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**A Comparison of 50-Year
and 70-Year Internal-
Dose-Conversion Factors**

M. T. Ryan
D. E. Dunning, Jr.

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DEPARTMENT OF ENERGY**

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Health and Safety Research Division

A COMPARISON OF 50-YEAR AND 70-YEAR
INTERNAL-DOSE-CONVERSION FACTORS

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CONTENTS

	<u>Page</u>
LIST OF TABLES	iv
ABSTRACT	v
1. INTRODUCTION	1
1.1 Comparison of the Acute Intake and Chronic Intake . . .	1
1.2 Comparison of 50-year and 70-year Dose Integration Period.	3
2. DISCUSSION	4
REFERENCES	8
APPENDIX I	25

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1 Radionuclides for which the differences in both inhalation and ingestion dose conversion factors are less than 1%	9
2 Calculated percent differences in 70-year chronic and 50-year acute inhalation dose conversion factors	11
3 Calculated percent differences in 70-year chronic and 50-year acute ingestion dose conversion factors.	15
4 Organs in which maximum DCF differences occur.	17
5 Calculated percent differences in 70-year chronic and 50-year acute inhalation effective committed dose conversion factors.	18
6 Calculated percent differences in 70-year chronic and 50-year acute ingestion effective committed dose conversion factors.	21
7 Summary of organ specific and effective dose equivalent dose conversion factor comparisons	23

ABSTRACT

The 50-year inhalation and ingestion dose commitments associated with an acute intake (of a radionuclide) of 3.7×10^4 Bq (1 μ Ci) in one day were compared with the corresponding dose commitments calculated for a 70-year integration period resulting from a chronic intake of the same amount at a rate of 101 Bq/d (0.00274 μ Ci/d) for one year. These values, known as dose conversion factors, estimate the dose accumulated during a given period of time following a unit intake of a radionuclide. It was demonstrated that the acute intake of 3.7×10^4 Bq in one day and the chronic intake of 101 Bq/d for one year (a total intake of 3.7×10^4 Bq) result in essentially the same dose commitment for a relatively long integration period. Therefore, the comparison of 50-year acute dose conversion factors and 70-year chronic dose conversion factors is essentially only a measure of the additional dose accumulated in the 50-70 year period. The metabolism (i.e., uptake and retention in various organs of the body) and the half-life of a radionuclide determine what fraction of the total dose is accumulated in this 50-70 year period. It was found that for radionuclides with atomic mass less than 200 the percent difference in the 70-year and 50-year dose conversion factors was essentially zero in most cases. Differences of approximately 5-50% were obtained for dose conversion factors for most alpha emitters with atomic masses of greater than 200. Comparisons were made on the basis of both organ dose equivalent and effective dose equivalent. Tables are provided which allow the calculation of 70-year dose conversion factors from reference 50-year dose conversion factors for any of 22 target organs for the 200 radionuclides examined. The implications and significance of these results are discussed.

1. INTRODUCTION

Estimates of radiation dose to various organs of the body are made by mathematically describing the intake of radionuclides into the body, distribution of radionuclides among various organs of the body, and retention of radionuclides in these organs using appropriate metabolism and kinetics models. Total integrated radiation doses to various organs of the body per unit intake of radionuclide are the quantities of interest. The length of the integration period used in calculating total integrated dose is evaluated here.

Comparisons for more than 200 radionuclides are made between 50-year integral dose commitments resulting from an acute unit intake (3.7×10^4 Bq d⁻¹ for 1 day) and 70-year integral dose commitments resulting from a chronic unit intake (101 Bq d⁻¹ for 365 days). All calculations were made using the INREM-II computer code developed by Killough, Dunning, and Pleasant.¹ Metabolic models and data were taken from tabulations by Killough et al. and Dunning et al.^{2,3}

1.1 Comparison of the Acute Intake and Chronic Intake

An important quantity required for the calculation of dose is the integral of the activity (typically $\mu\text{Ci-days}$ or Bq-days of residence) in an organ of reference. This quantity is physically defined as the total number of transformations that occur in the organ during a period of observation and may be calculated as the integral of the product of the intake rate times a retention function.

An organ retention function is usually of the form

$$R(t) = e^{-\lambda_{\text{eff}} t}, \quad (1)$$

where

λ_{eff} = the effective removal rate constant,

t = time elapsed since the intake of activity,

$R(t)$ = the fraction of activity remaining in the organ of reference at time, t .

For an acute intake P_0 (Bq) to the organ of reference at time zero the total accumulated transformations, Q_A , is given by

$$Q_A = \int_0^T P_0 e^{-\lambda_{\text{eff}} t} dt \quad (\text{transformations}) . \quad (2)$$

After integrating

$$Q_A = \frac{P_0}{\lambda_{\text{eff}}} (1 - e^{-\lambda_{\text{eff}} t}) \quad (\text{transformations}) . \quad (3)$$

The total residence (over $t_1 + t_2 =$ intake period + integration period) for the case of chronic exposure resulting from a protracted intake at a constant rate, P , for a period of time, t_1 , is given by

$$Q_C = \int_0^{t_1} \frac{P}{\lambda_{\text{eff}}} (1 - e^{-\lambda_{\text{eff}} t}) dt + \int_0^{t_2} \frac{P}{\lambda_{\text{eff}}} (1 - e^{-\lambda_{\text{eff}} t_1}) e^{-\lambda_{\text{eff}} t} dt \quad (\text{transformations}) . \quad (4)$$

After integrating and rearranging terms,

$$Q_C = \frac{P t_1}{\lambda_{\text{eff}}} - \frac{P}{\lambda_{\text{eff}}^2} \left[e^{-\lambda_{\text{eff}} t_1} - 1 + (1 - e^{-\lambda_{\text{eff}} t_1})(1 - e^{-\lambda_{\text{eff}} t_2}) \right] \quad (\text{transformations}) . \quad (5)$$

If an amount of activity, P , is taken into the body at a rate of P_0/t_1 (Bq d⁻¹) for t_1 days, Q_C is essentially equal to Q_A when t_1 is small relative to the total period of dose integration. For an effective half-time of 50,000 days a difference of approximately 1% is

calculated between Q_C and Q_A for $t_2 = 50$ years. For practical applications in radiation dosimetry it can be stated that the long-term (50 years or greater) integral dose commitment resulting from the intake of any radionuclide over periods of up to a year is essentially independent of the rate at which the radionuclide is taken in the body or some organ of reference.

1.2 Comparison of 50-year and 70-year Dose Integration Period

For radionuclides with short effective half-lives in organs of the body, the total integrated dose or dose commitment is realized in times much less than 50 years. The difference in 50-year and 70-year dose conversion factors (DCF) is essentially zero for such radionuclides. Table 1 lists radionuclides for which the calculated differences in the 50-year and 70-year inhalation and ingestion dose conversion factors are zero.

For radionuclides with effective half-lives that are relatively long compared to an integration period of 50 to 70 years, differences in the integral dose conversion factor can be calculated.

For a single radionuclide with no radioactive daughter products and a half-life that is much greater than the integration period, the maximum percent increase in the DCF is 40%.

$$\text{Percent increase} = \frac{DCF_{70} - DCF_{50}}{DCF_{50}} \times 100 \quad (6)$$

For radionuclides with radioactive daughters, the increase in the inhalation and ingestion DCF's may be larger.

Results are listed in Tables 2 and 3 for radionuclides commonly encountered in the nuclear fuel cycle. Table 2 gives the maximum percent increase in the inhalation DCF's for any of 22 target organs, the organ(s) in which the maximum increase occurs and the solubility class assumed for the inhaled radionuclide. (The activity median aerodynamic diameter assumed for these calculations is AMAD = 1.0 μm). Table 3 gives the maximum percent increase in the ingestion DCF's for any of

the 22 target organs, the organ(s) in which the maximum increase occurs, and the gastrointestinal uptake fraction, f_1 , assumed for the ingested radionuclide.

2. DISCUSSION

Inspection of Tables 2 and 3 indicates that most of the radionuclides for which significant differences in the 50-year and 70-year DCF's have been calculated are actinides and radium. In approximately 55% of the inhalation DCF comparisons, one or more of the three bone compartments (red marrow, endosteal cells, and bone) were the organs in which the maximum differences occurred. In approximately 60% of the ingestion DCF comparisons, one or more of these bone compartments were the organs in which the maximum differences occurred.

The INREM II code² requires metabolic input data which define the deposition and retention of radionuclides in various internal organs. These data are provided for each organ for which information is available. Generally, only a few individual organs can be explicitly described in this manner. The fraction of the activity in the body which is not accounted for by these explicit source organs is allocated to a complementary compartment denoted as "other," within which the activity is assumed to be uniformly distributed. Organs which do not have explicit uptake and retention data are irradiated primarily by transformations in 'OTHER'.³ Many organs for which dose commitments are tabulated in this report fall into this category for some or all of the radionuclides considered (see Table 4). The reader should exercise particular caution in attributing significance to doses or differences between 50- and 70-year dose commitment estimates for these organs.

Table 4 lists the number of times a given organ was one of the organs for which the maximum difference was calculated. Where 50-year and 70-year inhalation DCF's were compared, the adrenal glands, bladder wall, pancreas, bone, red marrow, yellow marrow, endosteal cells, thymus gland, thyroid, and uterus were organs for which the maximum calculated difference occurred in 30% or more the cases. Where 50-year

and 70-year ingestion DCF's were compared, the adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, and uterus were organs for which the calculated maximum difference occurred in 30% or more of the cases.

The difference in 50-year and 70-year dose conversion factors was also evaluated according to the methods recommended by the International Commission on Radiological Protection.⁴ The ICRP effective committed dose equivalent represents a weighted average of specific organ dose equivalents and provides an indication of the total expected stochastic health risk (somatic and genetic) from a radionuclide exposure. It includes consideration of critical organs (i.e., organs receiving maximum dose) as well as organs of particular radiosensitivity. Specific tissues considered include gonads, breast, red bone marrow, lungs, bone endosteum, thyroid, and the five remaining organs receiving maximum doses, with weighting factors of 0.25, 0.15, 0.12, 0.12, 0.03, 0.03, and 0.06 (for each of the "remainder" organs), respectively. For calculations in this report, the gonadal dose is defined as the maximum of the DCF for testes and ovaries, the lung dose employed is the average ("smeared") dose to the total lungs including respiratory lymph, and the dose to breast is assumed to be equivalent to the dose to organs in the "other" category described previously.

Resulting 50-year acute and 70-year inhalation and ingestion effective dose equivalents were compared using Eq. (6). Results are listed in Tables 5 and 6. Table 5 gives the radionuclide, solubility class, and the percent increase in the inhalation effective DCF. Table 6 gives the radionuclide, the gastrointestinal uptake fraction, and the percent increase in the ingestion effective DCF. Table 7 gives a summary of results for 50-year and 70-year dose conversion factors for comparisons made using organ-specific DCF's and effective dose equivalent DCF's. This summary of comparisons indicates that when effective dose equivalents are compared the difference is smaller (<10%) for a larger fraction of comparisons. However, there are still cases where the difference in the 50-year and 70-year effective inhalation and ingestion dose equivalents are large ($\geq 20\%$). The radionuclides for which this is true are actinides, exclusively.

In order to attach significance to these calculated differences, whether by comparison of organ specific DCF's or effective dose equivalents, the validity of radionuclide metabolism models (especially bone seeking actinide models) must be established. The validity of the metabolic models must hold for the entire dose integration period.

Because of the significant increases in the dose commitments associated with the bone seeking actinides, if the integration is carried out to 70 years, a review of the metabolic model for bone is appropriate. A brief review of the literature of bone metabolism indicates that marked changes begin about age 40, especially in women.⁵⁻⁹

Two of the most prominent metabolic changes that occur are a 10% loss per decade of cortical bone mineral content in women^{6,7} and an increased dietary requirement for calcium and vitamin D. Other changes that result in a loss of calcium from the bone include bone resorption in order to maintain serum calcium levels, and the action of parathyroid hormone to increase intestinal absorption of calcium and decrease its renal excretion.⁸ The exact genesis of the process, called osteoporosis, is not known, but it is thought to be part of the aging process and that bone loss is generalized in the population.^{7,10}

The question then arises, of the influence that these later life metabolic changes in bone may have on the dosimetry of previously incorporated bone-seeking radionuclides or of bone-seeking radionuclides ingested during this late period. One may question whether radionuclides are decorporated from the mineralized bone along with calcium and whether they are then excreted or redeposited in bone or other organs. Further, one may question if the pattern and magnitude of radionuclide deposition varies in people (especially post-menopausal women) after the age of 40-50 years due to these changes in bone metabolism. Finally, the relationship between radiation dose and risk of radiation-induced disease must be reevaluated in light of these late life changes in bone metabolism.

The 50-year DCF has served as a benchmark in internal radiation dosimetry assessment for many years. While in some cases these estimates may not have been wholly accurate, they are comparable to other assessments using the same assessment methodology. Using 70-year DCF's

would make comparisons of assessments more difficult and may not accurately account for late-life bone metabolism. This report is not intended to resolve the questions raised above, but to indicate that late-life metabolism especially of bone-seeking alpha emitters should be considered for long-term dose assessment.

In conclusion, for many of the commonly encountered radionuclides the differences between 50-year and 70-year dose conversion factors are equal to or nearly zero. There are, however, significant differences in 50-year and 70-year dose conversion factors for some of the important actinides. These significant differences exist whether the comparisons are based on organ-specific dose estimates or effective dose-equivalent estimates. Because these actinides are primarily bone-seeking radionuclides, the validity of the metabolic model for bone, which does not account for metabolic change that occurs in later life, must be considered. The significance of the calculated differences in these dose conversion factors cannot be established until the influence of later-life bone metabolism on the dosimetry of bone has been determined.

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Table 1. Radionuclides for which the differences in both inhalation and ingestion dose conversion factors are less than 1 percent

Radionuclide	Solubility class ^a	f ₁ ^b	Radionuclide	Solubility class ^a	f ₁ ^b
Be-7	W	0.002	Ru-97	D,W	0.04
C-11	gas (CO ₂)	0.95	Ru-103	Y	0.04
Na-22	D	0.95	Ru-105	Y	0.04
Na-24	D	0.95	Ru-106	Y	0.04
P-32	D	0.8	Rh-103m	Y	0.04
S-35	D,W	0.95	Rh-105	Y	0.04
Cr-51	D,Y	0.1	Rh-106	Y	0.04
Mn-54	D,W	0.1	Sn-113	D,W	0.05
Mn-56	D,W	0.1	Sb-124	W	0.05
Fe-59	W,Y	0.1	Sb-125	W	0.05
Co-57	W,Y	0.05	Sb-127	W	0.05
Co-58	W,Y	0.05	Te-125m	W	0.25
Co-60	W,Y	0.05	Te-127m	W	0.25
Zn-65	D,W,Y	0.5	Te-129	W	0.25
Ga-67	D,W	0.001	Te-129m	W	0.25
As-76	D,W	0.02	Te-131	W	0.25
Rb-88	D	0.95	Te-131m	W	0.25
Sr-89	D,Y	0.3, 0.01	Te-132	W	0.25
Sr-91	D,Y	0.3, 0.01	I-122	D	0.95
Y-90	W	0.0004	I-123	D	0.95
Zr-95	D,W,Y	0.002	I-125	D	0.95
Zr-97	D,W,Y	0.002	I-129	D	0.95
Nb-95	W,Y	0.01	I-131	D	0.95
Nh-97	W,Y	0.01	I-132	D	0.95
Nb-97m	W,Y	0.01	I-133	D	0.95
Mo-99	D,Y	0.95, 0.05	I-134	D	0.95
Tc-99	D,W	0.8	Cs-134	D	0.95
Tc-99m	D,W	0.8	Cs-135	D	0.95
Cs-136	D	0.95	Pb-209	W	0.08
Cs-137	D	0.95	Pb-211	W	0.08

Table 1 (continued)

Radionuclide	Solubility class ^a	f ₁ ^b	Radionuclide	Solubility class ^a	f ₁ ^b
Cs-138	D	0.95	Pb-212	W	0.08
Ba-133	D	0.1	Pb-214	W	0.08
Ba-133m	D	0.1	Bi-210	W	0.05
Ba-137m	D	0.1	Bi-211	W	0.05
Ba-139	D	0.01	Bi-212	W	0.05
Ba-140	D	0.1	Bi-213	W	0.05
La-140	W,Y	0.0001	Bi-214	W	0.05
Ce-141	W,Y	0.0001	Po-211	D,W	0.1
Ce-143	W,Y	0.0001	Po-212	D,W	0.1
Ce-144	D,W,Y	0.0001	Po-213	D,W	0.1
Pr-143	D,W,Y	0.0001	Po-215	D,W	0.1
Pr-144	D,W,Y	0.0001	Po-216	D,W	0.1
Pr-144m	W,Y	0.0001	Po-218	D,W	0.1
Nd-147	D,W,Y	0.0001	At-217	D	0.95
Pm-147	D,W,Y	0.0001	Fr-221	D	0.95
Tb-160	Y	0.0001	Ra-223	W	0.2
Ir-192	D,W,Y	0.01	Ra-224	W	0.2
Hg-197	D,W	0.2, 0.02	Ra-225	W	0.2
Hg-203	D,W	0.2, 0.02	Ra-228	W	0.2
Tl-207	W	0.95	Th-227	W,Y	0.001
Tl-208	W	0.95	Th-228	W,Y	0.001
Tl-209	W	0.95			

^a Pulmonary solubility class as defined by the ICRP.⁴

^b Gastrointestinal uptake fraction as defined by the ICRP.⁴

Table 2. Calculated percent differences in 70-year chronic and 50-year acute inhalation dose conversion factors^a

Radionuclide	Solubility class	Maximum percent difference	Organs in which maximum percent difference occurs
<u>Range of calculated differences: 1% - 4.9%</u>			
Sr-90	D	3	Total body, bone, red marrow, endosteal cells
Sr-90	Y	3	Respiratory lymph, bone, red marrow, endosteal cells
Pb-210	W	3	Total body
Po-214	W	3	Adrenal glands, thymus, pancreas
Po-214	D	2	Adrenal glands, bladder wall, liver, ovaries, thymus, thyroid, pancreas, bone, red marrow, yellow marrow, testes, uterus
U-232	D	4	Total body, adrenal glands, bladder wall, liver, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
U-232	W	4	Total body, ovaries, pancreas, bone, red marrow, yellow marrow, testes, thymus, thyroid, uterus, adrenal glands, bladder wall
Pu-236	Y	4	Adrenal glands, bladder wall
Pu-236	W	2	Adrenal glands, liver, pancreas, yellow marrow, spleen, thymus, thyroid, uterus
<u>Range of calculated differences: 5% - 9.9%</u>			
Sm-147	W	6	Total body, adrenal glands, bladder wall, liver, ovaries, pancreas, bone, yellow marrow, spleen, testes, thymus, thyroid, uterus
Sm-147	D	6	Total body, liver, bone, red marrow, endosteal cells
Eu-152	Y	8	Respiratory lymph
Gd-152	W	6	Total body, adrenal glands, bladder wall, kidneys, liver, ovaries, pancreas, bone, red marrow, yellow marrow, thymus, spleen, testes, thyroid, uterus
Gd-152	D	6	Adrenal glands, bladder wall, ovaries, pancreas, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
U-233	W	6	Total body, adrenal glands, bladder wall, liver
U-233	D	5	Total body, adrenal glands, bladder wall, liver, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
U-234	W	6	Total body, red marrow, endosteal cells
U-234	D	6	Red marrow
U-235	D	6	Adrenal glands, bladder wall, ovaries, red marrow, yellow marrow, endosteal cells, spleen, thyroid
U-236	W	6	Yellow marrow
U-236	D	6	Adrenal glands, liver, ovaries, pancreas, yellow marrow, spleen, testes, thymus, thyroid, uterus
U-238	W	6	Adrenal glands, liver, ovaries, pancreas, red marrow, yellow marrow, spleen, thymus, uterus
U-238	D	6	Adrenal glands, pancreas, red marrow, yellow marrow, spleen, testes, thymus, thyroid, uterus
Am-242	W	6	Endosteal cells

Table 2. (continued)

Radionuclide	Solubility class	Maximum percent difference	Organs in which maximum percent difference occurs
Cm-242	W	5	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Cm-244	W	7	Adrenal glands, bladder wall, ovaries, pancreas, bone red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
U-235	W	6	Adrenal glands, liver, pancreas, red marrow, yellow marrow, endosteal cells, testes, thymus, thyroid, uterus
<u>Range of calculated differences: 10% - 14.9%</u>			
Eu-154	Y	10	Respiratory lymph
Ra-226	W	10	Bone, endosteal cells
Ac-227	Y	10	Red marrow, endosteal cells
Ac-227	W	10	Testes
Cm-243	Y	14	Respiratory lymph
Cm-243	W	13	Yellow marrow
Cm-244	Y	11	Respiratory lymph
<u>Range of calculated differences: 15% - 19.9%</u>			
Cm-242	Y	15	Adrenal glands, bladder wall, pancreas, yellow marrow, spleen, thymus, thyroid, uterus
<u>Range of calculated differences: 20% - 24.9%</u>			
Np-238	Y	24	Bone, red marrow, endosteal cells
Np-238	W	23	Bone, red marrow, endosteal cells, testes
Pu-238	Y	24	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Pu-238	W	24	Endosteal cells
Gd-152	Y	23	Respiratory lymph
Sm-147	Y	23	Respiratory lymph
U-233	Y	23	Respiratory lymph
U-234	Y	23	Respiratory lymph
U-235	Y	23	Respiratory lymph
U-236	Y	23	Respiratory lymph
U-238	Y	23	Respiratory lymph
<u>Range of calculated differences: 25% - 29.9%</u>			
Np-239	Y	29	Endosteal cells
Np-239	W	29	Endosteal cells
Np-240	W	29	Endosteal cells
Np-240	Y	28	Endosteal cells
U-240	D	28	Endosteal cells

Table 2. (continued)

Radionuclide	Solubility class	Maximum percent difference	Organs in which maximum percent difference occurs
Range of calculated difference: 30% - 34.9%			
Th-229	W	32	Bladder wall, red marrow, endosteal cells
Th-230	Y	32	Bladder wall, adrenal glands, pancreas, ovaries, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Th-230	W	31	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, thymus, thyroid, uterus
Np-237	Y	32	Ovaries, pancreas, bone, red marrow, yellow marrow, adrenal glands, endosteal cells, spleen, thymus, thyroid, uterus, bladder wall
Np-240m	Y	30	Endosteal cells
Np-240m	W	30	Endosteal cells
Pu-239	Y	32	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Pu-239	W	32	Adrenal glands, pancreas, bone, yellow marrow, spleen, thymus, thyroid, uterus
Pu-240	Y	32	Adrenal glands, bladder wall, ovaries, pancreas, bone, uterus, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid
Pu-240	W	31	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, uterus, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid
Pu-242	Y	32	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Pu-242	W	31	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Pu-243	W	31	Endosteal cells
Pu-244	Y	32	Bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Pu-244	W	32	Bone, thyroid, uterus
Am-241	W	30	Bone, red marrow
Am-242m	W	33	Bone
Am-243	W	32	Pancreas, bone, endosteal cells
Cm-245	W	33	Adrenal glands, pancreas, bone, endosteal cells, spleen, thymus, thyroid, uterus
Cm-247	W	32	Uterus
Cm-248	Y	32	Ovaries, bone, red marrow, endosteal cells, testes, uterus
Cm-248	W	31	Ovaries, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Th-232	Y	33	Red marrow
Th-229	Y	32	Bone
U-240	Y	30	Endosteal cells

Table 2. (continued)

Radionuclide	Solubility class	Maximum percent difference	Organs in which maximum percent difference occurs
U-240	W	30	Endosteal cells
Np-237	W	32	Adrenal glands
Cm-245	Y	33	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thyroid, thymus, uterus
Cm-246	W	31	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thyroid, thymus, uterus
Cm-247	Y	32	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thyroid, thymus, uterus
Th-232	W	33	Endosteal cells
Pu-243	Y	32	Endosteal cells
Cm-246	Y	32	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, spleen, testes, thymus, thyroid, uterus
Range of calculated difference: 35% - 50%			
Pa-231	W	45	Bone, red marrow
Pu-241	Y	44	Ovaries, red marrow, bone, endosteal cells, testes
Pu-241	W	48	Bladder wall, red marrow
Th-231	Y	42	Endosteal cells
Th-231	W	43	Endosteal cells
Pa-231	Y	44	Bone

^aThe aerosol median aerodynamic diameter was assumed to be 1.0 μ .

Table 3. Calculated percent differences in 70-year chronic and 50-year acute ingestion dose conversion factors

Radionuclide	f_1	Maximum percent difference	Organs in which maximum percent difference occurs
Range of calculated differences: 0 - 9.9%			
Sr-90	0.2	3	Total body, bone, red marrow, endosteal cells
Sr-90	0.01	3	Bone, red marrow, endosteal cells
Sm-147	0.0001	6	Kidneys, bone, red marrow, endosteal cells
Gd-152	0.0001	6	Liver, bone, red marrow
Pb-210	0.08	2	Lungs, respiratory, lymph, total body, adrenal glands, bladder wall, kidneys, liver, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Po-214	0.1	2	Total body, adrenal glands, bladder wall, kidneys, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
U-232	0.002	4	Total body, adrenal glands, bladder wall, liver, ovaries, pancreas, uterus, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid
U-232	0.05	4	Total body, adrenal glands, bladder wall, liver, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
U-232	0.2	5	Liver
U-233	0.002	6	Adrenal glands, bladder wall, pancreas, yellow marrow, spleen, thymus, thyroid, uterus
U-233	0.05	6	Total body, bladder wall, red marrow
U-233	0.2	6	Total body, adrenal glands, bladder wall, yellow marrow, pancreas, spleen, thymus, thyroid, uterus
U-234	0.002	6	Endosteal cells
U-234	0.05	6	Bladder wall, red marrow
U-234	0.2	6	Endosteal cells
U-235	0.002	6	Total body, adrenal glands, liver, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid
U-235	0.05	6	Bladder wall, liver, ovaries, pancreas, red marrow, endosteal cells, spleen, testes, thymus, uterus
U-235	0.2	6	Adrenal glands, bladder wall, liver, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, testes, thymus, thyroid, uterus
U-236	0.002	6	Adrenal glands, bladder wall, liver, ovaries, pancreas, yellow marrow, spleen, testes, thymus, thyroid, uterus
U-236	0.05	6	Adrenal glands, bladder wall, liver, testes, ovaries, pancreas, red marrow, yellow marrow, spleen, thymus, thyroid, uterus, testes
U-236	0.2	6	Adrenal glands, bladder wall, liver, ovaries, pancreas, yellow marrow, spleen, testes, thymus, thyroid, uterus
U-238	0.002	6	Liver, ovaries
U-238	0.05	6	Liver, ovaries, yellow marrow, testes, uterus
U-238	0.2	6	Total body, liver
Np-239	0.001	9	Endosteal cells
Pu-236	3×10^{-5}	4	Lungs, respiratory lymph
Am-242	0.001	5	Bone, red marrow, endosteal cells, testes, thymus, thyroid

Table 3. (continued)

Radionuclide	f_1	Maximum percent difference	Organs in which maximum percent difference occurs
Cm-242	0.001	5	Adrenal glands, bladder wall, ovaries, pancreas, bone, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Cm-244	0.001	7	Total body, adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Range of calculated differences: 10 - 19.9%			
Ra-226	0.2	10	Endosteal cells
Ac-227	0.001	10	Thymus, thyroid, uterus
U-240	0.002	10	Endosteal cells
Pu-243	3×10^{-5}	18	Endosteal cells
Cm-243	0.001	12	Total body, adrenal glands, bladder wall, ovaries, bone, pancreas, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Range of calculated differences: 20 - 29.9%			
U-240	0.05	26	Endosteal cells
U-240	0.2	27	Endosteal cells
Np-238	0.001	23	Endosteal cells
Pu-238	3×10^{-5}	24	Bone
Range of calculated differences: over 30%			
Th-229	0.001	31	Adrenal cells, bladder wall, ovaries, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Th-230	0.001	32	Adrenal cells, pancreas, spleen, endosteal cells, thymus, thyroid, uterus
Th-231	0.001	30	Endosteal cells
Th-232	0.001	33	Lungs, respiratory lymph
Pa-231	0.001	46	Bone
Np-237	0.001	32	Pancreas, spleen, thymus, uterus, testes
Pu-239	3×10^{-5}	31	Adrenal glands, bladder wall, ovaries, pancreas, bone, red marrow, yellow marrow, endosteal cells, spleen, testes, thymus, thyroid, uterus
Pu-240	3×10^{-5}	32	Red marrow
Pu-241	3×10^{-5}	48	Yellow marrow
Pu-242	3×10^{-5}	32	Bone, endosteal cells
Pu-244	3×10^{-5}	32	Red marrow, endosteal cells
Am-241	0.001	30	Adrenal glands, ovaries, pancreas, bone, endosteal cells, spleen, testes, thymus, thyroid, uterus
Am-242m	0.001	33	Yellow marrow, endosteal cells
Am-243	0.001	32	Yellow marrow
Cm-245	0.001	33	Adrenal glands, bladder wall, ovaries, pancreas, bone, yellow marrow, endosteal cells, spleen, testes, uterus
Cm-246	0.001	32	Endosteal cells, testes
Cm-247	0.001	32	Red marrow, testes, thyroid
Cm-248	0.001	31	Ovaries, bone, red marrow, endosteal cells, spleen, testes, thymus, thyroid

Table 4. Organs in which maximum DCF differences occur
(The number of times a given organ was an organ in which the maximum difference in DCF was calculated and listed)

Organ	Inhalation	Ingestion
Lungs	0	2
Respiratory lymphatics	12	2
Stomach wall	0	0
Small intestine wall	0	0
Upper large intestine wall	0	0
Lower large intestine wall	0	0
Total body	10	10
Adrenal glands ^a	35	18
Bladder wall ^a	29	18
Kidneys ^b	1	2
Liver ^b	11	14
Ovaries ^b	29	18
Pancreas ^a	33	19
Bone ^b	40	21
Red marrow ^b	42	23
Yellow marrow ^a	34	20
Endosteal cells ^b	50	33
Spleen ^b	30	20
Testes ^b	29	23
Thymus ^a	33	22
Thyroid ^b	33	21
Uterus ^a	35	21

^aOrgans which are not used as explicit source organs for any radionuclides in this study. Activity is deposited in these organs only as they are grouped into a complementary organ category, OTHER, as described in ref. 3.

^bOrgans which are used as explicit source organs for some radionuclides in this study, but not for others.

Table 5. Calculated percent differences in 70-year chronic and 50-year acute inhalation effective committed dose conversion factors^a

Radionuclide	Solubility Class	Percent difference
Range of calculated differences: 1 - 9.9%		
Sr-90	D	2
Sr-90	Y	2
Sm-147	Y	9
Sm-147	W	5
Sm-147	D	6
Eu-152	Y	3
Eu-154	Y	4
Gd-152	Y	9
	W	6
	P	5
Pb-210	W	1
Ra-226	W	5
Ac-227	Y	5
	W	8
Th-231	Y	2
	W	5
U-232	Y	2
	W	3
	D	5
U-233	Y	9
	W	2
	D	4
U-234	Y	9
	W	2
	D	5
U-235	Y	9
	W	2
	D	5
U-236	W	2
	D	5
U-238	W	2
U-238	D	5
U-240	W	2
	D	4
Np-239	W	2
Np-240	Y	1
	W	3
Np-240m	Y	1
Np-240m	W	2
Pu-243	Y	3
	W	6

Table 5. (continued)

Radionuclide	Solubility Class	Percent difference
Am-242	W	3
Cm-242	W	3
Cm-243	Y	9
Cm-244	Y	5
Cm-244	W	6
Range of calculated differences: 10 - 19.9%		
Th-229	Y	19
U-236	Y	10
U-238	Y	10
Np-238	Y	14
Pu-238	Y	17
Cm-243	W	11
Cm-248	Y	17
Range of calculated differences: 20 - 24.9%		
Th-230	Y	23
Th-232	Y	24
Np-237	Y	23
Np-238	W	20
Pu-238	W	21
Pu-239	Y	22
Pu-240	Y	23
Pu-242	Y	23
Pu-244	Y	23
Cm-245	Y	23
Cm-246	Y	22
Cm-247	Y	23
Range of calculated differences: 25 - 29.9%		
Th-230	W	29
Np-237	W	29
Pu-239	W	28
Pu-240	W	28
Pu-242	W	28
Pu-244	W	28
Am-241	W	27

Table 5. (continued)

Radionuclide	Solubility Class	Percent difference
Am-243	W	29
Cm-245	W	29
Cm-246	W	28
Cm-247	W	28
Cm-248	W	25
Range of calculated differences: 30 - 34.9%		
Th-229	W	30
Th-232	W	30
Pu-231	Y	32
Am-242M	W	30
Range of calculated differences: 35 - 39.9%		
Pu-241	Y	39
Range of calculated differences: 40 - 50%		
Pa-231	W	40
Pu-241	W	44

^aICRP weighting factors (ref. 4).

Table 6. Calculated percent differences in 70-year chronic
and 50-year acute ingestion effective committed dose
conversion factors^a

Radionuclide	f_1	Percent difference
<u>Range of calculated differences: 1 - 9.9%</u>		
Sr-90	0.2	2
Sm-147	0.0001	5
Gd-152	0.0001	5
Pb-210	0.08	2
Ra-226	0.2	9
Ac-227	0.001	8
U-232	0.002	4
U-232	0.05	4
U-232	0.2	4
U-233	0.002	4
U-233	0.2	5
U-234	0.002	4
U-234	0.05	5
U-234	0.2	5
U-235	0.002	4
U-235	0.05	6
U-235	0.2	5
U-236	0.002	4
U-236	0.5	5
U-236	0.2	5
U-238	0.002	4
U-238	0.05	5
U-238	0.2	5
Np-238	0.001	1
Cm-242	0.001	3
Cm-244	0.001	6
<u>Range of calculated differences: 10 - 19.9%</u>		
Pu-238	0.00003	18
Cm-243	0.001	11
<u>Range of calculated differences: 20 - 29.9%</u>		
Th-229	0.001	29
Th-230	0.001	29
Np-237	0.001	29
Pu-239	0.00003	25
Pu-240	0.00003	25

Table 6. (continued)

Radionuclide	f_1	Percent difference
Pu-242	0.00003	27
Pu-244	0.00003	25
Am-241	0.001	27
Am-243	0.001	29
Cm-246	0.001	29
Cm-247	0.001	29
Cm-248	0.001	26
Range of calculated differences: >30%		
Th-232	0.001	30
Pa-231	0.001	42
Pu-241	0.0003	43
Am-242m	0.001	30
Cm-245	0.001	30

^aICRP weighting factors (ref. 4).

Table 7. Summary of organ-specific and effective dose equivalent dose conversion factor comparisons

Range of percent difference	Percent of the total number of organ-specific DCF comparisons	Percent of total number of effective dose equivalent DCF comparisons
For inhalation exposure		
1 - 9.9	30	55
10 - 19.9	9	8
20 - 24.9	12	14
25 - 29.9	6	14
30 - 34.9	37	5
>35	7	4
For ingestion exposure		
1 - 9.9	52	58
10 - 19.9	9	4
20 - 29.9	7	27
≥32	32	11

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APPENDIX I

The differences in 50-year and 70-year DCF's are summarized in this appendix for inhalation and ingestion exposures by specific organs. The 70-year dose conversion factors may be obtained adding the indicated percentages to existing 50-year DCF's. (See refs. 2 and 3 of the report text.) The abbreviations for organs are:

Lungs = Lungs
Res Lym = Respiratory Lymph
S Wall = Stomach Wall
SI Wall = Small Intestine Wall
ULI Wall = Upper Large Intestine Wall
LLI Wall = Lower Large Intestine Wall
T Body = Total Body
Adren = Adrenal Glands
Bl Wall = Bladder Wall
Kidneys = Kidneys
Liver = Liver
Ovaries = Ovaries
Pancreas = Pancreas
Bone = Bone
R Mar = Red Marrow
Y Mar = Yellow Marrow
Endost = Endosteal Cells
Spleen = Spleen
Testes = Testes
Thymus = Thymus
Thyroid = Thyroid
Uterus = Uterus

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Table I-1. Percentage increase in inhalation dose conversion factor due to 70-year integration

NUCLIDE	SOL	F1	AMAD	LUNGS	RES LYM	S WALL	SI WALL	ULT WALL	LLI WALL	T BODY	ADREN	BL WALL	KIDNEYS	LIVER
SR-90	D	0.20	1.0	0.0	0.0	0.0	0.0	0.0	0.0	5.	0.3	0.0	3.0	0.0
	Y	1.00E-02	1.0	2.	3.	2.	2.	2.	2.	2.	0.3	0.0	3.3	0.5
SM-147	Y	1.00E-04	1.0	0.0	2.5E 01	0.0	0.0	0.0	0.4	8.	6.	6.	6.	6.
	W	1.00E-04	1.0	0.0	0.0	0.0	0.0	0.1	0.0	6.	6.	6.	6.	6.
	D	1.00E-04	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.	5.	5.	5.	6.
EU-152	Y	1.00E-04	1.0	3.	8.	2.	1.	1.	0.5	2.	2.	1.	0.9	0.9
EU-154	Y	1.00E-04	1.0	4.	10.	3.	1.	1.	0.5	2.	2.	1.	1.	0.9
GD-152	Y	1.00E-04	1.0	0.0	2.5E 01	0.2	0.0	-0.5	0.0	7.	6.	6.	6.	6.
	W	1.00E-04	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.	6.	6.	6.	6.
	D	1.00E-04	1.0	0.0	0.0	0.3	0.0	0.0	0.0	5.	6.	6.	5.	5.
PB-210	W	8.00E-02	1.0	0.0	0.0	0.0	0.0	0.6	0.0	5.	2.	2.	0.9	2.
PD-214	W	1.00E-01	1.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	3.	2.	1.	2.
	D	1.00E-01	1.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	2.	2.	0.7	2.
PA-226	W	0.20	1.0	0.0	0.0	3.	2.	0.2	0.6	9.	0.6	0.6	0.8	0.6
AC-227	Y	1.30E-03	1.0	0.0	0.8	3.	4.	3.	3.	8.	8.	8.	6.	6.
	W	1.00E-03	1.0	0.0	0.0	6.	6.	3.	0.9	9.	9.	9.	6.	6.
TH-229	Y	1.00E-03	1.0	0.0	7.	1.1E 01	1.4E 01	6.	3.	2.7E 01	2.5E 01	2.5E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.0	0.0	2.5E 01	2.5E 01	1.8E 01	1.1E 01	3.0E 01	3.1E 01	3.2E 01	2.1E 01	2.1E 01
TH-230	Y	1.00E-03	1.0	0.0	2.3E 01	0.8	0.3	0.3	0.0	2.8E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.0	0.0	2.	0.9	0.3	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
TH-231	Y	1.00E-03	1.0	0.0	7.	0.0	0.0	0.0	0.0	1.1E 01	9.	6.	2.2E 01	2.5E 01
	W	1.00E-03	1.0	0.3	0.0	0.0	0.0	0.0	0.3	2.0E 01	1.2E 01	1.1E 01	1.6E 01	1.6E 01
TH-232	Y	1.00E-03	1.0	0.0	2.1E 01	1.5E 01	1.4E 01	5.	3.	3.0E 01	3.1E 01	3.0E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.0	0.0	2.7E 01	2.4E 01	10.	5.	3.1E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
PA-231	Y	1.00E-03	1.0	0.0	1.4E 01	2.7E 01	2.6E 01	1.3E 01	6.	4.1E 01	4.0E 01	3.9E 01	2.9E 01	3.0E 01
	W	1.00E-03	1.0	0.0	0.0	3.7E 01	3.6E 01	2.3E 01	1.0E 01	4.4E 01	4.3E 01	4.3E 01	3.0E 01	3.0E 01
U-232	W	5.00E-02	1.0	0.0	0.0	1.	0.0	0.2	0.0	4.	4.	4.	0.0	3.
	D	5.00E-02	1.0	0.0	0.0	0.8	1.	0.6	0.5	4.	4.	4.	3.0	4.

Table I-1. (continued)

NUCLIDE	SOL	F1	AMAD	OVARIES	PANCREAS	BONE	P. MAR	Y. MAR	ENDOST	SPLEEN	TESTES	THYMUS	THYROID	UTERUS
SR-90	D	0.20	1.0	0.0	0.0	3.	3.	0.0	3.	0.0	0.0	0.0	0.0	0.0
	Y	1.00E-02	1.0	0.3	0.3	3.	3.	0.3	3.	0.3	0.3	0.3	0.3	0.3
SM-147	Y	1.00E-04	1.0	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
	W	1.00E-04	1.0	6.	6.	6.	5.	6.	5.	6.	5.	6.	6.	6.
	D	1.00E-04	1.0	5.	5.	6.	6.	5.	6.	5.	5.	5.	5.	5.
EU-152	Y	1.00E-04	1.0	0.9	2.	1.	2.	2.	1.	2.	0.7	3.	3.	1.
EU-154	Y	1.00E-04	1.0	1.	2.	1.	2.	2.	1.	3.	1.	3.	3.	1.
GD-152	Y	1.00E-04	1.0	6.	6.	7.	6.	6.	6.	6.	6.	6.	6.	6.
	W	1.00E-04	1.0	6.	6.	6.	6.	6.	5.	6.	6.	5.	6.	6.
	D	1.00E-04	1.0	6.	6.	5.	6.	6.	6.	6.	6.	6.	6.	6.
PB-210	W	8.00E-02	1.0	2.	2.	2.	2.	2.	2.	0.9	2.	2.	2.	2.
PD-214	W	1.00E-01	1.0	2.	3.	2.	2.	2.	2.	0.6	2.	3.	2.	2.
	D	1.00E-01	1.0	2.	2.	2.	2.	2.	2.	0.0	2.	2.	2.	2.
RA-226	W	0.20	1.0	0.6	0.6	10.	9.	0.7	10.	0.6	0.6	0.6	0.6	0.6
AC-227	Y	1.00E-03	1.0	9.	8.	9.	10.	8.	10.	8.	5.	8.	8.	7.
	W	1.00E-03	1.0	9.	9.	9.	9.	9.	9.	9.	10.	9.	9.	9.
TH-229	Y	1.00E-03	1.0	3.0E 01	2.5E 01	3.2E 01	3.1E 01	2.5E 01	3.1E 01	2.4E 01	3.0E 01	2.4E 01	2.4E 01	2.5E 01
	W	1.00E-03	1.0	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
TH-230	Y	1.00E-03	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	1.00E-03	1.0	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
TH-231	Y	1.00E-03	1.0	7.	7.	3.8E 01	3.7E 01	7.	4.2E 01	8.	3.5E 01	7.	2.2E 01	7.
	W	1.00E-03	1.0	1.4E 01	1.1E 01	3.1E 01	4.0E 01	8.	4.3E 01	1.3E 01	2.5E 01	1.2E 01	2.2E 01	1.2E 01
TH-232	Y	1.00E-03	1.0	3.2E 01	3.1E 01	3.2E 01	3.3E 01	3.1E 01	3.2E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01
	W	1.00E-03	1.0	3.1E 01	3.1E 01	3.2E 01	3.2E 01	3.1E 01	3.3E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PA-231	Y	1.00E-03	1.0	4.1E 01	4.0E 01	4.4E 01	4.3E 01	4.0E 01	4.2E 01	3.9E 01	4.1E 01	4.0E 01	3.9E 01	3.9E 01
	W	1.00E-03	1.0	4.3E 01	4.2E 01	4.5E 01	4.5E 01	4.3E 01	4.5E 01	4.2E 01	4.5E 01	4.5E 01	4.5E 01	4.5E 01
U-232	W	5.00E-02	1.0	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.

Table I-1. (continued)

NUCLIDE	SOL	F1	AMAD	LUNGS	RES LYM	S WALL	SI WALL	ULI WALL	LLI WALL	T BODY	ADREN	BL WALL	KIDNEYS	LIVER
U-233	Y	2.00E-03	1.0	0.0	2.3E 01	0.2	0.0	0.0	0.0	1.1E 01	6.	6.	0.0	6.
	W	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.	6.	6.	0.2	6.
	D	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	3.0	5.
U-234	Y	2.00E-03	1.0	0.2	2.3E 01	0.0	0.0	0.0	0.0	1.1E 01	6.	6.	3.0	6.
	W	5.00E-02	1.0	0.0	0.0	0.1	0.0	0.0	0.0	6.	5.	5.	3.0	5.
	D	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	0.0	5.
U-235	Y	2.00E-03	1.0	0.0	2.3E 01	7.	2.	2.	2.	1.1E 01	6.	6.	3.6	9.
	W	5.00E-02	1.0	0.0	0.4	0.8	0.7	0.2	0.0	5.	6.	5.	3.0	6.
	D	5.00E-02	1.0	0.0	0.0	1.	2.	1.	0.8	5.	6.	6.	3.0	5.
U-236	Y	2.00E-03	1.0	0.0	2.3E 01	0.0	0.0	0.0	0.0	1.1E 01	6.	6.	3.6	6.
	W	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	3.0	5.
	D	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	5.	6.	5.	3.0	6.
U-238	Y	2.00E-03	1.0	0.0	2.3E 01	2.	2.	2.	2.	1.1E 01	7.	6.	0.0	6.
	W	5.00E-02	1.0	0.0	0.0	0.1	0.0	0.0	0.0	4.	6.	5.	0.0	6.
	D	5.00E-02	1.0	0.0	0.0	0.0	0.6	0.0	0.2	5.	6.	5.	3.7	5.
U-240	Y	2.00E-03	1.0	0.0	9.	0.0	0.0	0.0	0.0	3.	1.	0.8	7.	1.6E 01
	W	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.	2.	2.	7.	1.5E 01
	D	5.00E-02	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2E 01	2.	1.	7.	1.2E 01
NP-237	Y	1.00E-03	1.0	0.0	2.3E 01	1.7E 01	1.9E 01	1.1E 01	3.	2.9E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.2	0.0	2.3E 01	2.4E 01	1.8E 01	9.	3.0E 01	3.2E 01	3.1E 01	2.1E 01	2.2E 01
NP-238	Y	1.00E-03	1.0	0.0	2.1E 01	0.0	0.0	0.0	0.0	2.1E 01	1.6E 01	1.4E 01	1.6E 01	1.6E 01
	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2E 01	1.8E 01	1.8E 01	1.6E 01	1.6E 01
NP-239	Y	1.00E-03	1.0	0.0	10.	0.0	0.0	0.0	0.0	3.	0.9	0.5	6.	1.2E 01
	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	7.	1.	1.	6.	7.
NP-240	Y	1.00E-03	1.0	0.0	9.	0.0	0.2	0.0	0.1	3.	0.5	2.	3.	9.
	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	7.	0.9	3.	6.	10.
NP-240M	Y	1.00E-03	1.0	0.0	8.	0.0	0.0	0.0	0.0	4.	1.	1.0E 01	10.	1.6E 01

Table I-1. (continued)

NUCLIDE	SOL	F1	AMAD	CVARIES	PANCREAS	BONE	R. MAR	Y. MAR	ENDOST	SPLEEN	TESTES	THYMUS	THYROID	UTERUS
U-233	D	5.00E-02	1.0	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.
	Y	2.00E-03	1.0	7.	6.	6.	6.	6.	6.	6.	7.	6.	6.	6.
	W	5.00E-02	1.0	6.	6.	6.	5.	6.	6.	6.	6.	6.	6.	6.
U-234	D	5.00E-02	1.0	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
	Y	2.00E-03	1.0	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
	W	5.00E-02	1.0	5.	5.	5.	6.	5.	6.	5.	5.	5.	5.	5.
U-235	D	5.00E-02	1.0	5.	5.	5.	6.	5.	5.	5.	5.	5.	5.	5.
	Y	2.00E-03	1.0	7.	7.	6.	8.	7.	1.2E 01	7.	7.	6.	7.	6.
	W	5.00E-02	1.0	5.	6.	5.	6.	6.	6.	5.	6.	6.	6.	6.
U-236	D	5.00E-02	1.0	6.	5.	5.	6.	6.	6.	6.	5.	5.	6.	5.
	Y	2.00E-03	1.0	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
	W	5.00E-02	1.0	5.	5.	5.	5.	6.	5.	5.	5.	5.	5.	5.
U-238	D	5.00E-02	1.0	6.	6.	5.	5.	6.	5.	6.	6.	6.	6.	6.
	Y	2.00E-03	1.0	7.	7.	6.	6.	7.	6.	7.	6.	7.	7.	6.
	W	5.00E-02	1.0	6.	6.	5.	6.	6.	5.	6.	5.	6.	5.	6.
U-241	D	5.00E-02	1.0	5.	6.	5.	6.	6.	5.	6.	6.	6.	6.	6.
	Y	2.00E-03	1.0	2.	1.	1.2E 01	1.8E 01	2.	3.0E 01	1.	1.5E 01	1.	3.	1.
	W	5.00E-02	1.0	3.	2.	1.6E 01	1.9E 01	3.	3.0E 01	2.	1.5E 01	2.	3.	2.
NP-237	D	5.00E-02	1.0	3.	2.	1.3E 01	1.7E 01	2.	2.8E 01	2.	4.	2.	3.	2.
	Y	1.00E-03	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	1.00E-03	1.0	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
NP-238	Y	1.00E-03	1.0	1.8E 01	1.6E 01	2.4E 01	2.4E 01	1.9E 01	2.4E 01	1.6E 01	2.3E 01	1.4E 01	1.9E 01	1.5E 01
	W	1.00E-03	1.0	2.1E 01	1.9E 01	2.3E 01	2.3E 01	2.0E 01	2.3E 01	1.9E 01	2.3E 01	1.9E 01	2.1E 01	1.9E 01
NP-239	Y	1.00E-03	1.0	1.	0.0	1.6E 01	1.1E 01	0.9	2.9E 01	0.8	1.0	0.9	2.	0.9
	W	1.00E-03	1.0	3.	2.	1.3E 01	1.6E 01	2.	2.9E 01	2.	1.0E 01	0.9	4.	1.
NP-240	Y	1.00E-03	1.0	4.	0.0	1.5E 01	1.0E 01	0.0	2.8E 01	0.5	1.5E 01	0.3	0.0	2.
	W	1.00E-03	1.0	8.	0.4	1.7E 01	1.7E 01	2.	2.9E 01	0.9	1.7E 01	0.6	0.9	3.

Table I-1. (continued)

NUCLIDE	SOL	F1	AMAD	LUNGS	RES LYM	S WALL	SI WALL	ULI WALL	LLI WALL	T BODY	ADREN	BL WALL	KIDNEYS	LIVER
	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	8.	5.	1.4E 01	1.2E 01	1.4E 01
PU-236	Y	3.00E-05	1.0	0.0	0.9	0.3	0.8	0.7	0.8	0.5	4.	4.	-0.1	1.
	W	3.00E-05	1.0	0.0	0.0	0.9	0.4	0.5	0.0	0.4	2.	0.9	0.0	2.
PU-238	Y	3.00E-05	1.0	0.0	2.1E 01	0.0	0.0	0.0	0.0	2.1E 01	2.4E 01	2.4E 01	1.6E 01	1.6E 01
	W	3.00E-05	1.0	0.0	0.0	0.4	0.2	0.0	0.0	2.2E 01	2.3E 01	2.3E 01	1.6E 01	1.5E 01
PU-239	Y	3.00E-05	1.0	0.0	2.3E 01	0.4	0.2	0.0	0.0	2.9E 01	3.2E 01	3.2E 01	2.1E 01	2.2E 01
	W	3.00E-05	1.0	0.0	0.0	0.4	0.2	0.0	0.0	3.0E 01	3.2E 01	3.1E 01	2.1E 01	2.1E 01
PU-240	Y	3.00E-05	1.0	0.2	2.3E 01	0.0	0.0	0.0	0.0	2.8E 01	3.2E 01	3.2E 01	2.1E 01	2.2E 01
	W	3.00E-05	1.0	0.0	0.0	0.4	0.2	0.0	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
PU-241	Y	3.00E-05	1.0	0.9	2.4E 01	2.9E 01	2.5E 01	1.2E 01	3.	4.2E 01	4.3E 01	4.3E 01	3.2E 01	3.2E 01
	W	3.00E-05	1.0	0.6	0.0	3.5E 01	3.4E 01	2.1E 01	8.	4.6E 01	4.7E 01	4.8E 01	3.4E 01	3.4E 01
PU-242	Y	3.00E-05	1.0	0.2	2.3E 01	1.	0.3	0.0	0.0	2.9E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
	W	3.00E-05	1.0	0.0	0.0	2.	1.	0.0	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
PU-243	Y	3.00E-05	1.0	0.0	1.6E 01	0.0	0.0	0.0	0.0	1.0E 01	9.	1.3E 01	1.8E 01	2.0E 01
	W	3.00E-05	1.0	0.0	0.0	0.0	0.8	0.0	0.0	1.8E 01	1.4E 01	1.8E 01	1.6E 01	1.7E 01
PU-244	Y	3.00E-05	1.0	0.0	2.3E 01	1.4E 01	1.1E 01	6.	4.	2.8E 01	3.1E 01	3.2E 01	2.2E 01	2.2E 01
	W	3.00E-05	1.0	0.2	0.0	2.3E 01	2.2E 01	1.7E 01	9.	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
AM-241	W	1.00E-05	1.0	0.0	0.0	1.7E 01	1.3E 01	6.	0.9	2.8E 01	2.9E 01	2.9E 01	2.0E 01	2.0E 01
AM-242	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	4.	5.	5.	3.	3.
AM-242M	W	1.00E-03	1.0	0.0	0.0	1.6E 01	1.3E 01	6.	2.	3.1E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
AM-243	W	1.00E-03	1.0	0.0	0.0	2.3E 01	2.2E 01	1.6E 01	8.	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
CM-242	Y	1.00E-03	1.0	0.0	3.	0.0	0.0	0.0	0.0	3.	1.5E 01	1.5E 01	7.	7.
	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	4.	5.	5.	3.	3.
CM-243	Y	1.00E-03	1.0	0.0	1.4E 01	7.	6.	2.	0.0	1.1E 01	1.3E 01	1.3E 01	9.	9.
	W	1.00E-03	1.0	0.0	0.0	8.	8.	4.	1.	1.1E 01	1.2E 01	1.2E 01	8.	9.
CM-244	Y	1.00E-03	1.0	0.0	1.1E 01	0.0	0.0	0.0	0.0	7.	7.	7.	5.	5.
	W	1.00E-03	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.	7.	7.	5.	4.

Table I-1. (continued)

NUCLIDE	SOL	F1	AMAD	CVARIES	PANCREAS	BONE	R MAR	Y MAR	ENDOST	SPLEEN	TESTES	THYMUS	THYROID	UTERUS
NP-240M	Y	1.00E-03	1.0	2.0E 01	0.5	2.3E 01	2.2E 01	2.	3.0E 01	1.	2.8E 01	0.0	2.	1.1E 01
	W	1.00E-03	1.0	2.1E 01	2.	2.3E 01	2.4E 01	5.	3.0E 01	3.	2.4E 01	2.	5.	1.7E 01
PU-236	Y	3.00E-05	1.0	2.	4.	0.5	0.5	4.	0.0	4.	2.	4.	4.	4.
	W	3.00E-05	1.0	1.	2.	0.5	0.2	2.	0.3	2.	1.	2.	2.	2.
PL-238	Y	3.00E-05	1.0	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01	2.4E 01
	W	3.00E-05	1.0	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.4E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01
PL-239	Y	3.00E-05	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	3.00E-05	1.0	3.1E 01	3.2E 01	3.2E 01	3.1E 01	3.2E 01	3.1E 01	3.2E 01	3.1E 01	3.2E 01	3.2E 01	3.2E 01
PU-240	Y	3.00E-05	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	3.00E-05	1.0	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PU-241	Y	3.00E-05	1.0	4.4E 01	4.3E 01	4.4E 01	4.4E 01	4.3E 01	4.4E 01	4.3E 01	4.4E 01	4.3E 01	4.3E 01	4.3E 01
	W	3.00E-05	1.0	4.7E 01	4.7E 01	4.7E 01	4.8E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01
PU-242	Y	3.00E-05	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	3.00E-05	1.0	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.0E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PL-243	Y	3.00E-05	1.0	1.7E 01	7.	2.9E 01	2.8E 01	10.	3.2E 01	8.	3.0E 01	7.	1.8E 01	1.1E 01
	W	3.00E-05	1.0	2.2E 01	1.2E 01	2.5E 01	2.9E 01	1.4E 01	3.1E 01	1.4E 01	2.5E 01	1.2E 01	2.1E 01	1.7E 01
PU-244	Y	3.00E-05	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.1E 01	3.2E 01	3.2E 01
	W	3.00E-05	1.0	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.2E 01
AM-241	W	1.00E-05	1.0	2.9E 01	2.9E 01	3.0E 01	3.0E 01	2.9E 01	2.9E 01	2.9E 01	2.9E 01	2.9E 01	2.9E 01	2.9E 01
AM-242	W	1.00E-03	1.0	5.	5.	5.	5.	5.	6.	5.	5.	5.	5.	5.
AM-242M	W	1.00E-03	1.0	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.3E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
AM-243	W	1.00E-03	1.0	3.1E 01	3.2E 01	3.2E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
CM-242	Y	1.00E-03	1.0	1.2E 01	1.5E 01	1.2E 01	1.2E 01	1.5E 01	1.3E 01	1.5E 01	1.2E 01	1.5E 01	1.5E 01	1.5E 01
	W	1.00E-03	1.0	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
CM-243	Y	1.00E-03	1.0	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01	1.3E 01
	W	1.00E-03	1.0	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.3E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01
CM-244	Y	1.00E-03	1.0	7.	7.	7.	8.	7.	7.	7.	8.	7.	7.	7.

Table I-1. (continued)

NUCLIDE	SOL	F1	AMAD	LUNGS	RES LYM	S WALL	SI WALL	ULI WALL	LLI WALL	T BODY	ADREN	BL WALL	KIDNEYS	LIVER
CM-245	Y	1.00E-05	1.0	0.0	2.5E 01	1.8E 01	1.5E 01	6.	1.	3.0E 01	3.3E 01	3.3E 01	2.3E 01	2.3E 01
	W	1.00E-03	1.0	0.0	0.0	2.2E 01	2.0E 01	1.2E 01	4.	3.1E 01	3.3E 01	3.2E 01	2.2E 01	2.2E 01
CM-246	Y	1.00E-03	1.0	0.0	2.3E 01	1.4E 01	10.	3.	0.8	2.8E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.2	0.0	2.0E 01	1.6E 01	7.	2.	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
CM-247	Y	1.00E-03	1.0	0.0	2.3E 01	1.8E 01	1.9E 01	1.2E 01	5.	2.8E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.2	0.0	2.4E 01	2.3E 01	1.9E 01	1.2E 01	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
CM-248	Y	1.00E-03	1.0	0.0	2.3E 01	1.9E 01	2.3E 01	2.1E 01	1.9E 01	2.9E 01	3.0E 01	3.1E 01	2.2E 01	2.2E 01
	W	1.00E-03	1.0	0.4	0.0	2.4E 01	2.4E 01	2.2E 01	2.4E 01	3.0E 01	3.0E 01	3.1E 01	2.2E 01	2.1E 01

Table I-1. (continued)

NUCLIDE	SOL	F1	A440	OVARIES	PANCREAS	BONE	R MAR	Y MAR	ENDOS**	SPLEEN	TESTES	THYMUS	THYROID	UTERUS
	W	1.00E-03	1.0	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
CM-245	Y	1.00E-05	1.0	5.5E C1	5.5E 01	5.5E 01	5.5E 01	5.5E 01	3.3E 01	3.3E 01	3.3E 01	3.3E 01	3.3E 01	3.3E 01
	W	1.00E-03	1.0	3.2E C1	3.3E 01	3.3E 01	3.2E 01	3.2E 01	3.3E 01	3.3E 01	3.2E 01	3.3E 01	3.3E 01	3.3E 01
CM-246	Y	1.00E-03	1.0	3.2E C1	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.1E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	1.00E-03	1.0	3.1E C1	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
CM-247	Y	1.00E-03	1.0	3.2E C1	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
	W	1.00E-05	1.0	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.0E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.2E 01
CM-248	Y	1.00E-05	1.0	3.2E 01	3.0E 01	3.2E 01	3.2E 01	3.1E 01	3.2E 01	3.0E 01	3.2E 01	3.0E 01	3.1E 01	3.2E 01
	W	1.00E-03	1.0	3.1E 01	3.0E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01

Table I-2. Percentage increase in ingestion dose conversion factor due to 70-year integration

NUCLIDE	F1	LUNGS	RES LYM	S WALL	SI WALL	ULI WALL	LLI WALL	T BODY	ADREN	BL WALL	KIDNEYS	LIVER
SR-90	0.20	2.	2.	0.0	0.0	0.0	0.0	5.	0.0	0.0	0.0	0.0
	1.00E-02	2.	2.	0.0	0.0	0.0	0.0	2.	0.0	0.0	0.0	0.0
SM-147	1.00E-04	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	6.	5.
GD-152	1.00E-04	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	5.	6.
PB-210	8.00E-02	2.	2.	0.5	0.2	0.2	0.0	2.	2.	2.	2.	2.
PD-214	1.00E-01	0.0	0.0	0.0	0.0	0.0	0.0	2.	2.	2.	2.	2.
RA-226	0.20	9.	9.	2.	2.	0.1	0.0	9.	0.7	0.7	0.7	0.7
AC-227	1.00E-05	7.	7.	5.	5.	0.4	0.0	9.	9.	9.	6.	6.
TH-229	1.00E-03	2.7E 01	2.7E 01	6.	3.	0.7	0.5	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
TH-230	1.00E-03	1.4E 01	1.4E 01	0.0	0.0	0.0	0.0	3.0E 01	3.2E 01	3.1E 01	2.1E 01	2.2E 01
TH-231	1.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	2.	8.
TH-232	1.00E-03	3.3E 01	3.3E 01	0.9	0.3	0.0	0.0	3.1E 01	3.2E 01	3.1E 01	2.2E 01	2.2E 01
PA-231	1.00E-05	4.0E 01	4.0E 01	5.	0.9	0.2	0.0	4.5E 01	4.3E 01	4.3E 01	3.0E 01	3.0E 01
U-232	2.00E-03	2.	2.	0.0	0.0	0.0	0.0	4.	4.	4.	0.0	4.
	5.00E-02	1.	1.	0.4	0.0	0.0	0.0	4.	4.	4.	0.0	4.
	0.20	1.	1.	0.7	0.5	0.2	0.0	4.	4.	4.	0.0	5.
U-233	2.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	5.	6.	6.	0.0	5.
	5.00E-02	0.0	0.0	0.0	0.0	0.0	0.0	6.	5.	6.	0.0	5.
	0.20	0.0	0.0	0.0	0.0	0.0	0.0	6.	6.	6.	0.0	5.
U-234	2.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	0.0	5.
	5.00E-02	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	6.	0.0	5.
	0.20	0.0	0.0	0.0	0.0	0.0	0.0	5.	5.	5.	0.0	5.
U-235	2.00E-05	1.	1.	0.0	0.0	0.0	0.0	6.	6.	5.	0.2	6.
	5.00E-02	2.	2.	0.5	0.0	0.2	0.0	5.	5.	6.	0.0	6.
	0.20	2.	2.	0.8	0.6	0.4	0.0	5.	6.	6.	0.0	6.
U-236	2.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	5.	6.	6.	0.0	6.
	5.00E-02	0.0	0.0	0.0	0.0	0.0	0.0	5.	6.	6.	0.0	6.
	0.20	0.0	0.0	0.0	0.0	0.0	0.0	5.	6.	6.	0.0	6.

Table I-2. (continued)

NUCLIDE	F1	OVARIES	PANCREAS	BONE	R MAR	Y MAR	ENDOST	SPLEEN	TESTES	THYMUS	THYROID	UTERUS
SR-90	0.20	0.0	0.0	3.	3.	0.0	3.	0.0	0.0	0.0	0.0	0.0
	1.00E-02	0.0	0.0	3.	3.	0.0	3.	0.0	0.0	0.0	0.0	0.0
SM-147	1.00E-04	5.	5.	6.	6.	5.	6.	5.	5.	5.	5.	5.
GD-152	1.00E-04	5.	5.	6.	6.	5.	5.	5.	5.	5.	5.	5.
PB-210	8.00E-02	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
PO-214	1.00E-01	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
RA-226	0.20	0.7	0.7	9.	9.	0.7	10.	0.7	0.5	0.7	0.7	0.5
AC-227	1.00E-03	9.	9.	9.	9.	9.	9.	9.	9.	10.	10.	10.
TH-229	1.00E-03	3.1E 01	3.0E 01	3.1E C1	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
TH-230	1.00E-03	3.1E 01	3.2E 01	3.1E C1	3.1E 01	3.1E 01	3.2E 01	3.2E 01	3.1E 01	3.2E 01	3.2E 01	3.2E 01
TH-231	1.00E-03	0.1	0.1	3.	3.	0.1	3.0E 01	0.2	2.	5.	1.4E 01	0.5
TH-232	1.00E-05	3.1E 01	3.1E 01	3.2E C1	3.2E 01	3.2E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PA-231	1.00E-03	4.3E 01	4.3E 01	4.6E C1	4.5E 01	4.3E 01	4.4E 01	4.2E 01	4.3E 01	4.2E 01	4.2E 01	4.2E 01
U-232	2.00E-03	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.
	5.00E-02	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.
	0.20	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.
U-235	2.00E-05	5.	6.	5.	5.	6.	5.	6.	5.	6.	6.	6.
	5.00E-02	5.	5.	5.	6.	5.	5.	5.	5.	5.	5.	5.
	0.20	5.	6.	5.	5.	6.	5.	6.	5.	6.	6.	6.
U-234	2.00E-03	5.	5.	5.	5.	5.	6.	5.	5.	5.	5.	5.
	5.00E-02	5.	5.	5.	6.	5.	5.	5.	5.	5.	5.	5.
	0.20	5.	5.	5.	5.	5.	6.	5.	5.	5.	5.	5.
U-235	2.00E-05	5.	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.
	5.00E-02	6.	6.	5.	6.	5.	6.	6.	6.	6.	5.	6.
	0.20	6.	6.	6.	6.	6.	6.	5.	6.	6.	6.	6.
U-236	2.00E-03	6.	6.	5.	5.	6.	5.	6.	6.	6.	6.	6.
	5.00E-02	6.	6.	5.	6.	6.	5.	6.	6.	6.	6.	6.
	0.20	6.	6.	5.	5.	6.	5.	6.	6.	6.	6.	6.

Table I-2. (continued)

NUCLIDE	F1	LUNGS	RES LYM	S WALL	SI WALL	ULT WALL	LLT WALL	T BODY	ADREN	BL WALL	KIDNEYS	LIVER
U-238	2.00E-03	0.3	0.3	0.0	0.0	0.0	0.0	5.	5.	5.	0.0	6.
	5.00E-02	0.7	0.7	0.0	0.0	0.0	0.0	5.	5.	5.	0.0	6.
	0.20	0.3	0.3	0.1	0.0	0.0	0.0	6.	5.	5.	0.0	6.
U-240	2.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	2.	0.0
	5.00E-02	0.0	0.0	0.0	0.0	0.0	0.0	2.	0.4	0.0	6.	0.1
	0.20	0.0	0.0	0.0	0.0	0.0	0.0	5.	0.9	0.0	6.	0.5
NP-237	1.00E-03	2.5E 01	2.5E 01	3.	2.	0.3	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
NP-238	1.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	7.	0.9	0.3	6.	1.4E 01
NP-239	1.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.
PU-236	3.00E-05	4.	4.	0.0	0.0	0.0	0.0	0.8	3.	3.	0.0	1.
PU-238	3.00E-05	6.	6.	0.0	0.0	0.0	0.0	2.2E 01	2.3E 01	2.3E 01	1.6E 01	1.6E 01
PU-239	3.00E-05	6.	6.	0.0	0.0	0.0	0.0	2.9E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
PU-240	3.00E-05	9.	9.	0.0	0.0	0.0	0.0	2.9E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
PU-241	3.00E-05	3.8E 01	3.8E 01	0.4	0.0	0.0	0.0	4.6E 01	4.7E 01	4.7E 01	3.4E 01	3.5E 01
PU-242	3.00E-05	1.1E 01	1.1E 01	0.0	0.0	0.0	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
PU-243	3.00E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.3	0.5	4.
PU-244	3.00E-05	1.7E 01	1.7E 01	0.2	0.0	0.1	0.0	2.9E 01	3.1E 01	2.4E 01	2.1E 01	2.1E 01
AM-241	1.00E-03	2.3E 01	2.3E 01	0.4	0.0	0.0	0.0	2.8E 01	3.0E 01	2.9E 01	2.0E 01	2.0E 01
AM-242	1.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	4.	4.	2.	3.	3.
AM-242M	1.00E-03	2.1E 01	2.1E 01	3.	1.	0.1	0.0	3.1E 01	3.2E 01	3.2E 01	2.2E 01	2.2E 01
AM-243	1.00E-03	2.4E 01	2.4E 01	3.	2.	0.3	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.2E 01
CM-242	1.00E-03	0.0	0.0	0.0	0.0	0.0	0.0	4.	5.	5.	3.	3.
CM-243	1.00E-03	9.	9.	0.3	0.0	0.1	0.0	1.2E 01	1.2E 01	1.2E 01	8.	8.
CM-244	1.00E-03	1.	1.	0.0	0.0	0.0	0.0	7.	7.	7.	4.	4.
CM-245	1.00E-03	2.4E 01	2.4E 01	1.	0.0	0.0	0.0	3.1E 01	3.3E 01	3.3E 01	2.2E 01	2.2E 01
CM-246	1.00E-03	2.6E 01	2.6E 01	0.6	0.0	0.0	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.2E 01
CM-247	1.00E-03	2.5E 01	2.5E 01	4.	2.	0.4	0.0	3.0E 01	3.1E 01	3.1E 01	2.1E 01	2.1E 01
CM-248	1.00E-03	2.7E 01	2.7E 01	1.3E 01	5.	3.	0.9	3.0E 01	3.0E 01	2.8E 01	2.1E 01	2.1E 01

Table I-2. (continued)

NUCLIDE	F1	CVARIES	PANCREAS	BONE	F. MAR	Y MAR	ENDOST	SPLEEN	TESTES	THYMUS	THYROID	UTERUS
U-238	2.C0E-03	6.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
	5.C0E-02	6.	5.	5.	5.	6.	5.	5.	6.	5.	5.	6.
	0.20	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
U-240	2.C0E-03	0.0	0.0	1.	0.4	0.0	1.0E 01	0.0	0.0	0.0	0.5	0.0
	5.C0E-02	0.0	0.2	9.	6.	0.4	2.6E 01	0.3	0.5	0.7	2.	0.0
	0.20	0.0	0.8	1.0E 01	1.2E 01	0.9	2.7E 01	0.7	1.	2.	2.	0.0
NP-237	1.C0E-03	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.2E 01	3.2E 01	3.1E 01	3.2E 01
NP-238	1.C0E-03	1.	0.5	1.9E 01	1.3E 01	0.8	2.5E 01	1.	7.	6.	1.5E 01	0.2
NP-239	1.C0E-03	0.0	0.0	1.	0.0	0.0	9.	0.0	0.0	0.3	1.	0.0
PU-236	5.C0E-05	2.	5.	0.4	0.5	5.	0.4	3.	2.	3.	3.	3.
PU-238	3.C0E-05	2.3E 01	2.3E 01	2.4E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01	2.3E 01
PU-239	3.C0E-05	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PU-240	3.C0E-05	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PQ-241	3.C0E-05	4.7E 01	4.7E 01	4.7E 01	4.7E 01	4.8E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01	4.7E 01
PU-242	5.C0E-05	5.1E 01	5.1E 01	5.2E 01	5.1E 01	5.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.1E 01
PU-243	3.C0E-05	0.0	0.0	3.	1.	0.0	1.8E 01	0.0	1.	2.	9.	0.0
PU-244	3.C0E-05	2.9E 01	3.0E 01	3.1E 01	3.2E 01	3.0E 01	3.2E 01	3.0E 01	3.1E 01	3.1E 01	3.1E 01	2.7E 01
AM-241	1.C0E-03	3.0E 01	3.0E 01	3.0E 01	2.9E 01	2.9E 01	5.0E 01	5.0E 01	5.0E 01	5.0E 01	5.0E 01	5.0E 01
AM-242	1.C0E-03	3.	3.	5.	5.	3.	5.	4.	5.	5.	5.	2.
AM-242M	1.C0E-05	5.2E 01	5.2E 01	5.2E 01	5.2E 01	5.5E 01	3.3E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01	3.2E 01
AM-243	1.C0E-03	3.1E 01	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.0E 01	3.0E 01	3.1E 01
CM-242	1.C0E-03	5.	5.	5.	4.	5.	5.	5.	5.	5.	5.	5.
CM-243	1.C0E-03	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01	1.2E 01
CM-244	1.C0E-03	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
CM-245	1.C0E-05	5.5E 01	5.5E 01	5.5E 01	5.2E 01	5.5E 01	3.3E 01	3.3E 01	3.3E 01	3.2E 01	3.2E 01	3.3E 01
CM-246	1.C0E-03	3.1E 01	3.1E 01	3.0E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01
CM-247	1.C0E-03	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.1E 01	3.1E 01	3.2E 01	3.1E 01	3.2E 01	3.1E 01
CM-248	1.C0E-03	3.1E 01	3.0E 01	3.1E 01	3.1E 01	3.1E 01	5.1E 01	5.1E 01	5.1E 01	5.1E 01	5.1E 01	5.0E 01

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