NASA Procedural Requirements

NPR 8715.3C
Effective Date: March 12, 2008
Expiration Date: March 12, 2013

COMPLIANCE IS MANDATORY

Printable Format (PDF)

Request Notification of Change (NASA Only)

Subject: NASA General Safety Program Requirements

Responsible Office: Office of Safety and Mission Assurance

| TOC | ChangeLog | Preface | Chapter1 | Chapter2 | Chapter3 | Chapter4 | Chapter5 | Chapter6 | Chapter7 | Chapter8 | Chapter9 | Chapter10 | Chapter11 | AppendixA | AppendixB | AppendixC | AppendixD | AppendixE | AppendixF | AppendixG | AppendixH | AppendixI | ALL |

Appendix D. Activity and Radioactive Material Limits - Basic Al /A2 Values

1. Determination of A_2 Mission Multiple.

The A_2 multiplier for each radioactive source is based upon the International Atomic Energy Agency (IAEA), Safety Series Number 6, Regulations for the Safe Transport of Radioactive Material, 1985 Edition as amended in 1990, Section III, paragraphs 301 through 306, and summed to determine the A_2 mission multiple.

Table I of this Appendix contains the referenced IAEA document section which tabulates the A_2 values for specific isotopes and forms of radioactive material. Except as noted, for radioisotopes whose A_2 limit in Table I is "Unlimited" or is unlisted, the value of 3.7×10^{-2} teraBecquerals (TBq) (1.0 Curies (Ci)) shall be used as the A_2 value.

Exceptions are Sm-147, use 9×10^{-4} TBq (0.024 Ci) and Th-232, use 9×10^{-5} TBq (0.0024 Ci) as their respective A_2 values.

The A_2 mission multiple shall be determined as follows:

where n represents each source or line on the report in paragraph 5.4.1.2 for each radioactive material on the launch vehicle and spacecraft.

2. Values of A_1 and A_2 for individual radionuclides, which are the basis for many activity limits elsewhere in this NPR, are given in Table I.

This section has been reproduced with permission of the IAEA.

DETERMINATION OF A_1 AND A_2

3. For individual radionuclides whose identities are known, but which are not listed in Table I, the determination of the values of A_1 and A_2 shall require competent authority approval or, for international transport, multilateral approval. Alternatively, the values of A_1 and A_2 in Table II may be used without obtaining competent authority approval.

4. In the calculations of A_1 and A_2 for a radionuclide not in Table I, a single radioactive decay chain in which the 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 such daughter nuclides shall be considered as mixtures of different nuclides.

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

(a) For special form radioactive material:

(b) For other forms of radioactive material:

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 i, respectively.

Table I. A_1 And A_2 Values for Radionuclides

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{225}Ac (b)*	Actinium (89)	0.6	10	1 x 10^{-2}2 x 10^{-1}	10
^{227}Ac		40	1000	2 x 10^{-3}5 x 10^{-4}	
^{228}Ac		0.6	10	0.4	
^{105}Ag	Silver (47)	2	50	2	50
^{108}Ag^{m}		0.6	10	0.6	10
^{110}Ag^{m}		0.4	10	0.4	10
^{111}Ag		0.6	10	0.6	10
^{26}Al	Aluminum (13)	0.4	10	0.4	10
^{241}Am	Americium (95)	2	50	2 x 10^{-4}5 x 10^{-3}	
^{242}Am^{m}		2	50	2 x 10^{-4}5 x 10^{-3}	
^{243}Am		2	50	2 x 10^{-4}5 x 10^{-3}	
^{37}Ar	Argon (18)	40	1000	40	1000
^{39}Ar		20	500	20	500
^{41}Ar		0.6	10	0.6	10
^{42}Ar (b)		0.2	5	0.2	5
^{72}As	Arsenic(33)	0.2	5	0.2	5
^{73}As		40	1000	40	1000
^{74}As		1	20	0.5	10
^{76}As		0.2	5	0.2	5
^{77}As		20	500	0.5	10
^{211}At	Astatine (85)	30	800	2	50

- Note: (b) indicates a footnote at the end of Table I: this form is used to avoid confusion with the superscript m.

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{193}Au	Gold (79)	6	100	6	100
^{194}Au		1	20	1	20
^{195}Au		10	200	10	200
^{196}Au		2	50	2	50
^{198}Au		3	80	0.5	10
^{199}Au		10	200	0.9	20
^{131}Ba	Barium (56)	2	50	2	50
^{133}Ba^{m}		10	200	0.9	20
^{133}Ba		3	80	3	80
^{140}Ba (b)		0.4	10	0.4	10
^{7}Be	Beryllium (4)	20	500	20	500
^{10}Be		20	500	0.5	10
^{205}Bi	Bismuth (83)	0.6	10	0.6	10
^{206}Bi		0.3	8	0.3	8
^{207}Bi		0.7	10	0.7	10
^{210}Bi^{m} (b)		0.3	8	3 x 10^{-2}8 x 10^{-1}	
^{210}Bi		0.6	10	0.5	10
^{212}Bi (b)		0.3	8	0.3	8
^{247}Bk	Berkelium (97)	2	50	2 x 10^{-4}5 x 10^{-3}	
^{249}Bk		40	1000	8 x 10^{-2}2	
^{76}Br	Bromine (35)	0.3	8	0.3	8
^{77}Br		3	80	3	80
^{82}Br		0.4	10	0.4	10

^{11}C ^{14}C	Carbon (6)	1 40	20 1000	0.5 2	10 50
^{41}Ca ^{45}Ca ^{47}Ca	Calcium (20)	40 40 0.9	1000 1000 20	40 0.9 0.5	1000 20 10
^{109}Cd $^{113}Cd^{m}$ $^{115}Cd^{m}$ ^{115}Cd	Cadmium (48)	40 20 0.3 4	1000 500 8 100	1 9×10^{-2} 2 0.3 0.5	20 8 10
^{139}Ce ^{141}Ce ^{143}Ce ^{144}Ce (b)	Cerium (58)	6 10 0.6 0.2	100 200 10 5	6 0.5 0.5 0.2	100 10 10 5
^{248}Cf ^{249}Cf ^{250}Cf ^{251}Cf ^{252}Cf ^{253}Cf ^{254}Cf	Californium (98)	30 2 5 2 0.1 40 3×10^{-3} 8 $\times 10^{-2}$	800 50 100 50 2 1000 6×10^{-4} 1 $\times 10^{-2}$	3×10^{-3} 8 $\times 10^{-2}$ 2×10^{-4} 5 $\times 10^{-3}$ 5×10^{-4} 1 $\times 10^{-2}$ 2×10^{-4} 5 $\times 10^{-3}$ 1×10^{-3} 2 $\times 10^{-2}$ 6×10^{-2} 1	

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{36}Cl ^{38}Cl	Chlorine (17)	20 0.2	500 5	0.5 0.2	10 5
^{240}Cm ^{241}Cm ^{242}Cm ^{243}Cm ^{244}Cm ^{245}Cm ^{246}Cm ^{247}Cm ^{248}Cm	Curium (96)	40 2 40 3 4 2 2 2 4×10^{-2} 1	1000 50 1000 80 100 50 50 50 5×10^{-3}	2×10^{-2} 5 $\times 10^{-1}$ 0.9 1×10^{-2} 2 $\times 10^{-1}$ 3×10^{-4} 8 $\times 10^{-3}$ 4×10^{-4} 1 $\times 10^{-2}$ 2×10^{-4} 5 $\times 10^{-3}$ 2×10^{-4} 5 $\times 10^{-3}$ 2×10^{-4} 5 $\times 10^{-3}$ 1×10^{-3}	20
^{55}Co ^{56}Co ^{57}Co $^{58}Co^{m}$ ^{58}Co ^{60}Co	Cobalt (27)	0.5 0.3 8 40 1 0.4	10 8 200 1000 20 10	0.5 0.3 8 40 1 0.4	10 8 200 1000 20 10
^{51}Cr	Chromium (24)	30	800	30	800
^{129}Cs ^{131}Cs ^{132}Cs $^{134}Cs^{m}$ ^{134}Cs ^{135}Cs ^{136}Cs ^{137}Cs (b)	Cesium (55)	4 40 1 40 0.6 40 0.5 2	100 1000 20 1000 10 1000 10 50	4 40 1 9 0.5 0.9 0.5 0.5	100 1000 20 200 10 20 10 10
^{64}Cu ^{67}Cu	Copper (29)	5 9	100 200	0.9 0.9	20 20
^{159}Dy ^{165}Dy ^{166}Dy (b)	Dysprosium (66)	20 0.6 0.3	500 10 8	20 0.5 0.3	500 10 8
^{169}Er ^{171}Er	Erbium (68)	40 0.6	1000 10	0.9 0.5	20 10
^{147}Eu ^{148}Eu ^{149}Eu ^{150}Eu	Europium (63)	2 0.5 20 0.7	50 10 500 10	2 0.5 20 0.7	50 10 500 10

^{152}Eu[a]		0.6	10	0.6	10
^{152}Eu		0.9	20	0.9	20
^{154}Eu		0.8	20	0.8	10
^{155}Eu		20	500	2	50
^{156}Eu		0.6	10	0.5	10

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{18}F	Fluorine (9)	1	20	0.5	10
^{52}Fe (b) ^{55}Fe ^{59}Fe ^{60}Fe	Iron (26)	0.2 40 0.8 40	5 1000 20 1000	0.2 40 0.8 0.2	5 1000 20 5
^{67}Ga ^{68}Ga ^{72}Ga	Gallium (31)	6 0.3 0.4	100 8 10	6 0.3 0.4	100 8 10
^{146}Gd (b) ^{148}Gd ^{153}Gd ^{159}Gd	Gadolinium (64)	0.4 3 10 4	10 80 200 100	0.4 3 x 10^{-4}8 x 10^{-3} 5 0.5	10 100 10
^{68}Ge (b) ^{71}Ge ^{77}Ge	Germanium (32)	0.3 40 0.3	8 1000 8	0.3 40 0.3	8 1000 8
^{172}Hf (b) ^{175}Hf ^{181}Hf ^{182}Hf	Hafnium (72)	0.5 3 2 4	10 80 50 100	0.3 3 0.9 3 x 10^{-2}8 x 10^{-1}	8 80 20
^{194}Hg (b) ^{195}Hg[a] ^{197}Hg[a] ^{197}Hg ^{203}Hg	Mercury (80)	1 5 10 10 4	20 100 200 200 100	1 5 0.9 10 0.9	20 100 20 200 20
^{163}Ho ^{166}Ho[a] ^{166}Ho	Holmium (67)	40 0.6 0.3	1000 10 8	40 0.3 0.3	1000 8 8
^{123}I ^{124}I ^{125}I ^{126}I ^{129}I ^{131}I ^{132}I ^{133}I ^{134}I ^{135}I	Iodine (53)	6 0.9 20 2 Unlimited 3 0.4 0.6 0.3 0.6	100 20 500 50 80 10 10 8 10	6 0.9 2 0.9 Unlimited 0.5 0.4 0.5 0.3 0.5	100 20 50 20 10 10 10 8 10
^{111}In ^{113}In[a] ^{114}In[a] (b) ^{115}In[a]	Indium (49)	2 4 0.3 6	50 100 8 100	2 4 0.3 0.9	50 100 8 20

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{189}Ir ^{190}Ir ^{192}Ir ^{193}Ir[a] ^{194}Ir	Iridium (77)	10 0.7 1 10 0.2	200 10 20 200 5	10 0.7 0.5 10 0.2	200 10 10 200 5
^{40}K ^{42}K ^{43}K	Potassium (19)	0.6 0.2 1	10 5 20	0.6 0.2 0.5	10 5 10
^{81}Kr	Krypton (36)	40	1000	40	1000

$^{83}Kr^{m}$ ^{85}Kr ^{87}Kr		6 20 0.2	100 500 5	6 10 0.2	100 200 5
^{137}La ^{140}La	Lanthanum (57)	40 0.4	1000 10	2 0.4	50 10
LSA	Low specific	activity material	(see paragraph.	131 of Parent	Document)
^{172}Lu ^{173}Lu $^{174}Lu^{m}$ ^{174}Lu ^{177}Lu	Lutetium (71)	0.5 8 20 8 30	10 200 500 200 800	0.5 8 8 4 0.9	10 200 200 100 20
MFP	For mixed fission	products, use	formula for	mixtures or	Table II
^{28}Mg (b)	Magnesium (12)	0.2	5	0.2	5
^{52}Mn ^{53}Mn ^{54}Mn ^{56}Mn	Manganese (25)	0.3 Unlimited 1 0.2	8 20 5	0.3 Unlimited 1 0.2	8 20 5
^{93}Mo ^{99}Mo	Molybdenum (42)	40 0.6	1000 10	7 0.5	100 10
^{13}N	Nitrogen (7)	0.6	10	0.5	10
^{22}Na ^{24}Na	Sodium (11)	0.5 0.2	10 5	0.5 0.2	10 5
$^{92}Nb^{m}$ $^{93}Nb^{m}$ ^{94}Nb ^{95}Nb ^{97}Nb	Niobium (41)	0.7 40 0.6 1 0.6	10 1000 10 20 10	0.7 6 0.6 1 0.5	10 10 10 20 10
^{147}Nd ^{149}Nd	Neodymium (60)	4 0.36	100 10	0.5 0.5	10 10
^{59}Ni ^{63}Ni ^{65}Ni	Nickel (28)	40 40 0.3	1000 1000 8	40 30 0.3	1000 800 8

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{235}Np ^{236}Np ^{237}Np ^{239}Np	Neptunium (93)	40 7 2 6	1000 100 50 100	40 1 x 10^{-3}2 x 10^{-2} 2 x 10^{-4}5 x 10^{-3} 0.5	1000 10
^{185}Os $^{191}Os^{m}$ ^{191}Os ^{193}Os ^{194}Os (b)	Osmium (76)	1 40 10 0.6 0.2	20 1000 200 10 5	1 40 0.9 0.5 0.2	20 1000 20 10 5
^{32}P ^{33}P	Phosphorus (15)	0.3 40	8 1000	0.3 0.9	8 20
^{230}Pa ^{231}Pa ^{233}Pa	Protactinium (91)	2 0.6 5	50 10 100	0.1 6 x 10^{-3}1 x 10^{-3} 0.9	2 20
^{201}Pb ^{202}Pb ^{203}Pb ^{205}Pb ^{210}Pb (b) ^{212}Pb (b)	Lead (82)	1 40 3 Unlimited 0.6 0.3	20 1000 80 10 8	1 2 3 Unlimited 9 x 10^{-3}2 x 10^{-1} , , .3 , , ,	20 50 80 8
^{100}Pd ^{107}Pd ^{109}Pd	Palladium (46)	40 Unlimited 0.6	1000 10	40 Unlimited 0.5	1000 10

[illegible]Pm	Promethium (61)	3	80	3	80
^{144}Pm		0.6	10	0.6	10
^{145}Pm		30	800	7	100
^{147}Pm		40	1000	0.9	20
^{148}Pm^{m}		0.5	10	0.5	10
^{149}Pm		0.6	10	0.5	10
^{151}Pm		3	80	0.5	10
^{208}Po	Polonium (84)	40	1000	2×10^{-2} 5×10^{-1}	
^{209}Po		40	1000	2×10^{-2} 5×10^{-1}	
^{210}Po		40	1000	2×10^{-2} 5×10^{-1}	
^{142}Pr	Praseodymium (59)	0.2	5	0.2	5
^{143}Pr		4	100	0.5	10
^{188}Pt (b)	Platinum (78)	0.6	10	0.6	10
^{191}Pt		3	80	3	80
^{193}Pt^{m}		40	1000	9	200 **1000**
^{193}Pt		40	1000	40	**50**
^{195}Pt^{m}		10	200	2	**20**
^{197}Pt^{m}		10	200	0.9	**10**
^{197}Pt		20	500	0.5	

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{236}Pu	Plutonium (94)	7	100	7×10^{-4}	1×10^{-2}
^{237}Pu		20	500	20	500
^{238}Pu		2	50	2×10^{-4} 5×10^{-3}	
^{239}Pu		2	50	2×10^{-4} 5×10^{-3}	5×10^{-3}
^{240}Pu		2	50	2×10^{-4}	
^{241}Pu		40	1000	1×10^{-2} 2×10^{-1}	
^{242}Pu		2	50	2×10^{-4} 5×10^{-3}	
^{244}Pu (b)		0.3	8	2×10^{-4} 5×10^{-3}	
^{223}Ra (b)	Radium (88)	0.6	10	3×10^{-2} 8×10^{-1}	
^{224}Ra (b)		0.3	8	6×10^{-2} 1	
^{225}Ra (b)		0.6	10	2×10^{-2} 5×10^{-1}	
^{226}Ra (b)		0.3	8	2×10^{-2} 5×10^{-1}	
^{228}Ra (b)		0.6	10	4×10^{-2} 1	
^{81}Rb	Rubidium (37)	2	50	0.9	20
^{83}Rb		2	50	2	50
^{84}Rb		1	20	0.9	20
^{86}Rb		0.3	8	0.3	8
^{87}Rb		Unlimited		Unlimited	
Rb (natural)		Unlimited		Unlimited	
^{183}Re	Rhenium (75)	5	100	5	100
^{184}Re^{m}		3	80	3	80
^{184}Re		1	20	1	20
^{186}Re		4	100	0.5	10
^{187}Re		Unlimited		Unlimited	
^{188}Re		0.2	5	0.2	5
^{189}Re		4	100	0.5	10
Re (natural)		Unlimited		Unlimited	
^{99}Rh	Rhodium (45)	2	50	2	50
^{101}Rh		4	100	4	100
^{102}Rh^{m}		2	50	0.9	20
^{102}Rh		0.5	10	0.5	10
^{103}Rh^{m}		40	1000	40	1000
^{105}Rh		10	200	0.9	20
^{222}Rn (b)	Radon (86)	0.2	5	4×10^{-3} 1×10^{-1}	
^{97}Ru	Ruthenium (44)	4	100	4	100
^{103}Ru		2	50	0.9	20
^{105}Ru		0.6	10	0.5	10
^{106}Ru (b)		0.2	5	0.2	5
^{35}S	Sulfur (16)	40	1000	2	50

^{122}Sb	Antimony (51)	0.3	8	0.3	8
^{124}Sb		0.6	10	0.5	10
^{125}Sb		2	50	0.9	20
^{126}Sb		0.4	10	0.4	10

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2(TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{44}Sc	Scandium (21)	0.5	10	0.5	10
^{46}Sc		0.5	10	0.5	10
^{47}Sc		9	200	0.9	20
^{48}Sc		0.3	8	0.3	8
SCO	Surface	contaminated	objects (see parag.	144 of Parent	Document)
^{73}Se	Selenium (34)	3	80	3	80
^{79}Se		40	1000	2	50
^{31}Si	Silicon (14)	0.6	10	0.5	10
^{32}Si		40	1000	0.2	5
^{145}Sm	Samarium (62)	20	500	20	500
^{147}Sm		Unlimited			Unlimited
^{151}Sm		40	1000	4	100
^{153}Sm		4	100	0.5	10
^{113}Sn (b)	Tin (50)	4	100	4	100
$^{117}Sn^{m}$		6	100	2	50
$^{119}Sn^{m}$		40	1000	40	1000
$^{121}Sn^{m}$		40	1000	0.9	20
^{123}Sn		0.6	10	0.5	10
^{126}Sn (b)		0.2	5	0.2	5
		0.3	8	0.3	8
^{82}Sr (b)	Strontium (38)	0.2	5	0.2	5
$^{85}Sr^{m}$		5	100	5	100
^{85}Sr		2	50	2	50
$^{87}Sr^{m}$		3	80	3	80
^{89}Sr		0.6	10	0.5	10
^{90}Sr (b)		0.2	5	0.1	2
^{91}Sr		0.3	8	0.3	8
^{92}Sr (b)		0.8	5	0.5	10
T (all forms)	Tritium (1)	40	1000	40	1000
^{178}Ta	Tantalum (73)	1	20	1	20
^{179}Ta		30	800	30	800
^{182}Ta		0.8	20	0.5	10
^{157}Tb	Terbium (65)	40	1000	10	200
^{158}Tb		1	20	0.7	10
^{160}Tb		0.9	20	0.5	10

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
$^{93}Tc^{m}$	Technetium (43)	2	50	2	50
$^{96}Tc^{m}$ (b)		0.4	10	0.4	10
^{96}Tc		0.4	10	0.4	10
$^{97}Tc^{m}$		40	1000	40	1000
^{97}Tc		Unlimited		Unlimited	
^{98}Tc		0.7	10	0.7	10
$^{99}Tc^{m}$		8	200	8	20
^{99}Tc		40	1000	0.9	20
^{118}Te (b)	Tellurium (52)	0.2	5	0.2	5
$^{121}Te^{m}$		5	100	5	100
^{121}Te		2	50	2	50
$^{123}Te^{m}$		7	100	7	100
$^{125}Te^{m}$		30	800	9	200
$^{127}Te^{m}$ (b)		20	500	0.5	10
^{127}Te		20	50	0.5	10

^{129}Te^{m} (b) ^{129}Te ^{131}Te^{m} ^{132}Te (b)		0.6 0.6 0.7 0.4	10 10 10 10	0.5 0.5 0.5 0.4	10 10 10 10
^{227}Th ^{228}Th (b) ^{229}Th ^{230}Th ^{231}Th ^{232}Th ^{234}Th (b) Th (natural)	Thorium (90)	9 0.3 0.3 2 40 Unlimited 0.2 Unlimited	200 8 8 50 1000 5	1 x 10^{-2}2 x 10^{-1} 4 x 10^{-4}1 x 10^{-2} 3 x 10^{-3}8 x 10^{-4} 2 x 10^{-4}5 x 10^{-3} 0.9 Unlimited 0.2 Unlimited	20 5
^{44}Ti (b) ^{200}Ti ^{201}Ti ^{202}Ti ^{204}Ti	Titanium (22) Thallium (81)	0.5 0.8 10 2 4	10 20 200 50 100	0.2 0.8 10 2 0.5	5 20 200 50 10
^{167}Tm ^{168}Tm ^{170}Tm ^{171}Tm	Thulium (69)	7 0.8 4 40	100 20 100 1000	7 0.8 0.5 10	100 20 10 200

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{230}U ^{232}U ^{233}U ^{234}U ^{235}U ^{236}U U (natural) U (enriched 5% or less) U (enriched more than 5%) U (depleted)	Uranium (92)	40 3 10 10 Unlimited [c] 10 Unlimited Unlimited Unlimited [c] 10 Unlimited	1000 80 200 200 200 200	1 x 10^{-2}2 x 10^{-1} 3 x 10^{-4}8 x 10^{-3} 1 x 10^{-3}2 x 10^{-2} 1 x 10^{-3}2 x 10^{-2} Unlimited [c] 1 x 10^{-3}2 x 10^{-2} Unlimited Unlimited [d] Unlimited [c,d] 1 x 10^{-3} [d] 2 x 10^{-2} Unlimited [d]	
^{48}V ^{49}V	Vanadium (23)	0.3 40	8 1000	0.3 40	8 1000
^{178}W(b) ^{181}W ^{185}W ^{187}W ^{188}W (b)	Tungsten (74)	1 30 40 2 0.2	20 800 1000 50 5	1 30 0.9 0.2	20 800 20 10 5
^{122}Xe (b) ^{123}Xe ^{127}Xe ^{131}Xe^{m} ^{133}Xe ^{135}Xe	Xenon (54)	0.2 0.2 4 40 20 4	5 5 100 1000 500 100	0.2 0.2 4 40 20 4	5 5 100 1000 500 100
^{87}Y ^{88}Y ^{90}Y ^{91}Y^{m} ^{91}Y ^{92}Y ^{93}Y	Yttrium (39)	2 0.4 0.2 2 0.3 0.2 0.2	50 10 5 50 8 5 5	2 0.4 0.2 2 0.3 0.2 0.2	50 10 5 50 8 5 5
^{169}Yb ^{175}Yb	Ytterbium (70)	3 30	80 800	3 0.9	80 20
^{65}Zn ^{69}Zn^{m} (b) ^{69}Zn	Zinc (30)	2 2 4	50 50 100	2 0.5 0.5	50 10 10
^{88}Zr ^{93}Zr	Zirconium (40)	3 40	80 1000	3 0.2	80 5

^{93}Zr		1	20	0.9	20
^{97}Zr		0.3	8	0.3	8

[a] The curie values quoted are obtained by rounding down from the TBq figure after conversion to Ci. This ensures that the magnitude of A_1 or A_2 in Ci is always less than that in Tbq.

[b] A_1 and/or A_2 value limited by daughter product decay.

[c] A_1 and A_2 are unlimited for radiation control purposes only. For nuclear criticality safety this material is subject to the control placed on fissile material.

[d] These values do not apply to reprocessed uranium.

Alternatively, an A_2 value for mixtures may be determined as follows:

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.

6. 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 paragraphs 3 - 5. 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 or beta/gamma emitters, respectively.

7. For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in Table II shall be used.

TABLE II. GENERAL VALUES FOR A_1 AND A_2

Contents A_1 A_2 TBq (Ci)[a] TBq (Ci)[a] Only beta or gamma emitting 0.2 (5) 0.02 (0.5) nuclides are known to be present

Alpha emitting nuclides are 0.1 (2) 2×10^{-5} (5×10^{-4}) known to be present or no relevant data are available

a The curie values quoted in parentheses are approximate values and are not higher than the TBq values

a The curie values quoted in parentheses are approximate values and are not higher than the TBq values

| TOC | ChangeLog | Preface | Chapter1 | Chapter2 | Chapter3 | Chapter4 | Chapter5 | Chapter6 | Chapter7 | Chapter8 | Chapter9 | Chapter10 | Chapter11 | AppendixA | AppendixB | AppendixC | AppendixD | AppendixE | AppendixF | AppendixG | AppendixH | AppendixI | ALL |

| NODIS Library | Program Management(8000s) | Search |

DISTRIBUTION:
NODIS

This Document Is Uncontrolled When Printed.
Check the NASA Online Directives Information System (NODIS) Library
to Verify that this is the correct version before use: http://nodis3.gsfc.nasa.gov