8E-7	2E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
61	Promethium-150	W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{141}Pm	-	2E+4	7E-6	2E-8	-	-
61	Promethium-151	W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{141}Pm	-	3E+3	1E-6	4E-9	-	-
62	Samarium-141m[b]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Samarium-141[b]	W, all compounds	5E+4	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
62	Samarium-142[b]	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1	4E-2	1E-11	-	-	-
			Bone surf (3E+1)	Bone surf (6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1	4E-2	2E-11	-	-	-
			Bone surf (3E+1)	Bone surf (7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4	1E+2	4E-8	-	-	-
			LLI wall (1E+4)	Bone surf (2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155[b]	W, all compounds	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Europium-145	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Europium-150 (12 62 h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34 2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-152m	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	4E+3	9E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (1E+2)	-	2E-10	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
63	Europium-157	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
63	Europium-158[b]	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
64	Gadolinium-145[b]	D, all compounds except those given for W	5E+4	2E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	6E-4	6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ^{145}Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ^{145}Gd	-	3E+2	1E-7	4E-10	-	-
64	Gadolinium-147	D, see ^{145}Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{145}Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ^{145}Gd	1E+1	8E+3	3E-12	-	-	-
			Bone surf (2E+1)	Bone surf (2E-2)	-	2E-14	3E-7	3E-6
		W, see ^{145}Gd	-	3E-2	1E-11	-	-	-
			-	Bone surf (6E-2)	-	8E-14	-	-
64	Gadolinium-149	D, see ^{145}Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ^{145}Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ^{145}Gd	6E+3	4E+2	2E-7	-	9E-5	9E-4
			-	Bone surf (6E+2)	-	9E-10	-	-
		W, see ^{145}Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ^{145}Gd	2E+1	1E-2	4E-12	-	-	-
			Bone surf (3E+1)	Bone surf (2E-2)	-	3E-14	4E-7	4E-6
		W, see ^{145}Gd	-	4E-2	2E-11	-	-	-
			-	Bone surf (8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ^{145}Gd	5E+3	1E+2	6E-8	-	6E-5	6E-4
			-	Bone surf (2E+2)	-	3E-10	-	-
		W, see ^{145}Gd	-	6E+2	2E-7	8E-10	-	-
64	Gadolinium-159	D, see ^{145}Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{145}Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147[b]	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
65	Terbium-153	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Terbium-155	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Terbium-156m (5 0 h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
65	Terbium-156m (24 4 h)	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds	5E+4	3E+2	1E-7	-	-	-
			LLI wall (5E+4)	Bone surf (6E+2)	-	8E-10	7E-4	7E-3
65	Terbium-158	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds	2E+3	2E+3	7E-7	2E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2	7E+2	3E-7	1E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
67	Holmium-155[b]	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157[b]	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159[b]	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Holmium-162m[b]	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Holmium-162[b]	W, all compounds	5E+5	2E+6	1E-3	3E-6	-	-
			St wall (8E+5)	-	-	-	1E-2	1E-1
67	Holmium-164m[b]	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Holmium-164[b]	W, all compounds	2E+5	6E+5	3E-4	9E-7	-	-
			St wall (2E+5)	-	-	-	3E-3	3E-2
67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds	9E+2	2E+3	7E-7	2E-9	-	-
			LLI wall (9E+2)	-	-	-	1E-5	1E-4
67	Holmium-167	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
68	Erbium-169	W, all compounds	3E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col. 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
68	Erbium-171	W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
68	Erbium-172	W, all compounds	1E+3	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
69	Thulium-162[b]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
69	Thulium-166	W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
69	Thulium-167	W, all compounds	2E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
69	Thulium-170	W, all compounds	8E+2	2E+2	9E-8	3E-10	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
69	Thulium-171	W, all compounds	1E+4	3E+2	1E-7	-	-	-
			LLI wall (1E+4)	Bone surf (6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
69	Thulium-173	W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
69	Thulium-175[b]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
70	Ytterbium-162[b]	W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
		Y, oxides, hydroxides, and fluorides	-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ^{162}Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167[b]	W, see ^{162}Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
		Y, see ^{162}Yb	-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ^{162}Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ^{162}Yb	3E+3	4E+3	1E-6	5E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{162}Yb	-	3E+3	1E-6	5E-9	-	-
70	Ytterbium-177[b]	W, see ^{162}Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	5E+4	2E-5	6E-8	-	-
70	Ytterbium-178[b]	W, see ^{162}Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	4E+4	2E-5	5E-8	-	-
71	Lutetium-169	W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		Y, oxides, hydroxides, and fluorides	-	4E+3	2E-6	6E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col 2	Col 3	Col 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
71	Lutetium-170	W, see ^{169}Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-171	W, see ^{169}Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-172	W, see ^{169}Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ^{169}Lu	-	1E+3	5E-7	2E-9	-	-
71	Lutetium-173	W, see ^{169}Lu	5E+3	3E+2	1E-7	-	7E-5	7E-4
			-	Bone surf (5E+2)	-	6E-10	-	-
		Y, see ^{169}Lu	-	3E+2	1E-7	4E-10	-	-
71	Lutetium-174m	W, see ^{169}Lu	2E+3	2E+2	1E-7	-	-	-
			LLI wall (3E+3)	Bone surf (3E+2)	-	5E-10	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+2	9E-8	3E-10	-	-
71	Lutetium-176	W, see ^{169}Lu	7E+2	5E+0	2E-9	-	1E-5	1E-4
			-	Bone surf (1E+1)	-	2E-11	-	-
		Y, see ^{169}Lu	-	8E+0	3E-9	1E-11	-	-
71	Lutetium-177m	W, see ^{169}Lu	7E+2	1E+2	5E-8	-	1E-5	1E-4
			-	Bone surf (1E+2)	-	2E-10	-	-
		Y, see ^{169}Lu	-	8E+1	3E-8	1E-10	-	-
71	Lutetium-177	W, see ^{169}Lu	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+3	9E-7	3E-9	-	-
71	Lutetium-178m[b]	W, see ^{169}Lu	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
		Y, see ^{169}Lu	-	2E+5	7E-5	2E-7	-	-
71	Lutetium-178[b]	W, see ^{169}Lu	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{169}Lu	-	1E+5	5E-5	2E-7	-	-
71	Lutetium-179	W, see ^{169}Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{169}Lu	-	2E+4	6E-6	3E-8	-	-
72	Hafnium-170	D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
		W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-
72	Hafnium-172	D, see ^{170}Hf	1E+3	9E+0	4E-9	-	2E-5	2E-4
			-	Bone surf (2E+1)	-	3E-11	-	-
		W, see ^{170}Hf	-	4E+1	2E-8	-	-	-
			-	Bone surf (6E+1)	-	8E-11	-	-
72	Hafnium-173	D, see ^{170}Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{170}Hf	-	1E+4	5E-6	2E-8	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
72	Hafnium-175	D, see ^{170}Hf	3E+3	9E+2	4E-7	-	4E-5	4E-4
			-	Bone surf (1E+3)	-	1E-9	-	-
		W, see ^{170}Hf	-	1E+3	5E-7	2E-9	-	-
72	Hafnium-177m[b]	D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{170}Hf	-	9E+4	4E-5	1E-7	-	-
72	Hafnium-178m	D, see ^{170}Hf	3E+2	1E+0	5E-10	-	3E-6	3E-5
			-	Bone surf (2E+0)	-	3E-12	-	-
		W, see ^{170}Hf	-	5E+0	2E-9	-	-	-
			-	Bone surf (9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2	1E-7	-	1E-5	1E-4
			-	Bone surf (6E+2)	-	8E-10	-	-
		W, see ^{170}Hf	-	6E+2	3E-7	8E-10	-	-
72	Hafnium-180m	D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{170}Hf	-	3E+4	1E-5	4E-8	-	-
72	Hafnium-181	D, see ^{170}Hf	1E+3	2E+2	7E-8	-	2E-5	2E-4
			-	Bone surf (4E+2)	-	6E-10	-	-
		W, see ^{170}Hf	-	4E+2	2E-7	6E-10	-	-
72	Hafnium-182m[b]	D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
		W, see ^{170}Hf	-	1E+5	6E-5	2E-7	-	-
72	Hafnium-182	D, see ^{170}Hf	2E+2	8E-1	3E-10	-	-	-
			Bone surf (4E+2)	Bone surf (2E+0)	-	2E-12	5E-6	5E-5
		W, see ^{170}Hf	-	3E+0	1E-9	-	-	-
			-	Bone surf (7E+0)	-	1E-11	-	-
72	Hafnium-183[b]	D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{170}Hf	-	6E+4	2E-5	8E-8	-	-
72	Hafnium-184	D, see ^{170}Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{170}Hf	-	6E+3	3E-6	9E-9	-	-
73	Tantalum-172[b]	W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-
71	Lutetium-174	W, see ^{169}Lu	5E+3	1E+2	5E-8	-	7E-5	7E-4
			-	Bone surf (2E+2)	-	3E-10	-	-
		Y, see ^{169}Lu	-	2E+2	6E-8	2E-10	-	-
71	Lutetium-176m	W, see ^{169}Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		Y, see ^{169}Lu	-	2E+4	9E-6	3E-8	-	-
73	Tantalum-173	W, see ^{172}Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174[b]	W, see ^{172}Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	9E+4	4E-5	1E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col. 1	Col 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
73	Tantalum-175	W, see ^{172}Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
		Y, see ^{172}Ta	-	1E+4	6E-6	2E-8	-	-
73	Tantalum-176	W, see ^{172}Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		Y, see ^{172}Ta	-	1E+4	5E-6	2E-8	-	-
73	Tantalum-177	W, see ^{172}Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-178	W, see ^{172}Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
		Y, see ^{172}Ta	-	7E+4	3E-5	1E-7	-	-
73	Tantalum-179	W, see ^{172}Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
		Y, see ^{172}Ta	-	9E+2	4E-7	1E-9	-	-
73	Tantalum-180m	W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{172}Ta	-	6E+4	2E-5	8E-8	-	-
73	Tantalum-180	W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
		Y, see ^{172}Ta	-	2E+1	1E-8	3E-11	-	-
73	Tantalum-182m[b]	W, see ^{172}Ta	2E+5	5E+5	2E-4	8E-7	-	-
			St wall (2E+5)	-	-	-	3E-3	3E-2
		Y, see ^{172}Ta	-	4E+5	2E-4	6E-7	-	-
73	Tantalum-182	W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		Y, see ^{172}Ta	-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see ^{172}Ta	9E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{172}Ta	-	1E+3	4E-7	1E-9	-	-
73	Tantalum-184	W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
		Y, see ^{172}Ta	-	5E+3	2E-6	7E-9	-	-
73	Tantalum-185[b]	W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	6E+4	3E-5	9E-8	-	-
73	Tantalum-186[b]	W, see ^{172}Ta	5E+4	2E+5	1E-4	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, see ^{172}Ta	-	2E+5	9E-5	3E-7	-	-
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
74	Tungsten-179[b]	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
74	Tungsten-185	D, all compounds	2E+3	7E+3	3E-6	9E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col. 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
75	Rhenium-177[b]	D, all compounds except those given for W	9E+4	3E+5	1E-4	4E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-
75	Rhenium-178[b]	D, see ^{177}Re	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
		W, see ^{177}Re	-	3E+5	1E-4	4E-7	-	-
75	Rhenium-181	D, see ^{177}Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
		W, see ^{177}Re	-	9E+3	4E-6	1E-8	-	-
75	Rhenium-182 (12.7 h)	D, see ^{177}Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
		W, see ^{177}Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182 (64 0 h)	D, see ^{177}Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+3	9E-7	3E-9	-	-
75	Rhenium-184m	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	4E+2	2E-7	6E-10	-	-
75	Rhenium-184	D, see ^{177}Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{177}Re	-	1E+3	6E-7	2E-9	-	-
75	Rhenium-186m	D, see ^{177}Re	1E+3	2E+3	7E-7	-	-	-
			St wall (2E+3)	St wall (2E+3)	-	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+2	6E-8	2E-10	-	-
75	Rhenium-186	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	2E+3	7E-7	2E-9	-	-
75	Rhenium-187	D, see ^{177}Re	6E+5	8E+5	4E-4	-	8E-3	8E-2
			-	St wall (9E+5)	-	1E-6	-	-
		W, see ^{177}Re	-	1E+5	4E-5	1E-7	-	-
75	Rhenium-188m[b]	D, see ^{177}Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{177}Re	-	1E+5	6E-5	2E-7	-	-
75	Rhenium-188	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		W, see ^{177}Re	-	3E+3	1E-6	4E-9	-	-
75	Rhenium-189	D, see ^{177}Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
		W, see ^{177}Re	-	4E+3	2E-6	6E-9	-	-
76	Osmium-180[b]	D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
		W, halides and nitrates	-	5E+5	2E-4	7E-7	-	-
		Y, oxides and hydroxides	-	5E+5	2E-4	6E-7	-	-
76	Osmium-181[b]	D, see ^{180}Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{180}Os	-	5E+4	2E-5	6E-8	-	-
		Y, see ^{180}Os	-	4E+4	2E-5	6E-8	-	-
76	Osmium-182	D, see ^{180}Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
		W, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col 1	Col 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
76	Osmium-185	D, see ^{180}Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
76	Osmium-189m	D, see ^{180}Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, see ^{180}Os	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{180}Os	-	2E+5	7E-5	2E-7	-	-
76	Osmium-191m	D, see ^{180}Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{180}Os	-	2E+4	8E-6	3E-8	-	-
		Y, see ^{180}Os	-	2E+4	7E-6	2E-8	-	-
76	Osmium-191	D, see ^{180}Os	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (3E+3)	-	-	-	3E-5	3E-4
		W, see ^{180}Os	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{180}Os	-	1E+3	6E-7	2E-9	-	-
76	Osmium-193	D, see ^{180}Os	2E+3	5E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
		W, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
76	Osmium-194	D, see ^{180}Os	4E+2	4E+1	2E-8	6E-11	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		W, see ^{180}Os	-	6E+1	2E-8	8E-11	-	-
		Y, see ^{180}Os	-	8E+0	3E-9	1E-11	-	-
77	Iridium-182[b]	D, all compounds except those given for W and Y	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
77	Iridium-184	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-185	D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{182}Ir	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{182}Ir	-	1E+4	4E-6	1E-8	-	-
77	Iridium-186	D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{182}Ir	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{182}Ir	-	6E+3	2E-6	8E-9	-	-
77	Iridium-187	D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-188	D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
		Y, see ^{182}Ir	-	3E+3	1E-6	5E-9	-	-
77	Iridium-189	D, see ^{182}Ir	5E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	7E-5	7E-4
		W, see ^{182}Ir	-	4E+3	2E-6	5E-9	-	-
		Y, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col. 2 Inhalation	Col 3	Col 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
77	Iridium-190m[b]	D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
		W, see ^{182}Ir	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{182}Ir	-	2E+5	8E-5	3E-7	-	-
77	Iridium-190	D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
		W, see ^{182}Ir	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{182}Ir	-	9E+2	4E-7	1E-9	-	-
77	Iridium-192m	D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
		W, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
		Y, see ^{182}Ir	-	2E+1	6E-9	2E-11	-	-
77	Iridium-192	D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		W, see ^{182}Ir	-	4E+2	2E-7	6E-10	-	-
		Y, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
77	Iridium-194m	D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
		W, see ^{182}Ir	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{182}Ir	-	1E+2	4E-8	1E-10	-	-
77	Iridium-194	D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{182}Ir	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{182}Ir	-	2E+3	8E-7	3E-9	-	-
77	Iridium-195m	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	2E+4	9E-6	3E-8	-	-
77	Iridium-195	D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{182}Ir	-	5E+4	2E-5	7E-8	-	-
		Y, see ^{182}Ir	-	4E+4	2E-5	6E-8	-	-
78	Platinum-186	D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
78	Platinum-193m	D, all compounds	3E+3	6E+3	3E-6	8E-9	-	-
			LLI wall (3E+4)	-	-	-	4E-5	4E-4
78	Platinum-193	D, all compounds	4E+4	2E+4	1E-5	3E-8	-	-
			LLI wall (5E+4)	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
78	Platinum-197m[b]	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-199[b]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, halides and nitrates	-	2E+4	9E-6	3E-8	-	-
		Y, oxides and hydroxides	-	2E+4	8E-6	3E-8	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col 2	Col 3	Col. 1	Col 2	
			Oral Ingestion	Inhalation				
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
79	Gold-194	D, see ^{193}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193}Au	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{193}Au	-	5E+3	2E-6	7E-9	-	-
79	Gold-195	D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{193}Au	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{193}Au	-	4E+2	2E-7	6E-10	-	-
79	Gold-198m	D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
79	Gold-198	D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	2E+3	8E-7	3E-9	-	-
		Y, see ^{193}Au	-	2E+3	7E-7	2E-9	-	-
79	Gold-199	D, see ^{193}Au	3E+3	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		W, see ^{193}Au	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{193}Au	-	4E+3	2E-6	5E-9	-	-
79	Gold-200m	D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{193}Au	-	2E+4	1E-6	3E-9	-	-
79	Gold-200[b]	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{193}Au	-	8E+4	3E-5	1E-7	-	-
		Y, see ^{193}Au	-	7E+4	3E-5	1E-7	-	-
79	Gold-201[b]	D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{193}Au	-	2E+5	1E-4	3E-7	-	-
		Y, see ^{193}Au	-	2E+5	9E-5	3E-7	-	-
80	Mercury-193m	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		D, see ^{193m}Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	4E+4	2E-5	6E-8	-	-
80	Mercury-194	Vapor	-	3E+1	1E-8	4E-11	-	-
		Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
		D, see ^{193m}Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see ^{193m}Hg	-	1E+2	5E-8	2E-10	-	-
80	Mercury-195m	Vapor	-	4E+3	2E-6	6E-9	-	-
		Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
		D, see ^{193m}Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	4E+3	2E-6	5E-9	-	-
80	Mercury-195	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		D, see ^{193m}Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	3E+4	1E-5	5E-8	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col 1	Col 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
80	Mercury-197m	Vapor	-	5E+3	2E-6	7E-9	-	-
		Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		D, see ^{193m}Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193m}Hg	-	5E+3	2E-6	7E-9	-	-
80	Mercury-197	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
		D, see ^{193m}Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{193m}Hg	-	9E+3	4E-6	1E-8	-	-
80	Mercury-199m[b]	Vapor	-	8E+4	3E-5	1E-7	-	-
		Organic D	6E+4	2E+5	7E-5	2E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
		D, see ^{193m}Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
		W, see ^{193m}Hg	-	2E+5	7E-5	2E-7	-	-
80	Mercury-203	Vapor	-	8E+2	4E-7	1E-9	-	-
		Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
		D, see ^{193m}Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	1E+3	5E-7	2E-9	-	-
81	Thallium-194m[b]	D, all compounds	5E+4	2E+5	6E-5	2E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
81	Thallium-194[b]	D, all compounds	3E+5	6E+5	2E-4	8E-7	-	-
			St wall (3E+5)	-	-	-	4E-3	4E-2
81	Thallium-195[b]	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198m[b]	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
81	Thallium-198	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Lead-195m[b]	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199[b]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col. 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E-1	2E-1	1E-10	-	-	-
			Bone surf (1E+0)	Bone surf (4E-1)	-	6E-13	1E-8	1E-7
82	Lead-211[b]	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	8E+1	3E+1	1E-8	5E-11	-	-
			Bone surf (1E+2)	-	-	-	2E-6	2E-5
82	Lead-214[b]	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bismuth-200[b]	D, nitrates	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, all other compounds	-	1E+5	4E-5	1E-7	-	-
83	Bismuth-201[b]	D, see ^{200}Bi	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{200}Bi	-	4E+4	2E-5	5E-8	-	-
83	Bismuth-202[b]	D, see ^{200}Bi	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{200}Bi	-	8E+4	3E-5	1E-7	-	-
83	Bismuth-203	D, see ^{200}Bi	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{200}Bi	-	6E+3	3E-6	9E-9	-	-
83	Bismuth-205	D, see ^{200}Bi	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{200}Bi	-	1E+3	5E-7	2E-9	-	-
83	Bismuth-206	D, see ^{200}Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{200}Bi	-	9E+2	4E-7	1E-9	-	-
83	Bismuth-207	D, see ^{200}Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-210m	D, see ^{200}Bi	4E+1	5E+0	2E-9	-	-	-
			Kidneys (6E+1)	Kidneys (6E+0)	-	9E-12	8E-7	8E-6
		W, see ^{200}Bi	-	7E-1	3E-10	9E-13	-	-
83	Bismuth-210	D, see ^{200}Bi	8E+2	2E+2	1E-7	-	1E-5	1E-4
			-	Kidneys (4E+2)	-	5E-10	-	-
		W, see ^{200}Bi	-	3E+1	1E-8	4E-11	-	-
83	Bismuth-212[b]	D, see ^{200}Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
		W, see ^{200}Bi	-	3E+2	1E-7	4E-10	-	-
83	Bismuth-213[b]	D, see ^{200}Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-214[b]	D, see ^{200}Bi	2E+4	8E+2	3E-7	1E-9	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, see ^{200}Bi	-	9E-2	4E-7	1E-9	-	-
84	Polonium-203[b]	D, all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, oxides, hydroxides, and nitrates	-	9E+4	4E-5	1E-7	-	-
84	Polonium-205[b]	D, see ^{203}Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
		W, see ^{203}Po	-	7E+4	3E-5	1E-7	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
84	Polonium-207	D, see ^{203}Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{203}Po	-	3E+4	1E-5	4E-8	-	-
84	Polonium-210	D, see ^{203}Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
		W, see ^{203}Po	-	6E-1	3E-10	9E-13	-	-
85	Astatine-207[b]	D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
		W	-	2E+3	9E-7	3E-9	-	-
85	Astatine-211	D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
		W	-	5E+1	2E-8	8E-11	-	-
86	Radon-220	With daughters removed	-	2E+4	7E-6	2E-8	-	-
		With daughters present	-	2E+1 (or 12 WLM)	9E-9 (or 1 0 WL)	3E-11	-	-
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2 (or 4 WLM)	3E-8 (or 0.33 WL)	1E-10	-	-
87	Francium-222[b]	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
87	Francium-223[b]	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	5E+0	7E-1	3E-10	9E-13	-	-
			Bone surf (9E+0)	-	-	-	1E-7	1E-6
88	Radium-224	W, all compounds	8E+0	2E+0	7E-10	2E-12	-	-
			Bone surf (2E+1)	-	-	-	2E-7	2E-6
88	Radium-225	W, all compounds	8E+0	7E-1	3E-10	9E-13	-	-
			Bone surf (2E+1)	-	-	-	2E-7	2E-6
88	Radium-226	W, all compounds	2E+0	6E-1	3E-10	9E-13	-	-
			Bone surf (5E+0)	-	-	-	6E-8	6E-7
88	Radium-227[b]	W, all compounds	2E+4	1E+4	6E-6	-	-	-
			Bone surf (2E+4)	Bone surf (2E+4)	-	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E+0	1E+0	5E-10	2E-12	-	-
			Bone surf (4E+0)	-	-	-	6E-8	6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3	3E+1	1E-8	-	-	-
			LLI wall (2E+3)	Bone surf (4E+1)	-	5E-11	3E-5	3E-4
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D, see ^{224}Ac	5E+1	3E-1	1E-10	-	-	-
			LLI wall (5E+1)	Bone surf (5E-1)	-	7E-13	7E-7	7E-6
		W, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col 1	Col. 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
89	Actinium-226	D, see ^{224}Ac	1E+2	3E+0	1E-9	-	-	-
			LLI wall (1E+2)	Bone surf (4E+0)	-	5E-12	2E-6	2E-5
		W, see ^{224}Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ^{224}Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ^{224}Ac	2E-1	4E-4	2E-13	-	-	-
			Bone surf (4E-1)	Bone surf (8E-4)	-	1E-15	5E-9	5E-8
		W, see ^{224}Ac	-	2E-3	7E-13	-	-	-
			-	Bone surf (3E-3)	-	4E-15	-	-
		Y, see ^{224}Ac	-	4E-3	2E-12	6E-15	-	-
89	Actinium-228	D, see ^{224}Ac	2E+3	9E+0	4E-9	-	3E-5	3E-4
			-	Bone surf (2E+1)	-	2E-11	-	-
		W, see ^{224}Ac	-	4E+1	2E-8	-	-	-
			-	Bone surf (6E+1)	-	8E-11	-	-
		Y, see ^{224}Ac	-	4E+1	2E-8	6E-11	-	-
90	Thorium-226[b]	W, all compounds except those given for Y	5E+3	2E+2	6E-8	2E-10	-	-
			St wall (5E+3)	-	-	-	7E-5	7E-4
		Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	-	-
90	Thorium-227	W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
		Y, see ^{226}Th	-	3E-1	1E-10	5E-13	-	-
90	Thorium-228	W, see ^{226}Th	6E+0	1E-2	4E-12	-	-	-
			Bone surf (1E+1)	Bone surf (2E-2)	-	3E-14	2E-7	2E-6
		Y, see ^{226}Th	-	2E-2	7E-12	2E-14	-	-
90	Thorium-229	W, see ^{226}Th	6E-1	9E-4	4E-13	-	-	-
			Bone surf (1E+0)	Bone surf (2E-3)	-	3E-15	2E-8	2E-7
		Y, see ^{226}Th	-	2E-3	1E-12	-	-	-
			-	Bone surf (3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ^{226}Th	4E+0	6E-3	3E-12	-	-	-
			Bone surf (9E+0)	Bone surf (2E-2)	-	2E-14	1E-7	1E-6
		Y, see ^{226}Th	-	2E-2	6E-12	-	-	-
			-	Bone surf (2E-2)	-	3E-14	-	-
90	Thorium-231	W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
		Y, see ^{226}Th	-	6E+3	3E-6	9E-9	-	-
90	Thorium-232	W, see ^{226}Th	7E-1	1E-3	5E-13	-	-	-
			Bone surf (2E+0)	Bone surf (3E-3)	-	4E-15	3E-8	3E-7
		Y, see ^{226}Th	-	3E-3	1E-12	-	-	-
			-	Bone surf (4E-3)	-	6E-15	-	-
90	Thorium-234	W, see ^{226}Th	3E+2	2E+2	8E-8	3E-10	-	-
			LLI wall (4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{226}Th	-	2E+2	6E-8	2E-10	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col. 1	Col 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
91	Protactinium-227[b]	W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
		Y, oxides and hydroxides	-	1E+2	4E-8	1E-10	-	-
91	Protactinium-228	W, see ^{227}Pa	1E+3	1E+1	5E-9	-	2E-5	2E-4
			-	Bone surf (2E+1)	-	3E-11	-	-
		Y, see ^{227}Pa	-	1E+1	5E-9	2E-11	-	-
91	Protactinium-230	W, see ^{227}Pa	6E+2	5E+0	2E-9	7E-12	-	-
			Bone surf (9E+2)	-	-	-	1E-5	1E-4
		Y, see ^{227}Pa	-	4E+0	1E-9	5E-12	-	-
91	Protactinium-231	W, see ^{227}Pa	2E-1	2E-3	6E-13	-	-	-
			Bone surf (5E-1)	Bone surf (4E-3)	-	6E-15	6E-9	6E-8
		Y, see ^{227}Pa	-	4E-3	2E-12	-	-	-
			-	Bone surf (6E-3)	-	8E-15	-	-
91	Protactinium-232	W, see ^{227}Pa	1E+3	2E+1	9E-9	-	2E-5	2E-4
			-	Bone surf (6E+1)	-	8E-11	-	-
		Y, see ^{227}Pa	-	6E+1	2E-8	-	-	-
			-	Bone surf (7E+1)	-	1E-10	-	-
91	Protactinium-233	W, see ^{227}Pa	1E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
		Y, see ^{227}Pa	-	6E+2	2E-7	8E-10	-	-
91	Protactinium-234	W, see ^{227}Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{227}Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF_6, UO_2F_2, $UO_2(NO_3)_2$	4E+0	4E-1	2E-10	-	-	-
			Bone surf (6E+0)	Bone surf (6E-1)	-	8E-13	8E-8	8E-7
		W, UO_3, UF_4, UCl_4	-	4E-1	1E-10	5E-13	-	-
		Y, UO_2, U_3O_8	-	3E-1	1E-10	4E-13	-	-
92	Uranium-231	D, see ^{230}U	5E+3	8E+3	3E-6	1E-8	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ^{230}U	-	6E+3	2E-6	8E-9	-	-
		Y, see ^{230}U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see ^{230}U	2E+0	2E-1	9E-11	-	-	-
			Bone surf (4E+0)	Bone surf (4E-1)	-	6E-13	6E-8	6E-7
		W, see ^{230}U	-	4E-1	2E-10	5E-13	-	-
		Y, see ^{230}U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-233	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col. 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
92	Uranium-234[g]	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-235[g]	D, see ^{230}U	1E+1	1E+0	6E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-236	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-237	D, see ^{230}U	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ^{230}U	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{230}U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238[g]	D, see ^{230}U	1E+1	1E+0	6E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-239[h]	D, see ^{230}U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see ^{230}U	-	2E+5	7E-5	2E-7	-	-
		Y, see ^{230}U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see ^{230}U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{230}U	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{230}U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural[g]	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	9E-13	-	-
		Y, see ^{230}U	-	5E-2	2E-11	9E-14	-	-
93	Neptunium-232[h]	W, all compounds	1E+5	2E+3	7E-7	-	2E-3	2E-2
			-	Bone surf (5E+2)	-	6E-9	-	-
93	Neptunium-233[h]	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	2E+4	8E+2	3E-7	-	-	-
			LLI wall (2E+4)	Bone surf (1E+3)	-	2E-9	3E-4	3E-3
93	Neptunium-236 (1 15E+5 y)	W, all compounds	3E+0	2E-2	9E-12	-	-	-
			Bone surf (6E+0)	Bone surf (5E-2)	-	8E-14	9E-8	9E-7
93	Neptunium-236 (22 5 h)	W, all compounds	3E+3	3E+1	1E-8	-	-	-
			Bone surf (4E+3)	Bone surf (7E+1)	-	1E-10	5E-5	5E-4

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col 2 Inhalation	Col 3	Col. 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
93	Neptunium-237	W, all compounds	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	1E-14	2E-8	2E-7
93	Neptunium-238	W, all compounds	1E+3	6E+1	3E-8	-	2E-5	2E-4
			-	Bone surf (2E+2)	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
93	Neptunium-240[b]	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO_2	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO_2	-	2E+2	8E-8	3E-10	-	-
94	Plutonium-235[b]	W, see ^{234}Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
		Y, see ^{234}Pu	-	3E+6	1E-3	3E-6	-	-
94	Plutonium-236	W, see ^{234}Pu	2E+0	2E-2	8E-12	-	-	-
			Bone surf (4E+0)	Bone surf (4E-2)	-	5E-14	6E-8	6E-7
		Y, see ^{234}Pu	-	4E-2	2E-11	6E-14	-	-
94	Plutonium-237	W, see ^{234}Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
		Y, see ^{234}Pu	-	3E+3	1E-6	4E-9	-	-
94	Plutonium-238	W, see ^{234}Pu	9E-1	7E-3	3E-12	-	-	-
			Bone surf (2E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	8E-12	2E-14	-	-
94	Plutonium-239	W, see ^{234}Pu	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-240	W, see ^{234}Pu	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-241	W, see ^{234}Pu	4E+1	3E-1	1E-10	-	-	-
			Bone surf (7E+1)	Bone surf (6E-1)	-	8E-13	1E-6	1E-5
		Y, see ^{234}Pu	-	8E-1	3E-10	-	-	-
			-	Bone surf (1E+0)	-	1E-12	-	-
94	Plutonium-242	W, see ^{234}Pu	8E-1	7E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-243	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ^{234}Pu	-	4E+4	2E-5	5E-8	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col 1	Col 2	
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
94	Plutonium-244	W, see ^{234}Pu	8E-1	7E-3	3E-12	-	-	-
			Bone surf (2E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-245	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		Y, see ^{234}Pu	-	4E+3	2E-6	6E-9	-	-
94	Plutonium-246	W, see ^{234}Pu	4E+2	3E+2	1E-7	4E-10	-	-
			LLI wall (4E+2)	-	-	-	6E-6	6E-5
		Y, see ^{234}Pu	-	3E+2	1E-7	4E-10	-	-
95	Americium-237[b]	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238[b]	W, all compounds	4E+4	3E+3	1E-6	-	5E-4	5E-3
			-	Bone surf (6E+3)	-	9E-9	-	-
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242m	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	4E+3	8E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (9E+1)	-	1E-10	-	-
95	Americium-243	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-244m[b]	W, all compounds	6E+4	4E+3	2E-6	-	-	-
			St wall (8E+4)	Bone surf (7E+3)	-	1E-8	1E-3	1E-2
95	Americium-244	W, all compounds	3E+3	2E+2	8E-8	-	4E-5	4E-4
			-	Bone surf (3E+2)	-	4E-10	-	-
95	Americium-245	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Americium-246m[b]	W, all compounds	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
95	Americium-246[b]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
96	Curium-238	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	6E+1	6E-1	2E-10	-	-	-
			Bone surf (8E+1)	Bone surf (6E-1)	-	9E-13	1E-6	1E-5

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col. 2	Col 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
96	Curium-241	W, all compounds	1E+3	3E+1	1E-8	-	2E-5	2E-4
			-	Bone surf (4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1	3E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	1E+0	1E-2	5E-12	-	-	-
			Bone surf (3E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-246	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-247	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-248	W, all compounds	2E-1	2E-3	7E-13	-	-	-
			Bone surf (4E-1)	Bone surf (3E-3)	-	4E-15	5E-9	5E-8
96	Curium-249[b]	W, all compounds	5E+4	2E+4	7E-6	-	7E-4	7E-3
			-	Bone surf (3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2	3E-4	1E-13	-	-	-
			Bone surf (6E-2)	Bone surf (5E-4)	-	8E-16	9E-10	9E-9
97	Berkelium-245	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
97	Berkelium-246	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
97	Berkelium-247	W, all compounds	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2	2E+0	7E-10	-	-	-
			Bone surf (5E+2)	Bone surf (4E+0)	-	5E-12	6E-6	6E-5
97	Berkelium-250	W, all compounds	9E+3	3E+2	1E-7	-	1E-4	1E-3
			-	Bone surf (7E+2)	-	1E-9	-	-
98	Californium-244[b]	W, all compounds except those given for Y	3E+4	6E+2	2E-7	8E-10	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		Y, oxides and hydroxides	-	6E+2	2E-7	8E-10	-	-
98	Californium-246	W, see ^{244}Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
		Y, see ^{244}Cf	-	9E+0	4E-9	1E-11	-	-

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col 1	Col 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
98	Californium-248	W, see ^{244}Cf	8E+0	6E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	2E-13	2E-7	2E-6
		Y, see ^{244}Cf	-	1E-1	4E-11	1E-13	-	-
98	Californium-249	W, see ^{244}Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2	4E-12	-	-	-
			-	Bone surf (1E-2)	-	2E-14	-	-
98	Californium-250	W, see ^{244}Cf	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	4E-14	-	-
98	Californium-251	W, see ^{244}Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2	4E-12	-	-	-
			-	Bone surf (1E-2)	-	2E-14	-	-
98	Californium-252	W, see ^{244}Cf	2E+0	2E-2	8E-12	-	-	-
			Bone surf (5E+0)	Bone surf (4E-2)	-	5E-14	7E-8	7E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	5E-14	-	-
98	Californium-253	W, see ^{244}Cf	2E+2	2E+0	8E-10	3E-12	-	-
			Bone surf (4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{244}Cf	-	2E+0	7E-10	2E-12	-	-
98	Californium-254	W, see ^{244}Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	2E-2	7E-12	2E-14	-	-
99	Einsteinium-250	W, all compounds	4E+4	5E+2	2E-7	-	6E-4	6E-3
			-	Bone surf (1E+3)	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2	4E-7	-	1E-4	1E-3
			-	Bone surf (1E+3)	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
99	Einsteinium-254m	W, all compounds	3E+2	1E+1	4E-9	1E-11	-	-
			LLI wall (3E+2)	-	-	-	4E-6	4E-5
99	Einsteinium-254	W, all compounds	8E+0	7E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	2E-13	2E-7	2E-6
100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	2E+1	2E-1	7E-11	-	-	-
			Bone surf (4E+1)	Bone surf (2E-1)	-	3E-13	5E-7	5E-6

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col 1	Col 2	Col 3	Col 1	Col 2	
			Oral Ingestion	Inhalation				
Atomic No	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
101	Mendelevium-257	W, all compounds	7E+3	8E+1	4E-8	-	1E-4	1E-3
			-	Bone surf (9E+1)	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1	2E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	5E-13	6E-7	6E-6
- Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours		Submersion[a]	-	2E+2	1E-7	1E-9	-	-
- Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours		....	-	2E-1	1E-10	1E-12	1E-8	1E-7
- Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known		....	-	4E-4	2E-13	1E-15	2E-9	2E-8

Footnotes:

[a] *"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material*

[b] *These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures The licensee may substitute 1E-7 μCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits (See s. HFS 157 22 (3))*

[c] *For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see D 201e.) If the percent by weight enrichment of U-235 is not greater than 5, the concentration value for a 40-hour workweek is 0 2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek may not exceed 8E-3 (SA) μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6 77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:*

$$SA = 3\ 6E\text{-}7 \text{ curies/gram U} \quad \text{U-depleted}$$

$$SA = [0\ 4 + 0\ 38\ \text{enrichment} + 0\ 0034\ \text{enrichment}^2]\ E\text{-}6, \quad \text{enrichment} \geq 0\ 72$$

where enrichment is the percentage by weight of U-235, expressed as percent

Note

1. If the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture

2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture, or

Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure
Effluent Concentrations
Concentrations for Release to Sanitary Sewerage *(Continued)*

Atomic No.	Radionuclide	Class	Table I Occupational Values Col 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations Col. 1 Air (μCi/ml)	Col 2 Water (μCi/ml)	Table III Releases to Sewers Monthly Average Concentration (μCi/ml)
If it is known that Ac-227-D and Cm-250-W are not present			-	7E-4	3E-13	-	-	-
If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present			-	7E-3	3E-12	-	-	-
If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228-W,Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-254-W,Y are not present □			7E-2	3E-11	-	-	-	
If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present			-	7E-1	3E-10	-	-	-
If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D,W, La-138-D, Lu-176-W, Hf-178m-D,W, Hf-182-D,W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D,W,Y, Pa-230-W,Y, U-233-D,W, U-234-D,W, U-235-D,W, U-236-D,W, U-238-D,W, Pu-241-Y, Bk-249-W, Cf-253-W,Y, and Es-253-W are not present			-	7E+0	3E-9	-	-	-
If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th-232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present			-	-	-	1E-14	-	-
If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present			-	-	-	1E-13	-	-
If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not present			-	-	-	1E-12	-	-
If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present			-	-	-	-	1E-6	1E-5

3 If a mixture of radionuclides consists of uranium and its daughters in ore dust (10 μm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture 6E-11 μCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 μCi of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.

4 If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows· determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in Appendix E for the specific radionuclide when not in a mixture The sum of such ratios for all of the radionuclides in the mixture may not exceed "1," which is "unity".

Example: If radionuclides "A," "B," and "C" are present in concentrations C_A, C_B, and C_C, and if the applicable DACs are DAC_A, DAC_B, and DAC_C, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC} SUBB + \frac{C_C}{DAC_C} \leq 1$$

APPENDIX F

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

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37			
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

(In Atomic Number Order)

(Continued)

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

Rubidium-81m	1,000	Rubidium-81	1,000

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING

(In Atomic Number Order)

(Continued)

Radionuclide	Quantity (uCi)[b/]	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37.			
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

(In Atomic Number Order)

(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)[b/]
Note: To convert uCi to kBq, multiply the *u*Ci value by 37.			
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
(In Atomic Number Order)
(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)[b/]
Note: To convert uCi to kBq, multiply the uCi value by 37.			
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.O1 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
(In Atomic Number Order)
(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)[b]
NOTE: To convert uCi to kBq, multiply the uCi value by 37.			
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

(In Atomic Number Order)

(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)[b/]
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.O 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
(In Atomic Number Order)
(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)[b]
Note: To convert uCi to kBq, multiply the uCi value by 37.			
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.O 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
(In Atomic Number Order)
(Continued)

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
(In Atomic Number Order)
(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Note: To convert uCi to kBq, multiply the uCi value by 37.			
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

(In Atomic Number Order)

(Continued)

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

QUANTITIES OF LICENSED OR REGISTERED MATERIAL REQUIRING LABELING

(In Atomic Number Order)

(Continued)

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)[b/]
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: To convert uCi to kBq, multiply the uCi value by 37.

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.

APPENDIX G

REQUIREMENTS FOR TRANSFER OF LOW-LEVEL RADIOACTIVE WASTE FOR DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS

Section I. - Manifest.

The shipment manifest shall contain the name, address and telephone number of the person generating the waste. The manifest shall also include the name, address and telephone number or the name and the Environmental Protection Department hazardous waste identification number of the person transporting the waste to the land disposal facility. The manifest shall also indicate: a physical description of the waste, the volume, radionuclide identity and quantity, the total radioactivity and the principal chemical form. The solidification agent shall be specified. Waste containing more than 0.1 percent chelating agents by weight shall be identified and the weight percentage of the chelating agent estimated. Wastes classified as Class A, Class B or Class C in Section I of Appendix H shall be clearly identified as such in the manifest. The total quantity of the radionuclides hydrogen-3, carbon-14, technetium-99, and iodine-129 shall be shown. The manifest required by this paragraph may be shipping papers used to meet the Department of Transportation or the Environmental Protection Department regulations or requirements of the receiver, provided all the required information is included. Copies of manifests required by this section may be legible carbon copies or legible photocopies.

Section II. - Certification.

The waste generator shall include in the shipment manifest a certification that the transported materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the department. An authorized representative of the waste generator shall sign and date the manifest.

Section III. - Control and Tracking.

(a) Any radioactive waste generator who transfers radioactive waste to a land disposal facility or a licensed waste collector shall comply with the requirements in (a)(1) through (8). Any radioactive waste generator who transfers waste to a licensed waste processor who treats or repackages waste shall comply with the requirements of (a)(4) through (8). A licensee shall:

(1) Prepare all wastes so that the waste is classified according to Section I of Appendix H and meets the waste characteristics requirements in Section II of Appendix H;

(2) Label each package of waste to identify whether it is Class A waste, Class B waste or Class C waste under Section I of Appendix H;

(3) Conduct a quality control program to ensure compliance with Section I and II of Appendix H; the program shall include management evaluation of audits;

(4) Prepare shipping manifests to meet the requirements of Section I and II;

(5) Forward a copy of the manifest to the intended recipient, at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation from the collector;

(6) Include one copy of the manifest with the shipment;

(7) Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by s. HFS 157.13 (15); and

(8) For any shipments or any portion of a shipment for which acknowledgment of receipt has not been received within the times set forth in this section, conduct an investigation under Section III.(e).

(b) Any waste collector licensee who handles only prepackaged waste shall:

(1) Acknowledge receipt of the waste from the generator within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation;

(2) Prepare a new manifest to reflect consolidated shipments; the new manifest shall serve as a listing or index for the detailed generator manifests. Copies of the generator manifests shall be a part of the new manifest. The waste collector may prepare a new manifest without attaching the generator manifests, provided the new manifest contains for each package the information specified in Section I. The collector licensee shall certify that nothing has been done to the waste that would invalidate the generator's certification;

(3) Forward a copy of the new manifest to the land disposal facility operator at the time of shipment;

(4) Include the new manifest with the shipment to the disposal site;

(5) Retain a copy of the manifest and documentation of acknowledgement of receipt as the record of transfer of licensed material as required by s. HFS 157.13 (15) and retain information from generator manifest until the license is terminated and disposition is authorized by the department; and

(6) For any shipments or any portion of a shipment for which acknowledgement of receipt is not received within the times set forth in this section, conduct an investigation under Section III.(e).

(c) Any licensed waste processor who treats or repackages wastes shall:

(1) Acknowledge receipt of the waste from the generator within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation;

(2) Prepare a new manifest that meets the requirements of Section I and II. Preparation of the new manifest reflects that the processor is responsible for the waste;

(3) Prepare all wastes so that the waste is classified according to Section I of Appendix H and meets the waste characteristics requirements in Section II of Appendix H;

(4) Label each package of waste to identify whether it is Class A waste, Class B waste or Class C waste, under Section I and III of Appendix H;

(5) Conduct a quality control program to ensure compliance with Section I and II of Appendix H. The program shall include management evaluation of audits;

(6) Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest or equivalent documentation by the collector;

(7) Include the new manifest with the shipment;

(8) Retain copies of original manifests and new manifests and documentation of acknowledgement of receipt as the record of transfer of licensed material required by s. HFS 157.13 (15);

(9) For any shipment or portion of a shipment for which acknowledgement is not received within the times set forth in this section, conduct an investigation under Section III.(e).

(d) The land disposal facility operator shall:

(1) Acknowledge receipt of the waste within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received;

(2) Maintain copies of all completed manifests or equivalent documentation until license termination;

(3) Notify the shipper, that is, the generator, the collector, or processor, and the department when any shipment or portion of a shipment has not arrived within 60 days after the advance manifest was received unless notified by the shipper that the shipment has been cancelled.

(e) Any shipment or portion of a shipment for which acknowledgement is not received within the times set forth in this section shall:

(1) Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer;

(2) Be traced and reported to the generator. The investigation shall include tracing the shipment and filing a report with the department. Each shipper who conducts a trace investigation shall file a written report with the department within 2 weeks of completion of the investigation.

APPENDIX H

CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE

Section I. - Classification of Radioactive Waste for Land Disposal.

(a) Considerations. Determination of the classification of radioactive waste involves 2 considerations. First, consideration must be given to the concentration of long-lived radionuclides, and their shorter-lived precursors, whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

(b) Classes of waste.

(1) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in Section II.(a). If Class A waste also meets the stability requirements set forth in Section II.(b), it is not necessary to segregate the waste for disposal.

(2) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in Section II.

(3) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in Section II.

(4) Waste that is generally acceptable for near-surface disposal is waste for which form and disposal methods shall be different, and in general more stringent, than those specified for Class C waste. Such waste must be disposed of in a geologic repositito as defined in 10 CFR 60.

(c) Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table IV, classification shall be determined as follows:

(1) If the concentration does not exceed 0.1 times the value in Table IV, the waste is Class A.

(2) If the concentration exceeds 0.1 times the value in Table IV, but does not exceed the value in Table IV, the waste is Class C.

(3) If the concentration exceeds the value in Table IV, the waste is not generally acceptable for land disposal.

(4) For wastes containing mixtures of radionuclides listed in Table IV, the total concentration shall be determined by the sum of fractions rule described in Section I.(g).

TABLE IV

Radionuclide	Concentration Curie/Cubic Meter[a/]	Concentration Nanocurie/Gram[b/]
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half-life greater than 5 years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100

[a/] *To convert the Ci/m³ values to gigabecquerel (GBq) per cubic meter, multiply the Ci/m³ value by 37.*

[b/] *To convert the nCi/g values to becquerel (Bq) per gram, multiply the nCi/g value by 37.*

d) Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table IV, classification shall be determined based on the concentrations shown in Table V. However, as specified in Section I.(f), if radioactive waste does not contain any nuclides listed in either Table IV or V, it is Class A.

1) If the concentration does not exceed the value in Column 1, the waste is Class A.

2) If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.

3) If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.

4) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

5) For wastes containing mixtures of the radionuclides listed in Table V, the total concentration shall be determined by the sum of fractions rule described in Section I.(g).

TABLE V

Radionuclide	Concentration Column 1	Curie/Cubic Meter[a/] Column 2	Column 3
Total of all radio-nuclides with less than 5-year half-life	700	*	*
H-3	40	*	*
Co-60	700	*	*
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

[a/] *Note: To convert the Ci/m³ value to gigabecquerel (GBq) per cubic meter, multiply the Ci/m³ value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table V determine the waste to be Class C independent of these radionuclides.*

(e) Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table IV and some of which are listed in Table V, classification shall be determined as follows:

(1) If the concentration of a radionuclide listed in Table IV does not exceed 0.1 times the value listed in Table IV, the class shall be that determined by the concentration of radionuclides listed in Table V.

(2) If the concentration of a radionuclide listed in Table IV exceeds 0.1 times the value listed in Table IV, but does not exceed the value in Table IV, the waste shall be Class C, provided the concentration of radionuclides listed in Table V does not exceed the value shown in Column 3 of Table V.

(f) Classification of wastes with radionuclides other than those listed in Tables IV and V. If the waste does not contain any radionuclides listed in either Table IV or V, it is Class A.

(g) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 1.85 TBq/m^3 (50 Ci/m^3) and Cs-137 in a concentration of 814 GBq/m^3 (22 Ci/m^3). Since the concentrations both exceed the values in Column 1, Table V, they must be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33., for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

(h) Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as becquerel (nanocurie) per gram.

Section II. - Radioactive Waste Characteristics.

(a) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and safety of personnel at the disposal site.

(1) Wastes shall be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of this section, the site license conditions shall govern.

(2) Wastes may not be packaged for disposal in cardboard or fiberboard boxes.

(3) Liquid waste shall be packaged in sufficient absorbent material to absorb twice the volume of the liquid.

(4) Solid waste containing liquid shall contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the volume.

(5) Waste may not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

(6) Waste may not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged under Section II.(a)(8).

(7) Waste must not be pyrophoric. Pyrophoric materials contained in wastes shall be treated, prepared, and packaged to be nonflammable.

8) Wastes in a gaseous form shall be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20°C. Total activity may not exceed 3.7 TBq (100 Ci) per container.

9) Wastes containing hazardous, biological, pathogenic, or infectious material shall be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

(b) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

1) Waste shall have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability may be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

2) Notwithstanding the provisions in Section II.(a)(3) and (4), liquid wastes, or wastes containing liquid, shall be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5 percent of the volume of the waste for waste processed to a stable form.

3) Void spaces within the waste and between the waste and its package shall be reduced to the extent practicable.

Section III. - Labeling.

Each package of waste shall be clearly labeled to identify whether it is Class A, Class B or Class C waste, under Section I.

APPENDIX I

QUANTITIES FOR USE WITH DECOMMISSIONING UNDER SECTION HFS 157.15

NOTE: To convert μCi to kBq, multiply the μCi value by 37.

Material	Microcurie
Americium-241	0.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-133	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 (9.2 h)	100
Europium-152 (13 yr)	1

QUANTITIES FOR USE WITH DECOMMISSIONING UNDER SECTION HFS 157.15 *(Continued)*

Material	Microcurie
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	0
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10

QUANTITIES FOR USE WITH DECOMMISSIONING UNDER SECTION HFS 157.15 *(Continued)*

Material	Microcurie
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-22	1
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1

QUANTITIES FOR USE WITH DECOMMISSIONING UNDER SECTION HFS 157.15 *(Continued)*

Material	Microcurie
Strontium-91	10
Strontium-92	10
Sulfur -35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
Thorium (natural)[c/]	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
Uranium (natural)[d/]	100
Uranium-233	0.01
Uranium-234	0.01
Uranium-235	0.01
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10

[c/] *Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.*

[d/] *Based on alpha disintegration rate of U-238, U-234, and U-235.*

QUANTITIES FOR USE WITH DECOMMISSIONING UNDER SECTION HFS 157.15 *(Continued)*

Material	Microcurie
Zinc- 69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.01
Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition	0.1

Note: Where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of the ratios for all the isotopes in the combination may not exceed "1" – that is, unity.

APPENDIX J

SUBJECTS TO BE INCLUDED IN TRAINING COURSES FOR WELL LOGGING SUPERVISORS

I. Fundamentals of Radiation Safety

- A. Characteristics of radiation
- B. Units of radiation dose and quantity of radioactivity
- C. Significance of radiation dose **and hazards of exposure to radiation**
  1. Radiation protection standards
  2. Biological effects of radiation dose
- D. Levels of radiation from sources of radiation
- E. Methods of minimizing radiation dose
  1. Working time
  2. Working distances
  3. Shielding
- F. Radiation safety practices including prevention of contamination and methods of decontamination

II. Radiation Detection Instrumentation to be Used

- A. Use of radiation survey instruments
  1. Operation
  2. Calibration
  3. Limitations
- B. Survey techniques
- C. Use of personnel monitoring equipment

III. Equipment to be Used

- A. Handling equipment
- B. Sources of radiation
- C. Storage and control of equipment
- D. Operation and control of equipment

IV. The Requirements of Pertinent Federal and State Regulations

V. The Licensee's or Registrant's Written Operating and Emergency Procedures

VI. The Licensee's or Registrant's Record Keeping Procedures

VII. Case histories of well logging accidents

APPENDIX K

EXAMPLE OF PLAQUE FOR IDENTIFYING WELLS CONTAINING SEALED SOURCES CONTAINING RADIOACTIVE MATERIAL ABANDONED DOWNHOLE

The size of the plaque should be convenient for use on active or inactive wells, e.g., a 17 cm (7-inch) square and at least 3 mm (1/8") thick. Letter size of the word "CAUTION" should be approximately twice the letter size of the rest of the information, e.g., 2-inch and 1-inch letter size, respectively.

{NAME OF COMPANY}
{SECOND HEADING OF NAME OF COMPANY}

CAUTION

{QUANTITY AND TYPE OF RADIOACTIVE MATERIAL}
{DATE LOST AND DEPTH OF RADIOACTIVE MATERIAL}
DO NOT RE-ENTER THIS WELL BEFORE CONTACTING:

RADIATION PROTECTION SECTION
WI DEPARTMENT OF HEALTH AND FAMILY SERVICES

APPENDIX L (RESERVED)

~~DETERMINATION OF COMPETENCE FOR MEDICAL X-RAY OPERATORS~~

~~The following are areas in which the department considers it important that an individual have expertise for the competent operation of x-ray equipment:~~

~~(a) Familiarization with equipment~~
- ~~(1) Identification of controls~~
- ~~(2) Function of each control~~
- ~~(3) How to use a technique chart~~

~~(b) Radiation Protection~~
- ~~(1) Collimation~~
- ~~(2) Filtration~~
- ~~(3) Gonad shielding and other patient protection devices~~
- ~~(4) Restriction of x-ray tube radiation to the image receptor~~
- ~~(5) Personnel protection~~
- ~~(6) Grids~~
- ~~(7) Protection of children and pregnant women~~
- ~~(8) Repeat film analysis~~

~~(c) Film Processing~~
- ~~(1) Film speed as related to patient exposure~~
- ~~(2) Film processing parameters~~
- ~~(3) Quality assurance program~~

~~(d) Emergency procedures to terminate the exposure in the event of automatic timing device failure~~

~~(e) Proper use of personnel dpsimetry, if required~~

~~(f) Understanding units of radiation and the physics of radiation production~~

~~(g) Understanding the proper anatomical positioning techniques used for radiography~~

APPENDIX M

INFORMATION TO BE SUBMITTED BY PERSONS PROPOSING TO CONDUCT HEALING ARTS SCREENING

Persons requesting that the department approve a healing arts screening program shall submit the following information and evaluation. Mammography screening and bone density screening are exempt from this requirement unless persons under age 18 are involved:

a. Name and address of the applicant and, where applicable, the names and addresses of agents within this state.

b. Diseases or conditions for which the x-ray examinations are to be used in diagnoses.

c. A detailed description of the x-ray examinations proposed in the screening program.

d. A description of the population to be examined in the screening program, which is age, sex, physical condition, and other appropriate information. If the study involves women of reproductive age and the exam involves the trunk of the body, what precautions are being taken to ensure the subjects are not pregnant.

e. An evaluation of any known alternate methods not involving ionizing radiation which could achieve the goals of the screening program and why these methods are not used instead of the x-ray examinations.

f. An evaluation by a medical physicist of the x-ray system to be used in the screening program. The evaluation by the medical physicist shall show that the system satisfies all requirements of this chapter. The evaluation shall include a measurement of patient exposures from the x-ray examinations to be performed. This exposure information must be included in the informed consent papers signed by the subject. An explanation of the risk from the radiation exposure shall be included in the informed consent if the head, neck or trunk is involved in the procedure.

g. The name and address of the individual who will interpret the radiograph or images if any are produced. The interpreting physicians must be licensed in Wisconsin.

h. A description of the procedures to be used in advising the individuals screened and their private practitioners of the healing arts of the results of the screening procedure and any further medical needs indicated.

i. A description of the procedures for the retention or disposition of the radiographs, images, graphs and other records pertaining to the x-ray examinations.

n. An indication of the frequency of screening and the duration of the entire screening program.

o. Human-use committee approval of the screening program if one is required by local policy.

p. A copy of the informed consent information being provided to the subjects.

q. If minors are involved, parental consent is required.

APPENDIX N

EXEMPTIONS FROM PATIENT SHIELDING FOR CERTAIN FLUOROSCOPIC PROCEDURES

As specified in s. HFS 157.76 (9) (c), the following fluorscopic procedures are automatically exempt from normal protective barriers.

a. Angiograms

b. Arthrograms

c. Biliary drainage procedures

d. Fluoroscopic biopsy procedures

e. Myelograms

f. Percutaneous cholangiograms

g. Percutaneous nephrostomies

h. Sinograms or fistulograms

i. T-tube cholangiograms

APPENDIX O

DETERMINATION OF A_1 AND A_2

I. Values of A_1 and A_2 for individual radionuclides, which are the bases for many activity limits elsewhere in these regulations, are given in TABLE VI. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) figure. The curie values are expressed to 3 significant figures to assure that the difference in the TBq and Ci quantities is one tenth of one percent or less. Where values of A_1 or A_2 are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

II. For individual radionuclides whose identities are known, but which are not listed in TABLE VI, the determination of the values of A_1 and A_2 requires department approval, except that the values of A_1 and A_2 in TABLE VII may be used without obtaining department approval.

III. In the calculations of A_1 and A_2 for a radionuclide not in TABLE VI, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter nuclide has a half-life either longer than 10 days, or longer than that of the parent nuclide, shall be considered as a single radionuclide, and the activity to be taken into account, and the A_1 or A_2 value to be applied shall be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days, or greater than that of the parent nuclide, the parent and those daughter nuclides shall be considered as mixtures of different nuclides.

IV. For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:

(a) For special form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

(b) For normal form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_2(i)} \leq 1$$

where B(i) is the activity of radionuclide i and $A_1(i)$ and $A_2(i)$ are the A_1 and A_2 values for radionuclide respectively.
Alternatively, an A_1 value for mixtures of special form material may be determined as follows:

$$A_1 = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

where f(i) is the fraction of activity of nuclide I in the mixture and $A_1(i)$ is the appropriate A_1 value for nuclide i.

An A_2 value for mixtures of normal form material may be determined as follows:

$$A_2 = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

where f(i) is the fraction of activity of nuclide I in the mixture and $A_2(i)$ is the appropriate A_2 value for nuclide i.

V. When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph IV. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters and beta/gamma emitters.

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Ac-225	Actinium (89)	0.6	16.2	$1x10^{-2}$	0.270	$2.1x10^{3}$	$5.8x10^{4}$
Ac-227		40	1080	$2x10^{-5}$	$5.41x10^{-4}$	2.7	$7.2x10^{1}$
Ac-228		0.6	16.2	0.4	10.8	$8.4x10^{4}$	$2.2x10^{6}$
Ag-105	Silver (47)	2	54.1	2	54.1	$1.1x10^{3}$	$3.0x10^{4}$
Ag-108m		0.6	16.2	0.6	16.2	$9.7x10^{-1}$	$2.6x10^{1}$
Ag-110m		0.4	10.8	0.4	10.8	$1.8x10^{2}$	$4.7x10^{3}$
Ag-111		0.6	16.2	0.5	13.5	$5.8x10^{3}$	$1.6x10^{5}$
Al-26	Aluminum (13)	0.4	10.8	0.4	10.8	$7.0x10^{-4}$	$1.9x10^{-2}$
Am-241	Americium (95)	2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$1.3x10^{-1}$	3.4
Am-242m		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$3.6x10^{-1}$	$1.0x10^{1}$
Am-243		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$7.4x10^{-3}$	$2.0x10^{-1}$
Ar-37	Argon (18)	40	1080	40	1080	$3.7x10^{3}$	$9.9x10^{4}$
Ar-39		20	541	20	541	1.3	$3.4x10^{1}$
Ar-41		0.6	16.2	0.6	16.2	$1.5x10^{6}$	$4.2x10^{7}$
Ar-42		0.2	5.41	0.2	5.41	9.6	$2.6x10^{2}$
As-72	Arsenic (33)	0.2	5.41	0.2	5.41	$6.2x10^{4}$	$1.7x10^{6}$
As-73		40	1080	40	1080	$8.2x10^{2}$	$2.2x10^{4}$
As-74		1	27.0	0.5	13.5	$3.7x10^{3}$	$9.9x10^{4}$
As-76		0.2	5.41	0.2	5.41	$5.8x10^{4}$	$1.6x10^{6}$
As-77		20	541	0.5	13.5	$3.9x10^{4}$	$1.0x10^{6}$
At-211	Astatine (85)	30	811	2	54.1	$7.6x10^{4}$	$2.1x10^{6}$
Au-193	Gold (79)	6	162	6	162	$3.4x10^{4}$	$9.2x10^{5}$
Au-194		1	27.0	1	27.0	$1.5x10^{4}$	$4.1x10^{5}$
Au-195		10	270	10	270	$1.4x10^{2}$	$3.7x10^{3}$
Au-196		2	54.1	2	54.1	$4.0x10^{3}$	$1.1x10^{5}$
Au-198		3	81.1	0.5	13.5	$9.0x10^{3}$	$2.4x10^{5}$
Au-199		10	270	0.9	24.3	$7.7x10^{3}$	$2.1x10^{5}$
Ba-131	Barium (56)	2	54.1	2	54.1	$3.1x10^{3}$	$8.4x10^{4}$
Ba-133m		10	270	0.9	24.3	$2.2x10^{4}$	$6.1x10^{5}$
Ba-133		3	81.1	3	81.1	9.4	$2.6x10^{2}$
Ba-140		0.4	10.8	0.4	10.8	$2.7x10^{3}$	$7.3x10^{4}$
Be-7	Beryllium (4)	20	541	20	541	$1.3x10^{4}$	$3.5x10^{5}$
Be-10		20	541	0.5	13.5	$8.3x10^{-4}$	$2.2x10^{-2}$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Bi-205	Bismuth (83)	0.6	16.2	0.6	16.2	$1.5x10^{-3}$	$4.2x10^{4}$
Bi-206		0.3	8.11	0.3	8.11	$3.8x10^{3}$	$1.0x10^{5}$
Bi-207		0.7	18.9	0.7	18.9	1.9	$5.2x10^{1}$
Bi-210m		0.3	8.11	$3x10^{-2}$	0.811	$2.1x10^{-5}$	$5.7x10^{-4}$
Bi-210		0.6	16.2	0.5	13.5	$4.6x10^{3}$	$1.2x10^{5}$
Bi-212		0.3	8.11	0.3	8.11	$5.4x10^{5}$	$1.5x10^{7}$
Bk-247	Berkelium (97)	2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$3.8x10^{-2}$	1.0
Bk-249		40	1080	$8x10^{-2}$	2.16	$6.1x10^{1}$	$1.6x10^{3}$
Br-76	Bromine (35)	0.3	8.11	0.3	8.11	$9.4x10^{4}$	$2.5x10^{6}$
Br-77		3	81.1	3	81.1	$2.6x10^{4}$	$7.1x10^{5}$
Br-82		0.4	10.8	0.4	10.8	$4.0x10^{4}$	$1.1x10^{6}$
C-11	Carbon (6)	1	27	0.5	13.5	$3.1x10^{7}$	$8.4x10^{8}$
C-14		40	1080	2	54.1	$1.6x10^{-1}$	4.5
Ca-41	Calcium (20)	40	1080	40	1080	$3.1x10^{-3}$	$8.5x10^{-2}$
Ca-45		40	1080	0.9	24.3	$6.6x10^{2}$	$1.8x10^{4}$
Ca-47		0.9	24.3	0.5	13.5	$2.3x10^{4}$	$6.1x10^{5}$
Cd-109	Cadmium (48)	40	1080	1	27.0	$9.6x10^{1}$	$2.6x10^{3}$
Cd-113m		20	541	$9x10^{-2}$	2.43	8.3	$2.2x10^{2}$
Cd-115m		0.3	8.11	0.3	8.11	$9.4x10^{2}$	$2.5x10^{4}$
Cd-115		4	108	0.5	13.5	$1.9x10^{4}$	$5.1x10^{5}$
Ce-139	Cerium (58)	6	162	6	162	$2.5x10^{2}$	$6.8x10^{3}$
Ce-141		10	270	0.5	13.5	$1.1x10^{3}$	$2.8x10^{4}$
Ce-143		0.6	16.2	0.5	13.5	$2.5x10^{4}$	$6.6x10^{5}$
Ce-144		0.2	5.41	0.2	5.41	$1.2x10^{2}$	$3.2x10^{3}$
Cf-248	Californium (98)	30	811	$3x10^{-3}$	$8.11x10^{-2}$	$5.8x10^{1}$	$1.6x10^{3}$
Cf-249		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$1.5x10^{-1}$	4.1
Cf-250		5	135	$5x10^{-4}$	$1.35x10^{-2}$	4.0	$1.1x10^{2}$
Cf-251		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$5.9x10^{-2}$	1.6
Cf-252		0.1	2.70	$1x10^{-3}$	$2.70x10^{-2}$	$2.0x10^{1}$	$5.4x10^{2}$
Cf-253		40	1080	$6x10^{-2}$	1.62	$1.1x10^{3}$	$2.9x10^{4}$
Cf-254		$3x10^{-3}$	$8.11x10^{-2}$	$6x10^{-4}$	$1.62x10^{-2}$	$3.1x10^{2}$	$8.5x10^{3}$
Cl-36	Chlorine (17)	20	541	0.5	13.5	$1.2x10^{-3}$	$3.3x10^{-2}$
Cl-38		0.2	5.41	0.2	5.41	$4.9x10^{6}$	$1.3x10^{8}$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Cm-240	Curium (96)	40	1080	$2x10^{-2}$	0.541	$7.5x10^{2}$	$2.0x10^{4}$
Cm-241		2	54.1	0.9	24.3	$6.1x10^{2}$	$1.7x10^{4}$
Cm-242		40	1080	$1x10^{-2}$	0.270	$1.2x10^{2}$	$3.3x10^{3}$
Cm-243		3	81.1	$3x10^{-4}$	$8.11x10^{-3}$	1.9	$5.2x10^{1}$
Cm-244		4	108	$4x10^{-4}$	$1.08x10^{-2}$	3.0	$8.1x10^{1}$
Cm-245		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$6.4x10^{-3}$	$1.7x10^{-1}$
Cm-246		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$1.1x10^{-2}$	$3.1x10^{-1}$
Cm-247		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$3.4x10^{-6}$	$9.3x10^{-5}$
Cm-248		$4x10^{-2}$	1.08	$5x10^{-5}$	$1.35x10^{-3}$	$1.6x10^{-4}$	$4.2x10^{-3}$
Co-55	Cobalt (27)	0.5	13.5	0.5	13.5	$1.1x10^{5}$	$3.1x10^{6}$
Co-56		0.3	8.11	0.3	8.11	$1.1x10^{3}$	$3.0x10^{4}$
Co-57		8	216	8	216	$3.1x10^{2}$	$8.4x10^{3}$
Co-58m		40	1080	40	1080	$2.2x10^{5}$	$5.9x10^{6}$
Co-58		1	27.0	1	27.0	$1.2x10^{3}$	$3.2x10^{4}$
Co-60		0.4	10.8	0.4	10.8	$4.2x10^{1}$	$1.1x10^{3}$
Cr-51	Chromium (24)	30	811	30	811	$3.4x10^{3}$	$9.2x10^{4}$
Cs-129	Cesium (55)	4	108	4	108	$2.8x10^{4}$	$7.6x10^{5}$
Cs-131		40	1080	40	1080	$3.8x10^{3}$	$1.0x10^{5}$
Cs-132		1	27.0	1	27.0	$5.7x10^{3}$	$1.5x10^{5}$
Cs-134m		40	1080	9	243	$3.0x10^{5}$	$8.0x10^{6}$
Cs-134		0.6	16.2	0.5	13.5	$4.8x10^{1}$	$1.3x10^{3}$
Cs-135		40	1080	0.9	24.3	$4.3x10^{-5}$	$1.2x10^{-3}$
Cs-136		0.5	13.5	0.5	13.5	$2.7x10^{3}$	$7.3x10^{4}$
Cs-137		2	54.1	0.5	13.5	3.2	$8.7x10^{1}$
Cu-64	Copper (29)	5	135	0.9	24.3	$1.4x10^{5}$	$3.9x10^{6}$
Cu-67		9	243	0.9	24.3	$2.8x10^{4}$	$7.6x10^{5}$
Dy-159	Dysprosium (66)	20	541	20	541	$2.1x10^{2}$	$5.7x10^{3}$
Dy-165		0.6	16.2	0.5	13.5	$3.0x10^{5}$	$8.2x10^{6}$
Dy-166		0.3	8.11	0.3	8.11	$8.6x10^{3}$	$2.3x10^{5}$
Er-169	Erbium (68)	40	1080	0.9	24.3	$3.1x10^{3}$	$8.3x10^{4}$
Er-171		0.6	16.2	0.5	13.5	$9.0x10^{4}$	$2.4x10^{6}$
Es-253	Einsteinium (99)[a/]	200	5400	$2.1x10^{-2}$	$5.4x10^{-1}$	-- --	
Es-254		30	811	$3x10^{-3}$	$8.11x10^{-2}$	-- --	
Es-254m		0.6	16.2	0.4	10.8	-- --	
Es-255		--	--	--	--	-- --	

[a/] *International shipments of Einsteinium require multilateral approval of A_1 and A_2 values*

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	(Ci/g)
Eu-147	Europium (63)	2	54.1	2	54.1	$1.4x10^3$	$3.7x10^4$
Eu-148		0.5	13.5	0.5	13.5	$6.0x10^2$	$1.6x10^4$
Eu-149		20	541	20	541	$3.5x10^2$	$9.4x10^3$
Eu-150		0.7	18.9	0.7	18.9	$6.1x10^4$	$1.6x10^6$
Eu-152m		0.6	16.2	0.5	13.5	$8.2x10^4$	$2.2x10^6$
Eu-152		0.9	24.3	0.9	24.3	6.5	$1.8x10^2$
Eu-154		0.8	21.6	0.5	13.5	9.8	$2.6x10^2$
Eu-155		20	541	2	54.1	$1.8x10^1$	$4.9x10^2$
Eu-156		0.6	16.2	0.5	13.5	$2.0x10^3$	$5.5x10^4$
F-18	Fluorine (9)	1	27.0	0.5	13.5	$3.5x10^6$	$9.5x10^7$
Fe-52	Iron (26)	0.2	5.41	0.2	5.41	$2.7x10^5$	$7.3x10^6$
Fe-55		40	1080	40	1080	$8.8x10^1$	$2.4x10^3$
Fe-59		0.8	21.6	0.8	21.6	$1.8x10^3$	$5.0x10^4$
Fe-60		40	1080	0.2	5.41	$7.4x10^{-4}$	$2.0x10^{-2}$
Fm-255	Fermium (100)[b]	40	1080	0.8	21.6	-- --	
Fm-257		10	270	$8x10^{-3}$	$21.6x10^{-1}$	-- --	
Ga-67	Gallium (31)	6	162	6	162	$2.2x10^4$	$6.0x10^5$
Ga-68		0.3	8.11	0.3	8.11	$1.5x10^6$	$4.1x10^7$
Ga-72		0.4	10.8	0.4	10.8	$1.1x10^5$	$3.1x10^6$
Gd-146	Gadolinium (64)	0.4	10.8	0.4	10.8	$6.9x10^2$	$1.9x10^4$
Gd-148		3	81.1	$3x10^{-4}$	$8.11x10^{-3}$	1.2	$3.2x10^1$
Gd-153		10	270	5	135	$1.3x10^2$	$3.5x10^3$
Gd-159		4	108	0.5	13.5	$3.9x10^4$	$1.1x10^6$
Ge-68	Germanium (32)	0.3	8.11	0.3	8.11	$2.6x10^2$	$7.1x10^3$
Ge-71		40	1080	40	1080	$5.8x10^3$	$1.6x10^5$
Ge-77		0.3	8.11	0.3	8.11	$1.3x10^5$	$3.6x10^6$
H-3	Hydrogen (1)	See T-Tritium					
Hf-172	Hafnium (72)	0.5	13.5	0.3	8.11	$4.1x10^1$	$1.1x10^3$
Hf-175		3	81.1	3	81.1	$3.9x10^2$	$1.1x10^4$
Hf-181		2	54.1	0.9	24.3	$6.3x10^2$	$1.7x10^4$
Hf-182		4	108	$3x10^{-2}$	0.811	$8.1x10^{-6}$	$2.2x10^{-4}$

[b] *International shipments of Fermium require multilateral approval of A_1 and A_2 values*

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Hg-194	Mercury (80)	1	27.0	1	27.0	$1.3x10^{-1}$	3.5
Hg-195m		5	135	5	135	$1.5x10^{4}$	$4.0x10^{5}$
Hg-197m		10	270	0.9	24.3	$2.5x10^{4}$	$6.7x10^{5}$
Hg-197		10	270	10	270	$9.2x10^{3}$	$2.5x10^{5}$
Hg-203		4	108	0.9	24.3	$5.1x10^{2}$	$1.4x10^{4}$
Ho-163	Holmium (67)	40	1080	40	1080	2.7	$7.6x10^{1}$
Ho-166m		0.6	16.2	0.3	8.11	$6.6x10^{-2}$	1.8
Ho-166		0.3	8.11	0.3	8.11	$2.6x10^{4}$	$7.0x10^{5}$
I-123	Iodine (53)	6	162	6	162	$7.1x10^{4}$	$1.9x10^{6}$
I-124		0.9	24.3	0.9	24.3	$9.3x10^{3}$	$2.5x10^{5}$
I-125		20	541	2	54.1	$6.4x10^{2}$	$1.7x10^{4}$
I-126		2	54.1	0.9	24.3	$2.9x10^{3}$	$8.0x10^{4}$
I-129		Unlimited	Unlimited	Unlimited	Unlimited	$6.5x10^{-6}$	$1.8x10^{-4}$
I-131		3	81.1	0.5	13.5	$4.6x10^{3}$	$1.2x10^{5}$
I-132		0.4	10.8	0.4	10.8	$3.8x10^{5}$	$1.0x10^{7}$
I-133		0.6	16.2	0.5	13.5	$4.2x10^{4}$	$1.1x10^{6}$
I-134		0.3	8.11	0.3	8.11	$9.9x10^{5}$	$2.7x10^{7}$
I-135		0.6	16.2	0.5	13.5	$1.3x10^{5}$	$3.5x10^{6}$
In-111	Indium (49)	2	54.1	2	54.1	$1.5x10^{4}$	$4.2x10^{5}$
In-113m		4	108	4	108	$6.2x10^{5}$	$1.7x10^{7}$
In-114m		0.3	8.11	0.3	8.11	$8.6x10^{2}$	$2.3x10^{4}$
In-115m		6	162	0.9	24.3	$2.2x10^{5}$	$6.1x10^{6}$
Ir-189	Iridium (77)	10	270	10	270	$1.9x10^{3}$	$5.2x10^{4}$
Ir-190		0.7	18.9	0.7	18.9	$2.3x10^{3}$	$6.2x10^{4}$
Ir-192		1	27.0	0.5	13.5	$3.4x10^{2}$	$9.2x10^{3}$
Ir-193m		10	270	10	270	$2.4x10^{3}$	$6.4x10^{4}$
Ir-194		0.2	5.41	0.2	5.41	$3.1x10^{4}$	$8.4x10^{5}$
K-40	Potassium (19)	0.6	16.2	0.6	16.2	$2.4x10^{-7}$	$6.4x10^{-6}$
K-42		0.2	5.41	0.2	5.41	$2.2x10^{5}$	$6.0x10^{6}$
K-43		1.0	27.0	0.5	13.5	$1.2x10^{5}$	$3.3x10^{6}$
Kr-81	Krypton (36)	40	1080	40	1080	$7.8x10^{-4}$	$2.1x10^{-2}$
Kr-85m		6	162	6	162	$3.0x10^{5}$	$8.2x10^{6}$
Kr-85		20	541	10	270	$1.5x10^{1}$	$3.9x10^{2}$
Kr-87		0.2	5.41	0.2	5.41	$1.0x10^{6}$	$2.8x10^{7}$
La-137	Lanthanum (57)	40	1080	2	54.1	$1.6x10^{-3}$	$4.4x10^{-2}$
La-140		0.4	10.8	0.4	10.8	$2.1x10^{4}$	$5.6x10^{5}$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Lu-172	Lutetium (71)	0.5	13.5	0.5	13.5	$4.2x10^3$	$1.1x10^5$
Lu-173		8	216	8	216	$5.6x10^1$	$1.5x10^3$
Lu-174m		20	541	8	216	$2.0x10^2$	$5.3x10^3$
Lu-174		8	216	4	108	$2.3x10^1$	$6.2x10^2$
Lu-177		30	811	0.9	24.3	$4.1x10^3$	$1.1x10^5$
MFP	For mixed fission products, use formula for mixtures or TABLE VII.						
Mg-28	Magnesium (12)	0.2	5.41	0.2	5.41	$2.0x10^5$	$5.4x10^6$
Mn-52	Manganese (25)	0.3	8.11	0.3	8.11	$1.6x10^4$	$4.4x10^5$
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	$6.8x10^{-5}$	$1.8x10^{-3}$
Mn-54		1	27.0	1	27.0	$2.9x10^2$	$7.7x10^3$
Mn-56		0.2	5.41	0.2	5.41	$8.0x10^5$	$2.2x10^7$
Mo-93	Molybdenum (42)	40	1080	7	189	$4.1x10^{-2}$	1.1
Mo-99		0.6	16.2	0.5	13.5[g]	$1.8x10^4$	$4.8x10^5$
N-13	Nitrogen (7)	0.6	16.2	0.5	13.5	$5.4x10^7$	$1.5x10^9$
Na-22	Sodium (11)	0.5	13.5	0.5	13.5	$2.3x10^2$	$6.3x10^3$
Na-24		0.2	5.41	0.2	5.41	$3.2x10^5$	$8.7x10^6$
Nb-92m	Niobium (41)	0.7	18.9	0.7	18.9	$5.2x10^3$	$1.4x10^5$
Nb-93m		40	1080	6	162	8.8	$2.4x10^2$
Nb-94		0.6	16.2	0.6	16.2	$6.9x10^{-3}$	$1.9x10^{-1}$
Nb-95		1	27.0	1	27.0	$1.5x10^3$	$3.9x10^4$
Nb-97		0.6	16.2	0.5	13.5	$9.9x10^5$	$2.7x10^7$
Nd-147	Neodymium (60)	4	108	0.5	13.5	$3.0x10^3$	$8.1x10^4$
Nd-149		0.6	16.2	0.5	13.5	$4.5x10^5$	$1.2x10^7$
Ni-59	Nickel (28)	40	1080	40	1080	$3.0x10^{-3}$	$8.0x10^{-2}$
Ni-63		40	1080	30	811	2.1	$5.7x10^1$
Ni-65		0.3	8.11	0.3	8.11	$7.1x10^5$	$1.9x10^7$
Np-235	Neptunium (93)	40	1080	40	1080	$5.2x10^1$	$1.4x10^3$
Np-236		7	189	$1x10^{-3}$	$2.70x10^{-2}$	$4.7x10^{-4}$	$1.3x10^{-2}$
Np-237		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$2.6x10^{-5}$	$7.1x10^{-4}$
Np-239		6	162	0.5	13.5	$8.6x10^3$	$2.3x10^5$

[g] *20 Ci for Mo^{99} for domestic use*

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	(Ci/g)
Os-185	Osmium (76)	1	27.0	1	27.0	$2.8x10^2$	$7.5x10^3$
Os-191m		40	1080	40	1080	$4.6x10^4$	$1.3x10^6$
Os-191		10	270	0.9	24.3	$1.6x10^3$	$4.4x10^4$
Os-193		0.6	16.2	0.5	13.5	$2.0x10^4$	$5.3x10^5$
Os-194		0.2	5.41	0.2	5.41	$1.1x10^1$	$3.1x10^2$
P-32	Phosphorus (15)	0.3	8.11	0.3	8.11	$1.1x10^4$	$2.9x10^5$
P-33		40	1080	0.9	24.3	$5.8x10^3$	$1.6x10^5$
Pa-230	Protactinium (91)	2	54.1	0.1	2.70	$1.2x10^3$	$3.3x10^4$
Pa-231		0.6	16.2	$6x10^{-5}$	$1.62x10^{-3}$	$1.7x10^{-3}$	$4.7x10^{-2}$
Pa-233		5	135	0.9	24.3	$7.7x10^2$	$2.1x10^4$
Pb-201	Lead (82)	1	27.0	1	27.0	$6.2x10^4$	$1.7x10^6$
Pb-202		40	1080	2	54.1	$1.2x10^{-4}$	$3.4x10^{-3}$
Pb-203		3	81.1	3	81.1	$1.1x10^4$	$3.0x10^5$
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	$4.5x10^{-6}$	$1.2x10^{-4}$
Pb-210		0.6	16.2	$9x10^{-3}$	0.243	2.8	$7.6x10^1$
Pb-212		0.3	8.11	0.3	8.11	$5.1x10^4$	$1.4x10^6$
Pd-103	Palladium (46)	40	1080	40	1080	$2.8x10^3$	$7.5x10^4$
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	$1.9x10^{-5}$	$5.1x10^{-4}$
Pd-109		0.6	16.2	0.5	13.5	$7.9x10^4$	$2.1x10^6$
Pm-143	Promethium (61)	3	81.1	3	81.1	$1.3x10^2$	$3.4x10^3$
Pm-144		0.6	16.2	0.6	16.2	$9.2x10^1$	$2.5x10^3$
Pm-145		30	811	7	189	5.2	$1.4x10^2$
Pm-147		40	1080	0.9	24.3	$3.4x10^1$	$9.3x10^2$
Pm-148m		0.5	13.5	0.5	13.5	$7.9x10^2$	$2.1x10^4$
Pm-149		0.6	16.2	0.5	13.5	$1.5x10^4$	$4.0x10^5$
Pm-151		3	81.1	0.5	13.5	$2.7x10^4$	$7.3x10^5$
Po-208	Polonium (84)	40	1080	$2x10^{-2}$	0.541	$2.2x10^1$	$5.9x10^2$
Po-209		40	1080	$2x10^{-2}$	0.541	$6.2x10^{-1}$	$1.7x10^1$
Po-210		40	1080	$2x10^{-2}$	0.541	$1.7x10^2$	$4.5x10^3$
Pr-142	Praseodymium (59)	0.2	5.41	0.2	5.41	$4.3x10^4$	$1.2x10^6$
Pr-143		4	108	0.5	13.5	$2.5x10^3$	$6.7x10^4$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	(Ci/g)
Pt-188	Platinum (78)	0.6	16.2	0.6	16.2	$2.5x10^3$	$6.8x10^4$
Pt-191		3	81.1	3	81.1	$8.7x10^3$	$2.4x10^5$
Pt-193m		40	1080	9	243	$5.8x10^3$	$1.6x10^5$
Pt-193		40	1080	40	1080	1.4	$3.7x10^1$
Pt-195m		10	270	2	54.1	$6.2x10^3$	$1.7x10^5$
Pt-197m		10	270	0.9	24.3	$3.7x10^5$	$1.0x10^7$
Pt-197		20	541	0.5	13.5	$3.2x10^4$	$8.7x10^5$
Pu-236	Plutonium (94)	7	189	$7x10^{-4}$	$1.89x10^{-2}$	$2.0x10^1$	$5.3x10^2$
Pu-237		20	541	20	541	$4.5x10^2$	$1.2x10^4$
Pu-238		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$6.3x10^{-1}$	$1.7x10^1$
Pu-239		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$2.3x10^{-3}$	$6.2x10^{-2}$
Pu-240		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$8.4x10^{-3}$	$2.3x10^{-1}$
Pu-241		40	1080	$1x10^{-2}$	0.270	3.8	$1.0x10^2$
Pu-242		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$1.5x10^{-4}$	$3.9x10^{-3}$
Pu-244		0.3	8.11	$2x10^{-4}$	$5.41x10^{-3}$	$6.7x10^{-7}$	$1.8x10^{-5}$
Ra-223	Radium (88)	0.6	16.2	$3x10^{-2}$	0.811	$1.9x10^3$	$5.1x10^4$
Ra-224		0.3	8.11	$6x10^{-2}$	1.62	$5.9x10^3$	$1.6x10^5$
Ra-225		0.6	16.2	$2x10^{-2}$	0.541	$1.5x10^3$	$3.9x10^4$
Ra-226		0.3	8.11	$2x10^{-2}$	0.541	$3.7x10^{-2}$	1.0
Ra-228		0.6	16.2	$4x10^{-2}$	1.08	$1.0x10^1$	$2.7x10^2$
Rb-81	Rubidium (37)	2	54.1	0.9	24.3	$3.1x10^5$	$8.4x10^6$
Rb-83		2	54.1	2	54.1	$6.8x10^2$	$1.8x10^4$
Rb-84		1	27.0	0.9	24.3	$1.8x10^3$	$4.7x10^4$
Rb-86		0.3	8.11	0.3	8.11	$3.0x10^3$	$8.1x10^4$
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	$3.2x10^{-9}$	$8.6x10^{-8}$
Rb (natural)		Unlimited	Unlimited	Unlimited	Unlimited	$6.7x10^6$	$1.8x10^8$
Re-183	Rhenium (75)	5	135	5	135	$3.8x10^2$	$1.0x10^4$
Re-184m		3	81.1	3	81.1	$1.6x10^2$	$4.3x10^3$
Re-184		1	27.0	1	27.0	$6.9x10^2$	$1.9x10^4$
Re-186		4	108	0.5	13.5	$6.9x10^3$	$1.9x10^5$
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	$1.4x10^{-9}$	$3.8x10^{-8}$
Re-188		0.2	5.41	0.2	5.41	$3.6x10^4$	$9.8x10^5$
Re-189		4	108	0.5	13.5	$2.5x10^4$	$6.8x10^5$
Re (natural)		Unlimited	Unlimited	Unlimited	Unlimited	-- $2.4x10^{-8}$	
Rh-99	Rhodium (45)	2	54.1	2	54.1	$3.0x10^3$	$8.2x10^4$
Rh-101		4	108	4	108	$4.1x10^1$	$1.1x10^3$
Rh-102m		2	54.1	0.9	24.3	$2.3x10^2$	$6.2x10^3$
Rh-102		0.5	13.5	0.5	13.5	$4.5x10^1$	$1.2x10^3$
Rh-103m		40	1080	40	1080	$1.2x10^6$	$3.3x10^7$
Rh-105		10	270	0.9	24.3	$3.1x10^4$	$8.4x10^5$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Rn-222	Radon (86)	0.2	5.41	$4x10^{-3}$	0.108	$5.7x10^{3}$	$1.5x10^{5}$
Ru-97	Ruthenium (44)	4	108	4	108	$1.7x10^{4}$	$4.6x10^{5}$
Ru-103		2	54.1	0.9	24.3	$1.2x10^{3}$	$3.2x10^{4}$
Ru-105		0.6	16.2	0.5	13.5	$2.5x10^{5}$	$6.7x10^{6}$
Ru-106		0.2	5.41	0.2	5.41	$1.2x10^{2}$	$3.3x10^{3}$
S-35	Sulfur (16)	40	1080	2	54.1	$1.6x10^{3}$	$4.3x10^{4}$
Sb-122	Antimony (51)	0.3	8.11	0.3	8.11	$1.5x10^{4}$	$4.0x10^{5}$
Sb-124		0.6	16.2	0.5	13.5	$6.5x10^{2}$	$1.7x10^{4}$
Sb-125		2	54.1	0.9	24.3	$3.9x10^{1}$	$1.0x10^{3}$
Sb-126		0.4	10.8	0.4	10.8	$3.1x10^{3}$	$8.4x10^{4}$
Sc-44	Scandium (21)	0.5	13.5	0.5	13.5	$6.7x10^{5}$	$1.8x10^{7}$
Sc-46		0.5	13.5	0.5	13.5	$1.3x10^{3}$	$3.4x10^{4}$
Sc-47		9	243	0.9	24.3	$3.1x10^{4}$	$8.3x10^{5}$
Sc-48		0.3	8.11	0.3	8.11	$5.5x10^{4}$	$1.5x10^{6}$
Se-75	Selenium (34)	3	81.1	3	81.1	$5.4x10^{2}$	$1.5x10^{4}$
Se-79		40	1080	2	54.1	$2.6x10^{-3}$	$7.0x10^{-2}$
Si-31	Silicon (14)	0.6	16.2	0.5	13.5	$1.4x10^{6}$	$3.9x10^{7}$
Si-32		40	1080	0.2	5.41	3.9	$1.1x10^{2}$
Sm-145	Samarium (62)	20	541	20	541	$9.8x10^{1}$	$2.6x10^{3}$
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	$8.5x10^{-1}$	$2.3x10^{-8}$
Sm-151		40	1080	4	108	$9.7x10^{-1}$	$2.6x10^{1}$
Sm-153		4	108	0.5	13.5	$1.6x10^{4}$	$4.4x10^{5}$
Sn-113	Tin (50)	4	108	4	108	$3.7x10^{2}$	$1.0x10^{4}$
Sn-117m		6	162	2	54.1	$3.0x10^{3}$	$8.2x10^{4}$
Sn-119m		40	1080	40	1080	$1.4x10^{2}$	$3.7x10^{3}$
Sn-121m		40	1080	0.9	24.3	2.0	$5.4x10^{1}$
Sn-123		0.6	16.2	0.5	13.5	$3.0x10^{2}$	$8.2x10^{3}$
Sn-125		0.2	5.41	0.2	5.41	$4.0x10^{3}$	$1.1x10^{5}$
Sn-126		0.3	8.11	0.3	8.11	$1.0x10^{-3}$	$2.8x10^{-2}$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Sr-82	Strontium (38)	0.2	5.41	0.2	5.41	$2.3x10^3$	$6.2x10^4$
Sr-85m		5	135	5	135	$1.2x10^6$	$3.3x10^7$
Sr-85		2	54.1	2	54.1	$8.8x10^2$	$2.4x10^4$
Sr-87m		3	81.1	3	81.1	$4.8x10^5$	$1.3x10^7$
Sr-89		0.6	16.2	0.5	13.5	$1.1x10^3$	$2.9x10^4$
Sr-90		0.2	5.41	0.1	2.70	5.1	$1.4x10^2$
Sr-91		0.3	8.11	0.3	8.11	$1.3x10^5$	$3.6x10^6$
Sr-92		0.8	21.6	0.5	13.5	$4.7x10^5$	$1.3x10^7$
T	Tritium (1)	40	1080	40	1080	$3.6x10^2$	$9.7x10^3$
Ta-178	Tantalum (73)	1	27.0	1	27.0	$4.2x10^6$	$1.1x10^8$
Ta-179		30	811	30	811	$4.1x10^1$	$1.1x10^3$
Ta-182		0.8	21.6	0.5	13.5	$2.3x10^2$	$6.2x10^3$
Tb-157	Terbium (65)	40	1080	10	270	$5.6x10^{-1}$	$1.5x10^1$
Tb-158		1	27.0	0.7	18.9	$5.6x10^{-1}$	$1.5x10^1$
Tb-160		0.9	24.3	0.5	13.5	$4.2x10^2$	$1.1x10^4$
Tc-95m	Technetium (43)	2	54.1	2	54.1	$8.3x10^2$	$2.2x10^4$
Tc-96m		0.4	10.8	0.4	10.8	$1.4x10^6$	$3.8x10^7$
Tc-96		0.4	10.8	0.4	10.8	$1.2x10^4$	$3.2x10^5$
Tc-97m		40	1080	40	1080	$5.6x10^2$	$1.5x10^4$
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	$5.2x10^{-5}$	$1.4x10^{-3}$
Tc-98		0.7	18.9	0.7	18.9	$3.2x10^{-5}$	$8.7x10^{-4}$
Tc-99m		8	216	8	216	$1.9x10^5$	$5.3x10^6$
Tc-99		40	1080	0.9	24.3	$6.3x10^{-4}$	$1.7x10^{-2}$
Te-118	Tellurium (52)	0.2	5.41	0.2	5.41	$6.8x10^3$	$1.8x10^5$
Te-121m		5	135	5	135	$2.6x10^2$	$7.0x10^3$
Te-121		2	54.1	2	54.1	$2.4x10^3$	$6.4x10^4$
Te-123m		7	189	7	189	$3.3x10^2$	$8.9x10^3$
Te-125m		30	811	9	243	$6.7x10^2$	$1.8x10^4$
Te-127m		20	541	0.5	13.5	$3.5x10^2$	$9.4x10^3$
Te-127		20	541	0.5	13.5	$9.8x10^4$	$2.6x10^6$
Te-129m		0.6	16.2	0.5	13.5	$1.1x10^3$	$3.0x10^4$
Te-129		0.6	16.2	0.5	13.5	$7.7x10^5$	$2.1x10^7$
Te-131m		0.7	18.9	0.5	13.5	$3.0x10^4$	$8.0x10^5$
Te-132		0.4	10.8	0.4	10.8	$1.1x10^4$	$3.0x10^5$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Th-227	Thorium (90)	9	243	$1x10^{-2}$	0.270	$1.1x10^{3}$	$3.1x10^{4}$
Th-228		0.3	8.11	$4x10^{-4}$	$1.08x10^{-2}$	$3.0x10^{1}$	$8.2x10^{2}$
Th-229		0.3	8.11	$3x10^{-5}$	$8.11x10^{-4}$	$7.9x10^{-3}$	$2.1x10^{-1}$
Th-230		2	54.1	$2x10^{-4}$	$5.41x10^{-3}$	$7.6x10^{-4}$	$2.1x10^{-2}$
Th-231		40	1080	0.9	24.3	$2.0x10^{4}$	$5.3x10^{5}$
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	$4.0x10^{-9}$	$1.1x10^{-7}$
Th-234		0.2	5.41	0.2	5.41	$8.6x10^{2}$	$2.3x10^{4}$
Th (natural)		Unlimited	Unlimited	Unlimited	Unlimited	$8.1x10^{-9}$	$2.2x10^{-7}$
Ti-44	Titanium (22)	0.5	13.5	0.2	5.41	6.4	$1.7x10^{2}$
Tl-200	Thallium (81.1)	0.8	21.6	0.8	21.6	$2.2x10^{4}$	$6.0x10^{5}$
Tl-201		10	270	10	270	$7.9x10^{3}$	$2.1x10^{5}$
Tl-202		2	54.1	2	54.1	$2.0x10^{3}$	$5.3x10^{4}$
Tl-204		4	108	0.5	13.5	$1.7x10^{1}$	$4.6x10^{2}$
Tm-167	Thulium (69)	7	189	7	189	$3.1x10^{3}$	$8.5x10^{4}$
Tm-168		0.8	21.6	0.8	21.6	$3.1x10^{2}$	$8.3x10^{3}$
Tm-170		4	108	0.5	13.5	$2.2x10^{2}$	$6.0x10^{3}$
Tm-171		40	1080	10	270	$4.0x10^{1}$	$1.1x10^{3}$
U-230	Uranium (92)	40	1080	$1x10^{-2}$	0.270	$1.0x10^{3}$	$2.7x10^{4}$
U-232		3	81.1	$3x10^{-4}$	$8.11x10^{-3}$	$8.3x10^{-1}$	$2.2x10^{1}$
U-233		10	270	$1x10^{-3}$	$2.70x10^{-2}$	$3.6x10^{-4}$	$9.7x10^{-3}$
U-234		10	270	$1x10^{-3}$	$2.70x10^{-2}$	$2.3x10^{-4}$	$6.2x10^{-3}$
U-235		Unlimited	Unlimited	Unlimited	Unlimited	$8.0x10^{-8}$	$2.2x10^{-6}$
U-236		10	270	$1x10^{-3}$	$2.70x10^{-2}$	$2.4x10^{-6}$	$6.5x10^{-5}$
U-238		Unlimited	Unlimited	Unlimited	Unlimited	$1.2x10^{-8}$	$3.4x10^{-7}$
U (natural)		Unlimited	Unlimited	Unlimited	Unlimited	$2.6x10^{-8}$	$7.1x10^{-7}$
U (enriched 5 percent or less)		Unlimited	Unlimited	Unlimited	Unlimited	-- (TABLE VIII)	
U (enriched > 5 percent)		10	270	$1x10^{-3}$	$2.70x10^{-2}$	-- (TABLE VIII)	
U (depleted)		Unlimited	Unlimited	Unlimited	Unlimited	-- (TABLE VIII)	
V-48	Vanadium (23)	0.3	8.11	0.3	8.11	$6.3x10^{3}$	$1.7x10^{5}$
V-49		40	1080	40	1080	$3.0x10^{2}$	$8.1x10^{3}$
W-178	Tungsten (74)	1	27.0	1	27.0	$1.3x10^{3}$	$3.4x10^{4}$
W-181		30	811	30	811	$2.2x10^{2}$	$6.0x10^{3}$
W-185		40	1080	0.9	24.3	$3.5x10^{2}$	$9.4x10^{3}$
W-187		2	54.1	0.5	13.5	$2.6x10^{4}$	$7.0x10^{5}$
W-188		0.2	5.41	0.2	5.41	$3.7x10^{2}$	$1.0x10^{4}$

TABLE VI
A_1 AND A_2 VALUES FOR RADIONUCLIDES (cont.)

Symbol of RadioNuclide	Element and Atomic No.	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Xe-122	Xenon (54)	0.2	5.41	0.2	5.41	$4.8x10^4$	$1.3x10^6$
Xe-123		0.2	5.41	0.2	5.41	$4.4x10^5$	$1.2x10^7$
Xe-127		4	108	4	108	$1.0x10^3$	$2.8x10^4$
Xe-131m		40	1080	40	1080	$3.1x10^3$	$8.4x10^4$
Xe-133		20	541	20	541	$6.9x10^3$	$1.9x10^5$
Xe-135		4	108	4	108	$9.5x10^4$	$2.6x10^6$
Y-87	Yttrium (39)	2	54.1	2	54.1	$1.7x10^4$	$4.5x10^5$
Y-88		0.4	10.8	0.4	10.8	$5.2x10^2$	$1.4x10^4$
Y-90		0.2	5.41	0.2	5.41	$2.0x10^4$	$5.4x10^5$
Y-91m		2	54.1	2	54.1	$1.5x10^6$	$4.2x10^7$
Y-91		0.3	8.11	0.3	8.11	$9.1x10^2$	$2.5x10^4$
Y-92		0.2	5.41	0.2	5.41	$3.6x10^5$	$9.6x10^6$
Y-93		0.2	5.41	0.2	5.41	$1.2x10^5$	$3.3x10^6$
Yb-169	Ytterbium (70)	3	81.1	3	81.1	$8.9x10^2$	$2.4x10^4$
Yb-175		30	811	0.9	24.3	$6.6x10^3$	$1.8x10^5$
Zn-65	Zinc (30)	2	54.1	2	54.1	$3.0x10^2$	$8.2x10^3$
Zn-69m		2	54.1	0.5	13.5	$1.2x10^5$	$3.3x10^6$
Zn-69		4	108	0.5	13.5	$1.8x10^6$	$4.9x10^7$
Zr-88	Zirconium (40)	3	81.1	3	81.1	$6.6x10^2$	$1.8x10^4$
Zr-93		40	1080	0.2	5.41	$9.3x10^{-5}$	$2.5x10^{-3}$
Zr-95		1	27.0	0.9	24.3	$7.9x10^2$	$2.1x10^4$
Zr-97		0.3	8.11	0.3	8.11	$7.1x10^4$	$1.9x10^6$

TABLE VII
GENERAL VALUES FOR A_1 AND A_2

Contents	A_1		A_2	
	TBq	Ci	TBq	Ci
Only beta- or gamma-emitting nuclides are known to be present.	0.2	5	0.02	0.5
Alpha-emitting nuclides are known to be present, or no relevant data are available.	0.10	2.70	$2x10^{-5}$	$5.4x10^{-4}$

TABLE VIII
ACTIVITY-MASS RELATIONSHIPS FOR URANIUM

Uranium Enrichment*/ weight percent U-235 present	Specific Activity	
	Ci/g	TBq/g
0.45	1.8×10^{-8}	5.0×10^{-7}
0.72	2.6×10^{-8}	7.1×10^{-7}
1.0	2.8×10^{-8}	7.6×10^{-7}
1.5	3.7×10^{-8}	1.0×10^{-6}
5.0	1.0×10^{-7}	2.7×10^{-6}
10.0	1.8×10^{-7}	4.8×10^{-6}
20.0	3.7×10^{-7}	1.0×10^{-5}
35.0	7.4×10^{-7}	2.0×10^{-5}
50.0	9.3×10^{-7}	2.5×10^{-5}
90.0	2.2×10^{-6}	5.8×10^{-5}
93.0	2.6×10^{-6}	7.0×10^{-5}
95.0	3.4×10^{-6}	9.1×10^{-5}

*/ *The figures for uranium include representative values for the activity of the uranium-235 that is concentrated during the enrichment process*

APPENDIX P

QUANTITIES OF RADIOACTIVE MATERIALS REQUIRING CONSIDERATION OF THE NEED FOR A CONTINGENCY PLAN FOR RESPONDING TO A RELEASE

Radioactive Material[1/]	Release Fraction	Quantity (GBq)	Quantity (Ci)
Actinium-228	0.001	148,000	4,000
Americium-241	0.001	74	2
Americium-242	0.001	74	2
Americium-243	0.001	74	2
Antimony-124	0.01	148,000	4,000
Antimony-126	0.01	222,000	6,000
Barium-133	0.01	370,000	10,000
Barium-140	0.01	1,110,000	30,000
Bismuth-207	0.01	185,000	5,000
Bismuth-210	0.01	22,200	600
Cadmium-109	0.01	37,000	1,000
Cadmium-113	0.01	2,960	80
Calcium-45	0.01	740,000	20,000
Californium-252	0.001	333	9 (20 mg)
Carbon-14 (Non-CO_2)	0.01	1,850,000	50,000
Cerium-141	0.01	370,000	10,000
Cerium-144	0.01	11,100	300
Cesium-134	0.01	74,000	2,000
Cesium-137	0.01	111,000	3,000
Chlorine-36	0.5	3,700	100
Chromium-51	0.01	11,100,000	300,000
Cobalt-60	0.001	185,000	5,000
Copper-64	0.01	7,400,000	200,000
Curium-242	0.001	2,220	60
Curium-243	0.001	110	3
Curium-244	0.001	148	4
Curium-245	0.001	74	2
Europium-152	0.01	18,500	500
Europium-154	0.01	14,800	400
Europium-155	0.01	111,000	3,000
Gadolinium-153	0.01	185,000	5,000
Germanium	0.01	74,000	2,000
Gold-198	0.01	1,110,000	30,000

QUANTITIES OF RADIOACTIVE MATERIALS REQUIRING CONSIDERATION OF THE NEED FOR A CONTINGENCY PLAN FOR RESPONDING TO A RELEASE (cont.)

Radioactive Material[1/]	Release Fraction	Quantity (GBq)	Quantity (Ci)
Hafnium-172	0.01	14,800	400
Hafnium-181	0.01	259,000	7,000
Holmium-166m	0.01	3,700	100
Hydrogen-3	0.5	740,000	20,000
Indium-114m	0.01	37,000	1,000
Iodine-125	0.5	370	10
Iodine-131	0.5	370	10
Iridium-192	0.001	1,480,000	40,000
Iron-55 0.01	1,480,000	40,000	
Iron-59 0.01	259,000	7,000	
Krypton-85	1.0	222,000,000	6,000,000
Lead-210	0.01	296	8
Manganese-56	0.01	2,220,000	60,000
Mercury-203	0.01	370,000	10,000
Molybdenum-99	0.01	1,110,000	30,000
Neptunium-237	0.001	74	2
Nickel-63	0.01	740,000	20,000
Niobium-94	0.01	11,100	300
Phosphorus-32	0.5	3,700	100
Phosphorus-33	0.5	37,000	1,000
Polonium-210	0.01	370	10
Potassium-42	0.01	333,000	9,000
Promethium-145	0.01	148,000	4,000
Promethium-147	0.01	148,000	4,000
Ruthenium-106	0.01	7,400	200
Samarium-151	0.01	148,000	4,000
Scandium-46	0.01	111,000	3,000
Selenium-75	0.01	370,000	10,000
Silver-110m	0.01	37,000	1,000
Sodium-22	0.01	333,000	9,000
Sodium-24	0.01	370,000	10,000
Strontium-89	0.01	111,000	3,000
Strontium-90	0.01	3,330	90
Sulfur-35	0.5	33,30	900
Technetium-99	0.01	370,000	10,000
Technetium-99m	0.01	14,800,000	400,000
Tellurium-127m	0.01	185,000	5,000
Tellurium-129m	0.01	185,000	5,000
Terbium-160	0.01	148,000	4,000
Thulium-170	0.01	148,000	4,000

QUANTITIES OF RADIOACTIVE MATERIALS REQUIRING CONSIDERATION OF THE NEED FOR A CONTINGENCY PLAN FOR RESPONDING TO A RELEASE (cont.)

Radioactive Material[1/]	Release Fraction	Quantity (GBq)	Quantity (Ci)
Tin-1130.01	370,000	10,000	
Tin-1230.01	111,000	3,000	
Tin-1260.01	37,000	1,000	
Titanium-44	0.01	3,700	100
Vanadium-48	0.01	259,000	7,000
Xenon-133	1.0	33,300,000	900,000
Yttrium-91	0.01	74,000	2,000
Zinc-650.01	185,000	5,000	
Zirconium-93	0.01	14,800	400
Zirconium-95	0.01	185,000	5,000
Any other beta-gamma emitter	0.01	370,000	10,000
Mixed fission products	0.01	37,000	1,000
Mixed corrosion products	0.01	370,000	10,000
Contaminated equipment, beta-gamma	0.001	370,000	10,000
Irradiated material, any form other than solid noncombustible	0.01	37,000	1,000
Irradiated material, solid Noncombustible	0.001	370,000	10,000
Mixed radioactive waste, beta-gamma	0.01	37,000	1,000
Packaged mixed waste,[2/] beta-gamma	0.001	370,000	10,000
Any other alpha emitter	0.001	74	2
Contaminated equipment, alpha 0.0001	740	20	
Packaged waste, alpha[2/]	0.0001	740	20

[1/] *For combinations of radioactive materials, the licensee is required to consider whether an emergency plan is needed if the sum of the ratios of the quantity of each radioactive material authorized to the quantity listed for that material above exceeds one.*

[2/] *Waste packaged in Type B containers does not require an emergency plan.*

APPENDIX Q

CONTENTS OF AN EMERGENCY PLAN

Contents of a emergency Plan. An emergency plan for responding to an event in which radioactive material could be released from the site shall include the following information:

a. Facility description. A brief description of the licensee or applicant's facility and surroundings.

b. Types of accidents. An identification of each type of radioactive materials accident for which actions by licensee staff or offsite response organizations will be needed to protect members of the public.

c. Classification of accidents. A method for classifying and declaring an accident as alert or site area emergency.

d. Detection of accidents. Identification of the means for detecting each type of alert or site area emergency in a timely manner.

e. Mitigation of consequences. A brief description of the means and equipment that are available for mitigating the consequences of each type of accident, including those provided to protect workers onsite, and a description of the program for maintaining the equipment.

f. Assessment of releases. A brief description of the methods and equipment available to assess releases of radioactive material.

g. Responsibilities. A brief description of the responsibilities of the **licensee or** applicant's personnel who will respond if an accident occurs, including identification of personnel responsible for promptly notifying offsite response organizations, including the department.

h. Plan maintenance. A brief description of the positions assigned and methods to develop, maintain and update the plan.

i. A list of offsite response organizations, description of their responsibilities and anticipated actions, and copy of formal commitments, if any.

j. Notification and coordination. A brief description of the means to promptly notify the offsite response organizations and request offsite assistance including medical assistance for the treatment of contaminated injured onsite workers. The notification and coordination must include alternate provisions in case key personnel, parts of the facility, or some equipment are unavailable. The licensee shall also commit to notify the department immediately after notification of the appropriate offsite response organizations and not later than one hour after the licensee declares an emergency.

k. Information to be communicated. A brief description of the types of information on facility status, radioactive releases and recommended protective actions, if necessary, to be given to offsite response organizations and the department. **A licensee shall allow the offsite response organizations expected to respond in case of an accident 60 days to comment on the licensees emergency plan before submitting it to the department. A licensee shall provide any comments received within the 60 days to the department with the emergency plan.**

l. Training. A brief description of the frequency, performance objectives and plan for training that the licensee or applicant will provide workers on how to respond to an emergency, including any special instructions and orientation tours that the **licensee or** applicant will offer to fire, police, medical and other emergency personnel. The training shall familiarize personnel with site-specific hazards and emergency procedures. The training shall also prepare site personnel for their responsibilities in the event of accident scenarios postulated as most probable for the specific site, including the use of drills, exercises and team training for such scenarios.

m. Drills and exercises. Provisions for conducting quarterly communications checks with offsite response organizations and biennial onsite exercises to test response to simulated emergencies. The **licensee or** applicant shall invite offsite response organizations to participate in biennial exercises. The exercises shall use accident scenarios postulated as the most probable for the specific site and the scenarios may not be known to most exercise participants. Critiques of exercises must evaluate the appropriateness of the plan, emergency procedures, facilities, equipment, training of personnel and overall effectiveness of the response. Deficiencies found by the critiques must be corrected.

n. Safe condition. A brief description of the means of restoring the facility and surroundings to a safe condition after an accident.

o. Hazardous chemicals. A certification that the applicant has met its responsibilities under the Emergency Planning and Community Right-To-Know Act of 1986, Title III, Pub.L.99-499, if applicable to the applicant's activities at the proposed place of use of the radioactive material.

APPENDIX R

EXAMPLES OF SEVERITY LEVELS

The following examples of severity levels apply to licensees or registrants and are neither exhaustive nor controlling. They reflect only the seriousness of the violation and not the intent of the violator, the history of the violator, the amount necessary to deter future violations, or efforts to correct the violation.

A. Severity Level 1 - Most Significant Violations.

1. Exposure of a worker in excess of 250 mSv (25 rems) of radiation to the whole body, or 1.50 Sv (150 rems) to the skin of the whole body, or 3.75 Sv (375 rems) to the feet, ankles, hands, or forearms.

2. Annual whole body exposure in excess of 25 mSv (2.5 rems) of radiation to a non-radiation worker or a radiation worker who is a minor.

3. Release of radioactive material to an unrestricted area in excess of 10 times the limits specified in this chapter.

4. Radiation levels, contamination levels, or releases that exceed 10 times the limits specified in this chapter or the license.

5. Disposal of licensed material into a sanitary sewerage system in quantities or concentrations which exceed 10 times the limits of s. HFS 157.30 (3).

6. Exposure of a worker in a restricted area to 10 times the limits of s. HFS 157.22 (1).

7. A required system or equipment designed to prevent or mitigate a serious safety event not being operable when actually required to perform its designed function.

8. A material false statement in which the statement made is deliberately false.

9. Action by management to discriminate against an employee for attempting to communicate or for actually communicating with the department to report a real or suspected violation of this chapter or license condition.

10. Deliberate exposure of an individual except by or under the supervision of an individual licensed to engage in the healing arts.

11. Refusing authorized department personnel access to facilities, equipment or records necessary to conduct inspections or investigations.

12. Possession of licensable quantities of radioactive material without a license or loss of control of a source of radiation.

13. Falsification of records required by this chapter in which the records were deliberately falsified by or with the knowledge of the licensee or registrant.

14. Licensee or registrant failure to promptly respond to an emergency that has actual or potential offsite consequences.

15. Operating a mammography facility without proper certification.

~~16. Operating a mammography facility with repeat level 1 violations under 21 CFR Part 900.~~

B. Severity Level 2 - Very Significant Violations.

1. Single exposure of a worker in excess of 50 mSv of radiation to the whole body, 300 mSv to the skin of the whole body, or 750 mSv to the feet, ankles, hands or forearms.

2. Annual whole body exposure in excess of 50 mSv of radiation to a non-radiation worker or radiation worker who is a minor.

3. Release of radioactive material to an unrestricted area in excess of 5 times the limits of s. HFS 157.23 (2).

4. Radiation levels, contamination levels, or releases that exceed 5 times the limits specified in this chapter.

5. Failure to immediately notify the department as required by s. HFS 157.32 (1) and s. HFS 157.32 (2) (a) and (b).

6. Unauthorized disposal of licensed material in quantities or concentrations in excess of 5 times the limits of s. HFS 157.30 (3).

7. Exposure of a worker in a restricted area in excess of 5 times the limits specified in s. HFS 157.22.

8. A required system designed to prevent or mitigate a serious safety event or unnecessary exposure is absent or inoperable.

9. Failure to obtain appropriate department approval before moving to a new use or storage location.

10. A material false statement or a reporting failure involving information which, had it been available to the department and accurate at the time the information should have been submitted, would have resulted in regulatory action or would likely have resulted in the department seeking further information.

11. Radiation output on fluoroscopic devices which exceed 200 mGy per minute in high rate mode.

12. Failure to register sources of radiation as required by this chapter.

13. Operating a mammography facility without qualified personnel, under 21 CFR Part 900.

~~14. Operating a mammography facility without qualified personnel, under 21 CFR Part 900.~~

C. Severity Level 3 - Significant Violations.

1. Single exposure of a worker in excess of 30 mSv (3 rem) of radiation to the whole body, or 75 mSv (7.5 rem) to the skin of the whole body, or 187.5 mSv (18.75 rem) to the feet, ankles, hands or forearms.

2. A radiation level in an unrestricted area such that an individual could receive greater than 1.0 mSv (100 millirem) in a one-hour period or 5.0 mSv (500 millirem) in any 7 consecutive days.

3. Failure to notify the department immediately as required by s. HFS 157.32 (2) (a) or failure to notify the department within 24 hours as required by s. HFS 157.32 (2) (b).

4. Substantial potential for an exposure or release in excess of the limits of this chapter, such as entry into high radiation areas without performing an adequate survey or operation of a radiation device with a nonfunctioning interlock system, if one is required.

5. Release of radioactive material to an unrestricted area in excess of the limits of s. HFS 157.23 (2).

6. Unauthorized disposal of licensed material not covered in severity levels I or II.

7. Exposure of a worker in restricted areas in excess of the limits of s. HFS 157.22 (1).

8. Release for unrestricted use of radioactive material or contaminated equipment which poses a potential for significant exposure to members of the public, or which reflects a programmatic rather than isolated weakness in the radiation safety program.

9. Cumulative worker exposure regulatory limits in this chapter when such exposure reflects a programmatic rather than an isolated weakness in radiation protection.

~~10. Conduct of licensee or registrant activities by an unauthorized or an unqualified individual, including the use of x-ray machine operators without proper training as required in s. HFS 157.74(2).~~

~~11~~10. Any noncompliance with posting, labeling, placarding, shipping papers, packaging, loading, or other transportation requirements that could result in the following:

a. Improper identification of the type, quantity, or form of material.
b. Failure of the carrier or recipient to exercise adequate controls.
c. Substantial potential for personnel exposure or contamination.
d. Improper transfer of material.

~~12~~11. Failure to control access to licensed materials as specified by this chapter.

~~13~~12. Possession or use by a licensee or registrant of a unauthorized radiation machine or radioactive material in conducting registrant or licensee activities.

~~14~~13. Radiation levels, contamination levels or releases that exceed the limits specified in the license.

~~15~~14. Failure to use exposure reduction devices properly, such as collimators, filtration or patient shielding.

~~16~~15. Failure to hospitalize patients who have sealed source implants or therapeutic quantities of radioactive material in accordance with the license or license conditions.

D. Severity Level 4 - Violations.

1. Exposure in excess of the limits of s. HFS 157.22 (1) not constituting severity I, II, or III violations.

2. A radiation level in an unrestricted area such that an individual could receive greater than 0.02 mSv (2 millirems) in any one hour period or 1.0 mSv (100 millirems) in any 7 consecutive days.

3. Failure to notify the department within 30 days as required by s. HFS 157.32 (3).

4. Failure to make a follow-up written report to the department as required by s. HFS 157.32 (1) (b) or s. HFS 157.32 (6).

5. Failure to conduct required leakage or contamination tests or to use properly calibrated equipment.

6. Unless specified in a more severe category, changes in procedures or other conditions of a license or certificate of registration of which the department was not informed, such as change of address, change of person in control or changes in the use of registered or licensed devices.

7. Failure to maintain complete records and forms required by this chapter.

8. Failure to report medical events as required in s. HFS 157.72.

9. Failure to report a dose to a embryo, fetus or nursing child as required by s. HFS 157.72 (2).

10. Fluoroscopic systems where the maximum table top skin entrance exposure rate is 100 mGy (11.5 R) per minute having test values greater than 140 mGy (16.1 R) per minute but less than 200 mGy (23 R) per minute.

11. Radiographic systems in which it is possible to produce x-rays with the timer in the zero or off position.

12. Radiation therapy systems in which the registrant fails to maintain proper surveys, calibrations, spot checks or operating procedures.

E. Severity Level 5 - Minor Violations.

1. Failure to maintain a current copy of this chapter and current copies of active licenses or certificates of registration.

2. Failure to post notices required by this chapter.

3. Failure to report leaking sources as required by s. HFS 157.72 (3).

4. Other violations that have minor safety or environmental significance.

APPENDIX S

COURSE OUTLINE FOR PORTABLE GAUGE AND XRF DEVICE RADIATION SAFETY TRAINING PROGRAM

The following are areas in which the department considers it important that an individual have expertise for the competent operation of portable gauges and XRF devices using sealed sources of radioactive material. The course shall be at least 8 hours in length.

I. PRINCIPLES AND FUNDAMENTALS OF RADIATION SAFETY

A. Types and Characteristics of Radiation
1. Alpha, Beta, Gamma, X-ray and Neutron Radiation
2. Exposure: Natural versus Man-made Radiation
3. Irradiation versus Contamination/Internal vs. External
4. Radioactive Material Used in Portable Gauges and XRF Devices

B. Units of Radiation Dose and Quantities of Radioactivity
1. Curie, Rad, Rem and Roentgen
2. Prefixes
3. SI Units

C. Basic Math and Calculations Related to Radioactivity
1. Radioactive Decay
2. Dose Rates from the sources commonly used
3. Inverse Square Law

D. Biological Effects of Radiation
1. Acute, Chronic and Genetic Effects of Exposure
2. Radiation Protection Standards
3. The ALARA Philosophy

E. Radiation Levels From Radioactive Sealed Sources
1. Survey Meter Use for Portable Gauge Users, not including XRF devices

F. Methods of Controlling Radiation Dose
1. Time
2. Distance
3. Shielding

II. STATE AND FEDERAL REGULATIONS
A. Chapter HFS 157, Wisconsin Administrative Code
B. Title 10, Code of Federal Regulations, US Nuclear Regulatory Commission
C. Title 49, Code of Federal Regulations, Transportation

III. LICENSING AND INSPECTION
A. License Items and Conditions
B. Notices, Instructions and Reports to Workers
C. Inspections by the Department

IV. OPERATING AND EMERGENCY PROCEDURES

A. Operating Procedures
1. Training and Supervision
2. Personnel Monitoring
3. Availability of Procedures
4. Security of the Gauges or Devices When Stored and At The Work Location.
5. ALARA Philosophy
6. Transportation of the Gauges or Devices and Security
7. General Rules of Use
8. Posting Requirements
9. Routine Maintenance
10. Radiation Surveys Using Survey Meters at the Work Site for Portable Gauges

B. Emergency Procedures
1. Preventive Measures
2. Emergency Response
3. Notification Requirements
4. Case Histories

V. TRANSFER/DISPOSAL REQUIREMENTS

A. State and NRC Regulations
B. Transportation Requirements

VI. PRACTICAL TRAINING

A. Transport/Storage Containers
B. Hands-on Training Specific to the Gauge or Device
1. Proper Use
2. Safe Handling
3. Calibration of XRF Device Including Substrate Corrections
4. Demonstration of Measurements of Various Materials
5. Use of Survey Meters by Portable Gauge Users.

VII. Q&A SESSION

ENCLOSURE 3

WISCONSIN RADIATION PROTECTION SECTION NARRATIVE

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Radiological Emergency Preparedness and Response
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I. HISTORY AND OVERVIEW

Introduction

The State of Wisconsin seeks to enter into an Agreement with the Nuclear Regulatory Commission (NRC) for the purpose of assuming regulatory authority over reactor-produced (byproduct) radioactive materials, source materials and special nuclear materials in quantities not sufficient to form a critical mass. The following Radiation Protection Section (RPS) history and overview has been developed to provide supporting information for the application to become an 'Agreement State'. Wisconsin proposes to become the 33rd Agreement State in July, 2003.

History of Wisconsin Radiation Protection Section

In 1963, the Wisconsin Legislature enacted Chapter 325, Laws of 1963 (known as the Radiation Protection Act) which provided authority to the State Board of Health and the Industrial Commission to regulate sources of radiation. This statute lead to the creation of the Radiation Protection Section in the State Board of Health. Initially, authority to regulate sources of radiation was a cooperative arrangement between the State Board of Health and the Industrial Commission. The Radiation Protection Act provided the authority to promulgate radiation protection rules and develop necessary policies and programs, plus established the requirement to register radiation sources (machine produced radiation and non-AEA radioactive materials) with the Board of Health. The Act provided both agencies the authority to impound sources of ionizing radiation in the possession of a person who failed to observe safety standard established by rule and established penalties ranging from $10 - $500/day for violation of statute or rule. In addition, the Act created an Advisory Radiation Protection Council to advise the fledgling radiation control agencies and consult in carrying out the administration of statutes and in the development of rules. The State Board of Health, with the assistance of the Radiation Protection Council, subsequently promulgated the first radiation protection code (Chapter H 57, WI Administrative Code) developed under the authority of the 1963 Radiation Protection Act. The original code became effective in 1966.

The principal activities of the Radiation Protection Section during its initial years consisted of environmental monitoring to determine the radiological impact of atmospheric weapons testing on Wisconsin's environment and milk supply; review and approval of shielding plans for radiation installations; registration and inspection of x-ray equipment; and location and inspection of radium sources. In 1967, a major reorganization of state government reorganized the State Board of Health and the Industrial Commission into the Department of Health and Social Services (DHSS) and the Department of Industry, Labor and Human Relations (DILHR), respectively. The legislature concurrently passed Chapter 366, Laws of 1969 which provided DHSS the authority to develop a radiation protection code and enforce the rules pertaining to ionizing radiation in establishments principally engaged in furnishing medical, surgical, chiropractic and other health services to persons and animals. The Radiation Protection

Section was placed in DHSS. DILHR was provided authority to enforce the radiation protection code in industrial establishments. The Radiation Protection Council was retained to provide DHSS and the RPS with technical assistance in the administration of statutes, assist in the development of rules and help resolve jurisdictional problems between the two departments.

In 1973, the Radiation Protection Section added to its environmental monitoring activities by joining in the new Environmental Radiation Ambient Monitoring System (ERAMS) established by the Environmental Protection Agency (EPA). This network of air and precipitation sampling stations was established in many states, including Wisconsin, to assess the radiological impact of weapons tests and radiological accidents on the United States. The RPS was responsible for routine sample collection, preliminary analysis and distribution of samples to a designated EPA lab for further analysis.

Also in the 1970's, the RPS began participating with the Food and Drug Administration (FDA)/Bureau of Radiological Health in numerous programs for the nationwide evaluations of x-ray trends (NEXT) to determine patient exposure from various radiological examinations. The compiled national data was used to establish exposure limits for various diagnostic examinations. In 1975, the RPS began conducting compliance inspections of newly installed x-ray systems under contract to the FDA/Bureau of Radiological Health.

Uranium exploration in Wisconsin became a significant legislative issue in the late 1970's. At the direction of a Wisconsin Senate Subcommittee, the Radiation Protection Section developed and implemented a radiological monitoring study at two uranium exploration sites in northern Wisconsin to determine the health and environmental impact of uranium exploration on drill operators and the public. Monitoring began in August, 1980 and continued through January, 1981. The results of the study were published in a 1982 document entitled "Radiological Monitoring of Uranium Exploration Drilling in Northern Wisconsin; WI Dept. of Health and Social Services, Section of Radiation Protection; 1982".

In response to the 1979 Three Mile Island accident, the RPS worked with the state emergency management agency to develop a radiological emergency preparedness and response (REP) capability to address incidents at the five nuclear power plants in or adjacent to WI. This new capability included the creation of a State Radiological Coordinator in the RPS to coordinate the state technical response to radiological incidents and advise the Governor (or designee) on appropriate protective actions. The RPS also established and trained a network of field monitoring teams (first responders) located in proximity to all the power plant sites. The radiological emergency preparedness capability of the RPS was first exercised in 1979. In response to a legislative action directing the DHSS to conduct environmental monitoring within 20 miles of any nuclear power plant impacting Wisconsin, the RPS further expanded the scope of its environmental monitoring activities to include the areas around the 5 nuclear plants impacting Wisconsin. The legislative mandate requiring environmental monitoring around nuclear plants also authorized DHSS to assess an annual fee to the operating

utilities to support the program. Later, the RPS entered into a contract with the NRC to conduct split-sample monitoring around the in-state nuclear plants. The RPS also developed and submitted for promulgation a major revision of the radiation protection code incorporating the newest changes to federal radiation protection regulations. The new HSS 157 was approved by the legislature and became effective in 1982.

During the mid-1980's, the Radiation Protection Section expanded its REP capability to include a mobile radiological laboratory, increased field instrumentation, multi-agency ingestion sampling teams trained to sample the food supply after a radiological incident and an in-house germanium analysis system. In addition, the legislature authorized DHSS to begin providing radon information and public outreach to Wisconsin citizens and approved a standing appropriation that allowed creation of a Radon Information Center in each of the two counties with the highest natural radon levels in the state.

Between 1984 and 1986, nuclear plants in the states of Wisconsin and Minnesota began shipping spent reactor fuel to a reclamation facility in Morris, IL. RPS staff received training at the Morris facility to help prepare for potential problems and become familiar with shipment procedures, personnel involved and packaging. Program staff were responsible for independently monitoring spent fuel shipments originating in Wisconsin to determine if contamination and radiation levels were within allowable limits prior to shipment. As spent fuel shipments from Minnesota entered Wisconsin, staff from the RPS were stationed along the designated route to monitor the shipments and be available to respond quickly in the event of an incident. Local government officials were alerted to all shipments.

During 1990, the RPS applied for and was awarded one of the first State Indoor Radon Grants from the Environmental Protection Agency. This grant allowed expansion of the regional Radon Information Center concept to cover most counties of the state and allowed for increased public outreach, advisory assistance and radon related research by the RPS. Also in 1990, the RPS began participating in the Health Care Finance Administration (HCFA) mammography certification program. The HCFA program was superseded by the federal Mammography Quality Standards Act of 1992. The RPS subsequently entered into a contract with the Food and Drug Administration to conduct annual inspections of all mammography facilities in Wisconsin.

In 1992, the RPS initiated a Radioactive Materials Disposal Project designed to reduce the inventory of unwanted radioactive materials believed to be in the possession of Wisconsin schools. In collaboration with the State Dept. of Public Instruction, schools were notified of the opportunity to dispose of unwanted materials at a reduced cost. The RPS negotiated an agreement with a radioactive materials broker who collected the materials from participating schools and effected disposal. This initiative resulted in 254 separate radioactive items (primarily NARM) being sent for disposal.

In response to an increased use of radiation monitoring by the scrap industry, the RPS began to conduct incident response training (upon request) for scrap yards, local emergency responders, hazmat teams, and police and fire departments statewide

beginning in 1993. During that same year, the DILHR was reorganized into the Dept. of Commerce and radiation statutes modified to reflect the change.

During 1997, the Wisconsin legislature evaluated the abundance of state boards and advisory councils and voted to sunset a number of long-standing groups, including the Radiation Protection Council. That same year, the RPS initiated a second waste disposal initiative targeting schools, scrap yards and state agencies. 284 separate radioactive items (primarily NARM) were identified and sent for disposal. In 1998, DHSS was reorganized into the current Department of Health and Family Services (DHFS). The RPS was retained in DHFS.

In early 1998, staff from the RPS met with representatives of the radiation regulated community to gauge support for Wisconsin pursuing agreement state status with the Nuclear Regulatory Commission. The positive response from these meetings allowed the RPS to propose statutory, organizational, fiscal and position changes needed to pursue agreement state status. The Governor signed a letter of intent in September, 1998 requesting NRC assistance in pursuing agreement state status. In 1999, the Wisconsin legislature passed 1999 Wisconsin Act 9 that approved the proposed agreement state enabling legislation and expanded DHFS statutory authority to regulate sources of radiation.

Radiation statutes were expanded to authorize the following: Wisconsin's governor on behalf of the state to enter into an agreement with NRC to assume regulatory authority over byproduct, source and special nuclear materials; DHFS to annually assess a fee of 36% of the U.S. Nuclear Regulatory Commission license application fee and materials license annual fee for any NRC licensee (excluding nuclear power plants and federal facilities) in the state to support agreement state program development; licensing and registration of radioactive materials; substantial expansion of the penalties assessed by the department for violation of statute, rule, license condition or registration to a range of $100 to $100,000; assignment of the DHFS as the state radiation protection agency and removal of the authorization for the Dept. of Commerce to regulate sources of radiation. Wisconsin Act 9 also contained the initial budget and position authority to begin development of a DHFS radioactive materials licensing and inspection program located in the Radiation Protection Section.

In January, 1999, the RPS proposed creation of a new radiation protection code and repeal of the version last updated in 1982. Utilizing the assistance of a 40 member, ad-hoc advisory group representing a cross-section of the regulated community, the RPS developed a new radiation protection code (called HFS 157) modeled after the Suggested State Regulations for the Control of Radiation (SSRCR) developed by the Conference of Radiation Control Program Directors (CRCPD). The proposed code was developed to make the Wisconsin radiation protection code current and compatible with applicable federal regulations. *Attachment 5* contains a cross-reference list that shows the federal requirement and corresponding WI Rule. The new HFS 157 was submitted for promulgation in November, 2000 and became effective on August 1, 2002.

The prescribed promulgation process for adopting and amending radiation control rules entails 1) obtaining approval of the Department of Health and Family Services; 2) submitting the proposed rule to a legislature support agency called the Legislative Reference Bureau (LRB) – Rules Clearinghouse for review and comment; 3) presenting the proposed rules for public review and comment including scheduled public hearings; 4) responding to each public and LRB comment in a report provided to the legislature; 5) modifying the rule language to reflect public and LRB comments, as appropriate; 6) submitting the rule to the appropriate legislative standing committee for deliberation and legislative hearing, if scheduled; 7) obtaining approval of the Wisconsin legislature; and 8) publishing the legislatively approved rule action in the Wisconsin Administrative Register for adoption as law.

II. RADIATION PROTECTION SECTION DESCRIPTION

Organization, Mission, Staff Education & Experience, Training Activities and Overview

The Radiation Protection Section is located in the Department of Health and Family Services (DHFS). The Secretary of DHFS, Phyllis Dubé, was appointed by Governor Scott McCallum. The Division of Public Health Administrator, John Chapin, reports to Secretary Dubé. The Bureau Director for Environmental Health, Tom Sieger, reports to John Chapin. The Radiation Protection Section Chief, Paul Schmidt, reports to Tom Sieger. Organizational charts for these administrative levels within DHFS are presented in *Attachment 1*.

The mission of the WI Radiation Protection Section (RPS) is to protect the public - both occupationally exposed and general – from unnecessary exposure to sources of radiation. To help accomplish this mission, the Radiation Protection Section has a staff of well-qualified personnel from a variety of academic and professional backgrounds. Currently, the RPS employs 23 people with the following academic distribution:

- 1 staff with a Ph.D degree in Physics
- 2 staff with Master's degrees in scientific disciplines
- 11 staff with Bachelor's degrees in various disciplines, including mathematics, chemistry, environmental science, geology and radiologic technology
- 4 staff with Associate's degrees or equivalent in scientific specialties

Radiation Protection Section staff have wide ranging and extensive expertise in the areas of occupational health and safety, nuclear power plant operation, health physics, radon, training, environmental monitoring, radiochemistry, physics, emergency preparedness planning, geology, radiological incident response, dose assessment and radiation control. Staff members have published papers in well-known journals, such as the Health Physics Journal, Journal of Physics and the Wisconsin Medical Journal. In addition, the staff are actively involved in the CRCPD and other national organizations. The current radiation control program director was CRCPD Chairperson from 2000 – 2001. The staff also frequently present papers at national conferences, including the National Radon Conference, National REP Conference and the National Conference on Radiation Control

(CRCPD annual meeting). The RPS hosted the National Conference on Radiation Control in 1985 and again in 2002.

Training activities are a significant component of RPS activities. A full-time training coordinator is responsible for coordinating, developing and conducting training for local emergency responders, state agency staff, RPS staff, county emergency government staff and utility personnel. In 2001, four two hour training sessions covering the 'new' 10 CFR 20 were presented to the RPS staff. Capability has been expanded in recent years to include training for other areas. Currently, multiple staff are involved in developing and conducting general radiation and incident response training for police and fire departments, Level A Hazmat teams (8 located by region in the state) and scrap yard personnel, among others. The recent heightened awareness of possible need to respond to a terrorist threat involving radioactive materials will present additional opportunities to provide training to regional and local emergency responders.

The primary responsibilities of the Radiation Protection Section are listed below and are discussed in further detail in subsequent sections:

- Environmental radiation monitoring
- Radon public information and outreach
- Radiological emergency preparedness and response
- X-ray, NARM, and tanning registration and inspection; mammography facility inspection
- Radioactive materials licensing and inspection (developing)
- Radiological incident response

Environmental Radiation Monitoring

The RPS currently conducts environmental surveillance around each of the five nuclear power plants in or near Wisconsin – three in Wisconsin, one in Illinois and one in Minnesota. The Kewaunee and Point Beach plants are the only two operational, pressurized water reactors (PWR) in the state and are located within 3 miles of each other on the Wisconsin shore of Lake Michigan. The Lacrosse Boiling Water Reactor is a shutdown facility located in southwest Wisconsin. The Prairie Island plant is an operating PWR on the Minnesota side of the state's western border. The Zion plant is a shutdown PWR facility three miles south of the Wisconsin/Illinois border.

The most extensive monitoring activities are conducted around the operational Point Beach/ Kewaunee plants and include the following:

1. Passive TLD System

   The passive TLD monitoring system utilizes thermo-luminescent dosimeters (TLDs) to measure the cumulative level of radiation around the plant sites. They are placed in 31 locations within 20 miles of the plant sites. They are also located around the boundary of the Interim Spent Fuel Storage Installation (ISFSI) constructed at Point Beach. TLDs are changed quarterly and then sent to a NVLAP accredited dosimeter

processor to determine the amount of radiation the device received at that location during the monitoring period.

2. Environmental sampling (milk, water, vegetation, fish, soil, air particulate/air iodine, shoreline sediment)

   Environmental sampling is conducted to monitor the air, terrestrial and aquatic environments for radioactivity content. Continuous air sampling is performed by air samplers placed in multiple locations around the plant sites. Terrestrial and aquatic samples of milk, vegetation, potable water, soil, lake water, fish and shoreline sediments are routinely collected, and analyzed by the WI State Laboratory of Hygiene for radioactivity. Sampling activities have been conducted continuously since 1968.

3. Environmental Monitoring Reports

   The Radiation Protection Section compiles the analysis results of all environmental samples and TLDs collected around the plant sites into an annual report. Annual environmental monitoring reports are routinely provided to county, state and federal agencies and to public libraries, and other interested groups or individuals, upon request.

The RPS no longer conducts separate milk monitoring or participates in the ERAMS. Milk monitoring ended in June, 1996. The ERAMS site was transferred to a larger population center in eastern Wisconsin in January, 2000.

Radon Public Information and Outreach

The RPS has annually applied for and received a State Indoor Radon Grant from the EPA since the first grant award in 1990. This grant has been used to support a statewide network of twelve Radon Information Centers, trained staff and on-going research projects. The RPS staff are responsible for all aspects of grant management, including contracting with local agencies to provide services. Staff also provide technical assistance to local public health agency staff, conduct training for local public health and radon industry staff, and respond to public questions about methods to measure and mitigate radon levels in existing and new construction. The radon program is also coordinating with the state Dept. of Natural Resources to implement the new radon in water standards and the multi-media mitigation option contained in recent revisions to the EPA Safe Drinking Water Act.

Radiological Emergency Preparedness and Response

The Radiation Protection Section is responsible for maintaining the state's technical response capability to an incident at a nuclear power facility impacting Wisconsin. Routine staff responsibilities consist of:

a) training annually and equipping a network of state field sampling teams (first responders) located near each of the 5 nuclear plants impacting the state;

b) periodically training multi-agency ingestion sampling teams to sample the food supply for radiological contamination;

c) ensuring the operational readiness of a mobile radiological laboratory, radio-equipped response vehicles and field instrumentation;

d) providing radiation related training to local volunteer, state and county government, utility, hospital and ambulance service staff;

e) calibrating and maintaining an intrinsic germanium analysis system used in the mobile laboratory to quantify radioactive content in environmental samples; and

f) participating in all scheduled REP exercises or real events.

Staff also routinely interact with WI Emergency Management (WEM) to maintain the State Radiological Incident Response Plan and develop the technical portion of nuclear plant exercise scenarios. Three staff from the RPS are trained to function as the State Radiological Coordinator responsible for coordinating the state technical response during the emergency phase of a power plant incident, developing protective action recommendations based on dose assessment and providing technical advice to the Governor or designee during all phases of the incident. Radiation Protection Section staff have participated in over 50 REP exercises since the first exercise was held in 1979.

The RPS's mobile radiological laboratory is equipped to prepare and analyze environmental samples collected by state field teams during a power plant incident or exercise. Staff are trained to operate, maintain and calibrate a intrinsic germanium counting system used for radiological sample analysis. The mobile laboratory also functions as a communications center between the SRC and the field teams. A more detailed description of the Radiation Control Program's mobile laboratory is contained in *Attachment 10, Appendix A.*

<u>X-ray, NARM, Tanning Registration; Mammography Inspection:</u> The RPS is responsible for annually registering radiation producing devices, Naturally Occurring and Accelerator Produced Radioactive Materials (NARM) and tanning facilities. Staff conduct routine inspections of statewide x-ray facilities, periodic inspections of NARM users, and tanning facility inspections upon receipt of medical complaint.

During CY 2001, the RPS processed over 4,900 x-ray facility registrations, 130 NARM registrations and 1,400 tanning facility registrations. Staff also conducted inspections of 1,500 x-ray facilities statewide. X-ray devices are inspected at least once every 3 years.

Staff continue to conduct inspections of portable x-ray service suppliers certified by the Health Care Finance Administration.

The RPS has participated in the annual Nationwide Evaluation of X-ray Trends (NEXT) continuously for over 25 years. During CY 2001, staff attended the training offered for the 2001 pediatric chest NEXT and participated in the inspections.

Since 1992, the RPS has been under contract with the Food and Drug Administration to conduct annual inspections of all 250 mammography facilities in Wisconsin. The RPS has consistently met contractual obligation to inspect all mammography facilities in the state each year of the contract.

Radioactive Materials Licensing and Inspection: The RPS is responsible for developing the radioactive materials regulatory structure needed for Wisconsin to become an agreement state with the Nuclear Regulatory Commission. Currently, program staff are:

a) attending NRC training courses required for personnel who will license and inspect the use of radioactive materials;

b) accompanying the NRC during their inspections in Wisconsin (48);

c) conducting inspections of NARM users in Wisconsin (77); and

d) developing the application needed for Wisconsin to become an agreement state with the Nuclear Regulatory Commission.

Two Nuclear Engineers have spent a week in NRC's Region III Office for hands-on licensing training. Staff also assisted with the inspection of a university broad scope licensee in a neighboring agreement state. The Radioactive Materials Program staff resumes and individual training programs are shown in *Attachment 2.* Position descriptions for each staff member in the Radioactive Materials Program are located in *Attachment 3.*

The new Radioactive Materials Program (RMP) being developed for this purpose is described in greater detail in Section III.

Radiological Incident Response

The Radiation Protection Section routinely responds to all types of incidents within Wisconsin involving radioactive materials not of nuclear power plant origin. The three RPS staff trained to function as State Radiological Coordinator are available on a 24-hour, rotating on-call basis to augment local resources and help safeguard public health and safety in the event of a radiological incident. Additional RPS staff are also trained and experienced in responding to radiological incidents.

From 1995 through January, 2002, RPS staff responded to approximately 100 incidents involving radioactive materials. These incidents ranged from the detection of radioactive material at scrap facilities to a CY 2000 transportation accident that closed a portion of an

interstate highway. A copy of the event report and photos for this incident is located in *Attachment 7, Appendix A.*

III. RADIOACTIVE MATERIALS PROGRAM

As mentioned earlier, the Wisconsin legislature approved significant changes to radiation protection statutes in 1999 and minor changes in 2001 (*Enclosure 2).* These changes have allowed the RPS to begin development of a radioactive materials licensing, inspection and enforcement program necessary to become an agreement state with the NRC.

Accomplishments

1. All NRC licensees in Wisconsin have been informed of DHFS agreement state program development activities.

2. Operating funds to support program development are supplied by a statutorily mandated annual surcharge fee assessed to each NRC licensee in Wisconsin (excluding power plants and federal facilities). Beginning in 1999, all NRC licensees in WI pay an annual fee to the state amounting to 36% of their most recent annual license or application fee(s) paid to the NRC. The RPS is responsible for invoicing the licensees. This revenue source is dedicated and will adequately fund development of a materials licensing and inspection program in the RPS, including salary and fringe expenses, travel, training, observation of NRC inspections, incident response, printing, equipment and administrative costs. The surcharge fee is authorized only until Wisconsin becomes an agreement state. At that point, license and registration fees will fund program operation. The revenue and budget for FY 2002-2005 is located in *Attachment 12.*

3. A new Materials Licensing and Inspection Unit with a separate supervisor has been authorized for the Radiation Protection Section and will be referred to hereafter as the Radioactive Materials Program (RMP).

4. The RMP receives periodic updates of NRC licenses in Wisconsin from NRC Region III. A database has been compiled which contains all radioactive material users in Wisconsin, including all NRC licensees/licenses and current NARM registrants. This database contains basic information such as facility name, NRC license and/or NARM registration, location of material use, contact, license number, license type, fee code, and inspection priority. Currently, the database is being used for billing purposes and to determine future inspection and licensing workload. At present, the RMP estimates there are about 420 future Wisconsin licensees which includes both the NRC licensees and the WI NARM registrants.

5. The materials program is scheduled to have a total of 9.5 FTE staff including 8.0 FTE Nuclear Engineering staff and 1.5 program assistants. 9.25 FTE staff have already

been hired including the new materials program supervisor. The final .25 FTE (program assistant) will be added in SFY 2004.

Staff Designated for Training, Procedure & Regulation Development

The Radiation Materials Program intends to utilize the Nuclear Engineers assigned to the materials licensing, inspection and enforcement program in all aspects of the program. The initial staff will be trained to conduct licensing reviews, perform inspections and participate in enforcement activities. They will also be knowledgeable in medical, industrial and academic license applications plus incident response. During the implementation phase, individuals who have completed the appropriate Nuclear Regulatory Commission training courses will be the lead staff during inspections with newer, less trained staff participating as observers to receive on-the-job experience. The Materials Program Supervisor will perform accompaniments in order to qualify staff for each type of inspection. Ultimately, all full-time Nuclear Engineers will receive the appropriate training for each of the various types of license inspections.

Program Management

The Materials Program Supervisor (MPS) will:

- Inform the Radiation Protection Section Chief on a quarterly basis concerning the status of overdue inspections, licensing actions which exceed the assigned 30-60-90 day time-frames, and staffing and training needs.

- Conduct supervisory accompaniments annually for all Nuclear Engineers conducting radioactive materials inspections (see *Attachment 8, Appendix A* for Accompaniment Inspection Review Checklist).

- Ensure that survey instruments utilized by the RMP are calibrated annually.

- Ensure that notifications are made of reportable incidents to the NRC Operations Center and Region III Office for immediate and 24-hour reports, or the Region III Office and NMED for 30-day reports. See RMPP 4.02.

Licensing, Inspection & Enforcement, and Allegations & Incident Response Program Description

The Radioactive Materials Program will perform license reviews, conduct inspections and enforcement activities, notify licensees of generic problems, and respond to allegations and incidents involving radioactive materials. The routine activities for each aspect of the program are detailed in the Radioactive Materials Program Procedures (*Attachments 5-9*). An overview of the conduct of program activities is provided below.

License reviews will be conducted using the NUREG 1556 guidance documents or a version modified to show WI Rule requirements. The RMP has currently developed

Wisconsin regulatory guides or 'WISREGs' for Portable Gauges and XRFs, Fixed Gauges, Commercial Radiopharmacy, Risk from Occupational Exposure and Prenatal Radiation Exposure. These guides are located in *Attachment 5, Appendix B.* Application forms have been developed for eight specific license categories as follows:

- Portable Gauge and XRF Device
- Industrial Radiography
- Fixed Gauge Device
- Self Shielded Irradiator
- Academic, Research & Development and Other Licenses of Limited Scope
- Medical Use
- Commercial Radiopharmacy
- Broad Scope

The close correlation between the application form and the NUREG 1556 guidance, or adapted WISREG, will facilitate submittal of the needed information for renewals and new applications. The RMP has developed an expedited renewal form for each license category that can be used when insignificant changes have occurred in the licensee's program. Other forms including checklists, a Notice to Employees and information summaries have also been developed to assist licensees and registrants. The forms developed by the RMP are located in *Attachment 5, Appendix A.*

The Radioactive Materials Program has the option to modify regulatory requirements through the use of legally binding requirements. These can take the form of orders, notices, or license conditions-or a combination of these. HFS 157.04 grants DHFS authority to grant exemptions or exceptions. HFS 157.13(9)(b) grants DHFS authority to incorporate "additional requirements and conditions." For the specific regulatory issue of the lack of subpart J requirements in HFS 157, subchapter VI, DHFS proposes a policy statement in conjunction with license conditions. (see below). Other regulatory issues or problems that arise will be evaluated for the best approach.

DRAFT OFFICIAL NOTICE 8/02
HFS 157, Subchapter VI, Medical Use of Radioactive Material

Training and Experience Policy Statement & Sample License Conditions
For Authorized Users, Medical Physicists, and RSOs

Policy Statement:
Department of Health and Family Services (DHFS) will accept the training and experience requirements in 10 CFR 35, subpart J as meeting the training and experience requirements for authorized users, medical physicists or RSOs in HFS 157, subchapter VI until October 24, 2004.

Sample License Conditions:

Radiation Safety Officer:
In lieu of the requirements of HFS 157.61(7)(a), the requirements of 10 CFR 35.900(a) shall apply for the Radiation Safety Officer, (list name).

Authorized Medical Physicist:
In lieu of the requirements of HFS 157.61(8)(a), the requirements of 10 CFR 35.961(a) shall apply for the Authorized Medical Physicist, (list name).

Authorized Users:
In lieu of the requirements of "Column A", the requirements of 10 CFR "Column B" or 10 CFR "Column C" shall apply for authorized user(s), (list names).

Type of Use	Column A	Column B-Boards	Column C-T & E
157.63(1) [35.100]	157.63(4)(a)	35.910(a)	35.910(b) or (c)
157.63(2) [35.200]	157.63(5)(a)	35.920(a)	35.920(b) or (c)
157.64(1) [35.300]	157.64(4)(a)	35.930(a)	35.930(b)
157.64(5) [I-131, <33 mCi]	157.64(5)	N/A	35.932
157.64(6) [I-131, >33 mCi]	157.64(6)	N/A	35.934
157.65(1) [35.500]	157.65(8)(a)	35.940(a)	35.940(b)
Sr-90	157.65(9)	N/A	35.941
157.67(1) [35.600]	157.67(17)(a)	35.960(a)	35.960(b)

Inspection checklists/reports have been developed for the categories of Portable Gauges and XRF Devices, Fixed Gauges, and Commercial Radiopharmacies (*Attachment 6, Appendix A)*. Inspections will be performance based, therefore, if any area on the checklist was not covered during the inspection the report will state 'not reviewed'. The RMP will use the inspection checklists/reports to document the inspection findings for all license categories except broad-scope licensees for which a narrative report format will be used. Inspection checklists/reports will be based on the information discussed in NRC's Manual Chapter 2800, Inspection Procedures and modified as needed to reflect WI Rule and license conditions. The criteria for increased, reduced and follow-up inspections are outlined in RMPP 3.01.

Enforcement actions are discussed in RMPP 3.05 and include notices of violation, forfeitures and orders. The authority for the Radioactive Materials Program to issue orders is found in s. 254.37(2) and s. 254.38(2), WI Stats. An order can take a variety of forms ranging from a Notice of Violation to an Emergency Order. A notice of violation will normally be issued by the Radioactive Materials Program Supervisor or a Nuclear Engineer. Escalated enforcement actions must be issued by the Section Chief or higher level manager. The DHFS Office of Legal Counsel is available to provide assistance with enforcement actions upon the request of the Radiation Protection Section Chief.

Information Notices (INs) issued by the NRC will be evaluated for applicability to Wisconsin licensees. The RMP will also evaluate inspection findings for generic health and safety problems that are specific to Wisconsin licensees (e.g., NARM licensees). See RMPP 3.03. The RMP will forward applicable INs or generic health and safety information to affected licensees.

Field and laboratory equipment resources are located in *Attachment 10.* The RMP has purchased an Eberline RO-20 ion chamber, and an additional survey meter (Eberline E-600) with two 'smart' probes (pancake and energy compensated) that can be transported in a single suitcase for routine inspections. The other survey meters shown on the field equipment list are primarily emergency response equipment, but may be used by the RMP as needed. Contamination wipes may be counted on the intrinsic germanium system *(Attachment 10, Appendix A),* that is routinely stored in a sample preparation and counting room located in the same building as RPS office space. Alternatively, the wipes may be sent to the State Laboratory of Hygiene, *(Attachment 11),* and analyzed for a fee.

Response to allegations or incidents involving radioactive materials will be based on the guidance provided in the Radioactive Material Program Procedures *(Attachment 7).* These procedures will cover the entire Radiation Protection Section. The allegations procedure will be used by the x-ray and radioactive materials program staff to respond to allegations of impropriety or wrongdoing by licensees or registrants. The incident response procedure will draw upon available trained staff, as needed, from the entire RPS. A goal of the RPS is to increase the number of staff who have attended the Radiological Emergency Response Operations (RERO) course. Currently there are twelve professional staff who have attended this course. An additional resource is the five regional field teams (13 people) who are trained to take radiation measurements and environmental samples as part of nuclear power plant emergency response. The RPS routinely responds to incidents involving radioactive material and maintains a storage facility that can be used for impounded radiation sources that could present a danger to the public.

Administrative Tracking and Processing

The RMP has developed an Access database of license files. A hard copy file system has been created that is organized by a WI Radioactive Materials License Number. The computer database will permit identification of licenses up for renewal, inspections due, and tracking on-going licensing and inspection activities. Administrative procedures have been developed to track licensing actions and correspondence associated with completed inspections *(Attachment 9).* Licenses will be generated either using the Access database or by selecting 'word' templates for each specific license type.

Legal Assistance

The RMP receives legal assistance from the DHFS Office of Legal Counsel. The Office of Legal Counsel (OLC) is an office within DHFS that serves the Secretary and acts as a

legal resource for the entire department. The OLC consists of 18 attorneys, multiple support staff plus an administrative rules unit. OLC attorneys are designated to work in identified program areas and provide a wide range of legal assistance, including:

- providing formal legal opinions
- communicating informal legal advice
- litigating DHFS cases in administrative hearings
- assisting the Attorney General's office in court litigation
- offering formal and informal advocacy on behalf of DHFS programs
- providing training and guidance in investigation methods and legal issues.

The DHFS Administrative Rules Unit is organizationally located within the OLC. This unit is responsible for reviewing all drafted administrative rule related documents at various stages before rules are circulated for external review. The unit also maintains an internet web site with links to proposed permanent rules, emergency rules currently in effect and rules under development.

The OLC and the Administrative Rules Unit were involved in the development and promulgation of the new radiation protection rule, HFS 157, and will be available to assist with future RMP legal issues and rule actions.

Radioactive Materials Program Procedures

The Radioactive Materials Program Procedures (RMPP) are organized and located as follows:

• Licensing	Attachment 5
• Inspection and Enforcement	Attachment 6
• Incidents and Allegations	Attachment 7
• Qualifications and Training	Attachment 8
• Administrative	Attachment 9

A summary listing of each procedure is provided below. Radioactive Material Program Forms are not currently included as Attachments to the Procedures, but are located in *Attachment 5, Appendix A.*

Licensing:

2.02-Review of Initial Application for License or an Amendment Request
2.03-Renewal of Licenses
2.05-License Termination: This procedure addresses actions that need to be taken for different types of licenses including the close-out survey and decommissioning plan.
2.06-Prioritization of Licensing Actions

Inspections & Enforcement:

3.01-Scheduling of Inspections: This procedure addresses license priority and corresponding inspection frequency. Range: Priority I (annually) to V (every 5 years). The MPS may extend the next inspection date immediately after an inspection for a positive program review.
3.02-Inspection Preparation
3.03-Performance Based Inspection-requires Inspection Plan for all initial inspections and Priority I-III routine inspections.
3.04-Documentation of Inspection Results
3.05-Enforcement, Escalated Enforcement and Administrative Actions

Incidents and Allegations:

4.01-Management of Allegations
4.02-Radiological Incident Response

Administrative:

5.01-Receipt and Tracking of Licensing Actions
5.02-Renewal Notices, Tracking Inspection Reports and Correspondence

Qualifications and Training:

6.01-Qualifications and Training

Staff Needs Analysis

A Staff Needs Analysis was performed to confirm that the current and planned staff of 9.5 FTEs [6.0 FTE Nuclear Engineers, 1.0 FTE Nuclear Engineering Specialist Supervisor, 1.5 FTE Program Assistants, 1.0 FTE Nuclear Engineer Sr. (0.5 FTE each of two individuals)] matches projected workload as detailed below.

Assumptions:

420 licensees (Byproduct and NARM)
- Priority I- 29
- Priority II - 9
- Priority III- 96
- Priority V- 286

35 reciprocity licensees (inspections only)
- Service (HDR/Gamma Knife) 3
- Ind. Rad. (I) 10
- Well Logging (II) 3
- Mobile Nuc. Med. (II) 3
- Portable Gauge/XRF 16

6.5 FTE available for Inspections & Licensing
0.5 FTE available for Rule & Procedures development
1848 hrs/FTE/yr (2088 work hrs./yr-240 hrs for Vac., Hol., SL = 1848 hrs/FTE/yr)
230 staff days/FTE/yr
1495 total staff days (230 staff days x 6.5 FTE)

Inspections performed at NRC frequency, i.e., annually for Priority I's
License renewals performed every 5 years

Licensing:
The staff needs analysis projects 243 licensing actions per year. The NRC Region III Office has recently averaged (2001 data) 18 licensing actions/month. With the addition of about 100 NARM licenses and the more frequent 5 year renewal period for licenses, an average of about 20 actions/month is reasonable for the Wisconsin Radioactive Materials Program. Each qualified Nuclear Engineer will need to annually perform about 40 licensing actions, including 14 renewal or new application reviews. During the time period required to qualify new staff to perform licensing functions, each qualified nuclear engineer may be responsible for up to 80 licensing actions/year. A second review will routinely be performed, and documented, by another qualified reviewer or the Materials Program Supervisor for all licensing actions, with the exception of administrative actions such as "corrected copy" for minor editorial changes.

Inspections:
The staff needs analysis projects 137 inspections per year. This includes about 12 reciprocity inspections. Each qualified Nuclear Engineer would annually perform 36 inspections. During the time period required to qualify new inspectors, more inspections will need to be performed by the qualified staff in order to provide training and qualification opportunities for the new staff. It is likely that each inspector will need to perform up to 72 inspections a year until the full complement of qualified inspectors is attained. The annual total of inspections, classified by Priority, for WI licensees is as follows: I-29, II-5, III-33, V-58. Each qualified Nuclear Engineer would annually:

- Participate in 4 Broad Scope inspections
- Conduct 6 Industrial Radiography inspections
- Conduct 1 Service (HDR/Gamma Knife) inspection
- Conduct 1 Nuclear Pharmacy inspection
- Conduct 2 Priority II inspections (Well logging, Mobile Nuclear Medicine)
- Conduct 7 Priority III inspections
- Conduct 15 Priority V inspections

Although not directly addressed in the staff needs analysis, 0.5 FTE is planned for the on-going development of: Wisconsin Rule, professional training program(s), radioactive material program procedure updates, investigation of allegations, escalated enforcement activities, and other unplanned events such as emergency response to non nuclear power plant incidents. The General Licenses will be handled through the administrative process of registration and annual self-audits. If it becomes necessary, (such as when the annual self-audits are not performed/returned), follow-up inspections would be added to the workload, however, they are not addressed in the staff needs analysis.

STAFF NEEDS ANALYSIS

License Category	Number of Licenses	Times (x) # Actions	Licensing actions / yr	Staff days per action	Licensing Staff days	Times (x) Frequency	Inspections per year	Staff days / Inspection	Inspection staff days
Broadscope – Medical (I)	3	6	18	4	72	1	3	25	75
Broadscope – Academic (I)	3	6	18	4	72	1	3	25	75
Industrial Radiography (I)	16	1	16	2	32	1	16	10	160
Nuclear Pharmacy (I)	6	2	12	2	24	1	6	19	114
HDR (I)	1	1	1	2	2	1	1	10	10
Mobile Nuc-Med (II)	9	1	9	2	18	.50	5	8	40
Gamma Knife – Teletherapy (III)	1	1	1	2	2	.33	1	6	6
Medical – Diagnostic (III)	27	1	27	2	54	.33	9	6	54
Medical – Therapy (III)	66	1	66	2	132	.33	22	6	132
Manufacturing with Distribution (III)	2	1	2	2	4	.33	1	6	6
IN-Vitro Testing (V)	4	.25	1	2	2	.20	1	2	2
Fixed Gauges (V)	51	.25	13	2	26	.20	10	4	40
Portable Gauges (V)	135	.25	34	2	68	.20	27	4	108
Research & Development (V)	31	.25	8	2	16	.20	6	5	30
Self Shielded Irradiators (V)	8	.25	2	2	4	.20	2	4	8
Source Material (V)	1	1	1	2	2	.20	1	3	3
Other – NARM (V)	16	.25	4	2	8	.20	3	3	9
Other (V)	40	.25	10	2	20	.20	8	3	24
Reciprocity	35					Varies	12	16	38
TOTALS	455		243	40	558		137	165	934

STAFF RESOURCE ANALYSIS

Staff Member	Jason		Paul		Mike		NE#1		NE#2		NE#3		NE#4		TOTAL	TOTAL
License Category	Insp	Lic	Insp	Lic	Insp	Lic	Insp	Lic	Insp	Lic	Insp	Lic	Insp	Lic	Insp	Lic
Broadscope – Medical (I)	11	12	12	12	12		10	12	10	12	10	12	10	12	75	72
Broadscope – Academic (I)	12	12	11	12	12		10	12	10	12	10	12	10	12	75	72
Industrial Radiography (I)	20	6	20	6	20		25	5	25	5	25	5	25	5	160	32
Nuclear Pharmacy (I)	19	4	19	4			19	4	19	4	19	4	19	4	114	24
HDR (I)	1	1	1	1			2	0	2	0	2	0	2	0	10	2
Mobile Nuc-Med (II)	6	3	6	3			7	3	7	3	7	3	7	3	40	18
Gamma Knife – Teletherapy (III)	1	1	1	1			1	0	1	0	1	0	1	0	6	2
Medical – Diagnostic (III)	9	9	9	9			9	9	9	9	9	9	9	9	54	54
Medical – Therapy (III)	22	22	22	22			22	22	22	22	22	22	22	22	132	132
Manufacturing with Distribution (III)	1	0	1	0		4	1	0	1	0	1	0	1	0	6	4
IN-Vitro Testing (V)	1	1	1	1			0	0	0	0	0	0	0	0	2	2
Fixed Gauges (V)	5	4	5	4	6	2	6	4	6	4	6	4	6	4	40	26
Portable Gauges (V)	14	7	14	7	40	2	10	13	10	13	10	13	10	13	108	68
Research & Development (V)	5	4	5	4	4		4	2	4	2	4	2	4	2	30	16
Self Shielded Irradiators (V)	2	0	2	0			1	1	1	1	1	1	1	1	8	4
Source Material (V)	0	1	0	1	3		0	0	0	0	0	0	0	0	3	2
Other – NARM (V)	3	2	3	2	3		0	1	0	1	0	1	0	1	9	8
Other (V)	3	0	3	0	2		4	5	4	5	4	5	4	5	24	20
Reciprocity	6		6		6		5		5		5		5		38	
TOTAL	141	89	141	89	108	8	136	93	136	93	136	93	136	93	934	558

STAFF BALANCE ANALYSIS

License Category	Inspection staff days			Licensing staff days		
	Needed	Available		Needed	Available	
		Current Staff	Planned 4 FTE's		Current Staff	Planned 4 FTE's
Broadscope – Medical (I)	75	35	40	72	24	48
Broadscope – Academic (I)	75	35	40	72	24	48
Industrial Radiography (I)	160	60	100	32	12	20
Nuclear Pharmacy (I)	114	38	76	24	8	16
HDR (I)	10	2	8	2	2	0
Mobile Nuc-Med (II)	40	12	28	18	6	12
Gamma Knife – Teletherapy (III)	6	2	4	2	2	0
Medical – Diagnostic (III)	54	18	36	54	18	36
Medical – Therapy (III)	132	44	88	132	44	88
Manufacturing with Distribution (III)	6	2	4	4	4	0
IN-Vitro Testing (V)	2	2	0	2	2	0
Fixed Gauges (V)	40	16	24	26	10	16
Portable Gauges (V)	108	68	40	68	16	52
Research & Development (V)	30	14	16	16	8	8
Self Shielded Irradiators (V)	8	4	4	4	0	4
Source Material (V)	3	3	0	2	2	0
Other – NARM (V)	9	9	0	8	4	4
Other (V)	24	8	16	20	0	20
Reciprocity (V)	38	18	20			
Total	934	390	544	558	186	372