ORNL/TM-2009/288

Calculation Package:

Derivation of Facility-Specific Derived Air Concentration (DAC) Values in Support of Spallation Neutron Source Operations

December 2009

Prepared by
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Internal Dosimetrist

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Nuclear & Radiological Protection Division

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D. A. McLaughlin

December 2009

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Derivation of Facility-Specific Derived Air Concentration (DAC) Values in Support of Spallation Neutron Source Operations
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ACRONYMS AND ABBREVIATIONS

ALI	Annual Limit on Intake
AMAD	Activity Median Aerodynamic Diameter
CFR	Code of Federal Regulations
DAC	Derived Air Concentration
DCAL	Dose and Risk Calculation Software
DOE	Department of Energy
ET	Extra Thoracic
ICRP	International Commission on Radiological Protection
IMBA	Integrated Modules for Bioassay Analysis
JAERI	Japanese Atomic Energy Research Institute
K	Kidney
L	Liver
ORNL	Oak Ridge National Laboratory
PC	Personal Computer
SEECAL	Specific Effective Energy Calculation
SI	International System of Units
SNS	Spallation Neutron Source
St	Stochastic
T	Thyroid

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EXECUTIVE SUMMARY

Derived air concentration (DAC) values for 175 radionuclides* produced at the Oak Ridge National Laboratory (ORNL) Spallation Neutron Source (SNS), but not listed in Appendix A of 10 CFR 835 (01/01/2009 version), are presented. The proposed DAC values, ranging between 1 E-07 μCi/mL and 2 E-03 μCi/mL, were calculated in accordance with the recommendations of the International Commission on Radiological Protection (ICRP), and are intended to support an exemption request seeking regulatory relief from the 10 CFR 835, Appendix A, requirement to apply restrictive DACs of 2E-13 μCi/mL and 4E-11 μCi/mL and for non-listed alpha and non-alpha-emitting radionuclides, respectively.

1. INTRODUCTION

The DAC is a secondary radiation protection standard used to control personnel exposure to airborne radioactivity. The DAC is defined within 10 CFR 835.2 (ref. 1) as "the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours…" The annual limit on intake (ALI) is further defined in §835.2 as:

> "the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by reference man (ICRP Publication 23) that would result in a committed effective dose of 5 rem (0.05 sieverts (Sv)) (1 rem = 0.01 Sv) or a committed equivalent dose of 50 rems (0.5 Sv) to any individual organ or tissue. ALI values for intake by ingestion and inhalation of selected radionuclides are based on International Commission on Radiological Protection Publication 68, Dose Coefficients for Intakes of Radionuclides by Workers…"

DAC values mandated for Department of Energy (DOE) facilities are codified in Appendix A to 10 CFR 835 (01/01/2009 version). Appendix A lists DAC values for slightly over 700 radionuclides. The regulatory listing is primarily limited to radionuclides having half-lives greater than 10 minutes (unless supported by a longer-lived parent) which have published radioactive decay information† that are typically encountered in the nuclear fuel cycle, weapons research, or medical applications. However, early operational experience at the ORNL SNS has revealed that the 10 CFR 835, Appendix A, DAC listing is incomplete for the unique radiological mixture produced at the SNS.

The SNS generates neutrons through the bombardment of a mercury target by high-energy protons. The mercury target becomes radioactive due to the production of spallation products and the capture of neutrons and other secondary particles. The radioactive inventory for the mercury target and supporting structures is estimated to contain over 1500 radionuclides extending from tritium to radioactive lead. Many of these radionuclides are extremely short-lived and do not constitute a significant airborne radiological hazard. As such, this calculation package specifically analyzes a subset of 768 radionuclides identified in the SNS final safety assessment for accident analysis

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* The 175 total includes 174 particulates and reactive gases that are controlled by inhalation dose (tabulated in Table 1) and a single inert gas that is controlled by immersion dose (addressed in Appendix E).

† Dose coefficients published in ICRP Publication 68 (ref. 2) apply radioactive decay data presented in ICRP Publication 38 (ref. 3).

purposes (refs. 4, 5). Of this subset, DAC values are listed for 529 nuclides.‡ DACs are not listed in 10 CFR 835 for 239 remaining radionuclides.§

The distribution of radionuclides for which DACs are not listed is presented graphically in Fig. 1. On this plot, which mimics the chart of the nuclides, the line of stability is represented with the solid black squares, green squares represent radionuclides in the SNS accident inventory for which DAC values are listed, and DAC omissions are highlighted by red squares. Inspection of Fig. 1 shows that the majority of the non-listed nuclides lies above the line of stability (proton-rich), tends to group at the periphery of the charted values, and are clustered above an atomic mass of 150.

In cases of DAC omission, 10 CFR 835 requires that:

> "For any single radionuclide not listed in appendix A with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than two hours, the DAC value shall be 4E-11 μCi/mL (1 Bq/m^3). For any single radionuclide not listed in appendix A that decays by alpha emission or spontaneous fission the DAC value shall be 2 E-13μCi/mL (8 E-03 Bq/m^3)."

Of the 239 nuclides for which no DAC is listed, only 40 have a half-life greater than 2 hours. These nuclides are listed below. Operational experience at the SNS has shown that some of these longer-lived radionuclides (for example Re-183) are encountered and have been involved in personnel contamination events.

Nuclide	Half-life
Ar-42	32.9 years
Se-72	8.4 days
Nb-91	680.4 years
Nb-92m	10.12 days
Pd-112	21.1 hours
Ag-113	5.4 hours
Te-118	6 days
Te-119	16.1 hours
Te-119m	4.7 days
Ba-129	2.2 hours
Ba-129m	2.2 hours
La-133	3.9 hours
Ce-132	3.5 hours
Ce-133m	4.9 hours

Nuclide	Half-life
Nd-140	3.4 days
Tb-152	17.5 hours
Tb-154m	9.7 hours
Tb-154n	22.7 hours
Dy152	2.4 hours
Dy-153	6.4 hours
Ho-163	4556.9 years
Er-158	2.3 hours
Er-160	1.2 days
Tm-165	1.3 days
Tm-168	93.1 days
Hf-171	12.1 hours
Ta-178m	2.2 hours
Re-182	64 hours

Nuclide	Half-life
Re-183	70.0 days
Os-183	13.0 hours
Os-191	15.3 days
Os-183m	18.2 hours
Ir-186	15.6 hours
Pt-187	2.4 hours
Pt-202	1.8 days
Au-191	3.2 hours
Au-192	4.9 hours
Au-196	6.2 days
Au-196m	9.7 hours
Hg-192	4.9 hours

‡ The total of 529 radionuclides includes 21 inert radioactive gases for which DAC values are based on submersion, rather than inhalation, and are addressed in Appendix C to 10 CFR 835.

§ The total of 239 radionuclides includes four inert radioactive gases (N-13, Ar-42, Ar-43, and Ar-44) for which DAC values are based on submersion, rather than inhalation.

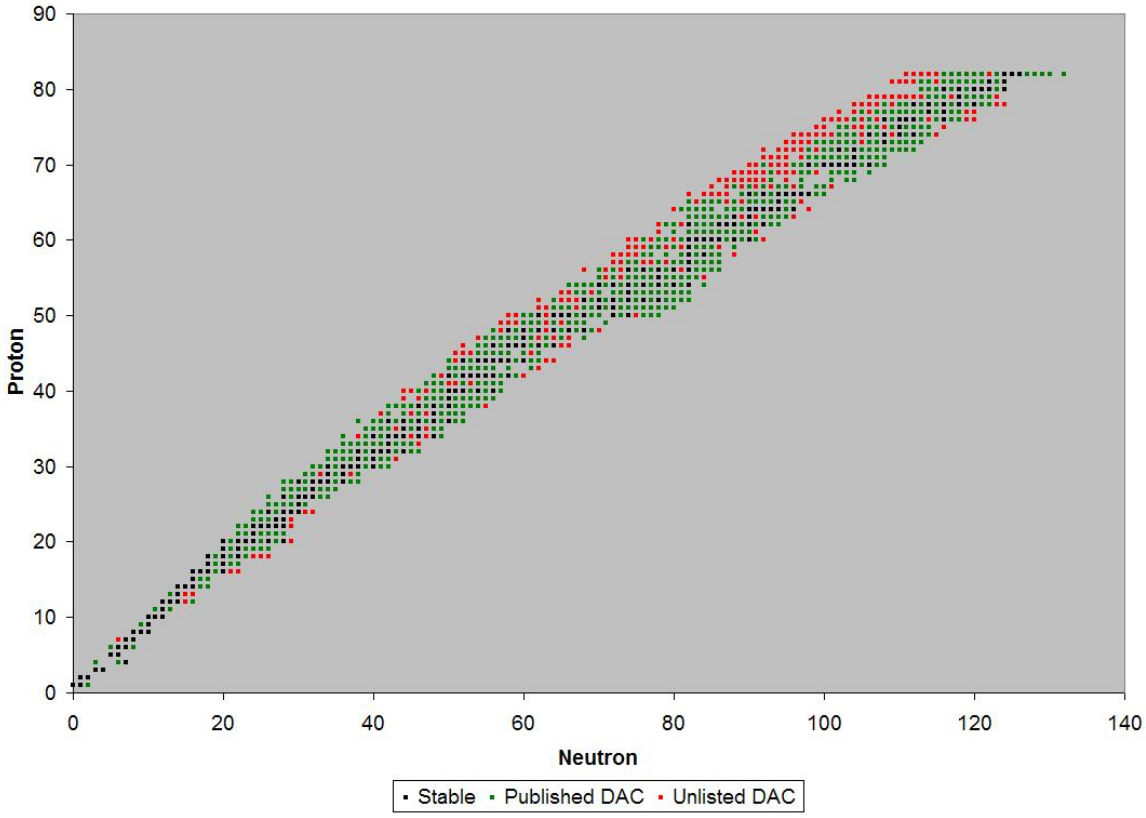

Fig. 1. DAC omissions for the SNS accident inventory plotted on the chart of the nuclides.

Given that the majority of the non-listed radionuclides included in the SNS inventory are short-lived and decay by electron capture, the regulatory DAC limitation is overly conservative. This conclusion is supported by an earlier dosimetric evaluation that calculated inhalation dose coefficients for the general public for off-site accident analyses. The accident-based dose factors suggest that the DACs for the non-listed radionuclides should range between 1E-07 μCi/mL and 8E-03 μCi/mL (ref. 6). However, because the accident-based dose coefficients apply to the general public, utilize a 1-μm AMAD particle size, and only address the effective whole body dose, the corresponding DAC values are inappropriate for occupational control.

In support of an application for regulatory exemption, this calculation package applies ICRP methodology combined with updated radiological decay data [ICRP 107 (ref. 7) and JAERI (ref. 8)] to calculate DAC values for the unlisted radionuclides produced at the SNS. To ensure compliance with 10 CFR 835, the DAC values calculated in this package apply a 5-μm AMAD particle size and evaluate both deterministic and stochastic control limits.**

** The SNS accident inventory contains four radioactive gases (N-13, Ar-42, Ar-43, and Ar-44) for which DAC values are not listed in 10 CFR 835. These nuclides are controlled by immersion dose rather than inhalation. DAC values for similarly controlled nuclides are tabulated in Appendix C to Part 835. For omitted radioactive gases with a decay mode other than alpha emission or spontaneous fission and a half-life of less than two hours, a DAC value of 6E-06 μCi/mL (2E+04 Bq/m^3) is to be applied. With the exception of Ar-42 (32.9-year half-life), this provision applies to all the non-listed radioactive gases produced at the SNS. A DAC value for Ar-42 is derived in Appendix E. No regulatory relief for the other three inert gases is sought.

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2. CALCULATION METHOD

Annual occupational dose limits for general employees are established in 10 CFR 835.202 as 5 rem (0.05 Sv) total effective dose and 50 rem (0.5 Sv) to any organ or tissue other than the lens of the eye. For internal exposures, these limitations account for the committed dose – that is, the dose delivered over 50 years following an intake of radioactive material.

10 CFR 835 defines the committed equivalent dose ($H_{T,50}$) as the equivalent dose calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. The committed effective dose (E_{50}) is defined as the sum of the committed equivalent doses to various tissues or organs in the body, each multiplied by the appropriate tissue weighting factor.

Mathematically, the committed equivalent dose ($H_{T,50}$) is calculated as (ref. 2):

$$H_{T,50} = \sum_{s} U_{s}(50) \sum_{R} \frac{Y_R \, E_R \, w_R \, AF(T \leftarrow S)_R}{m_T} \quad , \qquad (1)$$

where:

$H_{T,50}$ = the committed (50-year) equivalent dose to organ or target tissue "T",

$U_S(50)$ = the number of nuclear transformations (Bq s) in 50 years in source region "S" following an acute intake,

Y_R = the yield of radiation "R" per nuclear transformation,

E_R = the energy of radiation "R",

w_R = the radiation weighting factor for radiation "R" (from Table 8 of ICRP 68),

$AF(T \leftarrow S)_R$ = the absorbed fraction in tissue "T" per transformation in region "S" for radiation "R", and

m_T = mass of target tissue "T".

The committed effective dose is calculated as:

$$E_{50} = \sum w_T H_{T,50} \quad , \qquad (2)$$

where:

E_{50} = committed effective dose, and

w_T = weighting factor for organ/tissue "T".

The organ/tissue weighting factors are taken from 10 CFR 835 as follows:

Organ/tissue	Weighting factor
Gonads	0.20
Red bone marrow	0.12
Colon	0.12
Lungs	0.12
Stomach	0.12
Bladder	0.05
Breast	0.05
Liver	0.05
Esophagus	0.05
Thyroid	0.05
Skin	0.01
Bone surfaces	0.01
Remainder	0.05
Whole body	1.00

To control internal exposures, the ICRP introduced the ALI as a secondary radiation protection limit to meet occupational exposure recommendations. The ALI is defined as the greatest value of the annual intake which satisfies both of the following inequalities:

$$(\mathrm{ALI})\, E_{50} \le 0.05\,\mathrm{Sv} \quad \text{or} \quad \mathrm{ALI} \le \frac{0.05\,\mathrm{Sv}}{E_{50}} \quad , \qquad (3)$$

and

$$(\mathrm{ALI})\, H_{50,\mathrm{T}} \le 0.5\,\mathrm{Sv} \qquad \text{or} \qquad \mathrm{ALI} \le \frac{0.5\ \mathrm{Sv}}{H_{50,\mathrm{T}}} \quad , \qquad (4)$$

The DAC is "derived" from the ALI and is defined as that concentration in air which, if breathed by Reference Man for a working year of 2000 hours under conditions of "light activity," would result in the ALI by inhalation. Numerically, the ALI is given as:

$$\mathrm{DAC} = \frac{\mathrm{ALI\ Bq}}{2.4\mathrm{E}+03\ \mathrm{m}^3} \qquad , \qquad (5)$$

where the ALI is the controlling limit on intake from Eqs. 3 and 4 and the amount of air inhaled annually is 2.4E+03 m^3.

As shown above, values of E_{50} and $H_{50,\mathrm{T}}$ are complex functions combining metabolism, anatomy, radiation interactions, and radiological decay. Historically, listings of E_{50} and $H_{50,\mathrm{T}}$ have been published.

For example, Federal Guidance Report #11 (ref. 9) published dose coefficients for the effective whole body and seven organs/tissues based on ICRP 30 metabolism and ICRP 38 (ref. 3) decay data. Though 10 CFR 835 notes that DAC values are derived from dose coefficients published in ICRP 68, the ICRP 68 report does not provide organ-specific dose factors.

Given that organ-specific dose factors ($H_{50,T}$) are not published in the ICRP 68 report, this calculation package applies dose coefficients generated by the DCAL System (ref. 10). DCAL is a PC-based software code developed by Keith Eckerman and his colleagues in the ORNL Life Sciences Division to calculate both E_{50} and $H_{50,T}$ dose coefficients. DCAL is an extension of the SEECAL code originally used to calculate the dose conversion factors published in ICRP 68 (ref. 2; see reference to Christy and Eckerman on p. 19). DCAL has also been adopted by the U.S. Environmental Protection Agency for risk analysis (ref. 11). DCAL 09, the most recent version, utilizes current metabolic modeling information and updated radiological decay information from ICRP 107 (ref. 7) and the Japanese Atomic Energy Research Institute (ref. 8). The dose coefficients applied in this calculation package are provided in Appendix A.

By convention, DAC values are reported to one significant figure. In practice, as noted in a June 2007 Federal Register posting (ref. 1), DAC values listed in 10 CFR 835 are "truncated to one significant figure." Though the use of truncation is unambiguous, no discussion concerning mathematical rounding practices is provided. Depending on the point of application (for example, rounding any or all of the following: the dose conversion factor, the ALI, and/or the DAC) can alter the final DAC value, particularly when truncation is applied. Therefore, as standard rounding may be non-conservative,[††] this calculation applies the following truncation and rounding rules:

1) DCAL-generated inhalation dose conversion factors are rounded to two significant digits,

2) ALI values are neither rounded nor truncated, and

3) DACs are truncated to one significant digit.

An example calculation applying these rules is presented in Appendix B.

To validate the approach described above, DAC values for 57 radionuclides listed in 10 CFR 835 were calculated. One radioisotope was arbitrarily selected for each element for which a DAC calculation was required. All of the applicable solubility types, as defined within Appendix A, for each of these nuclides were evaluated. In addition, gaseous forms of S, Te, I, and Hg were examined. A comparison of the DCAL-generated committed effective dose coefficients (E_{50}) against ICRP 68 values and a comparison of calculated DAC values against 10 CFR 835 listed values are presented in Appendix C.

DAC values for 61 radionuclides remain uncalculated due to incomplete radiation emission data. These nuclides, of which only five have a half-life greater than 2 hours, are summarized in Appendix D. Until peer-reviewed decay information is published, these nuclides remain subject to the 10 CFR 835 DAC limitations of 2E-13 μCi/mL or 4E-11 μCi/mL, depending upon their decay characteristics.

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†† For example, given an ALI of 9 Bq, the corresponding DAC is 3.75E-03 Bq/m^3. By applying conventional rounding, the DAC would be reported as 4E-03 Bq/m^3 to one significant digit. Continuous exposure to such a concentration would exceed the ALI and the corresponding dose limit. Therefore, for conservatism, truncation (rather than rounding) is applied in this calculation package. As such, this DAC would be reported as 3 E-03 Bq/m^3.

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3. RESULTS

DAC values for 174 radionuclides present in the SNS target inventory, but not listed in Appendix A of 10 CFR 835, are presented below. The tabular format used in this report is identical to that presented in Appendix A of 10 CFR 835. The calculated DAC values for unlisted radionuclides range from a minimum of 1E-07 μCi/mL to a maximum of 2E-03 μCi/mL.

Table 1. DAC values for non-listed radionuclides

Radionuclide	Absorption type[b] (μCi/mL)			Absorption type[b] (Bq/m^3)			Stochastic or organ or tissue[a]
	F	M	S	F	M	S	(F/M/S)
Mg-27	1.E-05	1.E-05	-	6.E+05	4.E+05	-	ET / ET /
Al-28	3.E-05	3.E-05	-	1.E+06	1.E+06	-	ET / ET /
Al-29	1.E-05	1.E-05	-	6.E+05	5.E+05	-	ET / ET /
S-37 (vapor)	-	4.E-05	-	-	1.E+06	-	/ ET /
S-37	1.E-05	1.E-05	-	6.E+05	5.E+05	-	ET / ET /
S-38 (vapor)	-	2.E-06	-	-	1.E+05	-	/ St /
S-38	1.E-06	1.E-06	-	5.E+04	4.E+04	-	ET / E /
Ca-49	-	8.E-06	-	-	3.E+05	-	/ ET /
Ti-51	2.E-05	2.E-05	1.E-05	9.E+05	7.E+05	7.E+05	ET / ET / ET
V-52	2.E-05	2.E-05	-	9.E+05	8.E+05	-	ET / ET /
Cr-55	4.E-05	3.E-05	3.E-05	1.E+06	1.E+06	1.E+06	ET / ET / ET
Cr-56	1.E-05	1.E-05	1.E-05	7.E+05	5.E+05	5.E+05	ET / ET / ET
Cu-62	1.E-05	1.E-05	1.E-05	6.E+05	4.E+05	4.E+05	ET / ET / ET
Cu-66	3.E-05	2.E-05	2.E-05	1.E+06	8.E+05	8.E+05	ET / ET / ET
Ga-74	1.E-05	9.E-06	-	4.E+05	3.E+05	-	ET / ET /
As-79	-	1.E-05	-	-	4.E+05	-	/ ET /
Se-72	2.E-07	2.E-07	-	7.E+03	7.E+03	-	St / St /
Br-78	2.E-05	1.E-05	-	7.E+05	6.E+05	-	ET / ET /
Br-82m	1.E-04	9.E-05	-	3.E+06	3.E+06	-	ET / ET /
Rb-78	6.E-06	-	-	2.E+05	-	-	ET / /
Rb-82	6.E-05	-	-	2.E+06	-	-	ET / /
Rb-84m	2.E-05	-	-	8.E+05	-	-	ET / /
Sr-93	1.E-05	-	9.E-06	4.E+05	-	3.E+05	ET / / ET
Y-83	-	1.E-05	1.E-05	-	4.E+05	4.E+05	/ ET / ET
Y-85	-	2.E-06	2.E-06	-	9.E+04	9.E+04	/ ET / ET
Zr-85	1.E-05	1.E-05	1.E-05	5.E+05	4.E+05	4.E+05	ET / ET / ET
Zr-87	4.E-06	3.E-06	3.E-06	1.E+05	1.E+05	1.E+05	ET / ET / ET
Nb-91	-	3.E-06	5.E-07	-	1.E+05	1.E+04	/ St / St
Nb-91m	-	2.E-07	1.E-07	-	7.E+03	6.E+03	/ St / St
Nb-92m	-	6.E-07	6.E-07	-	2.E+04	2.E+04	/ ET / ET

Radionuclide	Absorption type[b] (μCi/mL)			Absorption type[b] (Bq/m^3)			Stochastic or organ or tissue[a]
	F	M	S	F	M	S	(F/M/S)
Mo-91	1.E-05	-	9.E-06	5.E+05	-	3.E+05	ET / / ET
Mo-102	1.E-05	-	7.E-06	4.E+05	-	2.E+05	ET / / ET
Tc-105	1.E-05	1.E-05	-	5.E+05	4.E+05	-	ET / ET /
Ru-95	4.E-06	3.E-06	3.E-06	1.E+05	1.E+05	1.E+05	ET / ET / ET
Ru-107	2.E-05	2.E-05	1.E-05	9.E+05	7.E+05	7.E+05	ET / ET / ET
Ru-108	1.E-05	1.E-05	1.E-05	5.E+05	4.E+05	4.E+05	ET / ET / ET
Rh-96	9.E-06	7.E-06	7.E-06	3.E+05	2.E+05	2.E+05	ET / ET / ET
Rh-97	8.E-06	7.E-06	7.E-06	3.E+05	2.E+05	2.E+05	ET / ET / ET
Rh-98	1.E-05	1.E-05	1.E-05	5.E+05	4.E+05	4.E+05	ET / ET / ET
Rh-106	1.E-04	1.E-04	1.E-04	6.E+06	6.E+06	6.E+06	ET / ET / ET
Pd-98	1.E-05	7.E-06	7.E-06	3.E+05	2.E+05	2.E+05	ET / ET / ET
Pd-111	1.E-05	1.E-05	1.E-05	5.E+05	3.E+05	3.E+05	ET / ET / ET
Pd-112	7.E-07	4.E-07	4.E-07	2.E+04	1.E+04	1.E+04	St / St / St
Ag-101	1.E-05	1.E-05	1.E-05	5.E+05	4.E+05	3.E+05	ET / ET / ET
Ag-109m	3.E-04	3.E-04	3.E-04	1.E+07	1.E+07	1.E+07	ET / ET / ET
Ag-111m	2.E-03	1.E-03	1.E-03	1.E+08	6.E+07	6.E+07	St / St / St
Ag-113	4.E-06	2.E-06	2.E-06	1.E+05	8.E+04	8.E+04	St / St / St
Cd-105	7.E-06	6.E-06	6.E-06	2.E+05	2.E+05	2.E+05	ET / ET / ET
Cd-111m	1.E-05	6.E-06	6.E-06	3.E+05	2.E+05	2.E+05	ET / ET / ET
Cd-118	7.E-06	4.E-06	4.E-06	2.E+05	1.E+05	1.E+05	ET / E / ET
In-106	1.E-05	1.E-05	-	4.E+05	4.E+05	-	ET / ET /
In-107	8.E-06	7.E-06	-	3.E+05	2.E+05	-	ET / ET /
In-108	2.E-06	2.E-06	-	1.E+05	9.E+04	-	ET / ET /
In-112m	1.E-05	6.E-06	-	3.E+05	2.E+05	-	ET / ET /
In-114	8.E-05	7.E-05	-	3.E+06	2.E+06	-	ET / ET /
In-119	4.E-05	3.E-05	-	1.E+06	1.E+06	-	ET / ET /
Sn-108	1.E-05	1.E-05	-	6.E+05	5.E+05	-	ET / ET /
Sn-109	1.E-05	9.E-06	-	4.E+05	3.E+05	-	ET / ET /
Sn-113m	9.E-05	7.E-05	-	3.E+06	2.E+06	-	ET / ET /
Sn-125m	2.E-05	1.E-05	-	7.E+05	5.E+05	-	ET / ET /
Sb-113	2.E-05	1.E-05	-	8.E+05	6.E+05	-	ET / ET /
Sb-114	2.E-05	2.E-05	-	9.E+05	7.E+05	-	ET / ET /
Sb-118	3.E-05	3.E-05	-	1.E+06	1.E+06	-	ET / ET /
Te-114 (vapor)	-	1.E-05	-	-	6.E+05	-	/ St /
Te-114	7.E-06	5.E-06	-	2.E+05	2.E+05	-	ET / ET /
Te-117 (vapor)	-	1.E-05	-	-	6.E+05	-	/ ET /
Te-117	5.E-06	5.E-06	-	2.E+05	1.E+05	-	ET / ET /
Te-118 (vapor)	-	2.E-07	-	-	1.E+04	-	/ St /
Te-118	4.E-07	2.E-07	-	1.E+04	9.E+03	-	St / St /
Te-119 (vapor)	-	5.E-06	-	-	1.E+05	-	/ ET /
Te-119	1.E-06	1.E-06	-	5.E+04	5.E+04	-	ET / ET /

Radionuclide	Absorption type[b] (μCi/mL)			Absorption type[b] (Bq/m^3)			Stochastic or organ or tissue[a]
	F	M	S	F	M	S	(F/M/S)
Te-119m (vapor)	-	8.E-07	-	-	3.E+04	-	/ St /
Te-119m	5.E-07	5.E-07	-	1.E+04	1.E+04	-	ET / ET /
I-118 (methyl)	3.E-06	-	-	1.E+05	-	-	T / /
I-118 (vapor)	-	2.E-06	-	-	9.E+04	-	/ T /
I-118	4.E-06	-	-	1.E+05	-	-	T / /
I-119 (methyl)	2.E-05	-	-	8.E+05	-	-	T / /
I-119 (vapor)	-	1.E-05	-	-	4.E+05	-	/ St /
I-119	1.E-05	-	-	4.E+05	-	-	ET / /
I-122 (methyl)	5.E-04	-	-	1.E+07	-	-	St / /
I-122 (vapor)	-	2.E-05	-	-	1.E+06	-	/ St /
I-122	3.E-05	-	-	1.E+06	-	-	ET / /
Cs-126	5.E-05	-	-	2.E+06	-	-	ET / /
Cs-128	3.E-05	-	-	1.E+06	-	-	ET / /
Cs-139	1.E-05	-	-	7.E+05	-	-	ET / /
Ba-124	1.E-05	-	-	4.E+05	-	-	ET / /
Ba-127	1.E-05	-	-	6.E+05	-	-	ET / /
Ba-129	8.E-06	-	-	3.E+05	-	-	ET / /
Ba-129m	3.E-06	-	-	1.E+05	-	-	ET / /
Ba-137m	1.E-04	-	-	6.E+06	-	-	ET / /
La-129	1.E-05	1.E-05	-	6.E+05	4.E+05	-	ET / ET /
La-130	1.E-05	1.E-05	-	5.E+05	4.E+05	-	ET / ET /
La-133	1.E-05	1.E-05	-	4.E+05	4.E+05	-	ET / ET /
La-134	3.E-05	2.E-05	-	1.E+06	9.E+05	-	ET / ET /
La-136	4.E-05	3.E-05	-	1.E+06	1.E+06	-	ET / ET /
Ce-130	-	5.E-06	5.E-06	-	2.E+05	2.E+05	/ ET / ET
Ce-131	-	1.E-05	1.E-05	-	4.E+05	3.E+05	/ ET / ET
Ce-132	-	2.E-06	2.E-06	-	7.E+04	7.E+04	/ ET / ET
Ce-133m	-	1.E-06	1.E-06	-	5.E+04	5.E+04	/ ET / ET
Ce-146	-	7.E-06	7.E-06	-	2.E+05	2.E+05	/ ET / ET
Pr-134m	-	7.E-06	6.E-06	-	2.E+05	2.E+05	/ ET / ET
Pr-135	-	9.E-06	9.E-06	-	3.E+05	3.E+05	/ ET / ET
Pr-138	-	6.E-05	6.E-05	-	2.E+06	2.E+06	/ ET / ET
Pr-140	-	4.E-05	4.E-05	-	1.E+06	1.E+06	/ ET / ET
Pr-146	-	7.E-06	7.E-06	-	2.E+05	2.E+05	/ ET / ET
Nd-134	-	1.E-05	1.E-05	-	4.E+05	4.E+05	/ ET / ET
Nd-135	-	7.E-06	6.E-06	-	2.E+05	2.E+05	/ ET / ET
Nd-137	-	6.E-06	6.E-06	-	2.E+05	2.E+05	/ ET / ET
Nd-140	-	4.E-07	4.E-07	-	1.E+04	1.E+04	/ St / St
Nd-152	-	7.E-06	7.E-06	-	2.E+05	2.E+05	/ ET / ET
Pm-139	-	2.E-05	2.E-05	-	9.E+05	8.E+05	/ ET / ET
Pm-152	-	2.E-05	2.E-05	-	8.E+05	8.E+05	/ ET / ET

Radionuclide	Absorption type[b] (μCi/mL)			Absorption type[b] (Bq/m^3)			Stochastic or organ or tissue[a]
	F	M	S	F	M	S	(F/M/S)
Sm-140	-	7.E-06	-	-	2.E+05	-	/ ET /
Sm-143	-	2.E-05	-	-	9.E+05	-	/ ET /
Eu-152n	-	5.E-05	-	-	1.E+06	-	/ St /
Eu-154m	-	1.E-04	-	-	3.E+06	-	/ E /
Eu-159	-	9.E-06	-	-	3.E+05	-	/ ET /
Gd-144	1.E-05	1.E-05	-	6.E+05	5.E+05	-	ET / ET /
Gd-162	1.E-05	8.E-06	-	4.E+05	3.E+05	-	ET / ET /
Tb-148	-	3.E-06	-	-	1.E+05	-	/ ET /
Tb-152	-	9.E-07	-	-	3.E+04	-	/ ET /
Tb-162	-	1.E-05	-	-	4.E+05	-	/ ET /
Dy-148	-	4.E-05	-	-	1.E+06	-	/ ET /
Dy-149	-	1.E-05	-	-	6.E+05	-	/ St /
Dy-150	-	2.E-06	-	-	8.E+04	-	/ St /
Dy-151	-	6.E-06	-	-	2.E+05	-	/ St /
Dy-152	-	5.E-06	-	-	1.E+05	-	/ ET /
Dy-153	-	2.E-06	-	-	8.E+04	-	/ ET /
Ho-154	-	1.E-05	-	-	3.E+05	-	/ ET /
Ho-156	-	3.E-06	-	-	1.E+05	-	/ ET /
Ho-160	-	9.E-06	-	-	3.E+05	-	/ ET /
Ho-163	-	2.E-06	-	-	1.E+05	-	/ BS /
Ho-168	-	2.E-05	-	-	9.E+05	-	/ ET /
Er-154	-	3.E-05	-	-	1.E+06	-	/ ET /
Er-156	-	1.E-05	-	-	4.E+05	-	/ ET /
Er-159	-	8.E-06	-	-	3.E+05	-	/ ET /
Er-163	-	1.E-04	-	-	4.E+06	-	/ ET /
Tm-161	-	6.E-06	-	-	2.E+05	-	/ ET /
Tm-163	-	4.E-06	-	-	1.E+05	-	/ ET /
Tm-164	-	6.E-05	-	-	2.E+06	-	/ ET /
Tm-165	-	1.E-06	-	-	5.E+04	-	/ ET /
Tm-168	-	1.E-07	-	-	6.E+03	-	/ St /
Yb-163	-	1.E-05	1.E-05	-	6.E+05	6.E+05	/ ET / ET
Yb-164	-	6.E-06	6.E-06	-	2.E+05	2.E+05	/ ET / ET
Yb-165	-	4.E-05	4.E-05	-	1.E+06	1.E+06	/ ET / ET
Lu-165	-	1.E-05	1.E-05	-	4.E+05	4.E+05	/ ET / ET
Lu-167	-	5.E-06	5.E-06	-	1.E+05	1.E+05	/ ET / ET
Hf-167	5.E-05	5.E-05	-	2.E+06	1.E+06	-	ET / ET /
Hf-169	8.E-05	7.E-05	-	3.E+06	2.E+06	-	ET / ET /
Ta-170	-	1.E-05	1.E-05	-	4.E+05	4.E+05	/ ET / ET
Ta-178m	-	2.E-06	2.E-06	-	1.E+05	1.E+05	/ ET / ET
W-179m	2.E-05	-	-	7.E+05	-	-	ET / /
W-183m	1.E-03	-	-	5.E+07	-	-	ET / /

Radionuclide	Absorption type[b] (μCi/mL)			Absorption type[b] (Bq/m^3)			Stochastic or organ or tissue[a]
	F	M	S	F	M	S	(F/M/S)
Re-179	1.E-05	1.E-05	-	6.E+05	4.E+05	-	ET / ET /
Re-180	5.E-05	4.E-05	-	1.E+06	1.E+06	-	ET / ET /
Re-182	4.E-07	3.E-07	-	1.E+04	1.E+04	-	ET / St /
Re-183	1.E-06	2.E-07	-	3.E+04	9.E+03	-	St / St /
Os-183	2.E-06	1.E-06	1.E-06	7.E+04	6.E+04	6.E+04	ET / ET / ET
Os-183m	1.E-06	1.E-06	1.E-06	6.E+04	5.E+04	5.E+04	ET / ET / ET
Os-190m	1.E-05	1.E-05	1.E-05	6.E+05	5.E+05	5.E+05	ET / ET / ET
Os-191	1.E-06	4.E-07	3.E-07	5.E+04	1.E+04	1.E+04	St / St / St
Os-196	7.E-06	4.E-06	4.E-06	2.E+05	1.E+05	1.E+05	ET / ET / ET
Ir-183	5.E-06	4.E-06	4.E-06	2.E+05	1.E+05	1.E+05	ET / ET / ET
Ir-186	7.E-07	7.E-07	7.E-07	2.E+04	2.E+04	2.E+04	ET / ET / ET
Ir-196	1.E-04	9.E-05	9.E-05	3.E+06	3.E+06	3.E+06	ET / ET / ET
Ir-196m	2.E-06	1.E-06	1.E-06	8.E+04	7.E+04	7.E+04	ET / ET / ET
Pt-184	8.E-06	-	-	3.E+05	-	-	ET / /
Pt-187	4.E-06	-	-	1.E+05	-	-	ET / /
Pt-202	4.E-07	-	-	1.E+04	-	-	St / /
Au-186	9.E-06	8.E-06	7.E-06	3.E+05	2.E+05	2.E+05	ET / ET / ET
Au-187	2.E-05	2.E-05	2.E-05	9.E+05	7.E+05	7.E+05	ET / ET / ET
Au-190	6.E-06	5.E-06	5.E-06	2.E+05	2.E+05	2.E+05	ET / ET / ET
Au-191	4.E-06	4.E-06	4.E-06	1.E+05	1.E+05	1.E+05	ET / ET / ET
Au-192	1.E-06	1.E-06	1.E-06	6.E+04	5.E+04	5.E+04	ET / ET / ET
Au-196	1.E-06	1.E-06	1.E-06	5.E+04	5.E+04	4.E+04	ET / ET / St
Au-196m	1.E-06	1.E-06	9.E-07	4.E+04	3.E+04	3.E+04	ET / St / St
Au-202	1.E-04	1.E-04	1.E-04	6.E+06	6.E+06	6.E+06	ET / ET / ET
Hg-190 (org)	1.E-05	-	-	4.E+05	-	-	ET / /
Hg-190	1.E-05	1.E-05	-	4.E+05	4.E+05	-	ET / ET /
Hg-190 (vapor)	-	7.E-06	-	-	2.E+05	-	/ St /
Hg-192 (org)	1.E-06	-	-	6.E+04	-	-	ET / /
Hg-192	1.E-06	1.E-06	-	6.E+04	6.E+04	-	ET / ET /
Hg-192 (vapor)	-	5.E-07	-	-	2.E+04	-	/ St /
Hg-205 (org)	2.E-05	-	-	1.E+06	-	-	ET / /
Hg-205	2.E-05	2.E-05	-	1.E+06	8.E+05	-	ET / ET /
Hg-205 (vapor)	-	4.E-05	-	-	1.E+06	-	/ St /
Tl-190	3.E-05	-	-	1.E+06	-	-	ET / /
Tl-196	3.E-06	-	-	1.E+05	-	-	ET / /
Pb-194	1.E-05	-	-	5.E+05	-	-	ET / /
Pb-195m	7.E-06	-	-	2.E+05	-	-	ET / /
Pb-196	6.E-06	-	-	2.E+05	-	-	ET / /
Pb-197	2.E-05	-	-	1.E+06	-	-	ET / /
Pb-204m	4.E-06	-	-	1.E+05	-	-	ET / /

a A determination of whether the DACs are controlled by stochastic (St) or deterministic (organ or tissue) dose for each absorption type is given in this column. The key to the organ notation for deterministic dose is: BS = bone surface, ET = extra thoracic, K = kidney, L = liver, and T = thyroid. The "St" notation is applied to stochastically controlled DACs. The notation "E" is applied in cases where the stochastic and deterministic DACs are equivalent. A blank indicates that no calculations were performed for the absorption type shown.

b A dash indicates no values given for this data category.

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APPENDIX A
DCAL VALUES OF E_{50} AND $H_{50,T}$

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APPENDIX A. DCAL VALUES OF E_{50} AND $H_{50,T}$

DCAL-generated committed effective dose (E_{50}) and committed equivalent dose ($H_{T,50}$) coefficients are presented in Table A.1. Unless otherwise noted, the nuclide-specific dose coefficients are applicable to the acute inhalation of 5-μm AMAD particles by adults. Dose coefficients are provided for each solubility type recognized by the ICRP. Values are listed for the following 17 tissues/organs which may be controlling based on deterministic health effects:‡‡

· ET airways	· Adrenals	· Bladder	· Bone surfaces
· Brain	· Breast	· Esophagus/thymus§§	· Kidney
· Lung	· Muscle	· Pancreas	· Remainder
· Skin	· Small intestine	· Spleen	· Thyroid
· Uterus			

The limiting dose coefficient for each nuclide/solubility combination is **bolded** (and highlighted with grey shading). For example, as dose to the ET airways is controlling for Type "F" Mg-27, the ET airways dose coefficient is bolded and shaded. In cases where stochastic and deterministic limits result in equivalent controls (cases where $H_{T,50}$ and E_{50} – rounded to two significant figures - differ by a factor of 10) both the committed effective coefficient and the limiting tissue/organ coefficient are bolded and shaded (for example, see Type" M" Cd-118).

‡‡ The tissue/organ listing includes those organs or tissues assigned a tissue weighting factor (w_T) less than 0.1. In practice, because the stochastic and deterministic control levels differ by a factor of 10 (5 rem vs 50 rem), deterministic effects become controlling for organs/tissues assigned weighting factors less than 0.1. For example, a thyroid dose of 100 rem is required to achieve an effective whole body dose of 5 rem [that is, 5 rem = (100 rem)(w_T) = (100 rem)(0.05)]. Therefore, the 50 rem deterministic limit is controlling. A survey of 10 CFR 835, Appendix A, shows that only five organs/tissues are currently listed as deterministic controls: ET airways, bone surfaces, kidneys, thyroid, and liver.

§§ DCAL does not generate a dose coefficient for the esophagus. As such, the thymus, for which a dose coefficient is calculated, is used as an anatomical analogue.

Table A.1. DCAL-generated dose coefficients

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)															
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Mg-27	F	1.310E-11	3.322E-10	6.773E-13	5.377E-13	5.094E-13	7.237E-13	5.449E-13	5.028E-13	8.410E-13	4.691E-13	1.665E-10	5.999E-13	6.812E-13	3.107E-12	7.003E-13	1.036E-12	7.861E-13	4.817E-13
Mg-27	M	1.807E-11	4.422E-10	4.123E-13	3.215E-13	2.851E-13	4.938E-13	1.157E-13	3.109E-13	6.620E-13	2.488E-13	2.214E-10	4.063E-13	4.562E-13	4.007E-12	4.958E-13	1.022E-12	6.844E-13	2.178E-13
Mg-28	F	1.081E-09	1.512E-08	1.328E-09	1.995E-10	1.796E-10	2.025E-10	4.171E-10	1.481E-10	2.135E-10	1.524E-10	7.670E-09	2.054E-10	1.966E-10	7.130E-10	2.108E-10	2.073E-10	1.821E-10	2.510E-10
Mg-28	M	1.679E-09	1.592E-08	7.827E-10	1.603E-10	1.532E-10	1.498E-10	2.902E-10	1.263E-10	1.841E-10	1.114E-10	8.058E-09	1.643E-10	1.358E-10	1.117E-09	1.739E-10	1.822E-10	1.560E-10	2.364E-10
Al-26	F	1.389E-08	3.062E-08	2.598E-08	1.111E-08	1.021E-08	9.899E-09	1.049E-08	7.710E-09	9.594E-09	7.374E-09	2.016E-08	1.252E-08	9.072E-09	1.218E-08	9.644E-09	1.154E-08	1.022E-08	1.164E-08
Al-26	M	1.207E-08	3.309E-08	7.043E-09	3.492E-09	4.357E-09	3.336E-09	2.798E-09	4.233E-09	5.088E-09	2.310E-09	3.351E-09	5.173E-09	2.356E-09	4.363E-09	3.349E-09	4.401E-09	4.082E-09	3.227E-09
Al-28	F	5.266E-12	1.544E-10	2.237E-13	1.227E-13	1.332E-13	2.917E-13	7.323E-14	1.748E-13	3.576E-13	1.496E-13	7.731E-11	1.548E-13	2.750E-13	2.572E-13	2.457E-13	2.472E-13	1.909E-13	8.610E-14
Al-28	M	5.961E-12	1.748E-10	1.785E-13	7.319E-14	8.513E-14	2.538E-13	1.700E-14	1.371E-13	3.281E-13	1.079E-13	8.752E-11	1.084E-13	2.386E-13	2.292E-13	2.067E-13	2.152E-13	1.528E-13	2.845E-14
Al-29	F	1.162E-11	2.983E-10	6.247E-13	4.716E-13	4.568E-13	7.153E-13	3.193E-13	4.867E-13	8.583E-13	4.395E-13	1.495E-10	5.356E-13	6.723E-13	2.144E-12	6.656E-13	9.273E-13	7.028E-13	3.955E-13
Al-29	M	1.503E-11	3.779E-10	4.145E-13	2.803E-13	2.622E-13	5.306E-13	7.853E-14	3.261E-13	7.173E-13	2.557E-13	1.892E-10	3.606E-13	4.927E-13	2.545E-12	4.945E-13	8.845E-13	5.974E-13	1.628E-13
S-35	F	7.973E-11	6.515E-10	4.279E-11	4.279E-11	4.279E-11	4.279E-11	1.284E-10	4.279E-11	4.279E-11	4.279E-11	3.472E-10	4.279E-11	4.279E-11	4.841E-11	4.279E-11	4.279E-11	4.279E-11	4.279E-11
S-35	M	1.100E-09	2.508E-09	8.241E-12	8.241E-12	8.241E-12	8.241E-12	2.473E-11	8.241E-12	8.241E-12	8.241E-12	1.058E-11	8.241E-12	8.241E-12	6.034E-11	8.241E-12	8.241E-12	8.241E-12	8.241E-12
S-35	V	1.086E-10	2.392E-10	7.254E-11	7.254E-11	7.254E-11	7.254E-11	2.176E-10	7.254E-11	7.254E-11	7.254E-11	1.559E-10	7.254E-11	7.254E-11	7.498E-11	7.254E-11	7.254E-11	7.254E-11	7.254E-11
S-37	F	1.098E-11	3.126E-10	6.890E-13	4.692E-13	4.704E-13	8.671E-13	6.110E-13	5.604E-13	1.027E-12	4.544E-13	1.567E-10	5.583E-13	8.082E-13	1.125E-12	7.617E-13	1.026E-12	7.522E-13	3.552E-13
S-37	M	1.347E-11	3.792E-10	5.609E-13	3.409E-13	3.417E-13	7.639E-13	1.244E-13	4.791E-13	9.686E-13	3.422E-13	1.899E-10	4.468E-13	7.118E-13	1.295E-12	6.656E-13	1.050E-12	7.130E-13	1.739E-13
S-37	V	1.109E-11	1.183E-10	8.077E-13	7.396E-13	1.001E-12	8.706E-13	1.098E-12	1.083E-12	1.379E-12	5.736E-13	5.957E-11	1.143E-12	6.152E-13	8.862E-13	8.204E-13	1.178E-12	1.066E-12	5.451E-13
S-38	F	2.438E-10	3.881E-09	4.113E-11	3.716E-11	3.590E-11	4.320E-11	7.332E-10	3.280E-11	4.609E-11	3.283E-11	1.963E-09	3.676E-11	4.085E-11	1.895E-10	4.267E-11	4.483E-11	3.930E-11	4.952E-11
S-38	M	4.301E-10	4.344E-09	2.065E-11	2.653E-11	2.250E-11	1.956E-11	1.019E-10	1.543E-11	2.654E-11	1.402E-11	2.195E-09	2.071E-11	1.745E-11	9.569E-10	2.623E-11	3.669E-11	2.736E-11	4.955E-11
S-38	V	1.893E-10	1.104E-09	5.921E-11	5.912E-11	5.883E-11	5.738E-11	1.327E-09	5.159E-11	5.950E-11	5.019E-11	6.062E-11	6.000E-11	5.294E-11	1.310E-10	5.878E-11	6.403E-11	5.978E-11	7.805E-11
Ca-45	M	2.191E-09	4.698E-09	3.131E-09	8.689E-12	8.689E-12	8.689E-12	1.670E-11	8.689E-12	8.689E-12	8.689E-12	1.278E-11	8.689E-12	8.689E-12	9.180E-11	8.689E-12	8.689E-12	8.689E-12	8.689E-12
Ca-49	M	3.020E-11	6.269E-10	1.193E-12	8.218E-13	7.546E-13	1.356E-12	4.087E-13	9.323E-13	1.743E-12	6.704E-13	3.143E-10	9.864E-13	1.256E-12	2.425E-11	1.266E-12	2.447E-12	1.648E-12	5.440E-13
Ti-45	F	8.319E-11	1.708E-09	1.199E-11	1.159E-11	1.058E-11	1.189E-11	1.078E-11	7.830E-12	1.226E-11	8.184E-12	8.612E-10	1.045E-11	1.108E-11	1.162E-10	1.262E-11	1.467E-11	1.195E-11	1.688E-11
Ti-45	M	1.409E-10	2.017E-09	7.107E-12	8.930E-12	7.485E-12	6.259E-12	7.290E-12	4.349E-12	8.055E-12	4.003E-12	1.015E-09	7.047E-12	5.572E-12	2.059E-10	9.099E-12	1.429E-11	1.001E-11	1.779E-11
Ti-45	S	1.473E-10	2.051E-09	6.568E-12	8.636E-12	7.144E-12	5.639E-12	6.905E-12	3.966E-12	7.603E-12	3.542E-12	1.032E-09	6.672E-12	4.964E-12	2.158E-10	8.710E-12	1.425E-11	9.799E-12	1.789E-11
Ti-51	F	8.451E-12	2.158E-10	2.698E-13	2.082E-13	2.053E-13	2.729E-13	1.689E-13	2.040E-13	2.994E-13	1.962E-13	1.081E-10	2.266E-13	2.620E-13	1.304E-12	2.635E-13	3.369E-13	2.759E-13	1.872E-13
Ti-51	M	1.103E-11	2.782E-10	1.376E-13	7.769E-14	7.408E-14	1.442E-13	2.587E-14	8.093E-14	1.805E-13	6.813E-14	1.392E-10	1.005E-13	1.348E-13	1.533E-12	1.394E-13	2.446E-13	1.682E-13	4.512E-14
Ti-51	S	1.132E-11	2.851E-10	1.230E-13	6.333E-14	5.965E-14	1.301E-13	1.012E-14	6.739E-14	1.674E-13	5.404E-14	1.426E-10	8.667E-14	1.208E-13	1.558E-12	1.258E-13	2.345E-13	1.563E-13	2.949E-14
V-49	F	2.589E-11	6.439E-12	2.913E-10	6.439E-12	6.439E-12	6.439E-12	8.589E-12	6.439E-12	6.439E-12	6.439E-12	6.492E-12	6.439E-12	6.439E-12	8.983E-12	6.439E-12	6.439E-12	6.439E-12	6.439E-12
V-49	M	2.252E-11	1.322E-12	5.922E-11	1.309E-12	1.309E-12	1.309E-12	1.747E-12	1.309E-12	1.309E-12	1.309E-12	1.420E-12	1.309E-12	1.309E-12	6.614E-12	1.309E-12	1.309E-12	1.309E-12	1.309E-12
V-52	F	7.667E-12	2.125E-10	3.424E-13	2.245E-13	2.281E-13	4.174E-13	2.374E-13	2.665E-13	5.122E-13	2.363E-13	1.064E-10	2.670E-13	3.930E-13	6.924E-13	3.719E-13	4.495E-13	3.430E-13	1.731E-13
V-52	M	9.195E-12	2.537E-10	2.506E-13	1.306E-13	1.352E-13	3.377E-13	4.180E-14	1.918E-13	4.509E-13	1.527E-13	1.270E-10	1.802E-13	3.159E-13	7.103E-13	2.938E-13	4.047E-13	2.790E-13	6.008E-14
Cr-51	F	2.989E-11	2.516E-10	2.419E-11	1.463E-11	1.406E-11	1.374E-11	1.994E-11	9.610E-12	1.327E-11	9.496E-12	1.327E-10	1.518E-11	1.211E-11	2.522E-11	1.366E-11	1.587E-11	1.402E-11	1.935E-11
Cr-51	M	3.450E-11	2.510E-10	1.134E-11	7.494E-12	1.075E-11	7.074E-12	8.928E-12	1.017E-11	1.325E-11	4.505E-12	1.297E-10	1.204E-11	4.193E-12	2.164E-11	8.367E-12	1.075E-11	9.780E-12	1.041E-11
Cr-51	S	3.650E-11	2.521E-10	9.930E-12	6.735E-12	1.113E-11	6.501E-12	7.258E-12	1.133E-11	1.454E-11	3.969E-12	1.301E-10	1.264E-11	3.084E-12	2.093E-11	7.998E-12	1.073E-11	9.871E-12	9.037E-12
Cr-55	F	5.501E-12	1.428E-10	8.046E-14	8.019E-14	8.019E-14	8.028E-14	9.618E-14	8.022E-14	8.032E-14	8.020E-14	7.144E-11	8.021E-14	8.027E-14	4.960E-13	8.026E-14	8.028E-14	8.024E-14	8.017E-14
Cr-55	M	6.728E-12	1.747E-10	8.153E-15	8.078E-15	8.080E-15	8.170E-15	9.642E-15	8.107E-15	8.217E-15	8.090E-15	8.736E-11	8.098E-15	8.161E-15	5.211E-13	8.149E-15	8.189E-15	8.139E-15	8.048E-15
Cr-55	S	6.863E-12	1.782E-10	1.978E-16	1.441E-16	1.470E-16	2.370E-16	1.216E-16	1.737E-16	2.851E-16	1.558E-16	8.911E-11	1.651E-16	2.278E-16	5.239E-13	2.158E-16	2.582E-16	2.063E-16	1.135E-16
Cr-56	F	1.248E-11	2.915E-10	9.387E-13	8.350E-13	7.739E-13	8.563E-13	1.683E-12	6.364E-13	9.268E-13	6.480E-13	1.463E-10	7.747E-13	8.077E-13	9.106E-12	9.082E-13	1.049E-12	8.745E-13	1.125E-12
Cr-56	M	1.780E-11	3.678E-10	5.149E-13	5.646E-13	4.787E-13	4.249E-13	5.586E-13	3.252E-13	5.814E-13	2.925E-13	1.844E-10	4.672E-13	3.800E-13	1.557E-11	5.846E-13	9.281E-13	6.622E-13	1.011E-12
Cr-56	S	1.838E-11	3.762E-10	4.682E-13	5.348E-13	4.462E-13	3.774E-13	4.346E-13	2.910E-13	5.434E-13	2.534E-13	1.885E-10	4.333E-13	3.328E-13	1.628E-11	5.489E-13	9.147E-13	6.388E-13	9.985E-13
Cu-62	F	1.574E-11	3.383E-10	9.459E-13	8.052E-13	8.100E-13	1.036E-12	6.167E-13	7.422E-13	1.115E-12	7.092E-13	1.697E-10	8.797E-13	1.036E-12	5.690E-12	1.004E-12	1.482E-12	1.130E-12	7.368E-13
Cu-62	M	2.160E-11	4.469E-10	5.129E-13	4.022E-13	3.637E-13	6.157E-13	1.337E-13	3.673E-13	7.494E-13	3.006E-13	2.238E-10	5.058E-13	5.760E-13	7.447E-12	6.181E-13	1.307E-12	8.770E-13	2.771E-13
Cu-62	S	2.225E-11	4.589E-10	4.652E-13	3.578E-13	3.146E-13	5.695E-13	8.052E-14	3.261E-13	7.092E-13	2.556E-13	2.298E-10	4.646E-13	5.253E-13	7.640E-12	5.756E-13	1.288E-12	8.492E-13	2.265E-13

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{t,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Cu-64	F	6.813E-11	1.318E-09	1.286E-11	1.201E-11	2.863E-11	1.266E-11	1.285E-11	9.563E-12	1.254E-11	9.728E-12	6.663E-10	1.201E-11	3.542E-11	4.901E-11	1.255E-11	2.989E-11	1.169E-11	1.415E-11
Cu-64	M	1.467E-10	1.531E-09	9.036E-12	8.839E-12	1.774E-11	8.532E-12	9.614E-12	6.912E-12	9.614E-12	6.333E-12	7.710E-10	8.786E-12	2.020E-11	8.067E-11	9.480E-12	1.958E-11	8.986E-12	1.260E-11
Cu-64	S	1.556E-10	1.554E-09	8.611E-12	8.484E-12	1.653E-11	8.073E-12	9.251E-12	6.620E-12	9.292E-12	5.954E-12	7.826E-10	8.429E-12	1.850E-11	8.414E-11	9.137E-12	1.843E-11	8.685E-12	1.243E-11
Cu-66	F	7.536E-12	1.634E-10	1.664E-13	1.568E-13	1.625E-13	1.724E-13	1.483E-13	1.585E-13	1.809E-13	1.561E-13	9.179E-11	1.612E-13	1.782E-13	1.145E-12	1.696E-13	1.884E-13	1.697E-13	1.519E-13
Cu-66	M	9.735E-12	2.355E-10	3.774E-14	2.821E-14	2.840E-14	4.449E-14	1.733E-14	3.166E-14	5.530E-14	2.817E-14	1.178E-10	3.354E-14	4.323E-14	1.318E-12	4.234E-14	6.072E-14	4.513E-14	2.108E-14
Cu-66	S	9.977E-12	2.412E-10	2.359E-14	1.406E-14	1.364E-14	3.043E-14	2.911E-15	1.771E-14	4.148E-14	1.409E-14	1.206E-10	1.949E-14	2.838E-14	1.337E-12	2.835E-14	4.668E-14	3.142E-14	6.682E-15
Ga-70	F	1.568E-11	3.152E-10	7.065E-13	5.911E-13	6.812E-13	5.926E-13	6.051E-13	5.890E-13	5.946E-13	5.888E-13	1.580E-10	5.914E-13	5.920E-13	1.200E-11	5.929E-13	5.999E-13	6.987E-13	5.916E-13
Ga-70	M	2.628E-11	4.850E-10	7.687E-14	6.536E-14	7.312E-14	6.585E-14	6.254E-14	6.355E-14	6.906E-14	6.245E-14	2.427E-10	6.617E-14	6.517E-14	1.850E-11	6.689E-14	7.907E-14	8.243E-14	6.561E-14
Ga-74	F	1.799E-11	4.726E-10	1.448E-12	1.090E-12	1.054E-12	1.696E-12	6.660E-13	1.080E-12	2.009E-12	9.435E-13	2.371E-10	1.246E-12	1.576E-12	3.925E-12	1.567E-12	2.404E-12	1.771E-12	9.066E-13
Ga-74	M	2.310E-11	5.883E-10	1.099E-12	8.039E-13	7.339E-13	1.406E-12	2.227E-13	8.745E-13	1.844E-12	6.627E-13	2.948E-10	1.005E-12	1.299E-12	4.770E-12	1.326E-12	2.608E-12	1.747E-12	5.031E-13
As-74	M	1.817E-09	8.430E-09	1.931E-10	4.389E-10	4.612E-10	1.746E-10	3.342E-10	2.231E-10	2.766E-10	1.261E-10	2.069E-10	2.686E-10	1.215E-10	4.817E-10	1.965E-10	2.525E-10	3.452E-10	2.263E-10
As-79	M	2.121E-11	4.680E-10	5.759E-14	4.947E-14	4.690E-14	5.396E-14	7.311E-14	4.493E-14	6.140E-14	4.215E-14	2.341E-10	5.094E-14	5.218E-14	4.658E-12	5.645E-14	8.578E-14	6.872E-14	4.234E-14
Se-72	F	2.694E-09	8.287E-09	1.207E-09	2.360E-08	1.155E-08	1.046E-09	1.364E-09	9.923E-10	1.099E-09	9.401E-10	1.239E-08	1.894E-09	9.475E-10	1.361E-09	1.137E-09	4.529E-09	4.741E-09	1.206E-09
Se-72	M	2.762E-09	8.175E-09	3.007E-10	3.911E-09	2.021E-09	2.484E-10	3.348E-10	3.263E-10	3.828E-10	2.043E-10	3.464E-10	4.722E-10	1.818E-10	6.524E-10	2.983E-10	8.708E-10	8.986E-10	3.405E-10
Se-79	F	1.497E-09	1.209E-09	5.055E-10	1.689E-08	7.271E-09	5.055E-10	5.803E-10	5.055E-10	5.055E-10	5.055E-10	8.707E-09	5.055E-10	5.055E-10	5.116E-10	5.055E-10	2.619E-09	2.910E-09	5.055E-10
Se-79	M	2.881E-09	5.988E-09	4.551E-10	1.520E-08	6.547E-09	4.551E-10	5.225E-10	4.551E-10	4.551E-10	4.551E-10	7.841E-09	4.551E-10	4.551E-10	4.679E-10	4.551E-10	2.358E-09	2.620E-09	4.551E-10
Br-74	F	4.979E-11	1.183E-09	6.941E-12	5.865E-12	5.531E-12	7.748E-12	4.141E-12	5.209E-12	8.622E-12	4.683E-12	5.949E-10	6.525E-12	7.121E-12	7.486E-12	7.254E-12	1.171E-11	8.714E-12	4.824E-12
Br-74	M	6.808E-11	1.444E-09	5.497E-12	4.982E-12	4.558E-12	6.387E-12	2.145E-12	4.661E-12	8.045E-12	3.535E-12	7.251E-10	6.072E-12	5.759E-12	7.466E-12	6.287E-12	1.439E-11	9.848E-12	2.871E-12
Br-78	F	1.068E-11	2.658E-10	5.639E-13	4.316E-13	4.256E-13	6.424E-13	3.092E-13	4.269E-13	7.018E-13	3.992E-13	1.332E-10	4.972E-13	6.065E-13	7.567E-13	6.030E-13	8.410E-13	6.481E-13	3.439E-13
Br-78	M	1.381E-11	3.371E-10	3.705E-13	2.424E-13	2.355E-13	4.618E-13	7.894E-14	2.639E-13	5.503E-13	2.182E-13	1.688E-10	3.276E-13	4.297E-13	6.767E-13	4.343E-13	7.847E-13	5.374E-13	1.097E-13
Br-82m	F	2.415E-12	5.582E-11	7.466E-13	6.493E-13	6.538E-13	7.401E-13	7.580E-13	4.830E-13	7.633E-13	4.568E-13	2.825E-11	6.912E-13	6.328E-13	7.940E-13	6.829E-13	7.521E-13	6.612E-13	7.502E-13
Br-82m	M	3.258E-12	5.959E-11	7.040E-13	6.070E-13	6.688E-13	7.048E-13	6.535E-13	5.499E-13	8.310E-13	4.239E-13	3.012E-11	7.254E-13	5.696E-13	7.213E-13	6.565E-13	7.776E-13	6.807E-13	6.525E-13
Rb-78	F	3.709E-11	8.455E-10	4.589E-12	3.718E-12	3.518E-12	4.994E-12	2.567E-12	3.403E-12	5.577E-12	3.049E-12	4.251E-10	4.165E-12	4.627E-12	5.127E-12	4.684E-12	7.537E-12	5.610E-12	2.985E-12
Rb-82	F	2.911E-12	8.809E-11	9.299E-14	4.223E-14	4.938E-14	1.194E-13	2.560E-14	6.301E-14	1.343E-13	5.696E-14	4.409E-11	5.692E-14	1.130E-13	5.502E-14	1.028E-13	8.299E-14	6.625E-14	2.844E-14
Rb-84m	F	8.915E-12	2.463E-10	1.737E-12	9.626E-13	9.142E-13	1.089E-12	8.575E-13	7.261E-13	1.127E-12	6.942E-13	1.237E-10	1.080E-12	1.002E-12	1.094E-12	1.040E-12	1.546E-12	1.221E-12	9.106E-13
Rb-88	F	2.819E-11	3.851E-10	2.585E-12	2.256E-12	2.222E-12	2.467E-12	2.076E-12	2.213E-12	2.595E-12	2.158E-12	1.938E-10	2.323E-12	2.407E-12	4.782E-12	2.412E-12	2.858E-12	2.555E-12	2.140E-12
Sr-89	F	1.404E-09	2.378E-09	6.810E-09	2.237E-10	2.237E-10	2.237E-10	7.659E-10	2.237E-10	2.237E-10	2.237E-10	2.297E-10	2.237E-10	2.237E-10	4.593E-10	2.237E-10	2.237E-10	2.237E-10	2.237E-10
Sr-89	S	5.585E-09	6.092E-09	9.892E-11	3.269E-12	3.286E-12	3.268E-12	1.114E-11	3.292E-12	3.301E-12	3.261E-12	2.142E-11	3.291E-12	3.255E-12	7.282E-10	3.273E-12	3.282E-12	3.281E-12	3.269E-12
Sr-93	F	1.971E-11	4.700E-10	4.341E-12	1.021E-12	9.768E-13	1.453E-12	3.144E-12	9.925E-13	1.675E-12	9.180E-13	2.358E-10	1.146E-12	1.376E-12	7.112E-12	1.381E-12	1.948E-12	1.486E-12	9.069E-13
Sr-93	S	2.961E-11	6.086E-10	8.123E-13	5.494E-13	4.989E-13	9.707E-13	1.615E-13	5.793E-13	1.295E-12	4.471E-13	3.049E-10	7.033E-13	8.966E-13	1.559E-11	9.449E-13	1.844E-12	1.227E-12	3.576E-13
Y-83	M	1.898E-11	4.153E-10	8.118E-13	4.917E-13	5.495E-13	6.981E-13	3.525E-13	4.417E-13	8.981E-13	3.533E-13	2.081E-10	5.836E-13	6.357E-13	5.329E-12	7.584E-13	1.286E-12	8.820E-13	5.548E-13
Y-83	S	1.947E-11	4.244E-10	5.923E-13	4.456E-13	4.249E-13	6.593E-13	2.820E-13	4.175E-13	8.753E-13	3.168E-13	2.126E-10	5.366E-13	5.914E-13	5.453E-12	7.243E-13	1.266E-12	8.618E-13	5.177E-13
Y-85	M	1.512E-10	2.204E-09	1.166E-11	1.192E-11	1.160E-11	8.024E-12	1.143E-11	5.738E-12	1.075E-11	5.086E-12	1.110E-09	9.642E-12	7.110E-12	2.552E-10	1.192E-11	1.896E-11	1.317E-11	2.385E-11
Y-85	S	1.567E-10	2.231E-09	9.311E-12	1.153E-11	9.697E-12	7.411E-12	9.075E-12	5.512E-12	1.046E-11	4.633E-12	1.124E-09	9.114E-12	6.404E-12	2.672E-10	1.155E-11	1.898E-11	1.311E-11	2.405E-11
Y-90	M	1.635E-09	2.222E-09	1.146E-10	3.964E-12	1.125E-10	3.964E-12	1.860E-11	3.964E-12	3.964E-12	3.964E-12	2.607E-11	3.964E-12	3.964E-12	1.013E-09	3.964E-12	3.964E-12	3.964E-12	3.964E-12
Y-90	S	1.729E-09	2.277E-09	1.353E-12	4.678E-14	1.327E-12	4.678E-14	2.196E-13	4.678E-14	4.678E-14	4.678E-14	2.333E-11	4.678E-14	4.678E-14	1.064E-09	4.685E-14	4.678E-14	4.678E-14	4.679E-14
Zr-85	F	1.895E-11	4.054E-10	2.730E-12	1.464E-12	1.339E-12	1.742E-12	1.295E-12	1.159E-12	1.877E-12	1.145E-12	2.037E-10	1.520E-12	1.663E-12	1.086E-11	1.754E-12	2.273E-12	1.774E-12	1.684E-12
Zr-85	M	2.591E-11	5.016E-10	1.145E-12	9.616E-13	8.485E-13	1.077E-12	6.363E-13	6.875E-13	1.379E-12	5.819E-13	2.516E-10	9.632E-13	9.814E-13	1.715E-11	1.248E-12	2.127E-12	1.470E-12	1.372E-12
Zr-85	S	2.668E-11	5.122E-10	9.573E-13	9.057E-13	7.981E-13	1.005E-12	5.622E-13	6.410E-13	1.331E-12	5.200E-13	2.569E-10	9.045E-13	9.044E-13	1.784E-11	1.193E-12	2.113E-12	1.439E-12	1.336E-12
Zr-87	F	8.229E-11	1.356E-09	2.707E-11	1.185E-11	1.047E-11	1.168E-11	1.246E-11	8.184E-12	1.191E-11	8.503E-12	6.856E-10	1.173E-11	1.132E-11	1.474E-10	1.240E-11	1.458E-11	1.194E-11	1.591E-11
Zr-87	M	1.339E-10	1.614E-09	7.927E-12	7.349E-12	6.344E-12	5.394E-12	6.879E-12	4.229E-12	7.352E-12	3.514E-12	8.137E-10	6.521E-12	4.693E-12	2.574E-10	7.777E-12	1.246E-11	8.897E-12	1.429E-11
Zr-87	S	1.396E-10	1.643E-09	5.779E-12	6.848E-12	5.897E-12	4.700E-12	6.252E-12	3.807E-12	6.865E-12	2.962E-12	8.278E-10	5.953E-12	3.955E-12	2.695E-10	7.267E-12	1.223E-11	8.566E-12	1.410E-11
Zr-93	F	2.802E-08	1.159E-11	1.425E-06	1.498E-11	1.302E-11	9.752E-12	3.140E-11	1.879E-11	1.669E-11	2.748E-11	3.431E-11	3.583E-11	5.399E-11	3.267E-11	3.392E-11	9.040E-12	1.150E-11	6.801E-12
Zr-93	M	6.402E-09	9.487E-10	3.152E-07	3.342E-12	2.923E-12	2.181E-12	7.003E-12	4.194E-12	3.724E-12	6.120E-12	8.569E-12	7.983E-12	1.201E-11	2.827E-11	7.571E-12	2.024E-12	2.575E-12	1.525E-12
Zr-93	S	1.648E-09	6.597E-09	3.551E-08	4.534E-13	2.298E-12	3.126E-13	9.391E-13	1.239E-12	6.631E-13	8.570E-13	6.954E-12	1.673E-12	1.491E-12	2.746E-11	3.276E-12	4.030E-13	1.120E-12	2.292E-13
Nb-90	M	1.054E-09	1.573E-08	1.243E-10	1.414E-10	1.353E-10	8.098E-11	1.604E-10	6.686E-11	1.172E-10	6.180E-11	7.937E-09	9.692E-11	6.907E-11	9.318E-10	1.329E-10	1.405E-10	1.092E-10	2.729E-10

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Nb-90	S	1.088E-09	1.578E-08	1.038E-10	1.249E-10	1.115E-10	7.613E-11	1.597E-10	6.544E-11	1.149E-10	5.914E-11	7.964E-09	9.046E-11	6.359E-11	9.727E-10	1.312E-10	1.378E-10	1.077E-10	2.792E-10
Nb-91	M	1.825E-10	1.460E-09	1.319E-10	1.816E-10	2.316E-10	1.460E-11	1.477E-11	1.594E-11	1.615E-11	1.186E-11	7.413E-10	2.043E-11	1.531E-11	2.703E-11	2.125E-11	1.658E-11	1.727E-11	1.446E-11
Nb-91	S	1.070E-09	7.588E-09	4.172E-11	3.488E-11	8.466E-11	8.168E-12	3.016E-12	2.711E-11	2.160E-11	5.999E-12	3.820E-09	2.745E-11	3.664E-12	1.822E-11	5.670E-11	1.430E-11	2.489E-11	3.316E-12
Nb-91m	M	2.759E-09	6.426E-09	1.638E-10	2.446E-10	2.915E-10	2.164E-11	3.081E-11	2.682E-11	2.886E-11	1.927E-11	3.319E-11	3.035E-11	1.903E-11	1.458E-10	2.555E-11	2.680E-11	2.586E-11	2.262E-11
Nb-91m	S	3.402E-09	7.938E-09	2.552E-11	3.277E-11	4.553E-11	7.949E-12	6.839E-12	1.651E-11	1.851E-11	5.628E-12	1.894E-11	1.605E-11	3.738E-12	1.382E-10	1.254E-11	1.248E-11	1.313E-11	7.418E-12
Nb-92m	M	5.386E-10	8.260E-09	1.457E-10	1.501E-10	2.128E-10	8.442E-11	1.357E-10	1.269E-10	1.676E-10	6.121E-11	4.194E-09	1.619E-10	5.247E-11	3.667E-10	1.253E-10	1.497E-10	1.274E-10	1.908E-10
Nb-92m	S	5.413E-10	8.269E-09	1.012E-10	1.014E-10	1.432E-10	7.569E-11	1.236E-10	1.316E-10	1.717E-10	5.393E-11	4.194E-09	1.395E-10	3.862E-11	3.621E-10	1.168E-10	1.323E-10	1.204E-10	1.804E-10
Mo-91	F	2.290E-11	4.140E-10	1.791E-12	2.015E-12	1.896E-12	1.854E-12	1.297E-12	1.421E-12	1.964E-12	1.379E-12	2.080E-10	1.684E-12	1.772E-12	1.270E-11	1.826E-12	2.593E-12	2.083E-12	1.514E-12
Mo-91	S	3.464E-11	5.781E-10	6.927E-13	6.445E-13	5.318E-13	8.043E-13	1.778E-13	4.943E-13	1.031E-12	3.824E-13	2.897E-10	7.753E-13	7.345E-13	2.465E-11	8.780E-13	2.213E-12	1.450E-12	5.561E-13
Mo-99	F	3.612E-10	3.594E-09	4.605E-10	1.387E-09	1.248E-09	1.187E-10	1.951E-10	1.098E-10	1.215E-10	1.074E-10	1.864E-09	1.509E-10	1.139E-10	1.788E-10	1.211E-10	1.458E-10	1.267E-10	1.255E-10
Mo-99	S	1.086E-09	4.102E-09	2.565E-11	2.835E-11	2.851E-11	1.080E-11	3.002E-11	1.307E-11	2.019E-11	8.133E-12	3.198E-11	1.652E-11	7.401E-12	5.309E-10	1.973E-11	1.905E-11	1.636E-11	4.154E-11
Mo-102	F	2.740E-11	5.224E-10	1.076E-12	1.336E-12	1.286E-12	1.044E-12	1.006E-12	1.014E-12	1.057E-12	1.010E-12	2.618E-10	1.030E-12	1.039E-12	1.103E-11	1.042E-12	1.094E-12	1.058E-12	1.014E-12
Mo-102	S	4.204E-11	7.777E-10	5.775E-14	4.410E-14	3.754E-14	6.162E-14	1.111E-14	3.775E-14	8.199E-14	2.917E-14	3.891E-10	5.371E-14	5.662E-14	1.928E-11	6.438E-14	1.507E-13	9.958E-14	3.172E-14
Tc-98	F	1.434E-09	1.334E-08	3.145E-10	3.320E-10	3.410E-10	1.874E-09	6.251E-10	1.996E-10	2.816E-10	1.977E-10	6.827E-09	3.244E-10	2.350E-10	6.118E-10	3.108E-10	5.079E-10	3.903E-10	4.501E-10
Tc-98	M	5.386E-09	2.218E-08	6.710E-10	5.875E-10	1.229E-09	1.011E-09	3.499E-10	1.456E-09	1.730E-09	3.671E-10	7.095E-10	1.427E-09	1.804E-10	9.063E-10	7.168E-10	1.146E-09	1.072E-09	4.110E-10
Tc-105	F	2.064E-11	3.781E-10	1.234E-12	1.045E-12	1.121E-12	3.897E-11	2.063E-12	9.228E-13	1.334E-12	8.988E-13	1.897E-10	1.088E-12	1.172E-12	4.948E-12	1.220E-12	1.626E-12	1.312E-12	1.059E-12
Tc-105	M	2.618E-11	4.880E-10	6.391E-13	5.584E-13	5.109E-13	5.121E-12	5.399E-13	4.032E-13	7.928E-13	3.476E-13	2.445E-10	5.451E-13	5.546E-13	1.292E-11	7.109E-13	1.183E-12	8.267E-13	8.098E-13
Ru-95	F	5.250E-11	1.364E-09	9.576E-12	8.757E-12	7.712E-12	9.062E-12	1.184E-11	5.123E-12	9.984E-12	5.356E-12	6.872E-10	7.804E-12	8.157E-12	3.523E-11	9.943E-12	1.235E-11	9.423E-12	1.426E-11
Ru-95	M	6.574E-11	1.457E-09	7.405E-12	8.685E-12	7.312E-12	6.260E-12	7.982E-12	4.651E-12	8.801E-12	4.047E-12	7.334E-10	7.219E-12	5.453E-12	5.681E-11	9.199E-12	1.485E-11	1.042E-11	1.714E-11
Ru-95	S	6.746E-11	1.467E-09	7.087E-12	8.676E-12	7.231E-12	5.834E-12	7.524E-12	4.529E-12	8.563E-12	3.856E-12	7.384E-10	7.073E-12	5.058E-12	6.022E-11	9.091E-12	1.507E-11	1.047E-11	1.768E-11
Ru-103	F	6.823E-10	5.377E-09	4.394E-10	4.223E-10	4.216E-10	4.054E-10	5.348E-10	3.144E-10	4.071E-10	2.991E-10	2.886E-09	4.379E-10	3.512E-10	5.836E-10	3.921E-10	4.600E-10	4.185E-10	5.026E-10
Ru-103	M	1.806E-09	7.363E-09	1.695E-10	1.546E-10	2.191E-10	1.512E-10	1.699E-10	2.163E-10	2.696E-10	1.014E-10	1.748E-10	2.424E-10	9.197E-11	3.955E-10	1.696E-10	2.203E-10	2.002E-10	1.917E-10
Ru-103	S	2.117E-09	8.164E-09	1.148E-10	9.836E-11	1.876E-10	1.002E-10	8.561E-11	2.129E-10	2.606E-10	5.977E-11	1.307E-10	2.159E-10	3.360E-11	3.506E-10	1.259E-10	1.782E-10	1.624E-10	1.199E-10
Ru-107	F	8.609E-12	2.140E-10	3.104E-13	2.606E-13	2.512E-13	3.151E-13	3.617E-13	2.427E-13	3.433E-13	2.355E-13	1.072E-10	2.738E-13	3.027E-13	2.441E-12	3.089E-13	4.027E-13	3.308E-13	2.581E-13
Ru-107	M	1.196E-11	2.822E-10	1.472E-13	1.099E-13	9.648E-14	1.533E-13	5.962E-14	9.521E-14	1.968E-13	7.933E-14	1.412E-10	1.274E-13	1.424E-13	3.477E-12	1.583E-13	3.169E-13	2.164E-13	9.966E-14
Ru-107	S	1.233E-11	2.897E-10	1.290E-13	9.314E-14	7.926E-14	1.353E-13	2.596E-14	7.875E-14	1.804E-13	6.195E-14	1.450E-10	1.111E-13	1.245E-13	3.606E-12	1.415E-13	3.073E-13	2.036E-13	8.229E-14
Ru-108	F	1.505E-11	3.705E-10	3.734E-13	3.201E-13	3.194E-13	3.779E-13	3.817E-13	3.208E-13	3.982E-13	3.138E-13	1.855E-10	3.363E-13	3.691E-13	2.062E-12	3.696E-13	4.210E-13	3.739E-13	3.020E-13
Ru-108	M	1.919E-11	4.713E-10	1.276E-13	7.437E-14	7.365E-14	1.357E-13	4.438E-14	8.173E-14	1.628E-13	7.120E-14	2.357E-10	9.400E-14	1.280E-13	2.306E-12	1.300E-13	2.011E-13	1.437E-13	4.752E-14
Ru-108	S	1.965E-11	4.824E-10	1.006E-13	4.730E-14	4.658E-14	1.090E-13	7.223E-15	5.539E-14	1.369E-13	4.448E-14	2.413E-10	6.732E-14	1.014E-13	2.336E-12	1.036E-13	1.769E-13	1.184E-13	1.951E-14
Rh-96	F	2.153E-11	5.853E-10	2.211E-12	1.704E-12	1.571E-12	2.560E-12	1.135E-12	1.510E-12	3.003E-12	1.357E-12	2.939E-10	1.970E-12	2.362E-12	5.141E-12	2.443E-12	4.053E-12	2.881E-12	1.473E-12
Rh-96	M	2.710E-11	7.088E-10	1.794E-12	1.409E-12	1.234E-12	2.191E-12	3.916E-13	1.321E-12	2.861E-12	1.035E-12	3.555E-10	1.776E-12	2.017E-12	6.337E-12	2.199E-12	4.736E-12	3.138E-12	9.651E-13
Rh-96	S	2.771E-11	7.224E-10	1.748E-12	1.376E-12	1.197E-12	2.150E-12	3.097E-13	1.301E-12	2.845E-12	1.000E-12	3.623E-10	1.755E-12	1.979E-12	6.468E-12	2.172E-12	4.811E-12	3.166E-12	9.091E-13
Rh-97	F	2.764E-11	6.265E-10	3.357E-12	2.988E-12	2.670E-12	3.390E-12	3.300E-12	2.185E-12	3.720E-12	2.122E-12	3.152E-10	3.029E-12	3.137E-12	2.217E-11	3.466E-12	5.451E-12	4.070E-12	3.581E-12
Rh-97	M	3.983E-11	7.853E-10	2.229E-12	2.344E-12	1.911E-12	2.234E-12	1.275E-12	1.551E-12	2.985E-12	1.234E-12	3.943E-10	2.458E-12	2.007E-12	3.455E-11	2.702E-12	6.378E-12	4.266E-12	3.040E-12
Rh-97	S	4.118E-11	8.028E-10	2.105E-12	2.273E-12	1.828E-12	2.106E-12	1.051E-12	1.482E-12	2.905E-12	1.136E-12	4.030E-10	2.396E-12	1.882E-12	3.591E-11	2.618E-12	6.480E-12	4.288E-12	2.980E-12
Rh-98	F	1.661E-11	3.792E-10	1.195E-12	9.612E-13	9.154E-13	1.349E-12	8.305E-13	8.916E-13	1.504E-12	8.311E-13	1.903E-10	1.079E-12	1.267E-12	5.279E-12	1.291E-12	1.936E-12	1.457E-12	8.486E-13
Rh-98	M	2.187E-11	4.812E-10	7.757E-13	5.804E-13	5.215E-13	9.519E-13	1.841E-13	5.590E-13	1.192E-12	4.479E-13	2.411E-10	7.412E-13	8.805E-13	6.694E-12	9.404E-13	1.933E-12	1.293E-12	3.786E-13
Rh-98	S	2.245E-11	4.924E-10	7.296E-13	5.385E-13	4.782E-13	9.083E-13	1.130E-13	5.224E-13	1.157E-12	4.058E-13	2.467E-10	7.040E-13	8.379E-13	6.849E-12	9.018E-13	1.933E-12	1.275E-12	3.269E-13
Rh-105	F	1.489E-10	1.774E-09	2.207E-11	2.061E-11	2.013E-11	2.031E-11	4.152E-11	1.805E-11	2.048E-11	1.828E-11	8.981E-10	2.002E-11	1.963E-11	1.066E-10	2.096E-11	2.108E-11	2.013E-11	2.485E-11
Rh-105	M	4.050E-10	2.123E-09	7.275E-12	6.664E-12	6.415E-12	5.284E-12	1.235E-11	4.880E-12	6.710E-12	4.396E-12	1.067E-09	6.029E-12	4.680E-12	1.733E-10	7.248E-12	7.253E-12	6.350E-12	1.282E-11
Rh-105	S	4.351E-10	2.163E-09	5.609E-12	5.091E-12	4.876E-12	3.593E-12	9.056E-12	3.407E-12	5.171E-12	2.832E-12	1.086E-09	4.462E-12	2.994E-12	1.806E-10	5.704E-12	5.698E-12	4.802E-12	1.145E-11
Rh-106	F	1.030E-12	3.243E-11	8.418E-15	4.287E-15	4.985E-15	1.055E-14	3.422E-15	6.300E-15	1.181E-14	5.866E-15	1.622E-11	5.328E-15	1.013E-14	6.232E-15	9.142E-15	5.972E-15	5.399E-15	3.461E-15
Rh-106	M	1.069E-12	3.374E-11	5.603E-15	1.387E-15	2.109E-15	7.799E-15	4.242E-16	3.518E-15	9.100E-15	3.065E-15	1.687E-11	2.455E-15	7.387E-15	3.409E-15	6.374E-15	3.117E-15	2.544E-15	5.082E-16
Rh-106	S	1.073E-12	3.388E-11	5.293E-15	1.068E-15	1.793E-15	7.496E-15	9.441E-17	3.212E-15	8.802E-15	2.757E-15	1.694E-11	2.139E-15	7.085E-15	3.099E-15	6.069E-15	2.803E-15	2.230E-15	1.834E-16
Pd-98	F	2.971E-11	5.412E-10	3.369E-12	5.837E-12	4.325E-12	3.285E-12	5.198E-12	2.331E-12	3.589E-12	2.269E-12	2.726E-10	3.187E-12	3.087E-12	3.083E-11	3.407E-12	5.613E-12	4.218E-12	3.361E-12
Pd-98	M	4.555E-11	7.222E-10	1.953E-12	2.376E-12	1.825E-12	1.927E-12	1.133E-12	1.369E-12	2.574E-12	1.090E-12	3.627E-10	2.280E-12	1.744E-12	4.716E-11	2.346E-12	6.291E-12	4.152E-12	2.331E-12
Pd-98	S	4.730E-11	7.421E-10	1.797E-12	1.995E-12	1.550E-12	1.777E-12	6.860E-13	1.263E-12	2.462E-12	9.601E-13	3.726E-10	2.180E-12	1.596E-12	4.896E-11	2.229E-12	6.365E-12	4.144E-12	2.217E-12
Pd-109	F	2.113E-10	2.081E-09	4.069E-11	4.637E-10	2.437E-10	6.834E-12	6.802E-11	6.774E-12	6.870E-12	6.789E-12	1.049E-09	7.198E-12	6.837E-12	2.070E-10	7.192E-12	7.111E-12	7.010E-12	7.173E-12

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Pd-109	M	**4.834E-10**	2.590E-09	4.836E-12	4.936E-11	2.607E-11	7.917E-13	7.510E-12	8.076E-13	6.685E-13	7.917E-13	1.300E-09	8.848E-13	7.786E-13	3.904E-10	1.227E-12	1.028E-12	9.231E-13	1.359E-12
Pd-109	S	**5.140E-10**	2.647E-09	8.521E-13	3.316E-12	1.885E-12	1.203E-13	7.856E-13	1.448E-13	2.018E-13	1.254E-13	1.328E-09	1.835E-13	1.054E-13	4.106E-10	5.641E-13	3.521E-13	2.468E-13	7.128E-13
Pd-111	F	2.149E-11	**3.454E-10**	1.322E-12	1.303E-11	7.224E-12	9.838E-13	3.165E-12	9.545E-13	9.981E-13	9.513E-13	1.734E-10	9.979E-13	9.773E-13	2.044E-11	9.968E-13	1.070E-12	1.016E-12	9.879E-13
Pd-111	M	3.776E-11	**5.280E-10**	1.970E-13	1.523E-12	8.559E-13	1.534E-13	3.465E-13	1.371E-13	1.800E-13	1.256E-13	2.644E-10	1.624E-13	1.463E-13	3.216E-11	1.746E-13	2.833E-13	2.136E-13	1.679E-13
Pd-111	S	3.964E-11	**5.481E-10**	7.049E-14	1.515E-13	1.001E-13	6.177E-14	3.321E-14	4.712E-14	8.996E-14	3.450E-14	2.745E-10	7.014E-14	5.452E-14	3.345E-11	8.386E-14	1.965E-13	1.251E-13	7.733E-14
Pd-112	F	**7.604E-10**	4.211E-09	1.526E-10	2.889E-09	1.557E-09	3.356E-11	2.574E-10	3.027E-11	3.820E-11	3.148E-11	8.518E-11	6.304E-11	3.223E-11	5.365E-10	4.465E-11	5.820E-11	4.534E-11	5.966E-11
Pd-112	M	**1.376E-09**	4.511E-09	3.398E-11	3.300E-10	1.858E-10	1.570E-11	6.137E-11	1.474E-11	2.335E-11	1.336E-11	5.286E-11	2.180E-11	1.301E-11	9.986E-10	2.803E-11	2.547E-11	2.104E-11	5.716E-11
Pd-112	S	**1.445E-09**	4.544E-09	2.073E-11	4.398E-11	3.253E-11	1.370E-11	3.935E-11	1.303E-11	2.173E-11	1.132E-11	4.922E-11	1.721E-11	1.085E-11	1.049E-09	2.617E-11	2.182E-11	1.833E-11	5.682E-11
Ag-101	F	1.745E-11	**4.139E-10**	1.557E-12	1.354E-12	2.889E-12	1.585E-12	9.323E-13	1.041E-12	1.790E-12	9.750E-13	2.078E-10	1.504E-12	1.471E-12	6.628E-12	1.614E-12	2.521E-12	1.796E-12	1.304E-12
Ag-101	M	2.346E-11	**5.212E-10**	1.066E-12	9.017E-13	1.044E-12	1.126E-12	4.500E-13	7.200E-13	1.472E-12	5.733E-13	2.613E-10	1.038E-12	1.023E-12	9.067E-12	1.258E-12	2.551E-12	1.706E-12	9.511E-13
Ag-101	S	2.414E-11	**5.330E-10**	1.005E-12	8.438E-13	7.587E-13	1.069E-12	3.979E-13	6.794E-13	1.431E-12	5.251E-13	2.672E-10	9.724E-13	9.682E-13	9.399E-12	1.215E-12	2.542E-12	1.691E-12	9.191E-13
Ag-106	F	1.673E-11	**3.625E-10**	1.410E-12	1.297E-12	1.936E-12	1.481E-12	9.724E-13	1.028E-12	1.587E-12	9.987E-13	1.821E-10	1.356E-12	1.394E-12	1.271E-11	1.502E-12	2.346E-12	1.772E-12	1.377E-12
Ag-106	M	2.529E-11	**4.876E-10**	8.179E-13	8.432E-13	7.666E-13	8.851E-13	3.423E-13	5.822E-13	1.122E-12	4.729E-13	2.445E-10	9.346E-13	8.072E-13	1.956E-11	1.026E-12	2.518E-12	1.667E-12	9.277E-13
Ag-106	S	2.624E-11	**5.014E-10**	7.511E-13	7.924E-13	6.347E-13	8.177E-13	2.721E-13	5.316E-13	1.069E-12	4.135E-13	2.514E-10	8.865E-13	7.408E-13	2.042E-11	9.729E-13	2.536E-12	1.654E-12	8.802E-13
Ag-109m	F	5.143E-13	**1.463E-11**	1.008E-15	3.440E-16	4.313E-16	4.738E-16	3.143E-16	4.106E-16	5.844E-16	4.084E-16	7.317E-12	4.038E-16	4.615E-16	6.552E-16	1.086E-15	5.135E-16	4.394E-16	3.255E-16
Ag-109m	M	5.416E-13	**1.539E-11**	7.051E-16	5.656E-17	1.382E-16	1.894E-16	3.215E-17	1.339E-16	3.052E-16	1.353E-16	7.694E-12	1.180E-16	1.770E-16	3.870E-16	8.244E-16	2.336E-16	1.566E-16	3.565E-17
Ag-109m	S	5.446E-13	**1.547E-11**	6.717E-16	2.494E-17	1.059E-16	1.582E-16	1.118E-18	1.034E-16	2.745E-16	1.053E-16	7.735E-12	8.661E-17	1.457E-16	3.576E-16	7.956E-16	2.028E-16	1.255E-16	3.769E-18
Ag-111m	F	**1.936E-13**	1.660E-12	1.178E-14	1.155E-14	3.449E-13	1.117E-14	1.144E-14	1.100E-14	1.136E-14	1.092E-14	8.359E-13	1.189E-14	1.106E-14	3.161E-14	1.183E-14	1.201E-14	1.122E-14	1.124E-14
Ag-111m	M	**2.983E-13**	1.826E-12	2.738E-15	2.202E-15	6.015E-14	2.272E-15	2.253E-15	2.233E-15	2.587E-15	2.072E-15	9.149E-13	2.404E-15	2.166E-15	4.182E-14	2.932E-15	2.601E-15	2.311E-15	2.357E-15
Ag-111m	S	**3.141E-13**	1.846E-12	1.052E-15	4.591E-16	5.754E-15	6.135E-16	5.420E-16	5.946E-16	9.446E-16	4.213E-16	9.243E-13	6.287E-16	5.096E-16	4.396E-14	1.271E-15	8.395E-16	6.463E-16	7.059E-16
Ag-113	F	**1.210E-10**	9.240E-10	1.193E-11	1.193E-11	1.344E-10	1.169E-11	1.186E-11	1.124E-11	1.181E-11	1.127E-11	4.705E-10	1.187E-11	1.158E-11	2.580E-10	1.188E-11	1.225E-11	1.169E-11	1.248E-11
Ag-113	M	**2.414E-10**	1.239E-09	2.538E-12	2.654E-12	1.942E-11	2.214E-12	2.622E-12	1.991E-12	2.505E-12	1.958E-12	6.257E-10	2.370E-12	2.120E-12	4.745E-10	2.652E-12	3.101E-12	2.613E-12	3.972E-12
Ag-113	S	**2.574E-10**	1.273E-09	1.132E-12	1.270E-12	2.215E-12	7.944E-13	1.250E-12	6.002E-13	1.103E-12	5.637E-13	6.426E-10	9.408E-13	7.034E-13	5.118E-10	1.273E-12	1.720E-12	1.245E-12	2.723E-12
Cd-105	F	2.986E-11	**7.101E-10**	4.782E-12	2.683E-11	9.999E-12	4.558E-12	3.251E-12	3.037E-12	5.224E-12	2.938E-12	3.579E-10	6.186E-12	4.144E-12	2.694E-11	5.013E-12	8.512E-12	6.606E-12	5.646E-12
Cd-105	M	4.046E-11	**8.220E-10**	3.226E-12	7.497E-12	4.161E-12	3.141E-12	2.035E-12	2.420E-12	4.432E-12	1.898E-12	4.134E-10	3.956E-12	2.766E-12	4.312E-11	4.029E-12	8.815E-12	6.041E-12	5.686E-12
Cd-105	S	4.166E-11	**8.344E-10**	3.047E-12	4.834E-12	3.371E-12	2.986E-12	1.888E-12	2.376E-12	4.374E-12	1.778E-12	4.196E-10	3.669E-12	2.607E-12	4.487E-11	3.916E-12	8.814E-12	5.950E-12	5.672E-12
Cd-109	F	9.633E-09	4.496E-09	2.242E-09	**2.353E-07**	4.283E-08	1.629E-09	1.542E-09	1.561E-09	1.624E-09	1.523E-09	1.185E-07	2.864E-09	1.627E-09	1.748E-09	1.794E-09	2.036E-09	2.455E-09	1.644E-09
Cd-109	M	5.168E-09	9.664E-09	6.047E-10	**6.150E-08**	1.122E-08	4.278E-10	4.048E-10	4.239E-10	4.358E-10	4.004E-10	3.100E-08	7.627E-10	4.255E-10	5.596E-10	4.866E-10	5.388E-10	6.545E-10	4.319E-10
Cd-109	S	**4.415E-09**	2.330E-08	2.429E-10	1.992E-08	3.694E-09	1.436E-10	1.328E-10	1.809E-10	1.717E-10	1.353E-10	4.112E-10	2.855E-10	1.382E-10	2.709E-10	2.023E-10	1.919E-10	2.464E-10	1.420E-10
Cd-111m	F	1.929E-11	**5.501E-10**	1.285E-12	3.455E-12	1.331E-12	9.756E-13	7.068E-13	6.025E-13	1.081E-12	6.075E-13	2.757E-10	9.749E-13	9.086E-13	8.615E-12	1.067E-12	1.723E-12	1.280E-12	1.231E-12
Cd-111m	M	3.584E-11	**8.110E-10**	9.198E-13	1.053E-12	6.629E-13	6.067E-13	3.937E-13	3.992E-13	8.417E-13	3.339E-13	4.061E-10	7.360E-13	5.467E-13	1.422E-11	8.453E-13	2.036E-12	1.345E-12	1.222E-12
Cd-111m	S	3.766E-11	**8.397E-10**	8.796E-13	7.880E-13	5.894E-13	5.661E-13	3.592E-13	3.768E-13	8.153E-13	3.038E-13	4.204E-10	7.097E-13	5.068E-13	1.484E-11	8.208E-13	2.070E-12	1.353E-12	1.221E-12
Cd-118	F	6.352E-11	**7.735E-10**	5.009E-12	4.727E-11	1.206E-11	5.019E-12	4.942E-12	4.937E-12	5.060E-12	4.933E-12	3.909E-10	5.012E-12	5.001E-12	1.398E-10	5.030E-12	5.167E-12	5.071E-12	5.061E-12
Cd-118	M	**1.174E-10**	**1.225E-09**	6.796E-13	5.281E-12	1.439E-12	6.835E-13	6.159E-13	6.410E-13	7.559E-13	6.180E-13	6.154E-10	7.067E-13	6.663E-13	2.384E-10	7.253E-13	9.806E-13	8.296E-13	8.078E-13
Cd-118	S	1.234E-10	**1.275E-09**	2.030E-13	6.582E-13	2.698E-13	2.061E-13	1.396E-13	1.680E-13	2.820E-13	1.429E-13	6.401E-10	2.327E-13	1.891E-13	2.493E-10	2.514E-13	5.196E-13	3.626E-13	3.395E-13
In-106	F	1.543E-11	**4.199E-10**	1.341E-12	9.766E-13	9.168E-13	1.560E-12	5.178E-13	9.115E-13	1.840E-12	8.164E-13	2.107E-10	1.107E-12	1.449E-12	2.579E-12	1.454E-12	2.162E-12	1.572E-12	7.092E-13
In-106	M	1.884E-11	**5.025E-10**	1.067E-12	6.854E-13	6.427E-13	1.344E-12	1.567E-13	7.538E-13	1.726E-12	6.037E-13	2.519E-10	9.190E-13	1.247E-12	2.900E-12	1.279E-12	2.316E-12	1.552E-12	3.633E-13
In-107	F	2.656E-11	**6.416E-10**	4.193E-12	5.230E-12	3.772E-12	3.235E-12	2.007E-12	2.083E-12	3.665E-12	1.985E-12	3.226E-10	2.934E-12	2.999E-12	1.931E-11	3.344E-12	5.382E-12	4.475E-12	3.336E-12
In-107	M	4.032E-11	**7.704E-10**	2.382E-12	2.660E-12	2.070E-12	2.278E-12	1.072E-12	1.610E-12	3.110E-12	1.275E-12	3.869E-10	2.454E-12	2.059E-12	3.095E-11	2.770E-12	6.541E-12	4.402E-12	3.078E-12
In-108	F	7.124E-11	**1.949E-09**	1.247E-11	1.398E-11	1.156E-11	1.206E-11	7.781E-12	6.909E-12	1.394E-11	6.824E-12	9.811E-10	1.116E-11	1.101E-11	3.781E-11	1.281E-11	2.035E-11	1.515E-11	1.541E-11
In-108	M	8.810E-11	**2.147E-09**	9.698E-12	1.192E-11	9.416E-12	9.414E-12	6.071E-12	6.770E-12	1.324E-11	5.580E-12	1.080E-09	1.091E-11	8.423E-12	5.859E-11	1.225E-11	2.700E-11	1.814E-11	1.838E-11
In-111	F	2.205E-10	**3.779E-09**	1.459E-10	2.968E-10	2.161E-10	4.018E-11	5.446E-11	2.772E-11	4.451E-11	2.683E-11	1.917E-09	8.960E-11	3.650E-11	1.396E-10	5.168E-11	8.138E-11	1.099E-10	7.576E-11
In-111	M	3.172E-10	**3.899E-09**	5.166E-11	6.080E-11	5.220E-11	1.909E-11	4.867E-11	2.036E-11	3.296E-11	1.340E-11	1.969E-09	3.389E-11	1.405E-11	1.828E-10	3.527E-11	3.780E-11	3.726E-11	7.112E-11
In-112m	F	2.013E-11	**5.419E-10**	9.383E-13	1.131E-12	8.548E-13	6.918E-13	5.616E-13	5.398E-13	7.264E-13	5.366E-13	2.714E-10	6.809E-13	6.626E-13	9.784E-12	7.402E-13	1.064E-12	9.402E-13	7.686E-13
In-112m	M	3.600E-11	**8.338E-10**	3.616E-13	4.090E-13	3.149E-13	2.946E-13	1.754E-13	2.203E-13	3.874E-13	1.835E-13	4.172E-10	3.722E-13	2.671E-13	1.562E-11	4.097E-13	1.035E-12	6.814E-13	4.854E-13
In-114	F	2.146E-12	**6.689E-11**	9.142E-15	9.286E-15	9.069E-15	8.984E-15	8.816E-15	8.890E-15	9.033E-15	8.877E-15	3.345E-11	8.871E-15	8.970E-15	2.596E-14	8.959E-15	8.914E-15	8.985E-15	8.820E-15

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
In-114	M	2.343E-12	7.311E-11	1.037E-15	9.623E-16	9.537E-16	1.063E-15	8.857E-16	9.693E-16	1.115E-15	9.544E-16	3.656E-11	9.457E-16	1.052E-15	1.968E-14	1.041E-15	9.928E-16	9.719E-16	8.903E-16
In-119	F	4.617E-12	1.425E-10	1.202E-13	6.823E-14	7.184E-14	1.473E-13	3.928E-14	8.426E-14	1.740E-13	7.570E-14	7.132E-11	8.394E-14	1.388E-13	1.466E-13	1.316E-13	1.374E-13	1.056E-13	4.632E-14
In-119	M	5.322E-12	1.640E-10	9.423E-14	3.838E-14	4.383E-14	1.254E-13	7.889E-15	6.275E-14	1.563E-13	5.231E-14	8.205E-11	5.860E-14	1.177E-13	1.327E-13	1.102E-13	1.206E-13	8.450E-14	1.403E-14
Sn-108	F	1.465E-11	3.367E-10	2.317E-12	1.908E-12	1.661E-12	2.105E-12	4.148E-12	1.338E-12	2.352E-12	1.297E-12	1.696E-10	1.874E-12	1.951E-12	1.448E-11	2.205E-12	3.480E-12	2.550E-12	2.470E-12
Sn-108	M	2.003E-11	3.943E-10	1.542E-12	1.704E-12	1.358E-12	1.493E-12	1.104E-12	1.082E-12	2.027E-12	8.599E-13	1.983E-10	1.674E-12	1.342E-12	2.343E-11	1.862E-12	4.377E-12	2.918E-12	2.357E-12
Sn-109	F	1.820E-11	5.160E-10	4.480E-12	2.322E-12	2.003E-12	2.841E-12	2.758E-12	1.644E-12	3.383E-12	1.544E-12	2.595E-10	2.363E-12	2.610E-12	6.387E-12	2.938E-12	4.778E-12	3.362E-12	2.901E-12
Sn-109	M	2.213E-11	5.836E-10	2.661E-12	2.331E-12	1.928E-12	2.421E-12	1.258E-12	1.668E-12	3.375E-12	1.322E-12	2.933E-10	2.391E-12	2.192E-12	8.927E-12	2.850E-12	6.197E-12	4.117E-12	2.963E-12
Sn-113m	F	3.000E-12	5.811E-11	9.219E-13	1.134E-13	1.049E-13	1.041E-13	3.030E-13	9.194E-14	1.045E-13	9.185E-14	2.913E-11	1.256E-13	1.078E-13	1.238E-12	1.265E-13	1.476E-13	1.163E-13	1.211E-13
Sn-113m	M	5.383E-12	7.921E-11	1.861E-13	2.645E-14	3.630E-14	2.267E-14	4.048E-14	3.376E-14	4.089E-14	1.964E-14	3.965E-11	4.137E-14	1.758E-14	1.845E-12	5.357E-14	8.970E-14	5.092E-14	3.606E-14
Sn-117m	F	3.985E-10	5.208E-09	7.002E-09	6.011E-11	5.123E-11	5.195E-11	1.375E-10	4.003E-11	5.119E-11	4.128E-11	6.301E-11	6.687E-11	5.440E-11	1.962E-10	5.764E-11	5.950E-11	5.171E-11	7.659E-11
Sn-117m	M	2.196E-09	6.721E-09	1.029E-09	2.280E-11	3.294E-11	1.896E-11	4.167E-11	2.917E-11	3.886E-11	1.308E-11	3.700E-11	3.552E-11	1.223E-11	2.665E-10	2.951E-11	3.210E-11	2.934E-11	4.204E-11
Sn-125m	F	1.196E-11	2.802E-10	9.689E-13	3.985E-13	3.831E-13	4.688E-13	7.841E-13	3.658E-13	5.037E-13	3.560E-13	1.404E-10	4.243E-13	4.527E-13	3.508E-12	4.626E-13	6.224E-13	5.104E-13	3.786E-13
Sn-125m	M	1.691E-11	3.853E-10	3.329E-13	1.524E-13	1.364E-13	2.173E-13	1.025E-13	1.338E-13	2.747E-13	1.106E-13	1.928E-10	1.857E-13	2.017E-13	4.624E-12	2.236E-13	4.685E-13	3.197E-13	1.102E-13
Sb-113	F	9.500E-12	2.451E-10	7.058E-13	4.453E-13	4.500E-13	6.887E-13	4.317E-13	4.237E-13	7.693E-13	3.906E-13	1.229E-10	5.194E-13	6.457E-13	1.842E-12	6.551E-13	9.655E-13	7.127E-13	3.712E-13
Sb-113	M	1.230E-11	3.064E-10	4.526E-13	2.834E-13	2.715E-13	5.334E-13	8.813E-14	2.984E-13	6.575E-13	2.382E-13	1.535E-10	3.814E-13	4.933E-13	2.217E-12	5.200E-13	9.785E-13	6.543E-13	1.620E-13
Sb-114	F	8.258E-12	2.324E-10	5.567E-13	3.294E-13	3.411E-13	6.850E-13	2.295E-13	3.967E-13	8.237E-13	3.491E-13	1.165E-10	4.127E-13	6.412E-13	7.631E-13	6.102E-13	7.409E-13	5.489E-13	2.345E-13
Sb-114	M	9.609E-12	2.691E-10	4.520E-13	2.197E-13	2.320E-13	6.009E-13	5.119E-14	3.203E-13	7.686E-13	2.584E-13	1.348E-10	3.165E-13	5.619E-13	7.519E-13	5.305E-13	7.161E-13	4.913E-13	9.215E-14
Sb-118	F	5.391E-12	1.469E-10	2.232E-13	1.447E-13	1.493E-13	2.595E-13	1.293E-13	1.594E-13	2.882E-13	1.470E-13	7.356E-11	1.731E-13	2.453E-13	4.928E-13	2.390E-13	2.887E-13	2.222E-13	1.140E-13
Sb-118	M	6.453E-12	1.751E-10	1.527E-13	7.469E-14	7.895E-14	1.976E-13	2.121E-14	9.999E-14	2.346E-13	8.314E-14	8.766E-11	1.080E-13	1.849E-13	5.053E-13	1.794E-13	2.492E-13	1.709E-13	3.273E-14
Sb-127	F	7.494E-10	7.547E-09	8.005E-10	1.193E-10	2.884E-10	1.063E-10	4.019E-10	8.178E-11	1.068E-10	8.554E-11	3.834E-09	1.252E-10	1.052E-10	3.966E-10	1.170E-10	1.208E-10	1.027E-10	1.571E-10
Sb-127	M	1.748E-09	8.383E-09	1.350E-10	5.653E-11	8.075E-11	4.142E-11	1.162E-10	4.797E-11	6.878E-11	3.147E-11	8.034E-11	5.996E-11	3.083E-11	6.402E-10	6.580E-11	6.636E-11	5.646E-11	1.232E-10
Te-114	F	3.494E-11	7.553E-10	4.051E-12	3.614E-12	3.173E-12	4.342E-12	3.985E-12	2.842E-12	4.894E-12	2.655E-12	3.800E-10	3.771E-12	3.937E-12	2.061E-11	4.258E-12	7.302E-12	5.324E-12	3.574E-12
Te-114	M	4.899E-11	9.661E-10	2.749E-12	2.725E-12	2.221E-12	3.027E-12	1.095E-12	2.092E-12	4.138E-12	1.623E-12	4.850E-10	3.089E-12	2.743E-12	2.991E-11	3.371E-12	8.558E-12	5.632E-12	2.501E-12
Te-114	V	3.320E-11	2.862E-10	6.666E-12	6.505E-12	6.997E-12	6.535E-12	9.081E-12	6.404E-12	7.991E-12	4.680E-12	1.463E-10	7.692E-12	5.143E-12	1.475E-11	6.250E-12	9.112E-12	7.847E-12	6.182E-12
Te-117	F	4.042E-11	1.022E-09	7.419E-12	6.099E-12	4.989E-12	6.749E-12	9.242E-12	3.782E-12	7.005E-12	3.766E-12	5.146E-10	5.435E-12	5.769E-12	3.110E-11	6.616E-12	9.432E-12	7.025E-12	8.027E-12
Te-117	M	5.557E-11	1.148E-09	5.034E-12	5.515E-12	4.424E-12	4.422E-12	3.843E-12	3.149E-12	6.024E-12	2.628E-12	5.774E-10	4.931E-12	3.895E-12	5.546E-11	5.840E-12	1.187E-11	8.017E-12	9.224E-12
Te-117	V	2.894E-11	3.422E-10	1.252E-11	1.078E-11	9.905E-12	1.032E-11	2.111E-11	7.687E-12	1.034E-11	6.321E-12	1.758E-10	1.071E-11	7.550E-12	2.299E-11	9.097E-12	1.261E-11	1.075E-11	1.170E-11
Te-118	F	1.387E-09	8.311E-09	1.813E-09	2.119E-09	2.514E-10	2.686E-09	8.749E-10	2.109E-10	2.507E-10	2.151E-10	4.302E-09	3.000E-10	2.527E-10	7.272E-10	2.651E-10	2.805E-10	2.610E-10	3.137E-10
Te-118	M	2.324E-09	8.732E-09	4.283E-10	4.854E-10	1.215E-10	5.882E-10	2.606E-10	1.069E-10	1.373E-10	7.208E-11	1.518E-10	1.321E-10	7.370E-11	1.215E-09	1.232E-10	1.303E-10	1.169E-10	1.839E-10
Te-118	V	1.938E-09	2.986E-09	4.358E-09	5.124E-09	5.882E-10	6.486E-09	2.063E-09	4.983E-10	5.576E-10	4.973E-10	6.322E-10	7.131E-10	5.648E-10	9.005E-10	5.784E-10	6.499E-10	6.097E-10	6.667E-10
Te-119	F	1.492E-10	3.609E-09	9.637E-11	4.554E-11	2.413E-11	4.607E-11	5.502E-11	1.538E-11	2.874E-11	1.677E-11	1.821E-09	2.577E-11	2.543E-11	7.892E-11	3.117E-11	3.020E-11	2.514E-11	4.494E-11
Te-119	M	1.872E-10	3.652E-09	3.736E-11	2.903E-11	2.356E-11	2.123E-11	3.888E-11	1.410E-11	2.480E-11	1.261E-11	1.842E-09	2.053E-11	1.499E-11	1.409E-10	2.961E-11	3.016E-11	2.344E-11	5.849E-11
Te-119	V	1.046E-10	1.111E-09	2.098E-10	9.486E-11	4.633E-11	8.756E-11	1.107E-10	2.972E-11	4.275E-11	2.809E-11	5.781E-10	5.390E-11	3.692E-11	8.562E-11	4.424E-11	5.416E-11	4.746E-11	6.731E-11
Te-119m	F	5.943E-10	1.104E-08	9.098E-10	4.356E-10	1.580E-10	3.820E-10	2.747E-10	1.027E-10	1.676E-10	1.075E-10	5.611E-09	2.202E-10	1.586E-10	3.638E-10	1.818E-10	1.967E-10	1.710E-10	2.523E-10
Te-119m	M	7.320E-10	1.113E-08	2.810E-10	1.757E-10	1.396E-10	1.403E-10	1.889E-10	1.147E-10	1.652E-10	6.939E-11	5.639E-09	1.471E-10	6.976E-11	4.903E-10	1.453E-10	1.499E-10	1.332E-10	2.457E-10
Te-119m	V	6.295E-10	3.544E-09	2.117E-09	1.005E-09	3.425E-10	8.441E-10	5.602E-10	2.199E-10	3.057E-10	2.140E-10	1.943E-09	5.048E-10	3.010E-10	5.492E-10	3.321E-10	4.216E-10	3.722E-10	4.563E-10
Te-127	F	7.254E-11	1.010E-09	1.445E-11	1.913E-11	6.271E-12	2.382E-11	4.662E-11	6.231E-12	6.294E-12	6.237E-12	5.089E-10	6.274E-12	6.278E-12	7.577E-11	6.302E-12	6.306E-12	6.279E-12	6.369E-12
Te-127	M	1.872E-10	1.343E-09	2.601E-12	3.421E-12	1.175E-12	4.195E-12	8.213E-12	1.127E-12	1.179E-12	1.123E-12	6.739E-10	1.162E-12	1.140E-12	1.662E-10	1.200E-12	1.222E-12	1.183E-12	1.342E-12
Te-127	V	7.723E-11	3.844E-10	3.594E-11	4.766E-11	1.559E-11	5.934E-11	1.163E-10	1.552E-11	1.558E-11	1.551E-11	2.005E-10	1.561E-11	1.555E-11	5.116E-11	1.558E-11	1.563E-11	1.559E-11	1.568E-11
I-118	F	7.429E-11	5.387E-10	2.843E-12	2.348E-12	2.269E-12	1.168E-09	1.248E-11	2.205E-12	3.374E-12	2.121E-12	3.278E-12	2.585E-12	2.962E-12	4.113E-12	2.990E-12	4.165E-12	3.278E-12	2.117E-12
I-118	V	1.597E-10	3.791E-10	4.645E-12	4.400E-12	4.640E-12	2.200E-09	2.526E-11	4.429E-12	5.476E-12	3.711E-12	4.873E-12	5.116E-12	4.204E-12	6.153E-12	4.666E-12	6.603E-12	5.595E-12	4.188E-12
I-118	VMethyl	9.608E-11	5.399E-12	5.500E-12	5.294E-12	5.320E-12	1.791E-09	3.454E-11	4.792E-12	5.410E-12	4.710E-12	5.267E-12	5.429E-12	5.090E-12	5.437E-12	5.269E-12	5.513E-12	5.298E-12	5.818E-12
I-119	F	2.518E-11	4.258E-10	1.989E-12	1.406E-12	1.349E-12	1.475E-10	7.626E-12	1.250E-12	2.232E-12	1.230E-12	2.139E-10	1.567E-12	1.935E-12	2.088E-12	1.994E-12	2.685E-12	2.044E-12	1.477E-12
I-119	V	4.863E-11	2.722E-10	2.946E-12	2.540E-12	2.658E-12	2.813E-10	1.531E-11	2.363E-12	3.241E-12	1.978E-12	2.936E-12	2.983E-12	2.443E-12	3.262E-12	2.802E-12	4.074E-12	3.327E-12	2.862E-12
I-119	VMethyl	1.589E-11	2.664E-12	2.862E-12	2.529E-12	2.550E-12	2.527E-10	1.817E-11	2.140E-12	2.683E-12	2.088E-12	2.583E-12	2.639E-12	2.431E-12	2.682E-12	2.587E-12	2.705E-12	2.531E-12	3.220E-12
I-122	F	6.159E-12	1.612E-10	2.741E-13	1.823E-13	1.872E-13	1.271E-12	3.095E-13	2.013E-13	3.570E-13	1.861E-13	8.077E-11	2.177E-13	3.051E-13	3.116E-13	2.962E-13	3.571E-13	2.770E-13	1.415E-13

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
I-122	V	1.879E-11	1.405E-10	4.045E-13	3.469E-13	4.282E-13	2.328E-12	6.172E-13	4.506E-13	5.935E-13	2.983E-13	7.046E-11	4.890E-13	3.482E-13	4.505E-13	4.142E-13	5.918E-13	4.992E-13	2.739E-13
I-122	VMethyl	1.112E-12	7.476E-13	7.699E-13	7.592E-13	7.624E-13	6.756E-12	1.918E-12	6.881E-13	7.483E-13	6.738E-13	7.319E-13	7.770E-13	7.078E-13	7.744E-13	7.312E-13	7.881E-13	7.596E-13	7.991E-13
I-125	F	7.484E-09	1.852E-09	8.348E-11	1.247E-11	1.280E-11	1.492E-07	7.165E-11	1.057E-11	2.449E-11	1.768E-11	6.450E-11	1.301E-11	1.714E-11	1.328E-11	6.834E-11	1.348E-11	1.300E-11	1.460E-11
I-125	V	1.403E-08	5.823E-10	1.526E-10	2.335E-11	2.400E-11	2.797E-07	1.343E-10	1.982E-11	4.510E-11	3.255E-11	1.160E-10	2.439E-11	3.185E-11	2.462E-11	1.244E-10	2.486E-11	2.422E-11	2.733E-11
I-125	VMethyl	1.094E-08	2.471E-11	1.184E-10	1.818E-11	1.867E-11	2.181E-07	1.047E-10	1.542E-11	3.502E-11	2.529E-11	8.968E-11	1.897E-11	2.479E-11	1.891E-11	9.635E-11	1.896E-11	1.870E-11	2.128E-11
Cs-126	F	3.337E-12	9.789E-11	1.294E-13	6.288E-14	7.109E-14	1.600E-13	3.890E-14	8.709E-14	1.809E-13	7.888E-14	4.902E-11	8.244E-14	1.513E-13	8.723E-14	1.401E-13	1.263E-13	9.928E-14	4.343E-14
Cs-128	F	5.364E-12	1.455E-10	2.471E-13	1.585E-13	1.632E-13	2.882E-13	1.062E-13	1.757E-13	3.208E-13	1.617E-13	7.286E-11	1.915E-13	2.719E-13	2.587E-13	2.649E-13	3.228E-13	2.474E-13	1.190E-13
Cs-130	F	1.411E-11	2.986E-10	1.549E-12	1.319E-12	1.270E-12	1.584E-12	1.078E-12	1.159E-12	1.568E-12	1.123E-12	1.501E-10	1.429E-12	1.494E-12	2.043E-12	1.548E-12	2.264E-12	1.786E-12	1.178E-12
Cs-139	F	1.777E-11	2.916E-10	1.442E-12	1.383E-12	1.377E-12	1.456E-12	1.384E-12	1.376E-12	1.496E-12	1.361E-12	1.465E-10	1.405E-12	1.439E-12	2.671E-12	1.439E-12	1.549E-12	1.466E-12	1.350E-12
Ba-124	F	2.723E-11	4.974E-10	4.128E-12	1.398E-12	1.293E-12	1.724E-12	3.304E-12	1.203E-12	1.895E-12	1.159E-12	2.497E-10	1.523E-12	1.659E-12	1.323E-11	1.739E-12	2.666E-12	2.005E-12	1.326E-12
Ba-127	F	1.369E-11	3.020E-10	3.077E-12	8.121E-13	7.049E-13	9.276E-13	1.516E-12	5.661E-13	1.011E-12	5.804E-13	1.515E-10	8.374E-13	9.123E-13	6.083E-12	1.014E-12	1.446E-12	1.050E-12	9.976E-13
Ba-129	F	3.248E-11	6.412E-10	2.508E-11	3.366E-12	2.651E-12	3.006E-12	6.415E-12	1.618E-12	3.119E-12	1.979E-12	3.228E-10	3.152E-12	3.201E-12	3.312E-11	3.932E-12	4.271E-12	3.104E-12	5.743E-12
Ba-129m	F	6.861E-11	1.742E-09	4.009E-11	1.052E-11	8.177E-12	9.691E-12	1.178E-11	4.903E-12	1.068E-11	5.859E-12	8.773E-10	9.560E-12	9.984E-12	4.222E-11	1.192E-11	1.455E-11	1.023E-11	1.749E-11
Ba-133	F	1.911E-09	5.299E-09	1.061E-08	1.239E-09	8.407E-10	9.759E-10	8.088E-10	5.800E-10	8.244E-10	6.646E-10	1.067E-09	1.840E-09	1.350E-09	1.406E-09	1.041E-09	1.163E-09	8.514E-10	1.099E-09
Ba-137m	F	1.031E-12	3.361E-11	8.574E-14	3.801E-14	4.155E-14	1.048E-13	1.989E-14	5.151E-14	1.238E-13	4.492E-14	1.685E-11	5.321E-14	9.806E-14	4.496E-14	9.215E-14	1.005E-13	7.205E-14	2.221E-14
La-129	F	1.470E-11	3.389E-10	1.795E-12	1.178E-12	3.004E-12	1.253E-12	8.325E-13	8.320E-13	1.396E-12	8.056E-13	1.702E-10	1.276E-12	1.175E-12	7.637E-12	1.339E-12	2.043E-12	1.438E-12	1.252E-12
La-129	M	2.061E-11	4.320E-10	9.743E-13	7.951E-13	8.821E-13	8.333E-13	4.706E-13	5.449E-13	1.098E-12	4.499E-13	2.166E-10	8.310E-13	7.551E-13	1.162E-11	1.035E-12	2.057E-12	1.372E-12	1.103E-12
La-130	F	1.586E-11	3.801E-10	1.349E-12	1.022E-12	1.183E-12	1.480E-12	6.542E-13	9.372E-13	1.596E-12	8.594E-13	1.908E-10	1.166E-12	1.382E-12	4.662E-12	1.417E-12	2.206E-12	1.616E-12	8.754E-13
La-130	M	2.050E-11	4.726E-10	9.592E-13	6.937E-13	6.426E-13	1.137E-12	1.892E-13	6.715E-13	1.458E-12	5.327E-13	2.369E-10	8.833E-13	1.050E-12	5.850E-12	1.129E-12	2.335E-12	1.554E-12	4.487E-13
La-133	F	2.111E-11	4.163E-10	1.682E-11	4.441E-12	3.189E-11	2.551E-12	2.438E-12	2.007E-12	2.954E-12	1.921E-12	2.101E-10	5.314E-12	2.405E-12	2.254E-11	3.460E-12	5.649E-12	2.985E-12	4.185E-12
La-133	M	2.797E-11	4.504E-10	4.734E-12	2.330E-12	6.992E-12	1.296E-12	1.779E-12	1.052E-12	1.840E-12	9.417E-13	2.268E-10	2.105E-12	1.147E-12	3.860E-11	2.410E-12	3.678E-12	2.276E-12	4.503E-12
La-134	F	7.496E-12	1.828E-10	3.996E-13	2.994E-13	3.578E-13	4.357E-13	2.133E-13	2.908E-13	4.790E-13	2.727E-13	9.161E-11	3.403E-13	4.121E-13	1.560E-12	4.179E-13	5.843E-13	4.460E-13	2.557E-13
La-134	M	9.678E-12	2.314E-10	2.466E-13	1.568E-13	1.549E-13	2.974E-13	4.376E-14	1.655E-13	3.612E-13	1.355E-13	1.159E-10	2.088E-13	2.765E-13	1.861E-12	2.900E-13	5.338E-13	3.577E-13	8.957E-14
La-136	F	5.444E-12	1.360E-10	3.408E-13	2.552E-13	3.166E-13	3.421E-13	1.761E-13	2.267E-13	3.781E-13	2.139E-13	6.816E-11	2.857E-13	3.219E-13	1.513E-12	3.438E-13	5.325E-13	3.919E-13	2.302E-13
La-136	M	7.434E-12	1.781E-10	2.187E-13	1.553E-13	1.460E-13	2.353E-13	4.560E-14	1.399E-13	2.943E-13	1.136E-13	8.922E-11	1.967E-13	2.171E-13	1.975E-12	2.536E-13	5.482E-13	3.575E-13	1.104E-13
La-137	F	1.040E-08	2.585E-09	7.180E-08	6.042E-09	1.228E-07	1.821E-09	1.443E-09	1.831E-09	1.973E-09	1.685E-09	3.084E-09	1.049E-08	2.171E-09	2.759E-09	3.095E-09	7.685E-09	2.030E-09	1.831E-09
La-137	M	2.400E-09	1.315E-09	1.576E-08	1.326E-09	2.691E-08	4.031E-10	3.197E-10	4.369E-10	4.623E-10	3.738E-10	6.966E-10	2.326E-09	4.754E-10	6.341E-10	6.999E-10	1.699E-09	4.687E-10	4.060E-10
Ce-130	M	5.869E-11	1.008E-09	3.135E-12	3.354E-12	2.883E-12	2.873E-12	1.416E-12	2.085E-12	3.943E-12	1.664E-12	5.062E-10	3.499E-12	2.589E-12	6.179E-11	3.635E-12	9.711E-12	6.384E-12	4.133E-12
Ce-130	S	6.092E-11	1.033E-09	2.896E-12	3.242E-12	2.500E-12	2.681E-12	1.223E-12	1.968E-12	3.813E-12	1.509E-12	5.188E-10	3.392E-12	2.399E-12	6.425E-11	3.502E-12	9.883E-12	6.430E-12	4.039E-12
Ce-131	M	2.351E-11	5.221E-10	1.398E-12	1.064E-12	1.130E-12	1.235E-12	4.484E-13	8.098E-13	1.656E-12	6.354E-13	2.619E-10	1.195E-12	1.120E-12	1.214E-11	1.414E-12	3.084E-12	2.038E-12	1.213E-12
Ce-131	S	2.424E-11	5.337E-10	1.201E-12	1.013E-12	8.679E-13	1.184E-12	3.922E-13	7.805E-13	1.626E-12	5.921E-13	2.677E-10	1.141E-12	1.068E-12	1.258E-11	1.376E-12	3.107E-12	2.043E-12	1.181E-12
Ce-132	M	2.266E-10	2.723E-09	2.109E-11	2.153E-11	3.159E-11	1.277E-11	2.463E-11	9.663E-12	1.789E-11	9.437E-12	1.375E-09	1.540E-11	1.110E-11	2.749E-10	2.223E-11	2.336E-11	1.717E-11	4.816E-11
Ce-132	S	2.343E-10	2.729E-09	1.819E-11	2.089E-11	1.852E-11	1.194E-11	2.486E-11	9.248E-12	1.738E-11	8.900E-12	1.378E-09	1.408E-11	1.021E-11	2.884E-10	2.190E-11	2.267E-11	1.695E-11	4.946E-11
Ce-133m	M	2.021E-10	3.836E-09	3.004E-11	2.721E-11	3.358E-11	1.701E-11	2.535E-11	1.278E-11	2.418E-11	1.192E-11	1.933E-09	2.078E-11	1.494E-11	1.911E-10	2.792E-11	3.697E-11	2.588E-11	5.730E-11
Ce-133m	S	2.070E-10	3.851E-09	2.336E-11	2.651E-11	2.321E-11	1.620E-11	2.550E-11	1.259E-11	2.384E-11	1.147E-11	1.941E-09	1.929E-11	1.403E-11	1.995E-10	2.766E-11	3.659E-11	2.604E-11	5.888E-11
Ce-144	M	2.320E-08	1.533E-08	3.405E-08	1.312E-09	1.009E-07	1.225E-09	1.220E-09	1.254E-09	1.266E-09	1.217E-09	1.287E-09	1.389E-09	1.213E-09	2.811E-09	1.248E-09	1.347E-09	1.255E-09	1.235E-09
Ce-144	S	2.876E-08	3.098E-08	1.174E-09	7.114E-11	3.385E-09	7.373E-11	4.899E-11	1.277E-10	1.448E-10	5.820E-11	1.287E-10	1.281E-10	4.617E-11	1.731E-09	8.028E-11	1.056E-10	1.026E-10	5.372E-11
Ce-146	M	4.207E-11	7.312E-10	9.687E-13	9.904E-13	9.764E-13	8.840E-13	4.679E-13	6.551E-13	1.199E-12	5.354E-13	3.666E-10	1.009E-12	8.034E-13	4.660E-11	1.068E-12	2.620E-12	1.765E-12	1.219E-12
Ce-146	S	4.388E-11	7.555E-10	8.197E-13	8.958E-13	6.960E-13	7.677E-13	3.520E-13	5.590E-13	1.099E-12	4.291E-13	3.788E-10	9.144E-13	6.877E-13	4.856E-11	9.672E-13	2.598E-12	1.711E-12	1.131E-12
Pr-134m	M	4.999E-11	7.997E-10	2.351E-12	2.686E-12	3.738E-12	2.220E-12	1.023E-12	1.536E-12	2.965E-12	1.189E-12	4.014E-10	2.243E-12	2.008E-12	3.585E-11	2.499E-12	5.651E-12	3.775E-12	2.070E-12
Pr-134m	S	5.164E-11	8.182E-10	1.944E-12	1.832E-12	1.577E-12	2.086E-12	7.959E-13	1.436E-12	2.867E-12	1.064E-12	4.106E-10	2.085E-12	1.871E-12	3.714E-11	2.384E-12	5.639E-12	3.738E-12	1.959E-12
Pr-135	M	3.333E-11	6.044E-10	1.979E-12	1.912E-12	2.032E-12	1.459E-12	1.475E-12	1.052E-12	1.999E-12	8.815E-13	3.035E-10	1.706E-12	1.299E-12	2.764E-11	2.064E-12	3.973E-12	2.667E-12	2.873E-12
Pr-135	S	3.446E-11	6.182E-10	1.760E-12	1.653E-12	1.409E-12	1.372E-12	1.365E-12	9.960E-13	1.941E-12	8.074E-13	3.104E-10	1.576E-12	1.207E-12	2.872E-11	2.004E-12	3.959E-12	2.656E-12	2.876E-12
Pr-138	M	2.807E-12	8.334E-11	6.434E-14	2.009E-14	2.629E-14	8.595E-14	4.278E-15	3.917E-14	9.970E-14	3.346E-14	4.171E-11	3.318E-14	8.095E-14	6.144E-14	7.343E-14	6.068E-14	4.401E-14	6.450E-15
Pr-138	S	2.834E-12	8.415E-11	6.230E-14	1.780E-14	2.395E-14	8.412E-14	1.813E-15	3.730E-14	9.803E-14	3.152E-14	4.211E-11	3.108E-14	7.916E-14	5.968E-14	7.159E-14	5.885E-14	4.208E-14	4.030E-15
Pr-140	M	4.198E-12	1.171E-10	1.029E-13	4.644E-14	5.045E-14	1.258E-13	1.122E-14	6.308E-14	1.495E-13	5.279E-14	5.863E-11	6.749E-14	1.177E-13	2.773E-13	1.168E-13	1.575E-13	1.073E-13	1.951E-14

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Pr-140	S	4.271E-12	1.192E-10	9.839E-14	4.150E-14	4.507E-14	1.218E-13	5.547E-15	5.933E-14	1.461E-13	4.875E-14	5.964E-11	6.330E-14	1.139E-13	2.774E-13	1.130E-13	1.550E-13	1.041E-13	1.426E-14
Pr-144	M	2.876E-11	4.395E-10	1.149E-13	1.470E-13	1.911E-13	1.073E-13	1.371E-13	9.948E-14	1.161E-13	9.544E-14	2.201E-10	1.052E-13	1.051E-13	2.361E-11	1.085E-13	1.438E-13	1.233E-13	1.012E-13
Pr-144	S	2.992E-11	4.559E-10	2.101E-14	2.092E-14	1.793E-14	2.473E-14	7.413E-15	1.729E-14	3.391E-14	1.302E-14	2.282E-10	2.301E-14	2.257E-14	2.447E-11	2.624E-14	6.312E-14	4.188E-14	1.881E-14
Pr-146	M	4.760E-11	7.297E-10	1.191E-12	1.315E-12	1.228E-12	1.274E-12	6.443E-13	9.203E-13	1.710E-12	7.405E-13	3.661E-10	1.294E-12	1.166E-12	5.091E-11	1.417E-12	3.291E-12	2.222E-12	1.316E-12
Pr-146	S	4.945E-11	7.519E-10	1.014E-12	1.080E-12	8.650E-13	1.123E-12	3.830E-13	7.912E-13	1.579E-12	5.989E-13	3.771E-10	1.164E-12	1.016E-12	5.291E-11	1.282E-12	3.245E-12	2.139E-12	1.186E-12
Nd-134	M	2.992E-11	4.585E-10	1.577E-12	1.321E-12	1.891E-12	1.266E-12	6.869E-13	9.177E-13	1.724E-12	7.151E-13	2.303E-10	1.446E-12	1.138E-12	2.742E-11	1.536E-12	3.821E-12	2.535E-12	1.502E-12
Nd-134	S	3.101E-11	4.700E-10	1.235E-12	1.241E-12	1.020E-12	1.175E-12	5.340E-13	8.551E-13	1.660E-12	6.352E-13	2.360E-10	1.363E-12	1.046E-12	2.847E-11	1.463E-12	3.845E-12	2.527E-12	1.436E-12
Nd-135	M	4.312E-11	7.980E-10	1.962E-12	1.656E-12	1.661E-12	1.590E-12	1.096E-12	1.085E-12	2.111E-12	8.973E-13	4.003E-10	1.722E-12	1.438E-12	3.167E-11	2.034E-12	4.390E-12	2.921E-12	2.285E-12
Nd-135	S	4.463E-11	8.186E-10	1.702E-12	1.561E-12	1.300E-12	1.479E-12	9.346E-13	1.008E-12	2.030E-12	8.014E-13	4.106E-10	1.616E-12	1.324E-12	3.286E-11	1.950E-12	4.403E-12	2.904E-12	2.232E-12
Nd-137	M	4.614E-11	8.199E-10	3.414E-12	3.168E-12	3.027E-12	2.585E-12	1.888E-12	1.850E-12	3.546E-12	1.542E-12	4.123E-10	2.999E-12	2.326E-12	6.115E-11	3.536E-12	7.734E-12	5.114E-12	5.113E-12
Nd-137	S	4.774E-11	8.337E-10	2.932E-12	3.092E-12	2.475E-12	2.433E-12	1.607E-12	1.771E-12	3.451E-12	1.429E-12	4.192E-10	2.906E-12	2.171E-12	6.390E-11	3.447E-12	7.865E-12	5.157E-12	5.128E-12
Nd-140	M	1.215E-09	5.630E-09	1.512E-10	4.583E-11	3.507E-10	2.763E-11	6.984E-11	3.424E-11	4.898E-11	2.152E-11	6.936E-11	5.121E-11	2.044E-11	8.193E-10	5.202E-11	5.510E-11	4.119E-11	9.759E-11
Nd-140	S	1.275E-09	5.666E-09	4.714E-11	3.770E-11	4.817E-11	2.519E-11	6.580E-11	3.334E-11	4.834E-11	1.895E-11	6.745E-11	3.986E-11	1.655E-11	8.567E-10	4.938E-11	4.689E-11	3.954E-11	9.795E-11
Nd-141	M	8.998E-12	1.839E-10	1.071E-12	5.667E-13	6.492E-13	3.335E-13	4.578E-13	2.752E-13	5.201E-13	2.540E-13	9.245E-11	4.482E-13	2.957E-13	1.052E-11	7.756E-13	1.260E-12	7.763E-13	1.439E-12
Nd-141	S	9.260E-12	1.855E-10	8.897E-13	5.521E-13	4.929E-13	3.051E-13	4.124E-13	2.646E-13	5.034E-13	2.370E-13	9.325E-11	4.228E-13	2.651E-13	1.101E-11	7.657E-13	1.279E-12	7.825E-13	1.472E-12
Nd-152	M	3.845E-11	7.356E-10	3.730E-13	2.980E-13	3.092E-13	3.377E-13	1.763E-13	2.448E-13	4.364E-13	2.068E-13	3.682E-10	3.372E-13	3.145E-13	1.870E-11	3.696E-13	8.299E-13	5.697E-13	2.563E-13
Nd-152	S	4.001E-11	7.634E-10	2.734E-13	2.200E-13	1.794E-13	2.569E-13	5.608E-14	1.679E-13	3.599E-13	1.275E-13	3.820E-10	2.605E-13	2.340E-13	1.930E-11	2.917E-13	7.713E-13	5.027E-13	1.753E-13
Pm-139	M	1.000E-11	2.327E-10	4.483E-13	2.392E-13	2.875E-13	3.613E-13	1.074E-13	2.120E-13	4.542E-13	1.745E-13	1.166E-10	2.830E-13	3.337E-13	3.496E-12	3.866E-13	6.985E-13	4.651E-13	2.517E-13
Pm-139	S	1.025E-11	2.373E-10	3.254E-13	2.202E-13	2.026E-13	3.437E-13	7.941E-14	1.988E-13	4.415E-13	1.579E-13	1.189E-10	2.634E-13	3.154E-13	3.612E-12	3.715E-13	6.940E-13	4.581E-13	2.365E-13
Pm-147	M	3.515E-09	5.374E-09	5.081E-08	2.991E-13	1.355E-08	2.703E-13	2.814E-12	2.754E-13	2.776E-13	2.694E-13	4.535E-12	3.216E-13	2.710E-13	7.501E-11	2.779E-13	3.084E-13	2.764E-13	2.733E-13
Pm-147	S	3.177E-09	1.866E-08	2.614E-09	2.023E-14	6.971E-10	2.026E-14	1.457E-13	3.242E-14	3.699E-14	1.695E-14	1.112E-11	3.457E-14	1.460E-14	8.218E-11	2.252E-14	2.929E-14	2.739E-14	1.551E-14
Pm-152	M	9.624E-12	2.404E-10	7.602E-14	4.121E-14	4.434E-14	8.445E-14	1.978E-14	5.150E-14	1.079E-13	4.353E-14	1.203E-10	5.347E-14	7.951E-14	9.903E-13	7.881E-14	1.115E-13	7.933E-14	2.482E-14
Pm-152	S	9.832E-12	2.456E-10	6.247E-14	2.846E-14	2.910E-14	7.200E-14	4.585E-15	3.922E-14	9.589E-14	3.103E-14	1.228E-10	4.092E-14	6.712E-14	9.992E-13	6.648E-14	1.002E-13	6.748E-14	1.157E-14
Sm-140	M	5.091E-11	7.708E-10	1.806E-12	1.269E-12	2.136E-12	1.481E-12	7.036E-13	1.015E-12	1.933E-12	8.079E-13	3.866E-10	1.482E-12	1.349E-12	3.625E-11	1.683E-12	3.698E-12	2.476E-12	1.291E-12
Sm-143	M	9.060E-12	2.064E-10	3.228E-13	1.928E-13	2.707E-13	2.870E-13	6.096E-14	1.755E-13	3.613E-13	1.397E-13	1.034E-10	2.530E-13	2.654E-13	2.497E-12	3.001E-13	6.247E-13	4.086E-13	1.234E-13
Sm-146	M	6.774E-06	1.587E-06	1.931E-04	2.260E-10	5.294E-05	2.260E-10	2.970E-10	2.260E-10	2.260E-10	2.260E-10	1.036E-09	2.260E-10	2.260E-10	8.212E-10	2.260E-10	2.260E-10	2.260E-10	2.260E-10
Eu-152n	M	1.056E-11	9.464E-11	3.099E-12	8.600E-13	2.910E-12	3.458E-13	4.480E-13	3.050E-13	5.483E-13	2.535E-13	4.783E-11	8.061E-13	3.250E-13	1.989E-11	6.365E-13	1.386E-12	8.193E-13	1.121E-12
Eu-154	M	3.391E-08	2.868E-08	2.626E-07	1.872E-08	2.101E-07	4.771E-09	3.925E-09	7.144E-09	7.595E-09	5.045E-09	8.050E-09	2.732E-08	5.260E-09	1.115E-08	7.945E-09	2.022E-08	7.575E-09	6.107E-09
Eu-154m	M	5.287E-12	5.335E-11	3.260E-12	4.163E-13	2.335E-12	1.739E-13	1.696E-13	1.689E-13	2.821E-13	1.362E-13	2.693E-11	4.584E-13	1.658E-13	8.919E-12	3.368E-13	8.521E-13	4.789E-13	4.353E-13
Eu-159	M	3.639E-11	5.767E-10	7.986E-13	7.051E-13	7.453E-13	3.479E-13	2.929E-13	2.594E-13	4.736E-13	2.240E-13	2.888E-10	3.775E-13	3.206E-13	2.455E-11	4.570E-13	9.983E-13	6.637E-13	4.187E-13
Gd-144	F	1.416E-11	3.275E-10	7.797E-13	5.779E-13	5.983E-13	8.576E-13	5.177E-13	5.796E-13	9.557E-13	5.380E-13	1.641E-10	6.318E-13	8.142E-13	2.444E-12	8.026E-13	1.021E-12	7.993E-13	4.619E-13
Gd-144	M	1.740E-11	3.997E-10	4.718E-13	2.619E-13	2.648E-13	5.856E-13	8.423E-14	3.206E-13	7.149E-13	2.616E-13	2.001E-10	3.550E-13	5.470E-13	2.672E-12	5.402E-13	8.460E-13	5.774E-13	1.302E-13
Gd-151	F	1.101E-09	1.395E-09	2.694E-08	5.820E-10	6.818E-09	7.898E-11	7.492E-11	9.026E-11	1.023E-10	7.536E-11	1.572E-10	5.355E-10	1.239E-10	2.353E-10	1.512E-10	3.863E-10	1.092E-10	1.100E-10
Gd-151	M	7.756E-10	1.986E-09	4.527E-09	1.098E-10	1.177E-09	2.738E-11	2.449E-11	6.234E-11	7.206E-11	2.139E-11	5.442E-11	1.340E-10	2.294E-11	1.272E-10	5.250E-11	9.735E-11	5.334E-11	3.548E-11
Gd-162	F	1.876E-11	4.787E-10	1.111E-12	9.275E-13	9.138E-13	1.017E-12	8.930E-13	6.865E-13	1.152E-12	6.508E-13	2.399E-10	9.280E-13	9.517E-13	5.287E-12	1.025E-12	1.758E-12	1.292E-12	8.213E-13
Gd-162	M	2.852E-11	6.846E-10	6.851E-13	5.983E-13	4.998E-13	6.867E-13	2.138E-13	4.480E-13	9.197E-13	3.541E-13	3.427E-10	7.003E-13	6.277E-13	7.128E-12	7.610E-13	1.952E-12	1.287E-12	4.779E-13
Tb-148	M	1.028E-10	1.521E-09	3.856E-10	8.020E-12	5.832E-11	5.964E-12	4.757E-12	4.335E-12	8.139E-12	3.594E-12	7.657E-10	6.822E-12	5.362E-12	1.478E-10	7.700E-12	1.665E-11	1.123E-11	1.161E-11
Tb-152	M	4.987E-10	6.237E-09	5.818E-11	6.804E-11	6.500E-11	3.173E-11	7.337E-11	2.649E-11	4.699E-11	2.429E-11	3.150E-09	4.050E-11	2.696E-11	4.856E-10	5.611E-11	5.830E-11	4.471E-11	1.192E-10
Tb-155	M	3.271E-10	2.164E-09	1.849E-10	3.696E-11	5.539E-11	9.669E-12	2.877E-11	1.498E-11	2.225E-11	7.166E-12	1.094E-09	2.256E-11	6.372E-12	1.388E-10	2.157E-11	2.313E-11	1.823E-11	4.107E-11
Tb-162	M	1.714E-11	4.601E-10	4.552E-13	2.937E-13	2.662E-13	4.981E-13	8.160E-14	2.896E-13	6.589E-13	2.324E-13	2.303E-10	3.774E-13	4.609E-13	2.085E-12	4.957E-13	9.830E-13	6.558E-13	1.753E-13
Dy-148	M	6.902E-12	1.219E-10	2.552E-11	4.859E-13	1.543E-12	4.723E-13	3.013E-13	3.137E-13	6.281E-13	2.605E-13	6.130E-11	4.622E-13	4.289E-13	8.632E-12	5.669E-13	1.129E-12	7.615E-13	6.924E-13
Dy-149	M	3.243E-11	2.273E-10	7.211E-12	8.890E-13	8.353E-13	7.794E-13	3.532E-13	5.199E-13	1.016E-12	4.363E-13	1.141E-10	6.175E-13	7.225E-13	2.643E-12	8.231E-13	1.279E-12	9.027E-13	6.161E-13
Dy-150	M	2.510E-10	2.817E-10	2.689E-12	1.397E-12	1.343E-12	1.167E-12	1.208E-12	1.043E-12	1.360E-12	9.834E-13	1.616E-12	1.231E-12	1.110E-12	7.242E-12	1.361E-12	1.753E-12	1.430E-12	1.830E-12
Dy-151	M	9.153E-11	4.709E-10	4.670E-12	2.139E-12	1.928E-12	1.933E-12	1.623E-12	1.458E-12	2.593E-12	1.247E-12	2.779E-12	2.027E-12	1.767E-12	9.775E-12	2.411E-12	4.449E-12	3.103E-12	2.861E-12
Dy-152	M	8.753E-11	1.081E-09	1.355E-11	9.785E-12	8.920E-12	5.288E-12	1.226E-11	4.270E-12	7.820E-12	3.964E-12	5.460E-10	6.637E-12	4.525E-12	7.104E-11	9.550E-12	1.048E-11	7.895E-12	2.058E-11
Dy-153	M	1.787E-10	2.625E-09	5.418E-11	1.917E-11	1.863E-11	1.079E-11	2.164E-11	8.725E-12	1.639E-11	7.800E-12	1.323E-09	1.376E-11	9.322E-12	1.568E-10	1.942E-11	2.332E-11	1.690E-11	4.152E-11

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Dy-165	M	8.768E-11	9.015E-10	1.331E-12	8.765E-13	7.852E-13	3.753E-13	1.836E-12	3.362E-13	4.356E-13	3.281E-13	4.527E-10	4.083E-13	3.603E-13	1.653E-10	4.695E-13	6.460E-13	5.124E-13	7.081E-13
Ho-154	M	2.537E-11	5.272E-10	1.142E-12	9.006E-13	8.030E-13	1.256E-12	3.070E-13	7.726E-13	1.630E-12	6.152E-13	2.643E-10	1.097E-12	1.155E-12	1.091E-11	1.308E-12	3.025E-12	1.969E-12	6.871E-13
Ho-156	M	8.928E-11	1.612E-09	5.901E-12	6.185E-12	5.460E-12	5.003E-12	3.685E-12	3.601E-12	6.944E-12	2.977E-12	8.106E-10	5.768E-12	4.495E-12	1.094E-10	6.508E-12	1.551E-11	9.738E-12	9.706E-12
Ho-160	M	2.384E-11	5.948E-10	2.155E-12	2.054E-12	1.676E-12	2.042E-12	7.936E-13	1.399E-12	2.859E-12	1.110E-12	2.987E-10	2.243E-12	1.847E-12	7.471E-12	2.459E-12	6.186E-12	4.028E-12	2.379E-12
Ho-161	M	1.122E-11	1.746E-10	1.817E-12	4.776E-13	6.229E-13	2.200E-13	4.615E-13	1.915E-13	4.002E-13	1.875E-13	8.781E-11	3.521E-13	1.930E-13	1.757E-11	7.004E-13	1.525E-12	7.116E-13	1.404E-12
Ho-163	M	7.019E-11	5.846E-15	2.037E-09	2.613E-15	5.431E-10	2.613E-15	8.706E-14	2.613E-15	2.613E-15	2.613E-15	3.990E-12	2.613E-15	2.613E-15	7.101E-13	2.613E-15	1.222E-09	2.613E-15	2.613E-15
Ho-168	M	7.582E-12	2.190E-10	1.394E-13	6.063E-14	6.661E-14	1.744E-13	1.464E-14	9.062E-14	2.210E-13	7.496E-14	1.096E-10	8.948E-14	1.634E-13	2.998E-13	1.557E-13	1.954E-13	1.346E-13	2.483E-14
Er-154	M	1.047E-11	1.512E-10	4.084E-13	3.467E-13	2.873E-13	3.872E-13	1.397E-13	2.607E-13	5.152E-13	2.074E-13	7.585E-11	4.047E-13	3.537E-13	4.733E-12	4.415E-13	1.135E-12	7.485E-13	2.918E-13
Er-156	M	3.027E-11	4.359E-10	2.349E-12	2.386E-12	1.904E-12	1.633E-12	1.754E-12	1.230E-12	2.304E-12	1.055E-12	2.196E-10	2.047E-12	1.455E-12	5.045E-11	2.364E-12	5.022E-12	3.383E-12	4.305E-12
Er-159	M	2.921E-11	6.431E-10	3.638E-12	2.589E-12	2.061E-12	2.056E-12	1.395E-12	1.452E-12	2.917E-12	1.188E-12	3.231E-10	2.465E-12	1.844E-12	2.019E-11	2.835E-12	6.816E-12	4.481E-12	4.143E-12
Er-163	M	2.209E-12	4.377E-11	5.917E-13	1.848E-13	1.540E-13	8.837E-14	1.286E-13	7.224E-14	1.638E-13	6.975E-14	2.203E-11	1.478E-13	7.705E-14	2.896E-12	2.528E-13	5.843E-13	3.534E-13	4.698E-13
Er-165	M	1.410E-11	2.054E-10	5.380E-12	1.020E-12	1.093E-12	4.383E-13	1.773E-12	4.111E-13	8.742E-13	4.020E-13	1.036E-10	6.684E-13	3.709E-13	1.674E-11	1.535E-12	1.574E-12	1.060E-12	3.649E-12
Tm-161	M	4.199E-11	6.461E-10	4.570E-12	3.517E-12	2.920E-12	2.736E-12	2.427E-12	1.972E-12	3.921E-12	1.682E-12	4.253E-10	3.085E-12	2.448E-12	3.150E-11	3.885E-12	7.688E-12	5.156E-12	6.167E-12
Tm-163	M	6.249E-11	1.290E-09	9.060E-12	7.734E-12	6.306E-12	5.357E-12	5.455E-12	3.952E-12	7.819E-12	3.470E-12	6.492E-10	6.282E-12	4.763E-12	5.535E-11	7.985E-12	1.462E-11	9.936E-12	1.514E-11
Tm-164	M	2.857E-12	8.422E-11	8.857E-14	2.874E-14	3.483E-14	1.054E-13	6.035E-15	5.140E-14	1.293E-13	4.280E-14	4.215E-11	4.535E-14	9.899E-14	8.217E-14	9.221E-14	9.186E-14	6.492E-14	9.875E-15
Tm-165	M	3.127E-10	3.654E-09	9.714E-11	2.817E-11	2.871E-11	1.707E-11	4.910E-11	1.575E-11	2.773E-11	1.304E-11	1.845E-09	2.334E-11	1.403E-11	2.273E-10	3.419E-11	3.220E-11	2.532E-11	7.605E-11
Tm-168	M	3.261E-09	1.460E-08	1.002E-08	7.490E-10	1.307E-09	5.858E-10	4.617E-10	8.415E-10	1.050E-09	3.824E-10	6.894E-10	1.313E-09	4.691E-10	1.110E-09	6.806E-10	9.494E-10	7.716E-10	6.524E-10
Tm-171	M	9.062E-10	1.741E-09	2.310E-08	3.008E-11	3.826E-10	2.933E-11	3.011E-11	2.934E-11	2.993E-11	2.868E-11	3.114E-11	3.169E-11	2.976E-11	6.099E-11	2.962E-11	3.032E-11	2.957E-11	2.951E-11
Yb-163	M	1.435E-11	3.131E-10	1.350E-12	1.136E-12	9.271E-13	9.593E-13	7.525E-13	6.647E-13	1.350E-12	5.658E-13	1.572E-10	1.015E-12	8.634E-13	8.621E-12	1.278E-12	2.495E-12	1.687E-12	1.898E-12
Yb-163	S	1.475E-11	3.183E-10	1.219E-12	1.116E-12	9.115E-13	9.236E-13	6.268E-13	6.547E-13	1.336E-12	5.435E-13	1.599E-10	1.002E-12	8.263E-13	8.945E-12	1.263E-12	2.547E-12	1.704E-12	1.918E-12
Yb-164	M	6.748E-11	8.482E-10	4.035E-12	3.801E-12	2.945E-12	2.630E-12	3.796E-12	1.938E-12	3.592E-12	1.681E-12	4.274E-10	3.156E-12	2.363E-12	1.370E-10	3.726E-12	7.766E-12	5.334E-12	6.351E-12
Yb-164	S	7.021E-11	8.660E-10	3.325E-12	3.425E-12	2.700E-12	2.355E-12	1.979E-12	1.749E-12	3.383E-12	1.454E-12	4.362E-10	2.969E-12	2.084E-12	1.433E-10	3.523E-12	7.800E-12	5.175E-12	6.271E-12
Yb-165	M	7.162E-12	1.255E-10	7.726E-13	3.078E-13	2.687E-13	2.676E-13	3.236E-13	1.943E-13	4.011E-13	1.603E-13	6.297E-11	2.868E-13	2.357E-13	2.391E-12	4.035E-13	6.714E-13	4.721E-13	5.155E-13
Yb-165	S	7.402E-12	1.281E-10	5.204E-13	2.751E-13	2.543E-13	2.562E-13	2.931E-13	1.917E-13	3.984E-13	1.520E-13	6.425E-11	2.758E-13	2.213E-13	2.466E-12	3.979E-13	6.767E-13	4.614E-13	5.159E-13
Yb-178	M	1.009E-10	1.067E-09	1.568E-12	1.327E-12	9.189E-13	7.417E-13	3.360E-12	6.269E-13	9.368E-13	5.870E-13	5.364E-10	8.359E-13	6.923E-13	2.172E-10	9.459E-13	1.525E-12	1.298E-12	1.583E-12
Yb-178	S	1.067E-10	1.107E-09	5.785E-13	6.719E-13	5.265E-13	4.257E-13	4.509E-13	3.273E-13	6.329E-13	2.802E-13	5.564E-10	5.360E-13	3.752E-13	2.278E-10	6.436E-13	1.261E-12	8.613E-13	1.310E-12
Lu-165	M	2.167E-11	4.508E-10	1.601E-12	8.256E-13	7.134E-13	9.178E-13	5.431E-13	6.145E-13	1.282E-12	4.903E-13	2.260E-10	9.061E-13	8.299E-13	7.539E-12	1.130E-12	2.448E-12	1.628E-12	1.004E-12
Lu-165	S	2.241E-11	4.620E-10	1.222E-12	7.921E-13	6.821E-13	8.815E-13	4.486E-13	5.973E-13	1.265E-12	4.613E-13	2.316E-10	8.807E-13	7.903E-13	7.772E-12	1.108E-12	2.483E-12	1.639E-12	9.810E-13
Lu-167	M	5.792E-11	1.077E-09	9.762E-12	5.300E-12	4.229E-12	4.104E-12	3.275E-12	3.043E-12	5.974E-12	2.464E-12	5.417E-10	4.826E-12	3.659E-12	4.676E-11	5.616E-12	1.275E-11	8.505E-12	8.724E-12
Lu-167	S	6.022E-11	1.093E-09	5.799E-12	5.250E-12	4.148E-12	3.943E-12	2.715E-12	3.021E-12	5.925E-12	2.373E-12	5.497E-10	4.795E-12	3.486E-12	4.871E-11	5.560E-12	1.310E-11	8.687E-12	8.822E-12
Lu-173	M	2.138E-09	4.758E-09	3.547E-08	4.037E-10	8.543E-10	2.647E-10	1.939E-10	3.062E-10	4.111E-10	1.621E-10	3.301E-10	6.995E-10	3.125E-10	5.032E-10	3.233E-10	4.401E-10	3.196E-10	2.993E-10
Lu-173	S	2.073E-09	1.060E-08	2.002E-09	1.632E-10	5.324E-10	1.989E-10	4.829E-11	5.752E-10	7.216E-10	1.049E-10	2.586E-10	5.714E-10	3.382E-11	2.228E-10	2.644E-10	4.234E-10	4.163E-10	7.378E-11
Hf-167	F	3.496E-12	9.550E-11	1.575E-12	2.657E-13	2.353E-13	3.340E-13	1.963E-13	1.933E-13	3.825E-13	1.886E-13	4.793E-11	2.693E-13	3.118E-13	1.267E-12	3.442E-13	4.881E-13	3.575E-13	3.454E-13
Hf-167	M	4.544E-12	1.086E-10	4.485E-13	2.395E-13	1.997E-13	2.500E-13	1.222E-13	1.626E-13	3.420E-13	1.335E-13	5.445E-11	2.348E-13	2.265E-13	1.992E-12	3.038E-13	5.997E-13	4.032E-13	3.669E-13
Hf-169	F	2.317E-12	6.276E-11	2.929E-12	2.144E-13	1.876E-13	2.785E-13	2.053E-13	1.528E-13	3.065E-13	1.531E-13	3.152E-11	2.439E-13	2.699E-13	5.078E-13	2.897E-13	3.206E-13	2.424E-13	2.689E-13
Hf-169	M	2.824E-12	7.058E-11	5.845E-13	1.534E-13	1.550E-13	2.078E-13	1.681E-13	1.363E-13	2.815E-13	1.098E-13	3.542E-11	1.664E-13	1.845E-13	6.728E-13	2.509E-13	2.938E-13	2.163E-13	2.654E-13
Hf-181	F	1.760E-09	7.572E-09	4.885E-08	5.044E-10	3.496E-10	3.762E-10	4.329E-10	2.505E-10	3.410E-10	2.677E-10	4.145E-10	6.902E-10	4.495E-10	7.307E-10	4.004E-10	4.772E-10	3.553E-10	4.911E-10
Hf-181	M	4.103E-09	1.116E-08	6.929E-09	1.504E-10	2.067E-10	1.317E-10	1.372E-10	2.097E-10	2.672E-10	8.354E-11	1.720E-10	2.753E-10	8.620E-11	5.434E-10	1.616E-10	2.155E-10	1.854E-10	1.794E-10
Ta-170	M	2.181E-11	4.499E-10	9.765E-13	6.965E-13	5.586E-13	6.749E-13	6.034E-13	4.978E-13	9.297E-13	3.857E-13	2.254E-10	6.405E-13	5.877E-13	6.191E-12	8.232E-13	1.198E-12	8.811E-13	8.921E-13
Ta-170	S	2.242E-11	4.602E-10	7.265E-13	5.137E-13	5.079E-13	6.151E-13	5.485E-13	4.620E-13	8.902E-13	3.362E-13	2.306E-10	5.748E-13	5.249E-13	6.328E-12	7.741E-13	1.155E-12	8.331E-13	8.475E-13
Ta-178m	M	1.146E-10	2.009E-09	1.180E-11	1.009E-11	7.577E-12	6.080E-12	7.027E-12	4.047E-12	8.440E-12	3.688E-12	1.010E-09	7.349E-12	5.397E-12	1.013E-10	9.525E-12	1.706E-11	1.163E-11	1.962E-11
Ta-178m	S	1.197E-10	2.041E-09	1.036E-11	9.402E-12	7.507E-12	5.716E-12	6.872E-12	3.940E-12	8.259E-12	3.490E-12	1.026E-09	7.205E-12	5.032E-12	1.060E-10	9.410E-12	1.739E-11	1.175E-11	2.007E-11
Ta-183	M	1.896E-09	7.102E-09	6.594E-10	1.781E-10	3.941E-11	2.645E-11	5.939E-11	3.147E-11	4.416E-11	2.047E-11	5.510E-11	4.015E-11	2.023E-11	5.329E-10	4.078E-11	4.261E-11	3.804E-11	7.367E-11
Ta-183	S	2.084E-09	7.276E-09	6.065E-11	2.687E-11	3.010E-11	1.583E-11	4.391E-11	2.402E-11	3.619E-11	1.108E-11	4.453E-11	2.879E-11	8.955E-12	5.480E-10	3.112E-11	3.195E-11	2.770E-11	6.402E-11
W-179m	F	8.988E-12	2.809E-10	1.781E-13	8.081E-14	7.258E-14	7.914E-14	2.774E-13	6.014E-14	9.007E-14	6.146E-14	1.405E-10	7.720E-14	7.657E-14	6.823E-13	9.546E-14	1.420E-13	1.116E-13	9.091E-14
W-181	F	4.750E-11	4.514E-10	7.206E-11	9.137E-11	2.340E-11	3.916E-12	2.418E-11	2.131E-12	3.854E-12	3.001E-12	2.301E-10	1.011E-11	5.517E-12	2.804E-11	7.102E-12	1.001E-11	8.057E-11	1.189E-11
W-183m	F	1.241E-13	3.816E-12	2.043E-15	6.907E-17	2.014E-16	6.832E-16	1.877E-17	2.933E-16	1.048E-15	2.914E-16	1.908E-12	2.084E-16	6.329E-16	3.228E-17	8.869E-16	1.984E-16	1.939E-16	2.105E-17

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq)	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Re-179	F	1.365E-11	3.421E-10	1.716E-12	1.128E-12	1.033E-12	1.369E-11	8.219E-13	8.239E-13	1.632E-12	7.720E-13	1.718E-10	1.224E-12	1.290E-12	3.515E-12	1.441E-12	2.729E-12	1.902E-12	1.098E-12
Re-179	M	1.896E-11	4.533E-10	1.437E-12	1.029E-12	8.734E-13	4.363E-12	3.981E-13	7.686E-13	1.573E-12	6.045E-13	2.274E-10	1.182E-12	1.049E-12	4.962E-12	1.329E-12	3.375E-12	2.221E-12	9.207E-13
Re-180	F	3.529E-12	1.109E-10	1.805E-13	7.349E-14	8.124E-14	2.908E-13	3.154E-14	1.026E-13	2.483E-13	8.904E-14	5.555E-11	1.022E-13	1.851E-13	8.588E-14	1.778E-13	1.907E-13	1.380E-13	4.273E-14
Re-180	M	4.017E-12	1.258E-10	1.685E-13	5.774E-14	6.639E-14	2.008E-13	9.542E-15	9.648E-14	2.487E-13	7.988E-14	6.301E-11	8.990E-14	1.792E-13	7.141E-14	1.717E-13	1.916E-13	1.331E-13	1.942E-14
Re-182	F	1.034E-09	1.353E-08	2.207E-10	1.751E-10	1.794E-10	2.098E-09	3.951E-10	1.078E-10	1.701E-10	1.097E-10	6.855E-09	1.699E-10	1.422E-10	3.694E-10	1.803E-10	2.666E-10	2.046E-10	2.481E-10
Re-182	M	1.628E-09	1.432E-08	2.166E-10	1.664E-10	1.941E-10	1.659E-09	3.297E-10	1.443E-10	2.113E-10	1.036E-10	7.252E-09	1.923E-10	1.239E-10	3.879E-10	1.798E-10	2.652E-10	2.114E-10	2.281E-10
Re-183	F	5.541E-10	2.626E-09	1.111E-10	6.685E-11	7.815E-11	1.084E-09	2.069E-10	4.920E-11	6.063E-11	4.936E-11	1.346E-09	6.732E-11	5.756E-11	1.223E-10	6.556E-11	9.378E-11	7.740E-11	8.639E-11
Re-183	M	2.215E-09	5.742E-09	1.710E-10	7.596E-11	1.335E-10	9.379E-10	1.779E-10	1.172E-10	1.471E-10	5.446E-11	9.088E-11	1.306E-10	5.105E-11	1.323E-10	8.859E-11	1.354E-10	1.204E-10	7.869E-11
Re-186	F	7.099E-10	2.243E-09	5.616E-11	5.325E-11	6.991E-11	2.593E-09	2.780E-10	5.204E-11	5.303E-11	5.209E-11	5.526E-11	5.324E-11	5.272E-11	9.463E-11	5.331E-11	5.494E-11	5.389E-11	5.471E-11
Re-186	M	1.188E-09	2.847E-09	4.521E-11	4.202E-11	5.560E-11	2.025E-09	2.174E-10	4.168E-11	4.285E-11	4.093E-11	4.531E-11	4.267E-11	4.132E-11	1.211E-10	4.230E-11	4.395E-11	4.301E-11	4.328E-11
Os-180	F	1.639E-11	4.218E-10	2.037E-12	1.703E-12	1.507E-12	1.741E-12	1.414E-12	1.073E-12	2.050E-12	1.024E-12	2.119E-10	1.635E-12	1.599E-12	6.758E-12	1.852E-12	3.417E-12	2.535E-12	1.746E-12
Os-180	M	2.495E-11	5.613E-10	1.600E-12	1.426E-12	1.133E-12	1.323E-12	5.541E-13	9.365E-13	1.887E-12	7.388E-13	2.816E-10	1.545E-12	1.193E-12	9.755E-12	1.652E-12	4.399E-12	2.887E-12	1.563E-12
Os-180	S	2.589E-11	5.767E-10	1.552E-12	1.395E-12	1.092E-12	1.277E-12	4.595E-13	9.215E-13	1.869E-12	7.074E-13	2.892E-10	1.536E-12	1.148E-12	1.008E-11	1.630E-12	4.507E-12	2.925E-12	1.543E-12
Os-183	F	1.441E-10	2.848E-09	3.805E-11	9.004E-11	9.090E-11	2.205E-11	4.062E-11	1.389E-11	2.385E-11	1.511E-11	1.439E-09	2.828E-11	2.015E-11	1.112E-10	2.757E-11	3.423E-11	7.797E-11	4.334E-11
Os-183	M	2.376E-10	3.019E-09	2.750E-11	2.911E-11	2.758E-11	1.242E-11	2.914E-11	9.997E-12	1.863E-11	8.963E-12	1.522E-09	1.615E-11	1.040E-11	1.771E-10	2.279E-11	2.561E-11	2.623E-11	5.060E-11
Os-183	S	2.506E-10	3.049E-09	2.630E-11	2.066E-11	1.912E-11	1.128E-11	2.768E-11	9.691E-12	1.823E-11	8.193E-12	1.537E-09	1.479E-11	9.180E-12	1.842E-10	2.221E-11	2.457E-11	1.917E-11	5.122E-11
Os-183m	F	1.541E-10	3.433E-09	3.471E-11	7.856E-11	8.156E-11	2.578E-11	4.108E-11	1.621E-11	2.935E-11	1.763E-11	1.733E-09	3.126E-11	2.326E-11	1.056E-10	3.186E-11	3.826E-11	6.808E-11	4.946E-11
Os-183m	M	2.166E-10	3.570E-09	2.610E-11	3.307E-11	3.112E-11	1.665E-11	3.306E-11	1.368E-11	2.517E-11	1.261E-11	1.801E-09	2.052E-11	1.412E-11	1.637E-10	2.853E-11	3.229E-11	2.946E-11	6.065E-11
Os-183m	S	2.255E-10	3.594E-09	2.512E-11	2.674E-11	2.443E-11	1.559E-11	3.203E-11	1.350E-11	2.484E-11	1.198E-11	1.812E-09	1.932E-11	1.300E-11	1.700E-10	2.812E-11	3.157E-11	2.416E-11	6.174E-11
Os-190m	F	9.936E-12	2.999E-10	9.497E-13	6.714E-13	6.167E-13	1.001E-12	4.007E-13	5.326E-13	1.152E-12	4.820E-13	1.504E-10	7.675E-13	9.187E-13	1.317E-12	9.658E-13	1.701E-12	1.199E-12	5.575E-13
Os-190m	M	1.282E-11	3.742E-10	8.308E-13	5.905E-13	5.140E-13	9.034E-13	1.519E-13	5.117E-13	1.147E-12	4.063E-13	1.875E-10	7.455E-13	8.311E-13	1.523E-12	9.264E-13	2.070E-12	1.370E-12	3.996E-13
Os-190m	S	1.314E-11	3.823E-10	8.177E-13	5.816E-13	5.027E-13	8.927E-13	1.245E-13	5.094E-13	1.147E-12	3.980E-13	1.916E-10	7.431E-13	8.215E-13	1.546E-12	9.221E-13	2.111E-12	1.389E-12	3.822E-13
Os-191	F	3.644E-10	2.049E-09	1.628E-10	1.380E-09	1.247E-09	1.080E-10	1.490E-10	1.003E-10	1.095E-10	9.809E-11	1.092E-09	1.463E-10	1.043E-10	2.205E-10	1.127E-10	1.486E-10	1.190E-09	1.244E-10
Os-191	M	1.351E-09	3.444E-09	4.801E-11	1.888E-10	1.791E-10	2.087E-11	3.313E-11	2.771E-11	3.491E-11	1.696E-11	3.486E-11	3.475E-11	1.590E-11	2.170E-10	2.719E-11	3.445E-11	1.694E-10	3.616E-11
Os-191	S	1.542E-09	3.756E-09	3.398E-11	3.194E-11	3.917E-11	9.769E-12	1.770E-11	1.930E-11	2.657E-11	6.434E-12	2.212E-11	2.117E-11	4.266E-12	2.147E-10	1.635E-11	2.020E-11	3.559E-11	2.433E-11
Os-196	F	4.824E-11	8.029E-10	3.219E-12	5.054E-12	4.695E-12	3.134E-12	7.708E-12	2.857E-12	3.223E-12	2.850E-12	4.037E-10	3.080E-12	3.080E-12	6.672E-11	3.172E-12	3.697E-12	5.029E-12	3.232E-12
Os-196	M	8.566E-11	1.256E-09	8.396E-13	1.021E-12	8.692E-13	7.458E-13	9.863E-13	5.872E-13	9.334E-13	5.223E-13	6.293E-10	8.284E-13	6.963E-13	1.096E-10	8.792E-13	1.847E-12	1.476E-12	1.020E-12
Os-196	S	8.978E-11	1.305E-09	5.777E-13	5.771E-13	4.480E-13	4.829E-13	2.464E-13	3.374E-13	6.813E-13	2.661E-13	6.542E-10	5.806E-13	4.339E-13	1.143E-10	6.269E-13	1.643E-12	1.085E-12	7.768E-13
Ir-183	F	4.200E-11	1.013E-09	7.637E-12	1.201E-11	1.189E-11	6.058E-12	8.136E-12	3.710E-12	6.889E-12	3.832E-12	5.104E-10	6.273E-12	5.529E-12	2.995E-11	6.902E-12	9.689E-12	1.181E-11	9.489E-12
Ir-183	M	6.172E-11	1.161E-09	5.837E-12	6.495E-12	5.644E-12	4.160E-12	5.096E-12	3.150E-12	6.020E-12	2.717E-12	5.838E-10	4.913E-12	3.645E-12	4.794E-11	6.146E-12	1.073E-11	8.038E-12	1.105E-11
Ir-183	S	6.409E-11	1.178E-09	5.636E-12	5.758E-12	4.845E-12	3.946E-12	4.746E-12	3.098E-12	5.938E-12	2.588E-12	5.923E-10	4.762E-12	3.427E-12	4.991E-11	6.058E-12	1.084E-11	7.521E-12	1.120E-11
Ir-186	F	3.585E-10	7.335E-09	7.438E-11	1.607E-10	1.707E-10	5.564E-11	1.002E-10	3.467E-11	6.172E-11	3.789E-11	3.704E-09	6.991E-11	4.989E-11	2.618E-10	6.980E-11	8.348E-11	1.385E-10	1.105E-10
Ir-186	M	5.296E-10	7.650E-09	5.759E-11	6.766E-11	6.353E-11	3.572E-11	8.163E-11	2.911E-11	5.274E-11	2.674E-11	3.859E-09	4.419E-11	2.988E-11	4.151E-10	6.258E-11	6.643E-11	5.947E-11	1.352E-10
Ir-186	S	5.488E-10	7.685E-09	5.573E-11	5.729E-11	5.163E-11	3.352E-11	7.952E-11	2.854E-11	5.180E-11	2.551E-11	3.877E-09	4.136E-11	2.766E-11	4.320E-10	6.178E-11	6.454E-11	5.069E-11	1.379E-10
Ir-190	F	1.059E-09	1.258E-08	5.130E-10	1.846E-09	2.202E-09	3.572E-10	4.927E-10	2.867E-10	3.887E-10	2.621E-10	6.517E-09	7.855E-10	2.924E-10	8.270E-10	4.277E-10	8.020E-10	1.609E-09	5.701E-10
Ir-190	M	1.468E-09	1.297E-08	2.325E-10	3.690E-10	4.797E-10	1.540E-10	2.502E-10	2.324E-10	3.087E-10	1.051E-10	6.599E-09	3.108E-10	8.680E-11	7.155E-10	2.247E-10	3.013E-10	3.830E-10	3.436E-10
Ir-190	S	1.550E-09	1.304E-08	2.014E-10	1.832E-10	2.688E-10	1.324E-10	2.179E-10	2.369E-10	3.121E-10	8.714E-11	6.625E-09	2.611E-10	6.120E-11	6.973E-10	2.029E-10	2.450E-10	2.338E-10	3.129E-10
Ir-196	F	1.775E-12	5.515E-11	1.861E-14	1.036E-14	1.153E-14	2.154E-14	8.636E-15	1.367E-14	2.456E-14	1.281E-14	2.758E-11	1.226E-14	2.068E-14	1.955E-14	1.915E-14	1.473E-14	1.312E-14	8.459E-15
Ir-196	M	1.891E-12	5.868E-11	1.186E-14	3.242E-15	4.488E-15	1.497E-14	1.070E-15	7.038E-15	1.818E-14	6.114E-15	2.945E-11	5.360E-15	1.416E-14	1.320E-14	1.255E-14	7.968E-15	6.210E-15	1.279E-15
Ir-196	S	1.903E-12	5.929E-11	1.112E-14	2.459E-15	3.714E-15	1.424E-14	2.381E-16	6.309E-15	1.748E-14	5.377E-15	2.965E-11	4.601E-15	1.344E-14	1.250E-14	1.182E-14	7.224E-15	5.450E-15	4.891E-16
Ir-196m	F	9.393E-11	2.377E-09	1.300E-11	1.597E-11	1.473E-11	1.225E-11	1.625E-11	7.002E-12	1.324E-11	7.261E-12	1.196E-09	1.127E-11	1.125E-11	7.565E-11	1.327E-11	1.951E-11	1.766E-11	1.776E-11
Ir-196m	M	1.462E-10	2.873E-09	9.894E-12	1.191E-11	9.605E-12	8.549E-12	7.741E-12	5.813E-12	1.142E-11	5.014E-12	1.443E-09	1.006E-11	7.638E-12	1.262E-10	1.178E-11	2.426E-11	1.672E-11	2.051E-11
Ir-196m	S	1.519E-10	2.926E-09	9.552E-12	1.146E-11	9.041E-12	8.142E-12	6.803E-12	5.683E-12	1.122E-11	4.767E-12	1.471E-09	9.926E-12	7.240E-12	1.317E-10	1.162E-11	2.478E-11	1.661E-11	2.081E-11
Pt-184	F	2.633E-11	6.481E-10	3.321E-12	6.231E-12	3.014E-12	2.630E-12	3.899E-12	1.569E-12	2.939E-12	1.641E-12	3.257E-10	3.082E-12	2.423E-12	1.653E-11	2.942E-12	4.061E-12	3.623E-12	3.875E-12
Pt-187	F	5.958E-11	1.352E-09	1.068E-11	2.762E-11	1.071E-11	7.108E-12	1.399E-11	4.314E-12	7.775E-12	4.705E-12	6.806E-10	1.062E-11	6.575E-12	5.644E-11	8.423E-12	1.040E-11	1.120E-11	1.266E-11
Pt-191	F	2.023E-10	3.034E-09	6.154E-11	3.971E-10	1.049E-10	3.124E-11	7.173E-11	2.178E-11	3.248E-11	2.334E-11	1.539E-09	1.080E-10	2.846E-11	1.381E-10	3.917E-11	5.025E-11	9.732E-11	6.113E-11
Pt-202	F	1.280E-09	4.323E-09	1.584E-10	4.246E-09	7.699E-10	1.560E-10	5.058E-10	1.524E-10	1.569E-10	1.531E-10	2.253E-10	9.720E-10	1.547E-10	1.093E-09	1.588E-10	1.620E-10	7.675E-10	1.667E-10

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)																
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Au-186	F	2.451E-11	5.685E-10	2.733E-12	2.169E-12	1.984E-12	2.508E-12	6.372E-12	1.558E-12	2.777E-12	1.564E-12	2.856E-10	2.099E-12	2.319E-12	1.173E-11	2.621E-12	3.422E-12	2.628E-12	3.015E-12
Au-186	M	3.376E-11	7.008E-10	1.992E-12	1.804E-12	1.565E-12	1.698E-12	1.885E-12	1.134E-12	2.275E-12	9.777E-13	3.516E-10	1.663E-12	1.522E-12	1.760E-11	2.160E-12	3.674E-12	2.545E-12	3.007E-12
Au-186	S	3.478E-11	7.154E-10	1.910E-12	1.764E-12	1.519E-12	1.609E-12	1.390E-12	1.088E-12	2.221E-12	9.131E-13	3.589E-10	1.615E-12	1.434E-12	1.824E-11	2.109E-12	3.702E-12	2.536E-12	3.005E-12
Au-187	F	8.502E-12	2.244E-10	1.199E-12	7.984E-13	7.300E-13	1.004E-12	1.877E-12	5.974E-13	1.162E-12	5.799E-13	1.128E-10	8.016E-13	9.267E-13	4.080E-12	1.039E-12	1.442E-12	1.068E-12	1.074E-12
Au-187	M	1.231E-11	2.677E-10	9.574E-13	7.007E-13	6.132E-13	7.613E-13	6.367E-13	4.961E-13	1.044E-12	4.132E-13	1.343E-10	6.868E-13	6.888E-13	6.634E-12	9.218E-13	1.640E-12	1.116E-12	1.079E-12
Au-187	S	1.273E-11	2.724E-10	9.308E-13	6.899E-13	6.004E-13	7.345E-13	4.998E-13	4.850E-13	1.031E-12	3.948E-13	1.367E-10	6.741E-13	6.625E-13	6.915E-12	9.089E-13	1.661E-12	1.121E-12	1.080E-12
Au-190	F	3.338E-11	8.605E-10	5.509E-12	4.738E-12	4.085E-12	5.435E-12	8.845E-12	3.296E-12	6.257E-12	3.127E-12	4.332E-10	4.624E-12	4.967E-12	2.069E-11	5.584E-12	9.011E-12	6.513E-12	6.404E-12
Au-190	M	4.322E-11	9.867E-10	4.414E-12	4.732E-12	3.775E-12	4.226E-12	2.922E-12	3.089E-12	5.858E-12	2.420E-12	4.962E-10	4.567E-12	3.791E-12	3.220E-11	5.135E-12	1.193E-11	8.002E-12	6.635E-12
Au-190	S	4.430E-11	1.001E-09	4.294E-12	4.731E-12	3.741E-12	4.092E-12	2.270E-12	3.066E-12	5.814E-12	2.342E-12	5.031E-10	4.561E-12	3.661E-12	3.346E-11	5.085E-12	1.226E-11	8.166E-12	6.661E-12
Au-191	F	5.238E-11	1.233E-09	1.138E-11	7.749E-12	6.971E-12	7.850E-12	1.996E-11	4.546E-12	8.355E-12	4.886E-12	6.213E-10	6.868E-12	7.202E-12	4.252E-11	8.767E-12	1.015E-11	7.993E-12	1.325E-11
Au-191	M	8.909E-11	1.377E-09	8.735E-12	7.119E-12	6.264E-12	4.909E-12	8.956E-12	3.677E-12	6.948E-12	3.163E-12	6.931E-10	5.822E-12	4.224E-12	7.236E-11	7.645E-12	1.133E-11	8.073E-12	1.536E-11
Au-191	S	9.331E-11	1.393E-09	8.444E-12	7.047E-12	6.190E-12	4.584E-12	7.723E-12	3.589E-12	6.802E-12	2.971E-12	7.011E-10	5.712E-12	3.891E-12	7.565E-11	7.522E-12	1.146E-11	8.084E-12	1.558E-11
Au-192	F	1.347E-10	3.334E-09	2.840E-11	2.464E-11	2.186E-11	2.555E-11	4.543E-11	1.454E-11	2.832E-11	1.542E-11	1.681E-09	2.106E-11	2.308E-11	9.691E-11	2.790E-11	3.033E-11	2.389E-11	4.194E-11
Au-192	M	1.700E-10	3.453E-09	2.317E-11	2.609E-11	2.233E-11	1.827E-11	2.766E-11	1.356E-11	2.539E-11	1.237E-11	1.741E-09	1.983E-11	1.593E-11	1.621E-10	2.666E-11	3.560E-11	2.609E-11	5.270E-11
Au-192	S	1.739E-10	3.466E-09	2.260E-11	2.624E-11	2.239E-11	1.747E-11	2.569E-11	1.346E-11	2.507E-11	1.203E-11	1.748E-09	1.970E-11	1.514E-11	1.693E-10	2.653E-11	3.619E-11	2.633E-11	5.388E-11
Au-196	F	2.144E-10	3.942E-09	7.928E-11	5.348E-11	5.035E-11	5.276E-11	1.458E-10	3.161E-11	5.402E-11	3.301E-11	2.000E-09	5.067E-11	4.605E-11	1.454E-10	5.745E-11	5.866E-11	5.051E-11	9.399E-11
Au-196	M	3.924E-10	4.074E-09	6.510E-11	4.354E-11	5.412E-11	3.537E-11	8.442E-11	4.504E-11	6.578E-11	2.321E-11	2.065E-09	5.488E-11	2.268E-11	2.132E-10	5.358E-11	5.785E-11	5.047E-11	9.539E-11
Au-196	S	4.173E-10	4.093E-09	6.392E-11	4.255E-11	5.545E-11	3.369E-11	7.674E-11	4.781E-11	6.859E-11	2.220E-11	2.074E-09	5.648E-11	1.991E-11	2.205E-10	5.347E-11	5.846E-11	5.117E-11	9.519E-11
Au-196m	F	2.130E-10	4.254E-09	2.823E-11	1.992E-11	1.913E-11	1.969E-11	9.688E-11	1.551E-11	2.030E-11	1.598E-11	2.139E-09	1.890E-11	1.874E-11	1.831E-10	2.112E-11	2.144E-11	1.945E-11	2.831E-11
Au-196m	M	5.569E-10	5.227E-09	1.671E-11	1.059E-11	1.071E-11	7.869E-12	2.849E-11	7.512E-12	1.169E-11	5.840E-12	2.622E-09	9.928E-12	6.487E-12	3.256E-10	1.198E-11	1.341E-11	1.095E-11	2.293E-11
Au-196m	S	5.957E-10	5.334E-09	1.546E-11	9.565E-12	9.843E-12	6.576E-12	2.085E-11	6.716E-12	1.084E-11	4.722E-12	2.676E-09	9.014E-12	5.117E-12	3.413E-10	1.098E-11	1.257E-11	1.006E-11	2.231E-11
Au-198	F	3.907E-10	4.516E-09	7.553E-11	6.874E-11	6.631E-11	6.865E-11	3.260E-10	5.505E-11	6.936E-11	5.636E-11	2.296E-09	6.598E-11	6.447E-11	2.797E-10	7.192E-11	7.154E-11	6.643E-11	9.423E-11
Au-198	M	9.844E-10	5.036E-09	3.844E-11	3.537E-11	3.646E-11	2.875E-11	1.063E-10	2.873E-11	4.058E-11	2.214E-11	2.542E-09	3.529E-11	2.334E-11	4.467E-10	4.031E-11	4.066E-11	3.544E-11	7.126E-11
Au-198	S	1.057E-09	5.097E-09	3.423E-11	3.155E-11	3.316E-11	2.423E-11	8.093E-11	2.590E-11	3.751E-11	1.823E-11	2.571E-09	3.194E-11	1.862E-11	4.649E-10	3.672E-11	3.721E-11	3.198E-11	6.850E-11
Au-202	F	9.804E-13	3.150E-11	6.463E-15	3.140E-15	3.681E-15	8.009E-15	8.241E-15	4.813E-15	9.392E-15	4.437E-15	1.575E-11	3.955E-15	7.679E-15	4.420E-15	6.901E-15	4.406E-15	3.978E-15	2.496E-15
Au-202	M	1.017E-12	3.274E-11	4.472E-15	1.086E-15	1.644E-15	6.065E-15	8.993E-16	2.849E-15	7.493E-15	2.458E-15	1.637E-11	1.920E-15	5.746E-15	2.412E-15	4.943E-15	2.383E-15	1.957E-15	3.923E-16
Au-202	S	1.021E-12	3.287E-11	4.253E-15	8.599E-16	1.420E-15	5.851E-15	9.162E-17	2.633E-15	7.284E-15	2.240E-15	1.644E-11	1.696E-15	5.533E-15	2.191E-15	4.728E-15	2.160E-15	1.734E-15	1.609E-16
Hg-190	F	1.738E-11	4.345E-10	3.186E-12	3.666E-12	2.274E-12	2.754E-12	2.016E-12	1.664E-12	3.110E-12	1.649E-12	2.188E-10	2.499E-12	2.515E-12	1.391E-11	2.936E-12	4.543E-12	3.369E-12	3.791E-12
Hg-190	FORG	1.722E-11	4.346E-10	3.232E-12	3.673E-12	2.256E-12	2.822E-12	1.964E-12	1.687E-12	3.148E-12	1.668E-12	2.189E-10	2.507E-12	3.402E-12	1.237E-11	2.926E-12	4.529E-12	3.365E-12	3.541E-12
Hg-190	M	2.377E-11	4.971E-10	2.469E-12	2.767E-12	2.081E-12	1.939E-12	1.477E-12	1.477E-12	2.757E-12	1.201E-12	2.501E-10	2.364E-12	1.720E-12	2.251E-11	2.644E-12	6.032E-12	4.077E-12	4.385E-12
Hg-190	V	7.648E-11	1.949E-12	2.258E-12	1.652E-12	3.896E-12	1.949E-12	1.907E-13	4.777E-12	5.620E-12	1.070E-12	1.857E-12	4.525E-12	4.032E-13	5.224E-13	1.949E-12	3.285E-12	3.323E-12	2.914E-13
Hg-192	F	1.459E-10	3.244E-09	3.503E-11	8.054E-11	2.633E-11	2.691E-11	3.186E-11	1.568E-11	2.885E-11	1.731E-11	1.638E-09	2.666E-11	2.415E-11	1.180E-10	3.098E-11	3.109E-11	2.734E-11	4.747E-11
Hg-192	FORG	1.336E-10	3.247E-09	3.775E-11	9.010E-11	2.523E-11	3.039E-11	2.748E-11	1.640E-11	3.012E-11	1.804E-11	1.641E-09	2.732E-11	8.098E-11	8.442E-11	3.011E-11	3.047E-11	2.742E-11	3.847E-11
Hg-192	M	2.023E-10	3.326E-09	2.639E-11	3.252E-11	2.331E-11	1.627E-11	3.287E-11	1.242E-11	2.316E-11	1.217E-11	1.678E-09	1.866E-11	1.390E-11	1.981E-10	2.772E-11	2.743E-11	2.162E-11	6.012E-11
Hg-192	V	9.937E-10	2.652E-11	3.185E-11	4.336E-11	4.858E-11	2.652E-11	8.286E-12	5.556E-11	6.597E-11	1.529E-11	2.571E-11	5.631E-11	8.926E-12	1.254E-11	2.648E-11	4.288E-11	4.293E-11	1.012E-11
Hg-195	F	5.115E-11	9.279E-10	1.375E-11	4.970E-11	8.237E-12	8.187E-12	9.677E-12	5.550E-12	8.576E-12	5.903E-12	4.692E-10	8.518E-12	7.626E-12	4.967E-11	9.320E-12	1.003E-11	8.904E-12	1.333E-11
Hg-195	FORG	4.604E-11	9.292E-10	1.603E-11	6.601E-11	8.646E-12	9.465E-12	9.188E-12	6.155E-12	9.340E-12	6.544E-12	4.708E-10	9.412E-12	4.537E-11	3.616E-11	9.678E-12	1.060E-11	9.644E-12	1.192E-11
Hg-195	M	9.649E-11	9.785E-10	8.707E-12	1.140E-11	5.348E-12	3.620E-12	7.367E-12	2.940E-12	5.382E-12	2.689E-12	4.933E-10	4.467E-12	3.088E-12	8.463E-11	6.507E-12	7.341E-12	5.563E-12	1.401E-11
Hg-195	V	1.503E-09	8.318E-12	1.450E-11	4.508E-11	1.402E-11	8.318E-12	4.847E-12	1.470E-11	1.766E-11	5.459E-12	8.806E-12	1.593E-11	4.508E-12	5.635E-12	8.653E-12	1.301E-11	1.280E-11	5.110E-12
Hg-205	F	6.704E-12	1.871E-10	7.552E-14	9.179E-14	7.416E-14	7.505E-14	7.369E-14	7.412E-14	7.541E-14	7.400E-14	9.361E-11	7.440E-14	7.485E-14	6.073E-13	7.498E-14	7.597E-14	7.514E-14	7.391E-14
Hg-205	FORG	6.704E-12	1.871E-10	7.545E-14	9.194E-14	7.409E-14	7.498E-14	7.361E-14	7.404E-14	7.534E-14	7.392E-14	9.361E-11	7.433E-14	8.430E-14	5.970E-13	7.491E-14	7.590E-14	7.506E-14	7.384E-14
Hg-205	M	8.773E-12	2.418E-10	9.468E-15	9.907E-15	8.113E-15	9.015E-15	7.474E-15	8.164E-15	9.562E-15	8.016E-15	1.209E-10	8.433E-15	8.886E-15	7.060E-13	9.039E-15	1.041E-14	9.391E-15	7.710E-15
Hg-205	V	1.254E-11	1.925E-15	2.536E-15	1.885E-15	3.376E-15	1.925E-15	8.516E-16	3.817E-15	4.503E-15	1.368E-15	1.971E-15	3.859E-15	9.413E-16	1.017E-15	2.036E-15	2.949E-15	2.914E-15	8.961E-16
Tl-190	F	6.919E-12	1.803E-10	7.191E-13	1.274E-12	4.747E-13	7.209E-13	3.803E-13	4.352E-13	7.935E-13	4.076E-13	9.049E-11	5.657E-13	6.640E-13	6.175E-13	6.674E-13	9.124E-13	7.094E-13	4.108E-13
Tl-196	F	5.593E-11	1.547E-09	1.335E-11	2.511E-11	9.788E-12	1.346E-11	9.257E-12	8.005E-12	1.438E-11	7.684E-12	7.798E-10	1.157E-11	1.212E-11	1.108E-11	1.237E-11	1.584E-11	1.352E-11	9.486E-12
Tl-197	F	2.851E-11	7.681E-10	9.360E-12	1.893E-11	5.573E-12	6.885E-12	6.522E-12	4.410E-12	7.152E-12	4.341E-12	3.874E-10	6.336E-12	6.312E-12	6.303E-12	6.517E-12	8.044E-12	6.848E-12	5.704E-12
Pb-194	F	1.579E-11	3.809E-10	3.229E-12	3.958E-12	2.137E-12	1.613E-12	2.656E-12	1.014E-12	1.832E-12	9.835E-13	1.914E-10	1.521E-12	1.527E-12	1.236E-11	1.671E-12	2.797E-12	2.025E-12	1.533E-12

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq	Committed equivalent $H_{T,50}$ (Sv/Bq)															
			ET airways	Bone surfaces	Kidney	Liver	Thyroid	Bladder	Breast	Esophagus/ thymus	Skin	Remainder	Adrenals	Brain	Small intestine	Muscle	Pancreas	Spleen	Uterus
Pb-195m	F	2.758E-11	7.374E-10	8.328E-12	4.947E-12	3.219E-12	2.625E-12	2.765E-12	1.536E-12	3.010E-12	1.506E-12	3.701E-10	2.533E-12	2.481E-12	9.198E-12	2.764E-12	4.495E-12	3.213E-12	2.718E-12
Pb-196	F	3.289E-11	8.521E-10	1.072E-11	1.067E-11	6.578E-12	4.469E-12	5.944E-12	2.538E-12	4.929E-12	2.696E-12	4.287E-10	4.596E-12	4.276E-12	2.326E-11	4.928E-12	6.680E-12	4.942E-12	6.426E-12
Pb-197	F	7.005E-12	2.035E-10	2.426E-12	1.514E-12	9.997E-13	9.483E-13	6.238E-13	5.418E-13	1.136E-12	4.989E-13	1.022E-10	7.889E-13	8.884E-13	1.819E-12	9.424E-13	1.467E-12	1.039E-12	6.834E-13
Pb-198	F	8.666E-11	2.204E-09	3.960E-11	3.662E-11	2.501E-11	1.478E-11	1.787E-11	8.237E-12	1.610E-11	9.075E-12	1.111E-09	1.668E-11	1.423E-11	5.546E-11	1.674E-11	1.852E-11	1.428E-11	2.242E-11
Pb-204m	F	4.329E-11	1.158E-09	9.116E-12	1.204E-11	8.334E-12	7.182E-12	7.417E-12	4.010E-12	8.232E-12	4.120E-12	5.880E-10	7.248E-12	6.791E-12	2.365E-11	7.772E-12	1.219E-11	8.670E-12	9.289E-12

Note: In addition to the standard solubility designations of "F", "M", and "S", the following abbreviations are also applied: "V" = vapors, "FORG" = soluble organics, and "VMethyl" = methyl compounds.

APPENDIX B
EXAMPLE CALCULATION

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APPENDIX B. EXAMPLE CALCULATION

An example calculation for Type "F" and "M" Au-196m is provided below.

From Appendix A, the committed effective dose coefficients for the effective whole body and the committed equivalent dose coefficients for the seven highest irradiated tissues/organs are summarized below.

Nuclide	Solubility	Committed effective $E(50)$ (Sv/Bq)	Committed equivalent $H_{T,50}$ (Sv/Bq)						
			ET	Remainder	Small intestine	Bladder	Uterus	Bone surfaces	Pancreas
Au-196m	F	2.130E-10	**4.254E-09**	2.139E-09	1.831E-10	9.688E-11	2.831E-11	2.823E-11	2.144E-11
Au-196m	M	**5.569E-10**	5.227E-09	2.622E-09	3.256E-10	2.849E-11	2.293E-11	1.671E-11	1.341E-11

By inspection, it is noted that the "ET" region is the limiting organ/tissue for both solubility types as this region has the greatest dose coefficient for all listed organ and tissues. For type "F" material, it is also noted that the ET region will be the overall controlling organ/tissue as its dose coefficient exceeds the whole body dose coefficient by nearly a factor of 20. Therefore, the 50-rem organ limit will be reached before the 5-rem whole body limit. In contrast, the whole body will be limiting for "M" material as the difference between the dose coefficients is less than a factor of 10, therefore the whole body limit will be reached before the organ/tissue limit.

By convention, in this calculation, the dose factors for the effective whole body and the controlling organ/tissue are rounded to two significant digits giving:

Nuclide	Solubility	Committed effective E_{50} (Sv/Bq)	Committed equivalent $H_{T,50}$ for ET airways (Sv/Bq)
Au-196m	F	2.1E-10	4.3E-09
Au-196m	M	5.6E-10	5.2E-09

Applying the whole body dose limit of 0.05 Sv and the tissue/organ dose limit of 0.50 Sv, the ALI values are calculated:

Type "F"

$$\mathrm{ALI}_{E(50)} = \frac{0.05\ \mathrm{Sv}}{2.1\mathrm{E}-10\ \mathrm{Sv/Bq}} = 2.38\mathrm{E}+08\ \mathrm{Bq}\ . \quad \mathrm{ALI}_{\mathrm{ET}} = \frac{0.5\ \mathrm{Sv}}{4.3\mathrm{E}-09\ \mathrm{Sv/Bq}} = 1.16\mathrm{E}+08\ \mathrm{Bq}\ .$$

Type "M"

$$ALI_{E(50)} = \frac{0.05\ \text{Sv}}{5.6\text{E}-10\ \text{Sv/Bq}} = 8.93\text{E}+07\ \text{Bq}\ . \qquad ALI_{ET} = \frac{0.5\ \text{Sv}}{5.2\text{E}-09\ \text{Sv/Bq}} = 9.61\text{E}+07\ \text{Bq}\ .$$

Review of the ALI calculations confirm that the ET region is controlling for type "F" material ($ALI_{ET} < ALI_{E(50)}$) and the whole body is controlling for type "M" material ($ALI_{E(50)} < ALI_{ET}$).

DAC values are then calculated by dividing the limiting ALI by the amount of air inhaled annually:

Type F (SI units)

$$\text{DAC} = \frac{1.16\text{E}+08\ \text{Bq}}{2.4\text{E}+03\ \text{m}^3} = 4.83\text{E}+04\ \text{Bq/m}^3.$$

Type M (SI units)

$$\text{DAC} = \frac{8.93\text{E}+07\ \text{Bq}}{2.4\text{E}+03\ \text{m}^3} = 3.72\text{E}+04\ \text{Bq/m}^3.$$

Applying convention units gives:

Type F (Conventional units)

$$\text{DAC} = \frac{(1.16\text{E}+08\ \text{Bq})(1\ \mu\text{Ci}/3.7\text{E}+04\ \text{Bq})}{2.4\text{E}+09\ \text{mL}} = 1.30\text{E}-06\ \mu\text{Ci/mL}\ .$$

Type M (Conventional units)

$$\text{DAC} = \frac{(8.93\text{E}+07\ \text{Bq})(1\ \mu\text{Ci}/3.7\text{E}+04\ \text{Bq})}{2.4\text{E}+09\ \text{mL}} = 1.00\text{E}-06\ \mu\text{Ci/mL}\ .$$

The four DAC values are then truncated to one significant digit giving:

Type F: DAC (SI units) = 4E+04 Bq/m^3.

DAC (conventional units) = 1E-06 μCi/mL.

Controlled by doses to the ET region.

Type M: DAC (SI units) = 3E+04 Bq/m^3.

DAC (conventional units) = 1E-06 μCi/mL.

Controlled by doses to the effective whole body, “St”.

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APPENDIX C
VALIDATION

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APPENDIX C. VALIDATION

The methods described in this calculation package for generating dose coefficients and calculating DAC values were validated by:

1) Comparing committed effective dose coefficients (E_{50}) generated by DCAL against those listed in ICRP Publication 68, and

2) Comparing calculated DACs against DACs listed in Appendix A of 10 CFR 835.

3) Comparing the controlling organs listed in 10 CFR 835 Appendix A against the controlling tissue identified in this report.

Validations were completed for 57 radioisotopes with one isotope selected for each element in the SNS target accident inventory which required a DAC to be calculated.*** Validation calculations were completed for each solubility type listed in 10 CFR 835. In addition, gaseous forms of S, Te, I, and Hg were examined. In total, the validation consists of 115 independent comparisons.

The objective of the validation process is to ensure that the radiological decay characteristics, anatomical parameters, and metabolic modeling assumptions applied in this report are consistent with those applied in 10 CFR 835, Appendix A. It is important to note that because of differences in the use of significant digits, rounding, and truncation between publications, exact agreement between published values and values calculated in this package is not expected.

For example, 10 CFR 835, Appendix A, lists the stochastically-controlled DAC for type "M" Eu-154 as 5E+02 Bq/m^3. ICRP 68 lists the committed effective dose coefficient as 3.5E-08 Sv/Bq. Applying the methods described in this package the DAC is calculated as:

$$\text{DAC} = \frac{0.05\ \text{Sv}}{\dfrac{3.5\text{E}-08\ \text{Sv/Bq}}{2.4\text{E}+03\ \text{m}^3}} = 595\ \text{Bq/m}^3,$$

which is truncated to 500 Bq and equals the 10 CFR 835 value. However, the DCAL-generated dose coefficient is 3.39E-08 Sv/Bq. Rounding this value to 3.4E-08 Sv/Bq and substituting into the DAC equation gives:

$$\text{DAC} = \frac{0.05\ \text{Sv}}{\dfrac{3.4\text{E}-08\ \text{Sv/Bq}}{2.4\text{E}+03\ \text{m}^3}} = 613\ \text{Bq/m}^3,$$

which, in this report, is truncated to 600 Bq. While the actual difference is +3% (613 compared to 595), the difference in the validation table is reported as +20% (600 compared to 500).

*** For example, a DAC calculation was required for Re-183. Appendix A lists DACs for 13 rhenium isotopes (Re-177, Re-178, Re-181, Re-182 (64 hour), Re-182 (12 hour), Re-184m, Re-184, Re-186m, Re-186, Re-187, Re-188m, Re-188, and Re-189). By arbitrary selection, the rhenium validation was performed against Re-186.

Truncating to one significant digit can account for differences ranging between 11% (the difference between a leading digit of 8 and 9) to 100% (the difference between a leading digit of 1 and 2).

Unless otherwise justified, the acceptance criteria applied in this package is:

1) Agreement between DCAL generated and ICRP 68 reported dose coefficients to within a factor of 2 (-50% to +100%), and

2) Agreement between calculated and reported 10 CFR 835, Appendix A, DAC values to within a factor of 2 (-50% to +100%).

The acceptance criteria were satisfied for all 57 test cases. The largest difference concerning the committed effective dose coefficient was +50% for Type S Lu-173. The largest DAC difference was ±50% for four radionuclides. With the exception of a very few nuclides (Cu-64, Pd-109, and W-181) the identified controlling organ/tissue agreed with those listed in Appendix A.

Specific comparisons show the following:

Dose factors:	Exact agreement was achieved for 50% of the examined dose factors. Agreement to within 10% was observed for 89% of cases. The largest difference was +50% for Type "S" Lu-173.
DACs, conventional units:	Exact agreement was achieved for 82% of the examined cases. Agreement to within 10% was observed for 83% of the cases. The largest difference was ±50% for four radionuclides (Ru-103, Tb-155, Lu-173, and Ir-190)
DACs, SI units:	Exact agreement was achieved for 85% of the examined cases. Agreement to within 10% was observed for 88% of the cases. The largest difference was -38% for Type "M" Lu-173.
Controlling organs:	Exact agreement was achieved for 97% of the examined cases. Differences were observed for three radionuclides (Cu-64, Pd-109, and W-181)

Differences greater than 10% are highlighted in Table C.1 and discussed in Table C.2.

In conclusion, the validation demonstrates that the calculation methods described in this package are consistent with the radiological protection philosophy and calculation methods adopted by DOE and incorporated in 10 CFR 835, Appendix A. The observed differences are understood and connected with either updated radiological decay information, revised metabolic models, or mathematical rounding and truncation practices. The observed differences are within the acceptance criteria established for this report.

Table C.1. Validation comparison

Nuclide		*E*(50)			DAC			DAC			Organ/tissue
		F (Sv/Bq)	M (Sv/Bq)	S (Sv/Bq)	F (uCi/ml)	M (uCi/ml)	S (uCi/ml)	F (Bq/m^3)	M (Bq/m^3)	S (Bq/m^3)	
Mg-28	Calculated	1.1E-09	1.7E-09	-	3.E-07	3.E-07	-	1.E+04	1.E+04	-	ET / St /
	Reported	1.1E-09	1.7E-09	-	3.E-07	3.E-07	-	1.E+04	1.E+04	-	ET / St /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
Al-26	Calculated	1.4E-08	1.2E-08	-	4.E-08	4.E-08	-	1.E+03	1.E+03	-	St / St /
	Reported	1.4E-08	1.2E-08	-	4.E-08	4.E-08	-	1.E+03	1.E+03	-	St / St /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
S-35	Calculated	8.0E-11	1.1E-09	-	7.E-06	5.E-07	-	2.E+05	1.E+04	-	St / St /
	Reported	8.0E-11	1.1E-09	-	7.E-06	5.E-07	-	2.E+05	1.E+04	-	St / St /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
S-35 (vapor)	Calculated	-	1.1E-10	-	-	5.E-06	-	-	1.E+05	-	/ St /
	Reported	-	1.2E-10	-	-	4.E-06	-	-	1.E+05	-	/ St /
	Difference	-	-8%	-	-	25%	-	-	0%	-	
Ca-45	Calculated	-	2.2E-09	-	-	2.E-07	-	-	9.E+03	-	/ St /
	Reported	-	2.3E-09	-	-	2.E-07	-	-	9.E+03	-	/ St /
	Difference	-	-4%	-	-	0%	-	-	0%	-	
Ti-45	Calculated	8.3E-11	1.4E-10	1.5E-10	3.E-06	2.E-06	2.E-06	1.E+05	1.E+05	9.E+04	ET / ET / ET
	Reported	8.3E-11	1.4E-10	1.5E-10	3.E-06	2.E-06	2.E-06	1.E+05	1.E+05	1.E+05	ET / ET / ET
	Difference	0%	0%	0%	0%	0%	0%	0%	0%	-10%	
V-49	Calculated	2.6E-11	2.3E-11	-	1.E-05	2.E-05	-	7.E+05	9.E+05	-	BS / St /
	Reported	2.6E-11	2.3E-11	-	1.E-05	2.E-05	-	7.E+05	9.E+05	-	BS / St /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
Cr-51	Calculated	3.0E-11	3.5E-11	3.7E-11	1.E-05	1.E-05	1.E-05	6.E+05	5.E+05	5.E+05	St / St / St
	Reported	3.0E-11	3.4E-11	3.6E-11	1.E-05	1.E-05	1.E-05	6.E+05	6.E+05	5.E+05	St / St / St
	Difference	0%	3%	3%	0%	0%	0%	0%	-17%	0%	
Cu-64	Calculated	6.8E-11	1.5E-10	1.6E-10	4.E-06	3.E-06	3.E-06	1.E+05	1.E+05	1.E+05	ET / E / E
	Reported	6.8E-11	1.5E-10	1.5E-10	4.E-06	3.E-06	3.E-06	1.E+05	1.E+05	1.E+05	ET / ET / ET
	Difference	0%	0%	7%	0%	0%	0%	0%	0%	0%	
Ga-70	Calculated	1.6E-11	2.6E-11	-	1.E-05	1.E-05	-	6.E+05	4.E+05	-	ET / ET /
	Reported	1.6E-11	2.6E-11	-	1.E-05	1.E-05	-	6.E+05	4.E+05	-	ET / ET /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
As-74	Calculated	-	1.8E-09	-	-	3.E-07	-	-	1.E+04	-	/ St /
	Reported	-	1.8E-09	-	-	3.E-07	-	-	1.E+04	-	/ St /
	Difference	-	0%	-	-	0%	-	-	0%	-	

Nuclide		*E*(50)			DAC			DAC			Organ/tissue
		F (Sv/Bq)	M (Sv/Bq)	S (Sv/Bq)	F (uCi/ml)	M (uCi/ml)	S (uCi/ml)	F (Bq/m^3)	M (Bq/m^3)	S (Bq/m^3)	
Se-79	Calculated	1.5E-09	2.9E-09	-	3.E-07	1.E-07	-	1.E+04	7.E+03	-	K / St /
	Reported	1.6E-09	3.1E-09	-	3.E-07	1.E-07	-	1.E+04	6.E+03	-	K / St /
	Difference	-6%	-6%	-	0%	0%	-	0%	17%	-	
Br-74	Calculated	5.0E-11	6.8E-11	-	4.E-06	4.E-06	-	1.E+05	1.E+05	-	ET / ET /
	Reported	5.0E-11	6.8E-11	-	4.E-06	4.E-06	-	1.E+05	1.E+05	=	ET / ET /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
Rb-88	Calculated	2.8E-11	-	-	1.E-05	-	-	5.E+05	-	-	ET / /
	Reported	2.8E-11	-	-	1.E-05	-	-	5.E+05	-	-	ET / /
	Difference	0%	-	-	0%	-	-	0%	-	-	
Sr-89	Calculated	1.4E-09	-	5.6E-09	4.E-07	-	1.E-07	1.E+04	-	3.E+03	St / / St
	Reported	1.4E-09	-	5.6E-09	4.E-07	-	1.E-07	1.E+04	-	3.E+03	St / / St
	Difference	0%	-	0%	0%	-	0%	0%	-	0%	
Y-90	Calculated	-	1.6E-09	1.7E-09	-	3.E-07	3.E-07	-	1.E+04	1.E+04	/ St / St
	Reported	-	1.6E-09	1.7E-09	-	3.E-07	3.E-07	-	1.E+04	1.E+04	/ St / St
	Difference	-	0%	0%	-	0%	0%	-	0%	0%	
Zr-93	Calculated	2.8E-08	6.4E-09	1.6E-09	4.E-09	1.E-08	1.E-07	1.E+02	6.E+02	5.E+03	BS / BS / BS
	Reported	2.9E-08	6.6E-09	1.7E-09	3.E-09	1.E-08	1.E-07	1.E+02	5.E+02	5.E+03	BS / BS / BS
	Difference	-3%	-3%	-6%	33%	0%	0%	0%	20%	0%	
Nb-90	Calculated	-	1.1E-09	1.1E-09	-	3.E-07	3.E-07	-	1.E+04	1.E+04	/ ET / ET
	Reported	-	1.0E-09	1.1E-09	-	3.E-07	3.E-07	-	1.E+04	1.E+04	/ ET / ET
	Difference	-	10%	0%	-	0%	0%	-	0%	0%	
Mo-99	Calculated	3.6E-10	-	1.1E-09	1.E-06	-	5.E-07	5.E+04	-	1.E+04	E / / St
	Reported	3.6E-10	-	1.1E-09	1.E-06	-	5.E-07	5.E+04	-	1.E+04	E / / St
	Difference	0%	-	0%	0%	-	0%	0%	-	0%	
Tc-98	Calculated	1.4E-09	5.7E-09	-	4.E-07	9.E-08	-	1.E+04	3.E+03	-	St / St /
	Reported	1.5E-09	6.1E-09	-	3.E-07	9.E-08	-	1.E+04	3.E+03	-	St / St /
	Difference	-7%	-7%	-	33%	0%	-	0%	0%	-	
Ru-103	Calculated	6.8E-10	1.8E-09	2.1E-09	8.E-07	3.E-07	2.E-07	3.E+04	1.E+04	9.E+03	St / St / St
	Reported	6.8E-10	1.9E-09	2.2E-09	8.E-07	2.E-07	2.E-07	3.E+04	1.E+04	9.E+03	St / St / St
	Difference	0%	-5%	-5%	0%	50%	0%	0%	0%	0%	
Rh-105	Calculated	1.5E-10	4.1E-10	4.4E-10	3.E-06	1.E-06	1.E-06	1.E+05	5.E+04	4.E+04	ET / St / St
	Reported	1.5E-10	4.1E-10	4.4E-10	3.E-06	1.E-06	1.E-06	1.E+05	5.E+04	4.E+04	ET / St / St
	Difference	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Pd-109	Calculated	2.1E-10	4.8E-10	5.1E-10	2.E-06	1.E-06	1.E-06	9.E+04	4.E+04	4.E+04	E / St / St
	Reported	2.1E-10	4.7E-10	5.0E-10	2.E-06	1.E-06	1.E-06	9.E+04	4.E+04	4.E+04	St / St / St
	Difference	0%	2%	2%	0%	0%	0%	0%	0%	0%	

Nuclide		*E*(50)			DAC			DAC			Organ/tissue
		F (Sv/Bq)	M (Sv/Bq)	S (Sv/Bq)	F (uCi/ml)	M (uCi/ml)	S (uCi/ml)	F (Bq/m^3)	M (Bq/m^3)	S (Bq/m^3)	
Ag-106	Calculated	1.7E-11	2.5E-11	2.6E-11	1.E-05	1.E-05	1.E-05	5.E+05	4.E+05	4.E+05	ET / ET / ET
	Reported	1.7E-11	2.6E-11	2.7E-11	1.E-05	1.E-05	1.E-05	5.E+05	4.E+05	4.E+05	ET / ET / ET
	Difference	0%	-4%	-4%	0%	0%	0%	0%	0%	0%	
Cd-109	Calculated	9.6E-09	5.2E-09	4.4E-09	2.E-08	9.E-08	1.E-07	8.E+02	3.E+03	4.E+03	K / K / St
	Reported	9.6E-09	5.1E-09	4.4E-09	2.E-08	9.E-08	1.E-07	9.E+02	3.E+03	4.E+03	K / K / St
	Difference	0%	2%	0%	0%	0%	0%	-11%	0%	0%	
In-111	Calculated	2.2E-10	3.2E-10	-	1.E-06	1.E-06	-	5.E+04	5.E+04	-	ET / ET /
	Reported	2.2E-10	3.1E-10	-	1.E-06	1.E-06	-	5.E+04	5.E+04	-	ET / ET /
	Difference	0%	3%	-	0%	0%	-	0%	0%	-	
Sn-117m	Calculated	4.0E-10	2.2E-09	-	8.E-07	2.E-07	-	2.E+04	9.E+03	-	BS / St /
	Reported	3.9E-10	2.2E-09	-	8.E-07	2.E-07	-	3.E+04	9.E+03	-	BS / St /
	Difference	3%	0%	-	0%	0%	-	-33%	0%	-	
Sb-127	Calculated	7.5E-10	1.7E-09	-	7.E-07	3.E-07	-	2.E+04	1.E+04	-	E / St /
	Reported	7.4E-10	1.7E-09	-	7.E-07	3.E-07	-	2.E+04	1.E+04	-	E / St /
	Difference	1%	0%	-	0%	0%	-	0%	0%	-	
Te-127	Calculated	7.3E-11	1.9E-10	-	5.E-06	2.E-06	-	2.E+05	1.E+05	-	ET / St /
	Reported	7.2E-11	1.8E-10	-	5.E-06	3.E-06	-	2.E+05	1.E+05	-	ET / St /
	Difference	1%	6%	-	0%	-33%	-	0%	0%	-	
Te-127 (vapor)	Calculated	-	7.7E-11	-	-	7.E-06	-	-	2.E+05	-	/ St /
	Reported	-	-	-	-	7.E-06	-	-	2.E+05	-	/ St /
	Difference	-	N/A	-	-	0%	-	-	0%	-	
I-125 (methyl)	Calculated	1.1E-08	-	-	2.E-08	-	-	9.E+02	-	-	T / /
	Reported	-	-	-	2.E-08	-	-	9.E+02	-	-	T / /
	Difference	N/A	-	-	0%	-	-	0%	-	-	
I-125 (vapor)	Calculated	-	1.4E-08	-	-	2.E-08	-	-	7.E+02	-	/ T /
	Reported	-	1.4E-08	-	-	2.E-08	-	-	7.E+02	-	/ T /
	Difference	-	0%	-	-	0%	-	-	0%	-	
I-125	Calculated	7.5E-09	-	-	3.E-08	-	-	1.E+03	-	-	T / /
	Reported	7.3E-09	-	-	3.E-08	-	-	1.E+03	-	-	T / /
	Difference	3%	-	-	0%	-	-	0%	-	-	
Cs-130	Calculated	1.4E-11	-	-	1.E-05	-	-	6.E+05	-	-	ET / /
	Reported	1.5E-11	-	-	1.E-05	-	-	6.E+05	-	-	ET / /
	Difference	-7%	-	-	0%	-	-	0%	-	-	
Ba-133	Calculated	1.9E-09	-	-	2.E-07	-	-	1.E+04	-	-	St / /
	Reported	1.8E-09	-	-	3.E-07	-	-	1.E+04	-	-	St / /
	Difference	6%	-	-	-33%	-	-	0%	-	-	

Nuclide		*E*(50)			DAC			DAC			
		F (Sv/Bq)	M (Sv/Bq)	S (Sv/Bq)	F (uCi/ml)	M (uCi/ml)	S (uCi/ml)	F (Bq/m^3)	M (Bq/m^3)	S (Bq/m^3)	Organ/tissue
La-137	Calculated	1.0E-08	2.4E-09	-	4.E-08	2.E-07	-	1.E+03	7.E+03	-	L / L /
	Reported	1.0E-08	2.3E-09	-	4.E-08	2.E-07	-	1.E+03	8.E+03	-	L / L /
	Difference	0%	4%	-	0%	0%	-	0%	-13%	-	
Ce-144	Calculated	-	2.3E-08	2.9E-08	-	2.E-08	1.E-08	-	9.E+02	7.E+02	/ St / St
	Reported	-	2.3E-08	2.9E-08	-	2.E-08	1.E-08	-	9.E+02	7.E+02	/ St / St
	Difference	-	0%	0%	-	0%	0%	-	0%	0%	
Pr-144	Calculated	-	2.9E-11	3.0E-11	-	1.E-05	1.E-05	-	4.E+05	4.E+05	/ ET / ET
	Reported	-	2.9E-11	3.0E-11	-	1.E-05	1.E-05	-	4.E+05	4.E+05	/ ET / ET
	Difference	-	0%	0%	-	0%	0%	-	0%	0%	
Nd-141	Calculated	-	9.0E-12	9.3E-12	-	3.E-05	2.E-05	-	1.E+06	1.E+06	/ ET / ET
	Reported	-	8.5E-12	8.8E-12	-	3.E-05	3.E-05	-	1.E+06	1.E+06	/ ET / ET
	Difference	-	6%	6%	-	0%	-33%	-	0%	0%	
Pm-147	Calculated	-	3.5E-09	3.2E-09	-	1.E-07	1.E-07	-	4.E+03	6.E+03	/ BS / St
	Reported	-	3.5E-09	3.2E-09	-	1.E-07	1.E-07	-	4.E+03	6.E+03	/ BS / St
	Difference	-	0%	0%	-	0%	0%	-	0%	0%	
Sm-146	Calculated	-	6.8E-06	-	-	2.E-11	-	-	1.E+00	-	/ BS /
	Reported	-	6.7E-06	-	-	2.E-11	-	-	1.E+00	-	/ BS /
	Difference	-	1%	-	-	0%	-	-	0%	-	
Eu-154	Calculated	-	3.4E-08	-	-	1.E-08	-	-	6.E+02	-	/ St /
	Reported	-	3.5E-08	-	-	1.E-08	-	-	5.E+02	-	/ St /
	Difference	-	-3%	-	-	0%	-	-	20%	-	
Gd-151	Calculated	1.1E-09	7.8E-10	-	2.E-07	7.E-07	-	7.E+03	2.E+04	-	BS / St /
	Reported	9.3E-10	6.5E-10	-	2.E-07	8.E-07	-	9.E+03	3.E+04	-	BS / St /
	Difference	18%	20%	-	0%	-13%	-	-22%	-33%	-	
Tb-155	Calculated	-	3.3E-10	-	-	1.E-06	-	-	6.E+04	-	/ St /
	Reported	-	2.5E-10	-	-	2.E-06	-	-	8.E+04	-	/ St /
	Difference	-	32%	-	-	-50%	-	-	-25%	-	
Dy-165	Calculated	-	8.8E-11	-	-	6.E-06	-	-	2.E+05	-	/ ET /
	Reported	-	8.7E-11	-	-	6.E-06	-	-	2.E+05	-	/ ET /
	Difference	-	1%	-	-	0%	-	-	0%	-	
Ho-161	Calculated	-	1.1E-11	-	-	3.E-05	-	-	1.E+06	-	/ ET /
	Reported	-	1.0E-11	-	-	3.E-05	-	-	1.E+06	-	/ ET /
	Difference	-	10%	-	-	0%	-	-	0%	-	
Er-165	Calculated	-	1.4E-11	-	-	2.E-05	-	-	9.E+05	-	/ ET /
	Reported	-	1.4E-11	-	-	2.E-05	-	-	1.E+06	-	/ ET /
	Difference	-	0%	-	-	0%	-	-	-10%	-	

Nuclide		*E*(50)			DAC			DAC			Organ/tissue
		F (Sv/Bq)	M (Sv/Bq)	S (Sv/Bq)	F (uCi/ml)	M (uCi/ml)	S (uCi/ml)	F (Bq/m^3)	M (Bq/m^3)	S (Bq/m^3)	
Tm-171	Calculated	-	9.1E-10	-	-	2.E-07	-	-	9.E+03	-	/ BS /
	Reported	-	9.1E-10	-	-	2.E-07	-	-	9.E+03	-	/ BS /
	Difference	-	0%	-	-	0%	-	-	0%	-	
Yb-178	Calculated	-	1.0E-10	1.1E-10	-	5.E-06	5.E-06	-	1.E+05	1.E+05	/ ET / E
	Reported	-	1.0E-10	1.1E-10	-	5.E-06	5.E-06	-	1.E+05	1.E+05	/ ET / E
	Difference	-	0%	0%	-	0%	0%	-	0%	0%	
Lu-173	Calculated	-	2.1E-09	2.1E-09	-	1.E-07	2.E-07	-	5.E+03	9.E+03	/ BS / St
	Reported	-	1.5E-09	1.4E-09	-	2.E-07	4.E-07	-	8.E+03	1.E+04	/ BS / St
	Difference	-	40%	50%	-	-50%	-50%	-	-38%	-10%	
Hf-181	Calculated	1.8E-09	4.1E-09	-	1.E-07	1.E-07	-	4.E+03	5.E+03	-	BS / St /
	Reported	1.8E-09	4.1E-09	-	1.E-07	1.E-07	-	4.E+03	5.E+03	-	BS / St /
	Difference	0%	0%	-	0%	0%	-	0%	0%	-	
Ta-183	Calculated	-	1.9E-09	2.1E-09	-	2.E-07	2.E-07	-	1.E+04	9.E+03	/ St / St
	Reported	-	1.8E-09	2.0E-09	-	3.E-07	2.E-07	-	1.E+04	1.E+04	/ St/ St
	Difference	-	6%	5%	-	-33%	0%	-	0%	-10%	
W-181	Calculated	4.8E-11	-	-	1.E-05	-	-	4.E+05	-	-	St / /
	Reported	4.3E-11	-	-	1.E-05	-	-	4.E+05	-	-	ET / /
	Difference	12%	-	-	0%	-	-	0%	-	-	
Re-186	Calculated	7.1E-10	1.2E-09	-	7.E-07	4.E-07	-	2.E+04	1.E+04	-	St / St /
	Reported	7.3E-10	1.2E-09	-	7.E-07	4.E-07	-	2.E+04	1.E+04	-	St / St /
	Difference	-3%	0%	-	0%	0%	-	0%	0%	-	
Os-180	Calculated	1.6E-11	2.5E-11	2.6E-11	1.E-05	1.E-05	9.E-06	4.E+05	3.E+05	3.E+05	ET / ET / ET
	Reported	1.6E-11	2.4E-11	2.5E-11	1.E-05	1.E-05	1.E-05	5.E+05	3.E+05	3.E+05	ET / ET / ET
	Difference	0%	4%	4%	0%	0%	-10%	-20%	0%	0%	
Ir-190	Calculated	1.1E-09	1.5E-09	1.6E-09	4.E-07	3.E-07	3.E-07	1.E+04	1.E+04	1.E+04	ET / St / St
	Reported	1.2E-09	2.3E-09	2.5E-09	4.E-07	2.E-07	2.E-07	1.E+04	9.E+03	8.E+03	ET / St / St
	Difference	-8%	-35%	-36%	0%	50%	50%	0%	11%	25%	
Pt-191	Calculated	2.0E-10	-	-	1.E-06	-	-	6.E+04	-	-	ET / /
	Reported	1.9E-10	-	-	1.E-06	-	-	7.E+04	-	-	ET / /
	Difference	5%	-	-	0%	-	-	-14%	-	-	
Au-198	Calculated	3.9E-10	9.8E-10	1.1E-09	1.E-06	5.E-07	5.E-07	4.E+04	2.E+04	1.E+04	ET / St / St
	Reported	3.9E-10	9.8E-10	1.1E-09	1.E-06	5.E-07	5.E-07	4.E+04	2.E+04	1.E+04	ET / St / St
	Difference	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Hg-195 (org)	Calculated	4.6E-11	-	-	6.E-06	-	-	2.E+05	-	-	ET / /
	Reported	4.4E-11	-	-	6.E-06	-	-	2.E+05	-	-	ET / /
	Difference	5%	-	-	0%	-	-	0%	-	-	

Nuclide		*E*(50)			DAC			DAC			Organ/tissue
		F (Sv/Bq)	M (Sv/Bq)	S (Sv/Bq)	F (uCi/ml)	M (uCi/ml)	S (uCi/ml)	F (Bq/m^3)	M (Bq/m^3)	S (Bq/m^3)	
Hg-195	Calculated	5.1E-11	9.6E-11	-	6.E-06	5.E-06	-	2.E+05	2.E+05	-	ET / ET /
	Reported	4.8E-11	9.2E-11	-	6.E-06	6.E-06	-	2.E+05	2.E+05	-	ET / ET /
	Difference	6%	4%	-	0%	-17%	-	0%	0%	-	
Hg-195 (vapor)	Calculated	-	1.5E-09	-	-	3.E-07	-	-	1.E+04	-	/ St /
	Reported	-	1.4E-09	-	-	4.E-07	-	-	1.E+04	-	/ St /
	Difference	-	7%	-	-	-25%	-	-	0%	-	
Tl-197	Calculated	2.9E-11	-	-	7.E-06	-	-	2.E+05	-	-	ET / /
	Reported	2.7E-11	-	-	8.E-06	-	-	2.E+05	-	-	ET / /
	Difference	7%	-	-	-13%	-	-	0%	-	-	
Pb-198	Calculated	8.7E-11	-	-	2.E-06	-	-	9.E+04	-	-	ET / /
	Reported	8.7E-11	-	-	2.E-06	-	-	9.E+04	-	-	ET / /
	Difference	0%	-	-	0%	-	-	0%	-	-	

Note: ICRP 68 does not list dose conversion factors for vaporous Te-127 or methyl I-125. As such, Table C.1 does not provide a comparison of E(50) values for these radionuclides.

Table C.2. Evaluation of observed differences

Radionuclide	Solubility	Observed differences
S-35	Vapor	A 25% difference is reported for the conventional unit-based DAC (5E-06 μCi/mL vs 4 E-06 μCi/mL). Dose to the effective whole body is controlling. DCAL and ICRP 68 effective whole body dose coefficients agree to within 8% (1.1E-10 Sv/Bq vs 1.2E-10 Sv/Bq). To two significant figures the corresponding DACs differ by only 9% (5.12E-06 μCi/mL vs 4.69E-06 μCi/mL). Truncation results in a 25% difference.
Cr-51	Type M	A 17% difference is reported for the SI unit DAC (5E+05 Bq/m^3 vs 6E+05 Bq/m^3). The DAC is stochastically controlled. DCAL and ICRP 68 effective whole body dose coefficients agree to within 3% (3.5E-11 Sv/Bq vs 3.4E-11 Sv/Bq). To two significant figures the DACs differ by only 3% (5.9E+05 Bq/m^3 vs 6.13E+05 Bq/m^3). Truncation results in a 17% difference.
Cu-64	Type M	10 CFR 835 identifies the ET airways as the controlling organ. DCAL gives an effective whole body dose coefficient of 1.467E-10 Sv/Bq and an ET airway dose coefficient of 1.531E-09 Sv/Bq. Rounded to two significant digits these coefficients differ by a factor of 10. Therefore, stochastic and deterministic controls are considered equal in this package.
Cu-64	Type S	10 CFR 835 identifies the ET airways as the controlling organ. DCAL gives an effective whole body dose coefficient of 1.556E-10 Sv/Bq and an ET airway dose coefficient of 1.554E-09 Sv/Bq. Rounded to two significant digits these coefficients differ by a factor of 10. Therefore, stochastic and deterministic controls are considered equal in this package.
Se-79	Type M	A 17% difference is reported for the SI unit DAC (7E+03 Bq/m^3 vs 6E+03 Bq/m^3). The DAC is stochastically controlled. DCAL and ICRP 68 effective whole body dose coefficients agree to within 6% (2.9E-09 Sv/Bq vs 3.1E-09 Sv/Bq). To two significant figures the DACs differ by only 7% (7.2E+03 Bq/m^3 vs 6.7E+03 Bq/m^3). Truncation results in a 17% difference.
Zr-93	Type F	A 33% difference is reported for the conventional unit-based DAC (4E-09 μCi/mL vs 3 E-09 μCi/mL). Dose to bone surface is controlling. The calculated DAC of 4E-09 μCi/mL (non-truncated: 4.02E-09 μCi/mL) is derived from a DCAL bone surface dose factor of 1.43E-06 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 3E-09 μCi/mL is unknown. IMBA[a] gives a bone surface dose coefficient of 1.48E-06 Sv/Bq. The IMBA value corresponds to a DAC of 3 E-09 μCi/mL (non-truncated: 3.75E-09 μCi/mL). The non-truncated DACs differ by only 7%. Truncation increases the difference to 33%.

Radionuclide	Solubility	Observed Differences
Zr-93	Type M	A 20% difference is reported for the SI unit-based DAC (600 Bq/m^3 vs 500 Bq/m^3). Dose to bone surface is controlling. The calculated DAC of 600 Bq/m^3 (non-truncated: 651 Bq/m^3) is derived from a DCAL bone surface dose factor of 3.15E-07 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 500 Bq/m^3 is unknown. IMBA give bone surface dose coefficient of 3.27E-07 Sv/Bq which corresponds to a DAC of 600 Bq/m^3 (non-truncated: 631 Bq/m^3). This value agrees with the calculated value. The Appendix A value could not be reproduced.
Tc-98	Type F	A 33% difference is reported for the conventional unit-based DAC (4E-07 μCi/mL vs 3 E-07 μCi/mL). Dose to the effective whole body is controlling. DCAL and ICRP 68 effective whole body dose coefficients agree to within 7% (1.4E-09 Sv/Bq vs 1.5E-09 Sv/Bq). To two significant figures the corresponding DACs differ by only 7% (4.0E-07 μCi/mL vs 3.8E-07 μCi/mL). Truncation results in a 33% difference.
Ru-103	Type M	A 50% difference is reported for the conventional unit-based DAC (3E-07 μCi/mL vs 2 E-07μCi/mL). Dose to the effective whole body is controlling. DCAL and ICRP 68 effective whole body dose coefficients agree to within 5% (1.8E-09 Sv/Bq vs 1.9E-09 Sv/Bq). To two significant figures the corresponding DACs differ by only 5% (3.13E-07 μCi/mL vs 2.96E-07 μCi/mL). Truncation results in a 50% difference.
Pd-109	Type F	10 CFR 835 identifies the effective whole body as the controlling organ. DCAL gives an effective whole body dose coefficient of 2.113E-10 Sv/Bq and an ET airway dose coefficient of 2.081E-09 Sv/Bq. Rounded to two significant digits these coefficients differ by a factor of 10. Therefore, stochastic and deterministic controls are considered equal in this package.
Cd-109	Type F	A 11% difference is reported for the SI unit-based DAC (800 Bq/m^3 vs 900 Bq/m^3). Dose to the kidney is controlling. The calculated DAC of 800 Bq/m^3 (non-truncated: 885 Bq/m^3) is derived from a DCAL kidney dose factor of 2.35E-07 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 900 Bq/m^3 is unknown. IMBA gives a bone surface dose coefficient of 2.35E-07 Sv/Bq. The IMBA-based value agrees with the DCAL value and produces an identical DAC value. The Appendix A value could not be reproduced.

Radionuclide	Solubility	Observed Differences
Sn-117m	Type F	A 33% difference is reported for the SI unit-based DAC (2E+04 Bq/m^3 vs 3E+04 Bq/m^3). Dose to bone surfaces is controlling. The calculated DAC of 2E+04 Bq/m^3 (non-truncated: 2.98E+04 Bq/m^3) is derived from a DCAL bone surface dose factor of 7.00E-09 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 3E+04 Bq/m^3 is unknown. IMBA gives a bone surface dose coefficient of 6.88E-09 Sv/Bq which yields a DAC of 3E+04 Bq/m^3 (non-truncated: 3.03E+04 Bq/m^3) which agrees with the Appendix A value. Before truncation the DAC values agree to within 2%.
Te-127	Type M	A 33% difference is reported for the conventional unit-based DAC (2E-06 μCi/mL vs 3 E-06μCi/mL). Dose to the effective whole body is controlling. The calculated DAC of 2E-06 μCi/mL (non-truncated: 2.96E-06 μCi/mL) is derived from a DCAL whole body dose factor of 1.9E-10 Sv/Bq. The ICRP 68 dose coefficient is reported as 1.8E-10 Sv/Bq which yields a DAC of 3E-06 μCi/mL (non-truncated: 3.13E-06 μCi/mL). The non-truncated DACs differ by only 5%. Truncation increases the difference to 33%.
Ba-133	Type F	A 33% difference is reported for the conventional unit-based DAC (2E-07 μCi/mL vs 3 E-07μCi/mL). Dose to the effective whole body is controlling. The calculated DAC of 2E-07 μCi/mL (non-truncated: 2.96E-07 μCi/mL) is derived from a DCAL whole body dose factor of 1.9E-09 Sv/Bq. The ICRP 68 dose coefficient is reported as 1.8E-09 Sv/Bq which yields a DAC of 3E-07 μCi/mL (non-truncated: 3.13E-07 μCi/mL). The non-truncated DACs differ by only 5%. Truncation increases the difference to 33%.
La-137	Type M	A 13% difference is reported for the SI unit-based DAC (7000 Bq/m^3 vs 8000 Bq/m^3). Dose to the liver is controlling. The calculated DAC of 7000 Bq/m^3 (non-truncated: 7740 Bq/m^3) is derived from a DCAL liver dose factor of 2.69E-08 Sv/Bq. ICRP 68 dose not provide liver dose coefficients. IMBA gives a liver dose coefficient of 2.59E-08 Sv/Bq which yields a DAC of 8000 Bq/m^3 (non-truncated: 8.04E+03 Bq/m^3) which agrees with the Appendix A. Before truncation the calculated DAC values agree to within 4%.
Nd-141	Type S	A 33% difference is reported for the conventional unit-based DAC (2E-05 μCi/mL vs 3 E-05μCi/mL). Dose to the ET airways is controlling. The calculated DAC of 2E-05 μCi/mL (non-truncated: 2.96E-05 μCi/mL) is derived from a DCAL ET dose factor of 1.86E-10 Sv/Bq which is rounded to 1.9E-10 Sv/Bq. ICRP 68 dose not provide ET dose coefficients. IMBA give an ET dose coefficient of 1.72E-10 Sv/Bq which yields a DAC of 3E-05 μCi/mL (non-truncated: 3.27E-05 μCi/mL) which agrees with the Appendix A value. Before truncation the calculated DAC values agree to within 9%.

Radionuclide	Solubility	Observed Differences
Eu-154	Type M	A 20% difference is reported for the SI unit-based DAC (600 Bq/m^3vs 500 Bq/m^3). Dose to the effective whole body is controlling. DCAL and ICRP 68 effective whole body dose coefficients also differ by 3% (3.4E-08 Sv/Bq vs 3.5E-08 Sv/Bq). To two significant figures the corresponding DACs differ by only 3% (613 Bq/m^3vs 595 Bq/m^3). Truncation results in a 20% difference.
Gd-151	Type F	An 18% increase is reported for the effective whole body dose coefficient (1.1E-09 Sv/Bq vs 9.3E-10 Sv/Bq). This difference is equal to the increase in total electron energy emissions reported in ICRP 107 (0.0394MeV) as compared to ICRP 38 (0.0335 MeV). The increased dose factor results in a decreased DAC value.
Gd-151	Type M	A 20% increase is reported for the effective whole body dose coefficient (7.8E-010 Sv/Bq vs 6.5E-10 Sv/Bq). This difference is approximately equal to the increase in total electron energy emissions reported in ICRP 107 (0.0394MeV) as compared to ICRP 38 (0.0335 MeV). The increased dose factor results in a decreased DAC value.
Tb-155	Type M	A 32% increase is reported for the effective whole body dose coefficient (3.3E-10 Sv/Bq vs 2.5E-10 Sv/Bq). This difference is equal to the increase in total energy emissions reported in ICRP 107 (0.2211 MeV) as compared to ICRP 38 (0.1704 MeV). The increased dose factor results in a decreased DAC value.
Lu-173	Type M	A 40% increase is reported for the effective whole body dose coefficient (2.1E-09 Sv/Bq vs 1.5E-09 Sv/Bq). This difference is approximately equal to the increase in total energy emissions reported in ICRP 107 (0.2360 MeV) as compared to ICRP 38 (0.1651 MeV). The increased dose factor results in a decreased DAC value.
Lu-173	Type S	A 50% increase is reported for the effective whole body dose coefficient (2.1E-09 Sv/Bq vs 1.4E-09 Sv/Bq). This difference is approximately equal to the increase in total energy emissions reported in ICRP 107 (0.2360 MeV) as compared to ICRP 38 (0.1651 MeV). The increased dose factor results in a decreased DAC value.
Ta-183	Type M	A 33% difference is reported for the conventional unit-based DAC (2E-07 μCi/mL vs 3 E-07μCi/mL). Dose to the effective whole body is controlling. The calculated DAC of 2E-07 μCi/mL (non-truncated: 2.96E-07 μCi/mL) is derived from a DCAL whole body dose factor of 1.9E-09 Sv/Bq. The ICRP 68 dose coefficient is reported as 1.8E-09 Sv/Bq which yields a DAC of 3E-07 μCi/mL (non-truncated: 3.13E-07 μCi/mL). The non-truncated DACs differ by only 5%. Truncation increases the difference to 33%.
W-181	Type F	A 12% increase is reported for the effective whole body dose coefficient (4.8E-11 Sv/Bq vs 4.3E-11 Sv/Bq). This difference is approximately equal to the increase in electron energy emissions reported in ICRP 107 (0.0129 MeV) as compared to ICRP 38 (0.0109 MeV).

Radionuclide	Solubility	Observed Differences
W-181	Type F	10 CFR 835 identifies the ET Airways as the controlling organ. DCAL gives an effective whole body dose coefficient of 4.750E-11 Sv/Bq and an ET airway dose coefficient of 4.514E-10 Sv/Bq. Rounded to two significant digits these coefficients differ by less than a factor of 10. Therefore, stochastic effects are considered controlling in this package.
Os-180	Type F	A 20% difference is reported for the SI unit-based DAC (4E+05 Bq/m^3 vs 5E+05 Bq/m^3). Dose to the ET airways is controlling. The calculated DAC of 4E+05 Bq/m^3 (non-truncated: 4.95E+05 Bq/m^3) is derived from a DCAL ET dose factor of 4.22E-10 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 5E+05 Bq/m^3 is unknown. IMBA gives an ET airway dose coefficient of 4.03E-10 Sv/Bq, which yields a DAC of 5.2E+05 Bq/m^3. To two significant figures the corresponding DACs differ by only 5% (5.2E+05 Bq/m^3vs 4.9E+05 Bq/m^3). Truncation results in a 20% difference.
Ir-190	Type M	A 35% decrease is reported for the effective whole body dose coefficient (1.5E-09 Sv/Bq vs 2.3E-09 Sv/Bq). This difference is approximately equal to the decrease in electron energy emissions reported in ICRP 107 (0.0746 MeV) as compared to ICRP 38 (0.123 MeV). The decreased dose factor results in an increased DAC.
Ir-190	Type S	A 36% decrease is reported for the effective whole body dose coefficient (1.6E-09 Sv/Bq vs 2.5E-09 Sv/Bq). This difference is approximately equal to the decrease in electron energy emissions reported in ICRP 107 (0.0746 MeV) as compared to ICRP 38 (0.123 MeV). The decreased dose factor results in an increased DAC.
Pt-191	Type F	A 14% difference is reported for the SI unit-based DAC (6E+04 Bq/m^3 vs 7E+04 Bq/m^3). Dose to the ET airways is controlling. The calculated DAC of 6E+04 Bq/m^3 (non-truncated: 6.87E+04 Bq/m^3) is derived from a DCAL ET dose factor of 3.03E-09 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 7E+04 Bq/m^3 is unknown. IMBA gives an ET airway dose coefficient of 2.89E-09 Sv/Bq which yields a DAC of 7.2E+04 Bq/ m^3. To two significant figures the corresponding DACs differ by only 5% (6.9E+04 Bq/m^3 vs 7.2E+04 Bq/m^3). Truncation results in a 14% difference
Hg-195	Type M	A 17% difference is reported for the conventional unit-based DAC (5E-06 μCi/mL vs 6E-06 μCi/mL). Dose to the ET airways is controlling. The calculated DAC of 5E-06 μCi/mL (non-truncated: 6.75E-06 μCi/mL) is derived from a DCAL ET dose factor of 9.79E-10 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 6E-05 μCi/mL is unknown. IMBA gives an ET airway dose coefficient of 9.34E-10 Sv/Bq which yields a DAC of 5.75E-06 μCi/mL. To two significant figures the corresponding DACs differ by only 5% (5.75E-06 μCi/mL vs 6.0E-06 μCi/mL). Truncation results in a 17% difference.

Radionuclide	Solubility	Observed Differences
Hg-195	Vapor	A 25% difference is reported for the conventional unit-based DAC (3E-07 μCi/mL vs 4 E-07μCi/mL). Dose to the effective whole body is controlling. The calculated DAC of 3E-07 μCi/mL (non-truncated: 3.75E-07 μCi/mL) is derived from a DCAL whole body dose factor of 1.5E-09 Sv/Bq. The ICRP 68 dose coefficient is reported as 1.4E-09 Sv/Bq which yields a DAC of 4E-07 μCi/mL (non-truncated: 4.02E-07 μCi/mL). The non-truncated DACs differ by only 7%. Truncation increases the difference to 25%.
Tl-197	Type F	A 13% difference is reported for the conventional unit-based DAC (7E-06 μCi/mL vs 8E-06 μCi/mL). Dose to the ET airways is controlling. The calculated DAC of 7E-06 μCi/mL (non-truncated: 7.33E-06 μCi/mL) is derived from a DCAL ET dose factor of 7.68E-10 Sv/Bq. ICRP 68 does not list organ-specific dose factors. Therefore, the coefficient used to generate the Appendix A DAC of 8E-06 μCi/mL is unknown. IMBA gives an ET airway dose coefficient of 7.01E-10 Sv/Bq which yields a DAC of 8.06E-06μCi/mL . To two significant figures the corresponding DACs differ by only 9% (5.33E-06 μCi/mL vs 8.0E-06 μCi/mL). Truncation results in a 13% difference.

a A. Birchall et al., IMBA (Integrated Modules for Bioassay Analysis) Professional Plus, Software Package, Version 4.0.53, Health Protection Agency, United Kingdom, September 2007.

APPENDIX D
NUCLIDES NOT ADDRESSED IN THIS CALCULATION PACKAGE

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APPENDIX D. NUCLIDES NOT ADDRESSED IN THIS CALCULATION PACKAGE

DAC evaluations were not completed for 61 radionuclides due to insufficient radiological decay data. All but five of these nuclides have half-lives of less than 2 hours (see highlighted entries below). The regulatory requirement to apply a DAC of 2E-13 μCi/mL and 4E-11 μCi/mL depending on decay mode will continue to be applied to this listing at this time.

Nuclide	Half Life	Nuclide	Half Life	Nuclide	Half Life
Zr-84	25.83 minutes	Hf-166	6.77 minutes	Os-195	6.5 minutes
Pr-133	6.5 minutes	Hf-168	26. minutes	Ir-179	4. minutes
Tb-154m	**9.7 hours**	**Hf-171**	**12.11 hours**	Ir-181	4.9 minutes
Tb-154n	**23. hours**	Ta-168	2.43 minutes	Ir-197	5.8 minutes
Ho-152	2.7 minutes	Ta-169	4.9 minutes	Pt-182	2.6 minutes
Ho-158	11 minutes	Ta-171	23.33 minutes	Pt-183	6.5 minutes
Er-155	5.3 minutes	W-170	4. minutes	Pt-185	1.18 hours
Er-157	18.67 minutes	W-171	2.4 minutes	Pt-201	2.5 minutes
Er-158	**2.25 hours**	W-172	6.67 minutes	Au-185	4.33 minutes
Er-160	**1.19 days**	W-173	7.97 minutes	Au-188	8.83 minutes
Tm-157	3.5 minutes	W-174	29.33 minutes	Au-189	28.67 minutes
Tm-158	4.02 minutes	W-175	34. minutes	Hg-187	2.4 minutes
Tm-159	9.15 minutes	W-189	11.5 minutes	Hg-188	3.25 minutes
Tm-160	9.4 minutes	Re-174	2.3 minutes	Hg-189	7.6 minutes
Yb-160	4.8 minutes	Re-175	5.8 minutes	Hg-191	48.33 minutes
Yb-161	4.2 minutes	Re-176	5.67 minutes	Tl-191m	5.2 minutes
Lu-163	3.97 minutes	Re-191	9.8 minutes	Tl-192	10.6 minutes
Lu-164	4.8 minutes	Os-176	3. minutes	Tl-193	21.67 minutes
Lu-166	2.65 minutes	Os-177	2.8 minutes	Pb-193m	5.8 minutes
Lu-168	5.5 minutes	Os-178	5. minutes	-	--
Hf-164	2.8 minutes	Os-179	6.5 minutes	-	-

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Appendix E
INERT GASES

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APPENDIX E. INERT GASES

The SNS accident inventory includes 25 inert gases. DAC values are not listed in 10 CFR 835, Appendix C, for four of these:

- N-13 (9.97 minutes)
- Ar-42 (32.9 years)
- Ar-43 (5.37 minutes)
- Ar-44 (11.87 minutes)

For omitted radioactive gases with a decay mode other than alpha emission or spontaneous fission and a half-life of less than 2 hours, 10 CFR 835 requires a DAC value of 6E-06 μCi/mL (2E+04 Bq/m^3) to be applied. As N-13, Ar-43, and Ar-44 have half-lives less than 2 hours, this provision applies to these radionuclides. Argon-42, however, is not addressed.

The majority of DAC values for noble gases are controlled by the effective whole body dose accumulated from the immersion within a semi-infinite cloud. Dose rate coefficients are published in Annex D of ICRP 68. However, ICRP 68 does not address Ar-42.

The DCAL system provides a utility to calculate effective whole body dose rate coefficients for inert gases. For Ar-42, the DCAL-generated effective whole body dose rate factor is 1.26E-16 Sv/s per Bq/m^3. Unit conversion gives a factor of 4.54E-13 Sv/hr per Bq/m^3. Given that an occupational worker is limited to a whole body dose of 0.05 Sv over an occupational year of 2000 hours, the DAC for Ar-42 is calculated as:

$$\mathrm{DAC} = \frac{\dfrac{0.05\ \mathrm{Sv}}{2000\ \mathrm{hr}}}{4.54\mathrm{E}-13\ \dfrac{\mathrm{Sv/hr}}{\mathrm{Bq/m^3}}} = 5.5\mathrm{E}+07\ \mathrm{Bq/m^3} \quad = \quad 1.5\mathrm{E}-03\ \mu\mathrm{Ci/mL}.$$

Truncation yields 5E+07 Bq/m^3 and 1E-03 μCi/mL.

For validation, the dose factors associated with Ar-41 are examined. For Ar-41, ICRP 68 gives a dose rate factor of 5.3E-09 Sv/day per Bq/m^3. The DCAL-generated whole body dose rate coefficient for Ar-41 is 6.15E-14 Sv/s per Bq/m^3. Unit conversion gives a DCAL value of 5.3E-09 Sv/day per Bq/m^3which exactly agrees with the ICRP 68 value.

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