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Age-Specific Inhalation Radiation Dose Commitment Factors for Selected Radionuclides

Prepared by D. L. Strenge, R. A. Peloquin, D. A. Baker

Pacific Northwest Laboratory
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ABSTRACT

Inhalation dose commitment factors are presented for selected radionuclides for exposure of individuals in four age groups: infant, child, teen and adult. Radionuclides considered are ^{35}S, ^{36}Cl, ^{45}Ca, ^{67}Ga, ^{75}Se, ^{85}Sr, ^{109}Cd, ^{113}Sn, ^{125}I, ^{133}Ba, ^{170}Tm, ^{169}Yb, ^{182}Ta, ^{192}Ir, ^{198}Au, ^{201}Tl, ^{204}Tl, and ^{236}Pu. The calculational method is based on the human metabolic model of ICRP as defined in Publication 2 (ICRP 1959) and as used in previous age-specific dose factor calculations by Hoenes and Soldat (1977). Dose commitment factors are presented for the following organs of reference: total body, bone, liver, kidney, thyroid, lung and lower large intestine.

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INTRODUCTION

This report presents inhalation dose commitment factors derived in support of a project for the Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards (NMSS). The overall project involves review of radiological contingency plans submitted by NMSS licensees in response to orders issued February 11, 1981. Dose commitment factors have been calculated for radionuclides which fuel cycle and materials licensees are authorized to possess in significant quantities. This report considers 18 radionuclides for which dose factors are not already available in NUREG-0172 (Hoenes and Soldat 1977). The methods employed in NUREG-0172 were followed for the present calculations to ensure compatibility of results with the previous work.

METHOD OF CALCULATION

The inhalation dose commitment factors presented here relate chronic one-year radionuclide intake to a 50-year dose commitment. The units of the factors are: mrem in 50 years per pCi inhaled during the first year. The dose received by an individual is dependent on several metabolic parameters that change with age. Therefore four age groups were considered in estimating the dose commitment factors. The age groups considered are "infant" (0 to 1 year old), "child" (1 to 11 years old), "teen" (11 to 17 years old) and "adult" (17 years and older).

The calculations require the following types of data:

- radioactive decay data
- metabolic parameters
- organ mass and diameter

The basic radioactive decay data as used in the present calculations is tabulated in Appendix A with appropriate references. The radionuclide specific metabolic parameters are given in Appendix B. The remaining data is presented in this section.

The radioactive decay data is used to estimate the effective absorbed energy in each organ of interest. The radiations considered are:

- photons (x-rays and gamma rays)
- beta particles (e^- and e^+)
- conversion electrons (and Auger electrons)
- alpha particles

The methods and equations defined in ICRP Publication 2 (1959) are used to estimate the effective absorbed energy for these radiation types. These effective absorbed energies are presented in Appendix B for each age group and organ of interest for each radionuclide. The effective energies for photon radiation are dependent on organ radius. The organ sizes and masses used in this study are given in Table 1 and are taken from Hoenes and Soldat (1977). The radius of each organ at a given age is assumed to be proportional to the cube root of the organ mass relative to the adult.

$$(X)_{age} = \left(\frac{X}{(mass)^{1/3}}\right)_{adult} \cdot \left(mass\right)^{1/3}_{age}$$

The mass of the contents of the lower large intestine (GI-LLI) is assumed to be proportional to the total body mass.

The chemical, radiological and biological parameters for each radionuclide used to calculate dose commitment factors are presented in Appendix B. These parameters include:

- physical half-life (days)
- biological half-time (days)
- effective half-life (days)

TABLE 1. Mass and Radius of Body Organs for the Four Age Groups*

Organ	Infant		Child		Teenager		Adult	
	Mass (g)	Radius (cm)	Mass (g)	Radius (cm)	Mass (g)	Radius (cm)	Mass (g)	Radius (cm)
Bone	770	2.4	1,640	3	4,900	4	7,000	5
Liver	200	5	530	7	1,200	9	1,700	10
Total Body	7,700	14	16,400	20	49,000	27	70,000	30
Thyroid	2	1.4	5	2	15	2.7	20	3
Kidney	55	4	100	5	210	6	300	7
Lung	110	5	300	7	580	8	1,000	10
GI-LLI	16	2.4	35	3	100	4	150	5

*Taken from Hoenes and Soldat (1977).

- fraction reaching organ of reference
- fraction not absorbed before reaching the LLI
- effective absorbed energy (MeV per disintegration)

For the radionuclides considered in this report, the biological half-time, effective half-life, fraction reaching the organ and the fraction not absorbed are assumed to be independent of age except for radioiodine. The variation of biological half-time with age for radioiodine is given in Table 2.

TABLE 2. Radioiodine Age Dependent Biological Half Times

Element	Organ	Half-life (days)			
		Infant	Child	Teenager	Adult
Iodine	Total Body and Thyroid	20	20	50	100

Equations for calculating inhalation dose commitment factors were derived by Hoenes and Soldat (1977) from those given by the ICRP (1959) for body burden and maximum permissible concentration (MPC). These equations use the data and parameters described above. The reader is referred to the Hoenes and Soldat report (1977) for details of the equations.

The model employed for age-dependence assumes an infant to be of uniform size for one year. Then the child immediately grows to the size of a four-year old and remains at this size for 10 years. At 11 years the child immediately becomes the size of a fourteen year old and remains at this size for seven

years at which time the size of an adult is assumed. Hoenes and Soldat present equations for each age period and indicate how each contribution is summed to get the appropriate dose conversion factors.

RESULTS

The calculated 50-year dose commitment factors for chronic one-year inhalation are presented in Tables 3 through 6. Each table lists dose commitment factors for one age group, six organs and the selected radionuclides. The factors give the 50-year dose commitment (mrem) normalized to unit intake (1 pCi) over a one-year period. The basic radionuclide specific input data used to generate the factors in Tables 3 through 6 are given in Appendix A and Appendix B.

TABLE 3. Infant Inhalation Dose Commitment Factors (mrem/50 yrs per pCi inhaled in first yr)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lungs	GI-LLI
^{35}S	5.4×10^{-5}	0	2.2×10^{-5}	0	0	0	1.9×10^{-7}
^{36}Cl	0	0	4.8×10^{-5}	0	0	0	8.7×10^{-7}
^{45}Ca	2.8×10^{-4}	0	6.5×10^{-6}	0	0	4.0×10^{-4}	7.2×10^{-6}
^{67}Ga	5.1×10^{-6}	3.5×10^{-6}	5.8×10^{-7}	0	1.2×10^{-6}	1.6×10^{-5}	1.5×10^{-6}
^{75}Se	0	2.0×10^{-6}	8.3×10^{-7}	0	1.9×10^{-6}	4.9×10^{-4}	3.4×10^{-6}
^{85}Sr	2.7×10^{-5}	0	5.4×10^{-6}	0	0	3.0×10^{-4}	4.8×10^{-6}
$^{109}Cd+D$	0	2.6×10^{-4}	1.0×10^{-5}	0	2.0×10^{-4}	6.2×10^{-4}	8.0×10^{-6}
$^{113}Sn+D$	6.0×10^{-5}	1.6×10^{-6}	3.6×10^{-6}	1.3×10^{-6}	0	7.8×10^{-4}	1.2×10^{-6}
^{125}I	9.6×10^{-6}	9.3×10^{-6}	6.8×10^{-6}	4.0×10^{-3}	1.1×10^{-5}	0	1.2×10^{-7}
^{133}Ba	1.9×10^{-4}	1.7×10^{-6}	1.3×10^{-5}	0	8.9×10^{-9}	9.1×10^{-4}	7.7×10^{-6}
^{170}Tm	5.7×10^{-4}	0	1.8×10^{-5}	0	4.7×10^{-5}	1.1×10^{-3}	2.7×10^{-5}
^{169}Yb	2.5×10^{-5}	0	1.4×10^{-6}	0	6.9×10^{-6}	3.3×10^{-4}	1.2×10^{-5}
^{182}Ta	6.7×10^{-5}	1.6×10^{-4}	2.2×10^{-5}	0	5.7×10^{-5}	1.3×10^{-3}	1.8×10^{-5}
^{192}Ir	0	2.1×10^{-5}	3.2×10^{-6}	0	2.3×10^{-5}	1.1×10^{-3}	2.0×10^{-5}
^{198}Au	0	4.4×10^{-8}	3.4×10^{-8}	0	1.2×10^{-7}	8.5×10^{-3}	3.0×10^{-5}
^{201}Tl	7.9×10^{-7}	4.7×10^{-7}	4.0×10^{-7}	0	2.3×10^{-6}	1.4×10^{-5}	4.2×10^{-6}
^{204}Tl	0	1.2×10^{-6}	8.0×10^{-7}	0	7.7×10^{-6}	1.6×10^{-3}	2.0×10^{-5}
^{236}Pu	8.1×10^{-1}	5.3×10^{-1}	3.6×10^{-2}	0	1.3×10^{-1}	3.8×10^{-1}	4.7×10^{-5}

TABLE 4. Child Inhalation Dose Commitment Factors (mrem/50 yrs per pCi inhaled in first yr)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lungs	GI-LLI
^{35}S	3.1×10^{-5}	0	1.2×10^{-5}	0	0	0	1.8×10^{-7}
^{36}Cl	0	0	2.5×10^{-5}	0	0	0	8.5×10^{-7}
^{45}Ca	2.1×10^{-4}	0	4.9×10^{-6}	0	0	1.8×10^{-4}	7.1×10^{-6}
^{67}Ga	2.4×10^{-6}	1.5×10^{-6}	3.2×10^{-7}	0	7.0×10^{-7}	6.5×10^{-6}	1.0×10^{-6}
^{75}Se	0	1.2×10^{-6}	5.7×10^{-7}	0	1.4×10^{-6}	2.4×10^{-4}	3.9×10^{-6}
^{85}Sr	1.2×10^{-5}	0	3.2×10^{-6}	0	0	1.5×10^{-4}	5.5×10^{-6}
$^{109}Cd+D$	0	1.9×10^{-4}	8.0×10^{-6}	0	1.7×10^{-4}	3.0×10^{-4}	8.1×10^{-6}
$^{113}Sn+D$	3.8×10^{-5}	8.9×10^{-7}	2.3×10^{-6}	7.1×10^{-7}	0	3.6×10^{-4}	1.3×10^{-6}
^{125}I	4.6×10^{-6}	4.0×10^{-6}	3.7×10^{-6}	1.8×10^{-3}	6.4×10^{-6}	0	1.3×10^{-7}
^{133}Ba	1.1×10^{-4}	1.1×10^{-6}	1.0×10^{-5}	0	5.4×10^{-9}	5.2×10^{-4}	8.3×10^{-6}
^{170}Tm	4.1×10^{-4}	0	1.2×10^{-5}	0	3.5×10^{-6}	4.5×10^{-4}	2.6×10^{-5}
^{169}Yb	1.2×10^{-5}	0	7.7×10^{-7}	0	4.0×10^{-6}	1.4×10^{-4}	1.3×10^{-5}
^{182}Ta	4.6×10^{-5}	1.1×10^{-4}	1.7×10^{-5}	0	4.6×10^{-5}	6.4×10^{-4}	2.0×10^{-5}
^{192}Ir	0	1.1×10^{-5}	2.1×10^{-6}	0	1.6×10^{-5}	5.6×10^{-4}	2.1×10^{-5}
^{198}Au	0	1.7×10^{-8}	1.7×10^{-8}	0	6.5×10^{-8}	3.3×10^{-5}	3.0×10^{-5}
^{201}Tl	3.7×10^{-7}	1.9×10^{-7}	2.1×10^{-7}	0	1.3×10^{-6}	5.4×10^{-6}	4.2×10^{-6}
^{204}Tl	0	4.6×10^{-7}	3.7×10^{-7}	0	4.2×10^{-6}	8.0×10^{-4}	2.0×10^{-5}
^{236}Pu	7.5×10^{-1}	4.8×10^{-1}	3.4×10^{-2}	0	1.2×10^{-1}	1.8×10^{-1}	4.7×10^{-5}

TABLE 5. Teen Inhalation Dose Commitment Factors (mrem/50 yrs per pCi inhaled in first yr)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lungs	GI-LLI
^{35}S	1.2×10^{-5}	0	4.2×10^{-6}	0	0	0	1.9×10^{-7}
^{36}Cl	0	0	8.5×10^{-6}	0	0	0	8.8×10^{-7}
^{45}Ca	7.0×10^{-5}	0	1.8×10^{-6}	0	0	9.3×10^{-5}	7.4×10^{-6}
^{67}Ga	8.3×10^{-7}	7.2×10^{-7}	1.2×10^{-7}	0	3.5×10^{-7}	3.5×10^{-6}	2.8×10^{-5}
^{75}Se	0	7.0×10^{-7}	2.6×10^{-7}	0	8.8×10^{-7}	1.3×10^{-4}	4.9×10^{-6}
^{85}Sr	5.0×10^{-6}	0	1.3×10^{-6}	0	0	8.8×10^{-5}	6.9×10^{-6}
$^{109}Cd+D$	0	1.0×10^{-4}	3.4×10^{-6}	0	6.7×10^{-5}	1.6×10^{-4}	8.6×10^{-6}
$^{113}Sn+D$	1.5×10^{-5}	4.7×10^{-7}	9.7×10^{-7}	2.9×10^{-7}	0	2.0×10^{-4}	1.5×10^{-6}
^{125}I	1.6×10^{-6}	2.0×10^{-6}	2.5×10^{-6}	1.3×10^{-3}	3.2×10^{-6}	0	1.4×10^{-7}
^{133}Ba	4.7×10^{-5}	8.0×10^{-7}	3.3×10^{-6}	0	2.8×10^{-9}	2.9×10^{-4}	9.7×10^{-6}
^{170}Tm	1.8×10^{-4}	0	5.1×10^{-6}	0	2.0×10^{-5}	2.3×10^{-4}	2.8×10^{-5}
^{169}Yb	6.1×10^{-6}	0	4.3×10^{-7}	0	3.0×10^{-6}	7.6×10^{-5}	1.4×10^{-5}
^{182}Ta	2.0×10^{-4}	6.2×10^{-5}	8.3×10^{-6}	0	2.8×10^{-5}	3.6×10^{-4}	2.3×10^{-5}
^{192}Ir	0	6.1×10^{-6}	8.7×10^{-7}	0	8.9×10^{-6}	3.1×10^{-4}	2.3×10^{-5}
^{198}Au	0	8.1×10^{-9}	6.4×10^{-9}	0	3.2×10^{-8}	1.7×10^{-5}	2.9×10^{-5}
^{201}Tl	1.3×10^{-7}	9.0×10^{-8}	7.7×10^{-8}	0	6.6×10^{-7}	2.9×10^{-6}	4.3×10^{-6}
^{204}Tl	0	2.0×10^{-7}	1.3×10^{-7}	0	2.0×10^{-6}	4.1×10^{-4}	2.1×10^{-5}
^{236}Pu	2.6×10^{-1}	2.1×10^{-1}	1.2×10^{-2}	0	5.4×10^{-2}	9.5×10^{-2}	4.8×10^{-5}

TABLE 6. Adult Inhalation Dose Commitment Factors (mrem/50 yrs per pCi inhaled in first yr)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lungs	GI-LLI
^{35}S	6.8×10^{-6}	0	2.6×10^{-6}	0	0	0	1.8×10^{-7}
^{36}Cl	0	0	5.9×10^{-6}	0	0	0	8.3×10^{-7}
^{45}Ca	4.9×10^{-5}	0	1.1×10^{-6}	0	0	5.4×10^{-5}	6.9×10^{-6}
^{67}Ga	6.0×10^{-7}	5.3×10^{-7}	8.9×10^{-8}	0	2.6×10^{-7}	2.2×10^{-6}	2.0×10^{-5}
^{75}Se	0	4.3×10^{-7}	1.6×10^{-7}	0	5.9×10^{-7}	8.6×10^{-5}	5.4×10^{-6}
^{85}Sr	4.0×10^{-6}	0	9.7×10^{-5}	0	0	6.0×10^{-5}	7.6×10^{-6}
$^{109}Cd+D$	0	4.9×10^{-5}	1.6×10^{-6}	0	4.7×10^{-5}	9.1×10^{-5}	8.2×10^{-6}
$^{113}Sn+D$	8.2×10^{-6}	2.7×10^{-7}	5.6×10^{-7}	1.7×10^{-7}	0	1.2×10^{-4}	1.5×10^{-6}
^{125}I	1.1×10^{-6}	1.4×10^{-6}	2.3×10^{-6}	1.2×10^{-3}	2.4×10^{-6}	0	1.4×10^{-7}
^{133}Ba	9.5×10^{-6}	4.2×10^{-7}	2.5×10^{-6}	0	2.1×10^{-9}	1.9×10^{-4}	1.0×10^{-5}
^{170}Tm	8.3×10^{-5}	0	2.4×10^{-6}	0	9.8×10^{-6}	1.3×10^{-4}	2.6×10^{-5}
^{169}Yb	3.6×10^{-6}	0	2.1×10^{-7}	0	1.5×10^{-6}	4.7×10^{-5}	1.4×10^{-5}
^{182}Ta	1.1×10^{-5}	3.3×10^{-5}	4.4×10^{-6}	0	1.5×10^{-5}	2.3×10^{-4}	2.4×10^{-5}
^{192}Ir	0	3.8×10^{-6}	5.7×10^{-7}	0	5.4×10^{-6}	2.0×10^{-4}	2.4×10^{-5}
^{198}Au	0	5.7×10^{-9}	4.5×10^{-8}	0	2.3×10^{-8}	1.0×10^{-5}	2.7×10^{-5}
^{201}Tl	9.0×10^{-8}	6.5×10^{-8}	5.6×10^{-8}	0	4.7×10^{-7}	1.8×10^{-6}	4.0×10^{-6}
^{204}Tl	0	1.4×10^{-7}	8.8×10^{-8}	0	1.4×10^{-6}	2.4×10^{-4}	1.9×10^{-5}
^{236}Pu	1.6×10^{-1}	1.2×10^{-1}	7.0×10^{-3}	0	3.2×10^{-2}	7.2×10^{-2}	4.6×10^{-5}

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ICRP. 1959. Report of Committee II on Permissible Dose for Internal Radiation. International Commission on Radiological Protection, ICRP Publication 2, Pergammon Press, Oxford.

APPENDIX A

RADIOACTIVE DECAY DATA

APPENDIX A--RADIOACTIVE DECAY DATA

The basic decay data for each radionuclide is given in Tables A-1 through A-11 as follows.

Table	Radionuclide
A-1	^{35}S
A-2	^{36}Cl
A-3	^{45}Ca
A-4	^{67}Ga
A-5	^{75}Se
A-6	^{85}Sr
A-7	^{109}Cd
A-8	^{113}In (daughter of ^{113}Sn)
A-9	^{113}Sn
A-10	^{125}I
A-11	^{133}Ba
A-12	^{170}Tm
A-13	^{169}Yb
A-14	^{182}Ta
A-15	^{192}Ir
A-16	^{198}Au
A-17	^{201}Tl
A-18	^{204}Tl
A-19	^{236}Pu

The source of data is provided by each radiation type. The references are listed at the end of this appendix. The tables only include significant radiations and are not intended to serve as a complete list of radiations.

TABLE A-1. Emission Data for ^{35}S

Beta Particles (Martin 1976)

Maximum Energy (MeV)	Intensity (%)
0.1674	100

TABLE A-2. Emission Data for ^{36}Cl

Beta Particles (Kocher 1981)

Maximum Energy (MeV)	Intensity (%)
0.710	99

TABLE A-3. Emission Data for ^{45}Ca

Beta Particles (Martin 1976)

Maximum Energy (MeV)	Intensity (%)
0.2587	100

TABLE A-4. Emission Data for ^{67}Ga

Photons (Kocher 1981)

Type	Energy (MeV)	Intensity (%)
Zn X-Rays	0.0086	48.5
	0.0096	6.6
Gamma	0.091	2.9
	0.093	35.7
	0.185	19.7
	0.209	2.2
	0.300	16.0
	0.394	4.5
	0.888	0.14

Electrons (Kocher 1981)

Energy (MeV)	Intensity (%)
0.0010	165
0.0075	60
0.0816	0.2
0.0837	26.8
0.0921	3.3
0.0932	1.1
0.1749	0.33

TABLE A-5. Emission Data for ^{75}Se

Phctons (Martin 1976)

Type	Energy MeV	Intensity (%)
As X-rays	0.011	48.
	0.012	7.3
Gamma	0.066	1.0
	0.097	3.2
	0.121	16.7
	0.136	56.8
	0.199	1.4
	0.265	59.5
	0.280	25.1
	0.304	1.4
	0.401	11.8

Electrons (Martin 1976)

Energy MeV	Intensity (%)
0.0125	4.4
0.0229	0.9
0.0242	0.1
0.0542	0.36
0.0850	2.5
0.0952	0.33
0.109	0.62
0.124	1.5
0.134	0.16
0.253	0.38
0.268	0.18

TABLE A-6. Emission Data for ^{85}Sr

Photons (Kocher 1981)

Type	Energy MeV	Intensity (%)
Rb X-Rays	0.0017	1.6
	0.0133	17.7
	0.0134	33.0
	0.015	8.7
Gamma	0.5139	99.3

Electrons (Kocher 1981)

Energy MeV	Intensity (%)
0.0017	108.2
0.0114	29.1
0.4988	0.63

TABLE A-7. Emission Data for ^{109}Cd*

Photons (Kocher 1981)

Type	Energy MeV	Intensity (%)
Ag X-Rays	0.003	11.1
	0.0220	28.5
	0.0222	54.0
	0.0249	17.4
Gamma	0.0880	3.7

Electrons (Kocher 1981)

Energy MeV	Intensity (%)
0.0026	166
0.0185	20.5
0.0625	41.7
0.0842	44.0
0.0873	8.9
0.0879	1.6

*Includes radiations from ^{109m}Ag.

TABLE A-8. Emission Data for ^{113m}In

Photons (Martin 1976)

Type	Energy (MeV)	Intensity (%)
In X-rays	0.0240	6.8
	0.0242	12.9
	0.0273	4.3
Gamma	0.392	64.9

Electrons (Martin 1976)

Energy (MeV)	Intensity (%)
0.0028	29.7
0.020	4.2
0.364	28.2
0.387	5.5
0.391	1.1
0.392	0.25

TABLE A-9. Emission Data for ^{113}Sn

Photons (Martin 1976)

Type	Energy (MeV)	Intensity (%)
In X-rays	0.0240	20.7
	0.0242	39.0
	0.0273	13.0
Gamma	0.2550	2.12

Electrons (Martin 1976)

Energy (MeV)	Intensity (%)
0.020	12.8
0.0028	85.0

TABLE A-10. Emission Data for ^{125}I

Photons (Martin 1976)

Type	Energy (MeV)	Intensity (%)
Te X-rays	0.0038	15.
	0.0272	39.8
	0.0275	74.2
	0.031	25.8
Gamma	0.0353	6.7

Electrons (Martin 1976)

Energy (MeV)	Intensity (%)
0.0032	156.
0.0037	80.
0.0227	20.
0.0305	10.5
0.0345	2.2
0.0353	0.7

TABLE A-11. Emission Data for ^{133}Ba

Photons (Kocher 1981)

Type	Energy (MeV)	Intensity (%)
Cs X-Rays	0.0043	17
	0.0306	34.2
	0.0310	63.4
	0.035	22.8
Gamma	0.0532	2.1
	0.0796	2.6
	0.0810	33.0
	0.1606	0.60
	0.2231	0.44
	0.2764	7.9
	0.3028	17.8
	0.3560	60
	0.3839	8.7

Electrons (Kocher 1981)

Energy (MeV)	Intensity (%)
0.0036	136
0.0172	10.5
0.0255	14.1
0.0436	3.9
0.0450	48
0.0474	1.6
0.0519	0.40
0.0739	0.56
0.0753	7.4
0.0798	1.5
0.0808	0.39
0.2404	0.32
0.2669	0.67
0.3200	1.28
0.3479	0.15
0.3503	0.21

TABLE A-12. Emission Data for ^{170}Tm

Photons (Lederer and Shirley 1978; Kocher 1981)

Type	Energy (MeV)	Intensity (%)
Yb X-rays	0.0514	1.3
	0.0524	2.3
	0.0593	0.9
	0.0610	0.4
Gamma	0.0786	0.39
	0.0843	3.2

Beta Particles (Lederer and Shirley 1978)

Maximum Energy (MeV)	Intensity (%)
0.968	76.
0.884	24.

TABLE A-13. Emission Data for ^{169}Yb

Photons (Kocher 1981)

Type	Energy (MeV)	Intensity (%)
Tm X-Rays	0.0072	51
	0.0498	52.8
	0.0507	93
	0.0575	38.3
Gamma	0.0084	0.33
	0.0208	0.21
	0.0631	43.7
	0.0936	2.7
	0.1098	17.4
	0.1182	1.9
	0.1305	11.1
	0.1772	21.4
	0.1980	34.9
	0.2403	0.12
	0.2611	1.8
	0.3077	10.8

TABLE A.13. (contd)

Electrons (Kocher 1981)

Energy (MeV)	Intensity (%)
0.0037	39.9
0.0057	160
0.0061	95
0.0106	9.3
0.0184	2.1
0.0203	0.68
0.0342	8.4
0.0409	10
0.0504	34.9
0.0530	7.1
0.0588	1.3
0.0608	1.6
0.0626	0.43
0.0711	6.0
0.0835	1.45
0.0913	0.42
0.0997	5.6
0.1075	1.3
0.1081	1.4
0.1093	0.37
0.1159	0.42
0.1178	10.3
0.1204	5.2
0.1282	1.25
0.1300	0.35
0.1386	12.7
0.1671	1.8
0.1749	0.42
0.1878	2.1
0.1956	0.47
0.2483	0.52

TABLE A-14. Emission Data for ^{182}Ta

Photons (Lederer and Shirley 1978; Kocher 1981)

Type	Energy (MeV)	Intensity (%)
W X-rays	0.0580	10.4
	0.0593	18.1
	0.0672	7.7
	0.0691	1.6
Gamma	0.0317	0.9
	0.0427	0.3
	0.0657	2.9
	0.0677	43.7
	0.0847	2.4
	0.100	13.5
	0.110	0.1
	0.114	1.8
	0.116	0.4
	0.152	6.7
	0.156	2.5
	0.179	2.9
	0.198	1.4
	0.222	7.2
	0.229	3.5
	0.264	3.4
	0.928	0.6
	0.960	0.3
	1.002	2.0
	1.113	0.4
	1.121	35.1
	1.157	1.0
	1.189	15.7
	1.221	25.9
	1.231	11.0
	1.257	1.5
	1.274	0.7
	1.289	1.4
	1.343	0.2
	1.374	0.2
	1.387	0.1

Beta Particles (Lederer and Shirley 1978)

Maximum Energy (MeV)	Intensity (%)
0.540	45
0.408	24
0.246	31

TABLE A-15. Emission Data for ^{192}Ir

Photons (Lederer and Shirley 1978)

Type	Energy (MeV)	Intensity (%)
Os X-rays	0.0615	1.2
	0.0630	2.0
	0.0713	0.7
	0.0734	0.17
Pt X-rays	0.0650	2.5
	0.0670	4.3
	0.0760	1.5
	0.0780	0.4
Gamma	0.136	0.2
	0.201	0.5
	0.206	3.2
	0.283	0.3
	0.296	28.7
	0.308	29.7
	0.317	82.9
	0.374	0.7
	0.416	0.7
	0.421	0.1
	0.468	48.1
	0.485	3.2
	0.489	0.4
	0.589	4.6
	0.604	8.3
	0.612	5.4
	0.885	0.3
	1.061	0.1

Beta Particles (Lederer and Shirley 1978)

Maximum Energy (MeV)	Intensity (%)
0.672	46
0.536	41
0.240	8

TABLE A-16. Emission Data for ^{198}Au

Photons (Martin 1976)

Type	Energy (MeV)	Intensity (%)
Hg X-rays	0.010	1.3
	0.0690	0.8
	0.0708	1.4
	0.080	0.6
Gamma	0.412	95.5
	0.676	1.1
	1.090	0.23

Beta Particles (Martin 1976)

Maximum Energy (MeV)	Intensity (%)
0.285	1.3
0.961	98.7

Electrons (Martin 1976)

Energy (MeV)	Intensity
0.0076	2.1
0.329	2.9
0.397	1.0
0.408	0.27
0.411	0.1

TABLE A-17. Emission Data for ^{201}Tl

Photons (Kocher 1981)

Type	Energy (MeV)	Intensity (%)
Hg X-Rays	0.010	44
	0.0689	27.4
	0.0708	46.5
	0.0803	20.5
Gamma	0.0306	0.22
	0.0322	0.22
	0.1353	2.65
	0.1674	10

Electrons (Kocher 1981)

Type	Energy (MeV)	Intensity (%)
	0.0076	73
	0.0158	8.1
	0.0174	7.0
	0.0270	2.5
	0.0286	2.2
	0.0522	7.5
	0.0538	3.3
	0.0843	15.4
	0.1205	1.3
	0.1318	0.4
	0.1526	2.62
	0.1639	0.61
	0.1666	0.2

TABLE A-18. Emission Data for ^{204}Tl

Photons (Lederer and Shirley 1978)

Type	Energy (MeV)	Intensity %
Hg X-rays	0.0689	0.41
	0.0718	0.71
	0.0802	0.24
	0.0825	0.04

Beta Particles (Lederer and Shirley 1978)

Maximum Energy (MeV)	Intensity (%)
0.7635	97.4

TABLE A-19. Emission Data for ^{236}Pu

Photons (Kocher 1981)

Type	Energy (MeV)	Intensity (%)
U X-Rays	0.0136	13

Electrons (Kocher 1981)

Energy (MeV)	Intensity (%)
0.0099	10.2
0.0259	23.3
0.0421	8.5

Alpha Particles (Kocher 1981)

Energy (MeV)	Intensity (%)
5.614	0.18
5.722	31.8
5.770	68.1

APPENDIX A--REFERENCES

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APPENDIX B

METABOLIC PARAMETERS

APPENDIX B--METABOLIC PARAMETERS

This appendix presents the metabolic parameters used to calculate the age-specific dose commitment factors for each radionuclide. The data presented here include parameters for both inhalation and ingestion uptake even though only inhalation dose commitment factors are calculated. The ingestion parameter values are included for completeness with respect to corresponding tables in the original report on age-specific dose commitment factors (Hoenes and Soldat 1977).

The data are listed in Table B-1 and include the following parameters.

Half-life • radiological decay half-time (days)

F-W • fraction of radionuclide reaching the organ of reference by ingestion, f_w

F-* for GI • fraction of radionuclide not absorbed before reaching the lower-large intestine. F-* is calculated by

$$F\text{-}* = 1 - f_w(\text{Total Body})$$

and

$$F\text{-}* \geq 0.05$$

F-A • fraction of radionuclide reaching the organ of reference by inhalation, f_a

F-2' • fraction of radionuclides transferred from the blood to the organ of reference, f_2'

TBIOL • biological removal half-time for the radionuclide and organ of reference and each age group (days)

EPSILON • effective absorbed energy for the radionuclide and organ of reference and each age group (MeV).

The values in the column in Table B-1 labeled F-A or F-2' represent either f_a or f_2' depending on the organ of reference and the material solubility. For radionuclides assumed to be soluble (^{35}S, ^{36}Cl, and ^{125}I) the value represents f_a for all organs. For radionuclides assumed to be insoluble the value represents f_a for lung and GI-LLI and f_2' for other organs.

The values for the parameter EPSILON were calculated using a small program prepared by N. M. Robinson and modified for the present calculations by D. L. Strenge.

TABLE B-1. Metabolic Parameters

ORGAN	F-W (F-* FOR GI)	F-A OR F-2'	INFANT TBIOL (DAY)	INFANT EPSILON (MEV)	CHILD TBIOL (DAY)	CHILD EPSILON (MEV)	TEEN TBIOL (DAY)	TEEN EPSILON (MEV)	ADULT TBIOL (DAY)	ADULT EPSILON (MEV)
S35	HALF LIFE = 8.740E 01 DAYS									
BONE	3.00E-02	3.00E-02	6.00E 02	2.80E-01	6.00E 02	2.80E-01	6.00E 02	2.80E-01	6.00E 02	2.80E-01
LIVER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL BODY	1.00E 00	1.00E 00	9.00E 01	5.60E-02	9.00E 01	5.60E-02	9.00E 01	5.60E-02	9.00E 01	5.60E-02
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
GI-LLI INGES	5.00E-02	0.	0.	5.60E-02	0.	5.60E-02	0.	5.60E-02	0.	5.60E-02
GI-LLI INHAL	5.00E-02	5.00E-0'	0.	5.60E-02	0.	5.60E-02	0.	5.60E-02	0.	5.60E-02
CL36	HALF LIFE = 1.100E 08 DAYS									
BONE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LIVER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL BODY	1.00E 00	7.50E-01	2.90E 01	2.58E-01	2.90E 01	2.58E-01	2.90E 01	2.58E-01	2.90E 01	2.58E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
GI-LLI INGES	5.00E-02	0.	0.	2.58E-01	0.	2.58E-01	0.	2.58E-01	0.	2.58E-01
GI-LLI INHAL	5.00E-02	5.00E-01	0.	2.58E-01	0.	2.58E-01	0.	2.58E-01	0.	2.58E-01
CA45	HALF LIFE = 1.650E 02 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	5.40E-01	9.00E-01	1.80E 04	4.38E-01	1.80E 04	4.38E-01	1.80E 04	4.38E-01	1.80E 04	4.38E-01
LIVER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL BODY	6.00E-01	1.00E 00	1.64E 04	8.76E-02	1.64E 04	8.76E-02	1.64E 04	8.76E-02	1.64E 04	8.76E-02
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	8.76E-02	1.20E 02	8.76E-02	1.20E 02	8.76E-02	1.20E 02	8.76E-02
GI-LLI INGES	4.00E-01	0.	0.	8.76E-02	0.	8.76E-02	0.	8.76E-02	0.	8.76E-02
GI-LLI INHAL	1.00E 00	6.20E-01	0.	8.76E-02	0.	8.76E-02	0.	8.76E-02	0.	8.76E-02

TABLE B-1. (contd)

GA67	HALF LIFE = 3.261E 00 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	3.00E-04	3.00E-01	1.20E 01	2.17E-01	1.20E 01	2.17E-01	1.20E 01	2.25E-01	1.20E 01	2.31E-01
LIVER	2.50E-04	2.50E-01	4.80E 00	6.21E-02	4.80E 00	6.92E-02	4.80E 00	7.58E-02	4.80E 00	7.90E-02
TOTAL BODY	1.00E-03	1.00E 00	6.00E 00	9.09E-02	6.00E 00	1.06E-01	6.00E 00	1.21E-01	6.00E 00	1.26E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	2.00E-05	2.00E-02	9.00E 00	5.84E-02	9.00E 00	6.21E-02	9.00E 00	6.57E-02	9.00E 00	6.92E-02
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	6.21E-02	1.20E 02	6.92E-02	1.20E 02	7.26E-02	1.20E 02	7.90E-02
GI-LLI INGES	1.00E 00	0.	0.	5.23E-02	0.	5.46E-02	0.	5.84E-02	0.	6.21E-02
GI-LLI INHAL	1.00E 00	6.20E-01	0.	5.23E-02	0.	5.46E-02	0.	5.84E-02	0.	6.21E-02

SE75	HALF LIFE = 1.185E 02 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LIVER	6.00E-02	7.00E-02	2.40E 01	6.80E-02	2.40E 01	8.70E-02	2.40E 01	1.05E-01	2.40E 01	1.14E-01
TOTAL BODY	9.00E-01	1.00E 00	1.10E 01	1.46E-01	1.10E 01	1.88E-01	1.10E 01	2.28E-01	1.10E 01	2.42E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	4.00E-02	4.00E-02	1.10E 01	5.80E-02	1.10E 01	6.80E-02	1.10E 01	8.20E-02	1.10E 01	9.60E-02
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	6.80E-02	1.20E 02	8.70E-02	1.20E 02	9.60E-02	1.20E 02	1.14E-01
GI-LLI INGES	1.00E-01	0.	0.	4.10E-02	0.	4.80E-02	0.	5.80E-02	0.	6.80E-02
GI-LLI INHAL	1.00E 00	6.20E-01	0.	4.10E-02	0.	4.80E-02	0.	5.80E-02	0.	6.80E-02

SR85	HALF LIFE = 6.484E 01 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	2.10E-01	7.00E-01	1.80E 04	1.50E-01	1.80E 04	1.50E-01	1.80E 04	1.75E-01	1.80E 04	1.98E-01
LIVER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL BODY	3.00E-01	1.00E 00	1.30E 04	2.07E-01	1.30E 04	2.65E-01	1.30E 04	3.19E-01	1.30E 04	3.39E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	9.69E-02	1.20E 02	1.24E-01	1.20E 02	1.37E-01	1.20E 02	1.62E-01
GI-LLI INGES	7.00E-01	0.	0.	5.84E-02	0.	6.76E-02	0.	8.25E-02	0.	9.69E-02
GI-LLI INHAL	1.00E 00	6.20E-01	0.	5.84E-02	0.	6.76E-02	0.	8.25E-02	0.	9.69E-02

TABLE B-1. (contd)

ORGAN	F-W (F-* FOR GI)	F-A OR F-2'	INFANT TBIOL (DAY)	INFANT EPSILON (MEV)	CHILD TBIOL (DAY)	CHILD EPSILON (MEV)	TEEN TBIOL (DAY)	TEEN EPSILON (MEV)	ADULT TBIOL (DAY)	ADULT EPSILON (MEV)
CD109+D	HALF LIFE = 4.640E 02 DAYS			INSOLUBLE FOR INHALATION ONLY						
BONE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LIVER	1.90E-03	7.50E-01	2.00E 02	1.04E-01	2.00E 02	1.06E-01	2.00E 02	1.07E-01	2.00E 02	1.08E-01
TOTAL BODY	2.50E-03	1.00E 00	2.00E 02	1.09E-01	2.00E 02	1.10E-01	2.00E 02	1.10E-01	2.00E 02	1.11E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	2.50E-04	1.00E-01	3.00E 02	1.02E-01	3.00E 02	1.04E-01	3.00E 02	1.05E-01	3.00E 02	1.06E-01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	1.04E-01	1.20E 02	1.06E-01	1.20E 02	1.07E-01	1.20E 02	1.08E-01
GI-LLI INGES	1.00E 00	0.	0.	9.77E-02	0.	9.95E-02	0.	1.02E-01	0.	1.04E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	9.77E-02	0.	9.95E-02	0.	1.02E-01	0.	1.04E-01
SN113+D	HALF LIFE = 1.150E 02 DAYS			INSOLUBLE FOR INHALATION ONLY						
BONE	2.00E-02	3.00E-01	1.00E 02	7.68E-01	1.00E 02	7.68E-01	1.00E 02	7.81E-01	1.00E 02	7.92E-01
LIVER	5.00E-04	1.00E-02	7.00E 01	1.92E-01	7.00E 01	2.10E-01	7.00E 01	2.24E-01	7.00E 01	2.31E-01
TOTAL BODY	5.00E-02	1.00E 00	3.50E 01	2.56E-01	3.50E 01	2.87E-01	3.50E 01	3.15E-01	3.50E 01	3.25E-01
THYROID	5.00E-06	1.00E-04	7.00E 01	1.57E-01	7.00E 01	1.64E-01	7.00E 01	1.71E-01	7.00E 01	1.74E-01
KIDNEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	1.92E-01	1.20E 02	2.10E-01	1.20E 02	2.17E-01	1.20E 02	2.31E-01
GI-LLI INGES	9.50E-01	0.	0.	1.46E-02	0.	1.58E-02	0.	1.76E-02	0.	1.91E-02
GI-LLI INHAL	1.00E 00	6.20E-01	0.	1.46E-02	0.	1.58E-02	0.	1.76E-02	0.	1.91E-02
I125	HALF LIFE = 6.020E 01 DAYS									
BONE	7.00E-02	5.30E-02	1.40E 01	1.69E-01	1.40E 01	1.69E-01	1.40E 01	1.71E-01	1.40E 01	1.73E-01
LIVER	1.20E-01	9.00E-02	7.00E 00	4.53E-02	7.00E 00	5.09E-02	7.00E 00	5.57E-02	7.00E 00	5.77E-02
TOTAL BODY	1.00E 00	7.50E-01	2.00E 01	6.45E-02	2.00E 01	7.14E-02	5.00E 01	7.65E-02	1.00E 02	7.81E-02
THYROID	3.00E-01	2.30E-01	2.00E 01	3.23E-02	2.00E 01	3.48E-02	5.00E 01	3.75E-02	1.00E 02	3.86E-02
KIDNEY	4.00E-02	3.00E-02	7.00E 00	4.21E-02	7.00E 00	4.53E-02	7.00E 00	4.81E-02	7.00E 00	5.09E-02
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
GI-LLI INGES	5.00E-02	0.	0.	3.64E-02	0.	3.86E-02	0.	4.21E-02	0.	4.53E-02
GI-LLI INHAL	5.00E-02	5.00E-01	0.	3.64E-02	0.	3.86E-02	0.	4.21E-02	0.	4.53E-02

TABLE B-1. (contd)

ORGAN	F-W (F-* FOR GI)	F-A OR F-2'	INFANT TBIOL (DAY)	INFANT EPSILON (MEV)	CHILD TBIOL (DAY)	CHILD EPSILON (MEV)	TEEN TBIOL (DAY)	TEEN EPSILON (MEV)	ADULT TBIOL (DAY)	ADULT EPSILON (MEV)
BA133	HALF LIFE = 3.840E 03 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	3.50E-02	7.00E-01	6.50E 01	3.83E-01	6.50E 01	3.83E-01	6.50E 01	4.01E-01	6.50E 01	4.18E-01
LIVER	3.00E-05	6.00E-04	9.75E 02	1.27E-01	9.75E 02	1.50E-01	9.75E 02	1.71E-01	9.75E 02	1.80E-01
TOTAL BODY	5.00E-02	1.00E 00	6.50E 01	2.15E-01	6.50E 01	2.57E-01	6.50E 01	2.96E-01	6.50E 01	3.10E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	5.00E-06	1.00E-04	8.50E 00	1.15E-01	8.50E 00	1.27E-01	8.50E 00	1.39E-01	8.50E 00	1.50E-01
LUNG INGES	1.00E-05	0.	6.50E 03	1.27E-01	6.50E 03	1.50E-01	6.50E 03	1.61E-01	6.50E 03	1.80E-01
LUNG INHAL	0.	1.20E-01	1.20E 02	1.27E-01	1.20E 02	1.50E-01	1.20E 02	1.61E-01	1.20E 02	1.80E-01
GI-LLI INGES	9.50E-01	0.	0.	9.36E-02	0.	1.02E-01	0.	1.15E-01	0.	1.27E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	9.36E-02	0.	1.02E-01	0.	1.15E-01	0.	1.27E-01
TM170	HALF LIFE = 1.286E 02 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	6.50E-05	6.50E-01	1.00E 03	1.16E 00	1.00E 03	1.16E 00	1.00E 03	1.16E 00	1.00E 03	1.16E 00
LIVER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL BODY	1.00E-04	1.00E 00	6.75E 02	3.26E-01	6.75E 02	3.27E-01	6.75E 02	3.27E-01	6.75E 02	3.28E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	2.00E-06	2.00E-02	3.35E 02	3.25E-01	3.35E 02	3.25E-01	3.35E 02	3.25E-01	3.35E 02	3.25E-01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	3.25E-01	1.20E 02	3.25E-01	1.20E 02	3.25E-01	1.20E 02	3.26E-01
GI-LLI INGES	1.00E 00	0.	0.	3.25E-01	0.	3.25E-01	0.	3.25E-01	0.	3.25E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	3.25E-01	0.	3.25E-01	0.	3.25E-01	0.	3.25E-01
YB169	HALF LIFE = 3.197E 01 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	5.80E-05	5.80E-01	1.00E 03	7.15E-01	1.00E 03	7.15E-01	1.00E 03	7.36E-01	1.00E 03	7.54E-01
LIVER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL BODY	1.00E-04	1.00E 00	6.85E 02	2.38E-01	6.85E 02	2.72E-01	6.85E 02	3.04E-01	6.85E 02	3.15E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	5.00E-06	5.00E-02	6.85E 02	1.64E-01	6.85E 02	1.73E-01	6.85E 02	1.81E-01	6.85E 02	1.89E-01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	1.73E-01	1.20E 02	1.89E-01	1.20E 02	1.97E-01	1.20E 02	2.11E-01
GI-LLI INGES	1.00E 00	0.	0.	1.50E-01	0.	1.56E-01	0.	1.64E-01	0.	1.73E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	1.50E-01	0.	1.56E-01	0.	1.64E-01	0.	1.73E-01

TABLE B-1. (contd)

ORGAN	F-W (F-* FOR GI)	F-A OR F-2'	INFANT TBIOL (DAY)	INFANT EPSILON (MEV)	CHILD TBIOL (DAY)	CHILD EPSILON (MEV)	TEEN TBIOL (DAY)	TEEN EPSILON (MEV)	ADULT TBIOL (DAY)	ADULT EPSILON (MEV)
TA182	HALF LIFE = 1.150E 02 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	2.00E-05	2.00E-01	3.00E 02	8.66E-01	3.00E 02	8.66E-01	3.00E 02	9.25E-01	3.00E 02	9.80E-01
LIVER	3.00E-05	3.00E-01	4.00E 02	3.07E-01	4.00E 02	3.69E-01	4.00E 02	4.25E-01	4.00E 02	4.57E-01
TOTAL BODY	1.00E-04	1.00E 00	2.40E 02	5.61E-01	2.40E 02	6.97E-01	2.40E 02	8.27E-01	2.40E 02	8.75E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	3.00E-06	3.00E-02	4.00E 02	2.74E-01	4.00E 02	3.07E-01	4.00E 02	3.38E-01	4.00E 02	3.69E-01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	3.07E-01	1.20E 02	3.69E-01	1.20E 02	3.99E-01	1.20E 02	4.57E-01
GI-LLI INGES	1.00E 00	0.	0.	2.20E-01	0.	2.41E-01	0.	2.74E-01	0.	3.07E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	2.20E-01	0.	2.41E-01	0.	2.74E-01	0.	3.07E-01
IR192	HALF LIFE = 7.420E 01 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LIVER	2.30E-02	2.30E-01	2.70E 01	2.99E-01	2.70E 01	3.43E-01	2.70E 01	3.84E-01	2.70E 01	4.03E-01
TOTAL BODY	1.00E-01	1.00E 00	2.00E 01	4.75E-01	2.00E 01	5.66E-01	2.00E 01	6.53E-01	2.00E 01	6.84E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	4.50E-03	4.50E-02	5.00E 01	2.77E-01	5.00E 01	2.99E-01	5.00E 01	3.21E-01	5.00E 01	3.43E-01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	2.99E-01	1.20E 02	3.43E-01	1.20E 02	3.64E-01	1.20E 02	4.03E-01
GI-LLI INGES	9.00E-01	0.	0.	2.39E-01	0.	2.53E-01	0.	2.77E-01	0.	2.99E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	2.39E-01	0.	2.53E-01	0.	2.77E-01	0.	2.99E-01
AU198	HALF LIFE = 2.700E 00 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LIVER	4.00E-03	4.00E-02	3.00E 02	3.98E-01	3.00E 02	4.19E-01	3.00E 02	4.40E-01	3.00E 02	4.49E-01
TOTAL BODY	1.00E-01	1.00E 00	1.20E 02	4.85E-01	1.20E 02	5.31E-01	1.20E 02	5.74E-01	1.20E 02	5.89E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	3.00E-03	3.00E-02	2.80E 02	3.86E-01	2.80E 02	3.98E-01	2.80E 02	4.09E-01	2.80E 02	4.19E-01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	3.98E-01	1.20E 02	4.19E-01	1.20E 02	4.30E-01	1.20E 02	4.49E-01
GI-LLI INGES	9.00E-01	0.	0.	3.67E-01	0.	3.74E-01	0.	3.86E-01	0.	3.98E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	3.67E-01	0.	3.74E-01	0.	3.86E-01	0.	3.98E-01

TABLE B-1. (contd)

ORGAN	F-W (F-* FOR GI)	F-A OR F-2'	INFANT TBIOL (DAY)	INFANT EPSILON (MEV)	CHILD TBIOL (DAY)	CHILD EPSILON (MEV)	TEEN TBIOL (DAY)	TEEN EPSILON (MEV)	ADULT TBIOL (DAY)	ADULT EPSILON (MEV)
TL201	HALF LIFE = 3.040E 00 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	2.50E-02	5.50E-02	7.00E 00	2.37E-01	7.00E 00	2.37E-01	7.00E 00	2.43E-01	7.00E 00	2.48E-01
LIVER	2.00E-02	4.00E-02	5.00E 00	5.74E-02	5.00E 00	6.14E-02	5.00E 00	6.52E-02	5.00E 00	6.70E-02
TOTAL BODY	4.50E-01	1.00E 00	5.00E 00	7.38E-02	5.00E 00	8.28E-02	5.00E 00	9.16E-02	5.00E 00	9.49E-02
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	2.30E-02	5.00E-02	7.00E 00	5.53E-02	7.00E 00	5.74E-02	7.00E 00	5.94E-02	7.00E 00	6.14E-02
LUNG INGES	2.70E-03	0.	6.00E 00	5.74E-02	6.00E 00	6.14E-02	6.00E 00	6.33E-02	6.00E 00	6.70E-02
LUNG INHAL	0.	1.20E-01	1.20E 02	5.74E-02	1.20E 02	6.14E-02	1.20E 02	6.33E-02	1.20E 02	6.70E-02
GI-LLI INGES	5.50E-01	0.	0.	5.18E-02	0.	5.32E-02	0.	5.53E-02	0.	5.74E-02
GI-LLI INHAL	1.00E 00	6.20E-01	0.	5.18E-02	0.	5.32E-02	0.	5.53E-02	0.	5.74E-02
TL204	HALF LIFE = 1.377E 03 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LIVER	2.00E-02	4.00E-02	5.00E 00	2.45E-01	5.00E 00	2.45E-01	5.00E 00	2.45E-01	5.00E 00	2.46E-01
TOTAL BODY	4.50E-01	1.00E 00	5.00E 00	2.46E-01	5.00E 00	2.46E-01	5.00E 00	2.46E-01	5.00E 00	2.46E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	2.30E-02	5.00E-02	7.00E 00	2.45E-01	7.00E 00	2.45E-01	7.00E 00	2.45E-01	7.00E 00	2.45E-01
LUNG INGES	2.70E-03	0.	6.00E 00	2.45E-01	6.00E 00	2.45E-01	6.00E 00	2.45E-01	6.00E 00	2.46E-01
LUNG INHAL	0.	1.20E-01	1.20E 02	2.45E-01	1.20E 02	2.45E-01	1.20E 02	2.45E-01	1.20E 02	2.46E-01
GI-LLI INGES	5.50E-01	0.	0.	2.45E-01	0.	2.45E-01	0.	2.45E-01	0.	2.45E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	2.45E-01	0.	2.45E-01	0.	2.45E-01	0.	2.45E-01
PU236	HALF LIFE = 1.041E 03 DAYS				INSOLUBLE FOR INHALATION ONLY					
BONE	1.35E-05	4.50E-01	3.65E 04	2.88E 02	3.65E 04	2.88E 02	3.65E 04	2.88E 02	3.65E 04	2.88E 02
LIVER	1.35E-05	4.50E-01	1.46E 04	5.76E 01	1.46E 04	5.76E 01	1.46E 04	5.76E 01	1.46E 04	5.76E 01
TOTAL BODY	3.00E-05	1.00E 00	6.50E 04	5.76E 01	6.50E 04	5.76E 01	6.50E 04	5.76E 01	6.50E 04	5.76E 01
THYROID	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KIDNEY	6.00E-07	2.00E-02	3.20E 04	5.76E 01	3.20E 04	5.76E 01	3.20E 04	5.76E 01	3.20E 04	5.76E 01
LUNG INGES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LUNG INHAL	0.	1.20E-01	1.20E 02	5.76E 01	1.20E 02	5.76E 01	1.20E 02	5.76E 01	1.20E 02	5.76E 01
GI-LLI INGES	1.00E 00	0.	0.	5.76E-01	0.	5.76E-01	0.	5.76E-01	0.	5.76E-01
GI-LLI INHAL	1.00E 00	6.20E-01	0.	5.76E-01	0.	5.76E-01	0.	5.76E-01	0.	5.76E-01

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Inhalation dose commitment factors are presented for selected radionuclides for exposure of individuals in four age groups: infant, child, teen and adult. Radionuclides considered are ^{35}S, ^{36}Cl, ^{45}Ca, ^{67}Ga, ^{75}Se, ^{85}Sr, ^{109}Cd, ^{113}Sn, ^{125}I, ^{133}Ba, ^{170}Tm, ^{169}Yb, ^{182}Ta, ^{192}Ir, ^{198}Au, ^{201}Tl, ^{204}Tl, and ^{236}Pu. The calculational method is based on the human metabolic model of ICRP as defined in Publication 2 (ICRP 1959) and as used in previous age-specific dose factor calculations by Hoenes and Soldat (1977). Dose commitment factors are presented for the following organs of reference: total body, bone, liver, kidney, thyroid, lung and lower large intestine.

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