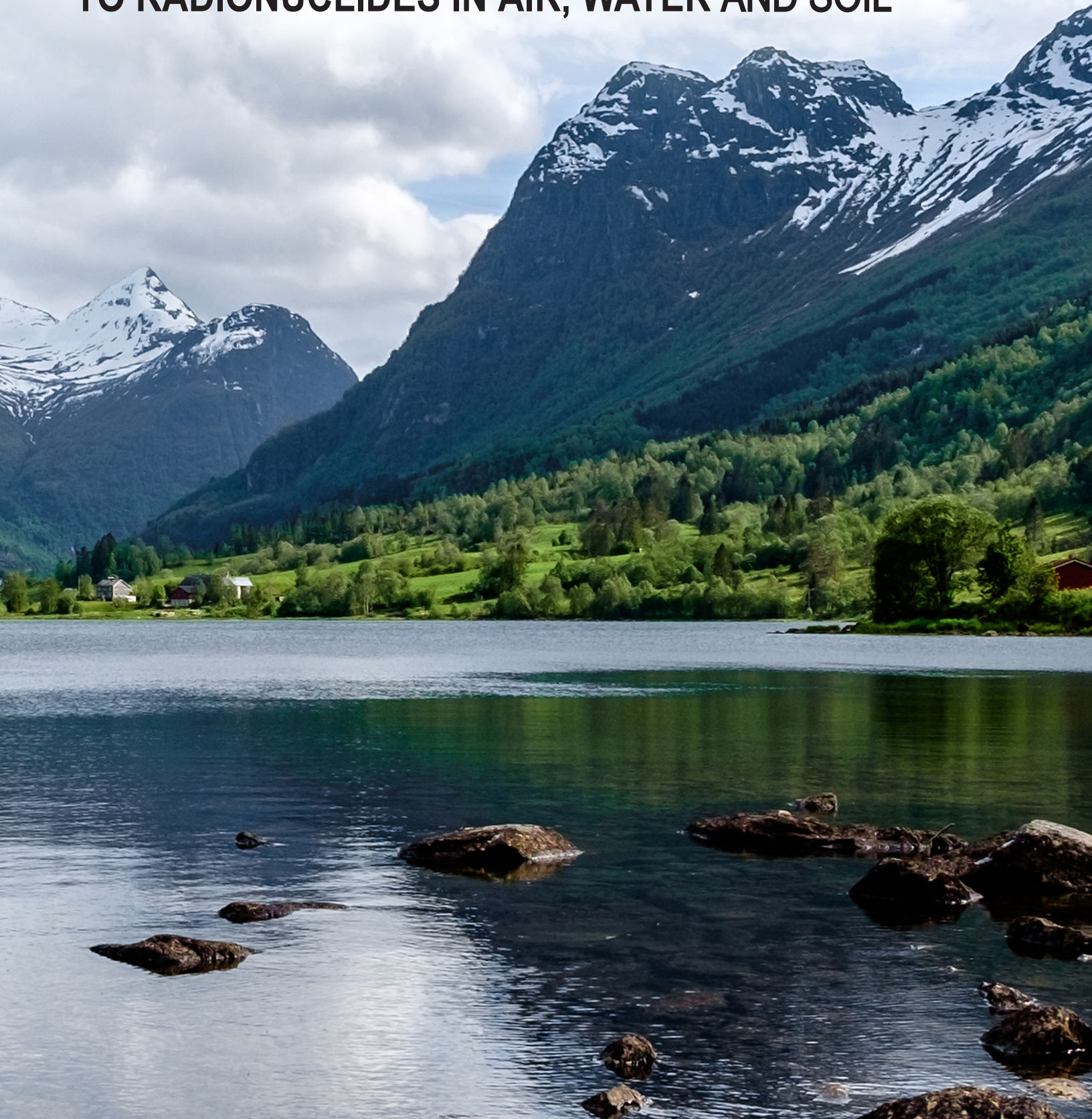


# External Exposure

## TO RADIONUCLIDES IN AIR, WATER AND SOIL



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**FEDERAL GUIDANCE REPORT NO. 15**

**EXTERNAL EXPOSURE TO RADIONUCLIDES  
IN AIR, WATER AND SOIL**

External Dose Rate Coefficients for General Application

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*For a summary of revisions, see errata at end of report*

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## PREFACE

The purpose of federal radiation protection guidance is to provide a common framework for ensuring that the assessment of exposure to ionizing radiation is carried out in a consistent manner. Federal guidance is issued by the Administrator of the U.S. Environmental Protection Agency (EPA) as part of his or her responsibility, under Executive Order 10831, to "...advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all federal agencies in the formulation of radiation standards and in the establishment and execution of programs of cooperation with States."

Federal Guidance Report No. 15, *External Exposure to Radionuclides in Air, Water and Soil*, is part of a series designed to provide technical information for use in implementing radiation protection programs. This report tabulates age-specific, reference person effective dose rate coefficients for 1,252 radionuclides based on external exposure to radionuclides distributed in air, water and soil. This report updates and expands Federal Guidance Report No. 12, *External Exposure to Radionuclides in Air, Water, and Soil* (EPA, 1993). Federal Guidance Report No. 15 incorporates advancements in scientific knowledge to help ensure that regulation of radiation exposure makes use of the best available information for relating concentrations of radionuclides in environmental media to dose in human populations due to external radiation.

The dose rate coefficients are intended for calculating age-specific effective doses from external exposure to environmental radionuclides. They were developed for use by federal agencies having regulatory responsibilities for protection of members of the public and/or workers. This guidance also may be used by those federal agencies with responsibilities related to the management of their own personnel and their contractor operations; for example, the U.S. Department of Energy (DOE) has derived age- and sex-weighted dose coefficients in DOE-STD-1196-2011 for assessing compliance with annual public dose limits. State and local authorities are encouraged to use the dose coefficients under their radiation protection authorities.

For the vast majority of radionuclides, external dose is due to x-rays, gamma radiation, conversion electrons and beta (negatron and positron) radiations. Dose rate coefficients are provided for the following exposure pathways: submersion in a contaminated atmospheric cloud (air submersion), immersion in contaminated water (water immersion), and exposure to contamination on or below the ground surface (ground exposure). For each exposure pathway, dose rate coefficients are provided for each of 1,252 radionuclides.

The dose coefficients developed in this report address the equivalent dose to tissues of the body and the effective dose as defined in International Commission on Radiological Protection (ICRP) Publication 103 (2007). The coefficients are based on the nuclear decay data of ICRP Publication 107 (2008) and a series of computational phantoms containing both male- and female-specific tissues (i.e., stylized hermaphrodites) representing newborns, children ages 1, 5, 10 and 15 years, and adults. Equivalent dose coefficients are derived for the tissues of the body including the male and female sex-specific tissues. Effective dose coefficients, the weighted sum of the average tissue-weighted equivalent dose in the male and female, are tabulated for the six ages. The equivalent dose and effective dose coefficients for external exposure to 1,252 radionuclides in the four environmental pathways are available electronically.<sup>1</sup> The effective dose coefficients tabulated in this report apply to a "reference person" of the stated age.

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<sup>1</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

This report discusses various methods for weighting or calculating a single coefficient for an individual isotope. Information is provided to allow the reader to modify dose rate coefficients relative to site-specific conditions (source depth profiles, air density or soil density).

The pertinent physical properties of the radionuclide are its radiological (physical) half-life and the types and energies of its emitted radiations. The methodology is built around the unifying concept of absorbed dose, defined as the mean energy deposited by ionizing radiation in the absorbing tissue per unit mass of tissue. The International System (SI) unit of absorbed dose is joules per kilogram ( $\text{J kg}^{-1}$ ), called the gray (Gy).

Absorbed doses from ionizing radiation originating from radionuclides outside the body are predicted by radiation transport models that describe the movement of different types and energies of ionizing radiation through different materials and their deposition of energy in those materials. The external dose rate coefficient for a specific radionuclide depends on the type, intensity and energy of the emitted radiations, along with the mode of exposure, the age of the reference person, and the anatomy that governs the energy deposition in body. The radiation dose depends strongly on the temporal and spatial distribution of the radionuclide to which a reference person is exposed and the duration of the exposure.

The previous version of this report, Federal Guidance Report No. 12 (1993), used the principal dose quantity, effective dose, recommended in Radiation Protection Guidance to Federal Agencies for Occupational Exposure (EPA, 1987). New estimates of radiation risk to the organs and tissues have been published since then (United Nations Scientific Committee on the Effects of Atomic Radiation [UNSCEAR], 2000, 2008; National Academy of Sciences–National Research Council [NAS–NRC], 2006; ICRP, 2007; EPA, 2011) and updated weighting factors have been recommended by ICRP (2007).

The tables in this report are available online,<sup>2</sup> allowing the user to easily integrate the data into programs for assessing dose.

We gratefully acknowledge the work of the authors—M. B. Bellamy, S. A. Dewji, R. W. Leggett, M. Hiller, K. Veinot, R. P. Manger, K. F. Eckerman, J. C. Ryman, C. E. Easterly, N. E. Hertel and D. J. Stewart—without whose outstanding contributions, tables such as these would not exist. This project was made possible through joint funding from three federal agencies: EPA, DOE, and the U.S. Nuclear Regulatory Commission (NRC). We appreciate the consistent support of project officers from EPA (M. Boyd), DOE (A. Wallo and D. Favret) and NRC (A. Huffert and V. Holahan) throughout the lengthy term of this work.

Comments and suggested improvements should be sent to [radiation.questions@epa.gov](mailto:radiation.questions@epa.gov).



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<sup>2</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

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## CHAPTER 1. INTRODUCTION

This report tabulates age-specific, reference person<sup>3</sup> effective dose rate coefficients for external exposure to photons and electrons emitted by radionuclides distributed in air, water and soil. The dose rate coefficients are intended for use in the calculation of age-specific effective doses from external exposure to radionuclides in the environment. Dose rate coefficients for calculation of equivalent doses to specific tissues are available online.<sup>4</sup>

Dose rate coefficients are provided for the following exposure pathways: submersion in a contaminated atmospheric cloud (air submersion); exposure to contamination on or below the ground surface (ground exposure); and immersion in contaminated water (water immersion). For each exposure pathway, dose rate coefficients are provided for 1,252 radionuclides. The coefficients are based on nuclear decay data of International Commission on Radiological Protection (ICRP) Publication 107 (2008) and a series of stylized hermaphrodite phantoms (i.e., phantoms containing both male and female reproductive organs) representing newborns, children ages 1, 5, 10 and 15 years, and adults (Han et al., 2006). These phantoms are modifications of age-specific mathematical phantoms originally developed at Oak Ridge National Laboratory (ORNL) (Cristy and Eckerman, 1987). The modifications address tissues considered in ICRP Publication 103 (2007) that were not identified in the original phantoms.

This report is made available to provide dose coefficients for external exposures consistent with ICRP Publication 103 (2007). At time of publication, no federal agencies have applied the ICRP Publication 103 system of protection in federal regulations. In addition, neither ICRP nor the National Council on Radiation Protection and Measurements (NCRP) have made recommendations regarding the appropriate use of age-specific dose coefficients in the radiation protection system. Federal Guidance Report No. 15 dose coefficients are not applicable for determining compliance with regulations that are based on earlier ICRP dosimetry methodologies. Although no federal agencies have used ICRP Publication 103-based age-specific dose coefficients in radiation protection systems, there have been limited examples of the use of age-specific coefficients. The U.S. Department of Energy (DOE) adopted ICRP Publication 60 (1991) in its radiation protection system (DOE Order 458.1) (DOE, 2011a) and used ICRP Publication 72 (1996) and Federal Guidance Report No. 13 (EPA, 1999) age-specific dose coefficients in DOE-STD-1196-2011 (DOE, 2011b) for estimating public doses from chronic (long-term) exposures of the public for assessing compliance with its dose limits. The standard utilizes age- and sex-weighted coefficients based on the population from 2010 U.S. census. The EPA Superfund program used Federal Guidance Report No. 13 age-specific risk factors when conducting assessments to estimate lifetime risks from chronic exposures. Unless an agency specifically authorizes use of ICRP Publication 103 in its regulations, the dose coefficients in this report should not be used for compliance purposes without approval of the appropriate regulatory authority.

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<sup>3</sup> In ICRP Publication 103 (2007), “reference person” is defined as “An idealised person for whom the organ or tissue equivalent doses are calculated by averaging the corresponding doses of the Reference Male and Reference Female. The equivalent doses of the Reference Person are used for the calculation of the effective dose by multiplying these doses by the corresponding tissue weighting factors.” (p. 31)

<sup>4</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

This report updates and expands Federal Guidance Report No. 12 (EPA, 1993), which tabulates external dose coefficients for a reference adult for 825 radionuclides. The coefficients provided in Federal Guidance Report No. 12 were based on nuclear decay data of ICRP Publication 38 (1983) and a stylized dosimetric hermaphrodite phantom representing the reference adult.

Dose rate coefficients for external exposure relate the dose rate to organs and tissues of the body to the concentrations of radionuclides in environmental media. This situation is in contrast to the intake of radionuclides by inhalation or ingestion, where the radiations are emitted within the body and the committed dose is dependent on the activity intake of the radionuclide. In either circumstance, the dosimetric quantities of interest are the radiation doses received by the radiosensitive organs and tissues of the body. The types of radiation of concern for external exposures are those sufficiently penetrating to traverse the overlying tissues of the body and deposit ionizing energy in radiosensitive organs and tissues. Penetrating radiations considered in this report are limited to photons (x-rays, gamma rays and bremsstrahlung) and electrons (negatrons and positrons). The radiation dose depends strongly on the temporal and spatial distribution of the radionuclide to which a reference person is exposed and the duration of the exposure.

It is common practice to consider idealized exposure geometries in which the radionuclide concentration in the medium, seen from the location of an exposed individual, is uniform and effectively infinite or semi-infinite in extent. Even for such simplified geometries, calculation of the energy and angular distributions of radiations incident on the body and the transport of radiation within the body is a demanding computational problem.

If one assumes an infinite or semi-infinite source region with a uniform concentration  $C(\tau)$  of a radionuclide at time  $\tau$ , the equivalent dose  $H_T(T_A, T_E)$  in tissue  $T$  of an individual of age  $T_A$  during an exposure of duration  $T_E$  can be expressed as

$$H_T(T_A, T_E) = \int_0^{T_E} C(\tau) \dot{h}_T(T_A + \tau) d\tau \quad (1)$$

where  $\dot{h}_T(\tau)$  is the time-dependent dose rate coefficient for external exposure. The coefficient  $\dot{h}_T$  represents the dose rate to tissue  $T$  of the body of an individual of initial age  $T_A$  per unit time-integrated exposure expressed in terms of the time-integrated concentration of the radionuclide. This coefficient varies with time due to anatomical changes as the receptor grows from a newborn to an adult.

In the case of the adult, the integral dose in tissue  $T$  can be calculated as the product of the adult's dose rate coefficient and the time-integrated activity concentration of the radionuclide in the environment. This is possible because, unlike nonadults, the dose rate coefficient of the adult is assumed to be time-independent. In most applications of the dose coefficients, the annual equivalent dose  $H_T$ , rather than the instantaneous dose rate, is the quantity of interest, so for the adult, the time integral of the concentration must be evaluated. For nonadults, the integral defined in Eq. (1) must be evaluated. Depending on the nature of the application it may be advantageous to view the numerical value of the coefficient as either the instantaneous dose rate per unit concentration or as the dose per unit time-integrated concentration.



However, when considering nonadults, attention needs to be given to the magnitude of error in neglecting to consider the changes in the dose coefficient as the individual ages. In this report we follow the latter presentation.

The external dose rate coefficient for a specific radionuclide depends on the type, intensity and energy of the emitted radiations; the mode of exposure; the age of the reference person; and the anatomy that governs the energy deposition in the body. The dose rate coefficient incorporates the transport of emitted radiations in the environment, their subsequent transport in the body, and estimation of the deposition of ionizing energy in the tissues of the body. Calculations of the radionuclide-specific dose rate coefficients involve three main steps:

1. Computation of the energy and angular distributions of the radiations incident on the body for a range of discrete initial energies of monoenergetic sources distributed in the environmental medium of interest.
2. For the incident radiation spectrum computed in step 1, evaluation of the transport and energy deposition in tissues of the body.
3. Calculation of the tissue dose rate coefficient for specific radionuclides, considering the energies and yields of the radiations emitted during nuclear decay of that radionuclide.

The result of the first two steps is a set of dose rate coefficients for monoenergetic sources of photons or electrons. The last step scales these coefficients to the emissions of the specified radionuclide.

## **1.1 Dosimetric quantities**

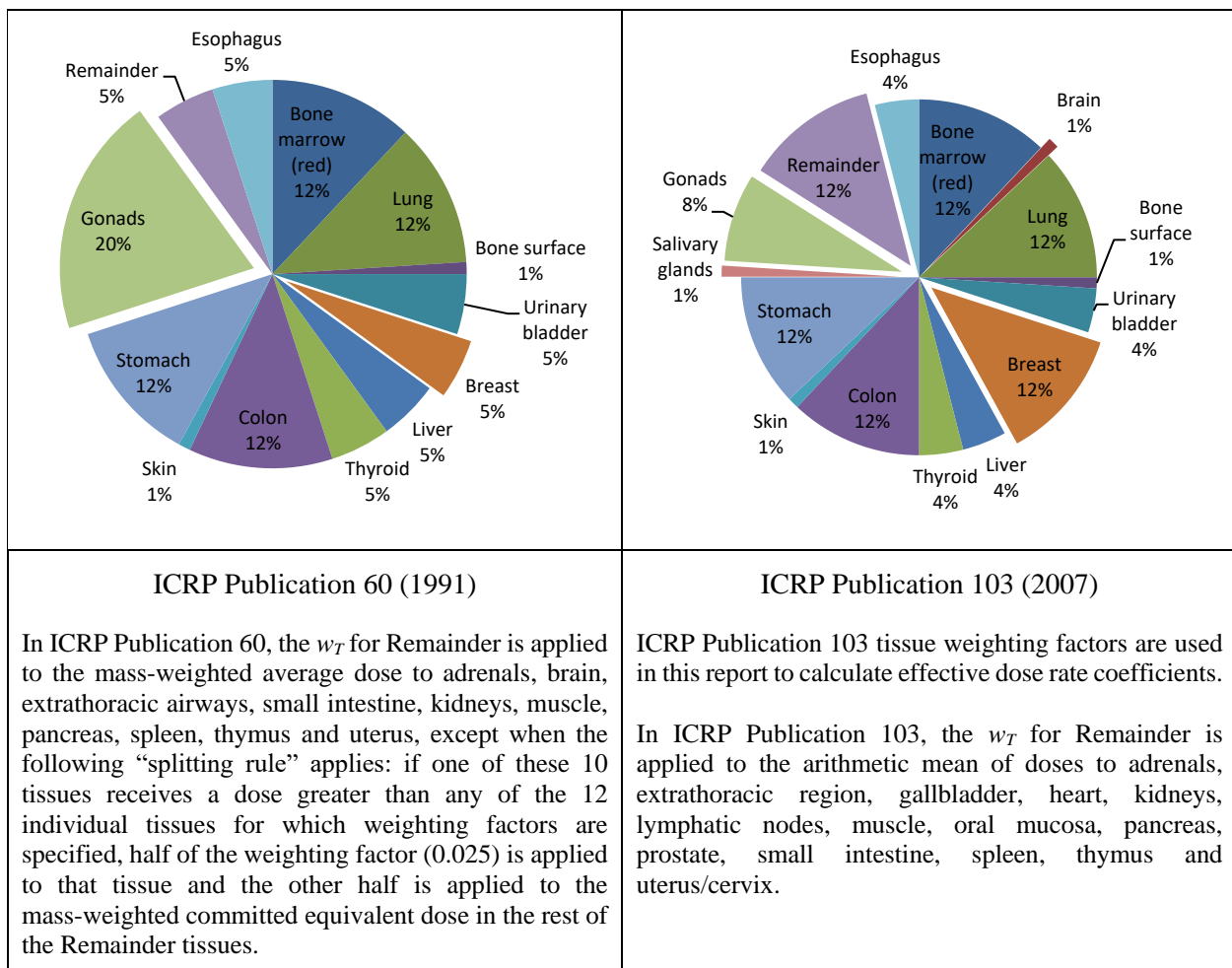
The fundamental measure of exposure to ionizing radiation is the absorbed dose. The absorbed dose to a tissue in which ionizing radiation is absorbed is the mean energy deposited in the tissue per unit mass of tissue. The International System (SI) unit of absorbed dose is joules per kilogram ( $\text{J kg}^{-1}$ ), which is called the gray (Gy).

The quantity equivalent dose places all ionizing radiations on a common scale with regard to their potential stochastic risk (ICRP, 2007). The equivalent dose to a tissue is the absorbed dose multiplied by a radiation weighting factor that reflects the relative biological effectiveness (RBE) of the radiation type. A radiation weighting factor of 1 is recommended by ICRP for photons and electrons (ICRP, 2007). Because radiation weighting factors are unitless, the SI unit of equivalent dose is the same as that of absorbed dose ( $\text{J kg}^{-1}$ ); however, it is called the sievert (Sv).

Dose-response relations for radiation-induced cancer, the dominant stochastic effect of ionizing radiation, are based largely on data for external exposures involving nearly uniform external irradiation of the human body by gamma rays or x-rays. In virtually all cases of radionuclide intake and in many cases of external exposure, radiation doses are distributed non-uniformly among tissues. A quantity called effective dose is used to compare stochastic risk from non-uniformly delivered dose with stochastic risk from uniform external exposure of the whole body (ICRP, 2007). Effective dose is used as a measure of stochastic risk

for either external exposure or internally deposited radionuclides, thus enabling the summation of these two types of exposure in the context of radiation protection. ICRP Publication 103 (2007) states, “effective dose is not recommended for epidemiological evaluations, nor should it be used for detailed specific retrospective investigations of individual exposure and risk” (p. 13).

The effective dose takes into account epidemiological findings that the relationship between equivalent dose and the probability of radiation effects depends on the organ or tissue irradiated. The effective dose is a weighted sum of equivalent doses to radiosensitive tissues, with the equivalent dose for a given tissue  $T$  weighted by a “tissue weighting factor,”  $w_T$ . The weighting factors represent the relative contribution of the different tissues to the total risk for the case of uniform irradiation of the whole body. Effective dose is expressed in the same unit as equivalent dose (i.e., Sv). The tissue weighting factors applied in this report are those recommended in ICRP Publication 103 (2007). The weighting factors specified in ICRP Publication 103 are presented in Figure 1-1, along with the weighting factors recommended in ICRP Publication 60 (1991).



**Figure 1-1. Comparison of the tissue weighting factors of ICRP Publication 60 (1991) with those used in this report (ICRP Publication 103, 2007).**

The dose coefficients developed in this report address the equivalent dose to tissues and the effective dose as defined in ICRP Publication 103 (2007). Effective dose rate coefficients are tabulated in this report and equivalent dose rate coefficients for individual tissues are available online.<sup>5</sup>

All effective dose rate coefficients presented in this report are sex-averaged and derived using mathematical hermaphrodite phantoms for newborns, children ages 1, 5, 10 and 15 years, and adults. Averaging of dose rate coefficients for males and females of a given age yields a dose rate coefficient for a “reference person” of that age. For example, the average of the tissue-specific dose rate coefficients developed separately for the 1-year-old male and the 1-year-old female (using doses to sex-specific reproductive organs in each case) for a given exposure scenario are available online.

This report tabulates dose rate coefficients for the radionuclides addressed in ICRP Publication 107 (2008). For the vast majority of radionuclides, external dose is due to x-rays, gamma, conversion electrons and beta (negatron and positron) radiations. For a few radionuclides, spontaneous fission produces penetrating radiations of potential importance, including fast neutrons. Prompt and delayed emissions for photons and beta particles following spontaneous fission are included in the decay data tabulations of ICRP Publication 107 (2008) and included in the calculations of dose rate coefficients in this report. The dose contribution from neutrons accompanying spontaneous fission, however, has not been considered because information has not been assembled on the neutron field resulting from environmental distribution of radionuclides undergoing spontaneous fission. The potential contribution to dose of long-lived fission products from radionuclides undergoing spontaneous fission also is not considered in the tabulated dose rate coefficient calculation.

## **1.2 Differences between Federal Guidance Report No. 15 and Federal Guidance Report No. 12**

Since the publication of Federal Guidance Report No. 12 (EPA, 1993), there have been substantial changes in computational capabilities, radiation protection databases, anthropomorphic computational phantoms and ICRP guidance. These changes have facilitated improved calculation of organ dose as a result of exposure to contaminated environmental media. This section discusses some of the differences between this report and Federal Guidance Report No. 12.

The largest difference between the two reports is that this report incorporates six age-specific phantoms from newborn through adult while Federal Guidance Report No. 12 only considers a single age. Thus, this report contains six times more tissue and effective dose rate coefficient tables and the associated datasets are correspondingly larger.

Next, this report’s effective doses are based on ICRP Publication 103 (2007) weighting factors while the Federal Guidance Report No. 12 effective dose numbers are based on ICRP Publication 26 (1977). In the context of external emitters, the most substantial effect of the updated tissue weighting coefficients is the inclusion of skin in the definition of effective dose. Many radionuclides, especially those that exclusively emit energy below 50 keV, have a skin dose which is much higher than other organ doses. For these radionuclides, the ICRP Publication 103 definition of effective dose would in general be larger than

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<sup>5</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

the effective dose computed under ICRP Publication 26 guidance. The most extreme example would be radionuclides for which 100 percent of the dose is deposited in skin. For these radionuclides, the Federal Guidance Report No. 12 (based on ICRP Publication 26) effective dose would be zero, while the Federal Guidance Report No. 15 (based on ICRP Publication 103) effective dose would be some positive quantity.

Advances in Monte Carlo computational power can be categorized into software advances and hardware advances. In the 25 years between the development of Federal Guidance Report No. 12 and this report, major advancements have been made in computer speed, availability, approachability and stability. The calculations in this work employed Monte Carlo N-Particle 6 (MCNP6) (Goorley et al., 2012) transport code in conjunction with Evaluated Nuclear Data File (ENDF/B-VI.8) (Herman and Trkov, 2005) cross sections. These advances have allowed for more precise calculations of organ doses from the Monte Carlo phase of the calculation, particularly at low photon energies.

Radionuclide dose rate coefficients included in this report are based on ICRP Publication 107 (2008), which includes a larger number of radionuclides and refinements to the decay data relative to ICRP Publication 38 (1983) that was used in Federal Guidance Report No. 12 calculations. Electron (negatron and positron) and photon emissions of the radionuclides addressed in ICRP Publication 107 were used to calculate the dose coefficients tabulated in this report. Notable differences between dose coefficients in this report and Federal Guidance Report No. 12 are present where substantial corrections have been made between the nuclear decay databases. Finally, because ICRP Publication 107 provides decay information for a larger number of radionuclides, this report correspondingly provides external dose rate coefficients for a larger number of radionuclides than were provided in Federal Guidance Report No. 12.

### **1.3 Organization of this report**

The remainder of this report is organized as follows. Chapter 2 describes previous external dose computational methods leading up to the present work. Chapter 3 describes the calculation of the monoenergetic dose rate coefficients and tabulates these coefficients. Information is provided to allow the reader to modify dose rate coefficients relative to site-specific conditions (source depth profiles, air density or soil density). Chapter 4 tabulates effective dose rate coefficients for individual radionuclides for the six reference persons. Chapter 5 addresses some practical issues regarding application of the tabulated coefficients of Chapter 4.

Further details of the computational methods are discussed in the appendices. Appendix A summarizes the nuclear decay data required to evaluate the total external dose from exposure to radioactive decay chains. Appendix B describes the mathematical phantoms used in the calculations of external dose rate coefficients. Appendix C tabulates information on the bremsstrahlung spectra used in the calculations. Appendix D provides sample calculations illustrating the application of external dose rate coefficients.



## CHAPTER 2. BACKGROUND

A number of reports have tabulated dose coefficients for external irradiation of the body from radionuclides distributed in the environment (Poston and Snyder, 1974; Dillman, 1974; O'Brien and Sanna, 1978; Koblinger and Nagy, 1985; Jacob et al., 1986, 1988a, 1988b; Kocher, 1981, 1983; DOE, 1988; Saito et al., 1990; Chen, 1991; Petoussi et al., 1991; EPA, 1993; Petoussi-Henss et al., 2012). As a result of limitations in computational hardware and, to a limited extent, methods, these tabulations generally have relied on idealized assumptions regarding the exposure conditions. In some cases, the radiations incident on the body have been assumed to be uniformly distributed in angle (an isotropic field) or to be incident perpendicular to the body surface while the body is uniformly rotated about its vertical axis (a rotational exposure). Variations in the intensity of the radiations with height above the ground frequently have been ignored in assessing the dose from radionuclides on or below the ground surface. Irradiation from bremsstrahlung has been ignored in many cases, even though for many pure beta emitters it is the only radiation that is sufficiently penetrating to reach tissues below the surface of the body. In this report, we have minimized simplifying assumptions in an effort to improve estimates of dose rates to human tissues based on the hypothesized distributions of radionuclides in the environment.

Early estimates of submersion dose (Poston and Snyder, 1974; O'Brien and Sanna, 1978; Eckerman et al., 1980; Kocher, 1981, 1983; DOE, 1988) generally were based on Monte Carlo calculations with poor statistics for some organ doses due to limitations in the computer systems or minor errors in sampling the radiation field. Saito et al. (1990) published a compilation of organ doses due to air submersion based on Monte Carlo methods that appear to have overcome the limitations in earlier work.

The seminal work of Beck and de Planque (1968) on external dose due to contaminated soil was limited to calculation of air dose for photon energies between 0.25 and 2.25 MeV. These data were used later to generate a tabulation of air exposure rates for a number of radionuclides (Beck, 1980). The next generation of calculations (Kocher, 1981, 1983; Kocher and Sjoreen, 1985; DOE, 1988) produced dose estimates for many radionuclides but was limited by simplifying assumptions regarding the energy and angular dependence of the radiation field. The field was assumed to be equivalent to that of submersion and the point kernel method used for characterizing the field strength. Other efforts (Williams et al., 1985; Koblinger and Nagy, 1985; Jacob et al., 1986, 1988a, 1988b; Saito et al., 1990; Petoussi et al., 1991) have been based on relatively sophisticated methods for analyzing the energy, angular and spatial dependence of the radiation field and computing organ doses for both mathematical and CT-derived phantoms of various ages. These data are primarily for plane sources at or near the air-ground interface, or for naturally-occurring radionuclides distributed to effectively infinite depth in the soil. The calculations of Chen (1991) include volume sources of various thicknesses, as well as plane sources at the air-ground interface, but are only for effective dose based on rotational normal beam exposure (ICRP, 1987). The computational approach of Federal Guidance Report No. 12 (EPA, 1993) was a combination of deterministic and Monte Carlo methods. In that document, external dose rate coefficients for radionuclides in air, water and soil were derived using an adult hermaphrodite phantom (Cristy and Eckerman, 1987). With the exception of dose rate coefficients for skin, the dose rate coefficients in this report are based entirely on a Monte Carlo approach. The contribution of electrons to the skin dose rate coefficient is based on point kernel methodology.

As stated in Section 1.2, over two decades have transpired between the introduction of Federal Guidance Report No. 12 and the publication of this report. During that time, advances in both software and hardware facilitated improved calculation of organ dose as a result of exposure to contaminated air, water and soil. The dose coefficients calculated in this report are derived using MCNP6 (Goorley et al., 2012) radiation transport codes and ENDF/B-VI.8 (Herman and Trkov, 2005) cross sections. Aside from the computational streamlining, this report incorporates six age-specific phantoms from newborn through adult; Federal Guidance Report No. 12 (EPA, 1993) considered only an adult. Radionuclide dose rate coefficients are based on ICRP Publication 107 (2008), which includes a larger number of radionuclides and updated physical data relative to the ICRP Publication 38 (1983) dataset used in Federal Guidance Report No. 12. Several details of this report's methodology are summarized in Table 2-1.

**Table 2-1. Details of the Federal Guidance Report No. 15 methodology.**

<b>Radiation transport</b>	Only Monte Carlo, except for electron dose to skin (uses point kernel methodology)
<b>Cross section library</b>	ENDF/B-VI.8 (Herman and Trkov, 2005)
<b>Mean free path definition</b>	Total cross section, including coherent scatter
<b>Phantom library</b>	Reference newborns, children age 1, 5, 10 and 15 years, and adults
<b>Tissue weighting factors</b>	ICRP Publication 103 (2007) tissue weighting factors
<b>Number of organs/tissues considered</b>	29
<b>Radiations considered</b>	Photons and electrons (negatrons and positrons). Beta and photon radiations associated with spontaneous fission are considered; neutrons are not addressed.
<b>Decay data</b>	ICRP Publication 107 (2008) decay data
<b>Number of radionuclides</b>	1,252 radionuclides
<b>Radiation transport code</b>	MCNP6 (Goorley et al., 2012)
<b>Water immersion method</b>	Single-step with no coupling surface
<b>Soil profile</b>	Uniform concentration with depth
<b>Monoenergetic interpolation grid</b>	13 energies
<b>Treatment of ground roughness</b>	Ground roughness is represented as an infinite plane source at a depth of $0.5 \text{ g cm}^{-2}$ , equivalent to 3 mm for a soil density of $1.6 \times 10^3 \text{ kg m}^{-3}$
<b>Variance reduction</b>	Employed path-length stretching and reflective boundary conditions (primarily for low-energy photons)
<b>Tissue compositions</b>	Tissue-specific compositions and densities from ICRP Publication 89 (2002) and ICRU Report 46 (1992)

ENDF = Evaluated Nuclear Data File

ICRP = International Commission on Radiological Protection

ICRU = International Commission on Radiation Units and Measurements

## CHAPTER 3. METHOD FOR MONOENERGETIC RESPONSE

Photons and electrons are the most significant radiations emitted by environmental radionuclides that can penetrate the body from outside to deposit ionizing energy in radiosensitive tissues. This chapter describes the radiation dose quantities used in this report and presents the methods used to calculate dose rate coefficients for external exposure to photons and electrons emitted from contaminated air, water, ground surfaces and ground volumes.

The calculation of organ doses from irradiation of the human body by photon emitters distributed in the environment requires the solution of a complex radiation transport problem. It is impractical to solve this problem for the precise spectrum of photons emitted by each radionuclide of interest. Thus tissue-specific dose rate coefficients are computed in stylized phantoms representing newborns, children age 1, 5, 10 and 15 years, and adults for monoenergetic photon sources at 13 energies, ranging from 0.01 to 5.0 MeV (Figure 3-1). Skin dose values for electrons are derived using the point kernel approximation. Bremsstrahlung photons generated by electrons in the environment are evaluated using the monoenergetic photon dose rate coefficients. Radionuclide-specific dose rate coefficients are derived by summing the product of the frequency of emission of each emitted photon and the energy-interpolated monoenergetic dose rate coefficient.

This chapter describes the methods used to compute tissue dose rate coefficients and effective dose rate coefficients. Effective dose rate coefficients are tabulated in this report. Effective dose rate coefficients and equivalent dose rate coefficients for individual organs are available online.<sup>6</sup>

### 3.1 Computational phantoms

This work utilizes a series of stylized computational phantoms. These phantoms were originally developed at ORNL in the early 1980s (Cristy and Eckerman, 1987) and modified in the mid-2000s by Han et al. (2006). The reader is referred to Appendix B for more information on the history and development of the phantoms.

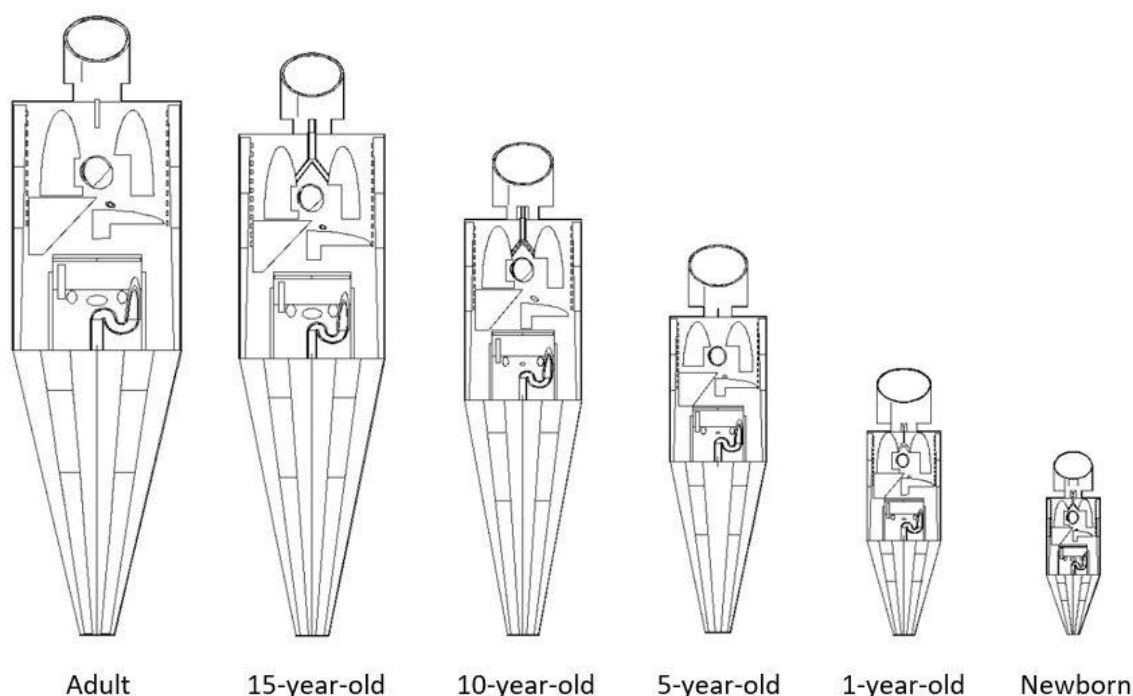
The update of the phantoms by Han et al. included changes to the head, brain, extra-thoracic airways, kidneys and rectosigmoid colon, and explicit representations of the salivary glands, alimentary track mucosa, respiratory tract airways and the urinary bladder. Tissue compositions and densities were updated in accordance with ICRP Publication 89 (2002) and International Commission on Radiation Units and Measurements (ICRU) Report 46 (1992). The series of phantoms was translated for use with the MCNP6 (Goorley et al., 2012) general purpose radiation transport code.

During quality assurance efforts, several organ volumes in the updated phantoms were found to be imprecisely declared. These differences were found by comparing the track-length estimated volume obtained by the ray tracing capability within MCNP6 with the declared volume. Corrections were made whenever the disparity in volume was greater than 3 percent.

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<sup>6</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>





**Figure 3-1. “Family” of phantoms including newborn through 15 years plus adults used in the derivation of external dose rate coefficients.**

## **3.2 Exposure to contaminated soil**

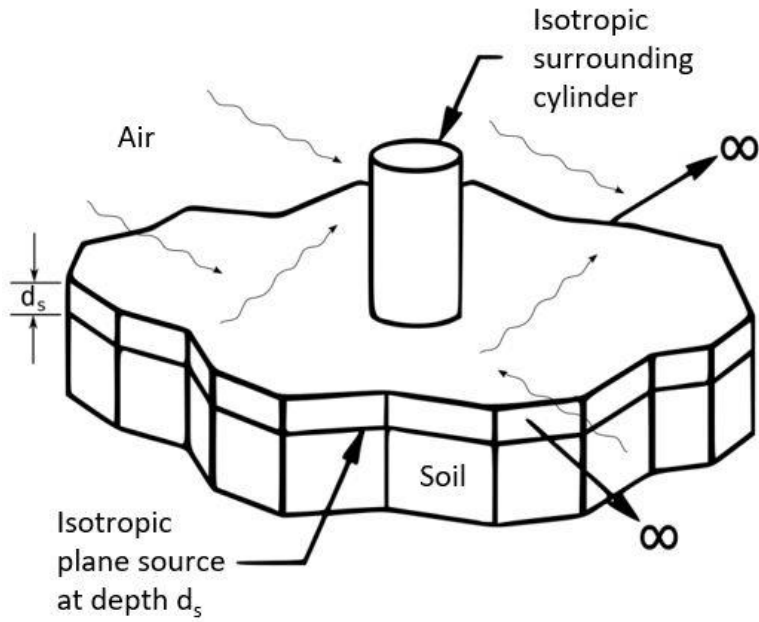
### **3.2.1 Summary of soil method**

Dose rate coefficients for exposure to contaminated ground planes are based on the assumption that an individual is standing on the ground. A direct Monte Carlo simulation involves the combination of a deep penetration (i.e., transport through many mean free paths of air and/or soil) and a complex geometry (the human phantom). The approach used in this work involves dividing the problem into two steps:

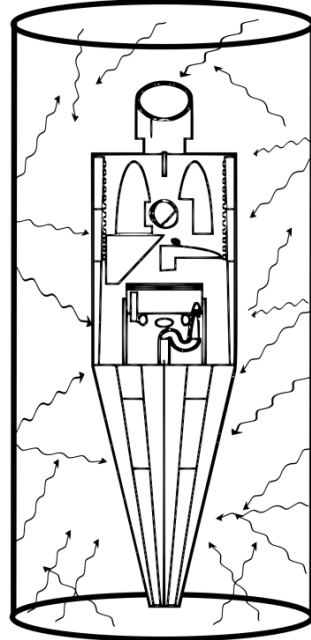
1. Calculation of photons incident on the phantom (angular and energy fluence) recorded on a closed surface surrounding the phantom (Figure 3-2). In this report, a cylinder of height 200 cm and radius 30 cm was used to represent the closed surface. This closed surface serves as a coupling surface for the second step in the simulations.
2. Calculation of organ dose rate coefficients due to photons transported from the cylinder into the phantom (Figure 3-3). The effective dose rates for the reference persons are computed from the tissue dose rates using the tissue weighting factors recommended in ICRP Publication 103 (2007) (see Figure 1-1 and Table 3-1).

**Table 3-1. ICRP Publication 103 (2007) tissue weighting factors for calculating effective dose rate coefficients.**

<b>Tissue</b>	<b><math>w_T</math></b>	<b>Representation in Phantom</b>
Red marrow	0.12	Multiple trabecular bone regions
Colon	0.12	Multiple segments represented
Lung	0.12	Both left & right lobes
Stomach	0.12	Contents excluded
Breast	0.12	Both male & female
<i>Gonads</i>		
Testes	0.04	Male tissue
Ovaries	0.04	Female tissue
Bladder	0.04	Contents excluded
Esophagus	0.04	Explicit tissue region
Liver	0.04	Explicit tissue region
Thyroid	0.04	Explicit tissue region
Bone surface	0.01	Trabecular & cortical bone regions
Brain	0.01	Explicit tissue region
Salivary glands	0.01	Explicit tissue region
Skin	0.01	Explicit tissue region
<i>Remainder</i>		
Adrenals	0.00923	Explicit tissue region
Extrathoracic region	0.00923	Explicit tissue region
Gall bladder	0.00923	Contents excluded
Heart	0.00923	Contents excluded
Kidneys	0.00923	Explicit tissue region
Lymphatic nodes	0.00923	Soft tissue surrogate
Muscle	0.00923	Explicit tissue region
Oral mucosa	0.00923	Explicit tissue region
Pancreas	0.00923	Explicit tissue region
Prostate	0.00462	Male tissue
Small intestine	0.00923	Contents excluded
Spleen	0.00923	Explicit tissue region
Thymus	0.00923	Soft tissue surrogate
Uterus/cervix	0.00462	Female tissue



**Figure 3-2. Radiation field due to a contaminated ground plane, on a cylinder surrounding the phantom.**



**Figure 3-3. Angular current source on the coupling cylinder surrounding the phantom.**

### **3.2.2 Environmental transport photons in soil**

To eliminate the complexity of the human phantom from the calculation of the incident radiation field, the phantom was removed from the geometry description. This may be done if the presence of the phantom does not significantly perturb the incoming angular flow rate across the coupling cylinder. The phantom can affect the incoming directions of the radiation field only for those photons which, having interacted in the phantom, pass out of the surrounding surface, scatter in the surrounding media, and return across the closed surface. This is at most a second-order effect, as demonstrated by Saito et al. (1990).

#### **3.2.2.1 Geometry overview**

The sources for the contaminated soil calculations are infinite planar sources of monoenergetic photons with unit strength in becquerel per square meter ( $1 \text{ Bq m}^{-2}$ ), located at the air-ground interface or at a specified depth in the soil. The photons are emitted in an isotropic manner. The results of these plane source calculations are used to determine the tissue dose coefficients for a reference person standing at the air-ground interface. For instance, the tissue dose rate due to a source in the soil that is uniformly distributed from the surface to a specified depth may be computed by integrating the dose rates due to a series of plane sources at different depths. This approach is easily extended to a variety of subsurface distributions of radionuclides by performing an appropriately weighted integration of the doses due to a series of plane sources at different depths.

#### **3.2.2.2 Soil composition**

The assumed soil composition, given in Table 3-2, is typical of silty soil (ICRU, 1994) containing 30 percent water and 20 percent air by volume. The air composition (see Table 3-3) is the same as for the submersion dose calculations. The assumed soil density is  $1.6 \times 10^3 \text{ kg m}^{-3}$ . In some circumstances, the radiation field above the air-ground interface can be scaled to account for differences in soil density (Beck and de Planque, 1968; Chen, 1991; Yu et al., 2015). The radiation field above the air-ground interface is relatively insensitive to soil composition for a plane surface source (Beck and de Planque, 1968), but this is not the case for photon emission within the soil at energies less than 100 keV (ICRU, 1994). At such energies the absorption properties differ for different soil types. Detailed information on the chemical composition of various soils has been tabulated by Helmke (1999). The issue of surface roughness for a contaminated surface plane is discussed in section 3.2.2.4. Changes in soil density have a much larger effect on the dose rate coefficient than changes to the elemental composition.

**Table 3-2. Soil composition.**

Element	Mass Fraction
H	0.021
C	0.016
O	0.577
Al	0.050
Si	0.271
K	0.013
Ca	0.041
Fe	0.011
Total	1.000

### 3.2.2.3 Soil depths considered

The radiation field due to isotropic infinite plane sources was computed for 13 energies and six depths into the soil. The monoenergetic photon energies ranged from 0.01 to 5.0 MeV. Source plane depths included 0 and 3 mm and four depths in an energy-dependent manner; that is, corresponding to 0.2, 1.0, 2.5 and 4.0 mean free paths at the specified photon energy. These depths were chosen to facilitate an accurate integration when determining dose rate coefficients for continuous source-depth profiles. The air-ground interface (0 mm) source is the mathematical idealized flat plane without anything other than air over the surface. This idealized geometry is rarely, if ever, present in the real world. Rather, there are a variety of conditions that provide shielding from ground surface sources, including the presence of vegetation, surface irregularities and, of course, migration of the deposited activity downward into the soil. The 3 mm source planar often is used to provide an accounting of the reduction in the dose rate resulting from the real-world departures (referred to as ground roughness) from a mathematical plane.

### 3.2.2.4 Ground roughness considerations

To account for these recognized dose-reduction conditions (collectively referred to as ground roughness), the dose rate coefficients for exposure to a contaminated ground surface have been calculated for an infinite planar source at a depth of  $0.5 \text{ g cm}^{-2}$  (equivalent to 3 mm for a soil density of  $1.6 \times 10^3 \text{ kg m}^{-3}$ ). The use of this relaxation mass of  $0.5 \text{ g cm}^{-2}$  is consistent with the results of previous studies in which it was shown that for a  $^{137}\text{Cs}/^{137\text{m}}\text{Ba}$  source with this geometry, the air kerma is reduced by a factor of 0.67 compared to a plane source on the ground. This reduction corresponds to the plane source at  $0.5 \text{ g cm}^{-2}$  in the ground and is applicable in the first months after a wet deposition (Jacob et al., 1990; ICRU, 1994). It is consistent with earlier work by Jacob et al. (1986), Saito et al. (1990) and Petoussi et al. (1991) and with the more recent work of Petoussi-Henss et al. (2012). Dose rate coefficients are provided in this report for a contaminated planar source covered by 3 mm of soil representing ground roughness.

### **3.2.2.5 Total soil depth**

The assumed effective dimensions of the half space of soil in the simulation varies with the depth of the ground plane. A total soil thickness of 3 mean free paths is employed for ground plane sources for depths of 0 mm, 3 mm and 0.2 and 1.0 mean free paths. However, for source planes at depths of 2.5 and 4 mean free paths, the total soil thicknesses are 3.5 and 5 mean free paths, respectively. Photons scattered at depths beyond the lower soil boundary are assumed to represent insignificant contributions to the dose rate coefficients because those photons would travel a minimum of 6 mean free paths and thus undergo significant attenuation.

### **3.2.2.6 Recording photons incident on the cylinder**

As previously mentioned in the first step for computing the dose rate coefficients, the radiation field incident on the cylindrical closed surface, in which the phantom is located in the second step of the calculation, was computed using the Monte Carlo transport code MCNP6 (Goorley et al., 2012). The “surface source write” feature of the code was used to record the position, angle and energy of photons incident on a coupling surface cylinder due to emission of monoenergetic photons from the ground plane source. As the phantom was not present in this step, the same surface source write file could be used for all reference persons. During this step, the volume inside of the coupling surface is filled with air.

Electrons liberated by photon interactions were not transported, but bremsstrahlung photons were generated and transported using the thick target assumption model available in MCNP6. For all photon energies and source depths, coupling cylinders 200 cm high with 30 cm radii were used. These coupling cylinders were chosen to be as small as possible while still completely enclosing the largest phantom. The distance between the base of the coupling cylinder and the air-soil interface was 0.01 cm. The coupling cylinder served as a passive detector/recorder of incident photons, thus the presence of the coupling surface did not affect the photon transport.

### **3.2.2.7 Geometry of the air above the soil**

In all soil calculations, the maximum altitude of air was 3 mean free paths (at the source energy) above the height of the coupling cylinder. Photons scattered in the atmosphere at a height greater than 3 mean free paths will travel more than 6 mean free paths from the source plane to reach the coupling surface and, therefore, would not make a significant contribution to tissue dose.

## **3.2.3 Monoenergetic organ dose from photons in soil**

Tissue dose rate coefficients in each phantom were computed using the photon fluence of the source write file. As described earlier, the uncollided and scattered photons from isotropic plane sources of radiation were recorded as a function of energy, angle and height above the air-ground interface. These recorded photons then serve as the source on the coupling cylinder surrounding the phantom for the tissue dose rate calculation. This was accomplished using the surface source read capabilities of MCNP6 in conjunction with the surface source write data previously described. Tissue dose rate coefficients were calculated for each combination of 13 source energies, 6 source plane depths and 6 phantoms.

### 3.2.3.1 Irradiation geometry

Phantoms were placed individually inside the coupling cylinder with the volume between the cylinder and phantom filled with air. The distance between the cylinder base and the phantom was less than 0.1 cm.

### 3.2.3.2 Calculating absorbed dose

Absorbed doses to tissues were computed using the kerma approximation. Tissue doses were calculated as the product of photon fluence and tissue-specific kerma coefficients. This photon fluence was calculated using the track-length estimator in MCNP6 (\*F6:P tally).<sup>7</sup> Absorbed dose rate coefficients for active marrow and bone surface were based on a track-length estimate of skeletal fluence, combined with ICRP skeletal fluence-to-dose response functions (Eckerman 1984; Eckerman and Cristy, 1984). Sufficient photon histories were generated to yield an MCNP6 statistical error in muscle less than 1 percent for all source energies. Effective dose rate coefficients are presented in this report. Organ equivalent dose rate coefficients are available online.<sup>8</sup>

### 3.2.3.3 Variance reduction

Variance reduction (exponential transform path-length stretching) was employed in all materials for several low-energy photon cases. This was done to achieve statistical convergence on the deep, heavily shielded organs, such as the kidneys. Exponential transform path-length stretching as implemented in MCNP6 often was used for 30, 20, 15 and 10 keV photon energies. This Monte Carlo approach improves the performance of radiation transport calculations in highly shielded targets by simultaneously lengthening the calculational path-length and reducing the transported photon's statistical weight to allow a larger population of photon tracks to enter the target volume.

## 3.2.4 Dose rate coefficients for volumetric sources

Dose rate coefficients for volumetric sources were obtained by first interpolating the dose rate coefficients for the six planes over soil depth and then integrating over the source volume. This allowed determination of dose rate coefficients corresponding to thicknesses of 1, 5 and 15 cm, and for an effectively infinite source (4 mean free paths thick). For volumetric sources, the source concentration was assumed to be uniform over the entire volume.

If  $\hat{h}_{T,P}(E, \tau) d\tau$  is the dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^2$ ) for tissue  $T$  for a plane isotropic source  $P$  at energy  $E$  and depth  $\tau$  (mean free paths), then the dose rate coefficient for a volumetric source extending from the air-ground interface to depth  $L$  (cm) is

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<sup>7</sup> The MCNP kerma tally (\*F6:P) estimates the energy deposited by photons in tissue by considering the average photon track length, the photon energy, the tissue elemental composition and the tissue density.

<sup>8</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

$$\hat{h}_{T,L}(E) = \frac{1}{\mu} \int_0^{\mu L} \hat{h}_{T,P}(E, \tau) d\tau \quad (2)$$

where  $\mu$  is the linear attenuation coefficient (including coherent scattering) for soil at energy  $E$  (Berger et al., 1998). The dose rate coefficients for each organ at the six source depths were interpolated on a fine grid using a log-linear Hermite cubic spline (Fritsch and Carlson, 1980). The interpolated data then were numerically integrated.

### 3.2.5 Dose rate coefficients for electrons in soil

#### 3.2.5.1 Electron skin dose

The contribution of electrons to dose to tissues other than skin need not be considered due to the short range in tissue of electrons emitted by radionuclides. However, bremsstrahlung produced by electrons slowing down in environmental media is sufficiently penetrating to contribute to the dose to underlying tissues. Bremsstrahlung production is discussed in Appendix C. The DOSFACTER code developed by Kocher (DOE, 1988) was used to calculate skin dose rate coefficients for a series of monoenergetic electron emissions that were convoluted to the spectra of the various radionuclides, using the energy and intensity of beta and electron emissions of radionuclides tabulated in ICRP Publication 107 (2008). The discussion of the computational details, presented below, is taken from Kocher (DOE, 1988).

In the calculations performed by DOSFACTER, the transport of energy through air and into the body was reduced to consideration of an equivalent thickness in air alone. Thus, for a height  $z$  of the body surface above the ground and depth  $x$  into the body, the effective height  $z'$  in air above the ground is given by

$$z' = z + 1.14 \frac{\rho_t}{\rho_a} x \quad (3)$$

where  $\rho_t$  and  $\rho_a$  are the densities of tissue and air, respectively, and the factor 1.14 approximates the ratio of mass stopping powers in tissue and air for any electron energy (NAS–NRC, 1964).

The electron dose rate coefficient for skin at the height  $z'$  in air above ground defined by Eq. (3) then is given by

$$e_{skin}(E) = \frac{1}{2} ER^a \int \Phi^a(r, E) d\sigma \quad (4)$$

where the integral is over the ground surface,  $R^a$  is the ratio of mass stopping powers in tissue and air evaluated at the emitted energy  $E$ ,  $\sigma$  denotes the ground surface,  $\Phi^a$  is the specific absorbed fraction for electrons in air, and  $r$  is the distance from any point on the ground surface to the receptor located at height  $z'$  in air above the ground. The factor  $\frac{1}{2}$  accounts for the impenetrability of the body by electrons, so that any point on the body surface is irradiated by only half of the source region.



The DOSFACTER code evaluates Eq. (4) numerically using the electron scaled point kernel,  $F$ , developed by Berger (1974). The scaled point kernel is defined in terms of the specific absorbed fraction  $\Phi$  as

$$F(r/r_o, E) d(r/r_o) = 4\pi\rho\Phi(r, E) r^2 dr \quad (5)$$

where  $r_o$  is the electron range for energy  $E$  in a medium of density  $\rho$ . Thus, the scaling of the specific absorbed fraction is accomplished by expressing distances in units of electron range.

Scaled point kernels in air,  $F^a$ , are obtained from those for water,  $F^w$ , given by Berger (1974) as

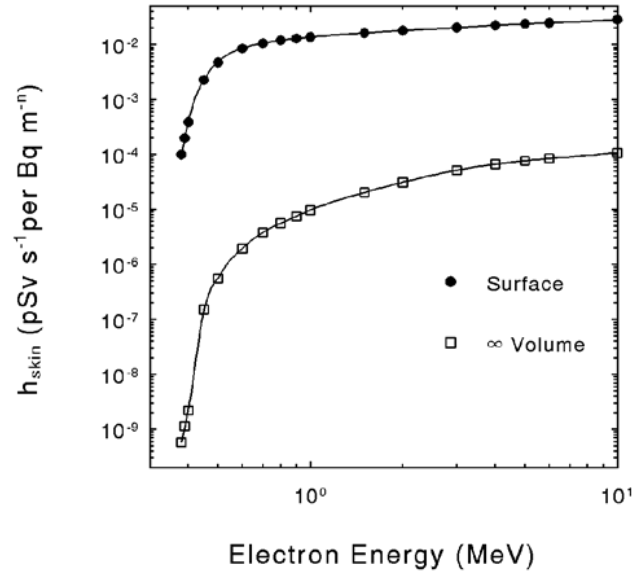
$$F^a(r/r_o^a, E) = \alpha' F^w(\alpha' r/r_o^a, E) \quad (6)$$

where  $\alpha'$  is a scaling parameter that depends on the energy  $E$ . By expressing Eq. (4) in terms of the scaled point kernel in air, the electron dose rate coefficient for skin is

$$e_{skin}(E) = \frac{1}{4r_o^a} \frac{E}{\rho_a} R^a \int_{z'/r_o^a}^{\infty} \frac{1}{u} F^a(u, E) du \quad (7)$$

where  $u$  is the scaled distance  $r/r_o^a$ .

The above formulations are not directly applicable to the situation where the source is uniformly distributed within the soil. To approximate this situation, an additional term was added to Eq. (3) to convert the depth of a planar source into its equivalent air thickness. Because of the limited range of electrons in the soil, the source may be regarded as infinitely thick. Calculations were performed for a series of planar sources, ranging from the surface to a depth beyond the range of the electrons. The result for a source distributed in the volume then was approximated by superposition of the results for the planar sources. The resulting coefficients for monoenergetic electron emitters on the surface and in the volume are seen in Figure 3-4.



**Figure 3-4. Electron skin dose rate coefficients for exposure to contaminated soil.**

### 3.2.5.2 Electron dose from bremsstrahlung

When electrons slow down in a medium, a small fraction of their initial kinetic energy is converted into energy in the form of photons called bremsstrahlung. Some radionuclides produce bremsstrahlung that is sufficiently penetrating to be of potential importance in the estimation of external dose. In this work, the contribution to dose rate coefficients from bremsstrahlung has been evaluated for all exposure modes. Bremsstrahlung energy is distributed from zero up to the initial electron energy. Although the bremsstrahlung yield is small (only about 0.2% for a 1.0 MeV electron in air) for pure beta emitters, it can be the only source of radiation sufficiently penetrating to irradiate deeper-lying radiosensitive tissues. Appendix C discusses the manner in which the bremsstrahlung spectra were evaluated in this report.

The energy spectra of emitted radiations are either discrete, as in the case of gamma emissions, or continuous, as in the case of beta particles and bremsstrahlung. The beta spectra from the ICRP Publication 107 (2008) dosimetric data file are used to evaluate the contribution of the beta particles to the skin dose and to determine the yield of bremsstrahlung.

### 3.3 Submersion in contaminated air

#### 3.3.1 Summary of air calculation

Air submersion dose rate coefficients are calculated assuming an individual is exposed to uniformly contaminated air with a monoenergetic photon emitter. The approach involves dividing the problem into two steps:

1. Calculation of photons incident on the coupling surface similar to the soil calculation.
2. Calculation of tissue equivalent dose rate coefficients due to photons transported from the coupling cylinder into the phantom. The effective dose rate coefficient for each reference person is derived using the tissue weighting factors recommended in ICRP Publication 103 (2007) (Table 3-1).

#### 3.3.2 Environmental transport of photons in air

##### 3.3.2.1 Description of scenario

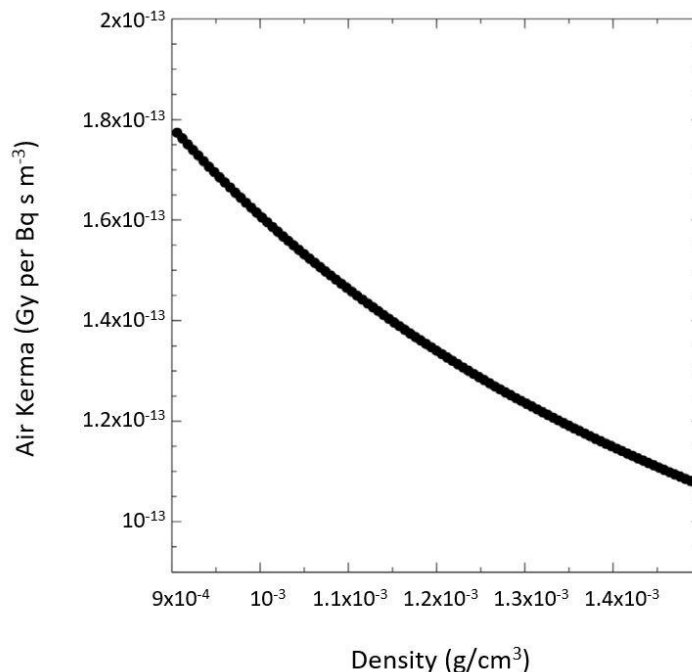
The air submersion exposure geometry involves an individual standing in a large volume of uniformly contaminated air. It is assumed that the individual is standing on an uncontaminated flat surface of infinite area. The source of radiation is a semi-infinite cloud containing a uniformly distributed monoenergetic photon emitter of strength ( $1 \text{ Bq m}^{-3}$ ) surrounding a human phantom standing on the air-ground interface.

##### 3.3.2.2 Air composition and density

The air composition given in Table 3-3 is for conditions of 40 percent relative humidity, a pressure of 760 mmHg, a temperature of 20 °C, and a density of  $1.2 \text{ kg m}^{-3}$ . The dose rate coefficients for submersion can be scaled to account for a different air density. Air kerma as a function of air density is illustrated for 1 MeV photons in Figure 3-5. The functional relation between air kerma and air density is virtually independent of photon energy.

**Table 3-3. Air composition.**

Element	Mass Fraction
H	0.00064
C	0.00014
N	0.75086
O	0.23555
Ar	0.01281
Total	1.00000

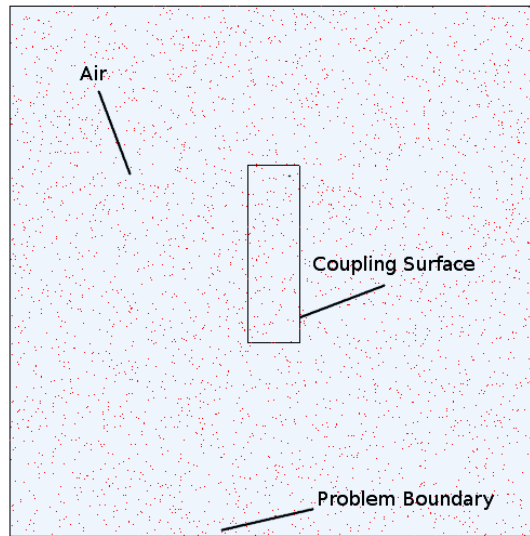


**Figure 3-5. Kerma as a function of air density for 1 MeV photons.**

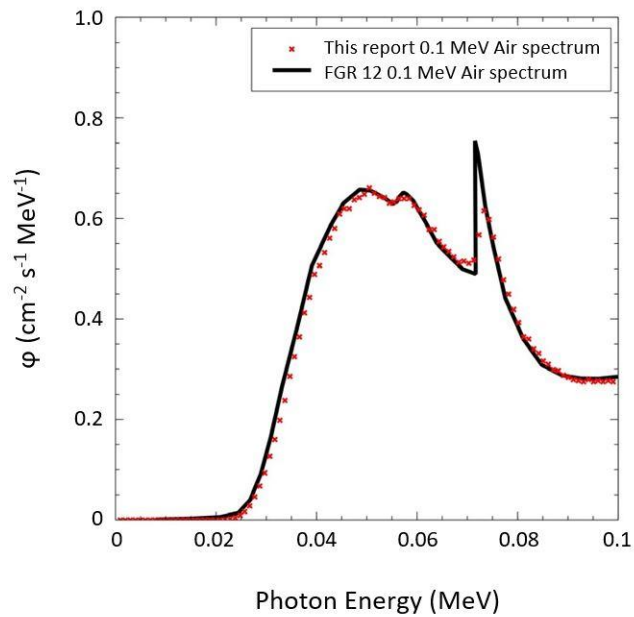
### 3.3.2.3 Computational geometry

The dose near the air-ground interface from a semi-infinite cloud source has been taken to be one-half that due to an infinite cloud source, following the practice of Dillman (1974), Poston and Snyder (1974), and Kocher (1981, 1983). Ryman et al. (1981) showed this to be a good approximation for air dose (within 20%) at energies of 20 keV or greater. At energies less than 10 keV (the lowest energy considered here), the dose at the interface should still be one-half that due to an infinite source, but there will be an increase in dose with increasing height along the phantom. The mean free path of these photons is so short that the upper portions of the phantom are effectively exposed to an infinite source. Between 10 and 20 keV there will be some increase in dose with increasing height, but this has not been considered here because the increase over the dimensions of the body should be small.

The uniformly distributed monoenergetic photon emitter in an infinite volume is simulated using a finite geometry in the following manner. Consider a cube with side length 10 m containing an emitter of strength 1 Bq m<sup>-3</sup>. An infinite volume is represented by setting reflective boundary conditions (Chilton et al., 1984) on the six walls of the cube. Photons contacting the wall do not pass through, but are reflected so that the angle of incidence is equal to the angle of reflection. No simulated photons escape; rather, they are down-scattered and absorbed within the air of the cube. Photon energy is not affected by wall reflections. The cylindrical coupling surface (surface source write feature of MCNP6) is placed in the middle of the cube and records the position, angle and energy of incident photons as discussed in the soil section. The geometry is illustrated in Figure 3-6. This method produces energy-dependent fluence nearly identical to the deterministic method used in Federal Guidance Report No. 12 (EPA, 1993), as illustrated in Figure 3-7. Calculations were performed for 13 monoenergetic sources, ranging from 0.01 to 5.0 MeV.



**Figure 3-6. Geometry used for generating the air submersion coupling surface.**  
*The dots denote source particle generated randomly within the cube.*



**Figure 3-7. Comparison of energy spectra of 0.1 MeV scattered photons for a contaminated air source as estimated here and in Federal Guidance Report No. 12.**  
*An air concentration of 1 Bq m<sup>-3</sup> is assumed.*

### 3.3.3 Submersion monoenergetic tissue dose rate coefficients from photons

As for the ground plane sources, tissue dose rate coefficients in each phantom are computed using the photon current of the source write file. Tissue doses were calculated as the product of a track-length fluence estimator (MCNP6 \*F6:P tally) and tissue-specific kerma coefficients. This product then is divided by 2 to account for the semi-infinite geometry. Dose rate coefficients for active marrow and bone surface were based on a track-length fluence estimator combined with ICRP skeletal fluence-to-dose response functions (Cristy and Eckerman, 1987). Calculations were iterated until the MCNP6 statistical error in muscle was less than 1 percent. Effective dose rate coefficients are tabulated in this report. Effective dose rate coefficients and equivalent dose rate coefficients for individual organs are provided electronically.<sup>9</sup>

### 3.3.4 Organ dose from electrons in air

For an exposed individual standing at the boundary of a semi-infinite, uniformly contaminated atmospheric cloud, we assume that the electron continuous-slowning-down range in air is 1 m. Therefore, the source region is assumed to be effectively infinite in extent, and the electron dose rate coefficient at the depth of interest in tissue (70  $\mu\text{m}$ ) is given in terms of the geometrical reduction factor  $G_{skin}$  for immersion in contaminated water, which, according to Berger (1974), is

$$e_{skin}(E) = \frac{E}{\rho_a} \frac{R^a}{\alpha} q(x, E) G_{skin}(E) \quad (8)$$

where  $\rho_a$  is the density of air,  $R^a/\alpha$  is the ratio of energy absorption in tissue to that in air at the emitted energy  $E$ ,  $q$  is the leakage correction factor, and  $G_{skin}$  is the geometrical reduction factor. Section 3.5.3 contains a more detailed description of  $q$  and  $G_{skin}$ .

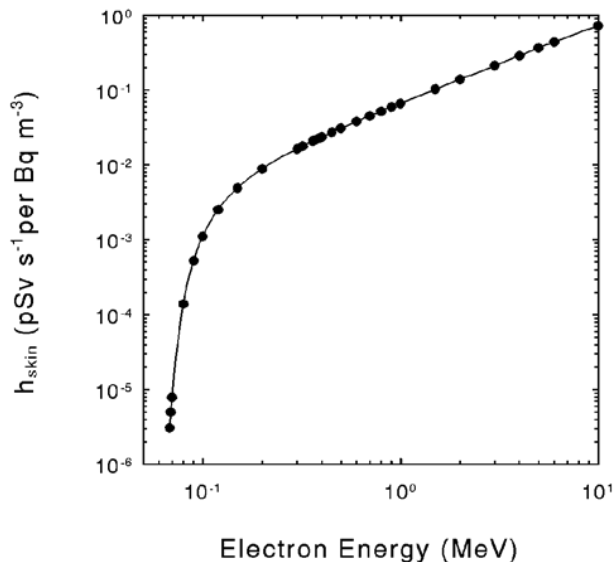
The energy-absorption rate  $R^a/\alpha$  consists of two factors. The first factor is the ratio of the mass stopping powers in tissue and air (NAS–NRC, 1964),

$$R^a = \left( \frac{1}{\rho} \frac{dE}{dx} \right)_t \div \left( \frac{1}{\rho} \frac{dE}{dx} \right)_a \quad (9)$$

which is evaluated at the emitted energy  $E$ . The second factor,  $\alpha$ , also depends on the emitted energy and accounts for the variations in mass stopping powers in tissue and air over the continuous energy spectrum of electrons incident on the body for a monoenergetic source of energy  $E$  in an infinite, uniformly contaminated atmospheric cloud (Berger, 1974). Dose rate coefficients for skin calculated using the DOSFACTER code for air submersion are shown in Figure 3-8.

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<sup>9</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>



**Figure 3-8. Electron skin dose rate coefficient for submersion in contaminated air.**

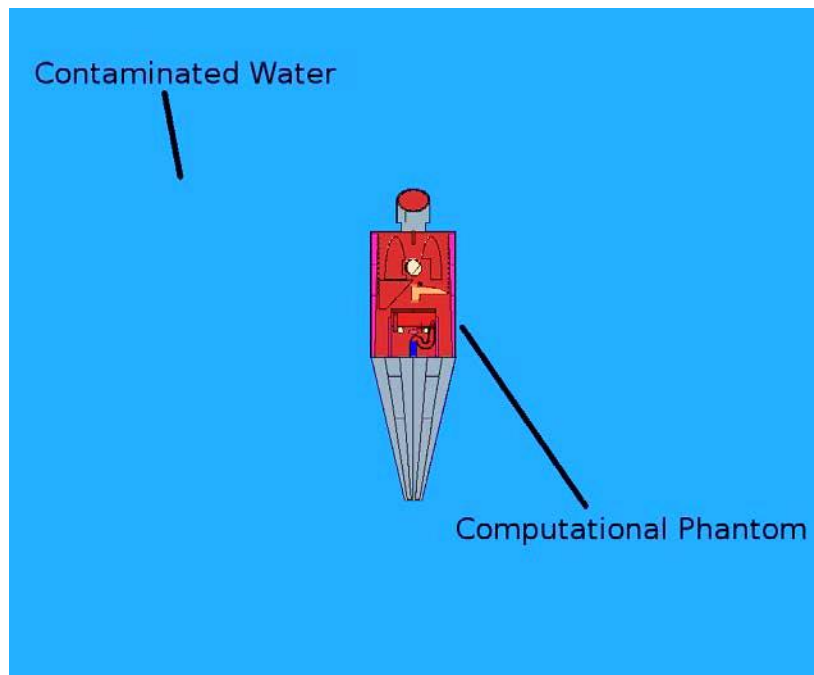
### 3.3.4.1 Electron dose from bremsstrahlung

In this report, the contribution to dose rate coefficients from bremsstrahlung has been evaluated for electrons slowing down in air. Although the bremsstrahlung yield is small (about 0.2% for a 1.0 MeV electron) for pure beta emitters, it can be the only source of radiations sufficiently penetrating to irradiate deeper-lying radiosensitive tissues. Appendix C discusses the manner in which the bremsstrahlung spectra were evaluated.

## 3.4 Immersion in contaminated water

### 3.4.1 Summary of the method for water immersion

Tissue dose rate coefficients for water immersion are calculated under the assumption that an individual is completely immersed in an infinite volume of uniformly contaminated water. In contrast to air submersion, with Monte Carlo methods it is possible to simulate an effectively infinite pool using relatively small dimensions. This is because the linear attenuation coefficient of water is much greater than that of air. For derivation of dose rate coefficients for monoenergetic photons for the case of immersion in contaminated water, each phantom is placed in a relatively small container of water, source photons are generated, and organ doses are derived. This is in contrast to the soil and air methods where photon dose rates are derived by a two-step process. The radionuclide-specific contribution of electrons to skin dose is derived using a point kernel method, as in the case of air submersion. The radionuclide-specific contribution of bremsstrahlung photons from the electron source is derived by folding the monoenergetic photon dose rate coefficients with the bremsstrahlung spectrum. Effective dose rate coefficients for the reference persons are derived using the tissue weighting factors recommended in ICRP Publication 103 (2007) (Table 3-1).



**Figure 3-9. Computational geometry used for water immersion for estimating the adult organ dose rate coefficients.**

### **3.4.2 Monoenergetic organ dose from photons in water**

The source for the water immersion calculations is an infinite pool of water containing a uniformly distributed monoenergetic photon emitter of strength  $1 \text{ Bq m}^{-3}$ . A phantom is assumed to be completely immersed in the pool, as illustrated in Figure 3-9. The water density is  $1.0 \times 10^3 \text{ kg m}^{-3}$  and the composition by mass fraction is 0.112 H and 0.888 O, representing pure water.

The computational phantoms are placed in a cube with 400 cm sides. This distance corresponds to 11 mean free paths for a 5 MeV photon. Monoenergetic source photons are generated uniformly in the contaminated water. Tissue dose rate coefficients are derived using the track-length fluence estimator as implemented in the soil and water calculation.

Although this method works for higher energies, it becomes inefficient below about 30 keV. For these energies, the theory of reciprocity is applied (Hiller et al., 2016). All tissues that were considered as target in the forward run were modeled as sources and the water surrounding the body is now the target. This is possible for the case of the phantom immersed in water, where the energy absorption coefficients of all materials (water and tissue) are approximately similar.



### 3.4.3 Organ dose from electrons in water

For immersion in an infinite, uniformly contaminated water medium, the skin dose rate coefficient at a depth of 70  $\mu\text{m}$  for a unit concentration of a monoenergetic electron emitter of energy  $E$  can be expressed as

$$e_{skin}(E) = \frac{E}{\rho_w} R^W(E)q(E)G_{skin}(E) \quad (10)$$

In this equation,  $\rho_w$  is the density of water,  $R^W$  is the ratio of the energy absorption in tissue to energy absorption in water at energy  $E$ ,  $q$  is a leakage correction factor, and  $G_{skin}$  is a geometrical reduction factor defined as the ratio of the absorbed dose at the depth of interest in a semi-infinite tissue medium to the absorbed dose in the contaminated water for the energy  $E$ . The energy-absorption ratio  $R^W$  is obtained from the mass stopping powers,  $\frac{1}{\rho} \frac{dE}{dx}$  in tissue ( $T$ ) and water ( $W$ ) as

$$R^W = \left( \frac{1}{\rho} \frac{dE}{dx} \right)_T \div \left( \frac{1}{\rho} \frac{dE}{dx} \right)_W \quad (11)$$

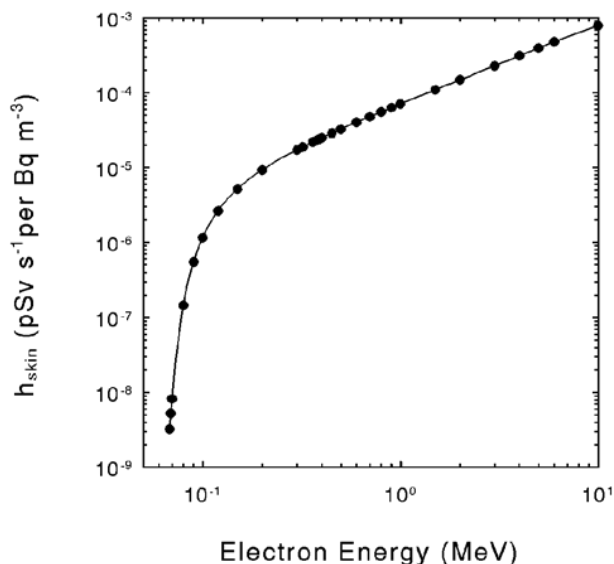
Because the stopping powers in tissue and water are nearly independent of energy, the ratio in Eq. (11) is evaluated at the emitted energy. The mass stopping powers in tissue and water used in the DOSFACTER code were reported in National Academy of Sciences–National Research Council Publication 1133 (NAS–NRC, 1964).

The geometrical reduction factor  $G_{skin}$  relates the dose to skin (at a depth of 70  $\mu\text{m}$ ) to the dose in water. This factor is obtained from electron-specific absorbed fractions in water calculated using Monte Carlo methods, as described by Berger (1974). In calculations of the geometrical reduction factors, it is assumed that a half-space occupied by water (as a surrogate for tissue) is in contact with a uniformly contaminated half-space containing water (the source). Thus,  $G_{skin}$  has a value of one-half at the interface (i.e., the body surface) and decreases with increasing depth into the body. The geometrical reduction factors used in the present calculations were derived by Berger (1974).

The leakage correction factor  $q$  accounts for the finite lateral extent of the body surface and is given by the empirical formula (Berger, 1974):

$$q(x, E) = 1 - q_1(E)q_2(x/a) \quad (12)$$

where  $x$  is the depth of interest, here taken as 70  $\mu\text{m}$ , and the parameter  $a$  depends only on the emitted energy  $E$ . Values of  $q_1$ ,  $a$  and  $q_2$  used in the DOSFACTER code were those given by Berger (1974). The DOSFACTER code was used to tabulate the dose rate coefficient for the skin,  $e_{skin}$  (dose per unit volume source), in water. The results are shown graphically in Figure 3-10.



**Figure 3-10. Electron skin dose rate coefficient for immersion in contaminated water.**

### 3.4.3.1 Electron dose from bremsstrahlung

In this report, the contribution to dose rate coefficients from bremsstrahlung has been evaluated for water. Although the bremsstrahlung yield is small for pure beta emitters, it can be the only source of radiations sufficiently penetrating to irradiate deeper-lying radiosensitive tissues. Appendix C discusses the manner in which the bremsstrahlung spectra were evaluated in this report.

## 3.5 Tables of monoenergetic dose rate coefficients

Equivalent dose rate coefficients for monoenergetic photons irradiating each age-specific reference person are available online at <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>.

## CHAPTER 4. RADIONUCLIDE DOSE RATE COEFFICIENTS

### 4.1 Dose rate coefficients for radionuclides

As described in earlier sections, the first step in the development of external dose rate coefficients for radionuclides is to derive dose rates to tissues for monoenergetic photon sources at 13 energies, ranging from 0.01 to 5.0 MeV. The next step is to derive radionuclide-specific dose rate coefficients by using the results for monoenergetic sources to construct the dose rate coefficients for the spectrum of energies for individual radionuclides.

For nearly all radionuclides addressed in this report, external dose is due entirely to gamma and electron emissions. For a few radionuclides, spontaneous fission also may produce penetrating radiations of potential importance. Prompt and delayed emissions for photons and  $\beta^+$  and  $\beta^-$  particles following spontaneous fission are included in the decay data tabulations of ICRP Publication 107 (2008) and thus are included in the calculations of dose rate coefficients in this report. The contribution from neutrons accompanying spontaneous fission is not included in the dose rate coefficients tabulated in this report because detailed information has not been assembled on the radiation field resulting from distributed sources of neutrons in the environment. Remaining fission products also are not considered in the dose rate coefficient calculation.

The dose rate coefficients provided in this report are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Users should take caution when applying dose rate coefficients, particularly when considering radionuclides for which decay chain progeny are likely to have a greater contribution to dose than the parent (e.g.,  $^{90}\text{Sr}$ ,  $^{137}\text{Cs}$  and  $^{222}\text{Rn}$ ). For more information on application of the provided dose rate coefficients, see Chapter 5: Application Considerations. For each radionuclide, radioactive decay products, if formed, are identified in Appendix A: Nuclear Decay Data.

To facilitate application of the dose coefficients, including conversion to other units, the coefficients are tabulated to three significant figures. No indication of the level of uncertainty, a term for describing the lack of precision and accuracy of a given estimate, is intended or should be inferred from this practice. A calculated dose should be rounded appropriately. For a comprehensive discussion of uncertainties associated with estimates of dose from external exposures, see NCRP Report No. 158 (2007).

#### 4.1.1 The ICRP Publication 107 Nuclear Decay Database

The energies and intensities of the radiations emitted in spontaneous nuclear transformations of radionuclides are provided in ICRP Publication 107 (2008), prepared by the Japan Atomic Energy Research Institute (JAERI) and ORNL. The nuclear decay data of Publication 107 are based on the Evaluated Nuclear Structure Data Files (ENSDF) of the U.S. Department of Energy's Nuclear Data Project as processed with an updated version of the EDISTR code (Dillman, 1980). The electronic data files accompanying ICRP Publication 107 (2008) include not only the full tabulations of the energies (average or unique) and intensities of the radiations, but also the beta spectra. The dose rate coefficients presented here for all environmental media (air, water and soil) are based on these data.

#### 4.1.1.1 Derivation of radionuclide-specific dose rate coefficients based on monoenergetic data and radionuclide spectra

The equivalent dose rate coefficient  $h_T^S$  for tissue  $T$  and exposure mode  $S$  can be expressed as

$$h_T^S = \sum_{j=e,\gamma} \left[ \sum_i y_j(E_i) \hat{h}_{T,j}^S(E_i) + \int_0^\infty y_j(E) \hat{h}_{T,j}^S(E) dE \right] \quad (13)$$

where  $\hat{h}_{T,j}^S(E_i)$  is the equivalent dose rate coefficient for tissue  $T$  irradiated in exposure mode  $S$  by monoenergetic radiation of type  $j$  and energy  $E_i$ ,  $y_j(E_i)$  is the yield of discrete radiations of type  $j$  and energy  $E_i$ , and  $y_j(E)$  denotes the yield of continuous radiations per nuclear transformation with energy between  $E$  and  $E + dE$ . The outer summation is over all electron and photon emissions. Each radiation potentially has two components: (1) the discrete energy emissions and (2) the continuous emissions. The contribution of the radiations to the dose in tissue or organ  $T$  is defined by the quantity  $\hat{h}_{T,j}^S(E_i)$ , which is tabulated as a function of energy for tissue and organ  $T$  for each exposure mode. In the case of the discrete emissions, a value appropriate to the energy of the discrete radiation being evaluated is obtained by interpolation. For photons (including bremsstrahlung), these data are tabulated for 29 target tissues of the body at each of 13 monoenergetic emissions; for electrons, only the skin is irradiated. Effective dose rate coefficients for reference persons, derived using the tissue weighting factors recommended in ICRP Publication 103 (2007) (Table 3-1), are presented for 1,252 radionuclides in Tables 4-1 through 4-7. Effective dose rate coefficients and equivalent dose rate coefficients for individual tissues are provided electronically.<sup>10</sup>

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<sup>10</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-1. Reference person effective dose rate coefficients for ground surface.**

**Explanation of entries**

For each radionuclide, values for the age-dependent effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. The coefficients are for a soil density of  $1.6 \times 10^3 \text{ kg m}^{-3}$ . The values in Table 4-1 account for ground roughness by assuming a 3 mm ground plane depth (see section 3.3.2.4 for explanation). Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>11</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^2$ ), that is, the effective dose rate per planar activity concentration of the radionuclide

$w_T$ : The tissue weighting factor

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^2$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-1 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from SI units ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^2$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{ y}^{-1} \text{ cm}^2$ ), multiply table entries by  $1.168 \times 10^{21}$ .

The coefficients are applicable for any soil density.

<sup>11</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-1. Reference person effective dose rate coefficients for ground surface.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	8.52E-22	7.94E-22	7.89E-22	7.31E-22	6.79E-22	6.65E-22
<b>Beryllium</b>						
Be-7	4.17E-17	3.93E-17	3.62E-17	3.49E-17	3.30E-17	3.21E-17
Be-10	1.21E-17	1.15E-17	1.14E-17	1.08E-17	1.03E-17	1.01E-17
<b>Carbon</b>						
C-10	1.59E-15	1.49E-15	1.42E-15	1.35E-15	1.28E-15	1.25E-15
C-11	8.97E-16	8.47E-16	7.87E-16	7.55E-16	7.18E-16	7.00E-16
C-14	7.83E-19	7.29E-19	7.25E-19	6.72E-19	6.24E-19	6.12E-19
<b>Nitrogen</b>						
N-13	9.25E-16	8.74E-16	8.14E-16	7.82E-16	7.44E-16	7.26E-16
N-16	2.97E-15	2.85E-15	2.79E-15	2.75E-15	2.63E-15	2.61E-15
<b>Oxygen</b>						
O-14	2.62E-15	2.46E-15	2.32E-15	2.27E-15	2.15E-15	2.11E-15
O-15	9.79E-16	9.27E-16	8.67E-16	8.34E-16	7.95E-16	7.77E-16
O-19	1.01E-15	9.53E-16	9.24E-16	8.91E-16	8.30E-16	8.18E-16
<b>Fluorine</b>						
F-17	9.79E-16	9.27E-16	8.68E-16	8.34E-16	7.96E-16	7.77E-16
F-18	8.39E-16	7.90E-16	7.32E-16	7.02E-16	6.66E-16	6.49E-16
<b>Neon</b>						
Ne-19	1.02E-15	9.66E-16	9.06E-16	8.72E-16	8.32E-16	8.14E-16
Ne-24	5.88E-16	5.59E-16	5.29E-16	5.10E-16	4.86E-16	4.76E-16
<b>Sodium</b>						
Na-22	1.77E-15	1.65E-15	1.58E-15	1.50E-15	1.41E-15	1.38E-15
Na-24	3.02E-15	2.83E-15	2.71E-15	2.65E-15	2.49E-15	2.46E-15
<b>Magnesium</b>						
Mg-27	8.37E-16	7.86E-16	7.79E-16	7.27E-16	6.83E-16	6.70E-16
Mg-28	1.07E-15	1.00E-15	9.72E-16	9.19E-16	8.55E-16	8.38E-16
<b>Aluminum</b>						
Al-26	2.14E-15	2.01E-15	1.89E-15	1.84E-15	1.74E-15	1.70E-15
Al-28	1.53E-15	1.44E-15	1.38E-15	1.35E-15	1.27E-15	1.25E-15
Al-29	1.23E-15	1.15E-15	1.12E-15	1.07E-15	1.01E-15	9.92E-16
<b>Silicon</b>						
Si-31	9.80E-17	9.60E-17	9.57E-17	9.38E-17	9.21E-17	9.16E-17
Si-32	1.38E-18	1.29E-18	1.28E-18	1.19E-18	1.10E-18	1.08E-18
<b>Phosphorus</b>						
P-30	1.09E-15	1.03E-15	9.74E-16	9.38E-16	8.96E-16	8.77E-16
P-32	1.18E-16	1.15E-16	1.15E-16	1.13E-16	1.11E-16	1.10E-16
P-33	1.64E-18	1.53E-18	1.52E-18	1.41E-18	1.31E-18	1.28E-18
<b>Sulfur</b>						
S-35	7.87E-19	7.33E-19	7.29E-19	6.76E-19	6.27E-19	6.15E-19
S-37	2.07E-15	1.96E-15	1.86E-15	1.84E-15	1.75E-15	1.72E-15
S-38	1.31E-15	1.23E-15	1.17E-15	1.14E-15	1.08E-15	1.06E-15
<b>Chlorine</b>						
Cl-34	1.17E-15	1.11E-15	1.05E-15	1.01E-15	9.67E-16	9.47E-16
Cl-34m	1.65E-15	1.55E-15	1.46E-15	1.43E-15	1.35E-15	1.32E-15

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	2.10E-17	2.03E-17	2.02E-17	1.95E-17	1.89E-17	1.87E-17
Cl-38	1.29E-15	1.22E-15	1.17E-15	1.14E-15	1.08E-15	1.06E-15
Cl-39	1.26E-15	1.18E-15	1.15E-15	1.10E-15	1.03E-15	1.01E-15
Cl-40	3.10E-15	2.92E-15	2.80E-15	2.73E-15	2.58E-15	2.54E-15
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	9.80E-18	9.28E-18	9.23E-18	8.73E-18	8.27E-18	8.15E-18
Ar-41	1.06E-15	9.94E-16	9.73E-16	9.23E-16	8.63E-16	8.48E-16
Ar-42	1.20E-17	1.14E-17	1.14E-17	1.08E-17	1.03E-17	1.02E-17
Ar-43	1.38E-15	1.30E-15	1.27E-15	1.21E-15	1.14E-15	1.12E-15
Ar-44	1.54E-15	1.44E-15	1.37E-15	1.34E-15	1.25E-15	1.23E-15
<b>Potassium</b>						
K-38	2.61E-15	2.46E-15	2.32E-15	2.26E-15	2.15E-15	2.11E-15
K-40	2.06E-16	1.96E-16	1.92E-16	1.86E-16	1.78E-16	1.76E-16
K-42	4.44E-16	4.23E-16	4.15E-16	4.02E-16	3.85E-16	3.80E-16
K-43	8.28E-16	7.78E-16	7.32E-16	7.01E-16	6.54E-16	6.39E-16
K-44	1.98E-15	1.87E-15	1.81E-15	1.74E-15	1.64E-15	1.61E-15
K-45	1.54E-15	1.45E-15	1.38E-15	1.34E-15	1.26E-15	1.24E-15
K-46	2.39E-15	2.26E-15	2.19E-15	2.11E-15	1.99E-15	1.97E-15
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	1.68E-18	1.56E-18	1.55E-18	1.44E-18	1.34E-18	1.31E-18
Ca-47	8.59E-16	8.03E-16	7.84E-16	7.43E-16	6.94E-16	6.81E-16
Ca-49	2.23E-15	2.11E-15	2.01E-15	1.99E-15	1.89E-15	1.86E-15
<b>Scandium</b>						
Sc-42m	3.54E-15	3.32E-15	3.18E-15	3.04E-15	2.86E-15	2.81E-15
Sc-43	8.81E-16	8.32E-16	7.74E-16	7.45E-16	7.06E-16	6.89E-16
Sc-44	1.82E-15	1.71E-15	1.65E-15	1.56E-15	1.47E-15	1.44E-15
Sc-44m	2.22E-16	2.06E-16	1.95E-16	1.91E-16	1.65E-16	1.62E-16
Sc-46	1.60E-15	1.49E-15	1.48E-15	1.37E-15	1.28E-15	1.25E-15
Sc-47	8.96E-17	8.80E-17	7.63E-17	7.46E-17	6.70E-17	6.61E-17
Sc-48	2.65E-15	2.47E-15	2.44E-15	2.28E-15	2.12E-15	2.08E-15
Sc-49	1.41E-16	1.38E-16	1.38E-16	1.35E-16	1.32E-16	1.32E-16
Sc-50	2.76E-15	2.59E-15	2.50E-15	2.39E-15	2.25E-15	2.21E-15
<b>Titanium</b>						
Ti-44	1.04E-16	9.84E-17	8.61E-17	8.61E-17	7.47E-17	7.19E-17
Ti-45	7.76E-16	7.33E-16	6.82E-16	6.55E-16	6.23E-16	6.08E-16
Ti-51	4.51E-16	4.27E-16	4.11E-16	4.01E-16	3.69E-16	3.63E-16
Ti-52	2.23E-16	2.14E-16	2.04E-16	1.97E-16	1.90E-16	1.87E-16
<b>Vanadium</b>						
V-47	9.70E-16	9.19E-16	8.60E-16	8.28E-16	7.90E-16	7.72E-16
V-48	2.32E-15	2.17E-15	2.11E-15	1.99E-15	1.86E-15	1.82E-15
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	1.09E-15	1.02E-15	9.78E-16	9.39E-16	8.80E-16	8.64E-16
V-52	1.29E-15	1.21E-15	1.18E-15	1.13E-15	1.06E-15	1.05E-15
V-53	9.96E-16	9.36E-16	9.29E-16	8.71E-16	8.17E-16	8.04E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	3.52E-16	3.23E-16	3.03E-16	2.94E-16	2.63E-16	2.56E-16
Cr-49	9.73E-16	9.19E-16	8.56E-16	8.23E-16	7.82E-16	7.63E-16
Cr-51	2.60E-17	2.43E-17	2.27E-17	2.23E-17	1.96E-17	1.92E-17
Cr-55	1.87E-16	1.83E-16	1.82E-16	1.78E-16	1.74E-16	1.73E-16
Cr-56	1.60E-16	1.51E-16	1.46E-16	1.41E-16	1.35E-16	1.33E-16
<b>Manganese</b>						
Mn-50m	3.94E-15	3.70E-15	3.57E-15	3.39E-15	3.18E-15	3.12E-15
Mn-51	9.95E-16	9.43E-16	8.85E-16	8.51E-16	8.13E-16	7.94E-16
Mn-52	2.74E-15	2.56E-15	2.49E-15	2.35E-15	2.20E-15	2.15E-15
Mn-52m	2.11E-15	1.98E-15	1.89E-15	1.81E-15	1.71E-15	1.68E-15
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	6.77E-16	6.32E-16	6.23E-16	5.76E-16	5.38E-16	5.26E-16
Mn-56	1.43E-15	1.35E-15	1.31E-15	1.25E-15	1.17E-15	1.15E-15
Mn-57	2.61E-16	2.52E-16	2.47E-16	2.40E-16	2.32E-16	2.30E-16
Mn-58m	2.14E-15	2.01E-15	1.96E-15	1.86E-15	1.75E-15	1.72E-15
<b>Iron</b>						
Fe-52	6.25E-16	5.93E-16	5.44E-16	5.25E-16	4.91E-16	4.79E-16
Fe-53	1.17E-15	1.11E-15	1.04E-15	1.00E-15	9.50E-16	9.29E-16
Fe-53m	2.40E-15	2.24E-15	2.18E-15	2.06E-15	1.92E-15	1.88E-15
Fe-55	1.25E-25	1.17E-25	1.04E-25	9.80E-26	9.21E-26	8.97E-26
Fe-59	9.34E-16	8.71E-16	8.57E-16	8.04E-16	7.47E-16	7.33E-16
Fe-60	1.21E-18	1.13E-18	1.12E-18	1.04E-18	9.68E-19	9.48E-19
Fe-61	1.27E-15	1.19E-15	1.17E-15	1.11E-15	1.04E-15	1.02E-15
Fe-62	5.65E-16	5.37E-16	5.07E-16	4.89E-16	4.68E-16	4.59E-16
<b>Cobalt</b>						
Co-54m	3.45E-15	3.24E-15	3.12E-15	2.97E-15	2.79E-15	2.74E-15
Co-55	1.68E-15	1.58E-15	1.52E-15	1.44E-15	1.35E-15	1.32E-15
Co-56	2.77E-15	2.59E-15	2.50E-15	2.39E-15	2.24E-15	2.20E-15
Co-57	9.34E-17	8.60E-17	7.76E-17	7.29E-17	6.87E-17	6.68E-17
Co-58	7.95E-16	7.43E-16	7.24E-16	6.74E-16	6.32E-16	6.18E-16
Co-58m	2.03E-21	1.38E-21	1.02E-21	9.40E-22	6.39E-22	6.18E-22
Co-60	1.95E-15	1.82E-15	1.78E-15	1.68E-15	1.57E-15	1.54E-15
Co-60m	3.61E-18	3.36E-18	3.20E-18	3.07E-18	2.82E-18	2.76E-18
Co-61	1.41E-16	1.36E-16	1.30E-16	1.28E-16	1.18E-16	1.17E-16
Co-62	1.48E-15	1.39E-15	1.36E-15	1.30E-15	1.22E-15	1.20E-15
Co-62m	2.26E-15	2.11E-15	2.06E-15	1.96E-15	1.84E-15	1.81E-15
<b>Nickel</b>						
Ni-56	1.38E-15	1.30E-15	1.24E-15	1.17E-15	1.09E-15	1.07E-15
Ni-57	1.53E-15	1.43E-15	1.36E-15	1.31E-15	1.23E-15	1.20E-15
Ni-59	1.30E-20	1.22E-20	1.13E-20	1.09E-20	1.03E-20	1.00E-20
Ni-63	1.02E-19	9.52E-20	9.46E-20	8.76E-20	8.14E-20	7.98E-20
Ni-65	5.30E-16	4.99E-16	4.87E-16	4.66E-16	4.39E-16	4.32E-16
Ni-66	1.56E-18	1.45E-18	1.44E-18	1.34E-18	1.24E-18	1.22E-18
<b>Copper</b>						
Cu-57	1.50E-15	1.42E-15	1.36E-15	1.30E-15	1.24E-15	1.22E-15



**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	1.43E-15	1.35E-15	1.28E-15	1.23E-15	1.17E-15	1.14E-15
Cu-60	3.17E-15	2.97E-15	2.84E-15	2.73E-15	2.58E-15	2.53E-15
Cu-61	7.27E-16	6.86E-16	6.43E-16	6.16E-16	5.82E-16	5.68E-16
Cu-62	1.06E-15	1.00E-15	9.42E-16	9.07E-16	8.66E-16	8.47E-16
Cu-64	1.59E-16	1.50E-16	1.40E-16	1.34E-16	1.27E-16	1.24E-16
Cu-66	2.58E-16	2.48E-16	2.47E-16	2.38E-16	2.30E-16	2.27E-16
Cu-67	9.51E-17	8.90E-17	8.14E-17	7.92E-17	6.93E-17	6.77E-17
Cu-69	5.70E-16	5.39E-16	5.31E-16	5.02E-16	4.75E-16	4.67E-16
<b>Zinc</b>						
Zn-60	1.46E-15	1.38E-15	1.30E-15	1.25E-15	1.18E-15	1.15E-15
Zn-61	1.53E-15	1.45E-15	1.37E-15	1.32E-15	1.26E-15	1.23E-15
Zn-62	3.64E-16	3.41E-16	3.18E-16	3.04E-16	2.87E-16	2.79E-16
Zn-63	1.07E-15	1.01E-15	9.53E-16	9.14E-16	8.71E-16	8.51E-16
Zn-65	4.57E-16	4.26E-16	4.21E-16	3.93E-16	3.65E-16	3.58E-16
Zn-69	3.32E-17	3.23E-17	3.22E-17	3.14E-17	3.06E-17	3.04E-17
Zn-69m	3.48E-16	3.28E-16	3.02E-16	2.92E-16	2.74E-16	2.67E-16
Zn-71	4.34E-16	4.14E-16	4.01E-16	3.86E-16	3.69E-16	3.63E-16
Zn-71m	1.37E-15	1.29E-15	1.22E-15	1.17E-15	1.10E-15	1.07E-15
Zn-72	1.15E-16	1.13E-16	9.70E-17	9.39E-17	8.54E-17	8.40E-17
<b>Gallium</b>						
Ga-64	2.83E-15	2.66E-15	2.55E-15	2.45E-15	2.32E-15	2.27E-15
Ga-65	1.10E-15	1.03E-15	9.72E-16	9.31E-16	8.85E-16	8.65E-16
Ga-66	1.96E-15	1.85E-15	1.77E-15	1.71E-15	1.62E-15	1.59E-15
Ga-67	1.24E-16	1.14E-16	1.06E-16	1.03E-16	9.17E-17	8.91E-17
Ga-68	9.18E-16	8.69E-16	8.16E-16	7.84E-16	7.47E-16	7.30E-16
Ga-70	1.13E-16	1.11E-16	1.10E-16	1.08E-16	1.06E-16	1.05E-16
Ga-72	2.13E-15	2.00E-15	1.92E-15	1.84E-15	1.73E-15	1.70E-15
Ga-73	3.46E-16	3.25E-16	3.10E-16	3.02E-16	2.73E-16	2.67E-16
Ga-74	2.52E-15	2.37E-15	2.26E-15	2.19E-15	2.07E-15	2.03E-15
<b>Germanium</b>						
Ge-66	5.59E-16	5.23E-16	4.88E-16	4.70E-16	4.35E-16	4.25E-16
Ge-67	1.35E-15	1.28E-15	1.21E-15	1.16E-15	1.10E-15	1.07E-15
Ge-68	2.96E-24	2.33E-24	9.16E-25	2.56E-25	1.67E-25	1.66E-25
Ge-69	7.79E-16	7.29E-16	7.04E-16	6.65E-16	6.23E-16	6.10E-16
Ge-71	3.01E-24	2.37E-24	9.29E-25	2.60E-25	1.70E-25	1.68E-25
Ge-75	8.61E-17	8.29E-17	8.10E-17	7.95E-17	7.48E-17	7.41E-17
Ge-77	9.71E-16	9.13E-16	8.72E-16	8.39E-16	7.71E-16	7.56E-16
Ge-78	2.39E-16	2.23E-16	2.10E-16	2.07E-16	1.78E-16	1.75E-16
<b>Arsenic</b>						
As-68	3.24E-15	3.05E-15	2.92E-15	2.79E-15	2.63E-15	2.58E-15
As-69	1.15E-15	1.08E-15	1.02E-15	9.84E-16	9.35E-16	9.16E-16
As-70	3.52E-15	3.30E-15	3.17E-15	3.02E-15	2.84E-15	2.78E-15
As-71	4.76E-16	4.50E-16	4.18E-16	4.02E-16	3.72E-16	3.64E-16
As-72	1.63E-15	1.54E-15	1.47E-15	1.40E-15	1.32E-15	1.29E-15
As-73	3.75E-18	3.19E-18	2.89E-18	2.79E-18	2.32E-18	2.25E-18
As-74	6.64E-16	6.25E-16	5.88E-16	5.60E-16	5.32E-16	5.19E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	5.17E-16	4.92E-16	4.74E-16	4.55E-16	4.35E-16	4.28E-16
As-77	1.99E-17	1.90E-17	1.85E-17	1.78E-17	1.66E-17	1.64E-17
As-78	1.23E-15	1.15E-15	1.11E-15	1.07E-15	1.01E-15	9.89E-16
As-79	1.78E-16	1.73E-16	1.71E-16	1.67E-16	1.62E-16	1.61E-16
<b>Selenium</b>						
Se-70	6.15E-16	5.78E-16	5.37E-16	5.17E-16	4.85E-16	4.73E-16
Se-71	1.54E-15	1.45E-15	1.38E-15	1.32E-15	1.25E-15	1.22E-15
Se-72	1.64E-17	1.31E-17	1.19E-17	1.14E-17	9.20E-18	8.87E-18
Se-73	9.60E-16	9.06E-16	8.41E-16	8.15E-16	7.60E-16	7.42E-16
Se-73m	2.42E-16	2.29E-16	2.14E-16	2.06E-16	1.95E-16	1.90E-16
Se-75	3.08E-16	2.89E-16	2.65E-16	2.59E-16	2.28E-16	2.23E-16
Se-77m	6.65E-17	6.53E-17	5.64E-17	5.53E-17	4.93E-17	4.86E-17
Se-79	8.71E-19	8.12E-19	8.07E-19	7.48E-19	6.94E-19	6.80E-19
Se-79m	7.14E-18	6.07E-18	5.82E-18	5.35E-18	5.11E-18	4.87E-18
Se-81	1.07E-16	1.05E-16	1.04E-16	1.02E-16	9.95E-17	9.90E-17
Se-81m	1.08E-17	9.14E-18	8.84E-18	8.13E-18	7.76E-18	7.42E-18
Se-83	2.12E-15	1.99E-15	1.90E-15	1.82E-15	1.70E-15	1.67E-15
Se-83m	9.75E-16	9.19E-16	8.97E-16	8.56E-16	8.07E-16	7.94E-16
Se-84	4.37E-16	4.15E-16	3.89E-16	3.78E-16	3.55E-16	3.48E-16
<b>Bromine</b>						
Br-72	2.79E-15	2.63E-15	2.53E-15	2.41E-15	2.27E-15	2.23E-15
Br-73	1.40E-15	1.33E-15	1.26E-15	1.20E-15	1.14E-15	1.11E-15
Br-74	3.50E-15	3.30E-15	3.14E-15	3.05E-15	2.89E-15	2.84E-15
Br-74m	3.36E-15	3.17E-15	3.02E-15	2.90E-15	2.74E-15	2.69E-15
Br-75	1.08E-15	1.02E-15	9.53E-16	9.20E-16	8.57E-16	8.38E-16
Br-76	2.24E-15	2.11E-15	2.00E-15	1.93E-15	1.82E-15	1.79E-15
Br-76m	2.34E-17	1.99E-17	1.82E-17	1.74E-17	1.49E-17	1.45E-17
Br-77	2.59E-16	2.43E-16	2.28E-16	2.19E-16	2.01E-16	1.96E-16
Br-77m	1.15E-17	9.76E-18	9.41E-18	8.65E-18	8.27E-18	7.91E-18
Br-78	1.04E-15	9.83E-16	9.24E-16	8.88E-16	8.47E-16	8.29E-16
Br-80	1.86E-16	1.79E-16	1.75E-16	1.70E-16	1.65E-16	1.63E-16
Br-80m	7.57E-18	5.71E-18	4.75E-18	4.41E-18	3.50E-18	3.33E-18
Br-82	2.13E-15	2.00E-15	1.93E-15	1.81E-15	1.70E-15	1.67E-15
Br-82m	7.33E-18	7.04E-18	6.96E-18	6.71E-18	6.47E-18	6.40E-18
Br-83	4.04E-17	3.92E-17	3.87E-17	3.76E-17	3.66E-17	3.63E-17
Br-84	1.46E-15	1.38E-15	1.33E-15	1.29E-15	1.22E-15	1.20E-15
Br-84m	2.34E-15	2.19E-15	2.12E-15	2.02E-15	1.89E-15	1.85E-15
Br-85	2.28E-16	2.21E-16	2.19E-16	2.12E-16	2.05E-16	2.03E-16
<b>Krypton</b>						
Kr-74	9.71E-16	9.16E-16	8.56E-16	8.24E-16	7.75E-16	7.57E-16
Kr-75	1.30E-15	1.23E-15	1.16E-15	1.11E-15	1.06E-15	1.03E-15
Kr-76	3.42E-16	3.20E-16	2.98E-16	2.90E-16	2.60E-16	2.54E-16
Kr-77	9.70E-16	9.21E-16	8.54E-16	8.21E-16	7.79E-16	7.62E-16
Kr-79	2.06E-16	1.93E-16	1.81E-16	1.74E-16	1.60E-16	1.56E-16
Kr-81	6.69E-19	6.22E-19	5.82E-19	5.75E-19	4.92E-19	4.81E-19
Kr-81m	1.03E-16	9.72E-17	8.84E-17	8.72E-17	7.42E-17	7.28E-17

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	9.12E-21	6.20E-21	4.70E-21	4.09E-21	2.93E-21	2.76E-21
Kr-85	1.91E-17	1.84E-17	1.82E-17	1.75E-17	1.68E-17	1.67E-17
Kr-85m	1.43E-16	1.39E-16	1.24E-16	1.21E-16	1.10E-16	1.09E-16
Kr-87	8.06E-16	7.64E-16	7.31E-16	7.13E-16	6.76E-16	6.65E-16
Kr-88	1.47E-15	1.38E-15	1.31E-15	1.28E-15	1.20E-15	1.18E-15
Kr-89	1.65E-15	1.56E-15	1.50E-15	1.45E-15	1.36E-15	1.34E-15
<b>Rubidium</b>						
Rb-77	1.53E-15	1.45E-15	1.37E-15	1.32E-15	1.24E-15	1.22E-15
Rb-78	3.17E-15	3.00E-15	2.84E-15	2.76E-15	2.62E-15	2.57E-15
Rb-78m	2.78E-15	2.62E-15	2.49E-15	2.39E-15	2.26E-15	2.21E-15
Rb-79	1.32E-15	1.25E-15	1.17E-15	1.13E-15	1.06E-15	1.04E-15
Rb-80	1.31E-15	1.24E-15	1.17E-15	1.13E-15	1.08E-15	1.05E-15
Rb-81	4.33E-16	4.08E-16	3.81E-16	3.65E-16	3.45E-16	3.37E-16
Rb-81m	2.03E-17	1.89E-17	1.78E-17	1.70E-17	1.60E-17	1.56E-17
Rb-82	1.15E-15	1.09E-15	1.03E-15	9.91E-16	9.45E-16	9.25E-16
Rb-82m	2.36E-15	2.21E-15	2.13E-15	2.01E-15	1.88E-15	1.84E-15
Rb-83	4.04E-16	3.80E-16	3.53E-16	3.38E-16	3.21E-16	3.13E-16
Rb-84	7.58E-16	7.10E-16	6.89E-16	6.45E-16	6.05E-16	5.92E-16
Rb-84m	3.12E-16	2.92E-16	2.72E-16	2.66E-16	2.36E-16	2.30E-16
Rb-86	1.84E-16	1.77E-16	1.76E-16	1.69E-16	1.62E-16	1.61E-16
Rb-86m	4.56E-16	4.29E-16	4.00E-16	3.82E-16	3.63E-16	3.53E-16
Rb-87	2.98E-18	2.78E-18	2.76E-18	2.56E-18	2.38E-18	2.33E-18
Rb-88	7.94E-16	7.53E-16	7.31E-16	7.09E-16	6.75E-16	6.66E-16
Rb-89	1.85E-15	1.74E-15	1.69E-15	1.62E-15	1.52E-15	1.49E-15
Rb-90	1.67E-15	1.58E-15	1.53E-15	1.49E-15	1.41E-15	1.39E-15
Rb-90m	2.57E-15	2.42E-15	2.34E-15	2.25E-15	2.12E-15	2.09E-15
<b>Strontium</b>						
Sr-79	1.27E-15	1.20E-15	1.13E-15	1.09E-15	1.03E-15	1.01E-15
Sr-80	3.60E-16	3.39E-16	3.16E-16	3.03E-16	2.85E-16	2.78E-16
Sr-81	1.31E-15	1.24E-15	1.16E-15	1.11E-15	1.05E-15	1.03E-15
Sr-82	2.13E-20	1.16E-20	8.47E-21	7.52E-21	2.63E-21	2.31E-21
Sr-83	6.80E-16	6.38E-16	6.08E-16	5.78E-16	5.43E-16	5.30E-16
Sr-85	4.11E-16	3.87E-16	3.59E-16	3.44E-16	3.26E-16	3.18E-16
Sr-85m	1.73E-16	1.63E-16	1.51E-16	1.49E-16	1.26E-16	1.23E-16
Sr-87m	2.65E-16	2.49E-16	2.30E-16	2.24E-16	2.05E-16	2.00E-16
Sr-89	9.53E-17	9.34E-17	9.31E-17	9.13E-17	8.96E-17	8.91E-17
Sr-90	7.96E-18	7.51E-18	7.47E-18	7.03E-18	6.63E-18	6.52E-18
Sr-91	6.71E-16	6.30E-16	6.20E-16	5.82E-16	5.48E-16	5.38E-16
Sr-92	1.04E-15	9.75E-16	9.47E-16	9.01E-16	8.41E-16	8.26E-16
Sr-93	1.90E-15	1.79E-15	1.72E-15	1.64E-15	1.54E-15	1.51E-15
Sr-94	1.24E-15	1.16E-15	1.13E-15	1.08E-15	1.02E-15	1.00E-15
<b>Yttrium</b>						
Y-81	1.27E-15	1.20E-15	1.13E-15	1.09E-15	1.03E-15	1.01E-15
Y-83	1.31E-15	1.24E-15	1.17E-15	1.13E-15	1.07E-15	1.05E-15
Y-83m	8.22E-16	7.77E-16	7.29E-16	7.05E-16	6.61E-16	6.47E-16
Y-84m	3.41E-15	3.20E-15	3.10E-15	2.92E-15	2.74E-15	2.68E-15

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	9.79E-16	9.24E-16	8.66E-16	8.30E-16	7.89E-16	7.70E-16
Y-85m	1.15E-15	1.08E-15	1.03E-15	9.87E-16	9.32E-16	9.13E-16
Y-86	2.84E-15	2.66E-15	2.57E-15	2.44E-15	2.28E-15	2.24E-15
Y-86m	1.77E-16	1.66E-16	1.54E-16	1.52E-16	1.29E-16	1.26E-16
Y-87	3.66E-16	3.45E-16	3.18E-16	3.06E-16	2.90E-16	2.82E-16
Y-87m	2.54E-16	2.38E-16	2.20E-16	2.15E-16	1.97E-16	1.92E-16
Y-88	2.04E-15	1.91E-15	1.84E-15	1.76E-15	1.66E-15	1.63E-15
Y-89m	7.26E-16	6.77E-16	6.72E-16	6.21E-16	5.77E-16	5.66E-16
Y-90	1.58E-16	1.54E-16	1.54E-16	1.50E-16	1.47E-16	1.47E-16
Y-90m	5.26E-16	4.96E-16	4.57E-16	4.43E-16	4.06E-16	3.96E-16
Y-91	1.01E-16	9.92E-17	9.89E-17	9.69E-17	9.49E-17	9.44E-17
Y-91m	4.43E-16	4.17E-16	3.89E-16	3.72E-16	3.53E-16	3.44E-16
Y-92	4.32E-16	4.12E-16	4.07E-16	3.90E-16	3.73E-16	3.68E-16
Y-93	2.68E-16	2.58E-16	2.54E-16	2.48E-16	2.38E-16	2.36E-16
Y-94	8.94E-16	8.45E-16	8.33E-16	7.90E-16	7.47E-16	7.35E-16
Y-95	1.01E-15	9.57E-16	9.24E-16	8.98E-16	8.51E-16	8.40E-16
<b>Zirconium</b>						
Zr-85	1.43E-15	1.35E-15	1.27E-15	1.23E-15	1.16E-15	1.14E-15
Zr-86	2.22E-16	2.07E-16	1.93E-16	1.90E-16	1.63E-16	1.60E-16
Zr-87	9.09E-16	8.61E-16	8.10E-16	7.79E-16	7.42E-16	7.26E-16
Zr-88	3.18E-16	2.98E-16	2.76E-16	2.68E-16	2.47E-16	2.40E-16
Zr-89	9.43E-16	8.82E-16	8.63E-16	8.04E-16	7.51E-16	7.35E-16
Zr-89m	5.24E-16	4.93E-16	4.64E-16	4.42E-16	4.19E-16	4.09E-16
Zr-93	1.21E-19	1.13E-19	1.12E-19	1.04E-19	9.64E-20	9.45E-20
Zr-95	6.03E-16	5.64E-16	5.48E-16	5.11E-16	4.79E-16	4.69E-16
Zr-97	8.36E-16	7.87E-16	7.66E-16	7.22E-16	6.82E-16	6.69E-16
<b>Niobium</b>						
Nb-87	1.27E-15	1.21E-15	1.13E-15	1.09E-15	1.03E-15	1.01E-15
Nb-88	3.64E-15	3.41E-15	3.29E-15	3.11E-15	2.92E-15	2.86E-15
Nb-88m	3.53E-15	3.31E-15	3.19E-15	3.03E-15	2.84E-15	2.78E-15
Nb-89	1.25E-15	1.18E-15	1.12E-15	1.08E-15	1.03E-15	1.01E-15
Nb-89m	1.22E-15	1.16E-15	1.08E-15	1.04E-15	9.89E-16	9.66E-16
Nb-90	3.21E-15	3.02E-15	2.87E-15	2.78E-15	2.61E-15	2.57E-15
Nb-91	1.50E-18	1.36E-18	1.25E-18	1.21E-18	1.10E-18	1.07E-18
Nb-91m	1.97E-17	1.83E-17	1.80E-17	1.69E-17	1.56E-17	1.53E-17
Nb-92	1.22E-15	1.14E-15	1.11E-15	1.03E-15	9.68E-16	9.46E-16
Nb-92m	7.68E-16	7.16E-16	7.11E-16	6.58E-16	6.11E-16	5.99E-16
Nb-93m	4.42E-20	2.91E-20	2.43E-20	2.43E-20	1.13E-20	1.09E-20
Nb-94	1.27E-15	1.19E-15	1.16E-15	1.08E-15	1.01E-15	9.90E-16
Nb-94m	4.04E-18	3.73E-18	3.67E-18	3.43E-18	3.16E-18	3.09E-18
Nb-95	6.25E-16	5.84E-16	5.70E-16	5.30E-16	4.97E-16	4.86E-16
Nb-95m	5.34E-17	4.99E-17	4.68E-17	4.63E-17	3.93E-17	3.85E-17
Nb-96	2.01E-15	1.88E-15	1.82E-15	1.71E-15	1.60E-15	1.56E-15
Nb-97	6.17E-16	5.82E-16	5.59E-16	5.28E-16	5.01E-16	4.90E-16
Nb-98m	2.37E-15	2.22E-15	2.15E-15	2.03E-15	1.91E-15	1.87E-15
Nb-99	3.66E-16	3.53E-16	3.37E-16	3.26E-16	3.13E-16	3.09E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	7.78E-16	7.37E-16	7.10E-16	6.91E-16	6.57E-16	6.47E-16
<b>Molybdenum</b>						
Mo-89	1.31E-15	1.24E-15	1.18E-15	1.13E-15	1.08E-15	1.05E-15
Mo-90	6.80E-16	6.36E-16	5.98E-16	5.76E-16	5.27E-16	5.15E-16
Mo-91	1.05E-15	9.96E-16	9.39E-16	9.04E-16	8.64E-16	8.45E-16
Mo-91m	1.21E-15	1.13E-15	1.08E-15	1.03E-15	9.76E-16	9.56E-16
Mo-93	2.47E-19	1.63E-19	1.36E-19	1.36E-19	6.30E-20	6.10E-20
Mo-93m	1.82E-15	1.70E-15	1.63E-15	1.56E-15	1.45E-15	1.42E-15
Mo-99	1.73E-16	1.64E-16	1.60E-16	1.52E-16	1.44E-16	1.42E-16
Mo-101	1.23E-15	1.15E-15	1.11E-15	1.06E-15	9.92E-16	9.74E-16
Mo-102	5.55E-17	5.38E-17	5.23E-17	5.12E-17	4.86E-17	4.82E-17
<b>Technetium</b>						
Tc-91	2.18E-15	2.06E-15	1.95E-15	1.89E-15	1.79E-15	1.76E-15
Tc-91m	1.47E-15	1.39E-15	1.32E-15	1.26E-15	1.20E-15	1.18E-15
Tc-92	3.31E-15	3.12E-15	2.97E-15	2.85E-15	2.67E-15	2.62E-15
Tc-93	1.21E-15	1.13E-15	1.09E-15	1.04E-15	9.72E-16	9.55E-16
Tc-93m	6.99E-16	6.57E-16	6.19E-16	6.06E-16	5.69E-16	5.58E-16
Tc-94	2.16E-15	2.02E-15	1.97E-15	1.83E-15	1.71E-15	1.68E-15
Tc-94m	1.69E-15	1.59E-15	1.53E-15	1.45E-15	1.37E-15	1.34E-15
Tc-95	6.40E-16	5.98E-16	5.84E-16	5.43E-16	5.08E-16	4.97E-16
Tc-95m	5.52E-16	5.17E-16	4.96E-16	4.68E-16	4.31E-16	4.21E-16
Tc-96	2.02E-15	1.89E-15	1.85E-15	1.72E-15	1.61E-15	1.57E-15
Tc-96m	3.35E-17	3.12E-17	3.04E-17	2.85E-17	2.66E-17	2.60E-17
Tc-97	3.77E-19	2.59E-19	2.12E-19	2.12E-19	1.04E-19	1.01E-19
Tc-97m	6.63E-19	5.02E-19	4.25E-19	4.25E-19	2.93E-19	2.82E-19
Tc-98	1.17E-15	1.09E-15	1.05E-15	9.85E-16	9.26E-16	9.05E-16
Tc-99	2.52E-18	2.35E-18	2.33E-18	2.16E-18	2.01E-18	1.97E-18
Tc-99m	9.66E-17	9.51E-17	8.08E-17	7.78E-17	7.18E-17	7.06E-17
Tc-101	3.44E-16	3.25E-16	3.08E-16	3.01E-16	2.73E-16	2.68E-16
Tc-102	3.68E-16	3.55E-16	3.50E-16	3.40E-16	3.28E-16	3.25E-16
Tc-102m	2.05E-15	1.93E-15	1.84E-15	1.77E-15	1.67E-15	1.64E-15
Tc-104	1.96E-15	1.84E-15	1.76E-15	1.71E-15	1.60E-15	1.58E-15
Tc-105	8.31E-16	7.87E-16	7.53E-16	7.27E-16	6.82E-16	6.71E-16
<b>Ruthenium</b>						
Ru-92	1.76E-15	1.65E-15	1.56E-15	1.51E-15	1.39E-15	1.36E-15
Ru-94	4.15E-16	3.88E-16	3.71E-16	3.53E-16	3.24E-16	3.16E-16
Ru-95	9.97E-16	9.33E-16	8.94E-16	8.52E-16	7.90E-16	7.73E-16
Ru-97	1.84E-16	1.72E-16	1.60E-16	1.58E-16	1.34E-16	1.31E-16
Ru-103	4.16E-16	3.92E-16	3.63E-16	3.48E-16	3.30E-16	3.21E-16
Ru-105	6.68E-16	6.28E-16	6.03E-16	5.71E-16	5.35E-16	5.24E-16
Ru-106	2.16E-20	2.01E-20	2.00E-20	1.85E-20	1.72E-20	1.69E-20
Ru-107	4.54E-16	4.31E-16	4.21E-16	4.04E-16	3.83E-16	3.78E-16
Ru-108	1.16E-16	1.13E-16	1.07E-16	1.05E-16	9.94E-17	9.85E-17
<b>Rhodium</b>						
Rh-94	3.40E-15	3.20E-15	3.07E-15	2.94E-15	2.77E-15	2.72E-15
Rh-95	2.16E-15	2.03E-15	1.95E-15	1.86E-15	1.75E-15	1.71E-15

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	7.10E-16	6.70E-16	6.32E-16	6.09E-16	5.78E-16	5.66E-16
Rh-96	3.29E-15	3.09E-15	2.96E-15	2.81E-15	2.64E-15	2.59E-15
Rh-96m	1.10E-15	1.03E-15	9.89E-16	9.44E-16	8.90E-16	8.72E-16
Rh-97	1.26E-15	1.19E-15	1.12E-15	1.07E-15	1.01E-15	9.91E-16
Rh-97m	1.68E-15	1.57E-15	1.49E-15	1.45E-15	1.36E-15	1.33E-15
Rh-98	1.70E-15	1.61E-15	1.52E-15	1.46E-15	1.38E-15	1.35E-15
Rh-99	4.49E-16	4.19E-16	3.92E-16	3.77E-16	3.50E-16	3.41E-16
Rh-99m	5.22E-16	4.89E-16	4.63E-16	4.44E-16	4.09E-16	3.99E-16
Rh-100	2.09E-15	1.96E-15	1.86E-15	1.80E-15	1.69E-15	1.66E-15
Rh-100m	3.71E-17	3.42E-17	3.18E-17	3.07E-17	2.82E-17	2.75E-17
Rh-101	2.18E-16	2.04E-16	1.86E-16	1.81E-16	1.59E-16	1.55E-16
Rh-101m	2.25E-16	2.10E-16	1.96E-16	1.93E-16	1.69E-16	1.65E-16
Rh-102	4.36E-16	4.11E-16	3.85E-16	3.69E-16	3.49E-16	3.41E-16
Rh-102m	1.75E-15	1.64E-15	1.57E-15	1.48E-15	1.39E-15	1.36E-15
Rh-103m	1.39E-19	9.89E-20	7.59E-20	7.59E-20	4.45E-20	4.34E-20
Rh-104	1.77E-16	1.73E-16	1.72E-16	1.68E-16	1.64E-16	1.63E-16
Rh-104m	2.17E-17	1.82E-17	1.65E-17	1.59E-17	1.33E-17	1.29E-17
Rh-105	6.88E-17	6.43E-17	6.03E-17	5.91E-17	5.22E-17	5.11E-17
Rh-106	4.00E-16	3.83E-16	3.73E-16	3.60E-16	3.47E-16	3.43E-16
Rh-106m	2.33E-15	2.18E-15	2.10E-15	1.99E-15	1.86E-15	1.82E-15
Rh-107	3.18E-16	3.00E-16	2.84E-16	2.78E-16	2.51E-16	2.47E-16
Rh-108	5.50E-16	5.26E-16	5.07E-16	4.91E-16	4.70E-16	4.63E-16
Rh-109	4.00E-16	3.81E-16	3.64E-16	3.57E-16	3.30E-16	3.25E-16
<b>Palladium</b>						
Pd-96	1.20E-15	1.12E-15	1.07E-15	1.01E-15	9.52E-16	9.31E-16
Pd-97	1.99E-15	1.87E-15	1.78E-15	1.71E-15	1.60E-15	1.57E-15
Pd-98	3.24E-16	2.99E-16	2.86E-16	2.69E-16	2.52E-16	2.45E-16
Pd-99	1.09E-15	1.03E-15	9.70E-16	9.32E-16	8.77E-16	8.59E-16
Pd-100	7.53E-17	6.88E-17	6.11E-17	5.94E-17	5.30E-17	5.10E-17
Pd-101	2.69E-16	2.51E-16	2.38E-16	2.28E-16	2.10E-16	2.05E-16
Pd-103	1.26E-18	9.06E-19	7.01E-19	7.01E-19	4.18E-19	4.09E-19
Pd-107	1.70E-20	1.59E-20	1.58E-20	1.46E-20	1.36E-20	1.33E-20
Pd-109	4.74E-17	4.58E-17	4.53E-17	4.41E-17	4.29E-17	4.25E-17
Pd-109m	8.45E-17	8.01E-17	7.27E-17	7.17E-17	6.10E-17	5.98E-17
Pd-111	1.81E-16	1.76E-16	1.74E-16	1.69E-16	1.64E-16	1.63E-16
Pd-112	1.88E-18	1.71E-18	1.66E-18	1.56E-18	1.39E-18	1.37E-18
Pd-114	1.04E-16	1.01E-16	9.88E-17	9.68E-17	9.32E-17	9.24E-17
<b>Silver</b>						
Ag-99	2.05E-15	1.93E-15	1.84E-15	1.76E-15	1.66E-15	1.62E-15
Ag-100m	2.56E-15	2.41E-15	2.30E-15	2.20E-15	2.08E-15	2.04E-15
Ag-101	1.41E-15	1.33E-15	1.26E-15	1.21E-15	1.14E-15	1.11E-15
Ag-102	2.83E-15	2.66E-15	2.54E-15	2.43E-15	2.29E-15	2.25E-15
Ag-102m	1.56E-15	1.47E-15	1.39E-15	1.35E-15	1.28E-15	1.25E-15
Ag-103	7.00E-16	6.57E-16	6.22E-16	5.94E-16	5.55E-16	5.43E-16
Ag-104	2.18E-15	2.04E-15	1.97E-15	1.86E-15	1.74E-15	1.70E-15
Ag-104m	1.55E-15	1.46E-15	1.38E-15	1.33E-15	1.26E-15	1.23E-15

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	4.08E-16	3.82E-16	3.58E-16	3.46E-16	3.14E-16	3.06E-16
Ag-105m	8.12E-19	7.58E-19	7.14E-19	6.92E-19	6.20E-19	6.06E-19
Ag-106	6.65E-16	6.30E-16	5.89E-16	5.67E-16	5.40E-16	5.28E-16
Ag-106m	2.25E-15	2.11E-15	2.02E-15	1.91E-15	1.79E-15	1.75E-15
Ag-108	1.15E-16	1.12E-16	1.11E-16	1.09E-16	1.06E-16	1.05E-16
Ag-108m	1.33E-15	1.25E-15	1.18E-15	1.12E-15	1.05E-15	1.03E-15
Ag-109m	3.49E-18	2.86E-18	2.54E-18	2.38E-18	2.08E-18	1.99E-18
Ag-110	2.23E-16	2.16E-16	2.14E-16	2.09E-16	2.03E-16	2.02E-16
Ag-110m	2.22E-15	2.08E-15	2.02E-15	1.89E-15	1.77E-15	1.74E-15
Ag-111	6.36E-17	6.11E-17	5.96E-17	5.83E-17	5.53E-17	5.47E-17
Ag-111m	3.44E-18	3.08E-18	2.80E-18	2.72E-18	2.36E-18	2.31E-18
Ag-112	7.58E-16	7.18E-16	6.93E-16	6.67E-16	6.35E-16	6.24E-16
Ag-113	1.87E-16	1.80E-16	1.77E-16	1.73E-16	1.65E-16	1.64E-16
Ag-113m	2.05E-16	1.93E-16	1.83E-16	1.77E-16	1.63E-16	1.60E-16
Ag-114	5.30E-16	5.07E-16	4.94E-16	4.78E-16	4.59E-16	4.53E-16
Ag-115	5.48E-16	5.20E-16	5.01E-16	4.87E-16	4.60E-16	4.53E-16
Ag-116	1.88E-15	1.78E-15	1.70E-15	1.65E-15	1.56E-15	1.53E-15
Ag-117	1.17E-15	1.10E-15	1.05E-15	1.03E-15	9.69E-16	9.54E-16
<b>Cadmium</b>						
Cd-101	2.12E-15	1.99E-15	1.89E-15	1.82E-15	1.72E-15	1.68E-15
Cd-102	6.83E-16	6.41E-16	6.04E-16	5.76E-16	5.41E-16	5.28E-16
Cd-103	1.64E-15	1.54E-15	1.47E-15	1.42E-15	1.33E-15	1.31E-15
Cd-104	1.89E-16	1.76E-16	1.66E-16	1.57E-16	1.47E-16	1.43E-16
Cd-105	1.04E-15	9.73E-16	9.27E-16	8.92E-16	8.40E-16	8.23E-16
Cd-107	1.04E-17	8.68E-18	7.81E-18	7.36E-18	6.43E-18	6.22E-18
Cd-109	5.50E-18	4.24E-18	3.56E-18	3.38E-18	2.69E-18	2.59E-18
Cd-111m	2.22E-16	2.08E-16	1.92E-16	1.89E-16	1.61E-16	1.58E-16
Cd-113	2.25E-18	2.10E-18	2.08E-18	1.93E-18	1.79E-18	1.76E-18
Cd-113m	7.63E-18	7.21E-18	7.16E-18	6.76E-18	6.38E-18	6.29E-18
Cd-115	1.95E-16	1.85E-16	1.74E-16	1.67E-16	1.59E-16	1.56E-16
Cd-115m	1.25E-16	1.21E-16	1.21E-16	1.17E-16	1.14E-16	1.13E-16
Cd-117	9.05E-16	8.47E-16	8.19E-16	7.83E-16	7.27E-16	7.14E-16
Cd-117m	1.57E-15	1.47E-15	1.42E-15	1.36E-15	1.27E-15	1.25E-15
Cd-118	5.46E-18	5.11E-18	5.08E-18	4.74E-18	4.43E-18	4.35E-18
Cd-119	1.38E-15	1.29E-15	1.24E-15	1.20E-15	1.12E-15	1.10E-15
Cd-119m	1.87E-15	1.75E-15	1.69E-15	1.62E-15	1.53E-15	1.50E-15
<b>Indium</b>						
In-103	2.40E-15	2.26E-15	2.16E-15	2.07E-15	1.95E-15	1.91E-15
In-105	1.71E-15	1.61E-15	1.52E-15	1.46E-15	1.38E-15	1.35E-15
In-106	3.07E-15	2.88E-15	2.78E-15	2.62E-15	2.47E-15	2.41E-15
In-106m	2.45E-15	2.31E-15	2.19E-15	2.11E-15	2.00E-15	1.96E-15
In-107	1.24E-15	1.17E-15	1.10E-15	1.07E-15	9.98E-16	9.78E-16
In-108	3.14E-15	2.94E-15	2.85E-15	2.68E-15	2.50E-15	2.45E-15
In-108m	2.17E-15	2.05E-15	1.94E-15	1.88E-15	1.78E-15	1.75E-15
In-109	5.06E-16	4.73E-16	4.49E-16	4.30E-16	3.93E-16	3.84E-16
In-109m	5.08E-16	4.77E-16	4.55E-16	4.29E-16	4.05E-16	3.96E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	2.50E-15	2.34E-15	2.28E-15	2.13E-15	1.99E-15	1.95E-15
In-110m	1.38E-15	1.30E-15	1.23E-15	1.18E-15	1.12E-15	1.09E-15
In-111	3.11E-16	2.93E-16	2.67E-16	2.64E-16	2.26E-16	2.21E-16
In-111m	3.98E-16	3.75E-16	3.49E-16	3.34E-16	3.17E-16	3.09E-16
In-112	2.49E-16	2.35E-16	2.21E-16	2.12E-16	2.02E-16	1.97E-16
In-112m	1.85E-17	1.75E-17	1.47E-17	1.43E-17	1.26E-17	1.24E-17
In-113m	2.13E-16	1.99E-16	1.84E-16	1.79E-16	1.65E-16	1.60E-16
In-114	1.34E-16	1.31E-16	1.30E-16	1.28E-16	1.25E-16	1.24E-16
In-114m	5.97E-17	5.58E-17	5.20E-17	4.99E-17	4.50E-17	4.40E-17
In-115	4.88E-18	4.57E-18	4.54E-18	4.22E-18	3.94E-18	3.86E-18
In-115m	1.30E-16	1.21E-16	1.12E-16	1.10E-16	9.80E-17	9.57E-17
In-116m	1.95E-15	1.82E-15	1.77E-15	1.68E-15	1.57E-15	1.54E-15
In-117	5.85E-16	5.55E-16	5.11E-16	4.90E-16	4.61E-16	4.50E-16
In-117m	1.28E-16	1.23E-16	1.17E-16	1.14E-16	1.06E-16	1.05E-16
In-118	3.55E-16	3.42E-16	3.39E-16	3.29E-16	3.17E-16	3.14E-16
In-118m	2.30E-15	2.15E-15	2.11E-15	1.99E-15	1.86E-15	1.82E-15
In-119	7.23E-16	6.80E-16	6.65E-16	6.24E-16	5.88E-16	5.77E-16
In-119m	2.20E-16	2.13E-16	2.11E-16	2.05E-16	1.98E-16	1.97E-16
In-121	9.13E-16	8.59E-16	8.51E-16	7.97E-16	7.48E-16	7.35E-16
In-121m	2.86E-16	2.76E-16	2.72E-16	2.65E-16	2.56E-16	2.54E-16
<b>Tin</b>						
Sn-106	9.87E-16	9.24E-16	8.80E-16	8.37E-16	7.76E-16	7.59E-16
Sn-108	5.48E-16	5.12E-16	4.79E-16	4.62E-16	4.21E-16	4.11E-16
Sn-109	1.69E-15	1.58E-15	1.52E-15	1.46E-15	1.36E-15	1.34E-15
Sn-110	2.26E-16	2.10E-16	1.96E-16	1.93E-16	1.66E-16	1.62E-16
Sn-111	4.20E-16	3.95E-16	3.72E-16	3.57E-16	3.38E-16	3.31E-16
Sn-113	7.96E-18	6.52E-18	5.62E-18	5.45E-18	4.33E-18	4.22E-18
Sn-113m	3.31E-18	2.35E-18	1.77E-18	1.64E-18	1.19E-18	1.15E-18
Sn-117m	1.12E-16	1.09E-16	9.34E-17	9.14E-17	8.16E-17	8.05E-17
Sn-119m	3.11E-18	2.13E-18	1.58E-18	1.45E-18	9.99E-19	9.64E-19
Sn-121	3.13E-18	2.91E-18	2.89E-18	2.68E-18	2.49E-18	2.44E-18
Sn-121m	2.26E-18	1.77E-18	1.51E-18	1.38E-18	1.15E-18	1.11E-18
Sn-123	8.76E-17	8.55E-17	8.53E-17	8.34E-17	8.15E-17	8.11E-17
Sn-123m	1.74E-16	1.71E-16	1.56E-16	1.53E-16	1.42E-16	1.41E-16
Sn-125	3.96E-16	3.75E-16	3.70E-16	3.52E-16	3.34E-16	3.29E-16
Sn-125m	4.19E-16	3.98E-16	3.80E-16	3.72E-16	3.43E-16	3.37E-16
Sn-126	4.02E-17	3.53E-17	3.23E-17	3.04E-17	2.79E-17	2.67E-17
Sn-127	1.56E-15	1.46E-15	1.42E-15	1.35E-15	1.26E-15	1.23E-15
Sn-127m	6.54E-16	6.21E-16	5.91E-16	5.71E-16	5.45E-16	5.35E-16
Sn-128	4.86E-16	4.55E-16	4.21E-16	4.03E-16	3.78E-16	3.68E-16
Sn-129	1.02E-15	9.61E-16	9.30E-16	8.85E-16	8.39E-16	8.23E-16
Sn-130	8.10E-16	7.61E-16	7.29E-16	6.92E-16	6.37E-16	6.24E-16
Sn-130m	9.19E-16	8.67E-16	8.44E-16	8.03E-16	7.57E-16	7.45E-16
<b>Antimony</b>						
Sb-111	1.44E-15	1.36E-15	1.28E-15	1.23E-15	1.16E-15	1.14E-15
Sb-113	1.17E-15	1.10E-15	1.04E-15	9.95E-16	9.43E-16	9.22E-16



**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	2.33E-15	2.18E-15	2.10E-15	2.00E-15	1.89E-15	1.85E-15
Sb-115	7.71E-16	7.27E-16	6.76E-16	6.49E-16	6.16E-16	6.01E-16
Sb-116	1.86E-15	1.75E-15	1.68E-15	1.61E-15	1.51E-15	1.48E-15
Sb-116m	2.47E-15	2.30E-15	2.23E-15	2.10E-15	1.96E-15	1.92E-15
Sb-117	1.34E-16	1.29E-16	1.12E-16	1.09E-16	9.84E-17	9.68E-17
Sb-118	8.14E-16	7.71E-16	7.26E-16	6.98E-16	6.66E-16	6.51E-16
Sb-118m	2.04E-15	1.90E-15	1.86E-15	1.75E-15	1.61E-15	1.58E-15
Sb-119	5.15E-18	3.54E-18	2.61E-18	2.39E-18	1.67E-18	1.61E-18
Sb-120	4.22E-16	3.99E-16	3.74E-16	3.59E-16	3.42E-16	3.34E-16
Sb-120m	1.93E-15	1.80E-15	1.77E-15	1.65E-15	1.53E-15	1.50E-15
Sb-122	4.58E-16	4.34E-16	4.12E-16	3.95E-16	3.77E-16	3.69E-16
Sb-122m	4.15E-17	3.75E-17	3.20E-17	3.18E-17	2.68E-17	2.58E-17
Sb-124	1.50E-15	1.41E-15	1.34E-15	1.29E-15	1.21E-15	1.19E-15
Sb-124m	3.80E-16	3.57E-16	3.37E-16	3.21E-16	3.04E-16	2.97E-16
Sb-124n	1.97E-22	1.35E-22	9.95E-23	9.00E-23	6.36E-23	6.13E-23
Sb-125	3.58E-16	3.36E-16	3.13E-16	2.99E-16	2.80E-16	2.73E-16
Sb-126	2.31E-15	2.16E-15	2.07E-15	1.95E-15	1.84E-15	1.80E-15
Sb-126m	1.38E-15	1.30E-15	1.24E-15	1.18E-15	1.11E-15	1.09E-15
Sb-127	6.03E-16	5.67E-16	5.41E-16	5.12E-16	4.81E-16	4.70E-16
Sb-128	2.60E-15	2.44E-15	2.35E-15	2.21E-15	2.07E-15	2.02E-15
Sb-128m	1.72E-15	1.61E-15	1.56E-15	1.47E-15	1.38E-15	1.35E-15
Sb-129	1.21E-15	1.14E-15	1.11E-15	1.04E-15	9.75E-16	9.56E-16
Sb-130	2.75E-15	2.58E-15	2.50E-15	2.36E-15	2.19E-15	2.15E-15
Sb-130m	2.35E-15	2.20E-15	2.16E-15	2.02E-15	1.89E-15	1.85E-15
Sb-131	1.71E-15	1.60E-15	1.56E-15	1.48E-15	1.38E-15	1.36E-15
Sb-133	2.20E-15	2.06E-15	1.99E-15	1.91E-15	1.79E-15	1.76E-15
<b>Tellurium</b>						
Te-113	2.03E-15	1.91E-15	1.83E-15	1.75E-15	1.66E-15	1.62E-15
Te-114	1.01E-15	9.43E-16	9.00E-16	8.62E-16	8.06E-16	7.90E-16
Te-115	1.92E-15	1.81E-15	1.73E-15	1.65E-15	1.55E-15	1.52E-15
Te-115m	2.17E-15	2.03E-15	1.95E-15	1.86E-15	1.75E-15	1.72E-15
Te-116	7.34E-17	6.46E-17	6.02E-17	5.62E-17	5.23E-17	5.06E-17
Te-117	1.25E-15	1.17E-15	1.12E-15	1.07E-15	1.00E-15	9.84E-16
Te-118	5.41E-18	3.77E-18	2.78E-18	2.50E-18	1.82E-18	1.74E-18
Te-119	6.17E-16	5.77E-16	5.49E-16	5.19E-16	4.89E-16	4.78E-16
Te-119m	1.17E-15	1.09E-15	1.06E-15	9.99E-16	9.24E-16	9.06E-16
Te-121	4.69E-16	4.40E-16	4.11E-16	3.91E-16	3.70E-16	3.61E-16
Te-121m	1.67E-16	1.55E-16	1.44E-16	1.41E-16	1.20E-16	1.18E-16
Te-123	9.41E-21	6.56E-21	4.83E-21	4.34E-21	3.16E-21	3.03E-21
Te-123m	1.07E-16	1.04E-16	8.93E-17	8.73E-17	7.79E-17	7.68E-17
Te-125m	1.16E-17	8.30E-18	6.25E-18	5.61E-18	4.25E-18	4.06E-18
Te-127	1.75E-17	1.68E-17	1.64E-17	1.58E-17	1.50E-17	1.48E-17
Te-127m	4.11E-18	3.09E-18	2.45E-18	2.24E-18	1.80E-18	1.74E-18
Te-129	1.30E-16	1.25E-16	1.22E-16	1.18E-16	1.14E-16	1.13E-16
Te-129m	6.08E-17	5.78E-17	5.64E-17	5.42E-17	5.21E-17	5.14E-17
Te-131	4.48E-16	4.29E-16	4.06E-16	3.90E-16	3.68E-16	3.62E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	1.17E-15	1.09E-15	1.06E-15	9.98E-16	9.28E-16	9.09E-16
Te-132	1.79E-16	1.64E-16	1.52E-16	1.50E-16	1.26E-16	1.23E-16
Te-133	1.05E-15	9.89E-16	9.51E-16	9.13E-16	8.51E-16	8.35E-16
Te-133m	1.52E-15	1.42E-15	1.38E-15	1.30E-15	1.22E-15	1.19E-15
Te-134	7.18E-16	6.72E-16	6.38E-16	6.06E-16	5.59E-16	5.46E-16
<b>Iodine</b>						
I-118	1.95E-15	1.84E-15	1.75E-15	1.67E-15	1.59E-15	1.56E-15
I-118m	3.25E-15	3.05E-15	2.91E-15	2.76E-15	2.60E-15	2.55E-15
I-119	8.31E-16	7.82E-16	7.35E-16	7.10E-16	6.59E-16	6.44E-16
I-120	2.23E-15	2.10E-15	1.99E-15	1.92E-15	1.82E-15	1.79E-15
I-120m	2.98E-15	2.80E-15	2.66E-15	2.54E-15	2.40E-15	2.35E-15
I-121	3.21E-16	3.00E-16	2.79E-16	2.71E-16	2.42E-16	2.37E-16
I-122	9.80E-16	9.28E-16	8.74E-16	8.40E-16	8.01E-16	7.84E-16
I-123	1.23E-16	1.18E-16	1.02E-16	9.90E-17	8.88E-17	8.74E-17
I-124	9.16E-16	8.59E-16	8.13E-16	7.79E-16	7.36E-16	7.20E-16
I-125	1.37E-17	9.69E-18	7.23E-18	6.48E-18	4.86E-18	4.64E-18
I-126	3.71E-16	3.48E-16	3.29E-16	3.13E-16	2.93E-16	2.86E-16
I-128	1.82E-16	1.76E-16	1.72E-16	1.67E-16	1.62E-16	1.60E-16
I-129	1.08E-17	8.07E-18	6.40E-18	5.80E-18	4.61E-18	4.41E-18
I-130	1.78E-15	1.67E-15	1.60E-15	1.51E-15	1.42E-15	1.39E-15
I-130m	1.13E-16	1.07E-16	1.01E-16	9.70E-17	9.25E-17	9.07E-17
I-131	3.23E-16	3.03E-16	2.83E-16	2.74E-16	2.50E-16	2.44E-16
I-132	1.91E-15	1.79E-15	1.73E-15	1.63E-15	1.53E-15	1.50E-15
I-132m	2.84E-16	2.66E-16	2.54E-16	2.39E-16	2.25E-16	2.20E-16
I-133	5.63E-16	5.31E-16	5.02E-16	4.79E-16	4.55E-16	4.45E-16
I-134	2.17E-15	2.03E-15	1.98E-15	1.86E-15	1.74E-15	1.71E-15
I-134m	2.26E-16	2.09E-16	1.96E-16	1.91E-16	1.66E-16	1.62E-16
I-135	1.27E-15	1.18E-15	1.15E-15	1.09E-15	1.02E-15	1.01E-15
<b>Xenon</b>						
Xe-120	3.07E-16	2.85E-16	2.70E-16	2.55E-16	2.35E-16	2.30E-16
Xe-121	1.23E-15	1.15E-15	1.09E-15	1.06E-15	9.94E-16	9.75E-16
Xe-122	4.49E-17	4.04E-17	3.61E-17	3.49E-17	3.09E-17	3.01E-17
Xe-123	5.26E-16	4.97E-16	4.64E-16	4.45E-16	4.16E-16	4.07E-16
Xe-125	2.04E-16	1.89E-16	1.74E-16	1.70E-16	1.47E-16	1.44E-16
Xe-127	2.13E-16	2.00E-16	1.81E-16	1.78E-16	1.54E-16	1.51E-16
Xe-127m	1.24E-16	1.16E-16	1.03E-16	9.82E-17	8.90E-17	8.70E-17
Xe-129m	2.38E-17	1.89E-17	1.55E-17	1.45E-17	1.17E-17	1.12E-17
Xe-131m	8.97E-18	7.12E-18	5.65E-18	5.24E-18	4.28E-18	4.14E-18
Xe-133	3.29E-17	2.90E-17	2.57E-17	2.44E-17	2.17E-17	2.09E-17
Xe-133m	2.54E-17	2.23E-17	2.00E-17	1.95E-17	1.61E-17	1.57E-17
Xe-135	2.31E-16	2.16E-16	2.04E-16	2.01E-16	1.75E-16	1.72E-16
Xe-135m	3.62E-16	3.41E-16	3.17E-16	3.04E-16	2.89E-16	2.82E-16
Xe-137	4.24E-16	4.07E-16	3.95E-16	3.84E-16	3.69E-16	3.65E-16
Xe-138	9.46E-16	8.89E-16	8.45E-16	8.25E-16	7.73E-16	7.60E-16
<b>Cesium</b>						
Cs-121	1.24E-15	1.18E-15	1.11E-15	1.07E-15	1.01E-15	9.91E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	1.18E-15	1.12E-15	1.05E-15	1.01E-15	9.53E-16	9.33E-16
Cs-123	1.05E-15	9.86E-16	9.31E-16	8.92E-16	8.46E-16	8.28E-16
Cs-124	1.27E-15	1.20E-15	1.13E-15	1.09E-15	1.04E-15	1.02E-15
Cs-125	6.74E-16	6.34E-16	5.95E-16	5.71E-16	5.41E-16	5.29E-16
Cs-126	1.17E-15	1.10E-15	1.04E-15	1.00E-15	9.50E-16	9.30E-16
Cs-127	3.48E-16	3.25E-16	3.01E-16	2.90E-16	2.69E-16	2.62E-16
Cs-128	8.85E-16	8.37E-16	7.86E-16	7.57E-16	7.20E-16	7.04E-16
Cs-129	2.17E-16	2.01E-16	1.85E-16	1.79E-16	1.63E-16	1.59E-16
Cs-130	4.79E-16	4.52E-16	4.24E-16	4.07E-16	3.88E-16	3.79E-16
Cs-130m	4.55E-17	4.00E-17	3.46E-17	3.29E-17	2.91E-17	2.81E-17
Cs-131	8.72E-18	6.31E-18	4.77E-18	4.26E-18	3.29E-18	3.13E-18
Cs-132	5.80E-16	5.41E-16	5.17E-16	4.86E-16	4.57E-16	4.47E-16
Cs-134	1.28E-15	1.20E-15	1.16E-15	1.09E-15	1.02E-15	9.98E-16
Cs-134m	1.65E-17	1.47E-17	1.27E-17	1.19E-17	1.08E-17	1.05E-17
Cs-135	2.09E-18	1.95E-18	1.94E-18	1.80E-18	1.67E-18	1.63E-18
Cs-135m	1.30E-15	1.22E-15	1.20E-15	1.11E-15	1.04E-15	1.01E-15
Cs-136	1.71E-15	1.59E-15	1.56E-15	1.46E-15	1.35E-15	1.32E-15
Cs-137	9.23E-18	8.80E-18	8.76E-18	8.33E-18	7.95E-18	7.85E-18
Cs-138	2.01E-15	1.88E-15	1.82E-15	1.75E-15	1.64E-15	1.62E-15
Cs-138m	3.63E-16	3.40E-16	3.25E-16	3.13E-16	2.92E-16	2.87E-16
Cs-139	4.89E-16	4.67E-16	4.57E-16	4.43E-16	4.24E-16	4.19E-16
Cs-140	1.62E-15	1.52E-15	1.46E-15	1.42E-15	1.34E-15	1.32E-15
<b>Barium</b>						
Ba-124	4.81E-16	4.50E-16	4.26E-16	4.06E-16	3.78E-16	3.70E-16
Ba-126	4.57E-16	4.25E-16	4.08E-16	3.87E-16	3.53E-16	3.46E-16
Ba-127	6.89E-16	6.51E-16	6.11E-16	5.88E-16	5.58E-16	5.46E-16
Ba-128	4.40E-17	3.90E-17	3.52E-17	3.43E-17	2.90E-17	2.83E-17
Ba-129	2.81E-16	2.63E-16	2.45E-16	2.36E-16	2.21E-16	2.16E-16
Ba-129m	1.25E-15	1.17E-15	1.12E-15	1.07E-15	9.88E-16	9.66E-16
Ba-131	3.79E-16	3.53E-16	3.26E-16	3.13E-16	2.89E-16	2.82E-16
Ba-131m	5.44E-17	4.60E-17	4.31E-17	3.97E-17	3.72E-17	3.57E-17
Ba-133	3.13E-16	2.90E-16	2.66E-16	2.60E-16	2.32E-16	2.26E-16
Ba-133m	4.79E-17	4.31E-17	3.94E-17	3.86E-17	3.27E-17	3.19E-17
Ba-135m	4.18E-17	3.74E-17	3.41E-17	3.34E-17	2.82E-17	2.75E-17
Ba-137m	5.01E-16	4.70E-16	4.49E-16	4.23E-16	4.00E-16	3.90E-16
Ba-139	1.87E-16	1.82E-16	1.78E-16	1.74E-16	1.68E-16	1.67E-16
Ba-140	1.78E-16	1.68E-16	1.57E-16	1.51E-16	1.43E-16	1.40E-16
Ba-141	8.94E-16	8.43E-16	8.08E-16	7.79E-16	7.22E-16	7.09E-16
Ba-142	8.81E-16	8.24E-16	8.05E-16	7.59E-16	7.01E-16	6.88E-16
<b>Lanthanum</b>						
La-128	2.50E-15	2.35E-15	2.24E-15	2.14E-15	2.01E-15	1.96E-15
La-129	8.56E-16	8.05E-16	7.56E-16	7.28E-16	6.84E-16	6.69E-16
La-130	1.98E-15	1.86E-15	1.77E-15	1.69E-15	1.59E-15	1.56E-15
La-131	5.64E-16	5.27E-16	4.92E-16	4.73E-16	4.41E-16	4.30E-16
La-132	1.66E-15	1.56E-15	1.47E-15	1.42E-15	1.34E-15	1.31E-15
La-132m	5.48E-16	5.14E-16	4.84E-16	4.59E-16	4.29E-16	4.19E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	1.27E-16	1.17E-16	1.09E-16	1.04E-16	9.64E-17	9.40E-17
La-134	7.24E-16	6.85E-16	6.44E-16	6.20E-16	5.91E-16	5.78E-16
La-135	1.96E-17	1.61E-17	1.39E-17	1.29E-17	1.12E-17	1.09E-17
La-136	3.83E-16	3.61E-16	3.38E-16	3.24E-16	3.08E-16	3.01E-16
La-137	1.07E-17	7.91E-18	6.20E-18	5.61E-18	4.40E-18	4.18E-18
La-138	9.54E-16	8.89E-16	8.62E-16	8.19E-16	7.65E-16	7.50E-16
La-140	1.86E-15	1.75E-15	1.67E-15	1.61E-15	1.51E-15	1.48E-15
La-141	1.88E-16	1.83E-16	1.81E-16	1.77E-16	1.73E-16	1.72E-16
La-142	1.87E-15	1.76E-15	1.68E-15	1.63E-15	1.54E-15	1.52E-15
La-143	4.13E-16	3.94E-16	3.86E-16	3.73E-16	3.58E-16	3.53E-16
<b>Cerium</b>						
Ce-130	3.93E-16	3.65E-16	3.44E-16	3.27E-16	3.00E-16	2.93E-16
Ce-131	1.40E-15	1.31E-15	1.25E-15	1.19E-15	1.12E-15	1.10E-15
Ce-132	2.08E-16	1.95E-16	1.76E-16	1.72E-16	1.50E-16	1.47E-16
Ce-133	4.90E-16	4.57E-16	4.26E-16	4.08E-16	3.87E-16	3.77E-16
Ce-133m	1.37E-15	1.28E-15	1.22E-15	1.16E-15	1.09E-15	1.06E-15
Ce-134	1.33E-17	1.01E-17	8.19E-18	7.54E-18	6.05E-18	5.77E-18
Ce-135	6.64E-16	6.19E-16	5.86E-16	5.59E-16	5.13E-16	5.01E-16
Ce-137	2.14E-17	1.77E-17	1.53E-17	1.43E-17	1.24E-17	1.20E-17
Ce-137m	3.82E-17	3.38E-17	3.10E-17	3.00E-17	2.55E-17	2.48E-17
Ce-139	1.15E-16	1.09E-16	9.39E-17	9.18E-17	8.05E-17	7.92E-17
Ce-141	6.22E-17	6.07E-17	5.19E-17	5.00E-17	4.57E-17	4.50E-17
Ce-143	2.75E-16	2.57E-16	2.45E-16	2.37E-16	2.16E-16	2.12E-16
Ce-144	1.59E-17	1.49E-17	1.31E-17	1.24E-17	1.14E-17	1.11E-17
Ce-145	7.56E-16	7.09E-16	6.85E-16	6.48E-16	6.08E-16	5.96E-16
<b>Praseodymium</b>						
Pr-134	2.73E-15	2.57E-15	2.44E-15	2.33E-15	2.18E-15	2.13E-15
Pr-134m	2.08E-15	1.96E-15	1.86E-15	1.79E-15	1.69E-15	1.65E-15
Pr-135	8.02E-16	7.54E-16	7.08E-16	6.82E-16	6.40E-16	6.26E-16
Pr-136	1.84E-15	1.73E-15	1.64E-15	1.57E-15	1.49E-15	1.45E-15
Pr-137	3.29E-16	3.09E-16	2.90E-16	2.78E-16	2.63E-16	2.57E-16
Pr-138	8.66E-16	8.21E-16	7.73E-16	7.44E-16	7.10E-16	6.95E-16
Pr-138m	2.02E-15	1.89E-15	1.84E-15	1.72E-15	1.60E-15	1.57E-15
Pr-139	1.04E-16	9.56E-17	8.84E-17	8.46E-17	7.92E-17	7.72E-17
Pr-140	5.46E-16	5.16E-16	4.84E-16	4.66E-16	4.44E-16	4.34E-16
Pr-142	1.79E-16	1.73E-16	1.71E-16	1.67E-16	1.62E-16	1.61E-16
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	3.28E-17	3.19E-17	3.18E-17	3.10E-17	3.02E-17	3.00E-17
Pr-144	2.23E-16	2.16E-16	2.14E-16	2.09E-16	2.04E-16	2.02E-16
Pr-144m	6.96E-18	5.49E-18	4.72E-18	4.41E-18	3.67E-18	3.52E-18
Pr-145	1.28E-16	1.25E-16	1.24E-16	1.21E-16	1.18E-16	1.17E-16
Pr-146	9.99E-16	9.43E-16	9.07E-16	8.74E-16	8.27E-16	8.14E-16
Pr-147	5.21E-16	4.90E-16	4.70E-16	4.52E-16	4.25E-16	4.17E-16
Pr-148	1.04E-15	9.77E-16	9.47E-16	9.11E-16	8.53E-16	8.39E-16
Pr-148m	1.03E-15	9.71E-16	9.30E-16	8.97E-16	8.37E-16	8.21E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	4.57E-16	4.30E-16	3.98E-16	3.84E-16	3.53E-16	3.45E-16
Nd-135	1.19E-15	1.12E-15	1.05E-15	1.01E-15	9.50E-16	9.30E-16
Nd-136	2.15E-16	1.96E-16	1.83E-16	1.73E-16	1.61E-16	1.56E-16
Nd-137	9.87E-16	9.24E-16	8.79E-16	8.39E-16	7.86E-16	7.69E-16
Nd-138	2.64E-17	2.20E-17	1.94E-17	1.85E-17	1.56E-17	1.50E-17
Nd-139	3.93E-16	3.68E-16	3.47E-16	3.32E-16	3.13E-16	3.06E-16
Nd-139m	1.26E-15	1.17E-15	1.14E-15	1.07E-15	9.96E-16	9.73E-16
Nd-140	1.43E-17	1.08E-17	8.96E-18	8.31E-18	6.60E-18	6.28E-18
Nd-141	5.40E-17	4.81E-17	4.44E-17	4.20E-17	3.83E-17	3.73E-17
Nd-141m	5.76E-16	5.39E-16	5.25E-16	4.90E-16	4.60E-16	4.50E-16
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.28E-16	1.18E-16	1.10E-16	1.05E-16	9.86E-17	9.60E-17
Nd-149	3.65E-16	3.43E-16	3.24E-16	3.14E-16	2.87E-16	2.81E-16
Nd-151	7.69E-16	7.20E-16	6.98E-16	6.62E-16	6.18E-16	6.06E-16
Nd-152	1.66E-16	1.56E-16	1.48E-16	1.46E-16	1.30E-16	1.27E-16
<b>Promethium</b>						
Pm-136	2.56E-15	2.41E-15	2.30E-15	2.19E-15	2.06E-15	2.02E-15
Pm-137m	1.62E-15	1.52E-15	1.43E-15	1.37E-15	1.28E-15	1.26E-15
Pm-139	9.41E-16	8.90E-16	8.39E-16	8.07E-16	7.67E-16	7.50E-16
Pm-140	1.18E-15	1.12E-15	1.06E-15	1.02E-15	9.75E-16	9.55E-16
Pm-140m	2.62E-15	2.46E-15	2.37E-15	2.24E-15	2.10E-15	2.06E-15
Pm-141	6.98E-16	6.58E-16	6.22E-16	5.97E-16	5.67E-16	5.55E-16
Pm-142	9.18E-16	8.70E-16	8.20E-16	7.90E-16	7.54E-16	7.38E-16
Pm-143	2.50E-16	2.31E-16	2.23E-16	2.08E-16	1.93E-16	1.89E-16
Pm-144	1.28E-15	1.20E-15	1.14E-15	1.08E-15	1.02E-15	9.91E-16
Pm-145	1.66E-17	1.29E-17	1.09E-17	1.03E-17	8.26E-18	7.88E-18
Pm-146	6.21E-16	5.81E-16	5.52E-16	5.21E-16	4.89E-16	4.77E-16
Pm-147	1.20E-18	1.12E-18	1.11E-18	1.03E-18	9.55E-19	9.37E-19
Pm-148	5.70E-16	5.37E-16	5.21E-16	4.99E-16	4.72E-16	4.64E-16
Pm-148m	1.65E-15	1.54E-15	1.47E-15	1.39E-15	1.31E-15	1.27E-15
Pm-149	5.44E-17	5.26E-17	5.20E-17	5.08E-17	4.89E-17	4.85E-17
Pm-150	1.29E-15	1.21E-15	1.17E-15	1.12E-15	1.04E-15	1.02E-15
Pm-151	2.92E-16	2.73E-16	2.57E-16	2.48E-16	2.26E-16	2.21E-16
Pm-152	4.38E-16	4.17E-16	4.09E-16	3.93E-16	3.75E-16	3.69E-16
Pm-152m	1.33E-15	1.25E-15	1.21E-15	1.15E-15	1.07E-15	1.05E-15
Pm-153	1.67E-16	1.60E-16	1.54E-16	1.50E-16	1.44E-16	1.43E-16
Pm-154	1.49E-15	1.40E-15	1.35E-15	1.30E-15	1.22E-15	1.20E-15
Pm-154m	1.55E-15	1.45E-15	1.40E-15	1.34E-15	1.25E-15	1.23E-15
<b>Samarium</b>						
Sm-139	1.36E-15	1.28E-15	1.21E-15	1.16E-15	1.09E-15	1.07E-15
Sm-140	4.76E-16	4.45E-16	4.22E-16	4.03E-16	3.76E-16	3.68E-16
Sm-141	1.25E-15	1.18E-15	1.11E-15	1.07E-15	1.01E-15	9.88E-16
Sm-141m	1.62E-15	1.51E-15	1.45E-15	1.38E-15	1.28E-15	1.26E-15
Sm-142	8.88E-17	8.11E-17	7.49E-17	7.17E-17	6.66E-17	6.49E-17
Sm-143	5.19E-16	4.90E-16	4.61E-16	4.43E-16	4.21E-16	4.12E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	5.69E-16	5.33E-16	5.19E-16	4.84E-16	4.54E-16	4.45E-16
Sm-145	3.57E-17	2.82E-17	2.43E-17	2.31E-17	1.87E-17	1.79E-17
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	1.39E-19	1.29E-19	1.28E-19	1.19E-19	1.10E-19	1.08E-19
Sm-153	5.81E-17	5.02E-17	4.76E-17	4.49E-17	4.12E-17	3.98E-17
Sm-155	1.67E-16	1.54E-16	1.51E-16	1.45E-16	1.39E-16	1.36E-16
Sm-156	9.75E-17	9.05E-17	8.35E-17	8.13E-17	7.13E-17	6.96E-17
Sm-157	4.72E-16	4.47E-16	4.29E-16	4.15E-16	3.83E-16	3.78E-16
<b>Europium</b>						
Eu-142	1.40E-15	1.33E-15	1.26E-15	1.22E-15	1.16E-15	1.14E-15
Eu-142m	3.06E-15	2.88E-15	2.77E-15	2.62E-15	2.47E-15	2.41E-15
Eu-143	1.12E-15	1.06E-15	1.01E-15	9.68E-16	9.20E-16	9.01E-16
Eu-144	1.21E-15	1.15E-15	1.09E-15	1.05E-15	9.99E-16	9.79E-16
Eu-145	9.98E-16	9.30E-16	9.01E-16	8.52E-16	7.96E-16	7.80E-16
Eu-146	1.92E-15	1.79E-15	1.72E-15	1.63E-15	1.53E-15	1.50E-15
Eu-147	3.69E-16	3.41E-16	3.27E-16	3.08E-16	2.82E-16	2.76E-16
Eu-148	1.81E-15	1.69E-15	1.61E-15	1.53E-15	1.44E-15	1.40E-15
Eu-149	4.46E-17	3.87E-17	3.52E-17	3.41E-17	2.93E-17	2.84E-17
Eu-150	1.27E-15	1.18E-15	1.12E-15	1.07E-15	9.90E-16	9.66E-16
Eu-150m	7.54E-17	7.18E-17	6.94E-17	6.73E-17	6.38E-17	6.29E-17
Eu-152	9.34E-16	8.68E-16	8.43E-16	7.95E-16	7.37E-16	7.22E-16
Eu-152m	3.18E-16	2.99E-16	2.95E-16	2.78E-16	2.62E-16	2.58E-16
Eu-152n	5.52E-17	4.75E-17	4.44E-17	4.12E-17	3.84E-17	3.67E-17
Eu-154	1.01E-15	9.41E-16	9.19E-16	8.62E-16	8.04E-16	7.88E-16
Eu-154m	4.77E-17	4.19E-17	3.76E-17	3.67E-17	3.21E-17	3.08E-17
Eu-155	4.60E-17	3.95E-17	3.70E-17	3.45E-17	3.19E-17	3.06E-17
Eu-156	1.01E-15	9.44E-16	9.15E-16	8.73E-16	8.20E-16	8.05E-16
Eu-157	2.79E-16	2.61E-16	2.45E-16	2.37E-16	2.20E-16	2.15E-16
Eu-158	1.16E-15	1.09E-15	1.07E-15	1.01E-15	9.44E-16	9.27E-16
Eu-159	3.77E-16	3.55E-16	3.44E-16	3.30E-16	3.11E-16	3.06E-16
<b>Gadolinium</b>						
Gd-142	9.64E-16	9.08E-16	8.59E-16	8.25E-16	7.78E-16	7.62E-16
Gd-143m	1.89E-15	1.78E-15	1.69E-15	1.62E-15	1.52E-15	1.48E-15
Gd-144	8.09E-16	7.63E-16	7.20E-16	6.96E-16	6.59E-16	6.46E-16
Gd-145	1.87E-15	1.75E-15	1.66E-15	1.62E-15	1.52E-15	1.49E-15
Gd-145m	5.83E-16	5.46E-16	5.27E-16	4.95E-16	4.66E-16	4.55E-16
Gd-146	1.79E-16	1.59E-16	1.43E-16	1.35E-16	1.22E-16	1.18E-16
Gd-147	1.12E-15	1.05E-15	1.01E-15	9.54E-16	8.76E-16	8.56E-16
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	4.18E-16	3.90E-16	3.64E-16	3.49E-16	3.16E-16	3.09E-16
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	4.68E-17	4.11E-17	3.68E-17	3.58E-17	3.02E-17	2.94E-17
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	7.12E-17	5.85E-17	5.43E-17	5.07E-17	4.53E-17	4.33E-17

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	7.32E-17	6.90E-17	6.59E-17	6.42E-17	5.98E-17	5.88E-17
Gd-162	3.81E-16	3.59E-16	3.33E-16	3.23E-16	3.02E-16	2.95E-16
<b>Terbium</b>						
Tb-146	3.02E-15	2.84E-15	2.72E-15	2.61E-15	2.46E-15	2.41E-15
Tb-147	1.76E-15	1.65E-15	1.59E-15	1.51E-15	1.41E-15	1.38E-15
Tb-147m	1.52E-15	1.42E-15	1.36E-15	1.31E-15	1.23E-15	1.21E-15
Tb-148	1.99E-15	1.87E-15	1.79E-15	1.71E-15	1.61E-15	1.58E-15
Tb-148m	2.61E-15	2.44E-15	2.35E-15	2.21E-15	2.07E-15	2.02E-15
Tb-149	1.07E-15	1.00E-15	9.58E-16	9.15E-16	8.51E-16	8.33E-16
Tb-149m	1.15E-15	1.08E-15	1.04E-15	9.76E-16	9.16E-16	8.95E-16
Tb-150	1.89E-15	1.77E-15	1.69E-15	1.62E-15	1.53E-15	1.50E-15
Tb-150m	2.09E-15	1.96E-15	1.86E-15	1.76E-15	1.66E-15	1.62E-15
Tb-151	7.98E-16	7.42E-16	6.99E-16	6.70E-16	6.16E-16	6.01E-16
Tb-151m	6.12E-17	5.63E-17	5.32E-17	5.06E-17	4.63E-17	4.52E-17
Tb-152	1.20E-15	1.12E-15	1.06E-15	1.03E-15	9.55E-16	9.36E-16
Tb-152m	6.12E-16	5.70E-16	5.34E-16	5.16E-16	4.66E-16	4.55E-16
Tb-153	2.56E-16	2.35E-16	2.21E-16	2.12E-16	1.89E-16	1.85E-16
Tb-154	1.70E-15	1.59E-15	1.52E-15	1.46E-15	1.37E-15	1.35E-15
Tb-155	1.29E-16	1.15E-16	1.05E-16	1.01E-16	8.93E-17	8.65E-17
Tb-156	1.53E-15	1.42E-15	1.37E-15	1.30E-15	1.20E-15	1.18E-15
Tb-156m	2.36E-17	1.93E-17	1.76E-17	1.70E-17	1.39E-17	1.35E-17
Tb-156n	2.39E-18	1.96E-18	1.79E-18	1.70E-18	1.46E-18	1.40E-18
Tb-157	2.74E-18	2.16E-18	1.93E-18	1.85E-18	1.49E-18	1.43E-18
Tb-158	6.39E-16	5.93E-16	5.84E-16	5.42E-16	5.02E-16	4.91E-16
Tb-160	9.09E-16	8.47E-16	8.32E-16	7.79E-16	7.19E-16	7.05E-16
Tb-161	2.59E-17	2.24E-17	2.04E-17	1.97E-17	1.68E-17	1.63E-17
Tb-162	9.66E-16	9.05E-16	8.82E-16	8.32E-16	7.65E-16	7.50E-16
Tb-163	6.90E-16	6.49E-16	6.05E-16	5.85E-16	5.43E-16	5.30E-16
Tb-164	2.06E-15	1.93E-15	1.86E-15	1.77E-15	1.65E-15	1.62E-15
Tb-165	7.94E-16	7.48E-16	7.27E-16	6.96E-16	6.56E-16	6.45E-16
<b>Dysprosium</b>						
Dy-148	5.87E-16	5.48E-16	5.18E-16	4.91E-16	4.62E-16	4.51E-16
Dy-149	1.27E-15	1.18E-15	1.14E-15	1.08E-15	1.01E-15	9.92E-16
Dy-150	2.26E-16	2.10E-16	1.94E-16	1.88E-16	1.73E-16	1.68E-16
Dy-151	1.09E-15	1.01E-15	9.72E-16	9.24E-16	8.60E-16	8.42E-16
Dy-152	2.24E-16	2.06E-16	1.92E-16	1.90E-16	1.60E-16	1.57E-16
Dy-153	6.80E-16	6.29E-16	6.00E-16	5.72E-16	5.24E-16	5.13E-16
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	5.24E-16	4.86E-16	4.66E-16	4.45E-16	4.02E-16	3.94E-16
Dy-157	2.76E-16	2.55E-16	2.36E-16	2.32E-16	2.04E-16	1.99E-16
Dy-159	2.71E-17	2.17E-17	1.95E-17	1.88E-17	1.52E-17	1.46E-17
Dy-165	8.41E-17	8.08E-17	7.96E-17	7.74E-17	7.48E-17	7.41E-17
Dy-165m	1.45E-17	1.31E-17	1.22E-17	1.17E-17	1.08E-17	1.04E-17
Dy-166	3.23E-17	2.80E-17	2.57E-17	2.46E-17	2.15E-17	2.08E-17
Dy-167	5.44E-16	5.14E-16	4.88E-16	4.72E-16	4.39E-16	4.30E-16
Dy-168	3.65E-16	3.44E-16	3.21E-16	3.10E-16	2.88E-16	2.82E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	1.86E-15	1.75E-15	1.68E-15	1.59E-15	1.51E-15	1.47E-15
Ho-153	9.22E-16	8.65E-16	8.20E-16	7.87E-16	7.31E-16	7.15E-16
Ho-153m	9.73E-16	9.14E-16	8.61E-16	8.26E-16	7.74E-16	7.57E-16
Ho-154	1.70E-15	1.60E-15	1.52E-15	1.45E-15	1.36E-15	1.33E-15
Ho-154m	2.08E-15	1.96E-15	1.84E-15	1.77E-15	1.65E-15	1.61E-15
Ho-155	5.14E-16	4.80E-16	4.51E-16	4.35E-16	4.02E-16	3.94E-16
Ho-156	1.75E-15	1.64E-15	1.56E-15	1.50E-15	1.40E-15	1.37E-15
Ho-157	4.63E-16	4.28E-16	4.04E-16	3.88E-16	3.51E-16	3.43E-16
Ho-159	2.93E-16	2.68E-16	2.49E-16	2.39E-16	2.13E-16	2.08E-16
Ho-160	1.36E-15	1.27E-15	1.24E-15	1.15E-15	1.07E-15	1.05E-15
Ho-161	3.34E-17	2.73E-17	2.47E-17	2.36E-17	1.96E-17	1.90E-17
Ho-162	1.25E-16	1.13E-16	1.07E-16	1.02E-16	9.35E-17	9.13E-17
Ho-162m	4.34E-16	4.01E-16	3.89E-16	3.67E-16	3.35E-16	3.28E-16
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	3.13E-17	2.77E-17	2.62E-17	2.54E-17	2.28E-17	2.23E-17
Ho-164m	2.75E-17	2.25E-17	2.03E-17	1.95E-17	1.60E-17	1.54E-17
Ho-166	1.32E-16	1.28E-16	1.27E-16	1.24E-16	1.20E-16	1.19E-16
Ho-166m	1.32E-15	1.24E-15	1.19E-15	1.12E-15	1.04E-15	1.01E-15
Ho-167	3.13E-16	2.92E-16	2.72E-16	2.66E-16	2.39E-16	2.33E-16
Ho-168	8.37E-16	7.88E-16	7.70E-16	7.25E-16	6.82E-16	6.70E-16
Ho-168m	3.88E-18	3.17E-18	2.88E-18	2.78E-18	2.27E-18	2.19E-18
Ho-170	1.48E-15	1.39E-15	1.36E-15	1.28E-15	1.18E-15	1.16E-15
<b>Erbium</b>						
Er-154	5.11E-17	4.47E-17	4.08E-17	3.92E-17	3.48E-17	3.38E-17
Er-156	4.12E-17	3.47E-17	3.12E-17	3.01E-17	2.52E-17	2.44E-17
Er-159	7.69E-16	7.18E-16	6.83E-16	6.51E-16	6.08E-16	5.95E-16
Er-161	7.87E-16	7.31E-16	7.14E-16	6.68E-16	6.18E-16	6.05E-16
Er-163	2.50E-17	2.05E-17	1.87E-17	1.80E-17	1.48E-17	1.43E-17
Er-165	2.33E-17	1.90E-17	1.73E-17	1.67E-17	1.36E-17	1.31E-17
Er-167m	7.54E-17	7.01E-17	6.47E-17	6.39E-17	5.36E-17	5.25E-17
Er-169	2.51E-18	2.34E-18	2.33E-18	2.16E-18	2.00E-18	1.96E-18
Er-171	3.43E-16	3.19E-16	3.01E-16	2.94E-16	2.63E-16	2.57E-16
Er-172	4.26E-16	3.98E-16	3.72E-16	3.56E-16	3.32E-16	3.24E-16
Er-173	7.65E-16	7.16E-16	6.95E-16	6.57E-16	6.05E-16	5.94E-16
<b>Thulium</b>						
Tm-161	1.01E-15	9.40E-16	8.88E-16	8.58E-16	7.97E-16	7.81E-16
Tm-162	1.54E-15	1.45E-15	1.38E-15	1.33E-15	1.25E-15	1.23E-15
Tm-163	1.02E-15	9.46E-16	9.09E-16	8.68E-16	8.03E-16	7.87E-16
Tm-164	7.14E-16	6.72E-16	6.37E-16	6.12E-16	5.79E-16	5.67E-16
Tm-165	4.45E-16	4.11E-16	3.89E-16	3.74E-16	3.36E-16	3.29E-16
Tm-166	1.52E-15	1.42E-15	1.36E-15	1.30E-15	1.22E-15	1.19E-15
Tm-167	1.09E-16	9.93E-17	9.13E-17	8.95E-17	7.55E-17	7.37E-17
Tm-168	1.00E-15	9.35E-16	8.99E-16	8.46E-16	7.81E-16	7.64E-16
Tm-170	3.63E-17	3.51E-17	3.48E-17	3.39E-17	3.28E-17	3.26E-17
Tm-171	6.31E-19	5.66E-19	5.26E-19	5.05E-19	4.39E-19	4.27E-19



**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	4.41E-16	4.15E-16	4.03E-16	3.87E-16	3.64E-16	3.58E-16
Tm-173	3.50E-16	3.30E-16	3.06E-16	2.98E-16	2.76E-16	2.70E-16
Tm-174	1.48E-15	1.38E-15	1.33E-15	1.27E-15	1.16E-15	1.13E-15
Tm-175	9.42E-16	8.84E-16	8.50E-16	8.05E-16	7.55E-16	7.39E-16
Tm-176	1.65E-15	1.55E-15	1.49E-15	1.43E-15	1.33E-15	1.31E-15
<b>Ytterbium</b>						
Yb-162	1.93E-16	1.79E-16	1.63E-16	1.56E-16	1.42E-16	1.39E-16
Yb-163	6.18E-16	5.79E-16	5.52E-16	5.27E-16	4.94E-16	4.83E-16
Yb-164	3.66E-17	3.18E-17	2.91E-17	2.80E-17	2.40E-17	2.33E-17
Yb-165	2.65E-16	2.43E-16	2.30E-16	2.20E-16	2.01E-16	1.96E-16
Yb-166	5.67E-17	4.84E-17	4.38E-17	4.23E-17	3.56E-17	3.44E-17
Yb-167	1.95E-16	1.72E-16	1.59E-16	1.51E-16	1.35E-16	1.31E-16
Yb-169	2.42E-16	2.20E-16	2.00E-16	1.95E-16	1.67E-16	1.63E-16
Yb-175	3.55E-17	3.31E-17	3.08E-17	2.99E-17	2.71E-17	2.64E-17
Yb-177	2.13E-16	2.03E-16	1.97E-16	1.87E-16	1.76E-16	1.74E-16
Yb-178	4.05E-17	3.81E-17	3.59E-17	3.48E-17	3.20E-17	3.13E-17
Yb-179	9.13E-16	8.62E-16	8.16E-16	7.80E-16	7.38E-16	7.22E-16
<b>Lutetium</b>						
Lu-165	9.24E-16	8.64E-16	8.16E-16	7.85E-16	7.32E-16	7.17E-16
Lu-167	1.30E-15	1.21E-15	1.16E-15	1.11E-15	1.04E-15	1.02E-15
Lu-169	1.02E-15	9.49E-16	9.19E-16	8.71E-16	8.07E-16	7.91E-16
Lu-169m	1.05E-22	7.50E-23	5.52E-23	4.89E-23	3.71E-23	3.54E-23
Lu-170	1.89E-15	1.77E-15	1.70E-15	1.64E-15	1.53E-15	1.51E-15
Lu-171	5.16E-16	4.79E-16	4.61E-16	4.32E-16	4.01E-16	3.92E-16
Lu-171m	2.22E-19	2.04E-19	1.79E-19	1.79E-19	1.51E-19	1.45E-19
Lu-172	1.55E-15	1.44E-15	1.41E-15	1.32E-15	1.22E-15	1.20E-15
Lu-172m	9.08E-22	7.04E-22	6.19E-22	5.88E-22	4.71E-22	4.51E-22
Lu-173	1.34E-16	1.21E-16	1.11E-16	1.08E-16	9.28E-17	9.04E-17
Lu-174	8.37E-17	7.58E-17	7.20E-17	6.86E-17	6.15E-17	6.01E-17
Lu-174m	4.02E-17	3.56E-17	3.21E-17	3.13E-17	2.65E-17	2.57E-17
Lu-176	3.93E-16	3.67E-16	3.41E-16	3.35E-16	2.90E-16	2.83E-16
Lu-176m	7.26E-17	7.01E-17	6.92E-17	6.75E-17	6.55E-17	6.50E-17
Lu-177	3.15E-17	2.91E-17	2.72E-17	2.63E-17	2.30E-17	2.24E-17
Lu-177m	8.00E-16	7.47E-16	6.87E-16	6.72E-16	5.94E-16	5.80E-16
Lu-178	2.19E-16	2.09E-16	2.06E-16	1.99E-16	1.91E-16	1.89E-16
Lu-178m	8.93E-16	8.34E-16	7.75E-16	7.56E-16	6.82E-16	6.65E-16
Lu-179	9.68E-17	9.38E-17	9.20E-17	9.03E-17	8.59E-17	8.52E-17
Lu-180	1.28E-15	1.20E-15	1.16E-15	1.11E-15	1.03E-15	1.01E-15
Lu-181	5.90E-16	5.57E-16	5.35E-16	5.11E-16	4.79E-16	4.70E-16
<b>Hafnium</b>						
Hf-167	5.88E-16	5.54E-16	5.19E-16	5.03E-16	4.68E-16	4.57E-16
Hf-169	5.47E-16	5.14E-16	4.76E-16	4.58E-16	4.31E-16	4.20E-16
Hf-170	3.48E-16	3.25E-16	3.01E-16	2.88E-16	2.65E-16	2.59E-16
Hf-172	6.88E-17	6.12E-17	5.45E-17	5.29E-17	4.56E-17	4.42E-17
Hf-173	3.08E-16	2.85E-16	2.62E-16	2.53E-16	2.26E-16	2.20E-16
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	2.82E-16	2.62E-16	2.42E-16	2.37E-16	2.11E-16	2.05E-16
Hf-177m	1.84E-15	1.72E-15	1.60E-15	1.56E-15	1.38E-15	1.35E-15
Hf-178m	1.84E-15	1.72E-15	1.60E-15	1.55E-15	1.41E-15	1.38E-15
Hf-179m	7.43E-16	6.97E-16	6.39E-16	6.22E-16	5.63E-16	5.50E-16
Hf-180m	8.06E-16	7.54E-16	6.98E-16	6.80E-16	6.13E-16	5.98E-16
Hf-181	4.40E-16	4.15E-16	3.80E-16	3.66E-16	3.43E-16	3.34E-16
Hf-182	1.93E-16	1.80E-16	1.68E-16	1.66E-16	1.42E-16	1.39E-16
Hf-182m	7.43E-16	6.94E-16	6.55E-16	6.26E-16	5.73E-16	5.59E-16
Hf-183	6.88E-16	6.47E-16	6.24E-16	5.89E-16	5.52E-16	5.40E-16
Hf-184	2.16E-16	2.05E-16	1.88E-16	1.83E-16	1.66E-16	1.63E-16
<b>Tantalum</b>						
Ta-170	1.11E-15	1.04E-15	9.94E-16	9.52E-16	9.01E-16	8.81E-16
Ta-172	1.42E-15	1.33E-15	1.28E-15	1.21E-15	1.13E-15	1.11E-15
Ta-173	4.65E-16	4.34E-16	4.11E-16	3.94E-16	3.64E-16	3.57E-16
Ta-174	8.27E-16	7.76E-16	7.36E-16	7.08E-16	6.57E-16	6.44E-16
Ta-175	8.58E-16	7.99E-16	7.63E-16	7.32E-16	6.75E-16	6.61E-16
Ta-176	1.69E-15	1.58E-15	1.52E-15	1.46E-15	1.36E-15	1.33E-15
Ta-177	4.71E-17	4.22E-17	3.82E-17	3.70E-17	3.21E-17	3.11E-17
Ta-178	8.99E-17	8.22E-17	7.69E-17	7.38E-17	6.66E-17	6.50E-17
Ta-178m	9.34E-16	8.69E-16	8.04E-16	7.84E-16	7.03E-16	6.85E-16
Ta-179	1.64E-17	1.46E-17	1.29E-17	1.27E-17	1.06E-17	1.03E-17
Ta-180	3.40E-17	3.03E-17	2.72E-17	2.65E-17	2.28E-17	2.20E-17
Ta-182	1.01E-15	9.44E-16	9.22E-16	8.69E-16	8.02E-16	7.86E-16
Ta-182m	1.99E-16	1.90E-16	1.68E-16	1.65E-16	1.44E-16	1.41E-16
Ta-183	2.36E-16	2.20E-16	2.02E-16	1.98E-16	1.73E-16	1.69E-16
Ta-184	1.33E-15	1.24E-15	1.19E-15	1.13E-15	1.04E-15	1.02E-15
Ta-185	2.24E-16	2.15E-16	2.04E-16	2.00E-16	1.86E-16	1.83E-16
Ta-186	1.32E-15	1.25E-15	1.19E-15	1.14E-15	1.06E-15	1.03E-15
<b>Tungsten</b>						
W-177	7.26E-16	6.75E-16	6.42E-16	6.09E-16	5.60E-16	5.47E-16
W-178	1.00E-17	9.11E-18	7.98E-18	7.91E-18	6.65E-18	6.44E-18
W-179	3.44E-17	3.08E-17	2.68E-17	2.64E-17	2.22E-17	2.14E-17
W-179m	4.02E-17	3.73E-17	3.34E-17	3.32E-17	2.80E-17	2.72E-17
W-181	2.67E-17	2.42E-17	2.12E-17	2.11E-17	1.77E-17	1.71E-17
W-185	3.64E-18	3.39E-18	3.37E-18	3.13E-18	2.90E-18	2.85E-18
W-185m	1.80E-17	1.71E-17	1.50E-17	1.48E-17	1.29E-17	1.26E-17
W-187	3.94E-16	3.71E-16	3.51E-16	3.34E-16	3.14E-16	3.07E-16
W-188	4.00E-18	3.73E-18	3.62E-18	3.44E-18	3.09E-18	3.03E-18
W-190	1.43E-16	1.38E-16	1.23E-16	1.21E-16	1.09E-16	1.07E-16
<b>Rhenium</b>						
Re-178	1.37E-15	1.29E-15	1.23E-15	1.18E-15	1.11E-15	1.09E-15
Re-179	8.57E-16	8.02E-16	7.54E-16	7.29E-16	6.72E-16	6.57E-16
Re-180	9.76E-16	9.10E-16	8.90E-16	8.30E-16	7.73E-16	7.56E-16
Re-181	6.44E-16	6.02E-16	5.69E-16	5.45E-16	4.99E-16	4.87E-16
Re-182	1.40E-15	1.31E-15	1.26E-15	1.20E-15	1.09E-15	1.07E-15
Re-182m	9.48E-16	8.84E-16	8.58E-16	8.11E-16	7.50E-16	7.35E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	1.13E-16	1.05E-16	9.31E-17	9.19E-17	7.94E-17	7.74E-17
Re-184	7.13E-16	6.64E-16	6.51E-16	6.05E-16	5.61E-16	5.49E-16
Re-184m	3.00E-16	2.80E-16	2.66E-16	2.53E-16	2.29E-16	2.24E-16
Re-186	5.30E-17	5.15E-17	4.94E-17	4.81E-17	4.61E-17	4.57E-17
Re-186m	9.96E-18	8.85E-18	7.80E-18	7.62E-18	6.48E-18	6.25E-18
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	1.77E-16	1.72E-16	1.67E-16	1.63E-16	1.57E-16	1.56E-16
Re-188m	4.90E-17	4.50E-17	3.97E-17	3.93E-17	3.42E-17	3.29E-17
Re-189	7.61E-17	7.26E-17	6.92E-17	6.78E-17	6.20E-17	6.11E-17
Re-190	1.20E-15	1.13E-15	1.07E-15	1.03E-15	9.55E-16	9.34E-16
Re-190m	8.13E-16	7.65E-16	7.21E-16	6.91E-16	6.44E-16	6.29E-16
<b>Osmium</b>						
Os-180	9.31E-17	8.72E-17	7.96E-17	7.76E-17	6.92E-17	6.73E-17
Os-181	1.09E-15	1.01E-15	9.77E-16	9.29E-16	8.55E-16	8.37E-16
Os-182	3.47E-16	3.27E-16	2.99E-16	2.90E-16	2.67E-16	2.60E-16
Os-183	5.01E-16	4.69E-16	4.35E-16	4.21E-16	3.83E-16	3.73E-16
Os-183m	7.91E-16	7.37E-16	7.24E-16	6.78E-16	6.27E-16	6.15E-16
Os-185	5.63E-16	5.28E-16	5.03E-16	4.75E-16	4.44E-16	4.34E-16
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	6.15E-23	4.01E-23	2.84E-23	2.19E-23	1.56E-23	1.47E-23
Os-190m	1.31E-15	1.23E-15	1.15E-15	1.10E-15	1.03E-15	1.00E-15
Os-191	6.01E-17	5.71E-17	4.96E-17	4.90E-17	4.34E-17	4.21E-17
Os-191m	4.06E-18	3.85E-18	3.34E-18	3.34E-18	2.83E-18	2.74E-18
Os-193	9.56E-17	9.16E-17	8.69E-17	8.48E-17	8.00E-17	7.87E-17
Os-194	1.52E-18	1.21E-18	1.09E-18	1.04E-18	8.46E-19	8.14E-19
Os-196	1.10E-16	1.05E-16	9.99E-17	9.75E-17	9.13E-17	8.98E-17
<b>Iridium</b>						
Ir-180	1.49E-15	1.40E-15	1.33E-15	1.27E-15	1.19E-15	1.16E-15
Ir-182	1.30E-15	1.22E-15	1.16E-15	1.11E-15	1.04E-15	1.01E-15
Ir-183	9.34E-16	8.75E-16	8.29E-16	8.00E-16	7.42E-16	7.27E-16
Ir-184	1.59E-15	1.48E-15	1.42E-15	1.36E-15	1.26E-15	1.23E-15
Ir-185	6.52E-16	6.10E-16	5.75E-16	5.58E-16	5.17E-16	5.06E-16
Ir-186	1.32E-15	1.23E-15	1.17E-15	1.12E-15	1.04E-15	1.02E-15
Ir-186m	9.89E-16	9.27E-16	8.87E-16	8.45E-16	7.89E-16	7.73E-16
Ir-187	2.61E-16	2.45E-16	2.31E-16	2.21E-16	2.02E-16	1.97E-16
Ir-188	1.57E-15	1.47E-15	1.39E-15	1.36E-15	1.27E-15	1.25E-15
Ir-189	5.59E-17	5.26E-17	4.66E-17	4.66E-17	3.95E-17	3.83E-17
Ir-190	1.21E-15	1.14E-15	1.06E-15	1.02E-15	9.46E-16	9.23E-16
Ir-190m	4.89E-23	2.74E-23	1.76E-23	1.05E-23	5.04E-24	4.62E-24
Ir-190n	3.97E-17	3.75E-17	3.25E-17	3.25E-17	2.77E-17	2.68E-17
Ir-191m	5.36E-17	5.10E-17	4.42E-17	4.37E-17	3.87E-17	3.76E-17
Ir-192	6.81E-16	6.38E-16	5.94E-16	5.78E-16	5.24E-16	5.11E-16
Ir-192m	5.57E-20	5.18E-20	4.84E-20	4.74E-20	4.24E-20	4.15E-20
Ir-192n	4.35E-19	4.19E-19	3.61E-19	3.61E-19	3.11E-19	3.02E-19
Ir-193m	2.19E-19	2.09E-19	1.81E-19	1.81E-19	1.54E-19	1.49E-19
Ir-194	2.09E-16	2.02E-16	1.98E-16	1.93E-16	1.84E-16	1.82E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	1.93E-15	1.81E-15	1.70E-15	1.63E-15	1.52E-15	1.48E-15
Ir-195	7.87E-17	7.50E-17	7.03E-17	6.95E-17	6.40E-17	6.27E-17
Ir-195m	3.20E-16	3.00E-16	2.80E-16	2.71E-16	2.48E-16	2.42E-16
Ir-196	3.81E-16	3.64E-16	3.55E-16	3.43E-16	3.26E-16	3.22E-16
Ir-196m	2.07E-15	1.94E-15	1.82E-15	1.74E-15	1.63E-15	1.59E-15
<b>Platinum</b>						
Pt-184	5.74E-16	5.42E-16	4.97E-16	4.83E-16	4.37E-16	4.26E-16
Pt-186	5.54E-16	5.20E-16	4.92E-16	4.67E-16	4.34E-16	4.23E-16
Pt-187	4.98E-16	4.67E-16	4.40E-16	4.22E-16	3.86E-16	3.76E-16
Pt-188	1.57E-16	1.49E-16	1.33E-16	1.33E-16	1.15E-16	1.12E-16
Pt-189	3.85E-16	3.61E-16	3.37E-16	3.25E-16	2.97E-16	2.90E-16
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	2.31E-16	2.18E-16	1.98E-16	1.94E-16	1.75E-16	1.70E-16
Pt-193	2.22E-22	1.14E-22	7.66E-23	4.48E-23	1.58E-23	1.35E-23
Pt-193m	7.45E-18	7.14E-18	6.21E-18	6.21E-18	5.31E-18	5.12E-18
Pt-195m	5.17E-17	4.84E-17	4.25E-17	4.25E-17	3.69E-17	3.55E-17
Pt-197	2.75E-17	2.60E-17	2.41E-17	2.35E-17	2.12E-17	2.06E-17
Pt-197m	6.21E-17	5.86E-17	5.28E-17	5.28E-17	4.61E-17	4.48E-17
Pt-199	2.45E-16	2.33E-16	2.23E-16	2.15E-16	2.04E-16	2.01E-16
Pt-200	5.12E-17	4.84E-17	4.38E-17	4.33E-17	3.81E-17	3.71E-17
Pt-202	1.08E-16	1.06E-16	1.06E-16	1.04E-16	1.02E-16	1.01E-16
<b>Gold</b>						
Au-186	1.37E-15	1.29E-15	1.22E-15	1.17E-15	1.09E-15	1.07E-15
Au-187	8.36E-16	7.84E-16	7.46E-16	7.18E-16	6.69E-16	6.55E-16
Au-190	1.79E-15	1.68E-15	1.59E-15	1.55E-15	1.45E-15	1.42E-15
Au-191	4.79E-16	4.50E-16	4.18E-16	4.05E-16	3.69E-16	3.60E-16
Au-192	1.47E-15	1.38E-15	1.31E-15	1.27E-15	1.18E-15	1.16E-15
Au-193	1.27E-16	1.20E-16	1.07E-16	1.07E-16	9.29E-17	9.03E-17
Au-193m	1.56E-16	1.45E-16	1.35E-16	1.35E-16	1.14E-16	1.11E-16
Au-194	8.07E-16	7.55E-16	7.16E-16	6.94E-16	6.38E-16	6.25E-16
Au-195	5.79E-17	5.45E-17	4.78E-17	4.78E-17	4.13E-17	3.98E-17
Au-195m	1.59E-16	1.48E-16	1.38E-16	1.37E-16	1.16E-16	1.14E-16
Au-196	3.84E-16	3.60E-16	3.32E-16	3.26E-16	2.92E-16	2.85E-16
Au-196m	1.84E-16	1.77E-16	1.55E-16	1.54E-16	1.34E-16	1.31E-16
Au-198	3.68E-16	3.47E-16	3.23E-16	3.13E-16	2.92E-16	2.85E-16
Au-198m	4.17E-16	3.89E-16	3.57E-16	3.51E-16	3.03E-16	2.95E-16
Au-199	7.49E-17	7.27E-17	6.36E-17	6.26E-17	5.52E-17	5.42E-17
Au-200	3.36E-16	3.19E-16	3.11E-16	2.99E-16	2.83E-16	2.79E-16
Au-200m	1.64E-15	1.53E-15	1.45E-15	1.38E-15	1.28E-15	1.25E-15
Au-201	8.62E-17	8.33E-17	8.13E-17	7.91E-17	7.65E-17	7.57E-17
Au-202	3.16E-16	3.03E-16	2.97E-16	2.87E-16	2.75E-16	2.71E-16
<b>Mercury</b>						
Hg-190	1.49E-16	1.45E-16	1.25E-16	1.23E-16	1.10E-16	1.07E-16
Hg-191m	1.19E-15	1.11E-15	1.06E-15	1.02E-15	9.33E-16	9.12E-16
Hg-192	2.12E-16	1.99E-16	1.81E-16	1.81E-16	1.55E-16	1.51E-16
Hg-193	6.53E-16	6.12E-16	5.85E-16	5.60E-16	5.15E-16	5.05E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	8.13E-16	7.61E-16	7.26E-16	6.94E-16	6.44E-16	6.30E-16
Hg-194	8.10E-22	4.36E-22	3.04E-22	2.36E-22	8.04E-23	6.81E-23
Hg-195	1.54E-16	1.45E-16	1.36E-16	1.31E-16	1.18E-16	1.15E-16
Hg-195m	1.58E-16	1.48E-16	1.37E-16	1.34E-16	1.19E-16	1.16E-16
Hg-197	5.10E-17	4.86E-17	4.25E-17	4.25E-17	3.66E-17	3.53E-17
Hg-197m	7.13E-17	6.81E-17	5.98E-17	5.88E-17	5.23E-17	5.10E-17
Hg-199m	1.40E-16	1.35E-16	1.19E-16	1.17E-16	1.04E-16	1.02E-16
Hg-203	1.93E-16	1.80E-16	1.68E-16	1.67E-16	1.43E-16	1.40E-16
Hg-205	8.88E-17	8.68E-17	8.63E-17	8.46E-17	8.25E-17	8.21E-17
Hg-206	1.50E-16	1.42E-16	1.36E-16	1.33E-16	1.22E-16	1.20E-16
Hg-207	2.16E-15	2.03E-15	1.95E-15	1.88E-15	1.76E-15	1.73E-15
<b>Thallium</b>						
Tl-190	1.30E-15	1.23E-15	1.16E-15	1.11E-15	1.05E-15	1.03E-15
Tl-190m	2.14E-15	2.01E-15	1.91E-15	1.81E-15	1.70E-15	1.67E-15
Tl-194	8.46E-16	7.99E-16	7.50E-16	7.20E-16	6.79E-16	6.63E-16
Tl-194m	2.10E-15	1.97E-15	1.87E-15	1.77E-15	1.66E-15	1.62E-15
Tl-195	9.41E-16	8.81E-16	8.42E-16	8.09E-16	7.53E-16	7.38E-16
Tl-196	1.48E-15	1.39E-15	1.32E-15	1.27E-15	1.19E-15	1.17E-15
Tl-197	3.62E-16	3.40E-16	3.19E-16	3.07E-16	2.83E-16	2.77E-16
Tl-198	1.55E-15	1.45E-15	1.38E-15	1.33E-15	1.24E-15	1.22E-15
Tl-198m	9.99E-16	9.38E-16	8.78E-16	8.42E-16	7.83E-16	7.63E-16
Tl-199	1.97E-16	1.86E-16	1.71E-16	1.67E-16	1.49E-16	1.45E-16
Tl-200	1.04E-15	9.75E-16	9.33E-16	8.91E-16	8.23E-16	8.05E-16
Tl-201	6.67E-17	6.39E-17	5.57E-17	5.57E-17	4.83E-17	4.68E-17
Tl-202	3.81E-16	3.59E-16	3.29E-16	3.20E-16	2.97E-16	2.89E-16
Tl-204	1.92E-17	1.85E-17	1.83E-17	1.78E-17	1.71E-17	1.70E-17
Tl-206	8.51E-17	8.33E-17	8.31E-17	8.15E-17	7.99E-17	7.96E-17
Tl-206m	1.98E-15	1.85E-15	1.77E-15	1.68E-15	1.55E-15	1.51E-15
Tl-207	7.73E-17	7.56E-17	7.54E-17	7.38E-17	7.23E-17	7.19E-17
Tl-208	2.51E-15	2.37E-15	2.24E-15	2.19E-15	2.07E-15	2.04E-15
Tl-209	1.77E-15	1.66E-15	1.58E-15	1.52E-15	1.43E-15	1.41E-15
Tl-210	2.33E-15	2.19E-15	2.12E-15	2.02E-15	1.89E-15	1.85E-15
<b>Lead</b>						
Pb-194	8.52E-16	7.98E-16	7.59E-16	7.27E-16	6.73E-16	6.58E-16
Pb-195m	1.37E-15	1.28E-15	1.22E-15	1.16E-15	1.08E-15	1.05E-15
Pb-196	3.97E-16	3.73E-16	3.45E-16	3.36E-16	3.03E-16	2.96E-16
Pb-197	1.20E-15	1.12E-15	1.08E-15	1.03E-15	9.58E-16	9.38E-16
Pb-197m	9.50E-16	8.90E-16	8.43E-16	8.06E-16	7.43E-16	7.25E-16
Pb-198	3.49E-16	3.28E-16	3.04E-16	2.96E-16	2.65E-16	2.58E-16
Pb-199	8.17E-16	7.64E-16	7.29E-16	6.99E-16	6.48E-16	6.34E-16
Pb-200	1.57E-16	1.50E-16	1.33E-16	1.31E-16	1.16E-16	1.13E-16
Pb-201	6.07E-16	5.68E-16	5.40E-16	5.17E-16	4.71E-16	4.60E-16
Pb-201m	3.33E-16	3.14E-16	2.99E-16	2.85E-16	2.70E-16	2.65E-16
Pb-202	3.02E-22	1.59E-22	1.08E-22	7.04E-23	2.62E-23	2.35E-23
Pb-202m	1.63E-15	1.52E-15	1.48E-15	1.39E-15	1.29E-15	1.26E-15
Pb-203	2.48E-16	2.32E-16	2.14E-16	2.12E-16	1.83E-16	1.79E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	1.68E-15	1.57E-15	1.54E-15	1.43E-15	1.33E-15	1.30E-15
Pb-205	3.09E-22	1.62E-22	1.10E-22	7.24E-23	2.69E-23	2.41E-23
Pb-209	9.64E-18	9.18E-18	9.14E-18	8.69E-18	8.28E-18	8.18E-18
Pb-210	1.25E-18	9.97E-19	9.06E-19	8.71E-19	7.05E-19	6.80E-19
Pb-211	1.19E-16	1.14E-16	1.12E-16	1.08E-16	1.03E-16	1.02E-16
Pb-212	1.17E-16	1.09E-16	1.01E-16	9.97E-17	8.52E-17	8.31E-17
Pb-214	2.19E-16	2.05E-16	1.92E-16	1.87E-16	1.67E-16	1.64E-16
<b>Bismuth</b>						
Bi-197	1.39E-15	1.30E-15	1.26E-15	1.19E-15	1.11E-15	1.09E-15
Bi-200	2.00E-15	1.88E-15	1.79E-15	1.70E-15	1.58E-15	1.54E-15
Bi-201	1.35E-15	1.26E-15	1.22E-15	1.16E-15	1.08E-15	1.06E-15
Bi-202	2.22E-15	2.08E-15	2.01E-15	1.89E-15	1.77E-15	1.73E-15
Bi-203	1.85E-15	1.73E-15	1.67E-15	1.59E-15	1.48E-15	1.46E-15
Bi-204	2.32E-15	2.16E-15	2.11E-15	1.98E-15	1.84E-15	1.80E-15
Bi-205	1.31E-15	1.22E-15	1.17E-15	1.12E-15	1.05E-15	1.03E-15
Bi-206	2.62E-15	2.45E-15	2.36E-15	2.23E-15	2.08E-15	2.04E-15
Bi-207	1.24E-15	1.16E-15	1.12E-15	1.06E-15	9.91E-16	9.70E-16
Bi-208	1.82E-15	1.72E-15	1.62E-15	1.60E-15	1.51E-15	1.49E-15
Bi-210	5.09E-17	4.98E-17	4.97E-17	4.86E-17	4.76E-17	4.73E-17
Bi-210m	2.11E-16	1.97E-16	1.84E-16	1.82E-16	1.58E-16	1.54E-16
Bi-211	3.88E-17	3.63E-17	3.36E-17	3.30E-17	2.96E-17	2.89E-17
Bi-212	1.64E-16	1.57E-16	1.54E-16	1.48E-16	1.42E-16	1.41E-16
Bi-212n	8.41E-17	8.23E-17	8.21E-17	8.05E-17	7.89E-17	7.85E-17
Bi-213	1.66E-16	1.58E-16	1.51E-16	1.46E-16	1.39E-16	1.37E-16
Bi-214	1.25E-15	1.17E-15	1.13E-15	1.08E-15	1.02E-15	1.00E-15
Bi-215	3.03E-16	2.87E-16	2.78E-16	2.69E-16	2.50E-16	2.46E-16
Bi-216	8.29E-16	7.87E-16	7.45E-16	7.18E-16	6.84E-16	6.71E-16
<b>Polonium</b>						
Po-203	1.30E-15	1.22E-15	1.18E-15	1.11E-15	1.03E-15	1.01E-15
Po-204	9.26E-16	8.64E-16	8.34E-16	7.85E-16	7.23E-16	7.07E-16
Po-205	1.26E-15	1.17E-15	1.14E-15	1.07E-15	9.99E-16	9.78E-16
Po-206	9.58E-16	8.95E-16	8.62E-16	8.14E-16	7.53E-16	7.36E-16
Po-207	1.03E-15	9.57E-16	9.36E-16	8.75E-16	8.13E-16	7.95E-16
Po-208	1.73E-20	1.62E-20	1.53E-20	1.46E-20	1.35E-20	1.32E-20
Po-209	4.95E-18	4.61E-18	4.48E-18	4.23E-18	3.84E-18	3.75E-18
Po-210	7.92E-21	7.40E-21	7.27E-21	6.74E-21	6.30E-21	6.16E-21
Po-211	6.68E-18	6.26E-18	6.07E-18	5.67E-18	5.32E-18	5.20E-18
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	5.63E-17	5.29E-17	4.99E-17	4.91E-17	4.64E-17	4.56E-17
Po-213	3.07E-20	2.87E-20	2.81E-20	2.61E-20	2.45E-20	2.39E-20
Po-214	6.76E-20	6.32E-20	6.20E-20	5.75E-20	5.38E-20	5.26E-20
Po-215	1.47E-19	1.39E-19	1.28E-19	1.23E-19	1.16E-19	1.13E-19
Po-216	1.25E-20	1.16E-20	1.14E-20	1.06E-20	9.91E-21	9.70E-21
Po-218	3.01E-22	2.80E-22	2.78E-22	2.58E-22	2.40E-22	2.35E-22
<b>Astatine</b>						
At-204	1.98E-15	1.86E-15	1.76E-15	1.67E-15	1.57E-15	1.54E-15

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	9.48E-16	8.89E-16	8.49E-16	8.06E-16	7.57E-16	7.40E-16
At-206	2.06E-15	1.93E-15	1.84E-15	1.75E-15	1.64E-15	1.60E-15
At-207	1.59E-15	1.48E-15	1.43E-15	1.35E-15	1.27E-15	1.24E-15
At-208	2.43E-15	2.28E-15	2.19E-15	2.07E-15	1.94E-15	1.89E-15
At-209	1.85E-15	1.73E-15	1.66E-15	1.56E-15	1.46E-15	1.43E-15
At-210	2.29E-15	2.14E-15	2.07E-15	1.97E-15	1.83E-15	1.79E-15
At-211	2.61E-17	2.39E-17	2.16E-17	2.08E-17	1.89E-17	1.82E-17
At-215	1.42E-19	1.34E-19	1.23E-19	1.20E-19	1.10E-19	1.08E-19
At-216	1.88E-18	1.73E-18	1.58E-18	1.54E-18	1.37E-18	1.32E-18
At-217	1.97E-19	1.84E-19	1.71E-19	1.68E-19	1.48E-19	1.44E-19
At-218	1.83E-19	1.79E-19	1.78E-19	1.74E-19	1.70E-19	1.69E-19
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	5.57E-16	5.28E-16	5.05E-16	4.93E-16	4.53E-16	4.45E-16
<b>Radon</b>						
Rn-207	8.31E-16	7.79E-16	7.41E-16	7.05E-16	6.57E-16	6.41E-16
Rn-209	9.61E-16	8.99E-16	8.56E-16	8.17E-16	7.62E-16	7.45E-16
Rn-210	4.93E-17	4.61E-17	4.40E-17	4.16E-17	3.87E-17	3.78E-17
Rn-211	1.49E-15	1.39E-15	1.35E-15	1.27E-15	1.19E-15	1.16E-15
Rn-212	2.79E-19	2.62E-19	2.51E-19	2.36E-19	2.22E-19	2.17E-19
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	6.29E-19	5.91E-19	5.58E-19	5.29E-19	5.01E-19	4.88E-19
Rn-219	4.79E-17	4.48E-17	4.16E-17	4.08E-17	3.62E-17	3.54E-17
Rn-220	5.25E-19	4.94E-19	4.60E-19	4.39E-19	4.17E-19	4.06E-19
Rn-222	3.25E-19	3.06E-19	2.84E-19	2.72E-19	2.58E-19	2.51E-19
Rn-223	3.60E-16	3.40E-16	3.27E-16	3.12E-16	2.96E-16	2.91E-16
<b>Francium</b>						
Fr-212	9.02E-16	8.40E-16	8.15E-16	7.72E-16	7.13E-16	6.99E-16
Fr-219	2.94E-18	2.76E-18	2.55E-18	2.48E-18	2.27E-18	2.21E-18
Fr-220	7.14E-18	6.55E-18	5.94E-18	5.70E-18	5.19E-18	5.02E-18
Fr-221	2.33E-17	2.17E-17	2.02E-17	1.99E-17	1.69E-17	1.65E-17
Fr-222	2.42E-16	2.30E-16	2.22E-16	2.16E-16	1.99E-16	1.96E-16
Fr-223	8.11E-17	7.58E-17	7.32E-17	7.10E-17	6.62E-17	6.52E-17
Fr-224	5.68E-16	5.36E-16	5.20E-16	4.99E-16	4.66E-16	4.59E-16
Fr-227	4.81E-16	4.53E-16	4.31E-16	4.14E-16	3.92E-16	3.84E-16
<b>Radium</b>						
Ra-219	1.38E-16	1.28E-16	1.20E-16	1.17E-16	1.04E-16	1.01E-16
Ra-220	3.91E-18	3.68E-18	3.40E-18	3.27E-18	3.09E-18	3.00E-18
Ra-221	2.75E-17	2.62E-17	2.30E-17	2.21E-17	2.02E-17	1.97E-17
Ra-222	7.53E-18	7.03E-18	6.55E-18	6.43E-18	5.68E-18	5.55E-18
Ra-223	1.09E-16	1.01E-16	9.31E-17	9.02E-17	8.08E-17	7.86E-17
Ra-224	8.32E-18	7.75E-18	7.24E-18	7.17E-18	6.05E-18	5.92E-18
Ra-225	8.91E-18	7.19E-18	6.47E-18	6.07E-18	5.09E-18	4.90E-18
Ra-226	5.76E-18	5.46E-18	4.94E-18	4.86E-18	4.17E-18	4.09E-18
Ra-227	1.65E-16	1.55E-16	1.48E-16	1.44E-16	1.33E-16	1.31E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	4.38E-20	3.05E-20	2.67E-20	2.67E-20	1.62E-20	1.57E-20
Ra-230	7.14E-17	6.65E-17	6.19E-17	5.98E-17	5.49E-17	5.34E-17
<b>Actinium</b>						
Ac-223	1.38E-17	1.28E-17	1.18E-17	1.14E-17	1.03E-17	1.00E-17
Ac-224	1.77E-16	1.63E-16	1.50E-16	1.45E-16	1.28E-16	1.25E-16
Ac-225	1.09E-17	9.98E-18	9.13E-18	8.73E-18	7.95E-18	7.71E-18
Ac-226	1.30E-16	1.23E-16	1.15E-16	1.12E-16	1.00E-16	9.82E-17
Ac-227	9.54E-20	8.33E-20	7.55E-20	7.19E-20	6.29E-20	6.10E-20
Ac-228	7.37E-16	6.90E-16	6.74E-16	6.35E-16	5.92E-16	5.80E-16
Ac-230	5.63E-16	5.33E-16	5.15E-16	4.97E-16	4.72E-16	4.65E-16
Ac-231	4.21E-16	3.95E-16	3.74E-16	3.66E-16	3.30E-16	3.23E-16
Ac-232	1.03E-15	9.67E-16	9.30E-16	8.99E-16	8.51E-16	8.37E-16
Ac-233	5.54E-16	5.27E-16	4.99E-16	4.80E-16	4.60E-16	4.51E-16
<b>Thorium</b>						
Th-223	5.44E-17	4.89E-17	4.50E-17	4.23E-17	3.94E-17	3.79E-17
Th-224	1.80E-17	1.71E-17	1.54E-17	1.51E-17	1.33E-17	1.30E-17
Th-226	6.05E-18	5.42E-18	5.09E-18	4.83E-18	4.39E-18	4.25E-18
Th-227	9.82E-17	9.07E-17	8.46E-17	8.31E-17	7.17E-17	7.00E-17
Th-228	1.59E-18	1.46E-18	1.33E-18	1.28E-18	1.14E-18	1.11E-18
Th-229	6.50E-17	5.85E-17	5.39E-17	5.12E-17	4.67E-17	4.50E-17
Th-230	3.01E-19	2.87E-19	2.49E-19	2.49E-19	2.12E-19	2.05E-19
Th-231	1.10E-17	9.71E-18	8.92E-18	8.40E-18	7.64E-18	7.36E-18
Th-232	1.59E-19	1.49E-19	1.27E-19	1.27E-19	1.07E-19	1.04E-19
Th-233	8.11E-17	7.79E-17	7.61E-17	7.37E-17	7.11E-17	7.03E-17
Th-234	7.36E-18	6.57E-18	6.07E-18	5.78E-18	5.27E-18	5.06E-18
Th-235	1.54E-16	1.49E-16	1.47E-16	1.42E-16	1.38E-16	1.37E-16
Th-236	6.91E-17	6.59E-17	6.43E-17	6.22E-17	5.97E-17	5.90E-17
<b>Protactinium</b>						
Pa-227	1.47E-17	1.30E-17	1.20E-17	1.14E-17	1.05E-17	1.00E-17
Pa-228	1.08E-15	1.00E-15	9.73E-16	9.17E-16	8.53E-16	8.34E-16
Pa-229	4.67E-17	4.01E-17	3.81E-17	3.52E-17	3.34E-17	3.19E-17
Pa-230	5.33E-16	4.94E-16	4.83E-16	4.50E-16	4.20E-16	4.10E-16
Pa-231	2.75E-17	2.53E-17	2.35E-17	2.30E-17	2.01E-17	1.96E-17
Pa-232	7.56E-16	7.06E-16	6.90E-16	6.43E-16	5.99E-16	5.86E-16
Pa-233	1.75E-16	1.61E-16	1.51E-16	1.46E-16	1.31E-16	1.27E-16
Pa-234	1.18E-15	1.10E-15	1.07E-15	1.01E-15	9.37E-16	9.17E-16
Pa-234m	1.50E-16	1.46E-16	1.46E-16	1.42E-16	1.39E-16	1.38E-16
Pa-235	7.10E-17	6.95E-17	6.93E-17	6.79E-17	6.66E-17	6.62E-17
Pa-236	8.33E-16	7.84E-16	7.55E-16	7.24E-16	6.86E-16	6.73E-16
Pa-237	5.85E-16	5.51E-16	5.38E-16	5.06E-16	4.77E-16	4.68E-16
<b>Uranium</b>						
U-227	9.12E-17	8.31E-17	7.79E-17	7.55E-17	6.63E-17	6.45E-17
U-228	3.05E-18	2.74E-18	2.55E-18	2.44E-18	2.19E-18	2.12E-18
U-230	8.71E-19	8.23E-19	7.26E-19	7.26E-19	6.20E-19	6.04E-19
U-231	5.33E-17	4.57E-17	4.33E-17	4.00E-17	3.78E-17	3.61E-17
U-232	2.05E-19	1.81E-19	1.59E-19	1.55E-19	1.31E-19	1.27E-19



**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	2.03E-19	1.80E-19	1.63E-19	1.59E-19	1.37E-19	1.33E-19
U-234	1.15E-19	9.47E-20	8.39E-20	8.18E-20	6.63E-20	6.42E-20
U-235	1.27E-16	1.21E-16	1.09E-16	1.07E-16	9.26E-17	9.07E-17
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	6.79E-20	5.29E-20	4.66E-20	4.62E-20	3.48E-20	3.36E-20
U-237	1.04E-16	9.37E-17	8.70E-17	8.35E-17	7.44E-17	7.20E-17
U-238	5.70E-20	4.52E-20	4.00E-20	3.97E-20	3.04E-20	2.94E-20
U-239	9.00E-17	8.66E-17	8.28E-17	8.14E-17	7.65E-17	7.54E-17
U-240	5.98E-18	5.35E-18	5.12E-18	4.79E-18	4.40E-18	4.27E-18
U-242	8.19E-17	7.88E-17	7.62E-17	7.43E-17	7.09E-17	7.00E-17
<b>Neptunium</b>						
Np-232	9.58E-16	8.89E-16	8.66E-16	8.12E-16	7.49E-16	7.32E-16
Np-233	6.63E-17	5.72E-17	5.46E-17	5.06E-17	4.79E-17	4.59E-17
Np-234	8.49E-16	7.89E-16	7.61E-16	7.27E-16	6.81E-16	6.68E-16
Np-235	5.33E-19	4.33E-19	3.99E-19	3.78E-19	3.28E-19	3.14E-19
Np-236	1.05E-16	9.57E-17	8.74E-17	8.27E-17	7.67E-17	7.43E-17
Np-236m	3.91E-17	3.41E-17	3.27E-17	3.03E-17	2.88E-17	2.77E-17
Np-237	1.79E-17	1.55E-17	1.42E-17	1.33E-17	1.22E-17	1.17E-17
Np-238	4.89E-16	4.56E-16	4.54E-16	4.21E-16	3.92E-16	3.85E-16
Np-239	1.42E-16	1.27E-16	1.20E-16	1.15E-16	1.03E-16	1.00E-16
Np-240	8.75E-16	8.18E-16	7.93E-16	7.44E-16	6.96E-16	6.81E-16
Np-240m	3.63E-16	3.45E-16	3.32E-16	3.19E-16	3.04E-16	2.98E-16
Np-241	8.44E-17	8.01E-17	7.84E-17	7.57E-17	7.32E-17	7.21E-17
Np-242	3.54E-16	3.37E-16	3.30E-16	3.18E-16	3.04E-16	3.00E-16
Np-242m	8.16E-16	7.66E-16	7.51E-16	7.04E-16	6.58E-16	6.45E-16
<b>Plutonium</b>						
Pu-232	4.53E-17	3.88E-17	3.71E-17	3.42E-17	3.26E-17	3.12E-17
Pu-234	4.90E-17	4.19E-17	4.01E-17	3.69E-17	3.52E-17	3.37E-17
Pu-235	6.73E-17	5.81E-17	5.58E-17	5.14E-17	4.89E-17	4.69E-17
Pu-236	7.86E-20	5.87E-20	5.00E-20	5.00E-20	3.39E-20	3.28E-20
Pu-237	3.53E-17	3.02E-17	2.88E-17	2.66E-17	2.53E-17	2.42E-17
Pu-238	5.85E-20	4.21E-20	3.51E-20	3.51E-20	2.18E-20	2.11E-20
Pu-239	7.12E-20	6.00E-20	5.33E-20	5.23E-20	4.31E-20	4.18E-20
Pu-240	5.82E-20	4.22E-20	3.54E-20	3.54E-20	2.25E-20	2.17E-20
Pu-241	2.35E-21	2.13E-21	2.05E-21	1.90E-21	1.78E-21	1.73E-21
Pu-242	1.12E-19	9.47E-20	8.61E-20	8.53E-20	7.04E-20	6.90E-20
Pu-243	2.39E-17	2.18E-17	2.04E-17	1.93E-17	1.78E-17	1.73E-17
Pu-244	1.69E-17	1.59E-17	1.53E-17	1.47E-17	1.38E-17	1.36E-17
Pu-245	3.47E-16	3.23E-16	3.10E-16	2.95E-16	2.73E-16	2.67E-16
Pu-246	1.05E-16	9.44E-17	8.78E-17	8.46E-17	7.45E-17	7.24E-17
<b>Americium</b>						
Am-237	2.91E-16	2.67E-16	2.51E-16	2.41E-16	2.19E-16	2.13E-16
Am-238	7.12E-16	6.61E-16	6.45E-16	6.03E-16	5.64E-16	5.51E-16
Am-239	1.78E-16	1.58E-16	1.50E-16	1.42E-16	1.29E-16	1.25E-16
Am-240	8.16E-16	7.57E-16	7.50E-16	6.94E-16	6.46E-16	6.32E-16
Am-241	1.55E-17	1.41E-17	1.23E-17	1.21E-17	1.02E-17	9.90E-18

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	1.80E-17	1.61E-17	1.56E-17	1.46E-17	1.39E-17	1.35E-17
Am-242m	4.01E-19	3.20E-19	2.69E-19	2.68E-19	1.99E-19	1.93E-19
Am-243	4.08E-17	3.84E-17	3.37E-17	3.37E-17	2.91E-17	2.81E-17
Am-244	6.47E-16	6.05E-16	5.89E-16	5.49E-16	5.13E-16	5.02E-16
Am-244m	8.90E-17	8.65E-17	8.62E-17	8.40E-17	8.18E-17	8.13E-17
Am-245	4.61E-17	4.31E-17	4.17E-17	4.03E-17	3.75E-17	3.68E-17
Am-246	6.41E-16	6.03E-16	5.77E-16	5.46E-16	5.09E-16	4.98E-16
Am-246m	8.44E-16	7.90E-16	7.80E-16	7.29E-16	6.82E-16	6.69E-16
Am-247	1.71E-16	1.61E-16	1.55E-16	1.50E-16	1.40E-16	1.37E-16
<b>Curium</b>						
Cm-238	5.89E-17	5.11E-17	4.85E-17	4.48E-17	4.26E-17	4.09E-17
Cm-239	1.96E-16	1.81E-16	1.66E-16	1.60E-16	1.42E-16	1.39E-16
Cm-240	8.80E-20	6.41E-20	5.19E-20	5.19E-20	3.20E-20	3.11E-20
Cm-241	4.01E-16	3.73E-16	3.46E-16	3.30E-16	3.12E-16	3.03E-16
Cm-242	7.55E-20	5.43E-20	4.39E-20	4.39E-20	2.64E-20	2.56E-20
Cm-243	1.00E-16	9.04E-17	8.51E-17	8.20E-17	7.28E-17	7.06E-17
Cm-244	7.55E-20	5.69E-20	4.73E-20	4.73E-20	3.17E-20	3.10E-20
Cm-245	7.68E-17	6.77E-17	6.35E-17	5.93E-17	5.55E-17	5.35E-17
Cm-246	3.07E-18	2.87E-18	2.76E-18	2.66E-18	2.49E-18	2.44E-18
Cm-247	2.60E-16	2.44E-16	2.26E-16	2.19E-16	2.02E-16	1.97E-16
Cm-248	1.11E-15	1.04E-15	1.00E-15	9.66E-16	9.08E-16	8.93E-16
Cm-249	4.06E-17	3.89E-17	3.79E-17	3.65E-17	3.51E-17	3.47E-17
Cm-250	1.13E-14	1.07E-14	1.03E-14	9.89E-15	9.31E-15	9.15E-15
Cm-251	1.50E-16	1.43E-16	1.38E-16	1.33E-16	1.27E-16	1.25E-16
<b>Berkelium</b>						
Bk-245	1.75E-16	1.57E-16	1.48E-16	1.41E-16	1.28E-16	1.24E-16
Bk-246	6.75E-16	6.27E-16	6.15E-16	5.71E-16	5.33E-16	5.22E-16
Bk-247	1.14E-16	1.04E-16	9.69E-17	9.37E-17	8.30E-17	8.05E-17
Bk-248m	5.61E-17	5.19E-17	4.95E-17	4.70E-17	4.49E-17	4.38E-17
Bk-249	3.85E-19	3.59E-19	3.56E-19	3.30E-19	3.07E-19	3.01E-19
Bk-250	7.36E-16	6.87E-16	6.83E-16	6.33E-16	5.89E-16	5.78E-16
Bk-251	9.14E-17	8.48E-17	7.97E-17	7.59E-17	7.18E-17	7.03E-17
<b>Californium</b>						
Cf-244	9.38E-20	6.55E-20	5.00E-20	5.00E-20	2.77E-20	2.71E-20
Cf-246	9.93E-20	7.68E-20	6.36E-20	6.36E-20	4.56E-20	4.44E-20
Cf-247	6.83E-17	6.06E-17	5.64E-17	5.27E-17	4.96E-17	4.79E-17
Cf-248	3.58E-19	3.16E-19	2.92E-19	2.84E-19	2.50E-19	2.45E-19
Cf-249	2.68E-16	2.51E-16	2.32E-16	2.26E-16	2.06E-16	2.01E-16
Cf-250	8.22E-18	7.72E-18	7.41E-18	7.14E-18	6.69E-18	6.58E-18
Cf-251	9.02E-17	8.22E-17	7.59E-17	7.26E-17	6.55E-17	6.37E-17
Cf-252	3.82E-16	3.60E-16	3.46E-16	3.33E-16	3.13E-16	3.08E-16
Cf-253	2.00E-18	1.77E-18	1.69E-18	1.58E-18	1.40E-18	1.37E-18
Cf-254	1.43E-14	1.34E-14	1.29E-14	1.24E-14	1.17E-14	1.15E-14
Cf-255	1.32E-17	1.26E-17	1.26E-17	1.21E-17	1.16E-17	1.15E-17
<b>Einsteinium</b>						
Es-249	3.25E-16	3.02E-16	2.85E-16	2.70E-16	2.51E-16	2.44E-16

**Table 4-1. Reference person effective dose rate coefficients for ground surface. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>2</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	9.48E-16	8.80E-16	8.49E-16	7.95E-16	7.37E-16	7.19E-16
Es-250m	4.31E-16	3.99E-16	3.90E-16	3.64E-16	3.39E-16	3.32E-16
Es-251	6.78E-17	6.09E-17	5.60E-17	5.24E-17	4.92E-17	4.77E-17
Es-253	2.90E-19	2.63E-19	2.39E-19	2.32E-19	2.08E-19	2.03E-19
Es-254	3.14E-18	2.72E-18	2.35E-18	2.35E-18	1.89E-18	1.83E-18
Es-254m	4.03E-16	3.78E-16	3.62E-16	3.41E-16	3.22E-16	3.15E-16
Es-255	2.20E-18	2.06E-18	2.03E-18	1.90E-18	1.77E-18	1.73E-18
Es-256	9.12E-17	8.92E-17	8.89E-17	8.72E-17	8.54E-17	8.50E-17
<b>Fermium</b>						
Fm-251	1.18E-16	1.08E-16	1.01E-16	9.48E-17	8.88E-17	8.64E-17
Fm-252	3.22E-19	2.75E-19	2.49E-19	2.42E-19	2.08E-19	2.04E-19
Fm-253	4.38E-17	3.96E-17	3.63E-17	3.42E-17	3.17E-17	3.07E-17
Fm-254	5.90E-18	5.52E-18	5.28E-18	5.09E-18	4.76E-18	4.68E-18
Fm-255	2.05E-18	1.70E-18	1.44E-18	1.42E-18	1.13E-18	1.09E-18
Fm-256	1.04E-14	9.76E-15	9.38E-15	9.03E-15	8.49E-15	8.34E-15
Fm-257	1.10E-16	1.02E-16	9.44E-17	9.04E-17	8.24E-17	8.04E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm.**

**Explanation of entries**

For each radionuclide, values for the age-dependent effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>12</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ), that is, the effective dose per unit time-integrated exposure to a radionuclide

$w_T$ : The tissue weighting factor

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-2 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to a source per unit mass basis ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{kg}$ ), multiply table entries by  $1.6 \times 10^3$ .

To convert from SI units ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{cm}^3$ ), multiply table entries by  $1.168 \times 10^{23}$ .

To convert from SI units for a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units for a source per unit mass basis ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{g}$ ), multiply table entries by  $1.868 \times 10^{23}$ .

**Radionuclide dose rate coefficients for soil contaminated to a finite depth cannot be scaled to account for a different soil density.**

<sup>12</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	8.10E-24	7.54E-24	7.43E-24	6.92E-24	6.42E-24	6.30E-24
<b>Beryllium</b>						
Be-7	3.94E-19	3.68E-19	3.41E-19	3.29E-19	3.08E-19	3.00E-19
Be-10	8.57E-20	7.98E-20	7.85E-20	7.33E-20	6.81E-20	6.68E-20
<b>Carbon</b>						
C-10	1.41E-17	1.32E-17	1.25E-17	1.19E-17	1.11E-17	1.09E-17
C-11	8.20E-18	7.67E-18	7.14E-18	6.85E-18	6.43E-18	6.28E-18
C-14	7.44E-21	6.93E-21	6.82E-21	6.36E-21	5.90E-21	5.79E-21
<b>Nitrogen</b>						
N-13	8.28E-18	7.74E-18	7.20E-18	6.92E-18	6.49E-18	6.34E-18
N-16	2.78E-17	2.66E-17	2.59E-17	2.55E-17	2.44E-17	2.42E-17
<b>Oxygen</b>						
O-14	2.42E-17	2.27E-17	2.13E-17	2.08E-17	1.96E-17	1.92E-17
O-15	8.47E-18	7.92E-18	7.38E-18	7.09E-18	6.65E-18	6.49E-18
O-19	8.39E-18	7.84E-18	7.55E-18	7.22E-18	6.69E-18	6.58E-18
<b>Fluorine</b>						
F-17	8.47E-18	7.92E-18	7.38E-18	7.09E-18	6.65E-18	6.50E-18
F-18	7.88E-18	7.37E-18	6.85E-18	6.58E-18	6.18E-18	6.03E-18
<b>Neon</b>						
Ne-19	8.66E-18	8.10E-18	7.56E-18	7.26E-18	6.82E-18	6.66E-18
Ne-24	4.74E-18	4.43E-18	4.16E-18	3.98E-18	3.73E-18	3.65E-18
<b>Sodium</b>						
Na-22	1.67E-17	1.56E-17	1.49E-17	1.42E-17	1.33E-17	1.30E-17
Na-24	2.84E-17	2.67E-17	2.54E-17	2.48E-17	2.33E-17	2.30E-17
<b>Magnesium</b>						
Mg-27	7.20E-18	6.71E-18	6.58E-18	6.14E-18	5.71E-18	5.60E-18
Mg-28	1.02E-17	9.51E-18	9.19E-18	8.71E-18	8.11E-18	7.95E-18
<b>Aluminum</b>						
Al-26	1.99E-17	1.86E-17	1.75E-17	1.70E-17	1.60E-17	1.57E-17
Al-28	1.35E-17	1.27E-17	1.21E-17	1.17E-17	1.10E-17	1.09E-17
Al-29	1.07E-17	1.00E-17	9.71E-18	9.24E-18	8.63E-18	8.49E-18
<b>Silicon</b>						
Si-31	3.15E-19	2.96E-19	2.91E-19	2.74E-19	2.58E-19	2.53E-19
Si-32	1.31E-20	1.22E-20	1.20E-20	1.12E-20	1.04E-20	1.02E-20
<b>Phosphorus</b>						
P-30	9.13E-18	8.54E-18	7.99E-18	7.67E-18	7.21E-18	7.04E-18
P-32	3.86E-19	3.63E-19	3.57E-19	3.38E-19	3.17E-19	3.13E-19
P-33	1.56E-20	1.45E-20	1.43E-20	1.33E-20	1.24E-20	1.21E-20
<b>Sulfur</b>						
S-35	7.48E-21	6.97E-21	6.86E-21	6.39E-21	5.93E-21	5.82E-21
S-37	1.92E-17	1.81E-17	1.72E-17	1.70E-17	1.60E-17	1.58E-17
S-38	1.22E-17	1.14E-17	1.08E-17	1.06E-17	9.95E-18	9.79E-18
<b>Chlorine</b>						
Cl-34	9.79E-18	9.17E-18	8.61E-18	8.26E-18	7.77E-18	7.59E-18
Cl-34m	1.53E-17	1.44E-17	1.35E-17	1.32E-17	1.24E-17	1.22E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	1.01E-19	9.38E-20	9.23E-20	8.63E-20	8.02E-20	7.88E-20
Cl-38	1.14E-17	1.07E-17	1.02E-17	9.92E-18	9.35E-18	9.20E-18
Cl-39	1.12E-17	1.05E-17	1.01E-17	9.64E-18	8.97E-18	8.81E-18
Cl-40	2.86E-17	2.69E-17	2.57E-17	2.51E-17	2.36E-17	2.33E-17
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	7.20E-20	6.70E-20	6.59E-20	6.16E-20	5.72E-20	5.61E-20
Ar-41	9.71E-18	9.05E-18	8.80E-18	8.34E-18	7.78E-18	7.64E-18
Ar-42	7.85E-20	7.31E-20	7.19E-20	6.72E-20	6.24E-20	6.13E-20
Ar-43	1.22E-17	1.14E-17	1.10E-17	1.05E-17	9.83E-18	9.66E-18
Ar-44	1.42E-17	1.33E-17	1.26E-17	1.23E-17	1.15E-17	1.13E-17
<b>Potassium</b>						
K-38	2.38E-17	2.23E-17	2.10E-17	2.05E-17	1.93E-17	1.89E-17
K-40	1.41E-18	1.32E-18	1.28E-18	1.22E-18	1.14E-18	1.12E-18
K-42	3.11E-18	2.91E-18	2.82E-18	2.70E-18	2.54E-18	2.50E-18
K-43	7.68E-18	7.16E-18	6.74E-18	6.45E-18	5.99E-18	5.86E-18
K-44	1.80E-17	1.68E-17	1.62E-17	1.56E-17	1.46E-17	1.44E-17
K-45	1.38E-17	1.29E-17	1.23E-17	1.19E-17	1.11E-17	1.09E-17
K-46	2.17E-17	2.04E-17	1.96E-17	1.90E-17	1.78E-17	1.76E-17
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	1.59E-20	1.48E-20	1.46E-20	1.36E-20	1.26E-20	1.24E-20
Ca-47	7.97E-18	7.43E-18	7.21E-18	6.84E-18	6.38E-18	6.26E-18
Ca-49	2.07E-17	1.95E-17	1.85E-17	1.83E-17	1.73E-17	1.71E-17
<b>Scandium</b>						
Sc-42m	3.25E-17	3.04E-17	2.90E-17	2.77E-17	2.59E-17	2.54E-17
Sc-43	7.95E-18	7.43E-18	6.92E-18	6.65E-18	6.23E-18	6.08E-18
Sc-44	1.67E-17	1.56E-17	1.49E-17	1.41E-17	1.32E-17	1.29E-17
Sc-44m	2.12E-18	1.97E-18	1.86E-18	1.80E-18	1.60E-18	1.57E-18
Sc-46	1.52E-17	1.42E-17	1.39E-17	1.30E-17	1.21E-17	1.19E-17
Sc-47	8.64E-19	8.25E-19	7.43E-19	7.19E-19	6.49E-19	6.39E-19
Sc-48	2.52E-17	2.35E-17	2.30E-17	2.16E-17	2.01E-17	1.97E-17
Sc-49	4.96E-19	4.67E-19	4.59E-19	4.35E-19	4.10E-19	4.04E-19
Sc-50	2.50E-17	2.34E-17	2.25E-17	2.15E-17	2.01E-17	1.97E-17
<b>Titanium</b>						
Ti-44	1.01E-18	9.29E-19	8.39E-19	8.14E-19	7.09E-19	6.89E-19
Ti-45	7.03E-18	6.57E-18	6.11E-18	5.87E-18	5.51E-18	5.38E-18
Ti-51	3.41E-18	3.17E-18	3.02E-18	2.90E-18	2.64E-18	2.59E-18
Ti-52	1.36E-18	1.27E-18	1.18E-18	1.12E-18	1.04E-18	1.02E-18
<b>Vanadium</b>						
V-47	8.32E-18	7.78E-18	7.26E-18	6.97E-18	6.54E-18	6.39E-18
V-48	2.20E-17	2.05E-17	1.99E-17	1.88E-17	1.75E-17	1.72E-17
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	1.04E-17	9.70E-18	9.29E-18	8.94E-18	8.37E-18	8.23E-18
V-52	1.13E-17	1.05E-17	1.02E-17	9.73E-18	9.10E-18	8.94E-18
V-53	8.49E-18	7.91E-18	7.78E-18	7.27E-18	6.76E-18	6.64E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	3.37E-18	3.10E-18	2.90E-18	2.80E-18	2.53E-18	2.48E-18
Cr-49	8.58E-18	8.01E-18	7.45E-18	7.15E-18	6.69E-18	6.53E-18
Cr-51	2.49E-19	2.31E-19	2.16E-19	2.10E-19	1.89E-19	1.85E-19
Cr-55	7.46E-19	7.04E-19	6.92E-19	6.57E-19	6.20E-19	6.11E-19
Cr-56	9.21E-19	8.38E-19	7.87E-19	7.47E-19	6.78E-19	6.62E-19
<b>Manganese</b>						
Mn-50m	3.62E-17	3.38E-17	3.25E-17	3.09E-17	2.88E-17	2.83E-17
Mn-51	8.46E-18	7.91E-18	7.38E-18	7.09E-18	6.65E-18	6.50E-18
Mn-52	2.61E-17	2.43E-17	2.35E-17	2.22E-17	2.07E-17	2.03E-17
Mn-52m	1.90E-17	1.77E-17	1.68E-17	1.61E-17	1.51E-17	1.48E-17
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	6.42E-18	5.97E-18	5.84E-18	5.44E-18	5.06E-18	4.96E-18
Mn-56	1.30E-17	1.21E-17	1.17E-17	1.11E-17	1.04E-17	1.02E-17
Mn-57	1.47E-18	1.38E-18	1.33E-18	1.26E-18	1.18E-18	1.16E-18
Mn-58m	1.92E-17	1.79E-17	1.73E-17	1.64E-17	1.54E-17	1.51E-17
<b>Iron</b>						
Fe-52	5.85E-18	5.49E-18	5.07E-18	4.88E-18	4.54E-18	4.44E-18
Fe-53	1.00E-17	9.36E-18	8.74E-18	8.40E-18	7.87E-18	7.69E-18
Fe-53m	2.28E-17	2.13E-17	2.06E-17	1.95E-17	1.82E-17	1.79E-17
Fe-55	1.20E-27	1.12E-27	1.02E-27	9.74E-28	8.94E-28	8.75E-28
Fe-59	8.89E-18	8.28E-18	8.09E-18	7.62E-18	7.09E-18	6.96E-18
Fe-60	1.15E-20	1.07E-20	1.06E-20	9.87E-21	9.16E-21	8.99E-21
Fe-61	1.11E-17	1.03E-17	1.00E-17	9.50E-18	8.85E-18	8.69E-18
Fe-62	4.49E-18	4.20E-18	3.93E-18	3.77E-18	3.54E-18	3.46E-18
<b>Cobalt</b>						
Co-54m	3.15E-17	2.94E-17	2.82E-17	2.68E-17	2.51E-17	2.46E-17
Co-55	1.55E-17	1.45E-17	1.39E-17	1.32E-17	1.23E-17	1.20E-17
Co-56	2.63E-17	2.46E-17	2.37E-17	2.26E-17	2.12E-17	2.08E-17
Co-57	8.99E-19	8.34E-19	7.62E-19	7.26E-19	6.67E-19	6.52E-19
Co-58	7.53E-18	7.02E-18	6.79E-18	6.37E-18	5.94E-18	5.81E-18
Co-58m	2.37E-23	1.59E-23	1.23E-23	1.12E-23	7.56E-24	7.18E-24
Co-60	1.86E-17	1.73E-17	1.69E-17	1.60E-17	1.49E-17	1.46E-17
Co-60m	3.38E-20	3.10E-20	2.94E-20	2.80E-20	2.56E-20	2.51E-20
Co-61	9.32E-19	8.63E-19	8.14E-19	7.75E-19	6.97E-19	6.82E-19
Co-62	1.29E-17	1.21E-17	1.17E-17	1.12E-17	1.04E-17	1.03E-17
Co-62m	2.05E-17	1.91E-17	1.86E-17	1.77E-17	1.65E-17	1.62E-17
<b>Nickel</b>						
Ni-56	1.32E-17	1.23E-17	1.18E-17	1.11E-17	1.03E-17	1.01E-17
Ni-57	1.44E-17	1.35E-17	1.29E-17	1.23E-17	1.16E-17	1.13E-17
Ni-59	1.23E-22	1.15E-22	1.07E-22	1.02E-22	9.61E-23	9.37E-23
Ni-63	9.71E-22	9.04E-22	8.90E-22	8.29E-22	7.70E-22	7.55E-22
Ni-65	4.48E-18	4.18E-18	4.04E-18	3.85E-18	3.60E-18	3.53E-18
Ni-66	1.48E-20	1.38E-20	1.36E-20	1.27E-20	1.17E-20	1.15E-20
<b>Copper</b>						
Cu-57	1.28E-17	1.20E-17	1.14E-17	1.09E-17	1.03E-17	1.01E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	1.24E-17	1.16E-17	1.09E-17	1.04E-17	9.79E-18	9.58E-18
Cu-60	2.93E-17	2.74E-17	2.61E-17	2.51E-17	2.35E-17	2.31E-17
Cu-61	6.59E-18	6.16E-18	5.77E-18	5.53E-18	5.17E-18	5.05E-18
Cu-62	8.85E-18	8.29E-18	7.75E-18	7.44E-18	6.99E-18	6.83E-18
Cu-64	1.49E-18	1.39E-18	1.30E-18	1.25E-18	1.17E-18	1.14E-18
Cu-66	1.45E-18	1.36E-18	1.34E-18	1.26E-18	1.18E-18	1.16E-18
Cu-67	9.10E-19	8.48E-19	7.84E-19	7.56E-19	6.74E-19	6.60E-19
Cu-69	4.57E-18	4.26E-18	4.16E-18	3.91E-18	3.64E-18	3.58E-18
<b>Zinc</b>						
Zn-60	1.28E-17	1.19E-17	1.12E-17	1.07E-17	1.00E-17	9.79E-18
Zn-61	1.33E-17	1.24E-17	1.17E-17	1.13E-17	1.06E-17	1.04E-17
Zn-62	3.45E-18	3.21E-18	3.00E-18	2.87E-18	2.68E-18	2.62E-18
Zn-63	9.19E-18	8.60E-18	8.06E-18	7.72E-18	7.24E-18	7.08E-18
Zn-65	4.35E-18	4.05E-18	3.97E-18	3.72E-18	3.46E-18	3.39E-18
Zn-69	1.27E-19	1.18E-19	1.17E-19	1.09E-19	1.02E-19	1.00E-19
Zn-69m	3.29E-18	3.07E-18	2.84E-18	2.74E-18	2.56E-18	2.50E-18
Zn-71	3.14E-18	2.94E-18	2.81E-18	2.67E-18	2.50E-18	2.45E-18
Zn-71m	1.25E-17	1.17E-17	1.10E-17	1.05E-17	9.78E-18	9.56E-18
Zn-72	1.12E-18	1.06E-18	9.52E-19	9.19E-19	8.32E-19	8.18E-19
<b>Gallium</b>						
Ga-64	2.58E-17	2.42E-17	2.30E-17	2.21E-17	2.08E-17	2.04E-17
Ga-65	9.57E-18	8.93E-18	8.37E-18	8.01E-18	7.49E-18	7.32E-18
Ga-66	1.81E-17	1.70E-17	1.62E-17	1.57E-17	1.48E-17	1.45E-17
Ga-67	1.19E-18	1.09E-18	1.02E-18	9.83E-19	8.85E-19	8.65E-19
Ga-68	7.90E-18	7.39E-18	6.90E-18	6.62E-18	6.21E-18	6.07E-18
Ga-70	4.04E-19	3.80E-19	3.73E-19	3.52E-19	3.30E-19	3.25E-19
Ga-72	1.99E-17	1.86E-17	1.79E-17	1.71E-17	1.61E-17	1.58E-17
Ga-73	2.91E-18	2.69E-18	2.54E-18	2.45E-18	2.22E-18	2.17E-18
Ga-74	2.32E-17	2.17E-17	2.06E-17	2.00E-17	1.88E-17	1.85E-17
<b>Germanium</b>						
Ge-66	5.27E-18	4.90E-18	4.58E-18	4.40E-18	4.07E-18	3.98E-18
Ge-67	1.18E-17	1.11E-17	1.04E-17	9.97E-18	9.32E-18	9.12E-18
Ge-68	5.58E-23	3.58E-23	2.04E-23	1.84E-23	6.64E-24	6.13E-24
Ge-69	7.28E-18	6.79E-18	6.53E-18	6.18E-18	5.76E-18	5.65E-18
Ge-71	5.67E-23	3.63E-23	2.07E-23	1.87E-23	6.74E-24	6.22E-24
Ge-75	4.62E-19	4.30E-19	4.12E-19	3.94E-19	3.58E-19	3.51E-19
Ge-77	8.63E-18	8.04E-18	7.65E-18	7.32E-18	6.73E-18	6.60E-18
Ge-78	2.24E-18	2.08E-18	1.95E-18	1.90E-18	1.69E-18	1.65E-18
<b>Arsenic</b>						
As-68	2.95E-17	2.76E-17	2.64E-17	2.52E-17	2.36E-17	2.31E-17
As-69	9.78E-18	9.15E-18	8.57E-18	8.23E-18	7.72E-18	7.54E-18
As-70	3.25E-17	3.04E-17	2.91E-17	2.77E-17	2.59E-17	2.54E-17
As-71	4.48E-18	4.19E-18	3.91E-18	3.75E-18	3.47E-18	3.40E-18
As-72	1.45E-17	1.35E-17	1.29E-17	1.22E-17	1.14E-17	1.12E-17
As-73	4.11E-20	3.48E-20	3.08E-20	2.85E-20	2.41E-20	2.35E-20
As-74	6.06E-18	5.66E-18	5.32E-18	5.08E-18	4.76E-18	4.65E-18



**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	3.94E-18	3.69E-18	3.51E-18	3.35E-18	3.14E-18	3.08E-18
As-77	1.41E-19	1.32E-19	1.26E-19	1.20E-19	1.10E-19	1.08E-19
As-78	1.07E-17	1.00E-17	9.59E-18	9.15E-18	8.57E-18	8.41E-18
As-79	8.05E-19	7.56E-19	7.36E-19	6.98E-19	6.54E-19	6.43E-19
<b>Selenium</b>						
Se-70	5.68E-18	5.29E-18	4.91E-18	4.72E-18	4.39E-18	4.29E-18
Se-71	1.34E-17	1.26E-17	1.19E-17	1.13E-17	1.06E-17	1.04E-17
Se-72	1.85E-19	1.48E-19	1.29E-19	1.17E-19	9.64E-20	9.38E-20
Se-73	8.73E-18	8.14E-18	7.58E-18	7.30E-18	6.77E-18	6.61E-18
Se-73m	2.14E-18	2.00E-18	1.87E-18	1.79E-18	1.67E-18	1.63E-18
Se-75	2.95E-18	2.75E-18	2.55E-18	2.47E-18	2.22E-18	2.17E-18
Se-77m	6.48E-19	6.18E-19	5.55E-19	5.38E-19	4.84E-19	4.77E-19
Se-79	8.28E-21	7.71E-21	7.59E-21	7.07E-21	6.57E-21	6.45E-21
Se-79m	6.84E-20	6.06E-20	5.70E-20	5.36E-20	4.91E-20	4.75E-20
Se-81	3.86E-19	3.62E-19	3.54E-19	3.35E-19	3.13E-19	3.08E-19
Se-81m	1.03E-19	9.16E-20	8.64E-20	8.13E-20	7.47E-20	7.25E-20
Se-83	1.98E-17	1.85E-17	1.77E-17	1.69E-17	1.58E-17	1.55E-17
Se-83m	8.23E-18	7.69E-18	7.44E-18	7.07E-18	6.60E-18	6.48E-18
Se-84	3.59E-18	3.35E-18	3.12E-18	3.01E-18	2.80E-18	2.73E-18
<b>Bromine</b>						
Br-72	2.51E-17	2.35E-17	2.25E-17	2.14E-17	2.01E-17	1.97E-17
Br-73	1.22E-17	1.14E-17	1.07E-17	1.02E-17	9.58E-18	9.36E-18
Br-74	3.26E-17	3.07E-17	2.91E-17	2.82E-17	2.66E-17	2.61E-17
Br-74m	3.11E-17	2.91E-17	2.77E-17	2.66E-17	2.50E-17	2.46E-17
Br-75	9.68E-18	9.03E-18	8.45E-18	8.12E-18	7.53E-18	7.36E-18
Br-76	2.08E-17	1.95E-17	1.84E-17	1.78E-17	1.67E-17	1.64E-17
Br-76m	2.47E-19	2.08E-19	1.85E-19	1.71E-19	1.47E-19	1.43E-19
Br-77	2.46E-18	2.29E-18	2.15E-18	2.07E-18	1.90E-18	1.86E-18
Br-77m	1.10E-19	9.82E-20	9.25E-20	8.71E-20	8.00E-20	7.77E-20
Br-78	8.82E-18	8.26E-18	7.72E-18	7.40E-18	6.95E-18	6.79E-18
Br-80	1.02E-18	9.55E-19	9.17E-19	8.71E-19	8.18E-19	8.02E-19
Br-80m	8.23E-20	6.18E-20	5.06E-20	4.53E-20	3.55E-20	3.42E-20
Br-82	2.02E-17	1.89E-17	1.82E-17	1.72E-17	1.60E-17	1.57E-17
Br-82m	4.51E-20	4.20E-20	4.06E-20	3.84E-20	3.57E-20	3.51E-20
Br-83	1.84E-19	1.72E-19	1.66E-19	1.57E-19	1.47E-19	1.44E-19
Br-84	1.31E-17	1.23E-17	1.19E-17	1.14E-17	1.07E-17	1.06E-17
Br-84m	2.13E-17	1.99E-17	1.92E-17	1.82E-17	1.70E-17	1.67E-17
Br-85	1.19E-18	1.12E-18	1.09E-18	1.03E-18	9.69E-19	9.53E-19
<b>Krypton</b>						
Kr-74	8.59E-18	8.01E-18	7.47E-18	7.18E-18	6.67E-18	6.52E-18
Kr-75	1.11E-17	1.04E-17	9.76E-18	9.36E-18	8.76E-18	8.57E-18
Kr-76	3.27E-18	3.03E-18	2.84E-18	2.74E-18	2.49E-18	2.43E-18
Kr-77	8.49E-18	7.95E-18	7.38E-18	7.09E-18	6.62E-18	6.47E-18
Kr-79	1.95E-18	1.82E-18	1.71E-18	1.64E-18	1.51E-18	1.48E-18
Kr-81	7.69E-21	6.87E-21	6.20E-21	6.00E-21	4.99E-21	4.87E-21
Kr-81m	9.85E-19	9.24E-19	8.52E-19	8.27E-19	7.28E-19	7.15E-19

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	5.74E-22	4.33E-22	3.10E-22	2.90E-22	1.15E-22	1.06E-22
Kr-85	1.06E-19	9.91E-20	9.66E-20	9.07E-20	8.44E-20	8.28E-20
Kr-85m	1.27E-18	1.21E-18	1.10E-18	1.06E-18	9.59E-19	9.42E-19
Kr-87	6.66E-18	6.25E-18	5.94E-18	5.76E-18	5.40E-18	5.31E-18
Kr-88	1.39E-17	1.30E-17	1.23E-17	1.20E-17	1.13E-17	1.11E-17
Kr-89	1.48E-17	1.39E-17	1.33E-17	1.28E-17	1.20E-17	1.18E-17
<b>Rubidium</b>						
Rb-77	1.33E-17	1.25E-17	1.17E-17	1.12E-17	1.05E-17	1.03E-17
Rb-78	2.94E-17	2.76E-17	2.61E-17	2.54E-17	2.39E-17	2.35E-17
Rb-78m	2.53E-17	2.37E-17	2.25E-17	2.16E-17	2.02E-17	1.98E-17
Rb-79	1.18E-17	1.10E-17	1.03E-17	9.86E-18	9.21E-18	9.00E-18
Rb-80	1.11E-17	1.04E-17	9.78E-18	9.37E-18	8.80E-18	8.61E-18
Rb-81	4.00E-18	3.74E-18	3.49E-18	3.35E-18	3.14E-18	3.06E-18
Rb-81m	1.89E-19	1.75E-19	1.65E-19	1.57E-19	1.45E-19	1.42E-19
Rb-82	9.77E-18	9.14E-18	8.58E-18	8.22E-18	7.71E-18	7.54E-18
Rb-82m	2.24E-17	2.09E-17	2.00E-17	1.90E-17	1.77E-17	1.73E-17
Rb-83	3.81E-18	3.57E-18	3.32E-18	3.19E-18	2.99E-18	2.92E-18
Rb-84	7.05E-18	6.57E-18	6.34E-18	5.96E-18	5.56E-18	5.44E-18
Rb-84m	2.97E-18	2.76E-18	2.58E-18	2.50E-18	2.26E-18	2.21E-18
Rb-86	1.08E-18	1.01E-18	9.90E-19	9.29E-19	8.67E-19	8.52E-19
Rb-86m	4.30E-18	4.01E-18	3.75E-18	3.59E-18	3.37E-18	3.29E-18
Rb-87	2.84E-20	2.64E-20	2.60E-20	2.42E-20	2.25E-20	2.21E-20
Rb-88	6.36E-18	5.97E-18	5.75E-18	5.54E-18	5.22E-18	5.13E-18
Rb-89	1.69E-17	1.58E-17	1.53E-17	1.46E-17	1.36E-17	1.34E-17
Rb-90	1.49E-17	1.41E-17	1.36E-17	1.31E-17	1.24E-17	1.22E-17
Rb-90m	2.36E-17	2.21E-17	2.13E-17	2.05E-17	1.92E-17	1.89E-17
<b>Strontium</b>						
Sr-79	1.07E-17	1.00E-17	9.40E-18	9.02E-18	8.45E-18	8.26E-18
Sr-80	3.39E-18	3.17E-18	2.96E-18	2.84E-18	2.65E-18	2.59E-18
Sr-81	1.15E-17	1.07E-17	1.00E-17	9.62E-18	8.98E-18	8.78E-18
Sr-82	2.46E-21	1.90E-21	1.40E-21	1.33E-21	4.75E-22	4.31E-22
Sr-83	6.33E-18	5.90E-18	5.61E-18	5.34E-18	4.98E-18	4.87E-18
Sr-85	3.88E-18	3.63E-18	3.38E-18	3.24E-18	3.04E-18	2.97E-18
Sr-85m	1.67E-18	1.55E-18	1.45E-18	1.41E-18	1.24E-18	1.21E-18
Sr-87m	2.51E-18	2.34E-18	2.17E-18	2.10E-18	1.94E-18	1.89E-18
Sr-89	3.08E-19	2.89E-19	2.84E-19	2.68E-19	2.52E-19	2.48E-19
Sr-90	6.24E-20	5.81E-20	5.72E-20	5.34E-20	4.95E-20	4.86E-20
Sr-91	5.78E-18	5.39E-18	5.25E-18	4.92E-18	4.58E-18	4.49E-18
Sr-92	9.92E-18	9.25E-18	8.94E-18	8.52E-18	7.95E-18	7.81E-18
Sr-93	1.74E-17	1.62E-17	1.56E-17	1.48E-17	1.39E-17	1.36E-17
Sr-94	1.10E-17	1.02E-17	9.88E-18	9.45E-18	8.84E-18	8.68E-18
<b>Yttrium</b>						
Y-81	1.07E-17	1.00E-17	9.40E-18	9.02E-18	8.45E-18	8.26E-18
Y-83	1.14E-17	1.06E-17	9.99E-18	9.57E-18	8.97E-18	8.77E-18
Y-83m	7.13E-18	6.66E-18	6.22E-18	5.99E-18	5.57E-18	5.44E-18
Y-84m	3.13E-17	2.92E-17	2.81E-17	2.66E-17	2.48E-17	2.43E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	8.74E-18	8.17E-18	7.64E-18	7.32E-18	6.86E-18	6.70E-18
Y-85m	1.03E-17	9.67E-18	9.13E-18	8.78E-18	8.22E-18	8.05E-18
Y-86	2.68E-17	2.50E-17	2.41E-17	2.29E-17	2.14E-17	2.10E-17
Y-86m	1.69E-18	1.57E-18	1.47E-18	1.43E-18	1.26E-18	1.23E-18
Y-87	3.46E-18	3.23E-18	3.00E-18	2.88E-18	2.70E-18	2.64E-18
Y-87m	2.41E-18	2.24E-18	2.08E-18	2.02E-18	1.86E-18	1.81E-18
Y-88	1.95E-17	1.82E-17	1.75E-17	1.68E-17	1.57E-17	1.55E-17
Y-89m	6.88E-18	6.41E-18	6.30E-18	5.86E-18	5.44E-18	5.33E-18
Y-90	5.97E-19	5.62E-19	5.53E-19	5.25E-19	4.95E-19	4.88E-19
Y-90m	4.97E-18	4.64E-18	4.31E-18	4.16E-18	3.82E-18	3.73E-18
Y-91	3.45E-19	3.24E-19	3.19E-19	3.01E-19	2.82E-19	2.78E-19
Y-91m	4.15E-18	3.88E-18	3.63E-18	3.47E-18	3.26E-18	3.18E-18
Y-92	3.01E-18	2.82E-18	2.75E-18	2.60E-18	2.43E-18	2.39E-18
Y-93	1.53E-18	1.44E-18	1.39E-18	1.33E-18	1.25E-18	1.23E-18
Y-94	7.30E-18	6.82E-18	6.66E-18	6.28E-18	5.87E-18	5.76E-18
Y-95	8.74E-18	8.21E-18	7.87E-18	7.63E-18	7.18E-18	7.07E-18
<b>Zirconium</b>						
Zr-85	1.25E-17	1.17E-17	1.09E-17	1.05E-17	9.84E-18	9.62E-18
Zr-86	2.14E-18	1.97E-18	1.85E-18	1.80E-18	1.59E-18	1.56E-18
Zr-87	7.78E-18	7.27E-18	6.81E-18	6.53E-18	6.13E-18	5.99E-18
Zr-88	3.02E-18	2.81E-18	2.61E-18	2.52E-18	2.33E-18	2.27E-18
Zr-89	8.88E-18	8.27E-18	8.04E-18	7.53E-18	7.01E-18	6.86E-18
Zr-89m	4.93E-18	4.60E-18	4.34E-18	4.14E-18	3.89E-18	3.80E-18
Zr-93	1.15E-21	1.07E-21	1.05E-21	9.82E-22	9.12E-22	8.95E-22
Zr-95	5.71E-18	5.32E-18	5.14E-18	4.82E-18	4.50E-18	4.40E-18
Zr-97	7.18E-18	6.70E-18	6.47E-18	6.09E-18	5.68E-18	5.57E-18
<b>Niobium</b>						
Nb-87	1.08E-17	1.02E-17	9.49E-18	9.12E-18	8.49E-18	8.30E-18
Nb-88	3.34E-17	3.11E-17	2.99E-17	2.83E-17	2.64E-17	2.58E-17
Nb-88m	3.24E-17	3.02E-17	2.90E-17	2.75E-17	2.57E-17	2.52E-17
Nb-89	1.10E-17	1.03E-17	9.69E-18	9.35E-18	8.78E-18	8.61E-18
Nb-89m	1.08E-17	1.01E-17	9.40E-18	9.02E-18	8.46E-18	8.26E-18
Nb-90	3.03E-17	2.84E-17	2.70E-17	2.61E-17	2.45E-17	2.41E-17
Nb-91	1.85E-20	1.62E-20	1.44E-20	1.39E-20	1.14E-20	1.10E-20
Nb-91m	1.92E-19	1.77E-19	1.72E-19	1.63E-19	1.50E-19	1.47E-19
Nb-92	1.15E-17	1.08E-17	1.04E-17	9.76E-18	9.10E-18	8.91E-18
Nb-92m	7.30E-18	6.79E-18	6.68E-18	6.22E-18	5.77E-18	5.66E-18
Nb-93m	1.30E-21	9.38E-22	7.46E-22	7.34E-22	3.34E-22	3.06E-22
Nb-94	1.21E-17	1.12E-17	1.09E-17	1.02E-17	9.52E-18	9.33E-18
Nb-94m	3.97E-20	3.59E-20	3.45E-20	3.23E-20	2.87E-20	2.80E-20
Nb-95	5.92E-18	5.52E-18	5.35E-18	5.01E-18	4.67E-18	4.57E-18
Nb-95m	4.98E-19	4.61E-19	4.32E-19	4.20E-19	3.68E-19	3.61E-19
Nb-96	1.90E-17	1.77E-17	1.71E-17	1.61E-17	1.50E-17	1.47E-17
Nb-97	5.41E-18	5.05E-18	4.81E-18	4.55E-18	4.26E-18	4.17E-18
Nb-98m	2.17E-17	2.03E-17	1.96E-17	1.85E-17	1.73E-17	1.69E-17
Nb-99	2.34E-18	2.20E-18	2.07E-18	1.97E-18	1.83E-18	1.80E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	6.39E-18	6.00E-18	5.73E-18	5.55E-18	5.21E-18	5.13E-18
<b>Molybdenum</b>						
Mo-89	1.11E-17	1.04E-17	9.83E-18	9.42E-18	8.85E-18	8.66E-18
Mo-90	6.37E-18	5.93E-18	5.58E-18	5.35E-18	4.91E-18	4.81E-18
Mo-91	8.79E-18	8.23E-18	7.70E-18	7.39E-18	6.95E-18	6.79E-18
Mo-91m	1.09E-17	1.02E-17	9.72E-18	9.28E-18	8.69E-18	8.51E-18
Mo-93	7.27E-21	5.25E-21	4.18E-21	4.11E-21	1.87E-21	1.71E-21
Mo-93m	1.73E-17	1.61E-17	1.55E-17	1.48E-17	1.38E-17	1.35E-17
Mo-99	1.32E-18	1.23E-18	1.18E-18	1.11E-18	1.03E-18	1.01E-18
Mo-101	1.12E-17	1.05E-17	1.01E-17	9.60E-18	8.96E-18	8.79E-18
Mo-102	2.86E-19	2.68E-19	2.55E-19	2.43E-19	2.21E-19	2.17E-19
<b>Technetium</b>						
Tc-91	1.96E-17	1.84E-17	1.74E-17	1.68E-17	1.58E-17	1.55E-17
Tc-91m	1.27E-17	1.19E-17	1.12E-17	1.07E-17	1.01E-17	9.83E-18
Tc-92	3.03E-17	2.83E-17	2.69E-17	2.58E-17	2.41E-17	2.36E-17
Tc-93	1.15E-17	1.07E-17	1.03E-17	9.87E-18	9.22E-18	9.06E-18
Tc-93m	6.67E-18	6.26E-18	5.90E-18	5.76E-18	5.40E-18	5.31E-18
Tc-94	2.04E-17	1.90E-17	1.85E-17	1.73E-17	1.61E-17	1.58E-17
Tc-94m	1.53E-17	1.43E-17	1.37E-17	1.30E-17	1.22E-17	1.19E-17
Tc-95	6.07E-18	5.65E-18	5.48E-18	5.13E-18	4.78E-18	4.68E-18
Tc-95m	5.24E-18	4.89E-18	4.68E-18	4.42E-18	4.08E-18	3.99E-18
Tc-96	1.92E-17	1.78E-17	1.74E-17	1.63E-17	1.51E-17	1.48E-17
Tc-96m	3.21E-19	2.98E-19	2.88E-19	2.72E-19	2.52E-19	2.47E-19
Tc-97	9.22E-21	6.47E-21	5.17E-21	5.09E-21	2.47E-21	2.28E-21
Tc-97m	1.11E-20	8.08E-21	6.75E-21	6.54E-21	4.10E-21	3.86E-21
Tc-98	1.10E-17	1.03E-17	9.86E-18	9.29E-18	8.68E-18	8.50E-18
Tc-99	2.39E-20	2.23E-20	2.19E-20	2.05E-20	1.90E-20	1.87E-20
Tc-99m	9.36E-19	8.95E-19	7.96E-19	7.67E-19	6.99E-19	6.87E-19
Tc-101	2.85E-18	2.65E-18	2.49E-18	2.41E-18	2.18E-18	2.13E-18
Tc-102	2.24E-18	2.11E-18	2.05E-18	1.96E-18	1.85E-18	1.82E-18
Tc-102m	1.87E-17	1.75E-17	1.67E-17	1.60E-17	1.50E-17	1.47E-17
Tc-104	1.75E-17	1.64E-17	1.56E-17	1.51E-17	1.41E-17	1.39E-17
Tc-105	6.88E-18	6.43E-18	6.11E-18	5.86E-18	5.44E-18	5.34E-18
<b>Ruthenium</b>						
Ru-92	1.61E-17	1.51E-17	1.42E-17	1.36E-17	1.26E-17	1.23E-17
Ru-94	3.95E-18	3.68E-18	3.50E-18	3.33E-18	3.07E-18	3.00E-18
Ru-95	9.41E-18	8.77E-18	8.38E-18	7.99E-18	7.41E-18	7.26E-18
Ru-97	1.77E-18	1.64E-18	1.54E-18	1.49E-18	1.31E-18	1.29E-18
Ru-103	3.92E-18	3.67E-18	3.41E-18	3.28E-18	3.07E-18	3.00E-18
Ru-105	5.99E-18	5.58E-18	5.33E-18	5.04E-18	4.69E-18	4.59E-18
Ru-106	2.05E-22	1.91E-22	1.88E-22	1.75E-22	1.63E-22	1.60E-22
Ru-107	3.35E-18	3.13E-18	3.02E-18	2.87E-18	2.67E-18	2.62E-18
Ru-108	6.80E-19	6.43E-19	5.96E-19	5.72E-19	5.21E-19	5.13E-19
<b>Rhodium</b>						
Rh-94	3.10E-17	2.90E-17	2.77E-17	2.65E-17	2.48E-17	2.44E-17
Rh-95	1.97E-17	1.84E-17	1.76E-17	1.68E-17	1.57E-17	1.54E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	6.62E-18	6.21E-18	5.85E-18	5.65E-18	5.31E-18	5.21E-18
Rh-96	3.05E-17	2.85E-17	2.72E-17	2.58E-17	2.42E-17	2.36E-17
Rh-96m	1.00E-17	9.35E-18	8.93E-18	8.52E-18	7.98E-18	7.82E-18
Rh-97	1.14E-17	1.07E-17	1.00E-17	9.62E-18	8.99E-18	8.80E-18
Rh-97m	1.59E-17	1.48E-17	1.41E-17	1.36E-17	1.28E-17	1.25E-17
Rh-98	1.50E-17	1.41E-17	1.33E-17	1.27E-17	1.19E-17	1.16E-17
Rh-99	4.26E-18	3.96E-18	3.71E-18	3.56E-18	3.30E-18	3.22E-18
Rh-99m	4.96E-18	4.61E-18	4.37E-18	4.18E-18	3.86E-18	3.78E-18
Rh-100	1.99E-17	1.86E-17	1.77E-17	1.71E-17	1.60E-17	1.57E-17
Rh-100m	3.61E-19	3.28E-19	3.05E-19	2.92E-19	2.66E-19	2.60E-19
Rh-101	2.10E-18	1.95E-18	1.80E-18	1.74E-18	1.55E-18	1.52E-18
Rh-101m	2.16E-18	2.00E-18	1.87E-18	1.81E-18	1.63E-18	1.60E-18
Rh-102	3.98E-18	3.72E-18	3.48E-18	3.34E-18	3.12E-18	3.05E-18
Rh-102m	1.66E-17	1.55E-17	1.48E-17	1.40E-17	1.30E-17	1.28E-17
Rh-103m	2.19E-21	1.48E-21	1.18E-21	1.13E-21	6.67E-22	6.27E-22
Rh-104	7.34E-19	6.91E-19	6.76E-19	6.42E-19	6.05E-19	5.95E-19
Rh-104m	2.39E-19	1.99E-19	1.77E-19	1.64E-19	1.38E-19	1.34E-19
Rh-105	6.50E-19	6.03E-19	5.66E-19	5.48E-19	4.94E-19	4.84E-19
Rh-106	2.66E-18	2.49E-18	2.39E-18	2.28E-18	2.14E-18	2.10E-18
Rh-106m	2.19E-17	2.04E-17	1.96E-17	1.86E-17	1.73E-17	1.70E-17
Rh-107	2.65E-18	2.46E-18	2.31E-18	2.24E-18	2.03E-18	1.98E-18
Rh-108	3.98E-18	3.73E-18	3.55E-18	3.40E-18	3.19E-18	3.13E-18
Rh-109	2.91E-18	2.70E-18	2.55E-18	2.46E-18	2.24E-18	2.20E-18
<b>Palladium</b>						
Pd-96	1.11E-17	1.04E-17	9.90E-18	9.37E-18	8.75E-18	8.56E-18
Pd-97	1.82E-17	1.70E-17	1.62E-17	1.55E-17	1.45E-17	1.42E-17
Pd-98	3.08E-18	2.85E-18	2.71E-18	2.56E-18	2.38E-18	2.32E-18
Pd-99	9.94E-18	9.30E-18	8.76E-18	8.40E-18	7.84E-18	7.68E-18
Pd-100	7.42E-19	6.68E-19	6.06E-19	5.81E-19	5.11E-19	4.97E-19
Pd-101	2.56E-18	2.37E-18	2.25E-18	2.15E-18	1.98E-18	1.94E-18
Pd-103	1.99E-20	1.35E-20	1.08E-20	1.04E-20	6.22E-21	5.85E-21
Pd-107	1.62E-22	1.51E-22	1.48E-22	1.38E-22	1.28E-22	1.26E-22
Pd-109	1.93E-19	1.76E-19	1.70E-19	1.60E-19	1.47E-19	1.44E-19
Pd-109m	8.16E-19	7.63E-19	7.03E-19	6.82E-19	5.99E-19	5.89E-19
Pd-111	8.76E-19	8.22E-19	7.98E-19	7.58E-19	7.11E-19	6.99E-19
Pd-112	2.05E-20	1.80E-20	1.71E-20	1.61E-20	1.39E-20	1.36E-20
Pd-114	4.63E-19	4.32E-19	4.15E-19	3.95E-19	3.64E-19	3.57E-19
<b>Silver</b>						
Ag-99	1.85E-17	1.73E-17	1.64E-17	1.57E-17	1.46E-17	1.44E-17
Ag-100m	2.31E-17	2.16E-17	2.05E-17	1.96E-17	1.84E-17	1.80E-17
Ag-101	1.26E-17	1.18E-17	1.11E-17	1.07E-17	9.95E-18	9.74E-18
Ag-102	2.61E-17	2.44E-17	2.32E-17	2.22E-17	2.08E-17	2.04E-17
Ag-102m	1.45E-17	1.36E-17	1.29E-17	1.25E-17	1.18E-17	1.15E-17
Ag-103	6.47E-18	6.04E-18	5.71E-18	5.45E-18	5.06E-18	4.96E-18
Ag-104	2.06E-17	1.92E-17	1.85E-17	1.75E-17	1.63E-17	1.60E-17
Ag-104m	1.40E-17	1.31E-17	1.24E-17	1.19E-17	1.12E-17	1.10E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	3.89E-18	3.61E-18	3.40E-18	3.27E-18	2.99E-18	2.92E-18
Ag-105m	7.77E-21	7.19E-21	6.78E-21	6.52E-21	5.93E-21	5.80E-21
Ag-106	5.77E-18	5.39E-18	5.03E-18	4.83E-18	4.53E-18	4.42E-18
Ag-106m	2.14E-17	1.99E-17	1.91E-17	1.81E-17	1.69E-17	1.66E-17
Ag-108	4.69E-19	4.39E-19	4.27E-19	4.04E-19	3.79E-19	3.73E-19
Ag-108m	1.26E-17	1.17E-17	1.11E-17	1.06E-17	9.86E-18	9.64E-18
Ag-109m	3.72E-20	3.02E-20	2.68E-20	2.53E-20	2.11E-20	2.03E-20
Ag-110	1.06E-18	9.99E-19	9.75E-19	9.27E-19	8.73E-19	8.60E-19
Ag-110m	2.11E-17	1.96E-17	1.90E-17	1.79E-17	1.67E-17	1.64E-17
Ag-111	3.54E-19	3.30E-19	3.15E-19	3.01E-19	2.76E-19	2.71E-19
Ag-111m	3.47E-20	3.02E-20	2.75E-20	2.63E-20	2.28E-20	2.22E-20
Ag-112	6.17E-18	5.78E-18	5.53E-18	5.29E-18	4.97E-18	4.88E-18
Ag-113	1.00E-18	9.37E-19	9.04E-19	8.62E-19	7.97E-19	7.82E-19
Ag-113m	1.76E-18	1.64E-18	1.54E-18	1.48E-18	1.36E-18	1.33E-18
Ag-114	3.76E-18	3.54E-18	3.40E-18	3.26E-18	3.08E-18	3.02E-18
Ag-115	4.29E-18	4.01E-18	3.83E-18	3.70E-18	3.45E-18	3.39E-18
Ag-116	1.68E-17	1.57E-17	1.50E-17	1.45E-17	1.36E-17	1.34E-17
Ag-117	1.02E-17	9.52E-18	9.03E-18	8.79E-18	8.24E-18	8.11E-18
<b>Cadmium</b>						
Cd-101	1.93E-17	1.80E-17	1.71E-17	1.64E-17	1.54E-17	1.51E-17
Cd-102	6.43E-18	5.99E-18	5.65E-18	5.40E-18	5.03E-18	4.92E-18
Cd-103	1.53E-17	1.44E-17	1.36E-17	1.32E-17	1.23E-17	1.21E-17
Cd-104	1.81E-18	1.67E-18	1.58E-18	1.49E-18	1.38E-18	1.35E-18
Cd-105	9.66E-18	9.02E-18	8.57E-18	8.25E-18	7.73E-18	7.58E-18
Cd-107	1.12E-19	9.11E-20	8.16E-20	7.69E-20	6.48E-20	6.27E-20
Cd-109	6.45E-20	4.83E-20	4.10E-20	3.86E-20	2.94E-20	2.82E-20
Cd-111m	2.14E-18	1.98E-18	1.85E-18	1.79E-18	1.58E-18	1.55E-18
Cd-113	2.14E-20	1.99E-20	1.96E-20	1.83E-20	1.70E-20	1.67E-20
Cd-113m	5.84E-20	5.43E-20	5.35E-20	4.99E-20	4.63E-20	4.55E-20
Cd-115	1.64E-18	1.53E-18	1.43E-18	1.37E-18	1.29E-18	1.26E-18
Cd-115m	5.70E-19	5.34E-19	5.24E-19	4.93E-19	4.61E-19	4.53E-19
Cd-117	8.27E-18	7.71E-18	7.42E-18	7.08E-18	6.57E-18	6.45E-18
Cd-117m	1.49E-17	1.39E-17	1.34E-17	1.28E-17	1.20E-17	1.18E-17
Cd-118	4.80E-20	4.46E-20	4.39E-20	4.10E-20	3.81E-20	3.74E-20
Cd-119	1.24E-17	1.16E-17	1.11E-17	1.07E-17	9.96E-18	9.79E-18
Cd-119m	1.71E-17	1.60E-17	1.54E-17	1.48E-17	1.38E-17	1.36E-17
<b>Indium</b>						
In-103	2.17E-17	2.03E-17	1.93E-17	1.85E-17	1.73E-17	1.70E-17
In-105	1.54E-17	1.44E-17	1.36E-17	1.30E-17	1.22E-17	1.19E-17
In-106	2.82E-17	2.63E-17	2.52E-17	2.39E-17	2.23E-17	2.18E-17
In-106m	2.22E-17	2.08E-17	1.97E-17	1.89E-17	1.78E-17	1.75E-17
In-107	1.15E-17	1.07E-17	1.02E-17	9.80E-18	9.14E-18	8.97E-18
In-108	2.97E-17	2.77E-17	2.67E-17	2.53E-17	2.35E-17	2.30E-17
In-108m	2.02E-17	1.89E-17	1.79E-17	1.73E-17	1.63E-17	1.60E-17
In-109	4.81E-18	4.48E-18	4.25E-18	4.06E-18	3.73E-18	3.66E-18
In-109m	4.75E-18	4.43E-18	4.21E-18	3.99E-18	3.74E-18	3.65E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	2.37E-17	2.21E-17	2.14E-17	2.01E-17	1.87E-17	1.83E-17
In-110m	1.25E-17	1.16E-17	1.10E-17	1.05E-17	9.86E-18	9.65E-18
In-111	3.00E-18	2.80E-18	2.59E-18	2.51E-18	2.22E-18	2.18E-18
In-111m	3.69E-18	3.45E-18	3.22E-18	3.09E-18	2.90E-18	2.83E-18
In-112	2.18E-18	2.04E-18	1.90E-18	1.82E-18	1.71E-18	1.67E-18
In-112m	1.86E-19	1.69E-19	1.48E-19	1.43E-19	1.25E-19	1.23E-19
In-113m	2.02E-18	1.88E-18	1.74E-18	1.69E-18	1.55E-18	1.52E-18
In-114	4.74E-19	4.46E-19	4.38E-19	4.15E-19	3.90E-19	3.85E-19
In-114m	5.73E-19	5.30E-19	4.95E-19	4.73E-19	4.30E-19	4.21E-19
In-115	4.43E-20	4.12E-20	4.06E-20	3.79E-20	3.51E-20	3.45E-20
In-115m	1.24E-18	1.14E-18	1.06E-18	1.03E-18	9.33E-19	9.12E-19
In-116m	1.84E-17	1.71E-17	1.66E-17	1.58E-17	1.47E-17	1.44E-17
In-117	5.48E-18	5.14E-18	4.77E-18	4.58E-18	4.26E-18	4.17E-18
In-117m	8.66E-19	8.07E-19	7.56E-19	7.29E-19	6.61E-19	6.49E-19
In-118	2.13E-18	2.01E-18	1.97E-18	1.87E-18	1.76E-18	1.74E-18
In-118m	2.12E-17	1.98E-17	1.93E-17	1.81E-17	1.69E-17	1.66E-17
In-119	6.25E-18	5.82E-18	5.64E-18	5.29E-18	4.93E-18	4.83E-18
In-119m	1.16E-18	1.09E-18	1.06E-18	1.01E-18	9.43E-19	9.28E-19
In-121	7.71E-18	7.19E-18	7.05E-18	6.58E-18	6.12E-18	6.00E-18
In-121m	1.57E-18	1.47E-18	1.43E-18	1.36E-18	1.27E-18	1.25E-18
<b>Tin</b>						
Sn-106	9.28E-18	8.64E-18	8.21E-18	7.81E-18	7.24E-18	7.08E-18
Sn-108	5.22E-18	4.85E-18	4.55E-18	4.36E-18	4.00E-18	3.91E-18
Sn-109	1.61E-17	1.50E-17	1.44E-17	1.38E-17	1.29E-17	1.27E-17
Sn-110	2.17E-18	2.00E-18	1.87E-18	1.82E-18	1.61E-18	1.58E-18
Sn-111	3.78E-18	3.53E-18	3.32E-18	3.19E-18	2.98E-18	2.92E-18
Sn-113	8.42E-20	6.71E-20	5.84E-20	5.55E-20	4.47E-20	4.34E-20
Sn-113m	3.68E-20	2.55E-20	2.01E-20	1.84E-20	1.31E-20	1.25E-20
Sn-117m	1.10E-18	1.04E-18	9.24E-19	8.95E-19	8.02E-19	7.90E-19
Sn-119m	3.58E-20	2.41E-20	1.87E-20	1.70E-20	1.16E-20	1.10E-20
Sn-121	2.97E-20	2.77E-20	2.72E-20	2.54E-20	2.36E-20	2.31E-20
Sn-121m	2.33E-20	1.80E-20	1.54E-20	1.41E-20	1.15E-20	1.11E-20
Sn-123	3.15E-19	2.95E-19	2.90E-19	2.74E-19	2.56E-19	2.52E-19
Sn-123m	1.26E-18	1.19E-18	1.09E-18	1.05E-18	9.50E-19	9.36E-19
Sn-125	3.02E-18	2.82E-18	2.75E-18	2.59E-18	2.42E-18	2.37E-18
Sn-125m	3.18E-18	2.96E-18	2.79E-18	2.70E-18	2.46E-18	2.41E-18
Sn-126	3.89E-19	3.44E-19	3.17E-19	3.00E-19	2.68E-19	2.60E-19
Sn-127	1.45E-17	1.35E-17	1.31E-17	1.24E-17	1.16E-17	1.13E-17
Sn-127m	5.17E-18	4.84E-18	4.56E-18	4.37E-18	4.10E-18	4.02E-18
Sn-128	4.60E-18	4.26E-18	3.96E-18	3.79E-18	3.52E-18	3.44E-18
Sn-129	8.61E-18	8.05E-18	7.73E-18	7.33E-18	6.86E-18	6.72E-18
Sn-130	7.36E-18	6.85E-18	6.54E-18	6.19E-18	5.69E-18	5.57E-18
Sn-130m	7.66E-18	7.15E-18	6.90E-18	6.53E-18	6.09E-18	5.97E-18
<b>Antimony</b>						
Sb-111	1.26E-17	1.18E-17	1.11E-17	1.06E-17	9.90E-18	9.68E-18
Sb-113	1.04E-17	9.69E-18	9.06E-18	8.69E-18	8.14E-18	7.95E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	2.12E-17	1.98E-17	1.89E-17	1.80E-17	1.69E-17	1.65E-17
Sb-115	7.05E-18	6.58E-18	6.12E-18	5.88E-18	5.51E-18	5.38E-18
Sb-116	1.72E-17	1.61E-17	1.54E-17	1.47E-17	1.38E-17	1.35E-17
Sb-116m	2.34E-17	2.18E-17	2.10E-17	1.99E-17	1.85E-17	1.81E-17
Sb-117	1.30E-18	1.22E-18	1.10E-18	1.06E-18	9.58E-19	9.42E-19
Sb-118	6.89E-18	6.44E-18	6.03E-18	5.78E-18	5.43E-18	5.30E-18
Sb-118m	1.94E-17	1.81E-17	1.76E-17	1.66E-17	1.53E-17	1.50E-17
Sb-119	5.84E-20	3.94E-20	3.06E-20	2.77E-20	1.90E-20	1.81E-20
Sb-120	3.67E-18	3.42E-18	3.19E-18	3.06E-18	2.87E-18	2.80E-18
Sb-120m	1.84E-17	1.71E-17	1.67E-17	1.57E-17	1.45E-17	1.42E-17
Sb-122	3.78E-18	3.54E-18	3.33E-18	3.18E-18	2.98E-18	2.92E-18
Sb-122m	4.22E-19	3.67E-19	3.23E-19	3.08E-19	2.61E-19	2.54E-19
Sb-124	1.40E-17	1.31E-17	1.24E-17	1.19E-17	1.12E-17	1.10E-17
Sb-124m	3.50E-18	3.27E-18	3.08E-18	2.93E-18	2.75E-18	2.68E-18
Sb-124n	2.19E-24	1.48E-24	1.14E-24	1.03E-24	7.15E-25	6.79E-25
Sb-125	3.39E-18	3.15E-18	2.94E-18	2.82E-18	2.62E-18	2.56E-18
Sb-126	2.16E-17	2.01E-17	1.92E-17	1.82E-17	1.70E-17	1.66E-17
Sb-126m	1.24E-17	1.16E-17	1.10E-17	1.05E-17	9.78E-18	9.56E-18
Sb-127	5.53E-18	5.15E-18	4.90E-18	4.65E-18	4.33E-18	4.24E-18
Sb-128	2.42E-17	2.26E-17	2.16E-17	2.04E-17	1.90E-17	1.86E-17
Sb-128m	1.54E-17	1.43E-17	1.38E-17	1.30E-17	1.21E-17	1.18E-17
Sb-129	1.12E-17	1.05E-17	1.01E-17	9.57E-18	8.92E-18	8.75E-18
Sb-130	2.55E-17	2.37E-17	2.29E-17	2.16E-17	2.01E-17	1.96E-17
Sb-130m	2.13E-17	1.99E-17	1.93E-17	1.81E-17	1.69E-17	1.65E-17
Sb-131	1.57E-17	1.47E-17	1.42E-17	1.35E-17	1.26E-17	1.23E-17
Sb-133	2.03E-17	1.90E-17	1.83E-17	1.75E-17	1.64E-17	1.61E-17
<b>Tellurium</b>						
Te-113	1.82E-17	1.70E-17	1.62E-17	1.55E-17	1.45E-17	1.42E-17
Te-114	9.50E-18	8.85E-18	8.42E-18	8.07E-18	7.53E-18	7.38E-18
Te-115	1.75E-17	1.64E-17	1.56E-17	1.49E-17	1.39E-17	1.37E-17
Te-115m	2.00E-17	1.87E-17	1.78E-17	1.70E-17	1.59E-17	1.56E-17
Te-116	7.07E-19	6.26E-19	5.81E-19	5.47E-19	4.98E-19	4.85E-19
Te-117	1.16E-17	1.09E-17	1.03E-17	9.89E-18	9.26E-18	9.08E-18
Te-118	5.83E-20	3.98E-20	3.08E-20	2.77E-20	1.97E-20	1.87E-20
Te-119	5.84E-18	5.44E-18	5.17E-18	4.91E-18	4.59E-18	4.49E-18
Te-119m	1.11E-17	1.04E-17	1.00E-17	9.49E-18	8.79E-18	8.63E-18
Te-121	4.44E-18	4.13E-18	3.86E-18	3.69E-18	3.46E-18	3.38E-18
Te-121m	1.60E-18	1.48E-18	1.38E-18	1.34E-18	1.18E-18	1.15E-18
Te-123	1.01E-22	6.92E-23	5.36E-23	4.81E-23	3.42E-23	3.26E-23
Te-123m	1.05E-18	9.89E-19	8.82E-19	8.53E-19	7.65E-19	7.53E-19
Te-125m	1.22E-19	8.53E-20	6.68E-20	5.98E-20	4.41E-20	4.22E-20
Te-127	1.15E-19	1.07E-19	1.03E-19	9.75E-20	9.05E-20	8.87E-20
Te-127m	4.03E-20	2.91E-20	2.34E-20	2.11E-20	1.61E-20	1.55E-20
Te-129	7.25E-19	6.75E-19	6.42E-19	6.11E-19	5.69E-19	5.57E-19
Te-129m	3.68E-19	3.38E-19	3.23E-19	3.04E-19	2.82E-19	2.76E-19
Te-131	3.59E-18	3.37E-18	3.18E-18	3.03E-18	2.81E-18	2.75E-18



**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	1.11E-17	1.03E-17	9.99E-18	9.41E-18	8.74E-18	8.56E-18
Te-132	1.73E-18	1.58E-18	1.47E-18	1.42E-18	1.24E-18	1.22E-18
Te-133	9.39E-18	8.76E-18	8.37E-18	8.02E-18	7.45E-18	7.30E-18
Te-133m	1.42E-17	1.32E-17	1.28E-17	1.21E-17	1.12E-17	1.10E-17
Te-134	6.79E-18	6.32E-18	6.00E-18	5.70E-18	5.26E-18	5.15E-18
<b>Iodine</b>						
I-118	1.73E-17	1.62E-17	1.53E-17	1.46E-17	1.37E-17	1.34E-17
I-118m	2.98E-17	2.78E-17	2.65E-17	2.52E-17	2.35E-17	2.30E-17
I-119	7.38E-18	6.87E-18	6.44E-18	6.19E-18	5.72E-18	5.59E-18
I-120	2.04E-17	1.91E-17	1.81E-17	1.74E-17	1.64E-17	1.61E-17
I-120m	2.75E-17	2.57E-17	2.43E-17	2.33E-17	2.18E-17	2.13E-17
I-121	3.03E-18	2.80E-18	2.62E-18	2.52E-18	2.28E-18	2.23E-18
I-122	8.34E-18	7.80E-18	7.31E-18	7.01E-18	6.58E-18	6.43E-18
I-123	1.20E-18	1.12E-18	1.00E-18	9.66E-19	8.67E-19	8.53E-19
I-124	8.50E-18	7.93E-18	7.49E-18	7.18E-18	6.73E-18	6.59E-18
I-125	1.43E-19	9.97E-20	7.75E-20	6.93E-20	5.06E-20	4.84E-20
I-126	3.42E-18	3.18E-18	3.00E-18	2.86E-18	2.66E-18	2.60E-18
I-128	9.72E-19	9.10E-19	8.69E-19	8.29E-19	7.77E-19	7.62E-19
I-129	1.11E-19	8.15E-20	6.60E-20	5.91E-20	4.61E-20	4.44E-20
I-130	1.67E-17	1.56E-17	1.49E-17	1.41E-17	1.32E-17	1.29E-17
I-130m	9.25E-19	8.62E-19	8.08E-19	7.74E-19	7.25E-19	7.09E-19
I-131	3.06E-18	2.84E-18	2.66E-18	2.56E-18	2.35E-18	2.30E-18
I-132	1.77E-17	1.65E-17	1.58E-17	1.49E-17	1.40E-17	1.37E-17
I-132m	2.63E-18	2.45E-18	2.33E-18	2.20E-18	2.05E-18	2.01E-18
I-133	4.97E-18	4.64E-18	4.37E-18	4.17E-18	3.91E-18	3.82E-18
I-134	2.00E-17	1.87E-17	1.81E-17	1.70E-17	1.59E-17	1.56E-17
I-134m	2.15E-18	1.97E-18	1.85E-18	1.78E-18	1.59E-18	1.55E-18
I-135	1.18E-17	1.10E-17	1.06E-17	1.01E-17	9.47E-18	9.30E-18
<b>Xenon</b>						
Xe-120	2.93E-18	2.70E-18	2.55E-18	2.42E-18	2.22E-18	2.17E-18
Xe-121	1.12E-17	1.04E-17	9.85E-18	9.51E-18	8.90E-18	8.73E-18
Xe-122	4.34E-19	3.86E-19	3.49E-19	3.34E-19	2.98E-19	2.90E-19
Xe-123	4.86E-18	4.53E-18	4.25E-18	4.07E-18	3.78E-18	3.70E-18
Xe-125	1.96E-18	1.80E-18	1.68E-18	1.61E-18	1.43E-18	1.40E-18
Xe-127	2.05E-18	1.90E-18	1.75E-18	1.69E-18	1.50E-18	1.47E-18
Xe-127m	1.20E-18	1.11E-18	1.01E-18	9.65E-19	8.69E-19	8.52E-19
Xe-129m	2.40E-19	1.87E-19	1.56E-19	1.44E-19	1.16E-19	1.13E-19
Xe-131m	9.06E-20	7.01E-20	5.75E-20	5.28E-20	4.26E-20	4.13E-20
Xe-133	3.21E-19	2.79E-19	2.52E-19	2.38E-19	2.08E-19	2.02E-19
Xe-133m	2.48E-19	2.15E-19	1.94E-19	1.86E-19	1.59E-19	1.55E-19
Xe-135	2.04E-18	1.89E-18	1.78E-18	1.72E-18	1.53E-18	1.50E-18
Xe-135m	3.33E-18	3.11E-18	2.90E-18	2.78E-18	2.61E-18	2.55E-18
Xe-137	2.82E-18	2.65E-18	2.54E-18	2.43E-18	2.29E-18	2.25E-18
Xe-138	8.49E-18	7.94E-18	7.52E-18	7.31E-18	6.83E-18	6.71E-18
<b>Cesium</b>						
Cs-121	1.06E-17	9.92E-18	9.31E-18	8.93E-18	8.36E-18	8.18E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	1.03E-17	9.60E-18	9.01E-18	8.64E-18	8.05E-18	7.88E-18
Cs-123	9.09E-18	8.48E-18	7.97E-18	7.62E-18	7.13E-18	6.97E-18
Cs-124	1.08E-17	1.01E-17	9.49E-18	9.11E-18	8.55E-18	8.36E-18
Cs-125	6.02E-18	5.61E-18	5.25E-18	5.04E-18	4.72E-18	4.61E-18
Cs-126	1.00E-17	9.39E-18	8.80E-18	8.45E-18	7.91E-18	7.74E-18
Cs-127	3.30E-18	3.06E-18	2.84E-18	2.73E-18	2.53E-18	2.47E-18
Cs-128	7.59E-18	7.09E-18	6.63E-18	6.36E-18	5.97E-18	5.83E-18
Cs-129	2.07E-18	1.90E-18	1.75E-18	1.69E-18	1.55E-18	1.51E-18
Cs-130	4.13E-18	3.85E-18	3.59E-18	3.44E-18	3.23E-18	3.15E-18
Cs-130m	4.49E-19	3.88E-19	3.43E-19	3.24E-19	2.82E-19	2.74E-19
Cs-131	8.93E-20	6.33E-20	4.95E-20	4.41E-20	3.31E-20	3.17E-20
Cs-132	5.49E-18	5.10E-18	4.85E-18	4.58E-18	4.28E-18	4.19E-18
Cs-134	1.21E-17	1.13E-17	1.08E-17	1.02E-17	9.55E-18	9.35E-18
Cs-134m	1.62E-19	1.43E-19	1.25E-19	1.18E-19	1.05E-19	1.03E-19
Cs-135	1.99E-20	1.85E-20	1.82E-20	1.70E-20	1.58E-20	1.55E-20
Cs-135m	1.23E-17	1.15E-17	1.12E-17	1.04E-17	9.70E-18	9.51E-18
Cs-136	1.62E-17	1.51E-17	1.47E-17	1.38E-17	1.28E-17	1.25E-17
Cs-137	6.13E-20	5.71E-20	5.62E-20	5.25E-20	4.88E-20	4.79E-20
Cs-138	1.81E-17	1.69E-17	1.62E-17	1.56E-17	1.46E-17	1.43E-17
Cs-138m	3.25E-18	3.02E-18	2.87E-18	2.75E-18	2.56E-18	2.51E-18
Cs-139	3.48E-18	3.27E-18	3.16E-18	3.04E-18	2.86E-18	2.81E-18
Cs-140	1.43E-17	1.34E-17	1.28E-17	1.24E-17	1.16E-17	1.14E-17
<b>Barium</b>						
Ba-124	4.41E-18	4.10E-18	3.87E-18	3.68E-18	3.41E-18	3.34E-18
Ba-126	4.35E-18	4.03E-18	3.86E-18	3.66E-18	3.36E-18	3.29E-18
Ba-127	5.97E-18	5.57E-18	5.21E-18	5.00E-18	4.68E-18	4.57E-18
Ba-128	4.28E-19	3.75E-19	3.41E-19	3.27E-19	2.84E-19	2.77E-19
Ba-129	2.55E-18	2.36E-18	2.20E-18	2.12E-18	1.96E-18	1.92E-18
Ba-129m	1.19E-17	1.11E-17	1.06E-17	1.01E-17	9.35E-18	9.17E-18
Ba-131	3.60E-18	3.33E-18	3.09E-18	2.97E-18	2.73E-18	2.67E-18
Ba-131m	5.25E-19	4.59E-19	4.24E-19	3.98E-19	3.61E-19	3.50E-19
Ba-133	3.00E-18	2.75E-18	2.54E-18	2.46E-18	2.22E-18	2.17E-18
Ba-133m	4.65E-19	4.14E-19	3.80E-19	3.66E-19	3.20E-19	3.12E-19
Ba-135m	4.07E-19	3.60E-19	3.30E-19	3.17E-19	2.76E-19	2.69E-19
Ba-137m	4.65E-18	4.34E-18	4.13E-18	3.91E-18	3.65E-18	3.57E-18
Ba-139	8.97E-19	8.46E-19	8.07E-19	7.71E-19	7.14E-19	7.03E-19
Ba-140	1.52E-18	1.41E-18	1.32E-18	1.26E-18	1.18E-18	1.15E-18
Ba-141	7.64E-18	7.12E-18	6.79E-18	6.50E-18	5.99E-18	5.88E-18
Ba-142	8.09E-18	7.52E-18	7.30E-18	6.88E-18	6.36E-18	6.24E-18
<b>Lanthanum</b>						
La-128	2.28E-17	2.12E-17	2.02E-17	1.93E-17	1.79E-17	1.76E-17
La-129	7.54E-18	7.02E-18	6.57E-18	6.31E-18	5.87E-18	5.73E-18
La-130	1.79E-17	1.67E-17	1.58E-17	1.52E-17	1.41E-17	1.38E-17
La-131	5.18E-18	4.80E-18	4.48E-18	4.30E-18	3.98E-18	3.89E-18
La-132	1.53E-17	1.43E-17	1.35E-17	1.30E-17	1.22E-17	1.19E-17
La-132m	5.16E-18	4.80E-18	4.53E-18	4.30E-18	3.99E-18	3.91E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	1.18E-18	1.08E-18	1.00E-18	9.56E-19	8.81E-19	8.61E-19
La-134	6.14E-18	5.74E-18	5.37E-18	5.15E-18	4.83E-18	4.72E-18
La-135	1.95E-19	1.58E-19	1.36E-19	1.26E-19	1.08E-19	1.05E-19
La-136	3.31E-18	3.08E-18	2.87E-18	2.75E-18	2.58E-18	2.52E-18
La-137	1.11E-19	8.04E-20	6.40E-20	5.70E-20	4.39E-20	4.21E-20
La-138	9.09E-18	8.47E-18	8.16E-18	7.78E-18	7.26E-18	7.13E-18
La-140	1.73E-17	1.61E-17	1.54E-17	1.48E-17	1.38E-17	1.36E-17
La-141	8.40E-19	7.90E-19	7.73E-19	7.35E-19	6.92E-19	6.82E-19
La-142	1.72E-17	1.61E-17	1.53E-17	1.49E-17	1.40E-17	1.38E-17
La-143	2.87E-18	2.69E-18	2.60E-18	2.49E-18	2.34E-18	2.30E-18
<b>Cerium</b>						
Ce-130	3.74E-18	3.45E-18	3.26E-18	3.09E-18	2.84E-18	2.78E-18
Ce-131	1.28E-17	1.19E-17	1.13E-17	1.08E-17	1.00E-17	9.82E-18
Ce-132	2.01E-18	1.86E-18	1.70E-18	1.64E-18	1.46E-18	1.43E-18
Ce-133	4.31E-18	3.98E-18	3.69E-18	3.53E-18	3.29E-18	3.21E-18
Ce-133m	1.30E-17	1.21E-17	1.15E-17	1.10E-17	1.02E-17	1.00E-17
Ce-134	1.37E-19	1.03E-19	8.40E-20	7.57E-20	6.00E-20	5.79E-20
Ce-135	6.31E-18	5.85E-18	5.53E-18	5.27E-18	4.85E-18	4.75E-18
Ce-137	2.14E-19	1.74E-19	1.50E-19	1.39E-19	1.20E-19	1.16E-19
Ce-137m	3.75E-19	3.29E-19	3.01E-19	2.86E-19	2.49E-19	2.43E-19
Ce-139	1.12E-18	1.04E-18	9.26E-19	8.93E-19	7.92E-19	7.78E-19
Ce-141	6.01E-19	5.69E-19	5.06E-19	4.86E-19	4.41E-19	4.33E-19
Ce-143	2.30E-18	2.11E-18	1.99E-18	1.90E-18	1.73E-18	1.69E-18
Ce-144	1.55E-19	1.43E-19	1.29E-19	1.22E-19	1.11E-19	1.08E-19
Ce-145	6.55E-18	6.07E-18	5.82E-18	5.49E-18	5.09E-18	4.98E-18
<b>Praseodymium</b>						
Pr-134	2.51E-17	2.34E-17	2.22E-17	2.12E-17	1.97E-17	1.93E-17
Pr-134m	1.88E-17	1.75E-17	1.65E-17	1.59E-17	1.49E-17	1.46E-17
Pr-135	7.08E-18	6.59E-18	6.17E-18	5.92E-18	5.51E-18	5.38E-18
Pr-136	1.68E-17	1.57E-17	1.48E-17	1.42E-17	1.33E-17	1.31E-17
Pr-137	2.92E-18	2.71E-18	2.53E-18	2.42E-18	2.26E-18	2.21E-18
Pr-138	7.27E-18	6.80E-18	6.37E-18	6.11E-18	5.74E-18	5.61E-18
Pr-138m	1.90E-17	1.77E-17	1.71E-17	1.61E-17	1.49E-17	1.46E-17
Pr-139	9.57E-19	8.70E-19	8.02E-19	7.65E-19	7.07E-19	6.90E-19
Pr-140	4.62E-18	4.31E-18	4.02E-18	3.86E-18	3.62E-18	3.53E-18
Pr-142	9.18E-19	8.62E-19	8.37E-19	8.00E-19	7.52E-19	7.40E-19
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	1.25E-19	1.16E-19	1.14E-19	1.07E-19	9.99E-20	9.82E-20
Pr-144	1.06E-18	9.99E-19	9.76E-19	9.31E-19	8.78E-19	8.65E-19
Pr-144m	7.22E-20	5.65E-20	4.80E-20	4.36E-20	3.61E-20	3.50E-20
Pr-145	5.19E-19	4.86E-19	4.77E-19	4.50E-19	4.22E-19	4.15E-19
Pr-146	8.49E-18	7.94E-18	7.59E-18	7.28E-18	6.82E-18	6.70E-18
Pr-147	4.17E-18	3.85E-18	3.66E-18	3.48E-18	3.22E-18	3.15E-18
Pr-148	8.70E-18	8.13E-18	7.81E-18	7.47E-18	6.95E-18	6.83E-18
Pr-148m	8.56E-18	7.99E-18	7.60E-18	7.27E-18	6.73E-18	6.59E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	4.21E-18	3.91E-18	3.64E-18	3.48E-18	3.20E-18	3.13E-18
Nd-135	1.05E-17	9.78E-18	9.14E-18	8.78E-18	8.16E-18	7.98E-18
Nd-136	2.05E-18	1.86E-18	1.73E-18	1.64E-18	1.51E-18	1.47E-18
Nd-137	9.10E-18	8.46E-18	8.01E-18	7.65E-18	7.12E-18	6.97E-18
Nd-138	2.68E-19	2.21E-19	1.93E-19	1.80E-19	1.53E-19	1.49E-19
Nd-139	3.51E-18	3.26E-18	3.06E-18	2.92E-18	2.72E-18	2.66E-18
Nd-139m	1.20E-17	1.11E-17	1.07E-17	1.01E-17	9.39E-18	9.19E-18
Nd-140	1.52E-19	1.14E-19	9.37E-20	8.38E-20	6.63E-20	6.40E-20
Nd-141	5.23E-19	4.61E-19	4.23E-19	3.97E-19	3.60E-19	3.51E-19
Nd-141m	5.38E-18	5.01E-18	4.85E-18	4.54E-18	4.23E-18	4.14E-18
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.14E-18	1.04E-18	9.66E-19	9.19E-19	8.46E-19	8.25E-19
Nd-149	3.07E-18	2.85E-18	2.67E-18	2.56E-18	2.33E-18	2.28E-18
Nd-151	6.76E-18	6.29E-18	6.05E-18	5.73E-18	5.31E-18	5.20E-18
Nd-152	1.39E-18	1.29E-18	1.22E-18	1.17E-18	1.05E-18	1.03E-18
<b>Promethium</b>						
Pm-136	2.31E-17	2.16E-17	2.05E-17	1.95E-17	1.82E-17	1.78E-17
Pm-137m	1.46E-17	1.36E-17	1.28E-17	1.22E-17	1.13E-17	1.11E-17
Pm-139	8.09E-18	7.56E-18	7.09E-18	6.80E-18	6.37E-18	6.23E-18
Pm-140	1.00E-17	9.39E-18	8.85E-18	8.48E-18	7.96E-18	7.79E-18
Pm-140m	2.41E-17	2.24E-17	2.15E-17	2.04E-17	1.90E-17	1.86E-17
Pm-141	6.06E-18	5.65E-18	5.32E-18	5.09E-18	4.77E-18	4.66E-18
Pm-142	7.72E-18	7.23E-18	6.77E-18	6.50E-18	6.11E-18	5.97E-18
Pm-143	2.38E-18	2.19E-18	2.10E-18	1.96E-18	1.82E-18	1.78E-18
Pm-144	1.22E-17	1.13E-17	1.07E-17	1.02E-17	9.50E-18	9.28E-18
Pm-145	1.77E-19	1.36E-19	1.14E-19	1.03E-19	8.29E-20	8.02E-20
Pm-146	5.85E-18	5.44E-18	5.16E-18	4.89E-18	4.56E-18	4.45E-18
Pm-147	1.14E-20	1.06E-20	1.04E-20	9.74E-21	9.04E-21	8.87E-21
Pm-148	4.74E-18	4.43E-18	4.26E-18	4.06E-18	3.80E-18	3.73E-18
Pm-148m	1.56E-17	1.45E-17	1.38E-17	1.31E-17	1.22E-17	1.19E-17
Pm-149	2.46E-19	2.29E-19	2.22E-19	2.11E-19	1.94E-19	1.90E-19
Pm-150	1.15E-17	1.07E-17	1.03E-17	9.83E-18	9.14E-18	8.97E-18
Pm-151	2.64E-18	2.45E-18	2.30E-18	2.20E-18	2.01E-18	1.96E-18
Pm-152	3.10E-18	2.90E-18	2.81E-18	2.66E-18	2.49E-18	2.44E-18
Pm-152m	1.19E-17	1.11E-17	1.07E-17	1.01E-17	9.37E-18	9.19E-18
Pm-153	9.17E-19	8.46E-19	7.96E-19	7.55E-19	6.94E-19	6.80E-19
Pm-154	1.34E-17	1.26E-17	1.21E-17	1.16E-17	1.08E-17	1.06E-17
Pm-154m	1.39E-17	1.30E-17	1.24E-17	1.19E-17	1.10E-17	1.08E-17
<b>Samarium</b>						
Sm-139	1.21E-17	1.12E-17	1.06E-17	1.02E-17	9.46E-18	9.25E-18
Sm-140	4.37E-18	4.06E-18	3.83E-18	3.66E-18	3.39E-18	3.32E-18
Sm-141	1.13E-17	1.05E-17	9.92E-18	9.52E-18	8.90E-18	8.71E-18
Sm-141m	1.50E-17	1.40E-17	1.33E-17	1.27E-17	1.18E-17	1.16E-17
Sm-142	8.25E-19	7.43E-19	6.81E-19	6.47E-19	5.93E-19	5.79E-19
Sm-143	4.44E-18	4.13E-18	3.87E-18	3.70E-18	3.47E-18	3.39E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	5.30E-18	4.94E-18	4.77E-18	4.47E-18	4.17E-18	4.08E-18
Sm-145	3.84E-19	3.01E-19	2.55E-19	2.32E-19	1.88E-19	1.83E-19
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	1.32E-21	1.23E-21	1.21E-21	1.13E-21	1.04E-21	1.02E-21
Sm-153	5.23E-19	4.51E-19	4.16E-19	3.88E-19	3.46E-19	3.36E-19
Sm-155	1.04E-18	9.43E-19	8.96E-19	8.46E-19	7.78E-19	7.59E-19
Sm-156	9.13E-19	8.41E-19	7.80E-19	7.50E-19	6.67E-19	6.53E-19
Sm-157	3.68E-18	3.43E-18	3.26E-18	3.11E-18	2.84E-18	2.79E-18
<b>Europium</b>						
Eu-142	1.20E-17	1.13E-17	1.06E-17	1.02E-17	9.60E-18	9.41E-18
Eu-142m	2.80E-17	2.61E-17	2.50E-17	2.37E-17	2.21E-17	2.16E-17
Eu-143	9.72E-18	9.08E-18	8.57E-18	8.22E-18	7.72E-18	7.55E-18
Eu-144	1.03E-17	9.67E-18	9.10E-18	8.75E-18	8.22E-18	8.05E-18
Eu-145	9.50E-18	8.84E-18	8.51E-18	8.07E-18	7.53E-18	7.38E-18
Eu-146	1.82E-17	1.69E-17	1.62E-17	1.54E-17	1.44E-17	1.41E-17
Eu-147	3.54E-18	3.26E-18	3.11E-18	2.93E-18	2.69E-18	2.63E-18
Eu-148	1.72E-17	1.60E-17	1.52E-17	1.44E-17	1.35E-17	1.32E-17
Eu-149	4.51E-19	3.88E-19	3.49E-19	3.30E-19	2.87E-19	2.80E-19
Eu-150	1.20E-17	1.12E-17	1.05E-17	1.01E-17	9.34E-18	9.13E-18
Eu-150m	5.04E-19	4.67E-19	4.43E-19	4.22E-19	3.90E-19	3.81E-19
Eu-152	8.86E-18	8.22E-18	7.93E-18	7.49E-18	6.94E-18	6.81E-18
Eu-152m	2.52E-18	2.34E-18	2.28E-18	2.13E-18	1.98E-18	1.94E-18
Eu-152n	5.33E-19	4.70E-19	4.36E-19	4.10E-19	3.70E-19	3.58E-19
Eu-154	9.50E-18	8.84E-18	8.57E-18	8.07E-18	7.50E-18	7.36E-18
Eu-154m	4.73E-19	4.13E-19	3.73E-19	3.54E-19	3.09E-19	3.00E-19
Eu-155	4.49E-19	3.95E-19	3.66E-19	3.44E-19	3.09E-19	3.00E-19
Eu-156	9.26E-18	8.65E-18	8.33E-18	7.96E-18	7.44E-18	7.31E-18
Eu-157	2.41E-18	2.21E-18	2.06E-18	1.97E-18	1.81E-18	1.77E-18
Eu-158	1.02E-17	9.53E-18	9.29E-18	8.75E-18	8.14E-18	7.99E-18
Eu-159	2.78E-18	2.56E-18	2.44E-18	2.30E-18	2.12E-18	2.08E-18
<b>Gadolinium</b>						
Gd-142	8.54E-18	7.97E-18	7.51E-18	7.19E-18	6.72E-18	6.58E-18
Gd-143m	1.71E-17	1.60E-17	1.51E-17	1.45E-17	1.35E-17	1.32E-17
Gd-144	7.19E-18	6.71E-18	6.31E-18	6.08E-18	5.70E-18	5.59E-18
Gd-145	1.75E-17	1.64E-17	1.55E-17	1.51E-17	1.42E-17	1.39E-17
Gd-145m	5.35E-18	4.98E-18	4.78E-18	4.51E-18	4.20E-18	4.11E-18
Gd-146	1.79E-18	1.59E-18	1.43E-18	1.35E-18	1.20E-18	1.17E-18
Gd-147	1.07E-17	9.94E-18	9.52E-18	9.02E-18	8.31E-18	8.14E-18
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	4.03E-18	3.72E-18	3.48E-18	3.32E-18	3.02E-18	2.96E-18
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	4.80E-19	4.15E-19	3.71E-19	3.50E-19	3.01E-19	2.94E-19
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	7.23E-19	6.08E-19	5.50E-19	5.09E-19	4.47E-19	4.33E-19

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	5.31E-19	4.86E-19	4.55E-19	4.35E-19	3.96E-19	3.87E-19
Gd-162	3.41E-18	3.18E-18	2.96E-18	2.85E-18	2.65E-18	2.58E-18
<b>Terbium</b>						
Tb-146	2.79E-17	2.60E-17	2.49E-17	2.39E-17	2.24E-17	2.20E-17
Tb-147	1.65E-17	1.54E-17	1.48E-17	1.40E-17	1.31E-17	1.28E-17
Tb-147m	1.42E-17	1.33E-17	1.27E-17	1.22E-17	1.14E-17	1.12E-17
Tb-148	1.83E-17	1.71E-17	1.63E-17	1.55E-17	1.46E-17	1.43E-17
Tb-148m	2.44E-17	2.28E-17	2.18E-17	2.06E-17	1.92E-17	1.88E-17
Tb-149	1.02E-17	9.49E-18	9.04E-18	8.63E-18	8.02E-18	7.86E-18
Tb-149m	1.07E-17	9.97E-18	9.56E-18	9.01E-18	8.40E-18	8.22E-18
Tb-150	1.78E-17	1.66E-17	1.58E-17	1.52E-17	1.43E-17	1.40E-17
Tb-150m	1.97E-17	1.84E-17	1.74E-17	1.65E-17	1.54E-17	1.51E-17
Tb-151	7.62E-18	7.05E-18	6.64E-18	6.34E-18	5.84E-18	5.71E-18
Tb-151m	5.94E-19	5.42E-19	5.09E-19	4.82E-19	4.41E-19	4.31E-19
Tb-152	1.12E-17	1.04E-17	9.90E-18	9.52E-18	8.86E-18	8.69E-18
Tb-152m	5.87E-18	5.42E-18	5.08E-18	4.87E-18	4.44E-18	4.34E-18
Tb-153	2.48E-18	2.27E-18	2.13E-18	2.02E-18	1.82E-18	1.78E-18
Tb-154	1.62E-17	1.52E-17	1.45E-17	1.40E-17	1.31E-17	1.29E-17
Tb-155	1.28E-18	1.14E-18	1.04E-18	9.87E-19	8.75E-19	8.53E-19
Tb-156	1.46E-17	1.35E-17	1.29E-17	1.23E-17	1.14E-17	1.12E-17
Tb-156m	2.63E-19	2.16E-19	1.90E-19	1.75E-19	1.46E-19	1.42E-19
Tb-156n	2.52E-20	2.09E-20	1.86E-20	1.72E-20	1.47E-20	1.43E-20
Tb-157	3.04E-20	2.41E-20	2.08E-20	1.88E-20	1.54E-20	1.50E-20
Tb-158	6.09E-18	5.63E-18	5.50E-18	5.12E-18	4.73E-18	4.64E-18
Tb-160	8.60E-18	7.99E-18	7.79E-18	7.31E-18	6.77E-18	6.64E-18
Tb-161	2.66E-19	2.27E-19	2.04E-19	1.91E-19	1.64E-19	1.59E-19
Tb-162	8.73E-18	8.12E-18	7.86E-18	7.40E-18	6.80E-18	6.66E-18
Tb-163	6.33E-18	5.90E-18	5.51E-18	5.30E-18	4.91E-18	4.79E-18
Tb-164	1.89E-17	1.76E-17	1.69E-17	1.60E-17	1.49E-17	1.46E-17
Tb-165	6.75E-18	6.30E-18	6.08E-18	5.80E-18	5.41E-18	5.32E-18
<b>Dysprosium</b>						
Dy-148	5.57E-18	5.17E-18	4.87E-18	4.63E-18	4.32E-18	4.22E-18
Dy-149	1.21E-17	1.12E-17	1.07E-17	1.02E-17	9.54E-18	9.36E-18
Dy-150	2.17E-18	2.00E-18	1.85E-18	1.78E-18	1.64E-18	1.60E-18
Dy-151	1.03E-17	9.61E-18	9.19E-18	8.74E-18	8.13E-18	7.96E-18
Dy-152	2.18E-18	1.99E-18	1.86E-18	1.80E-18	1.58E-18	1.54E-18
Dy-153	6.55E-18	6.03E-18	5.72E-18	5.44E-18	5.00E-18	4.90E-18
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	5.03E-18	4.65E-18	4.43E-18	4.22E-18	3.85E-18	3.77E-18
Dy-157	2.67E-18	2.45E-18	2.27E-18	2.19E-18	1.97E-18	1.92E-18
Dy-159	3.01E-19	2.42E-19	2.10E-19	1.91E-19	1.58E-19	1.54E-19
Dy-165	4.07E-19	3.75E-19	3.61E-19	3.40E-19	3.15E-19	3.09E-19
Dy-165m	1.39E-19	1.25E-19	1.15E-19	1.09E-19	9.96E-20	9.71E-20
Dy-166	3.34E-19	2.88E-19	2.61E-19	2.44E-19	2.13E-19	2.07E-19
Dy-167	4.51E-18	4.19E-18	3.95E-18	3.79E-18	3.49E-18	3.41E-18
Dy-168	3.22E-18	3.00E-18	2.79E-18	2.67E-18	2.47E-18	2.41E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	1.65E-17	1.54E-17	1.47E-17	1.39E-17	1.30E-17	1.28E-17
Ho-153	8.31E-18	7.73E-18	7.30E-18	6.97E-18	6.45E-18	6.31E-18
Ho-153m	8.70E-18	8.09E-18	7.60E-18	7.26E-18	6.75E-18	6.59E-18
Ho-154	1.53E-17	1.43E-17	1.35E-17	1.30E-17	1.21E-17	1.18E-17
Ho-154m	1.93E-17	1.80E-17	1.69E-17	1.62E-17	1.51E-17	1.47E-17
Ho-155	4.75E-18	4.40E-18	4.12E-18	3.95E-18	3.65E-18	3.57E-18
Ho-156	1.62E-17	1.51E-17	1.44E-17	1.37E-17	1.28E-17	1.25E-17
Ho-157	4.45E-18	4.08E-18	3.83E-18	3.65E-18	3.33E-18	3.25E-18
Ho-159	2.88E-18	2.62E-18	2.43E-18	2.31E-18	2.07E-18	2.03E-18
Ho-160	1.30E-17	1.20E-17	1.17E-17	1.09E-17	1.01E-17	9.93E-18
Ho-161	3.63E-19	2.97E-19	2.61E-19	2.41E-19	2.02E-19	1.97E-19
Ho-162	1.21E-18	1.09E-18	1.02E-18	9.66E-19	8.81E-19	8.62E-19
Ho-162m	4.18E-18	3.85E-18	3.71E-18	3.50E-18	3.20E-18	3.14E-18
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	2.50E-19	2.11E-19	1.91E-19	1.76E-19	1.52E-19	1.48E-19
Ho-164m	3.03E-19	2.48E-19	2.17E-19	1.99E-19	1.66E-19	1.61E-19
Ho-166	5.88E-19	5.47E-19	5.30E-19	5.02E-19	4.68E-19	4.60E-19
Ho-166m	1.26E-17	1.17E-17	1.12E-17	1.06E-17	9.77E-18	9.57E-18
Ho-167	2.92E-18	2.71E-18	2.53E-18	2.44E-18	2.22E-18	2.17E-18
Ho-168	7.17E-18	6.68E-18	6.47E-18	6.08E-18	5.66E-18	5.55E-18
Ho-168m	4.31E-20	3.53E-20	3.10E-20	2.84E-20	2.37E-20	2.31E-20
Ho-170	1.34E-17	1.24E-17	1.21E-17	1.14E-17	1.05E-17	1.03E-17
<b>Erbium</b>						
Er-154	5.15E-19	4.45E-19	4.00E-19	3.75E-19	3.31E-19	3.22E-19
Er-156	4.37E-19	3.66E-19	3.23E-19	3.00E-19	2.55E-19	2.48E-19
Er-159	7.31E-18	6.79E-18	6.44E-18	6.14E-18	5.71E-18	5.60E-18
Er-161	7.51E-18	6.96E-18	6.74E-18	6.32E-18	5.85E-18	5.74E-18
Er-163	2.76E-19	2.27E-19	2.00E-19	1.84E-19	1.54E-19	1.50E-19
Er-165	2.59E-19	2.12E-19	1.86E-19	1.70E-19	1.42E-19	1.38E-19
Er-167m	7.33E-19	6.75E-19	6.27E-19	6.06E-19	5.30E-19	5.19E-19
Er-169	2.39E-20	2.22E-20	2.19E-20	2.04E-20	1.90E-20	1.86E-20
Er-171	3.03E-18	2.79E-18	2.62E-18	2.52E-18	2.27E-18	2.22E-18
Er-172	4.05E-18	3.76E-18	3.51E-18	3.36E-18	3.11E-18	3.04E-18
Er-173	6.68E-18	6.20E-18	5.97E-18	5.62E-18	5.15E-18	5.05E-18
<b>Thulium</b>						
Tm-161	9.61E-18	8.90E-18	8.38E-18	8.06E-18	7.48E-18	7.33E-18
Tm-162	1.43E-17	1.34E-17	1.27E-17	1.22E-17	1.15E-17	1.12E-17
Tm-163	9.78E-18	9.06E-18	8.66E-18	8.26E-18	7.65E-18	7.51E-18
Tm-164	6.31E-18	5.88E-18	5.54E-18	5.31E-18	4.97E-18	4.86E-18
Tm-165	4.29E-18	3.95E-18	3.72E-18	3.55E-18	3.22E-18	3.16E-18
Tm-166	1.45E-17	1.35E-17	1.29E-17	1.24E-17	1.16E-17	1.13E-17
Tm-167	1.10E-18	9.85E-19	9.03E-19	8.63E-19	7.51E-19	7.35E-19
Tm-168	9.55E-18	8.87E-18	8.50E-18	8.01E-18	7.39E-18	7.24E-18
Tm-170	1.54E-19	1.43E-19	1.38E-19	1.30E-19	1.20E-19	1.18E-19
Tm-171	6.48E-21	5.73E-21	5.27E-21	4.93E-21	4.33E-21	4.23E-21

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	3.75E-18	3.49E-18	3.37E-18	3.22E-18	3.00E-18	2.95E-18
Tm-173	3.17E-18	2.96E-18	2.75E-18	2.65E-18	2.45E-18	2.39E-18
Tm-174	1.38E-17	1.28E-17	1.23E-17	1.17E-17	1.07E-17	1.05E-17
Tm-175	8.55E-18	7.97E-18	7.62E-18	7.22E-18	6.73E-18	6.58E-18
Tm-176	1.50E-17	1.40E-17	1.34E-17	1.28E-17	1.19E-17	1.17E-17
<b>Ytterbium</b>						
Yb-162	1.89E-18	1.74E-18	1.59E-18	1.52E-18	1.38E-18	1.35E-18
Yb-163	5.66E-18	5.26E-18	4.99E-18	4.76E-18	4.43E-18	4.34E-18
Yb-164	3.87E-19	3.33E-19	2.99E-19	2.79E-19	2.42E-19	2.36E-19
Yb-165	2.53E-18	2.31E-18	2.17E-18	2.05E-18	1.88E-18	1.83E-18
Yb-166	6.09E-19	5.17E-19	4.60E-19	4.28E-19	3.64E-19	3.54E-19
Yb-167	1.96E-18	1.74E-18	1.59E-18	1.50E-18	1.34E-18	1.30E-18
Yb-169	2.43E-18	2.19E-18	1.99E-18	1.90E-18	1.66E-18	1.62E-18
Yb-175	3.39E-19	3.14E-19	2.93E-19	2.82E-19	2.58E-19	2.52E-19
Yb-177	1.66E-18	1.55E-18	1.49E-18	1.40E-18	1.30E-18	1.27E-18
Yb-178	3.60E-19	3.34E-19	3.14E-19	3.02E-19	2.77E-19	2.71E-19
Yb-179	7.96E-18	7.43E-18	7.00E-18	6.68E-18	6.24E-18	6.10E-18
<b>Lutetium</b>						
Lu-165	8.56E-18	7.96E-18	7.50E-18	7.19E-18	6.67E-18	6.54E-18
Lu-167	1.24E-17	1.15E-17	1.10E-17	1.06E-17	9.83E-18	9.65E-18
Lu-169	9.77E-18	9.07E-18	8.74E-18	8.29E-18	7.68E-18	7.54E-18
Lu-169m	1.51E-23	9.71E-24	5.65E-24	5.09E-24	2.04E-24	1.89E-24
Lu-170	1.81E-17	1.69E-17	1.62E-17	1.56E-17	1.46E-17	1.44E-17
Lu-171	4.95E-18	4.57E-18	4.37E-18	4.10E-18	3.79E-18	3.71E-18
Lu-171m	2.30E-21	2.04E-21	1.81E-21	1.73E-21	1.48E-21	1.44E-21
Lu-172	1.48E-17	1.37E-17	1.33E-17	1.25E-17	1.16E-17	1.14E-17
Lu-172m	1.50E-23	1.10E-23	8.49E-24	7.67E-24	5.45E-24	5.26E-24
Lu-173	1.35E-18	1.21E-18	1.10E-18	1.05E-18	9.19E-19	8.98E-19
Lu-174	8.38E-19	7.53E-19	7.08E-19	6.66E-19	5.99E-19	5.87E-19
Lu-174m	4.22E-19	3.67E-19	3.29E-19	3.09E-19	2.66E-19	2.59E-19
Lu-176	3.76E-18	3.48E-18	3.25E-18	3.15E-18	2.80E-18	2.74E-18
Lu-176m	3.03E-19	2.78E-19	2.68E-19	2.52E-19	2.32E-19	2.28E-19
Lu-177	3.02E-19	2.79E-19	2.61E-19	2.50E-19	2.23E-19	2.18E-19
Lu-177m	7.70E-18	7.13E-18	6.61E-18	6.38E-18	5.74E-18	5.61E-18
Lu-178	1.35E-18	1.26E-18	1.22E-18	1.16E-18	1.09E-18	1.07E-18
Lu-178m	8.29E-18	7.68E-18	7.15E-18	6.90E-18	6.28E-18	6.13E-18
Lu-179	4.63E-19	4.32E-19	4.15E-19	3.96E-19	3.61E-19	3.54E-19
Lu-180	1.17E-17	1.09E-17	1.05E-17	9.94E-18	9.22E-18	9.05E-18
Lu-181	4.87E-18	4.53E-18	4.31E-18	4.09E-18	3.78E-18	3.70E-18
<b>Hafnium</b>						
Hf-167	5.17E-18	4.81E-18	4.48E-18	4.32E-18	3.99E-18	3.90E-18
Hf-169	5.09E-18	4.73E-18	4.38E-18	4.21E-18	3.92E-18	3.83E-18
Hf-170	3.36E-18	3.11E-18	2.88E-18	2.75E-18	2.53E-18	2.47E-18
Hf-172	7.15E-19	6.27E-19	5.60E-19	5.27E-19	4.57E-19	4.45E-19
Hf-173	3.00E-18	2.76E-18	2.55E-18	2.44E-18	2.20E-18	2.15E-18
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00



**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	2.73E-18	2.51E-18	2.33E-18	2.24E-18	2.03E-18	1.98E-18
Hf-177m	1.77E-17	1.64E-17	1.53E-17	1.48E-17	1.33E-17	1.30E-17
Hf-178m	1.75E-17	1.62E-17	1.51E-17	1.46E-17	1.34E-17	1.31E-17
Hf-179m	7.12E-18	6.62E-18	6.11E-18	5.90E-18	5.38E-18	5.26E-18
Hf-180m	7.70E-18	7.15E-18	6.64E-18	6.41E-18	5.84E-18	5.71E-18
Hf-181	4.18E-18	3.91E-18	3.61E-18	3.47E-18	3.23E-18	3.15E-18
Hf-182	1.86E-18	1.72E-18	1.61E-18	1.56E-18	1.38E-18	1.35E-18
Hf-182m	7.07E-18	6.56E-18	6.19E-18	5.90E-18	5.41E-18	5.30E-18
Hf-183	6.17E-18	5.74E-18	5.50E-18	5.19E-18	4.82E-18	4.72E-18
Hf-184	1.90E-18	1.77E-18	1.62E-18	1.56E-18	1.42E-18	1.39E-18
<b>Tantalum</b>						
Ta-170	9.57E-18	8.93E-18	8.45E-18	8.07E-18	7.54E-18	7.37E-18
Ta-172	1.31E-17	1.22E-17	1.17E-17	1.11E-17	1.03E-17	1.01E-17
Ta-173	4.38E-18	4.06E-18	3.84E-18	3.66E-18	3.38E-18	3.31E-18
Ta-174	7.57E-18	7.05E-18	6.67E-18	6.39E-18	5.92E-18	5.80E-18
Ta-175	8.23E-18	7.64E-18	7.28E-18	6.96E-18	6.44E-18	6.32E-18
Ta-176	1.61E-17	1.51E-17	1.44E-17	1.39E-17	1.29E-17	1.27E-17
Ta-177	4.84E-19	4.28E-19	3.87E-19	3.65E-19	3.18E-19	3.10E-19
Ta-178	8.86E-19	8.03E-19	7.48E-19	7.09E-19	6.40E-19	6.26E-19
Ta-178m	8.95E-18	8.28E-18	7.69E-18	7.42E-18	6.73E-18	6.57E-18
Ta-179	1.73E-19	1.51E-19	1.34E-19	1.26E-19	1.07E-19	1.04E-19
Ta-180	3.48E-19	3.04E-19	2.72E-19	2.56E-19	2.21E-19	2.15E-19
Ta-182	9.66E-18	8.98E-18	8.73E-18	8.23E-18	7.62E-18	7.48E-18
Ta-182m	1.96E-18	1.83E-18	1.65E-18	1.59E-18	1.41E-18	1.38E-18
Ta-183	2.28E-18	2.10E-18	1.94E-18	1.87E-18	1.66E-18	1.63E-18
Ta-184	1.23E-17	1.14E-17	1.09E-17	1.04E-17	9.55E-18	9.34E-18
Ta-185	1.50E-18	1.40E-18	1.30E-18	1.25E-18	1.13E-18	1.10E-18
Ta-186	1.17E-17	1.09E-17	1.03E-17	9.83E-18	9.08E-18	8.89E-18
<b>Tungsten</b>						
W-177	6.96E-18	6.44E-18	6.12E-18	5.79E-18	5.33E-18	5.21E-18
W-178	1.05E-19	9.23E-20	8.19E-20	7.76E-20	6.62E-20	6.44E-20
W-179	3.58E-19	3.12E-19	2.75E-19	2.60E-19	2.21E-19	2.15E-19
W-179m	4.03E-19	3.64E-19	3.31E-19	3.18E-19	2.75E-19	2.68E-19
W-181	2.79E-19	2.45E-19	2.18E-19	2.07E-19	1.76E-19	1.72E-19
W-185	3.45E-20	3.21E-20	3.16E-20	2.95E-20	2.73E-20	2.68E-20
W-185m	1.77E-19	1.64E-19	1.48E-19	1.42E-19	1.26E-19	1.23E-19
W-187	3.59E-18	3.35E-18	3.16E-18	3.01E-18	2.80E-18	2.74E-18
W-188	3.83E-20	3.55E-20	3.43E-20	3.24E-20	2.96E-20	2.90E-20
W-190	1.22E-18	1.13E-18	1.02E-18	9.81E-19	8.70E-19	8.53E-19
<b>Rhenium</b>						
Re-178	1.27E-17	1.18E-17	1.13E-17	1.08E-17	1.01E-17	9.93E-18
Re-179	8.18E-18	7.62E-18	7.17E-18	6.90E-18	6.38E-18	6.24E-18
Re-180	9.19E-18	8.54E-18	8.29E-18	7.76E-18	7.20E-18	7.05E-18
Re-181	6.16E-18	5.71E-18	5.40E-18	5.15E-18	4.73E-18	4.63E-18
Re-182	1.34E-17	1.25E-17	1.20E-17	1.14E-17	1.04E-17	1.02E-17
Re-182m	9.05E-18	8.41E-18	8.13E-18	7.69E-18	7.12E-18	6.98E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	1.13E-18	1.03E-18	9.26E-19	8.89E-19	7.79E-19	7.62E-19
Re-184	6.79E-18	6.30E-18	6.13E-18	5.72E-18	5.30E-18	5.19E-18
Re-184m	2.89E-18	2.67E-18	2.54E-18	2.40E-18	2.19E-18	2.14E-18
Re-186	2.84E-19	2.65E-19	2.48E-19	2.35E-19	2.15E-19	2.11E-19
Re-186m	1.04E-19	9.02E-20	7.99E-20	7.53E-20	6.44E-20	6.26E-20
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	9.13E-19	8.59E-19	8.21E-19	7.82E-19	7.27E-19	7.15E-19
Re-188m	4.89E-19	4.39E-19	3.96E-19	3.79E-19	3.31E-19	3.22E-19
Re-189	5.45E-19	5.08E-19	4.78E-19	4.59E-19	4.13E-19	4.05E-19
Re-190	1.07E-17	1.00E-17	9.47E-18	9.04E-18	8.37E-18	8.19E-18
Re-190m	7.38E-18	6.88E-18	6.47E-18	6.19E-18	5.73E-18	5.60E-18
<b>Osmium</b>						
Os-180	9.09E-19	8.34E-19	7.69E-19	7.35E-19	6.59E-19	6.43E-19
Os-181	1.04E-17	9.63E-18	9.25E-18	8.78E-18	8.11E-18	7.95E-18
Os-182	3.32E-18	3.09E-18	2.85E-18	2.74E-18	2.52E-18	2.46E-18
Os-183	4.81E-18	4.45E-18	4.15E-18	3.99E-18	3.64E-18	3.56E-18
Os-183m	7.54E-18	7.00E-18	6.84E-18	6.41E-18	5.94E-18	5.83E-18
Os-185	5.35E-18	4.97E-18	4.73E-18	4.47E-18	4.16E-18	4.07E-18
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	6.40E-23	4.30E-23	2.59E-23	2.35E-23	8.33E-24	7.67E-24
Os-190m	1.24E-17	1.16E-17	1.08E-17	1.04E-17	9.65E-18	9.44E-18
Os-191	5.89E-19	5.45E-19	4.89E-19	4.71E-19	4.18E-19	4.08E-19
Os-191m	4.10E-20	3.71E-20	3.30E-20	3.19E-20	2.73E-20	2.65E-20
Os-193	6.60E-19	6.15E-19	5.75E-19	5.51E-19	5.07E-19	4.96E-19
Os-194	1.68E-20	1.34E-20	1.16E-20	1.05E-20	8.67E-21	8.43E-21
Os-196	7.74E-19	7.20E-19	6.76E-19	6.48E-19	5.93E-19	5.80E-19
<b>Iridium</b>						
Ir-180	1.33E-17	1.24E-17	1.18E-17	1.12E-17	1.04E-17	1.02E-17
Ir-182	1.16E-17	1.09E-17	1.03E-17	9.82E-18	9.11E-18	8.92E-18
Ir-183	8.84E-18	8.24E-18	7.81E-18	7.51E-18	6.97E-18	6.83E-18
Ir-184	1.49E-17	1.39E-17	1.33E-17	1.27E-17	1.17E-17	1.15E-17
Ir-185	6.23E-18	5.81E-18	5.48E-18	5.30E-18	4.91E-18	4.82E-18
Ir-186	1.25E-17	1.17E-17	1.10E-17	1.06E-17	9.81E-18	9.61E-18
Ir-186m	9.36E-18	8.73E-18	8.34E-18	7.95E-18	7.41E-18	7.27E-18
Ir-187	2.50E-18	2.32E-18	2.20E-18	2.08E-18	1.91E-18	1.86E-18
Ir-188	1.50E-17	1.41E-17	1.33E-17	1.29E-17	1.21E-17	1.19E-17
Ir-189	5.54E-19	5.05E-19	4.57E-19	4.42E-19	3.82E-19	3.73E-19
Ir-190	1.15E-17	1.07E-17	1.00E-17	9.62E-18	8.90E-18	8.70E-18
Ir-190m	7.09E-23	4.89E-23	3.02E-23	2.76E-23	9.55E-24	8.77E-24
Ir-190n	3.98E-19	3.61E-19	3.22E-19	3.10E-19	2.67E-19	2.60E-19
Ir-191m	5.26E-19	4.87E-19	4.36E-19	4.21E-19	3.73E-19	3.64E-19
Ir-192	6.45E-18	6.00E-18	5.61E-18	5.42E-18	4.95E-18	4.84E-18
Ir-192m	7.18E-22	6.02E-22	5.06E-22	4.81E-22	3.76E-22	3.65E-22
Ir-192n	4.82E-21	4.33E-21	3.77E-21	3.65E-21	3.06E-21	2.99E-21
Ir-193m	2.26E-21	2.04E-21	1.81E-21	1.75E-21	1.48E-21	1.44E-21
Ir-194	1.19E-18	1.11E-18	1.07E-18	1.02E-18	9.48E-19	9.31E-19

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	1.83E-17	1.71E-17	1.60E-17	1.53E-17	1.43E-17	1.39E-17
Ir-195	5.42E-19	4.97E-19	4.61E-19	4.42E-19	3.93E-19	3.83E-19
Ir-195m	2.97E-18	2.76E-18	2.58E-18	2.48E-18	2.27E-18	2.22E-18
Ir-196	2.60E-18	2.44E-18	2.34E-18	2.23E-18	2.08E-18	2.04E-18
Ir-196m	1.94E-17	1.81E-17	1.70E-17	1.63E-17	1.51E-17	1.48E-17
<b>Platinum</b>						
Pt-184	5.50E-18	5.12E-18	4.75E-18	4.56E-18	4.15E-18	4.06E-18
Pt-186	5.26E-18	4.90E-18	4.64E-18	4.40E-18	4.07E-18	3.98E-18
Pt-187	4.71E-18	4.37E-18	4.13E-18	3.93E-18	3.60E-18	3.52E-18
Pt-188	1.52E-18	1.41E-18	1.29E-18	1.25E-18	1.11E-18	1.08E-18
Pt-189	3.67E-18	3.41E-18	3.20E-18	3.06E-18	2.80E-18	2.74E-18
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	2.22E-18	2.06E-18	1.89E-18	1.83E-18	1.66E-18	1.61E-18
Pt-193	1.72E-22	1.20E-22	7.64E-23	7.03E-23	2.43E-23	2.23E-23
Pt-193m	7.37E-20	6.74E-20	6.02E-20	5.86E-20	5.04E-20	4.90E-20
Pt-195m	5.07E-19	4.62E-19	4.16E-19	4.03E-19	3.51E-19	3.42E-19
Pt-197	2.36E-19	2.18E-19	2.04E-19	1.95E-19	1.74E-19	1.70E-19
Pt-197m	6.00E-19	5.54E-19	5.08E-19	4.93E-19	4.38E-19	4.27E-19
Pt-199	1.82E-18	1.70E-18	1.61E-18	1.54E-18	1.43E-18	1.40E-18
Pt-200	4.81E-19	4.45E-19	4.10E-19	3.96E-19	3.51E-19	3.43E-19
Pt-202	3.61E-19	3.40E-19	3.34E-19	3.16E-19	2.97E-19	2.93E-19
<b>Gold</b>						
Au-186	1.23E-17	1.15E-17	1.09E-17	1.04E-17	9.67E-18	9.47E-18
Au-187	7.90E-18	7.37E-18	7.01E-18	6.73E-18	6.27E-18	6.15E-18
Au-190	1.70E-17	1.59E-17	1.50E-17	1.47E-17	1.37E-17	1.34E-17
Au-191	4.56E-18	4.25E-18	3.97E-18	3.81E-18	3.49E-18	3.41E-18
Au-192	1.40E-17	1.31E-17	1.24E-17	1.20E-17	1.12E-17	1.10E-17
Au-193	1.23E-18	1.14E-18	1.04E-18	1.01E-18	8.91E-19	8.70E-19
Au-193m	1.50E-18	1.39E-18	1.30E-18	1.26E-18	1.11E-18	1.09E-18
Au-194	7.69E-18	7.17E-18	6.80E-18	6.56E-18	6.06E-18	5.95E-18
Au-195	5.69E-19	5.18E-19	4.67E-19	4.52E-19	3.93E-19	3.82E-19
Au-195m	1.53E-18	1.41E-18	1.32E-18	1.28E-18	1.13E-18	1.11E-18
Au-196	3.67E-18	3.41E-18	3.16E-18	3.06E-18	2.78E-18	2.72E-18
Au-196m	1.78E-18	1.67E-18	1.51E-18	1.47E-18	1.30E-18	1.28E-18
Au-198	3.30E-18	3.08E-18	2.86E-18	2.76E-18	2.56E-18	2.50E-18
Au-198m	4.01E-18	3.71E-18	3.44E-18	3.33E-18	2.95E-18	2.89E-18
Au-199	7.27E-19	6.88E-19	6.22E-19	6.03E-19	5.39E-19	5.29E-19
Au-200	2.50E-18	2.33E-18	2.25E-18	2.14E-18	1.99E-18	1.95E-18
Au-200m	1.55E-17	1.45E-17	1.36E-17	1.30E-17	1.20E-17	1.18E-17
Au-201	4.57E-19	4.27E-19	4.08E-19	3.88E-19	3.62E-19	3.55E-19
Au-202	2.04E-18	1.91E-18	1.85E-18	1.76E-18	1.64E-18	1.61E-18
<b>Mercury</b>						
Hg-190	1.45E-18	1.37E-18	1.22E-18	1.19E-18	1.06E-18	1.04E-18
Hg-191m	1.13E-17	1.05E-17	9.98E-18	9.56E-18	8.82E-18	8.64E-18
Hg-192	2.05E-18	1.89E-18	1.75E-18	1.70E-18	1.50E-18	1.47E-18
Hg-193	6.23E-18	5.80E-18	5.55E-18	5.29E-18	4.88E-18	4.79E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	7.73E-18	7.20E-18	6.86E-18	6.55E-18	6.08E-18	5.95E-18
Hg-194	2.61E-22	1.91E-22	1.28E-22	1.19E-22	4.12E-23	3.77E-23
Hg-195	1.47E-18	1.37E-18	1.29E-18	1.23E-18	1.12E-18	1.09E-18
Hg-195m	1.51E-18	1.40E-18	1.31E-18	1.26E-18	1.13E-18	1.11E-18
Hg-197	4.99E-19	4.58E-19	4.12E-19	4.01E-19	3.47E-19	3.38E-19
Hg-197m	6.90E-19	6.45E-19	5.84E-19	5.64E-19	5.05E-19	4.94E-19
Hg-199m	1.35E-18	1.27E-18	1.15E-18	1.12E-18	1.00E-18	9.83E-19
Hg-203	1.86E-18	1.72E-18	1.61E-18	1.56E-18	1.39E-18	1.36E-18
Hg-205	3.13E-19	2.94E-19	2.87E-19	2.72E-19	2.53E-19	2.49E-19
Hg-206	1.12E-18	1.04E-18	9.78E-19	9.42E-19	8.54E-19	8.36E-19
Hg-207	1.99E-17	1.85E-17	1.78E-17	1.71E-17	1.59E-17	1.56E-17
<b>Thallium</b>						
Tl-190	1.15E-17	1.07E-17	1.01E-17	9.66E-18	9.03E-18	8.84E-18
Tl-190m	1.97E-17	1.84E-17	1.74E-17	1.66E-17	1.55E-17	1.51E-17
Tl-194	7.59E-18	7.09E-18	6.65E-18	6.37E-18	5.94E-18	5.81E-18
Tl-194m	1.97E-17	1.84E-17	1.74E-17	1.65E-17	1.54E-17	1.51E-17
Tl-195	8.95E-18	8.36E-18	7.98E-18	7.66E-18	7.13E-18	7.00E-18
Tl-196	1.40E-17	1.31E-17	1.24E-17	1.19E-17	1.11E-17	1.09E-17
Tl-197	3.44E-18	3.20E-18	3.03E-18	2.89E-18	2.67E-18	2.61E-18
Tl-198	1.48E-17	1.38E-17	1.31E-17	1.26E-17	1.18E-17	1.16E-17
Tl-198m	9.46E-18	8.82E-18	8.28E-18	7.92E-18	7.35E-18	7.18E-18
Tl-199	1.89E-18	1.76E-18	1.63E-18	1.57E-18	1.42E-18	1.38E-18
Tl-200	9.91E-18	9.23E-18	8.82E-18	8.41E-18	7.78E-18	7.62E-18
Tl-201	6.51E-19	6.02E-19	5.42E-19	5.27E-19	4.61E-19	4.50E-19
Tl-202	3.62E-18	3.37E-18	3.11E-18	3.01E-18	2.78E-18	2.71E-18
Tl-204	9.36E-20	8.72E-20	8.51E-20	7.98E-20	7.38E-20	7.24E-20
Tl-206	2.75E-19	2.58E-19	2.54E-19	2.39E-19	2.25E-19	2.21E-19
Tl-206m	1.87E-17	1.74E-17	1.66E-17	1.58E-17	1.46E-17	1.43E-17
Tl-207	2.60E-19	2.44E-19	2.40E-19	2.26E-19	2.12E-19	2.08E-19
Tl-208	2.35E-17	2.21E-17	2.09E-17	2.04E-17	1.92E-17	1.89E-17
Tl-209	1.62E-17	1.51E-17	1.43E-17	1.38E-17	1.29E-17	1.27E-17
Tl-210	2.13E-17	1.99E-17	1.91E-17	1.83E-17	1.70E-17	1.67E-17
<b>Lead</b>						
Pb-194	8.10E-18	7.55E-18	7.18E-18	6.87E-18	6.36E-18	6.24E-18
Pb-195m	1.28E-17	1.20E-17	1.14E-17	1.08E-17	1.00E-17	9.80E-18
Pb-196	3.78E-18	3.51E-18	3.28E-18	3.15E-18	2.87E-18	2.81E-18
Pb-197	1.14E-17	1.06E-17	1.02E-17	9.72E-18	9.04E-18	8.87E-18
Pb-197m	9.00E-18	8.38E-18	7.94E-18	7.58E-18	6.99E-18	6.84E-18
Pb-198	3.34E-18	3.10E-18	2.90E-18	2.79E-18	2.52E-18	2.47E-18
Pb-199	7.76E-18	7.23E-18	6.89E-18	6.60E-18	6.12E-18	6.00E-18
Pb-200	1.52E-18	1.42E-18	1.29E-18	1.25E-18	1.12E-18	1.09E-18
Pb-201	5.78E-18	5.37E-18	5.11E-18	4.87E-18	4.46E-18	4.37E-18
Pb-201m	2.84E-18	2.65E-18	2.51E-18	2.38E-18	2.23E-18	2.17E-18
Pb-202	2.95E-22	2.02E-22	1.25E-22	1.14E-22	4.01E-23	3.68E-23
Pb-202m	1.54E-17	1.43E-17	1.38E-17	1.30E-17	1.21E-17	1.18E-17
Pb-203	2.38E-18	2.20E-18	2.05E-18	1.99E-18	1.77E-18	1.73E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	1.58E-17	1.47E-17	1.44E-17	1.34E-17	1.25E-17	1.22E-17
Pb-205	2.99E-22	2.04E-22	1.26E-22	1.16E-22	4.06E-23	3.72E-23
Pb-209	6.41E-20	5.97E-20	5.87E-20	5.48E-20	5.09E-20	5.00E-20
Pb-210	1.45E-20	1.17E-20	1.01E-20	9.23E-21	7.49E-21	7.28E-21
Pb-211	7.13E-19	6.66E-19	6.42E-19	6.07E-19	5.65E-19	5.54E-19
Pb-212	1.12E-18	1.04E-18	9.69E-19	9.39E-19	8.29E-19	8.11E-19
Pb-214	2.03E-18	1.89E-18	1.77E-18	1.71E-18	1.55E-18	1.51E-18
<b>Bismuth</b>						
Bi-197	1.30E-17	1.21E-17	1.16E-17	1.10E-17	1.03E-17	1.00E-17
Bi-200	1.89E-17	1.76E-17	1.68E-17	1.59E-17	1.47E-17	1.44E-17
Bi-201	1.28E-17	1.20E-17	1.15E-17	1.10E-17	1.02E-17	1.00E-17
Bi-202	2.10E-17	1.96E-17	1.88E-17	1.78E-17	1.66E-17	1.62E-17
Bi-203	1.76E-17	1.64E-17	1.57E-17	1.50E-17	1.40E-17	1.38E-17
Bi-204	2.20E-17	2.05E-17	1.98E-17	1.87E-17	1.74E-17	1.70E-17
Bi-205	1.24E-17	1.16E-17	1.11E-17	1.06E-17	9.94E-18	9.75E-18
Bi-206	2.48E-17	2.32E-17	2.22E-17	2.11E-17	1.96E-17	1.92E-17
Bi-207	1.17E-17	1.09E-17	1.05E-17	9.89E-18	9.22E-18	9.03E-18
Bi-208	1.76E-17	1.65E-17	1.56E-17	1.54E-17	1.45E-17	1.43E-17
Bi-210	1.70E-19	1.60E-19	1.57E-19	1.47E-19	1.38E-19	1.36E-19
Bi-210m	2.02E-18	1.87E-18	1.76E-18	1.70E-18	1.52E-18	1.49E-18
Bi-211	3.70E-19	3.43E-19	3.20E-19	3.10E-19	2.82E-19	2.76E-19
Bi-212	1.08E-18	1.01E-18	9.73E-19	9.22E-19	8.63E-19	8.47E-19
Bi-212n	2.71E-19	2.55E-19	2.51E-19	2.36E-19	2.22E-19	2.18E-19
Bi-213	1.20E-18	1.12E-18	1.05E-18	1.01E-18	9.41E-19	9.19E-19
Bi-214	1.13E-17	1.05E-17	1.01E-17	9.67E-18	9.06E-18	8.89E-18
Bi-215	2.28E-18	2.12E-18	2.03E-18	1.93E-18	1.77E-18	1.74E-18
Bi-216	6.76E-18	6.32E-18	5.94E-18	5.69E-18	5.34E-18	5.22E-18
<b>Polonium</b>						
Po-203	1.23E-17	1.14E-17	1.11E-17	1.05E-17	9.71E-18	9.52E-18
Po-204	8.80E-18	8.18E-18	7.87E-18	7.42E-18	6.84E-18	6.70E-18
Po-205	1.19E-17	1.11E-17	1.08E-17	1.01E-17	9.41E-18	9.23E-18
Po-206	9.08E-18	8.44E-18	8.11E-18	7.66E-18	7.09E-18	6.94E-18
Po-207	9.72E-18	9.05E-18	8.79E-18	8.25E-18	7.65E-18	7.50E-18
Po-208	1.64E-22	1.52E-22	1.44E-22	1.37E-22	1.27E-22	1.24E-22
Po-209	4.71E-20	4.37E-20	4.22E-20	3.98E-20	3.64E-20	3.57E-20
Po-210	7.50E-23	6.98E-23	6.80E-23	6.35E-23	5.91E-23	5.79E-23
Po-211	6.31E-20	5.89E-20	5.68E-20	5.34E-20	4.98E-20	4.87E-20
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	5.40E-19	5.08E-19	4.79E-19	4.70E-19	4.44E-19	4.37E-19
Po-213	2.90E-22	2.70E-22	2.62E-22	2.45E-22	2.28E-22	2.24E-22
Po-214	6.40E-22	5.96E-22	5.81E-22	5.42E-22	5.05E-22	4.95E-22
Po-215	1.39E-21	1.30E-21	1.20E-21	1.16E-21	1.08E-21	1.06E-21
Po-216	1.18E-22	1.10E-22	1.07E-22	1.00E-22	9.30E-23	9.12E-23
Po-218	2.86E-24	2.66E-24	2.62E-24	2.44E-24	2.27E-24	2.23E-24
<b>Astatine</b>						
At-204	1.84E-17	1.72E-17	1.62E-17	1.54E-17	1.44E-17	1.41E-17

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	8.83E-18	8.23E-18	7.84E-18	7.46E-18	6.95E-18	6.81E-18
At-206	1.93E-17	1.80E-17	1.71E-17	1.63E-17	1.52E-17	1.48E-17
At-207	1.51E-17	1.40E-17	1.34E-17	1.28E-17	1.19E-17	1.17E-17
At-208	2.30E-17	2.15E-17	2.06E-17	1.95E-17	1.82E-17	1.78E-17
At-209	1.75E-17	1.63E-17	1.56E-17	1.48E-17	1.37E-17	1.34E-17
At-210	2.19E-17	2.04E-17	1.97E-17	1.87E-17	1.74E-17	1.71E-17
At-211	2.51E-19	2.29E-19	2.11E-19	2.02E-19	1.80E-19	1.75E-19
At-215	1.35E-21	1.26E-21	1.16E-21	1.13E-21	1.04E-21	1.02E-21
At-216	1.81E-20	1.66E-20	1.53E-20	1.48E-20	1.32E-20	1.28E-20
At-217	1.88E-21	1.74E-21	1.63E-21	1.58E-21	1.42E-21	1.39E-21
At-218	7.48E-22	7.05E-22	6.93E-22	6.59E-22	6.22E-22	6.13E-22
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	4.33E-18	4.04E-18	3.82E-18	3.68E-18	3.36E-18	3.29E-18
<b>Radon</b>						
Rn-207	7.73E-18	7.19E-18	6.83E-18	6.50E-18	6.03E-18	5.90E-18
Rn-209	9.05E-18	8.44E-18	8.03E-18	7.66E-18	7.13E-18	6.98E-18
Rn-210	4.67E-19	4.34E-19	4.14E-19	3.92E-19	3.63E-19	3.56E-19
Rn-211	1.42E-17	1.32E-17	1.27E-17	1.20E-17	1.12E-17	1.10E-17
Rn-212	2.64E-21	2.46E-21	2.35E-21	2.22E-21	2.07E-21	2.03E-21
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	5.93E-21	5.54E-21	5.23E-21	4.98E-21	4.66E-21	4.56E-21
Rn-219	4.57E-19	4.24E-19	3.96E-19	3.84E-19	3.47E-19	3.39E-19
Rn-220	4.95E-21	4.62E-21	4.32E-21	4.13E-21	3.88E-21	3.79E-21
Rn-222	3.07E-21	2.87E-21	2.66E-21	2.56E-21	2.40E-21	2.34E-21
Rn-223	2.89E-18	2.69E-18	2.57E-18	2.44E-18	2.27E-18	2.22E-18
<b>Francium</b>						
Fr-212	8.54E-18	7.95E-18	7.67E-18	7.27E-18	6.73E-18	6.60E-18
Fr-219	2.79E-20	2.60E-20	2.42E-20	2.33E-20	2.15E-20	2.10E-20
Fr-220	6.80E-20	6.22E-20	5.71E-20	5.46E-20	4.90E-20	4.77E-20
Fr-221	2.24E-19	2.07E-19	1.94E-19	1.88E-19	1.65E-19	1.62E-19
Fr-222	1.68E-18	1.56E-18	1.49E-18	1.42E-18	1.29E-18	1.26E-18
Fr-223	5.43E-19	4.90E-19	4.59E-19	4.33E-19	3.88E-19	3.80E-19
Fr-224	4.63E-18	4.32E-18	4.15E-18	3.96E-18	3.66E-18	3.60E-18
Fr-227	3.85E-18	3.57E-18	3.37E-18	3.21E-18	2.99E-18	2.92E-18
<b>Radium</b>						
Ra-219	1.31E-18	1.22E-18	1.14E-18	1.10E-18	9.95E-19	9.72E-19
Ra-220	3.69E-20	3.45E-20	3.20E-20	3.08E-20	2.88E-20	2.81E-20
Ra-221	2.66E-19	2.49E-19	2.26E-19	2.17E-19	1.96E-19	1.92E-19
Ra-222	7.19E-20	6.67E-20	6.23E-20	6.05E-20	5.46E-20	5.34E-20
Ra-223	1.05E-18	9.67E-19	8.97E-19	8.64E-19	7.79E-19	7.60E-19
Ra-224	7.99E-20	7.39E-20	6.94E-20	6.74E-20	5.93E-20	5.81E-20
Ra-225	9.45E-20	7.59E-20	6.66E-20	6.05E-20	5.07E-20	4.93E-20
Ra-226	5.54E-20	5.19E-20	4.78E-20	4.63E-20	4.09E-20	4.01E-20
Ra-227	1.27E-18	1.17E-18	1.10E-18	1.06E-18	9.66E-19	9.45E-19

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	1.41E-21	1.08E-21	8.63E-22	8.37E-22	3.96E-22	3.67E-22
Ra-230	6.51E-19	6.02E-19	5.61E-19	5.38E-19	4.92E-19	4.80E-19
<b>Actinium</b>						
Ac-223	1.32E-19	1.22E-19	1.13E-19	1.09E-19	9.90E-20	9.66E-20
Ac-224	1.70E-18	1.57E-18	1.45E-18	1.40E-18	1.25E-18	1.22E-18
Ac-225	1.05E-19	9.66E-20	8.91E-20	8.53E-20	7.69E-20	7.50E-20
Ac-226	1.09E-18	1.01E-18	9.46E-19	9.13E-19	8.14E-19	7.98E-19
Ac-227	1.13E-21	9.60E-22	8.54E-22	8.09E-22	6.54E-22	6.34E-22
Ac-228	6.71E-18	6.25E-18	6.06E-18	5.71E-18	5.30E-18	5.20E-18
Ac-230	4.55E-18	4.26E-18	4.08E-18	3.91E-18	3.67E-18	3.60E-18
Ac-231	3.49E-18	3.23E-18	3.03E-18	2.93E-18	2.64E-18	2.58E-18
Ac-232	8.94E-18	8.36E-18	7.99E-18	7.71E-18	7.24E-18	7.11E-18
Ac-233	4.43E-18	4.14E-18	3.89E-18	3.72E-18	3.50E-18	3.42E-18
<b>Thorium</b>						
Th-223	5.21E-19	4.75E-19	4.39E-19	4.18E-19	3.80E-19	3.69E-19
Th-224	1.73E-19	1.63E-19	1.49E-19	1.45E-19	1.29E-19	1.27E-19
Th-226	5.83E-20	5.31E-20	4.96E-20	4.74E-20	4.27E-20	4.17E-20
Th-227	9.48E-19	8.71E-19	8.14E-19	7.88E-19	6.99E-19	6.84E-19
Th-228	1.57E-20	1.44E-20	1.32E-20	1.27E-20	1.12E-20	1.09E-20
Th-229	6.25E-19	5.69E-19	5.27E-19	5.02E-19	4.52E-19	4.40E-19
Th-230	3.36E-21	3.01E-21	2.65E-21	2.58E-21	2.12E-21	2.06E-21
Th-231	1.11E-19	9.76E-20	8.97E-20	8.48E-20	7.45E-20	7.23E-20
Th-232	1.96E-21	1.71E-21	1.48E-21	1.43E-21	1.12E-21	1.08E-21
Th-233	4.46E-19	4.14E-19	3.97E-19	3.76E-19	3.49E-19	3.42E-19
Th-234	7.18E-20	6.45E-20	5.97E-20	5.66E-20	5.06E-20	4.92E-20
Th-235	7.90E-19	7.39E-19	7.15E-19	6.77E-19	6.33E-19	6.21E-19
Th-236	4.05E-19	3.76E-19	3.59E-19	3.40E-19	3.15E-19	3.09E-19
<b>Protactinium</b>						
Pa-227	1.43E-19	1.28E-19	1.18E-19	1.12E-19	1.01E-19	9.78E-20
Pa-228	1.03E-17	9.53E-18	9.18E-18	8.68E-18	8.06E-18	7.90E-18
Pa-229	4.46E-19	3.97E-19	3.73E-19	3.51E-19	3.21E-19	3.12E-19
Pa-230	5.06E-18	4.69E-18	4.55E-18	4.26E-18	3.96E-18	3.87E-18
Pa-231	2.67E-19	2.44E-19	2.27E-19	2.19E-19	1.95E-19	1.91E-19
Pa-232	7.16E-18	6.67E-18	6.48E-18	6.07E-18	5.64E-18	5.53E-18
Pa-233	1.67E-18	1.54E-18	1.44E-18	1.39E-18	1.26E-18	1.23E-18
Pa-234	1.12E-17	1.04E-17	1.00E-17	9.45E-18	8.77E-18	8.59E-18
Pa-234m	6.17E-19	5.80E-19	5.69E-19	5.39E-19	5.06E-19	4.98E-19
Pa-235	2.29E-19	2.15E-19	2.12E-19	1.99E-19	1.87E-19	1.84E-19
Pa-236	7.20E-18	6.72E-18	6.42E-18	6.15E-18	5.76E-18	5.65E-18
Pa-237	5.00E-18	4.66E-18	4.51E-18	4.24E-18	3.95E-18	3.87E-18
<b>Uranium</b>						
U-227	8.75E-19	8.02E-19	7.51E-19	7.23E-19	6.46E-19	6.31E-19
U-228	2.97E-20	2.70E-20	2.51E-20	2.40E-20	2.14E-20	2.08E-20
U-230	9.15E-21	8.33E-21	7.48E-21	7.28E-21	6.17E-21	6.02E-21
U-231	5.15E-19	4.56E-19	4.26E-19	4.02E-19	3.65E-19	3.54E-19
U-232	2.73E-21	2.30E-21	1.99E-21	1.90E-21	1.45E-21	1.40E-21

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	2.32E-21	2.01E-21	1.79E-21	1.72E-21	1.41E-21	1.37E-21
U-234	1.78E-21	1.43E-21	1.22E-21	1.16E-21	8.10E-22	7.78E-22
U-235	1.23E-18	1.15E-18	1.06E-18	1.02E-18	9.07E-19	8.90E-19
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	1.25E-21	9.73E-22	8.07E-22	7.70E-22	4.84E-22	4.60E-22
U-237	1.01E-18	9.17E-19	8.51E-19	8.13E-19	7.25E-19	7.08E-19
U-238	1.03E-21	8.02E-22	6.69E-22	6.39E-22	4.07E-22	3.88E-22
U-239	5.39E-19	4.98E-19	4.67E-19	4.46E-19	4.02E-19	3.92E-19
U-240	5.94E-20	5.34E-20	5.05E-20	4.75E-20	4.27E-20	4.17E-20
U-242	4.80E-19	4.47E-19	4.23E-19	4.03E-19	3.71E-19	3.63E-19
<b>Neptunium</b>						
Np-232	9.09E-18	8.43E-18	8.15E-18	7.67E-18	7.08E-18	6.93E-18
Np-233	6.32E-19	5.66E-19	5.32E-19	5.03E-19	4.61E-19	4.48E-19
Np-234	8.06E-18	7.51E-18	7.21E-18	6.90E-18	6.45E-18	6.33E-18
Np-235	7.25E-21	5.88E-21	5.15E-21	4.90E-21	3.69E-21	3.54E-21
Np-236	1.02E-18	9.36E-19	8.61E-19	8.21E-19	7.46E-19	7.28E-19
Np-236m	3.69E-19	3.32E-19	3.14E-19	2.96E-19	2.72E-19	2.65E-19
Np-237	1.75E-19	1.54E-19	1.41E-19	1.33E-19	1.18E-19	1.15E-19
Np-238	4.49E-18	4.18E-18	4.12E-18	3.84E-18	3.56E-18	3.49E-18
Np-239	1.36E-18	1.24E-18	1.16E-18	1.11E-18	1.00E-18	9.76E-19
Np-240	8.10E-18	7.54E-18	7.26E-18	6.84E-18	6.36E-18	6.22E-18
Np-240m	2.81E-18	2.63E-18	2.50E-18	2.38E-18	2.23E-18	2.18E-18
Np-241	4.60E-19	4.24E-19	4.04E-19	3.82E-19	3.53E-19	3.45E-19
Np-242	2.54E-18	2.37E-18	2.30E-18	2.19E-18	2.05E-18	2.01E-18
Np-242m	7.20E-18	6.70E-18	6.52E-18	6.10E-18	5.66E-18	5.54E-18
<b>Plutonium</b>						
Pu-232	4.33E-19	3.87E-19	3.64E-19	3.42E-19	3.15E-19	3.05E-19
Pu-234	4.69E-19	4.18E-19	3.93E-19	3.70E-19	3.40E-19	3.30E-19
Pu-235	6.45E-19	5.77E-19	5.44E-19	5.12E-19	4.70E-19	4.57E-19
Pu-236	1.58E-21	1.17E-21	9.57E-22	9.21E-22	5.31E-22	5.00E-22
Pu-237	3.40E-19	3.03E-19	2.84E-19	2.67E-19	2.44E-19	2.37E-19
Pu-238	1.31E-21	9.57E-22	7.68E-22	7.42E-22	3.96E-22	3.70E-22
Pu-239	1.00E-21	8.15E-22	7.02E-22	6.74E-22	4.94E-22	4.75E-22
Pu-240	1.27E-21	9.30E-22	7.49E-22	7.22E-22	3.93E-22	3.68E-22
Pu-241	2.25E-23	2.06E-23	1.97E-23	1.85E-23	1.70E-23	1.67E-23
Pu-242	1.64E-21	1.32E-21	1.14E-21	1.10E-21	7.87E-22	7.58E-22
Pu-243	2.22E-19	2.02E-19	1.90E-19	1.80E-19	1.63E-19	1.59E-19
Pu-244	1.52E-19	1.42E-19	1.36E-19	1.31E-19	1.22E-19	1.20E-19
Pu-245	3.18E-18	2.95E-18	2.82E-18	2.67E-18	2.47E-18	2.41E-18
Pu-246	1.02E-18	9.24E-19	8.57E-19	8.21E-19	7.30E-19	7.13E-19
<b>Americium</b>						
Am-237	2.77E-18	2.55E-18	2.40E-18	2.30E-18	2.10E-18	2.05E-18
Am-238	6.76E-18	6.27E-18	6.08E-18	5.72E-18	5.32E-18	5.21E-18
Am-239	1.71E-18	1.55E-18	1.45E-18	1.39E-18	1.25E-18	1.22E-18
Am-240	7.75E-18	7.19E-18	7.06E-18	6.57E-18	6.10E-18	5.98E-18
Am-241	1.64E-19	1.44E-19	1.27E-19	1.21E-19	1.02E-19	9.93E-20



**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	1.52E-19	1.37E-19	1.31E-19	1.23E-19	1.13E-19	1.10E-19
Am-242m	6.04E-21	4.59E-21	3.85E-21	3.70E-21	2.50E-21	2.39E-21
Am-243	4.00E-19	3.66E-19	3.30E-19	3.19E-19	2.78E-19	2.70E-19
Am-244	6.09E-18	5.67E-18	5.49E-18	5.14E-18	4.78E-18	4.68E-18
Am-244m	3.59E-19	3.35E-19	3.29E-19	3.10E-19	2.89E-19	2.84E-19
Am-245	3.29E-19	3.03E-19	2.88E-19	2.74E-19	2.49E-19	2.44E-19
Am-246	5.78E-18	5.38E-18	5.13E-18	4.85E-18	4.49E-18	4.40E-18
Am-246m	7.60E-18	7.08E-18	6.93E-18	6.49E-18	6.03E-18	5.92E-18
Am-247	1.21E-18	1.12E-18	1.06E-18	1.01E-18	9.16E-19	8.96E-19
<b>Curium</b>						
Cm-238	5.66E-19	5.09E-19	4.76E-19	4.49E-19	4.13E-19	4.01E-19
Cm-239	1.89E-18	1.75E-18	1.61E-18	1.55E-18	1.39E-18	1.36E-18
Cm-240	1.73E-21	1.24E-21	9.99E-22	9.65E-22	5.37E-22	5.03E-22
Cm-241	3.80E-18	3.53E-18	3.27E-18	3.14E-18	2.93E-18	2.85E-18
Cm-242	1.52E-21	1.08E-21	8.68E-22	8.39E-22	4.58E-22	4.28E-22
Cm-243	9.62E-19	8.78E-19	8.23E-19	7.91E-19	7.09E-19	6.92E-19
Cm-244	1.40E-21	1.02E-21	8.31E-22	8.03E-22	4.72E-22	4.46E-22
Cm-245	7.39E-19	6.69E-19	6.22E-19	5.90E-19	5.39E-19	5.25E-19
Cm-246	2.83E-20	2.63E-20	2.50E-20	2.41E-20	2.23E-20	2.19E-20
Cm-247	2.47E-18	2.30E-18	2.14E-18	2.07E-18	1.91E-18	1.86E-18
Cm-248	9.99E-18	9.36E-18	8.95E-18	8.61E-18	8.06E-18	7.91E-18
Cm-249	2.52E-19	2.35E-19	2.25E-19	2.13E-19	1.99E-19	1.95E-19
Cm-250	1.02E-16	9.56E-17	9.15E-17	8.80E-17	8.24E-17	8.09E-17
Cm-251	1.06E-18	9.86E-19	9.32E-19	8.89E-19	8.30E-19	8.12E-19
<b>Berkelium</b>						
Bk-245	1.68E-18	1.54E-18	1.43E-18	1.37E-18	1.24E-18	1.21E-18
Bk-246	6.41E-18	5.96E-18	5.79E-18	5.42E-18	5.03E-18	4.93E-18
Bk-247	1.09E-18	1.00E-18	9.36E-19	9.00E-19	8.05E-19	7.86E-19
Bk-248m	4.59E-19	4.23E-19	3.97E-19	3.77E-19	3.50E-19	3.42E-19
Bk-249	3.66E-21	3.41E-21	3.35E-21	3.13E-21	2.90E-21	2.85E-21
Bk-250	6.87E-18	6.39E-18	6.29E-18	5.87E-18	5.44E-18	5.34E-18
Bk-251	7.27E-19	6.70E-19	6.21E-19	5.91E-19	5.40E-19	5.28E-19
<b>Californium</b>						
Cf-244	1.76E-21	1.21E-21	9.58E-22	9.23E-22	4.96E-22	4.62E-22
Cf-246	1.54E-21	1.13E-21	9.40E-22	9.03E-22	5.88E-22	5.60E-22
Cf-247	6.61E-19	6.00E-19	5.55E-19	5.27E-19	4.81E-19	4.69E-19
Cf-248	4.02E-21	3.39E-21	3.07E-21	2.95E-21	2.45E-21	2.39E-21
Cf-249	2.55E-18	2.37E-18	2.20E-18	2.13E-18	1.96E-18	1.91E-18
Cf-250	7.52E-20	7.01E-20	6.69E-20	6.43E-20	5.99E-20	5.89E-20
Cf-251	8.71E-19	8.00E-19	7.41E-19	7.10E-19	6.39E-19	6.25E-19
Cf-252	3.46E-18	3.24E-18	3.10E-18	2.98E-18	2.79E-18	2.74E-18
Cf-253	2.12E-20	1.83E-20	1.72E-20	1.60E-20	1.39E-20	1.36E-20
Cf-254	1.29E-16	1.20E-16	1.15E-16	1.11E-16	1.04E-16	1.02E-16
Cf-255	7.39E-20	6.89E-20	6.77E-20	6.33E-20	5.88E-20	5.78E-20
<b>Einsteinium</b>						
Es-249	3.10E-18	2.87E-18	2.71E-18	2.58E-18	2.38E-18	2.33E-18

**Table 4-2. Reference person effective dose rate coefficients for soil to 1 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	9.04E-18	8.38E-18	8.04E-18	7.57E-18	6.99E-18	6.84E-18
Es-250m	4.10E-18	3.80E-18	3.68E-18	3.46E-18	3.21E-18	3.15E-18
Es-251	6.57E-19	6.00E-19	5.52E-19	5.25E-19	4.79E-19	4.68E-19
Es-253	2.99E-21	2.65E-21	2.40E-21	2.31E-21	2.04E-21	1.98E-21
Es-254	3.76E-20	3.08E-20	2.68E-20	2.57E-20	2.00E-20	1.94E-20
Es-254m	3.73E-18	3.47E-18	3.31E-18	3.13E-18	2.93E-18	2.87E-18
Es-255	2.07E-20	1.93E-20	1.88E-20	1.77E-20	1.65E-20	1.62E-20
Es-256	3.03E-19	2.83E-19	2.78E-19	2.63E-19	2.46E-19	2.42E-19
<b>Fermium</b>						
Fm-251	1.13E-18	1.04E-18	9.72E-19	9.22E-19	8.50E-19	8.30E-19
Fm-252	3.67E-21	3.01E-21	2.69E-21	2.57E-21	2.09E-21	2.03E-21
Fm-253	4.28E-19	3.90E-19	3.58E-19	3.42E-19	3.09E-19	3.02E-19
Fm-254	5.44E-20	5.04E-20	4.80E-20	4.62E-20	4.29E-20	4.21E-20
Fm-255	2.62E-20	2.07E-20	1.77E-20	1.69E-20	1.26E-20	1.21E-20
Fm-256	9.39E-17	8.79E-17	8.41E-17	8.09E-17	7.57E-17	7.43E-17
Fm-257	1.05E-18	9.71E-19	9.04E-19	8.67E-19	7.87E-19	7.70E-19

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm.**

**Explanation of entries**

For each radionuclide, values for the age-dependent effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>13</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ), that is, the effective dose per unit time-integrated exposure to a radionuclide:

$w_T$ : The tissue weighting factor:

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-3 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to a source per unit mass basis ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{kg}$ ), multiply table entries by  $1.6 \times 10^3$ .

To convert from SI units ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{cm}^3$ ), multiply table entries by  $1.168 \times 10^{23}$ .

To convert from SI units from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units for a source per unit mass basis ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{g}$ ), multiply table entries by  $1.868 \times 10^{23}$ .

**Radionuclide dose rate coefficients for soil contaminated to a finite depth cannot be scaled to account for a different soil density.**

<sup>13</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	2.40E-23	2.22E-23	2.13E-23	2.02E-23	1.88E-23	1.85E-23
<b>Beryllium</b>						
Be-7	1.16E-18	1.06E-18	9.92E-19	9.53E-19	8.78E-19	8.61E-19
Be-10	2.53E-19	2.35E-19	2.26E-19	2.14E-19	1.99E-19	1.95E-19
<b>Carbon</b>						
C-10	4.15E-17	3.83E-17	3.60E-17	3.44E-17	3.18E-17	3.12E-17
C-11	2.41E-17	2.22E-17	2.07E-17	1.99E-17	1.83E-17	1.80E-17
C-14	2.20E-20	2.04E-20	1.96E-20	1.86E-20	1.73E-20	1.70E-20
<b>Nitrogen</b>						
N-13	2.43E-17	2.24E-17	2.09E-17	2.00E-17	1.85E-17	1.81E-17
N-16	8.56E-17	8.19E-17	7.96E-17	7.82E-17	7.46E-17	7.39E-17
<b>Oxygen</b>						
O-14	7.19E-17	6.70E-17	6.32E-17	6.15E-17	5.75E-17	5.66E-17
O-15	2.48E-17	2.28E-17	2.13E-17	2.05E-17	1.89E-17	1.85E-17
O-19	2.44E-17	2.26E-17	2.16E-17	2.07E-17	1.92E-17	1.89E-17
<b>Fluorine</b>						
F-17	2.48E-17	2.28E-17	2.13E-17	2.05E-17	1.89E-17	1.85E-17
F-18	2.32E-17	2.13E-17	1.99E-17	1.91E-17	1.76E-17	1.73E-17
<b>Neon</b>						
Ne-19	2.53E-17	2.33E-17	2.18E-17	2.09E-17	1.93E-17	1.89E-17
Ne-24	1.38E-17	1.27E-17	1.19E-17	1.14E-17	1.06E-17	1.04E-17
<b>Sodium</b>						
Na-22	4.95E-17	4.58E-17	4.34E-17	4.15E-17	3.85E-17	3.79E-17
Na-24	8.53E-17	7.99E-17	7.60E-17	7.41E-17	6.95E-17	6.85E-17
<b>Magnesium</b>						
Mg-27	2.12E-17	1.96E-17	1.88E-17	1.78E-17	1.65E-17	1.62E-17
Mg-28	3.01E-17	2.80E-17	2.66E-17	2.55E-17	2.37E-17	2.33E-17
<b>Aluminum</b>						
Al-26	5.89E-17	5.48E-17	5.17E-17	5.01E-17	4.68E-17	4.60E-17
Al-28	4.00E-17	3.74E-17	3.55E-17	3.45E-17	3.24E-17	3.19E-17
Al-29	3.16E-17	2.95E-17	2.82E-17	2.70E-17	2.52E-17	2.48E-17
<b>Silicon</b>						
Si-31	8.63E-19	8.04E-19	7.72E-19	7.35E-19	6.86E-19	6.75E-19
Si-32	3.89E-20	3.61E-20	3.46E-20	3.28E-20	3.04E-20	2.99E-20
<b>Phosphorus</b>						
P-30	2.65E-17	2.44E-17	2.29E-17	2.19E-17	2.03E-17	1.99E-17
P-32	1.04E-18	9.72E-19	9.34E-19	8.89E-19	8.30E-19	8.18E-19
P-33	4.62E-20	4.28E-20	4.11E-20	3.89E-20	3.62E-20	3.56E-20
<b>Sulfur</b>						
S-35	2.22E-20	2.05E-20	1.97E-20	1.87E-20	1.73E-20	1.70E-20
S-37	5.82E-17	5.48E-17	5.22E-17	5.12E-17	4.82E-17	4.76E-17
S-38	3.62E-17	3.39E-17	3.21E-17	3.14E-17	2.95E-17	2.90E-17
<b>Chlorine</b>						
Cl-34	2.82E-17	2.60E-17	2.44E-17	2.34E-17	2.17E-17	2.13E-17
Cl-34m	4.55E-17	4.24E-17	4.01E-17	3.89E-17	3.64E-17	3.58E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	2.95E-19	2.74E-19	2.63E-19	2.49E-19	2.32E-19	2.28E-19
Cl-38	3.36E-17	3.14E-17	2.98E-17	2.91E-17	2.73E-17	2.69E-17
Cl-39	3.31E-17	3.08E-17	2.94E-17	2.82E-17	2.63E-17	2.58E-17
Cl-40	8.58E-17	8.05E-17	7.67E-17	7.47E-17	7.02E-17	6.92E-17
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	2.13E-19	1.97E-19	1.89E-19	1.80E-19	1.67E-19	1.64E-19
Ar-41	2.88E-17	2.68E-17	2.56E-17	2.45E-17	2.28E-17	2.25E-17
Ar-42	2.32E-19	2.15E-19	2.06E-19	1.96E-19	1.82E-19	1.79E-19
Ar-43	3.58E-17	3.34E-17	3.18E-17	3.06E-17	2.86E-17	2.81E-17
Ar-44	4.22E-17	3.94E-17	3.73E-17	3.62E-17	3.39E-17	3.33E-17
<b>Potassium</b>						
K-38	7.06E-17	6.58E-17	6.20E-17	6.03E-17	5.63E-17	5.54E-17
K-40	4.13E-18	3.85E-18	3.68E-18	3.53E-18	3.30E-18	3.25E-18
K-42	8.84E-18	8.26E-18	7.88E-18	7.59E-18	7.10E-18	6.99E-18
K-43	2.26E-17	2.08E-17	1.95E-17	1.87E-17	1.72E-17	1.69E-17
K-44	5.33E-17	4.98E-17	4.75E-17	4.59E-17	4.30E-17	4.23E-17
K-45	4.08E-17	3.81E-17	3.61E-17	3.50E-17	3.27E-17	3.22E-17
K-46	6.45E-17	6.04E-17	5.78E-17	5.59E-17	5.24E-17	5.17E-17
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	4.72E-20	4.38E-20	4.20E-20	3.98E-20	3.70E-20	3.64E-20
Ca-47	2.36E-17	2.20E-17	2.10E-17	2.01E-17	1.87E-17	1.84E-17
Ca-49	6.27E-17	5.91E-17	5.63E-17	5.52E-17	5.20E-17	5.14E-17
<b>Scandium</b>						
Sc-42m	9.60E-17	8.90E-17	8.43E-17	8.09E-17	7.52E-17	7.39E-17
Sc-43	2.34E-17	2.15E-17	2.01E-17	1.93E-17	1.78E-17	1.74E-17
Sc-44	4.92E-17	4.55E-17	4.31E-17	4.12E-17	3.82E-17	3.75E-17
Sc-44m	6.30E-18	5.76E-18	5.43E-18	5.18E-18	4.76E-18	4.66E-18
Sc-46	4.51E-17	4.18E-17	4.01E-17	3.80E-17	3.53E-17	3.47E-17
Sc-47	2.53E-18	2.36E-18	2.18E-18	2.09E-18	1.90E-18	1.86E-18
Sc-48	7.47E-17	6.93E-17	6.64E-17	6.32E-17	5.88E-17	5.78E-17
Sc-49	1.33E-18	1.24E-18	1.19E-18	1.13E-18	1.06E-18	1.04E-18
Sc-50	7.38E-17	6.86E-17	6.53E-17	6.27E-17	5.84E-17	5.74E-17
<b>Titanium</b>						
Ti-44	2.46E-18	2.19E-18	2.01E-18	1.91E-18	1.67E-18	1.63E-18
Ti-45	2.07E-17	1.90E-17	1.77E-17	1.70E-17	1.57E-17	1.54E-17
Ti-51	9.94E-18	9.13E-18	8.61E-18	8.23E-18	7.59E-18	7.44E-18
Ti-52	3.77E-18	3.50E-18	3.26E-18	3.13E-18	2.84E-18	2.80E-18
<b>Vanadium</b>						
V-47	2.43E-17	2.24E-17	2.09E-17	2.01E-17	1.86E-17	1.82E-17
V-48	6.52E-17	6.04E-17	5.76E-17	5.50E-17	5.11E-17	5.02E-17
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	3.08E-17	2.87E-17	2.73E-17	2.64E-17	2.47E-17	2.43E-17
V-52	3.33E-17	3.10E-17	2.96E-17	2.84E-17	2.66E-17	2.62E-17
V-53	2.49E-17	2.31E-17	2.22E-17	2.10E-17	1.96E-17	1.92E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	9.81E-18	8.97E-18	8.38E-18	8.02E-18	7.33E-18	7.18E-18
Cr-49	2.50E-17	2.30E-17	2.14E-17	2.06E-17	1.89E-17	1.86E-17
Cr-51	7.37E-19	6.73E-19	6.31E-19	6.04E-19	5.54E-19	5.43E-19
Cr-55	1.96E-18	1.83E-18	1.76E-18	1.68E-18	1.57E-18	1.55E-18
Cr-56	2.36E-18	2.14E-18	2.00E-18	1.91E-18	1.72E-18	1.68E-18
<b>Manganese</b>						
Mn-50m	1.07E-16	9.90E-17	9.40E-17	8.99E-17	8.35E-17	8.21E-17
Mn-51	2.47E-17	2.27E-17	2.13E-17	2.04E-17	1.88E-17	1.85E-17
Mn-52	7.72E-17	7.16E-17	6.82E-17	6.51E-17	6.05E-17	5.95E-17
Mn-52m	5.58E-17	5.18E-17	4.89E-17	4.70E-17	4.37E-17	4.29E-17
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	1.90E-17	1.75E-17	1.67E-17	1.59E-17	1.47E-17	1.44E-17
Mn-56	3.83E-17	3.56E-17	3.39E-17	3.26E-17	3.04E-17	2.99E-17
Mn-57	4.08E-18	3.79E-18	3.60E-18	3.44E-18	3.19E-18	3.14E-18
Mn-58m	5.63E-17	5.23E-17	4.99E-17	4.77E-17	4.45E-17	4.37E-17
<b>Iron</b>						
Fe-52	1.72E-17	1.58E-17	1.48E-17	1.42E-17	1.30E-17	1.28E-17
Fe-53	2.92E-17	2.69E-17	2.52E-17	2.42E-17	2.23E-17	2.19E-17
Fe-53m	6.76E-17	6.28E-17	5.99E-17	5.72E-17	5.32E-17	5.23E-17
Fe-55	3.41E-27	3.16E-27	2.91E-27	2.79E-27	2.51E-27	2.47E-27
Fe-59	2.64E-17	2.45E-17	2.35E-17	2.24E-17	2.08E-17	2.05E-17
Fe-60	3.42E-20	3.17E-20	3.04E-20	2.88E-20	2.68E-20	2.63E-20
Fe-61	3.26E-17	3.03E-17	2.89E-17	2.76E-17	2.57E-17	2.53E-17
Fe-62	1.31E-17	1.20E-17	1.13E-17	1.08E-17	9.98E-18	9.79E-18
<b>Cobalt</b>						
Co-54m	9.26E-17	8.58E-17	8.14E-17	7.79E-17	7.24E-17	7.11E-17
Co-55	4.58E-17	4.24E-17	4.01E-17	3.83E-17	3.55E-17	3.49E-17
Co-56	7.83E-17	7.29E-17	6.95E-17	6.69E-17	6.24E-17	6.14E-17
Co-57	2.54E-18	2.35E-18	2.16E-18	2.07E-18	1.87E-18	1.83E-18
Co-58	2.22E-17	2.05E-17	1.95E-17	1.85E-17	1.72E-17	1.69E-17
Co-58m	2.43E-23	1.65E-23	1.28E-23	1.17E-23	7.83E-24	7.43E-24
Co-60	5.51E-17	5.13E-17	4.91E-17	4.69E-17	4.37E-17	4.30E-17
Co-60m	9.23E-20	8.45E-20	7.98E-20	7.61E-20	6.99E-20	6.87E-20
Co-61	2.46E-18	2.24E-18	2.11E-18	2.00E-18	1.81E-18	1.77E-18
Co-62	3.80E-17	3.54E-17	3.39E-17	3.25E-17	3.03E-17	2.99E-17
Co-62m	6.06E-17	5.65E-17	5.40E-17	5.17E-17	4.82E-17	4.75E-17
<b>Nickel</b>						
Ni-56	3.88E-17	3.59E-17	3.40E-17	3.24E-17	3.00E-17	2.94E-17
Ni-57	4.28E-17	3.98E-17	3.77E-17	3.63E-17	3.38E-17	3.32E-17
Ni-59	3.61E-22	3.32E-22	3.09E-22	2.97E-22	2.74E-22	2.69E-22
Ni-63	2.87E-21	2.67E-21	2.56E-21	2.42E-21	2.25E-21	2.21E-21
Ni-65	1.32E-17	1.23E-17	1.17E-17	1.12E-17	1.05E-17	1.03E-17
Ni-66	4.38E-20	4.07E-20	3.90E-20	3.70E-20	3.43E-20	3.38E-20
<b>Copper</b>						
Cu-57	3.69E-17	3.42E-17	3.22E-17	3.10E-17	2.88E-17	2.83E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	3.61E-17	3.33E-17	3.13E-17	3.00E-17	2.78E-17	2.73E-17
Cu-60	8.68E-17	8.07E-17	7.65E-17	7.38E-17	6.87E-17	6.76E-17
Cu-61	1.94E-17	1.78E-17	1.67E-17	1.60E-17	1.48E-17	1.45E-17
Cu-62	2.57E-17	2.37E-17	2.22E-17	2.13E-17	1.97E-17	1.93E-17
Cu-64	4.39E-18	4.04E-18	3.77E-18	3.62E-18	3.34E-18	3.28E-18
Cu-66	4.06E-18	3.78E-18	3.63E-18	3.45E-18	3.22E-18	3.16E-18
Cu-67	2.63E-18	2.42E-18	2.26E-18	2.15E-18	1.96E-18	1.92E-18
Cu-69	1.33E-17	1.24E-17	1.18E-17	1.12E-17	1.05E-17	1.03E-17
<b>Zinc</b>						
Zn-60	3.73E-17	3.43E-17	3.22E-17	3.08E-17	2.84E-17	2.79E-17
Zn-61	3.87E-17	3.58E-17	3.36E-17	3.24E-17	3.00E-17	2.95E-17
Zn-62	1.01E-17	9.24E-18	8.64E-18	8.27E-18	7.63E-18	7.48E-18
Zn-63	2.69E-17	2.48E-17	2.32E-17	2.23E-17	2.06E-17	2.02E-17
Zn-65	1.29E-17	1.20E-17	1.15E-17	1.09E-17	1.01E-17	9.95E-18
Zn-69	3.66E-19	3.40E-19	3.27E-19	3.10E-19	2.88E-19	2.84E-19
Zn-69m	9.67E-18	8.88E-18	8.27E-18	7.95E-18	7.32E-18	7.17E-18
Zn-71	9.04E-18	8.36E-18	7.91E-18	7.56E-18	7.00E-18	6.88E-18
Zn-71m	3.67E-17	3.38E-17	3.17E-17	3.04E-17	2.80E-17	2.75E-17
Zn-72	3.22E-18	2.99E-18	2.76E-18	2.65E-18	2.39E-18	2.35E-18
<b>Gallium</b>						
Ga-64	7.63E-17	7.10E-17	6.73E-17	6.49E-17	6.05E-17	5.96E-17
Ga-65	2.79E-17	2.57E-17	2.41E-17	2.31E-17	2.13E-17	2.09E-17
Ga-66	5.41E-17	5.05E-17	4.79E-17	4.64E-17	4.34E-17	4.27E-17
Ga-67	3.41E-18	3.12E-18	2.91E-18	2.78E-18	2.53E-18	2.48E-18
Ga-68	2.31E-17	2.13E-17	1.99E-17	1.91E-17	1.76E-17	1.73E-17
Ga-70	1.11E-18	1.03E-18	9.93E-19	9.45E-19	8.81E-19	8.67E-19
Ga-72	5.92E-17	5.51E-17	5.24E-17	5.05E-17	4.71E-17	4.64E-17
Ga-73	8.52E-18	7.80E-18	7.35E-18	7.01E-18	6.45E-18	6.32E-18
Ga-74	6.89E-17	6.43E-17	6.09E-17	5.91E-17	5.52E-17	5.43E-17
<b>Germanium</b>						
Ge-66	1.54E-17	1.41E-17	1.32E-17	1.26E-17	1.16E-17	1.14E-17
Ge-67	3.46E-17	3.20E-17	3.00E-17	2.88E-17	2.66E-17	2.61E-17
Ge-68	5.58E-23	3.58E-23	2.04E-23	1.84E-23	6.64E-24	6.13E-24
Ge-69	2.15E-17	1.99E-17	1.89E-17	1.80E-17	1.67E-17	1.64E-17
Ge-71	5.67E-23	3.63E-23	2.07E-23	1.87E-23	6.74E-24	6.22E-24
Ge-75	1.34E-18	1.23E-18	1.17E-18	1.11E-18	1.03E-18	1.01E-18
Ge-77	2.54E-17	2.34E-17	2.22E-17	2.12E-17	1.96E-17	1.92E-17
Ge-78	6.65E-18	6.07E-18	5.71E-18	5.45E-18	5.00E-18	4.90E-18
<b>Arsenic</b>						
As-68	8.68E-17	8.06E-17	7.64E-17	7.33E-17	6.81E-17	6.70E-17
As-69	2.85E-17	2.63E-17	2.46E-17	2.37E-17	2.19E-17	2.15E-17
As-70	9.61E-17	8.92E-17	8.46E-17	8.11E-17	7.53E-17	7.41E-17
As-71	1.32E-17	1.22E-17	1.14E-17	1.09E-17	1.00E-17	9.84E-18
As-72	4.25E-17	3.92E-17	3.70E-17	3.54E-17	3.28E-17	3.22E-17
As-73	7.94E-20	6.60E-20	5.82E-20	5.33E-20	4.51E-20	4.40E-20
As-74	1.78E-17	1.64E-17	1.54E-17	1.47E-17	1.36E-17	1.34E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	1.14E-17	1.05E-17	9.96E-18	9.54E-18	8.85E-18	8.69E-18
As-77	4.16E-19	3.84E-19	3.65E-19	3.47E-19	3.21E-19	3.15E-19
As-78	3.14E-17	2.91E-17	2.77E-17	2.65E-17	2.47E-17	2.43E-17
As-79	2.22E-18	2.06E-18	1.97E-18	1.87E-18	1.74E-18	1.71E-18
<b>Selenium</b>						
Se-70	1.65E-17	1.52E-17	1.42E-17	1.36E-17	1.25E-17	1.23E-17
Se-71	3.93E-17	3.63E-17	3.42E-17	3.27E-17	3.03E-17	2.97E-17
Se-72	3.10E-19	2.47E-19	2.12E-19	1.90E-19	1.58E-19	1.54E-19
Se-73	2.55E-17	2.34E-17	2.18E-17	2.09E-17	1.93E-17	1.89E-17
Se-73m	6.26E-18	5.76E-18	5.39E-18	5.17E-18	4.76E-18	4.67E-18
Se-75	8.66E-18	7.94E-18	7.41E-18	7.09E-18	6.48E-18	6.35E-18
Se-77m	1.90E-18	1.77E-18	1.63E-18	1.57E-18	1.42E-18	1.39E-18
Se-79	2.45E-20	2.27E-20	2.18E-20	2.07E-20	1.92E-20	1.89E-20
Se-79m	1.80E-19	1.63E-19	1.51E-19	1.44E-19	1.28E-19	1.26E-19
Se-81	1.07E-18	9.90E-19	9.48E-19	9.03E-19	8.41E-19	8.27E-19
Se-81m	2.78E-19	2.53E-19	2.34E-19	2.24E-19	2.01E-19	1.97E-19
Se-83	5.88E-17	5.45E-17	5.16E-17	4.96E-17	4.61E-17	4.53E-17
Se-83m	2.41E-17	2.24E-17	2.13E-17	2.04E-17	1.90E-17	1.87E-17
Se-84	1.05E-17	9.67E-18	9.04E-18	8.67E-18	7.99E-18	7.83E-18
<b>Bromine</b>						
Br-72	7.35E-17	6.81E-17	6.45E-17	6.19E-17	5.75E-17	5.65E-17
Br-73	3.54E-17	3.26E-17	3.06E-17	2.93E-17	2.71E-17	2.66E-17
Br-74	9.76E-17	9.11E-17	8.64E-17	8.39E-17	7.84E-17	7.72E-17
Br-74m	9.22E-17	8.57E-17	8.11E-17	7.83E-17	7.29E-17	7.17E-17
Br-75	2.84E-17	2.61E-17	2.45E-17	2.35E-17	2.16E-17	2.12E-17
Br-76	6.17E-17	5.74E-17	5.42E-17	5.24E-17	4.88E-17	4.80E-17
Br-76m	4.97E-19	4.21E-19	3.75E-19	3.47E-19	3.01E-19	2.95E-19
Br-77	7.26E-18	6.67E-18	6.26E-18	5.98E-18	5.51E-18	5.40E-18
Br-77m	2.99E-19	2.72E-19	2.52E-19	2.41E-19	2.16E-19	2.12E-19
Br-78	2.58E-17	2.37E-17	2.22E-17	2.13E-17	1.97E-17	1.93E-17
Br-80	2.89E-18	2.67E-18	2.53E-18	2.42E-18	2.25E-18	2.21E-18
Br-80m	1.11E-19	8.38E-20	6.79E-20	6.03E-20	4.76E-20	4.60E-20
Br-82	5.98E-17	5.53E-17	5.25E-17	5.01E-17	4.64E-17	4.56E-17
Br-82m	1.22E-19	1.13E-19	1.08E-19	1.03E-19	9.57E-20	9.41E-20
Br-83	5.33E-19	4.94E-19	4.70E-19	4.48E-19	4.16E-19	4.08E-19
Br-84	3.90E-17	3.65E-17	3.48E-17	3.37E-17	3.15E-17	3.11E-17
Br-84m	6.30E-17	5.85E-17	5.56E-17	5.32E-17	4.95E-17	4.87E-17
Br-85	3.29E-18	3.06E-18	2.93E-18	2.80E-18	2.61E-18	2.57E-18
<b>Krypton</b>						
Kr-74	2.51E-17	2.30E-17	2.15E-17	2.06E-17	1.90E-17	1.86E-17
Kr-75	3.23E-17	2.98E-17	2.79E-17	2.68E-17	2.47E-17	2.43E-17
Kr-76	9.58E-18	8.76E-18	8.21E-18	7.85E-18	7.21E-18	7.06E-18
Kr-77	2.48E-17	2.28E-17	2.13E-17	2.05E-17	1.88E-17	1.85E-17
Kr-79	5.75E-18	5.29E-18	4.96E-18	4.75E-18	4.37E-18	4.29E-18
Kr-81	2.02E-20	1.82E-20	1.69E-20	1.61E-20	1.44E-20	1.41E-20
Kr-81m	2.90E-18	2.66E-18	2.49E-18	2.38E-18	2.17E-18	2.13E-18



**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	5.86E-22	4.42E-22	3.18E-22	2.96E-22	1.20E-22	1.10E-22
Kr-85	3.12E-19	2.89E-19	2.76E-19	2.63E-19	2.44E-19	2.40E-19
Kr-85m	3.72E-18	3.45E-18	3.20E-18	3.07E-18	2.79E-18	2.74E-18
Kr-87	1.95E-17	1.82E-17	1.72E-17	1.67E-17	1.56E-17	1.53E-17
Kr-88	4.13E-17	3.87E-17	3.67E-17	3.57E-17	3.35E-17	3.30E-17
Kr-89	4.38E-17	4.08E-17	3.88E-17	3.75E-17	3.50E-17	3.45E-17
<b>Rubidium</b>						
Rb-77	3.86E-17	3.56E-17	3.35E-17	3.21E-17	2.96E-17	2.91E-17
Rb-78	8.77E-17	8.19E-17	7.75E-17	7.53E-17	7.03E-17	6.93E-17
Rb-78m	7.46E-17	6.92E-17	6.53E-17	6.28E-17	5.83E-17	5.73E-17
Rb-79	3.45E-17	3.18E-17	2.97E-17	2.85E-17	2.63E-17	2.58E-17
Rb-80	3.21E-17	2.96E-17	2.78E-17	2.67E-17	2.47E-17	2.42E-17
Rb-81	1.18E-17	1.08E-17	1.01E-17	9.72E-18	8.97E-18	8.79E-18
Rb-81m	5.39E-19	4.95E-19	4.64E-19	4.44E-19	4.08E-19	4.00E-19
Rb-82	2.84E-17	2.62E-17	2.45E-17	2.35E-17	2.17E-17	2.13E-17
Rb-82m	6.60E-17	6.11E-17	5.80E-17	5.53E-17	5.13E-17	5.04E-17
Rb-83	1.12E-17	1.03E-17	9.65E-18	9.25E-18	8.54E-18	8.37E-18
Rb-84	2.08E-17	1.92E-17	1.82E-17	1.73E-17	1.61E-17	1.58E-17
Rb-84m	8.78E-18	8.03E-18	7.53E-18	7.20E-18	6.61E-18	6.47E-18
Rb-86	3.09E-18	2.87E-18	2.76E-18	2.62E-18	2.44E-18	2.40E-18
Rb-86m	1.26E-17	1.16E-17	1.09E-17	1.04E-17	9.64E-18	9.45E-18
Rb-87	8.40E-20	7.79E-20	7.48E-20	7.09E-20	6.58E-20	6.47E-20
Rb-88	1.83E-17	1.71E-17	1.63E-17	1.58E-17	1.48E-17	1.46E-17
Rb-89	5.01E-17	4.67E-17	4.45E-17	4.28E-17	3.99E-17	3.93E-17
Rb-90	4.46E-17	4.19E-17	4.01E-17	3.90E-17	3.66E-17	3.62E-17
Rb-90m	7.02E-17	6.57E-17	6.26E-17	6.05E-17	5.67E-17	5.58E-17
<b>Strontium</b>						
Sr-79	3.10E-17	2.85E-17	2.67E-17	2.56E-17	2.36E-17	2.32E-17
Sr-80	9.98E-18	9.18E-18	8.60E-18	8.23E-18	7.59E-18	7.45E-18
Sr-81	3.35E-17	3.09E-17	2.89E-17	2.77E-17	2.56E-17	2.51E-17
Sr-82	2.46E-21	1.90E-21	1.40E-21	1.33E-21	4.75E-22	4.31E-22
Sr-83	1.86E-17	1.72E-17	1.62E-17	1.55E-17	1.44E-17	1.41E-17
Sr-85	1.14E-17	1.05E-17	9.80E-18	9.41E-18	8.68E-18	8.51E-18
Sr-85m	4.93E-18	4.51E-18	4.24E-18	4.04E-18	3.69E-18	3.62E-18
Sr-87m	7.41E-18	6.79E-18	6.34E-18	6.08E-18	5.59E-18	5.48E-18
Sr-89	8.39E-19	7.81E-19	7.51E-19	7.15E-19	6.67E-19	6.56E-19
Sr-90	1.85E-19	1.71E-19	1.64E-19	1.56E-19	1.45E-19	1.42E-19
Sr-91	1.70E-17	1.57E-17	1.50E-17	1.43E-17	1.32E-17	1.30E-17
Sr-92	2.94E-17	2.74E-17	2.61E-17	2.51E-17	2.34E-17	2.30E-17
Sr-93	5.14E-17	4.77E-17	4.52E-17	4.34E-17	4.03E-17	3.97E-17
Sr-94	3.24E-17	3.02E-17	2.88E-17	2.77E-17	2.59E-17	2.54E-17
<b>Yttrium</b>						
Y-81	3.09E-17	2.85E-17	2.67E-17	2.56E-17	2.36E-17	2.32E-17
Y-83	3.31E-17	3.05E-17	2.87E-17	2.75E-17	2.54E-17	2.50E-17
Y-83m	2.08E-17	1.91E-17	1.79E-17	1.72E-17	1.58E-17	1.55E-17
Y-84m	9.21E-17	8.53E-17	8.10E-17	7.72E-17	7.16E-17	7.03E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	2.57E-17	2.36E-17	2.21E-17	2.12E-17	1.96E-17	1.92E-17
Y-85m	3.05E-17	2.82E-17	2.66E-17	2.56E-17	2.37E-17	2.33E-17
Y-86	7.95E-17	7.37E-17	7.00E-17	6.71E-17	6.24E-17	6.14E-17
Y-86m	4.99E-18	4.57E-18	4.30E-18	4.10E-18	3.75E-18	3.68E-18
Y-87	1.02E-17	9.34E-18	8.71E-18	8.36E-18	7.71E-18	7.56E-18
Y-87m	7.10E-18	6.51E-18	6.07E-18	5.83E-18	5.36E-18	5.25E-18
Y-88	5.80E-17	5.41E-17	5.14E-17	4.96E-17	4.64E-17	4.57E-17
Y-89m	2.03E-17	1.88E-17	1.81E-17	1.71E-17	1.58E-17	1.56E-17
Y-90	1.58E-18	1.47E-18	1.41E-18	1.35E-18	1.26E-18	1.24E-18
Y-90m	1.46E-17	1.34E-17	1.25E-17	1.20E-17	1.10E-17	1.08E-17
Y-91	9.43E-19	8.79E-19	8.44E-19	8.04E-19	7.50E-19	7.39E-19
Y-91m	1.22E-17	1.13E-17	1.05E-17	1.01E-17	9.32E-18	9.13E-18
Y-92	8.52E-18	7.92E-18	7.58E-18	7.23E-18	6.73E-18	6.62E-18
Y-93	4.26E-18	3.97E-18	3.79E-18	3.63E-18	3.39E-18	3.34E-18
Y-94	2.11E-17	1.96E-17	1.88E-17	1.79E-17	1.66E-17	1.64E-17
Y-95	2.58E-17	2.42E-17	2.30E-17	2.24E-17	2.10E-17	2.07E-17
<b>Zirconium</b>						
Zr-85	3.64E-17	3.36E-17	3.15E-17	3.02E-17	2.79E-17	2.74E-17
Zr-86	6.27E-18	5.72E-18	5.38E-18	5.13E-18	4.70E-18	4.60E-18
Zr-87	2.27E-17	2.10E-17	1.96E-17	1.88E-17	1.74E-17	1.71E-17
Zr-88	8.89E-18	8.15E-18	7.60E-18	7.30E-18	6.71E-18	6.57E-18
Zr-89	2.62E-17	2.42E-17	2.31E-17	2.19E-17	2.03E-17	2.00E-17
Zr-89m	1.45E-17	1.34E-17	1.26E-17	1.21E-17	1.12E-17	1.10E-17
Zr-93	3.40E-21	3.16E-21	3.03E-21	2.87E-21	2.66E-21	2.62E-21
Zr-95	1.68E-17	1.55E-17	1.48E-17	1.40E-17	1.30E-17	1.27E-17
Zr-97	2.11E-17	1.95E-17	1.85E-17	1.76E-17	1.63E-17	1.61E-17
<b>Niobium</b>						
Nb-87	3.14E-17	2.90E-17	2.71E-17	2.60E-17	2.40E-17	2.35E-17
Nb-88	9.82E-17	9.08E-17	8.61E-17	8.21E-17	7.61E-17	7.47E-17
Nb-88m	9.54E-17	8.83E-17	8.37E-17	8.00E-17	7.42E-17	7.29E-17
Nb-89	3.23E-17	2.99E-17	2.82E-17	2.72E-17	2.52E-17	2.48E-17
Nb-89m	3.15E-17	2.90E-17	2.71E-17	2.60E-17	2.40E-17	2.36E-17
Nb-90	9.02E-17	8.42E-17	7.98E-17	7.73E-17	7.22E-17	7.11E-17
Nb-91	4.31E-20	3.86E-20	3.54E-20	3.41E-20	2.98E-20	2.91E-20
Nb-91m	5.56E-19	5.15E-19	4.92E-19	4.70E-19	4.35E-19	4.28E-19
Nb-92	3.40E-17	3.15E-17	2.99E-17	2.84E-17	2.63E-17	2.59E-17
Nb-92m	2.16E-17	2.00E-17	1.92E-17	1.81E-17	1.68E-17	1.65E-17
Nb-93m	1.29E-21	9.33E-22	7.42E-22	7.30E-22	3.32E-22	3.04E-22
Nb-94	3.56E-17	3.29E-17	3.14E-17	2.98E-17	2.76E-17	2.71E-17
Nb-94m	1.07E-19	9.82E-20	9.33E-20	8.85E-20	8.07E-20	7.92E-20
Nb-95	1.75E-17	1.61E-17	1.54E-17	1.46E-17	1.35E-17	1.32E-17
Nb-95m	1.46E-18	1.34E-18	1.26E-18	1.20E-18	1.10E-18	1.07E-18
Nb-96	5.60E-17	5.18E-17	4.93E-17	4.69E-17	4.34E-17	4.27E-17
Nb-97	1.59E-17	1.47E-17	1.39E-17	1.32E-17	1.22E-17	1.20E-17
Nb-98m	6.41E-17	5.95E-17	5.66E-17	5.41E-17	5.02E-17	4.94E-17
Nb-99	6.36E-18	5.91E-18	5.55E-18	5.32E-18	4.87E-18	4.79E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	1.87E-17	1.75E-17	1.66E-17	1.61E-17	1.50E-17	1.48E-17
<b>Molybdenum</b>						
Mo-89	3.23E-17	2.98E-17	2.80E-17	2.69E-17	2.49E-17	2.44E-17
Mo-90	1.87E-17	1.72E-17	1.62E-17	1.55E-17	1.42E-17	1.40E-17
Mo-91	2.55E-17	2.35E-17	2.20E-17	2.11E-17	1.95E-17	1.92E-17
Mo-91m	3.22E-17	2.98E-17	2.82E-17	2.70E-17	2.51E-17	2.46E-17
Mo-93	7.24E-21	5.22E-21	4.15E-21	4.09E-21	1.86E-21	1.70E-21
Mo-93m	5.12E-17	4.76E-17	4.51E-17	4.33E-17	4.03E-17	3.96E-17
Mo-99	3.85E-18	3.56E-18	3.38E-18	3.21E-18	2.97E-18	2.91E-18
Mo-101	3.32E-17	3.08E-17	2.93E-17	2.81E-17	2.61E-17	2.57E-17
Mo-102	8.28E-19	7.65E-19	7.25E-19	6.90E-19	6.36E-19	6.25E-19
<b>Technetium</b>						
Tc-91	5.78E-17	5.37E-17	5.07E-17	4.90E-17	4.57E-17	4.49E-17
Tc-91m	3.69E-17	3.40E-17	3.19E-17	3.06E-17	2.84E-17	2.78E-17
Tc-92	8.91E-17	8.26E-17	7.80E-17	7.49E-17	6.95E-17	6.83E-17
Tc-93	3.41E-17	3.17E-17	3.02E-17	2.90E-17	2.71E-17	2.67E-17
Tc-93m	2.00E-17	1.86E-17	1.76E-17	1.71E-17	1.60E-17	1.57E-17
Tc-94	6.03E-17	5.58E-17	5.31E-17	5.04E-17	4.67E-17	4.59E-17
Tc-94m	4.51E-17	4.18E-17	3.96E-17	3.79E-17	3.51E-17	3.45E-17
Tc-95	1.79E-17	1.65E-17	1.57E-17	1.49E-17	1.38E-17	1.36E-17
Tc-95m	1.55E-17	1.42E-17	1.35E-17	1.28E-17	1.18E-17	1.16E-17
Tc-96	5.66E-17	5.23E-17	4.99E-17	4.73E-17	4.38E-17	4.31E-17
Tc-96m	9.38E-19	8.68E-19	8.27E-19	7.87E-19	7.29E-19	7.17E-19
Tc-97	9.17E-21	6.43E-21	5.13E-21	5.05E-21	2.45E-21	2.26E-21
Tc-97m	1.48E-20	1.15E-20	9.87E-21	9.55E-21	6.75E-21	6.48E-21
Tc-98	3.25E-17	3.00E-17	2.84E-17	2.70E-17	2.50E-17	2.45E-17
Tc-99	7.09E-20	6.58E-20	6.31E-20	5.98E-20	5.55E-20	5.46E-20
Tc-99m	2.69E-18	2.51E-18	2.31E-18	2.22E-18	2.00E-18	1.97E-18
Tc-101	8.40E-18	7.69E-18	7.23E-18	6.91E-18	6.35E-18	6.22E-18
Tc-102	6.07E-18	5.66E-18	5.41E-18	5.18E-18	4.84E-18	4.77E-18
Tc-102m	5.55E-17	5.15E-17	4.88E-17	4.71E-17	4.38E-17	4.31E-17
Tc-104	5.17E-17	4.81E-17	4.56E-17	4.41E-17	4.11E-17	4.04E-17
Tc-105	2.00E-17	1.85E-17	1.75E-17	1.68E-17	1.56E-17	1.53E-17
<b>Ruthenium</b>						
Ru-92	4.74E-17	4.37E-17	4.12E-17	3.95E-17	3.65E-17	3.58E-17
Ru-94	1.17E-17	1.07E-17	1.01E-17	9.65E-18	8.90E-18	8.73E-18
Ru-95	2.78E-17	2.57E-17	2.44E-17	2.33E-17	2.16E-17	2.12E-17
Ru-97	5.22E-18	4.76E-18	4.48E-18	4.27E-18	3.91E-18	3.82E-18
Ru-103	1.15E-17	1.06E-17	9.91E-18	9.51E-18	8.77E-18	8.60E-18
Ru-105	1.76E-17	1.62E-17	1.54E-17	1.46E-17	1.35E-17	1.33E-17
Ru-106	6.07E-22	5.63E-22	5.41E-22	5.12E-22	4.75E-22	4.67E-22
Ru-107	9.66E-18	8.95E-18	8.51E-18	8.13E-18	7.55E-18	7.42E-18
Ru-108	1.95E-18	1.81E-18	1.70E-18	1.62E-18	1.48E-18	1.45E-18
<b>Rhodium</b>						
Rh-94	9.10E-17	8.45E-17	8.01E-17	7.70E-17	7.16E-17	7.04E-17
Rh-95	5.82E-17	5.40E-17	5.12E-17	4.91E-17	4.57E-17	4.49E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	1.97E-17	1.83E-17	1.72E-17	1.66E-17	1.54E-17	1.52E-17
Rh-96	8.99E-17	8.32E-17	7.87E-17	7.53E-17	6.98E-17	6.85E-17
Rh-96m	2.95E-17	2.73E-17	2.59E-17	2.48E-17	2.31E-17	2.27E-17
Rh-97	3.36E-17	3.10E-17	2.91E-17	2.79E-17	2.59E-17	2.54E-17
Rh-97m	4.71E-17	4.39E-17	4.16E-17	4.03E-17	3.76E-17	3.70E-17
Rh-98	4.40E-17	4.06E-17	3.82E-17	3.66E-17	3.39E-17	3.33E-17
Rh-99	1.24E-17	1.14E-17	1.07E-17	1.03E-17	9.44E-18	9.26E-18
Rh-99m	1.46E-17	1.35E-17	1.27E-17	1.21E-17	1.12E-17	1.10E-17
Rh-100	5.91E-17	5.50E-17	5.21E-17	5.04E-17	4.70E-17	4.62E-17
Rh-100m	9.77E-19	8.92E-19	8.35E-19	8.01E-19	7.34E-19	7.20E-19
Rh-101	6.08E-18	5.58E-18	5.21E-18	4.98E-18	4.52E-18	4.44E-18
Rh-101m	6.36E-18	5.81E-18	5.45E-18	5.21E-18	4.78E-18	4.68E-18
Rh-102	1.17E-17	1.08E-17	1.01E-17	9.67E-18	8.93E-18	8.76E-18
Rh-102m	4.89E-17	4.51E-17	4.27E-17	4.07E-17	3.77E-17	3.70E-17
Rh-103m	2.27E-21	1.54E-21	1.23E-21	1.17E-21	7.04E-22	6.62E-22
Rh-104	1.97E-18	1.83E-18	1.75E-18	1.68E-18	1.56E-18	1.54E-18
Rh-104m	4.63E-19	3.87E-19	3.44E-19	3.17E-19	2.70E-19	2.63E-19
Rh-105	1.92E-18	1.76E-18	1.65E-18	1.58E-18	1.45E-18	1.42E-18
Rh-106	7.48E-18	6.93E-18	6.57E-18	6.29E-18	5.84E-18	5.74E-18
Rh-106m	6.47E-17	5.99E-17	5.68E-17	5.43E-17	5.03E-17	4.94E-17
Rh-107	7.81E-18	7.15E-18	6.72E-18	6.42E-18	5.91E-18	5.79E-18
Rh-108	1.12E-17	1.04E-17	9.81E-18	9.40E-18	8.72E-18	8.56E-18
Rh-109	8.39E-18	7.70E-18	7.25E-18	6.93E-18	6.38E-18	6.26E-18
<b>Palladium</b>						
Pd-96	3.27E-17	3.02E-17	2.85E-17	2.72E-17	2.52E-17	2.47E-17
Pd-97	5.39E-17	5.00E-17	4.72E-17	4.54E-17	4.22E-17	4.15E-17
Pd-98	8.90E-18	8.20E-18	7.72E-18	7.36E-18	6.76E-18	6.64E-18
Pd-99	2.92E-17	2.70E-17	2.54E-17	2.45E-17	2.26E-17	2.22E-17
Pd-100	1.83E-18	1.63E-18	1.50E-18	1.43E-18	1.26E-18	1.23E-18
Pd-101	7.49E-18	6.89E-18	6.49E-18	6.20E-18	5.72E-18	5.62E-18
Pd-103	2.17E-20	1.51E-20	1.23E-20	1.18E-20	7.49E-21	7.08E-21
Pd-107	4.79E-22	4.45E-22	4.27E-22	4.04E-22	3.75E-22	3.69E-22
Pd-109	5.21E-19	4.79E-19	4.56E-19	4.33E-19	3.99E-19	3.92E-19
Pd-109m	2.39E-18	2.19E-18	2.05E-18	1.95E-18	1.78E-18	1.74E-18
Pd-111	2.43E-18	2.26E-18	2.16E-18	2.06E-18	1.92E-18	1.89E-18
Pd-112	5.17E-20	4.68E-20	4.45E-20	4.22E-20	3.82E-20	3.75E-20
Pd-114	1.31E-18	1.21E-18	1.15E-18	1.09E-18	1.01E-18	9.93E-19
<b>Silver</b>						
Ag-99	5.43E-17	5.02E-17	4.74E-17	4.55E-17	4.22E-17	4.15E-17
Ag-100m	6.76E-17	6.27E-17	5.92E-17	5.68E-17	5.28E-17	5.18E-17
Ag-101	3.71E-17	3.42E-17	3.22E-17	3.09E-17	2.86E-17	2.80E-17
Ag-102	7.72E-17	7.16E-17	6.76E-17	6.50E-17	6.04E-17	5.94E-17
Ag-102m	4.32E-17	4.02E-17	3.80E-17	3.69E-17	3.45E-17	3.39E-17
Ag-103	1.90E-17	1.76E-17	1.65E-17	1.58E-17	1.46E-17	1.44E-17
Ag-104	6.09E-17	5.63E-17	5.34E-17	5.10E-17	4.73E-17	4.65E-17
Ag-104m	4.14E-17	3.83E-17	3.60E-17	3.47E-17	3.22E-17	3.17E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	1.14E-17	1.05E-17	9.83E-18	9.40E-18	8.65E-18	8.48E-18
Ag-105m	2.28E-20	2.09E-20	1.97E-20	1.88E-20	1.73E-20	1.69E-20
Ag-106	1.69E-17	1.55E-17	1.45E-17	1.39E-17	1.29E-17	1.26E-17
Ag-106m	6.31E-17	5.84E-17	5.53E-17	5.28E-17	4.90E-17	4.81E-17
Ag-108	1.30E-18	1.21E-18	1.16E-18	1.10E-18	1.02E-18	1.01E-18
Ag-108m	3.70E-17	3.41E-17	3.21E-17	3.07E-17	2.83E-17	2.78E-17
Ag-109m	7.49E-20	6.43E-20	5.82E-20	5.53E-20	4.73E-20	4.61E-20
Ag-110	2.86E-18	2.66E-18	2.55E-18	2.43E-18	2.27E-18	2.23E-18
Ag-110m	6.23E-17	5.77E-17	5.49E-17	5.23E-17	4.85E-17	4.76E-17
Ag-111	1.03E-18	9.51E-19	8.99E-19	8.58E-19	7.93E-19	7.78E-19
Ag-111m	8.60E-20	7.68E-20	7.12E-20	6.78E-20	6.10E-20	5.97E-20
Ag-112	1.79E-17	1.67E-17	1.58E-17	1.52E-17	1.42E-17	1.39E-17
Ag-113	2.84E-18	2.63E-18	2.50E-18	2.38E-18	2.21E-18	2.17E-18
Ag-113m	5.17E-18	4.74E-18	4.46E-18	4.26E-18	3.92E-18	3.85E-18
Ag-114	1.05E-17	9.80E-18	9.32E-18	8.96E-18	8.37E-18	8.23E-18
Ag-115	1.25E-17	1.16E-17	1.10E-17	1.06E-17	9.89E-18	9.73E-18
Ag-116	4.95E-17	4.62E-17	4.38E-17	4.24E-17	3.96E-17	3.90E-17
Ag-117	2.99E-17	2.80E-17	2.65E-17	2.57E-17	2.41E-17	2.37E-17
<b>Cadmium</b>						
Cd-101	5.66E-17	5.25E-17	4.96E-17	4.78E-17	4.44E-17	4.37E-17
Cd-102	1.89E-17	1.74E-17	1.64E-17	1.57E-17	1.45E-17	1.42E-17
Cd-103	4.55E-17	4.23E-17	4.01E-17	3.88E-17	3.62E-17	3.56E-17
Cd-104	5.13E-18	4.70E-18	4.42E-18	4.21E-18	3.86E-18	3.79E-18
Cd-105	2.86E-17	2.65E-17	2.51E-17	2.42E-17	2.25E-17	2.22E-17
Cd-107	2.35E-19	2.04E-19	1.86E-19	1.77E-19	1.55E-19	1.52E-19
Cd-109	1.03E-19	8.28E-20	7.27E-20	6.89E-20	5.58E-20	5.41E-20
Cd-111m	6.28E-18	5.74E-18	5.38E-18	5.14E-18	4.69E-18	4.60E-18
Cd-113	6.34E-20	5.88E-20	5.64E-20	5.35E-20	4.97E-20	4.88E-20
Cd-113m	1.73E-19	1.60E-19	1.54E-19	1.46E-19	1.35E-19	1.33E-19
Cd-115	4.81E-18	4.43E-18	4.15E-18	3.98E-18	3.67E-18	3.60E-18
Cd-115m	1.61E-18	1.50E-18	1.44E-18	1.37E-18	1.27E-18	1.25E-18
Cd-117	2.45E-17	2.27E-17	2.16E-17	2.07E-17	1.92E-17	1.89E-17
Cd-117m	4.44E-17	4.13E-17	3.93E-17	3.79E-17	3.54E-17	3.49E-17
Cd-118	1.42E-19	1.32E-19	1.26E-19	1.20E-19	1.11E-19	1.09E-19
Cd-119	3.67E-17	3.42E-17	3.24E-17	3.13E-17	2.92E-17	2.88E-17
Cd-119m	5.09E-17	4.74E-17	4.51E-17	4.34E-17	4.05E-17	3.99E-17
<b>Indium</b>						
In-103	6.40E-17	5.93E-17	5.61E-17	5.39E-17	5.01E-17	4.92E-17
In-105	4.51E-17	4.17E-17	3.93E-17	3.78E-17	3.50E-17	3.44E-17
In-106	8.30E-17	7.67E-17	7.26E-17	6.92E-17	6.41E-17	6.29E-17
In-106m	6.54E-17	6.07E-17	5.73E-17	5.53E-17	5.14E-17	5.05E-17
In-107	3.40E-17	3.15E-17	2.98E-17	2.87E-17	2.67E-17	2.62E-17
In-108	8.78E-17	8.13E-17	7.73E-17	7.38E-17	6.84E-17	6.73E-17
In-108m	6.00E-17	5.59E-17	5.28E-17	5.12E-17	4.77E-17	4.70E-17
In-109	1.41E-17	1.30E-17	1.23E-17	1.18E-17	1.09E-17	1.07E-17
In-109m	1.40E-17	1.29E-17	1.22E-17	1.16E-17	1.07E-17	1.05E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	7.00E-17	6.47E-17	6.16E-17	5.85E-17	5.42E-17	5.32E-17
In-110m	3.66E-17	3.38E-17	3.18E-17	3.06E-17	2.83E-17	2.78E-17
In-111	8.80E-18	8.06E-18	7.55E-18	7.20E-18	6.57E-18	6.44E-18
In-111m	1.09E-17	9.99E-18	9.34E-18	8.96E-18	8.26E-18	8.10E-18
In-112	6.38E-18	5.87E-18	5.49E-18	5.27E-18	4.86E-18	4.77E-18
In-112m	4.82E-19	4.41E-19	4.03E-19	3.86E-19	3.45E-19	3.39E-19
In-113m	5.93E-18	5.43E-18	5.07E-18	4.86E-18	4.47E-18	4.38E-18
In-114	1.27E-18	1.18E-18	1.14E-18	1.08E-18	1.01E-18	9.98E-19
In-114m	1.65E-18	1.51E-18	1.42E-18	1.35E-18	1.24E-18	1.22E-18
In-115	1.31E-19	1.22E-19	1.17E-19	1.11E-19	1.03E-19	1.01E-19
In-115m	3.62E-18	3.30E-18	3.09E-18	2.96E-18	2.71E-18	2.66E-18
In-116m	5.45E-17	5.07E-17	4.83E-17	4.63E-17	4.32E-17	4.25E-17
In-117	1.61E-17	1.49E-17	1.39E-17	1.33E-17	1.22E-17	1.20E-17
In-117m	2.48E-18	2.29E-18	2.15E-18	2.05E-18	1.88E-18	1.85E-18
In-118	5.78E-18	5.39E-18	5.17E-18	4.95E-18	4.63E-18	4.56E-18
In-118m	6.27E-17	5.83E-17	5.57E-17	5.30E-17	4.93E-17	4.85E-17
In-119	1.83E-17	1.70E-17	1.61E-17	1.53E-17	1.42E-17	1.39E-17
In-119m	3.20E-18	2.98E-18	2.86E-18	2.72E-18	2.54E-18	2.50E-18
In-121	2.26E-17	2.09E-17	2.00E-17	1.90E-17	1.76E-17	1.73E-17
In-121m	4.13E-18	3.83E-18	3.67E-18	3.50E-18	3.26E-18	3.21E-18
<b>Tin</b>						
Sn-106	2.73E-17	2.51E-17	2.37E-17	2.27E-17	2.09E-17	2.05E-17
Sn-108	1.53E-17	1.40E-17	1.32E-17	1.26E-17	1.16E-17	1.13E-17
Sn-109	4.77E-17	4.44E-17	4.22E-17	4.06E-17	3.79E-17	3.73E-17
Sn-110	6.36E-18	5.79E-18	5.44E-18	5.19E-18	4.76E-18	4.66E-18
Sn-111	1.11E-17	1.02E-17	9.63E-18	9.26E-18	8.57E-18	8.42E-18
Sn-113	1.68E-19	1.43E-19	1.29E-19	1.23E-19	1.07E-19	1.05E-19
Sn-113m	4.24E-20	3.04E-20	2.45E-20	2.25E-20	1.65E-20	1.58E-20
Sn-117m	3.13E-18	2.90E-18	2.67E-18	2.56E-18	2.31E-18	2.27E-18
Sn-119m	3.71E-20	2.52E-20	1.96E-20	1.78E-20	1.21E-20	1.15E-20
Sn-121	8.80E-20	8.16E-20	7.83E-20	7.42E-20	6.89E-20	6.78E-20
Sn-121m	3.93E-20	3.25E-20	2.89E-20	2.69E-20	2.32E-20	2.26E-20
Sn-123	8.77E-19	8.16E-19	7.84E-19	7.45E-19	6.95E-19	6.84E-19
Sn-123m	3.63E-18	3.38E-18	3.14E-18	3.01E-18	2.74E-18	2.69E-18
Sn-125	8.77E-18	8.15E-18	7.80E-18	7.43E-18	6.92E-18	6.80E-18
Sn-125m	9.28E-18	8.51E-18	8.01E-18	7.66E-18	7.06E-18	6.92E-18
Sn-126	9.57E-19	8.55E-19	7.87E-19	7.49E-19	6.61E-19	6.47E-19
Sn-127	4.29E-17	3.98E-17	3.80E-17	3.63E-17	3.37E-17	3.32E-17
Sn-127m	1.50E-17	1.38E-17	1.30E-17	1.25E-17	1.16E-17	1.14E-17
Sn-128	1.32E-17	1.21E-17	1.13E-17	1.08E-17	9.93E-18	9.73E-18
Sn-129	2.51E-17	2.33E-17	2.21E-17	2.11E-17	1.96E-17	1.92E-17
Sn-130	2.15E-17	1.98E-17	1.87E-17	1.78E-17	1.64E-17	1.61E-17
Sn-130m	2.22E-17	2.06E-17	1.96E-17	1.87E-17	1.73E-17	1.71E-17
<b>Antimony</b>						
Sb-111	3.67E-17	3.38E-17	3.17E-17	3.04E-17	2.81E-17	2.75E-17
Sb-113	3.03E-17	2.79E-17	2.62E-17	2.51E-17	2.32E-17	2.27E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	6.23E-17	5.78E-17	5.48E-17	5.25E-17	4.88E-17	4.80E-17
Sb-115	2.06E-17	1.90E-17	1.77E-17	1.70E-17	1.57E-17	1.54E-17
Sb-116	5.09E-17	4.73E-17	4.49E-17	4.31E-17	4.01E-17	3.95E-17
Sb-116m	6.89E-17	6.39E-17	6.08E-17	5.80E-17	5.38E-17	5.29E-17
Sb-117	3.70E-18	3.43E-18	3.17E-18	3.04E-18	2.76E-18	2.71E-18
Sb-118	2.01E-17	1.85E-17	1.73E-17	1.66E-17	1.53E-17	1.50E-17
Sb-118m	5.73E-17	5.31E-17	5.08E-17	4.83E-17	4.49E-17	4.41E-17
Sb-119	6.06E-20	4.13E-20	3.21E-20	2.91E-20	1.99E-20	1.89E-20
Sb-120	1.07E-17	9.84E-18	9.20E-18	8.82E-18	8.14E-18	7.99E-18
Sb-120m	5.42E-17	5.02E-17	4.81E-17	4.57E-17	4.24E-17	4.16E-17
Sb-122	1.11E-17	1.02E-17	9.59E-18	9.18E-18	8.49E-18	8.33E-18
Sb-122m	8.82E-19	7.59E-19	6.83E-19	6.42E-19	5.49E-19	5.34E-19
Sb-124	4.14E-17	3.85E-17	3.64E-17	3.51E-17	3.27E-17	3.21E-17
Sb-124m	1.03E-17	9.48E-18	8.90E-18	8.52E-18	7.87E-18	7.72E-18
Sb-124n	2.26E-24	1.55E-24	1.20E-24	1.08E-24	7.47E-25	7.10E-25
Sb-125	9.87E-18	9.07E-18	8.49E-18	8.12E-18	7.49E-18	7.34E-18
Sb-126	6.37E-17	5.87E-17	5.55E-17	5.29E-17	4.89E-17	4.80E-17
Sb-126m	3.66E-17	3.37E-17	3.18E-17	3.04E-17	2.80E-17	2.75E-17
Sb-127	1.63E-17	1.50E-17	1.41E-17	1.35E-17	1.25E-17	1.22E-17
Sb-128	7.14E-17	6.59E-17	6.24E-17	5.94E-17	5.50E-17	5.40E-17
Sb-128m	4.52E-17	4.17E-17	3.96E-17	3.77E-17	3.48E-17	3.42E-17
Sb-129	3.32E-17	3.08E-17	2.93E-17	2.79E-17	2.60E-17	2.55E-17
Sb-130	7.51E-17	6.95E-17	6.60E-17	6.28E-17	5.82E-17	5.72E-17
Sb-130m	6.28E-17	5.82E-17	5.55E-17	5.27E-17	4.89E-17	4.80E-17
Sb-131	4.66E-17	4.33E-17	4.12E-17	3.95E-17	3.67E-17	3.61E-17
Sb-133	6.03E-17	5.62E-17	5.35E-17	5.15E-17	4.81E-17	4.73E-17
<b>Tellurium</b>						
Te-113	5.32E-17	4.93E-17	4.66E-17	4.48E-17	4.16E-17	4.09E-17
Te-114	2.79E-17	2.59E-17	2.45E-17	2.36E-17	2.19E-17	2.15E-17
Te-115	5.17E-17	4.79E-17	4.53E-17	4.34E-17	4.03E-17	3.96E-17
Te-115m	5.89E-17	5.47E-17	5.18E-17	4.97E-17	4.62E-17	4.54E-17
Te-116	1.83E-18	1.66E-18	1.54E-18	1.47E-18	1.33E-18	1.30E-18
Te-117	3.43E-17	3.18E-17	3.01E-17	2.90E-17	2.69E-17	2.65E-17
Te-118	6.15E-20	4.25E-20	3.30E-20	2.95E-20	2.10E-20	1.99E-20
Te-119	1.71E-17	1.58E-17	1.49E-17	1.42E-17	1.32E-17	1.29E-17
Te-119m	3.28E-17	3.05E-17	2.91E-17	2.78E-17	2.58E-17	2.53E-17
Te-121	1.29E-17	1.19E-17	1.11E-17	1.07E-17	9.85E-18	9.66E-18
Te-121m	4.64E-18	4.24E-18	4.00E-18	3.80E-18	3.48E-18	3.41E-18
Te-123	1.07E-22	7.39E-23	5.73E-23	5.13E-23	3.64E-23	3.47E-23
Te-123m	2.98E-18	2.77E-18	2.55E-18	2.44E-18	2.21E-18	2.17E-18
Te-125m	1.38E-19	9.82E-20	7.74E-20	6.92E-20	5.16E-20	4.94E-20
Te-127	3.38E-19	3.12E-19	2.97E-19	2.82E-19	2.62E-19	2.57E-19
Te-127m	5.19E-20	3.92E-20	3.25E-20	2.96E-20	2.35E-20	2.27E-20
Te-129	2.06E-18	1.90E-18	1.79E-18	1.71E-18	1.58E-18	1.55E-18
Te-129m	1.01E-18	9.30E-19	8.81E-19	8.38E-19	7.74E-19	7.61E-19
Te-131	1.04E-17	9.66E-18	9.10E-18	8.70E-18	8.01E-18	7.87E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	3.27E-17	3.03E-17	2.88E-17	2.74E-17	2.54E-17	2.50E-17
Te-132	4.90E-18	4.45E-18	4.17E-18	3.97E-18	3.62E-18	3.54E-18
Te-133	2.77E-17	2.57E-17	2.43E-17	2.34E-17	2.17E-17	2.13E-17
Te-133m	4.20E-17	3.89E-17	3.70E-17	3.53E-17	3.27E-17	3.22E-17
Te-134	1.99E-17	1.83E-17	1.73E-17	1.65E-17	1.52E-17	1.49E-17
<b>Iodine</b>						
I-118	5.05E-17	4.66E-17	4.39E-17	4.21E-17	3.90E-17	3.83E-17
I-118m	8.76E-17	8.09E-17	7.64E-17	7.30E-17	6.76E-17	6.63E-17
I-119	2.16E-17	1.98E-17	1.86E-17	1.78E-17	1.64E-17	1.61E-17
I-120	6.02E-17	5.60E-17	5.28E-17	5.11E-17	4.75E-17	4.68E-17
I-120m	8.09E-17	7.49E-17	7.06E-17	6.78E-17	6.28E-17	6.17E-17
I-121	8.80E-18	8.06E-18	7.56E-18	7.22E-18	6.63E-18	6.50E-18
I-122	2.43E-17	2.24E-17	2.09E-17	2.01E-17	1.86E-17	1.82E-17
I-123	3.36E-18	3.10E-18	2.86E-18	2.74E-18	2.48E-18	2.43E-18
I-124	2.50E-17	2.31E-17	2.18E-17	2.09E-17	1.94E-17	1.91E-17
I-125	1.57E-19	1.10E-19	8.59E-20	7.65E-20	5.60E-20	5.35E-20
I-126	1.00E-17	9.20E-18	8.65E-18	8.26E-18	7.62E-18	7.48E-18
I-128	2.73E-18	2.52E-18	2.39E-18	2.28E-18	2.12E-18	2.08E-18
I-129	1.46E-19	1.11E-19	9.11E-20	8.20E-20	6.59E-20	6.36E-20
I-130	4.93E-17	4.55E-17	4.29E-17	4.10E-17	3.79E-17	3.72E-17
I-130m	2.66E-18	2.45E-18	2.30E-18	2.21E-18	2.04E-18	2.00E-18
I-131	9.01E-18	8.26E-18	7.73E-18	7.40E-18	6.81E-18	6.67E-18
I-132	5.21E-17	4.81E-17	4.57E-17	4.35E-17	4.03E-17	3.96E-17
I-132m	7.69E-18	7.09E-18	6.69E-18	6.37E-18	5.88E-18	5.78E-18
I-133	1.46E-17	1.35E-17	1.26E-17	1.21E-17	1.12E-17	1.10E-17
I-134	5.92E-17	5.48E-17	5.22E-17	4.97E-17	4.61E-17	4.53E-17
I-134m	6.18E-18	5.62E-18	5.29E-18	5.03E-18	4.61E-18	4.52E-18
I-135	3.50E-17	3.26E-17	3.11E-17	2.98E-17	2.78E-17	2.74E-17
<b>Xenon</b>						
Xe-120	8.35E-18	7.66E-18	7.21E-18	6.87E-18	6.31E-18	6.19E-18
Xe-121	3.29E-17	3.05E-17	2.88E-17	2.78E-17	2.58E-17	2.54E-17
Xe-122	1.12E-18	1.01E-18	9.33E-19	8.91E-19	8.08E-19	7.91E-19
Xe-123	1.42E-17	1.31E-17	1.23E-17	1.18E-17	1.09E-17	1.07E-17
Xe-125	5.57E-18	5.08E-18	4.76E-18	4.53E-18	4.14E-18	4.06E-18
Xe-127	5.88E-18	5.37E-18	5.01E-18	4.78E-18	4.36E-18	4.27E-18
Xe-127m	3.34E-18	3.08E-18	2.84E-18	2.72E-18	2.45E-18	2.41E-18
Xe-129m	4.04E-19	3.31E-19	2.89E-19	2.68E-19	2.29E-19	2.23E-19
Xe-131m	1.46E-19	1.20E-19	1.03E-19	9.56E-20	8.08E-20	7.87E-20
Xe-133	7.31E-19	6.45E-19	5.90E-19	5.58E-19	4.90E-19	4.78E-19
Xe-133m	6.11E-19	5.43E-19	5.02E-19	4.76E-19	4.29E-19	4.20E-19
Xe-135	6.02E-18	5.50E-18	5.18E-18	4.94E-18	4.54E-18	4.44E-18
Xe-135m	9.78E-18	9.00E-18	8.40E-18	8.06E-18	7.43E-18	7.29E-18
Xe-137	7.87E-18	7.30E-18	6.92E-18	6.64E-18	6.18E-18	6.07E-18
Xe-138	2.51E-17	2.34E-17	2.21E-17	2.15E-17	2.00E-17	1.97E-17
<b>Cesium</b>						
Cs-121	3.07E-17	2.83E-17	2.65E-17	2.55E-17	2.35E-17	2.31E-17



**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	2.98E-17	2.75E-17	2.58E-17	2.47E-17	2.28E-17	2.24E-17
Cs-123	2.64E-17	2.43E-17	2.28E-17	2.19E-17	2.02E-17	1.98E-17
Cs-124	3.12E-17	2.88E-17	2.70E-17	2.59E-17	2.40E-17	2.36E-17
Cs-125	1.76E-17	1.62E-17	1.51E-17	1.45E-17	1.34E-17	1.32E-17
Cs-126	2.92E-17	2.69E-17	2.52E-17	2.42E-17	2.24E-17	2.20E-17
Cs-127	9.55E-18	8.75E-18	8.17E-18	7.83E-18	7.20E-18	7.06E-18
Cs-128	2.21E-17	2.03E-17	1.90E-17	1.83E-17	1.69E-17	1.65E-17
Cs-129	5.87E-18	5.35E-18	4.98E-18	4.77E-18	4.38E-18	4.29E-18
Cs-130	1.20E-17	1.10E-17	1.03E-17	9.90E-18	9.14E-18	8.96E-18
Cs-130m	9.94E-19	8.73E-19	7.90E-19	7.48E-19	6.55E-19	6.40E-19
Cs-131	1.01E-19	7.25E-20	5.67E-20	5.02E-20	3.78E-20	3.62E-20
Cs-132	1.60E-17	1.47E-17	1.39E-17	1.33E-17	1.22E-17	1.20E-17
Cs-134	3.57E-17	3.30E-17	3.12E-17	2.97E-17	2.75E-17	2.70E-17
Cs-134m	3.90E-19	3.51E-19	3.19E-19	3.04E-19	2.70E-19	2.65E-19
Cs-135	5.89E-20	5.46E-20	5.24E-20	4.97E-20	4.61E-20	4.54E-20
Cs-135m	3.63E-17	3.36E-17	3.20E-17	3.03E-17	2.81E-17	2.76E-17
Cs-136	4.79E-17	4.44E-17	4.23E-17	4.02E-17	3.73E-17	3.66E-17
Cs-137	1.80E-19	1.67E-19	1.60E-19	1.52E-19	1.41E-19	1.39E-19
Cs-138	5.34E-17	4.97E-17	4.73E-17	4.56E-17	4.25E-17	4.19E-17
Cs-138m	9.44E-18	8.74E-18	8.28E-18	7.95E-18	7.38E-18	7.26E-18
Cs-139	9.90E-18	9.25E-18	8.83E-18	8.51E-18	7.97E-18	7.85E-18
Cs-140	4.20E-17	3.92E-17	3.73E-17	3.61E-17	3.37E-17	3.32E-17
<b>Barium</b>						
Ba-124	1.28E-17	1.18E-17	1.11E-17	1.06E-17	9.78E-18	9.60E-18
Ba-126	1.27E-17	1.17E-17	1.11E-17	1.05E-17	9.74E-18	9.56E-18
Ba-127	1.73E-17	1.60E-17	1.50E-17	1.44E-17	1.33E-17	1.30E-17
Ba-128	1.09E-18	9.68E-19	8.97E-19	8.52E-19	7.72E-19	7.55E-19
Ba-129	7.35E-18	6.76E-18	6.32E-18	6.07E-18	5.60E-18	5.50E-18
Ba-129m	3.50E-17	3.24E-17	3.07E-17	2.93E-17	2.72E-17	2.67E-17
Ba-131	1.03E-17	9.48E-18	8.84E-18	8.47E-18	7.77E-18	7.62E-18
Ba-131m	1.33E-18	1.20E-18	1.10E-18	1.05E-18	9.37E-19	9.19E-19
Ba-133	8.48E-18	7.71E-18	7.19E-18	6.87E-18	6.28E-18	6.15E-18
Ba-133m	1.24E-18	1.11E-18	1.03E-18	9.81E-19	8.92E-19	8.73E-19
Ba-135m	1.06E-18	9.52E-19	8.85E-19	8.41E-19	7.64E-19	7.47E-19
Ba-137m	1.37E-17	1.26E-17	1.19E-17	1.13E-17	1.05E-17	1.03E-17
Ba-139	2.46E-18	2.29E-18	2.17E-18	2.07E-18	1.92E-18	1.89E-18
Ba-140	4.42E-18	4.07E-18	3.80E-18	3.64E-18	3.36E-18	3.29E-18
Ba-141	2.24E-17	2.07E-17	1.96E-17	1.87E-17	1.73E-17	1.70E-17
Ba-142	2.38E-17	2.20E-17	2.10E-17	2.00E-17	1.85E-17	1.82E-17
<b>Lanthanum</b>						
La-128	6.68E-17	6.17E-17	5.82E-17	5.58E-17	5.16E-17	5.07E-17
La-129	2.19E-17	2.02E-17	1.89E-17	1.81E-17	1.67E-17	1.64E-17
La-130	5.26E-17	4.86E-17	4.58E-17	4.39E-17	4.07E-17	3.99E-17
La-131	1.50E-17	1.38E-17	1.29E-17	1.23E-17	1.13E-17	1.11E-17
La-132	4.51E-17	4.18E-17	3.93E-17	3.79E-17	3.52E-17	3.46E-17
La-132m	1.50E-17	1.38E-17	1.30E-17	1.24E-17	1.14E-17	1.12E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	3.29E-18	3.01E-18	2.81E-18	2.68E-18	2.46E-18	2.42E-18
La-134	1.78E-17	1.64E-17	1.54E-17	1.48E-17	1.36E-17	1.34E-17
La-135	3.75E-19	3.18E-19	2.83E-19	2.66E-19	2.34E-19	2.29E-19
La-136	9.58E-18	8.80E-18	8.23E-18	7.89E-18	7.27E-18	7.13E-18
La-137	1.35E-19	9.85E-20	7.81E-20	6.91E-20	5.33E-20	5.13E-20
La-138	2.68E-17	2.50E-17	2.38E-17	2.28E-17	2.13E-17	2.09E-17
La-140	5.11E-17	4.76E-17	4.51E-17	4.35E-17	4.06E-17	3.99E-17
La-141	2.28E-18	2.13E-18	2.04E-18	1.95E-18	1.82E-18	1.80E-18
La-142	5.11E-17	4.78E-17	4.54E-17	4.41E-17	4.13E-17	4.07E-17
La-143	8.18E-18	7.62E-18	7.27E-18	6.99E-18	6.53E-18	6.43E-18
<b>Cerium</b>						
Ce-130	1.07E-17	9.84E-18	9.26E-18	8.83E-18	8.12E-18	7.97E-18
Ce-131	3.74E-17	3.45E-17	3.25E-17	3.12E-17	2.89E-17	2.84E-17
Ce-132	5.68E-18	5.19E-18	4.83E-18	4.61E-18	4.19E-18	4.11E-18
Ce-133	1.22E-17	1.11E-17	1.04E-17	9.94E-18	9.13E-18	8.95E-18
Ce-133m	3.81E-17	3.52E-17	3.33E-17	3.19E-17	2.96E-17	2.91E-17
Ce-134	1.92E-19	1.48E-19	1.23E-19	1.11E-19	9.01E-20	8.73E-20
Ce-135	1.84E-17	1.69E-17	1.59E-17	1.52E-17	1.40E-17	1.37E-17
Ce-137	4.15E-19	3.52E-19	3.13E-19	2.93E-19	2.59E-19	2.52E-19
Ce-137m	9.41E-19	8.38E-19	7.77E-19	7.35E-19	6.65E-19	6.51E-19
Ce-139	3.07E-18	2.81E-18	2.59E-18	2.48E-18	2.23E-18	2.19E-18
Ce-141	1.69E-18	1.57E-18	1.44E-18	1.38E-18	1.25E-18	1.23E-18
Ce-143	6.52E-18	5.96E-18	5.60E-18	5.33E-18	4.90E-18	4.80E-18
Ce-144	4.15E-19	3.81E-19	3.51E-19	3.35E-19	3.01E-19	2.96E-19
Ce-145	1.89E-17	1.74E-17	1.65E-17	1.57E-17	1.45E-17	1.42E-17
<b>Praseodymium</b>						
Pr-134	7.36E-17	6.79E-17	6.40E-17	6.13E-17	5.67E-17	5.57E-17
Pr-134m	5.50E-17	5.09E-17	4.79E-17	4.61E-17	4.28E-17	4.20E-17
Pr-135	2.05E-17	1.89E-17	1.77E-17	1.69E-17	1.56E-17	1.53E-17
Pr-136	4.94E-17	4.57E-17	4.30E-17	4.13E-17	3.83E-17	3.77E-17
Pr-137	8.41E-18	7.73E-18	7.24E-18	6.94E-18	6.40E-18	6.28E-18
Pr-138	2.10E-17	1.94E-17	1.82E-17	1.74E-17	1.61E-17	1.58E-17
Pr-138m	5.60E-17	5.17E-17	4.92E-17	4.68E-17	4.33E-17	4.25E-17
Pr-139	2.61E-18	2.37E-18	2.21E-18	2.11E-18	1.94E-18	1.90E-18
Pr-140	1.34E-17	1.23E-17	1.15E-17	1.10E-17	1.02E-17	9.98E-18
Pr-142	2.57E-18	2.40E-18	2.29E-18	2.20E-18	2.06E-18	2.03E-18
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	3.59E-19	3.33E-19	3.20E-19	3.04E-19	2.83E-19	2.78E-19
Pr-144	2.85E-18	2.66E-18	2.55E-18	2.44E-18	2.29E-18	2.25E-18
Pr-144m	1.18E-19	9.54E-20	8.22E-20	7.53E-20	6.41E-20	6.24E-20
Pr-145	1.43E-18	1.33E-18	1.28E-18	1.22E-18	1.13E-18	1.11E-18
Pr-146	2.48E-17	2.31E-17	2.19E-17	2.11E-17	1.96E-17	1.93E-17
Pr-147	1.18E-17	1.08E-17	1.02E-17	9.76E-18	9.02E-18	8.85E-18
Pr-148	2.53E-17	2.35E-17	2.24E-17	2.14E-17	2.00E-17	1.96E-17
Pr-148m	2.48E-17	2.29E-17	2.16E-17	2.07E-17	1.91E-17	1.88E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	1.21E-17	1.11E-17	1.04E-17	9.95E-18	9.13E-18	8.95E-18
Nd-135	3.04E-17	2.79E-17	2.62E-17	2.51E-17	2.31E-17	2.27E-17
Nd-136	5.59E-18	5.09E-18	4.74E-18	4.52E-18	4.13E-18	4.05E-18
Nd-137	2.65E-17	2.44E-17	2.30E-17	2.21E-17	2.04E-17	2.01E-17
Nd-138	5.42E-19	4.61E-19	4.13E-19	3.86E-19	3.40E-19	3.32E-19
Nd-139	1.01E-17	9.31E-18	8.74E-18	8.36E-18	7.72E-18	7.57E-18
Nd-139m	3.50E-17	3.24E-17	3.08E-17	2.93E-17	2.71E-17	2.66E-17
Nd-140	2.06E-19	1.55E-19	1.26E-19	1.12E-19	8.91E-20	8.62E-20
Nd-141	1.30E-18	1.17E-18	1.08E-18	1.03E-18	9.36E-19	9.18E-19
Nd-141m	1.58E-17	1.46E-17	1.39E-17	1.32E-17	1.22E-17	1.20E-17
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	3.13E-18	2.85E-18	2.65E-18	2.53E-18	2.31E-18	2.27E-18
Nd-149	8.87E-18	8.13E-18	7.63E-18	7.28E-18	6.68E-18	6.55E-18
Nd-151	1.98E-17	1.83E-17	1.74E-17	1.66E-17	1.53E-17	1.51E-17
Nd-152	4.09E-18	3.74E-18	3.52E-18	3.35E-18	3.08E-18	3.02E-18
<b>Promethium</b>						
Pm-136	6.74E-17	6.22E-17	5.87E-17	5.60E-17	5.18E-17	5.09E-17
Pm-137m	4.23E-17	3.90E-17	3.66E-17	3.50E-17	3.23E-17	3.17E-17
Pm-139	2.35E-17	2.16E-17	2.03E-17	1.95E-17	1.80E-17	1.76E-17
Pm-140	2.89E-17	2.67E-17	2.51E-17	2.41E-17	2.23E-17	2.19E-17
Pm-140m	7.07E-17	6.53E-17	6.19E-17	5.90E-17	5.46E-17	5.36E-17
Pm-141	1.76E-17	1.62E-17	1.53E-17	1.46E-17	1.35E-17	1.33E-17
Pm-142	2.23E-17	2.06E-17	1.93E-17	1.85E-17	1.71E-17	1.68E-17
Pm-143	6.77E-18	6.21E-18	5.88E-18	5.57E-18	5.14E-18	5.05E-18
Pm-144	3.55E-17	3.27E-17	3.08E-17	2.94E-17	2.71E-17	2.66E-17
Pm-145	2.62E-19	2.03E-19	1.69E-19	1.52E-19	1.23E-19	1.20E-19
Pm-146	1.71E-17	1.57E-17	1.48E-17	1.41E-17	1.30E-17	1.28E-17
Pm-147	3.37E-20	3.13E-20	3.00E-20	2.85E-20	2.64E-20	2.60E-20
Pm-148	1.39E-17	1.29E-17	1.23E-17	1.18E-17	1.10E-17	1.08E-17
Pm-148m	4.58E-17	4.22E-17	3.98E-17	3.80E-17	3.51E-17	3.45E-17
Pm-149	7.11E-19	6.56E-19	6.26E-19	5.95E-19	5.52E-19	5.42E-19
Pm-150	3.39E-17	3.15E-17	2.99E-17	2.87E-17	2.66E-17	2.62E-17
Pm-151	7.65E-18	7.01E-18	6.58E-18	6.28E-18	5.77E-18	5.65E-18
Pm-152	8.79E-18	8.17E-18	7.79E-18	7.44E-18	6.92E-18	6.81E-18
Pm-152m	3.50E-17	3.24E-17	3.08E-17	2.94E-17	2.72E-17	2.68E-17
Pm-153	2.47E-18	2.27E-18	2.13E-18	2.03E-18	1.85E-18	1.82E-18
Pm-154	3.97E-17	3.70E-17	3.52E-17	3.40E-17	3.17E-17	3.12E-17
Pm-154m	4.08E-17	3.79E-17	3.59E-17	3.45E-17	3.21E-17	3.15E-17
<b>Samarium</b>						
Sm-139	3.52E-17	3.24E-17	3.05E-17	2.92E-17	2.70E-17	2.65E-17
Sm-140	1.26E-17	1.16E-17	1.10E-17	1.05E-17	9.69E-18	9.52E-18
Sm-141	3.30E-17	3.05E-17	2.87E-17	2.75E-17	2.55E-17	2.50E-17
Sm-141m	4.41E-17	4.07E-17	3.85E-17	3.69E-17	3.41E-17	3.35E-17
Sm-142	2.17E-18	1.96E-18	1.81E-18	1.73E-18	1.58E-18	1.55E-18
Sm-143	1.28E-17	1.18E-17	1.10E-17	1.06E-17	9.76E-18	9.58E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	1.56E-17	1.44E-17	1.37E-17	1.30E-17	1.20E-17	1.18E-17
Sm-145	5.99E-19	4.71E-19	3.98E-19	3.59E-19	2.94E-19	2.86E-19
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	3.89E-21	3.61E-21	3.46E-21	3.28E-21	3.04E-21	2.99E-21
Sm-153	1.23E-18	1.09E-18	9.99E-19	9.42E-19	8.37E-19	8.20E-19
Sm-155	2.81E-18	2.57E-18	2.41E-18	2.29E-18	2.08E-18	2.04E-18
Sm-156	2.57E-18	2.35E-18	2.19E-18	2.09E-18	1.90E-18	1.86E-18
Sm-157	1.06E-17	9.77E-18	9.24E-18	8.82E-18	8.13E-18	7.99E-18
<b>Europium</b>						
Eu-142	3.46E-17	3.20E-17	3.02E-17	2.90E-17	2.69E-17	2.64E-17
Eu-142m	8.19E-17	7.57E-17	7.17E-17	6.84E-17	6.34E-17	6.22E-17
Eu-143	2.82E-17	2.61E-17	2.45E-17	2.36E-17	2.19E-17	2.15E-17
Eu-144	2.98E-17	2.75E-17	2.59E-17	2.49E-17	2.31E-17	2.26E-17
Eu-145	2.79E-17	2.58E-17	2.46E-17	2.35E-17	2.19E-17	2.15E-17
Eu-146	5.35E-17	4.95E-17	4.69E-17	4.49E-17	4.16E-17	4.09E-17
Eu-147	1.00E-17	9.23E-18	8.72E-18	8.28E-18	7.63E-18	7.49E-18
Eu-148	5.03E-17	4.64E-17	4.38E-17	4.19E-17	3.87E-17	3.80E-17
Eu-149	1.05E-18	9.14E-19	8.33E-19	7.85E-19	7.03E-19	6.87E-19
Eu-150	3.52E-17	3.24E-17	3.04E-17	2.91E-17	2.69E-17	2.63E-17
Eu-150m	1.45E-18	1.33E-18	1.25E-18	1.20E-18	1.11E-18	1.09E-18
Eu-152	2.59E-17	2.40E-17	2.28E-17	2.17E-17	2.01E-17	1.98E-17
Eu-152m	7.27E-18	6.72E-18	6.42E-18	6.09E-18	5.64E-18	5.54E-18
Eu-152n	1.33E-18	1.19E-18	1.09E-18	1.04E-18	9.16E-19	8.97E-19
Eu-154	2.80E-17	2.59E-17	2.47E-17	2.35E-17	2.18E-17	2.14E-17
Eu-154m	1.08E-18	9.51E-19	8.64E-19	8.17E-19	7.13E-19	6.97E-19
Eu-155	1.11E-18	9.96E-19	9.15E-19	8.69E-19	7.70E-19	7.54E-19
Eu-156	2.74E-17	2.55E-17	2.43E-17	2.33E-17	2.18E-17	2.14E-17
Eu-157	6.73E-18	6.14E-18	5.73E-18	5.47E-18	5.01E-18	4.91E-18
Eu-158	3.00E-17	2.79E-17	2.66E-17	2.54E-17	2.36E-17	2.32E-17
Eu-159	7.59E-18	6.96E-18	6.57E-18	6.24E-18	5.74E-18	5.64E-18
<b>Gadolinium</b>						
Gd-142	2.49E-17	2.29E-17	2.16E-17	2.07E-17	1.92E-17	1.88E-17
Gd-143m	5.00E-17	4.61E-17	4.35E-17	4.17E-17	3.86E-17	3.79E-17
Gd-144	2.10E-17	1.94E-17	1.83E-17	1.76E-17	1.63E-17	1.61E-17
Gd-145	5.19E-17	4.84E-17	4.59E-17	4.45E-17	4.16E-17	4.09E-17
Gd-145m	1.57E-17	1.45E-17	1.37E-17	1.30E-17	1.21E-17	1.18E-17
Gd-146	4.44E-18	3.99E-18	3.63E-18	3.45E-18	3.07E-18	3.02E-18
Gd-147	3.13E-17	2.88E-17	2.73E-17	2.60E-17	2.40E-17	2.36E-17
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	1.15E-17	1.05E-17	9.83E-18	9.37E-18	8.58E-18	8.42E-18
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	1.10E-18	9.64E-19	8.75E-19	8.22E-19	7.30E-19	7.15E-19
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	1.56E-18	1.35E-18	1.22E-18	1.14E-18	9.98E-19	9.77E-19

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	1.48E-18	1.34E-18	1.26E-18	1.20E-18	1.10E-18	1.08E-18
Gd-162	1.00E-17	9.19E-18	8.58E-18	8.23E-18	7.58E-18	7.43E-18
<b>Terbium</b>						
Tb-146	8.22E-17	7.64E-17	7.25E-17	6.99E-17	6.51E-17	6.41E-17
Tb-147	4.86E-17	4.50E-17	4.28E-17	4.09E-17	3.80E-17	3.73E-17
Tb-147m	4.19E-17	3.90E-17	3.70E-17	3.56E-17	3.32E-17	3.27E-17
Tb-148	5.38E-17	4.98E-17	4.72E-17	4.53E-17	4.21E-17	4.13E-17
Tb-148m	7.18E-17	6.63E-17	6.27E-17	5.97E-17	5.52E-17	5.42E-17
Tb-149	2.99E-17	2.77E-17	2.62E-17	2.51E-17	2.33E-17	2.29E-17
Tb-149m	3.13E-17	2.89E-17	2.74E-17	2.60E-17	2.41E-17	2.36E-17
Tb-150	5.27E-17	4.90E-17	4.64E-17	4.48E-17	4.17E-17	4.11E-17
Tb-150m	5.78E-17	5.32E-17	5.00E-17	4.78E-17	4.41E-17	4.33E-17
Tb-151	2.20E-17	2.02E-17	1.90E-17	1.81E-17	1.67E-17	1.64E-17
Tb-151m	1.64E-18	1.49E-18	1.39E-18	1.32E-18	1.21E-18	1.19E-18
Tb-152	3.29E-17	3.05E-17	2.88E-17	2.77E-17	2.57E-17	2.53E-17
Tb-152m	1.69E-17	1.55E-17	1.45E-17	1.38E-17	1.27E-17	1.25E-17
Tb-153	6.87E-18	6.25E-18	5.86E-18	5.56E-18	5.08E-18	4.99E-18
Tb-154	4.80E-17	4.48E-17	4.25E-17	4.11E-17	3.84E-17	3.78E-17
Tb-155	3.23E-18	2.89E-18	2.65E-18	2.51E-18	2.25E-18	2.20E-18
Tb-156	4.26E-17	3.94E-17	3.73E-17	3.57E-17	3.31E-17	3.25E-17
Tb-156m	4.75E-19	3.86E-19	3.37E-19	3.05E-19	2.56E-19	2.50E-19
Tb-156n	4.93E-20	4.14E-20	3.67E-20	3.39E-20	2.91E-20	2.84E-20
Tb-157	4.92E-20	3.89E-20	3.31E-20	2.97E-20	2.44E-20	2.38E-20
Tb-158	1.76E-17	1.63E-17	1.55E-17	1.47E-17	1.36E-17	1.34E-17
Tb-160	2.53E-17	2.34E-17	2.24E-17	2.13E-17	1.97E-17	1.94E-17
Tb-161	5.60E-19	4.81E-19	4.35E-19	4.05E-19	3.53E-19	3.45E-19
Tb-162	2.57E-17	2.37E-17	2.25E-17	2.14E-17	1.98E-17	1.94E-17
Tb-163	1.86E-17	1.71E-17	1.60E-17	1.53E-17	1.41E-17	1.38E-17
Tb-164	5.56E-17	5.15E-17	4.88E-17	4.67E-17	4.33E-17	4.26E-17
Tb-165	1.98E-17	1.84E-17	1.76E-17	1.68E-17	1.57E-17	1.54E-17
<b>Dysprosium</b>						
Dy-148	1.61E-17	1.48E-17	1.39E-17	1.33E-17	1.22E-17	1.20E-17
Dy-149	3.53E-17	3.27E-17	3.10E-17	2.97E-17	2.76E-17	2.72E-17
Dy-150	6.19E-18	5.64E-18	5.24E-18	5.02E-18	4.61E-18	4.51E-18
Dy-151	3.02E-17	2.80E-17	2.65E-17	2.53E-17	2.35E-17	2.31E-17
Dy-152	6.17E-18	5.58E-18	5.22E-18	4.97E-18	4.53E-18	4.44E-18
Dy-153	1.86E-17	1.71E-17	1.61E-17	1.54E-17	1.42E-17	1.39E-17
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	1.45E-17	1.33E-17	1.26E-17	1.20E-17	1.11E-17	1.09E-17
Dy-157	7.57E-18	6.86E-18	6.40E-18	6.11E-18	5.59E-18	5.47E-18
Dy-159	5.08E-19	4.06E-19	3.48E-19	3.14E-19	2.61E-19	2.54E-19
Dy-165	1.12E-18	1.03E-18	9.77E-19	9.29E-19	8.57E-19	8.42E-19
Dy-165m	3.66E-19	3.30E-19	3.05E-19	2.90E-19	2.63E-19	2.58E-19
Dy-166	7.38E-19	6.40E-19	5.81E-19	5.43E-19	4.77E-19	4.66E-19
Dy-167	1.31E-17	1.20E-17	1.13E-17	1.08E-17	9.95E-18	9.77E-18
Dy-168	9.30E-18	8.53E-18	7.97E-18	7.62E-18	7.00E-18	6.86E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	4.79E-17	4.43E-17	4.18E-17	3.99E-17	3.70E-17	3.63E-17
Ho-153	2.42E-17	2.22E-17	2.09E-17	2.00E-17	1.84E-17	1.81E-17
Ho-153m	2.52E-17	2.31E-17	2.17E-17	2.07E-17	1.91E-17	1.88E-17
Ho-154	4.49E-17	4.14E-17	3.90E-17	3.73E-17	3.46E-17	3.39E-17
Ho-154m	5.67E-17	5.21E-17	4.89E-17	4.68E-17	4.32E-17	4.24E-17
Ho-155	1.36E-17	1.25E-17	1.17E-17	1.13E-17	1.04E-17	1.02E-17
Ho-156	4.75E-17	4.40E-17	4.16E-17	3.99E-17	3.70E-17	3.63E-17
Ho-157	1.25E-17	1.14E-17	1.07E-17	1.02E-17	9.35E-18	9.17E-18
Ho-159	7.78E-18	7.06E-18	6.57E-18	6.24E-18	5.66E-18	5.55E-18
Ho-160	3.79E-17	3.49E-17	3.32E-17	3.15E-17	2.92E-17	2.87E-17
Ho-161	6.73E-19	5.56E-19	4.89E-19	4.48E-19	3.80E-19	3.71E-19
Ho-162	3.20E-18	2.90E-18	2.71E-18	2.57E-18	2.36E-18	2.31E-18
Ho-162m	1.20E-17	1.10E-17	1.05E-17	9.94E-18	9.18E-18	9.02E-18
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	5.11E-19	4.35E-19	3.92E-19	3.63E-19	3.16E-19	3.10E-19
Ho-164m	5.38E-19	4.37E-19	3.80E-19	3.44E-19	2.88E-19	2.81E-19
Ho-166	1.58E-18	1.47E-18	1.40E-18	1.33E-18	1.24E-18	1.22E-18
Ho-166m	3.69E-17	3.40E-17	3.22E-17	3.06E-17	2.82E-17	2.77E-17
Ho-167	8.53E-18	7.79E-18	7.29E-18	6.97E-18	6.40E-18	6.27E-18
Ho-168	2.10E-17	1.94E-17	1.85E-17	1.75E-17	1.62E-17	1.60E-17
Ho-168m	7.68E-20	6.24E-20	5.42E-20	4.91E-20	4.11E-20	4.01E-20
Ho-170	3.92E-17	3.62E-17	3.46E-17	3.28E-17	3.04E-17	2.98E-17
<b>Erbium</b>						
Er-154	1.16E-18	1.01E-18	9.18E-19	8.62E-19	7.68E-19	7.51E-19
Er-156	8.76E-19	7.39E-19	6.58E-19	6.09E-19	5.28E-19	5.16E-19
Er-159	2.13E-17	1.96E-17	1.85E-17	1.77E-17	1.64E-17	1.61E-17
Er-161	2.18E-17	2.01E-17	1.92E-17	1.82E-17	1.68E-17	1.65E-17
Er-163	5.02E-19	4.10E-19	3.58E-19	3.25E-19	2.74E-19	2.67E-19
Er-165	4.61E-19	3.74E-19	3.25E-19	2.94E-19	2.47E-19	2.40E-19
Er-167m	2.09E-18	1.90E-18	1.78E-18	1.69E-18	1.54E-18	1.51E-18
Er-169	7.07E-20	6.56E-20	6.30E-20	5.97E-20	5.54E-20	5.45E-20
Er-171	8.72E-18	7.95E-18	7.45E-18	7.11E-18	6.51E-18	6.37E-18
Er-172	1.17E-17	1.07E-17	9.99E-18	9.55E-18	8.78E-18	8.61E-18
Er-173	1.93E-17	1.78E-17	1.69E-17	1.60E-17	1.48E-17	1.45E-17
<b>Thulium</b>						
Tm-161	2.75E-17	2.54E-17	2.39E-17	2.30E-17	2.13E-17	2.10E-17
Tm-162	4.22E-17	3.92E-17	3.71E-17	3.58E-17	3.33E-17	3.28E-17
Tm-163	2.83E-17	2.62E-17	2.48E-17	2.38E-17	2.20E-17	2.17E-17
Tm-164	1.83E-17	1.69E-17	1.59E-17	1.52E-17	1.41E-17	1.39E-17
Tm-165	1.22E-17	1.11E-17	1.04E-17	9.94E-18	9.12E-18	8.94E-18
Tm-166	4.27E-17	3.96E-17	3.76E-17	3.61E-17	3.36E-17	3.31E-17
Tm-167	2.84E-18	2.53E-18	2.34E-18	2.21E-18	1.99E-18	1.95E-18
Tm-168	2.78E-17	2.56E-17	2.42E-17	2.30E-17	2.12E-17	2.08E-17
Tm-170	4.28E-19	3.94E-19	3.75E-19	3.55E-19	3.28E-19	3.22E-19
Tm-171	1.51E-20	1.32E-20	1.22E-20	1.14E-20	1.01E-20	9.88E-21

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	1.10E-17	1.02E-17	9.74E-18	9.35E-18	8.72E-18	8.58E-18
Tm-173	9.30E-18	8.53E-18	7.96E-18	7.63E-18	7.02E-18	6.88E-18
Tm-174	4.06E-17	3.74E-17	3.55E-17	3.38E-17	3.12E-17	3.06E-17
Tm-175	2.51E-17	2.32E-17	2.19E-17	2.09E-17	1.94E-17	1.90E-17
Tm-176	4.42E-17	4.10E-17	3.90E-17	3.74E-17	3.48E-17	3.42E-17
<b>Ytterbium</b>						
Yb-162	5.15E-18	4.70E-18	4.35E-18	4.14E-18	3.75E-18	3.68E-18
Yb-163	1.64E-17	1.51E-17	1.42E-17	1.36E-17	1.26E-17	1.24E-17
Yb-164	8.27E-19	7.09E-19	6.38E-19	5.92E-19	5.18E-19	5.06E-19
Yb-165	6.83E-18	6.21E-18	5.82E-18	5.53E-18	5.05E-18	4.96E-18
Yb-166	1.21E-18	1.02E-18	9.05E-19	8.34E-19	7.11E-19	6.94E-19
Yb-167	4.86E-18	4.34E-18	3.98E-18	3.77E-18	3.36E-18	3.29E-18
Yb-169	6.14E-18	5.48E-18	5.04E-18	4.76E-18	4.25E-18	4.16E-18
Yb-175	9.84E-19	9.00E-19	8.41E-19	8.05E-19	7.38E-19	7.23E-19
Yb-177	4.79E-18	4.45E-18	4.23E-18	4.02E-18	3.72E-18	3.66E-18
Yb-178	1.06E-18	9.69E-19	9.09E-19	8.70E-19	8.01E-19	7.85E-19
Yb-179	2.33E-17	2.15E-17	2.02E-17	1.93E-17	1.78E-17	1.75E-17
<b>Lutetium</b>						
Lu-165	2.47E-17	2.28E-17	2.15E-17	2.06E-17	1.90E-17	1.87E-17
Lu-167	3.63E-17	3.37E-17	3.19E-17	3.08E-17	2.86E-17	2.82E-17
Lu-169	2.85E-17	2.64E-17	2.51E-17	2.40E-17	2.22E-17	2.19E-17
Lu-169m	1.52E-23	9.78E-24	5.71E-24	5.14E-24	2.08E-24	1.93E-24
Lu-170	5.38E-17	5.02E-17	4.77E-17	4.61E-17	4.31E-17	4.25E-17
Lu-171	1.41E-17	1.29E-17	1.22E-17	1.16E-17	1.06E-17	1.04E-17
Lu-171m	5.01E-21	4.33E-21	3.91E-21	3.66E-21	3.14E-21	3.06E-21
Lu-172	4.32E-17	3.99E-17	3.81E-17	3.62E-17	3.36E-17	3.30E-17
Lu-172m	2.03E-23	1.51E-23	1.18E-23	1.06E-23	7.87E-24	7.62E-24
Lu-173	3.36E-18	2.97E-18	2.73E-18	2.58E-18	2.30E-18	2.25E-18
Lu-174	2.14E-18	1.92E-18	1.80E-18	1.70E-18	1.55E-18	1.52E-18
Lu-174m	9.03E-19	7.75E-19	7.00E-19	6.51E-19	5.65E-19	5.52E-19
Lu-176	1.10E-17	1.00E-17	9.37E-18	8.94E-18	8.18E-18	8.01E-18
Lu-176m	8.04E-19	7.37E-19	6.98E-19	6.62E-19	6.07E-19	5.97E-19
Lu-177	8.62E-19	7.87E-19	7.37E-19	7.02E-19	6.39E-19	6.26E-19
Lu-177m	2.21E-17	2.02E-17	1.89E-17	1.80E-17	1.64E-17	1.61E-17
Lu-178	3.85E-18	3.58E-18	3.42E-18	3.27E-18	3.04E-18	2.99E-18
Lu-178m	2.40E-17	2.20E-17	2.05E-17	1.96E-17	1.80E-17	1.76E-17
Lu-179	1.32E-18	1.22E-18	1.16E-18	1.10E-18	1.02E-18	9.99E-19
Lu-180	3.43E-17	3.18E-17	3.03E-17	2.89E-17	2.69E-17	2.64E-17
Lu-181	1.40E-17	1.29E-17	1.22E-17	1.16E-17	1.07E-17	1.05E-17
<b>Hafnium</b>						
Hf-167	1.49E-17	1.37E-17	1.28E-17	1.22E-17	1.13E-17	1.10E-17
Hf-169	1.46E-17	1.34E-17	1.25E-17	1.20E-17	1.10E-17	1.08E-17
Hf-170	9.43E-18	8.62E-18	8.02E-18	7.66E-18	6.99E-18	6.86E-18
Hf-172	1.58E-18	1.37E-18	1.23E-18	1.15E-18	1.00E-18	9.77E-19
Hf-173	8.33E-18	7.59E-18	7.05E-18	6.72E-18	6.10E-18	5.98E-18
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	7.71E-18	6.99E-18	6.51E-18	6.22E-18	5.68E-18	5.56E-18
Hf-177m	5.14E-17	4.69E-17	4.39E-17	4.19E-17	3.84E-17	3.76E-17
Hf-178m	5.10E-17	4.68E-17	4.37E-17	4.18E-17	3.84E-17	3.77E-17
Hf-179m	2.05E-17	1.88E-17	1.75E-17	1.67E-17	1.53E-17	1.50E-17
Hf-180m	2.24E-17	2.05E-17	1.91E-17	1.83E-17	1.68E-17	1.64E-17
Hf-181	1.22E-17	1.12E-17	1.04E-17	9.97E-18	9.15E-18	8.97E-18
Hf-182	5.44E-18	4.96E-18	4.66E-18	4.45E-18	4.07E-18	3.98E-18
Hf-182m	2.05E-17	1.88E-17	1.76E-17	1.68E-17	1.55E-17	1.52E-17
Hf-183	1.80E-17	1.66E-17	1.57E-17	1.49E-17	1.38E-17	1.35E-17
Hf-184	5.40E-18	4.94E-18	4.60E-18	4.40E-18	4.00E-18	3.93E-18
<b>Tantalum</b>						
Ta-170	2.76E-17	2.54E-17	2.39E-17	2.29E-17	2.11E-17	2.07E-17
Ta-172	3.83E-17	3.54E-17	3.36E-17	3.21E-17	2.98E-17	2.92E-17
Ta-173	1.25E-17	1.15E-17	1.08E-17	1.03E-17	9.51E-18	9.35E-18
Ta-174	2.20E-17	2.03E-17	1.91E-17	1.83E-17	1.70E-17	1.67E-17
Ta-175	2.39E-17	2.21E-17	2.09E-17	2.00E-17	1.86E-17	1.82E-17
Ta-176	4.76E-17	4.43E-17	4.21E-17	4.06E-17	3.79E-17	3.73E-17
Ta-177	1.10E-18	9.65E-19	8.78E-19	8.22E-19	7.20E-19	7.04E-19
Ta-178	2.29E-18	2.07E-18	1.93E-18	1.83E-18	1.66E-18	1.63E-18
Ta-178m	2.57E-17	2.34E-17	2.19E-17	2.09E-17	1.91E-17	1.87E-17
Ta-179	3.56E-19	3.02E-19	2.70E-19	2.50E-19	2.13E-19	2.08E-19
Ta-180	7.46E-19	6.41E-19	5.78E-19	5.38E-19	4.64E-19	4.53E-19
Ta-182	2.83E-17	2.62E-17	2.51E-17	2.39E-17	2.21E-17	2.18E-17
Ta-182m	5.39E-18	4.93E-18	4.55E-18	4.34E-18	3.91E-18	3.83E-18
Ta-183	6.34E-18	5.76E-18	5.36E-18	5.11E-18	4.63E-18	4.54E-18
Ta-184	3.61E-17	3.32E-17	3.14E-17	2.99E-17	2.76E-17	2.71E-17
Ta-185	4.15E-18	3.81E-18	3.57E-18	3.40E-18	3.10E-18	3.04E-18
Ta-186	3.41E-17	3.14E-17	2.96E-17	2.82E-17	2.61E-17	2.56E-17
<b>Tungsten</b>						
W-177	1.99E-17	1.83E-17	1.72E-17	1.64E-17	1.51E-17	1.48E-17
W-178	2.21E-19	1.89E-19	1.70E-19	1.58E-19	1.35E-19	1.31E-19
W-179	7.35E-19	6.25E-19	5.59E-19	5.19E-19	4.43E-19	4.32E-19
W-179m	9.98E-19	8.84E-19	8.14E-19	7.68E-19	6.81E-19	6.65E-19
W-181	5.88E-19	5.03E-19	4.52E-19	4.20E-19	3.59E-19	3.50E-19
W-185	1.02E-19	9.46E-20	9.07E-20	8.60E-20	7.98E-20	7.85E-20
W-185m	4.67E-19	4.24E-19	3.90E-19	3.71E-19	3.31E-19	3.24E-19
W-187	1.04E-17	9.62E-18	9.04E-18	8.63E-18	7.95E-18	7.80E-18
W-188	1.12E-19	1.03E-19	9.84E-20	9.35E-20	8.63E-20	8.47E-20
W-190	3.20E-18	2.91E-18	2.68E-18	2.55E-18	2.28E-18	2.23E-18
<b>Rhenium</b>						
Re-178	3.73E-17	3.47E-17	3.28E-17	3.16E-17	2.94E-17	2.89E-17
Re-179	2.39E-17	2.20E-17	2.07E-17	1.99E-17	1.84E-17	1.80E-17
Re-180	2.68E-17	2.47E-17	2.36E-17	2.24E-17	2.07E-17	2.03E-17
Re-181	1.78E-17	1.63E-17	1.53E-17	1.46E-17	1.34E-17	1.32E-17
Re-182	3.90E-17	3.60E-17	3.42E-17	3.26E-17	3.01E-17	2.95E-17
Re-182m	2.63E-17	2.43E-17	2.32E-17	2.21E-17	2.05E-17	2.02E-17



**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	2.84E-18	2.55E-18	2.34E-18	2.21E-18	1.96E-18	1.92E-18
Re-184	1.97E-17	1.82E-17	1.73E-17	1.64E-17	1.52E-17	1.49E-17
Re-184m	8.21E-18	7.52E-18	7.10E-18	6.74E-18	6.18E-18	6.06E-18
Re-186	7.82E-19	7.21E-19	6.76E-19	6.44E-19	5.87E-19	5.77E-19
Re-186m	2.16E-19	1.84E-19	1.65E-19	1.54E-19	1.32E-19	1.28E-19
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	2.55E-18	2.37E-18	2.24E-18	2.14E-18	1.98E-18	1.95E-18
Re-188m	1.15E-18	1.01E-18	9.23E-19	8.72E-19	7.59E-19	7.41E-19
Re-189	1.58E-18	1.45E-18	1.36E-18	1.30E-18	1.19E-18	1.17E-18
Re-190	3.15E-17	2.90E-17	2.73E-17	2.61E-17	2.41E-17	2.36E-17
Re-190m	2.15E-17	1.98E-17	1.86E-17	1.78E-17	1.64E-17	1.61E-17
<b>Osmium</b>						
Os-180	2.39E-18	2.15E-18	2.00E-18	1.90E-18	1.71E-18	1.67E-18
Os-181	3.02E-17	2.80E-17	2.65E-17	2.53E-17	2.35E-17	2.30E-17
Os-182	9.47E-18	8.66E-18	8.06E-18	7.72E-18	7.06E-18	6.92E-18
Os-183	1.37E-17	1.25E-17	1.17E-17	1.11E-17	1.02E-17	9.98E-18
Os-183m	2.21E-17	2.04E-17	1.95E-17	1.86E-17	1.72E-17	1.69E-17
Os-185	1.55E-17	1.43E-17	1.35E-17	1.28E-17	1.18E-17	1.16E-17
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	6.40E-23	4.30E-23	2.59E-23	2.36E-23	8.35E-24	7.69E-24
Os-190m	3.66E-17	3.36E-17	3.14E-17	3.01E-17	2.77E-17	2.72E-17
Os-191	1.51E-18	1.37E-18	1.25E-18	1.20E-18	1.06E-18	1.04E-18
Os-191m	9.25E-20	8.08E-20	7.34E-20	6.91E-20	5.95E-20	5.79E-20
Os-193	1.88E-18	1.72E-18	1.61E-18	1.54E-18	1.41E-18	1.39E-18
Os-194	2.81E-20	2.25E-20	1.94E-20	1.75E-20	1.46E-20	1.42E-20
Os-196	2.21E-18	2.03E-18	1.90E-18	1.82E-18	1.67E-18	1.63E-18
<b>Iridium</b>						
Ir-180	3.88E-17	3.57E-17	3.37E-17	3.22E-17	2.97E-17	2.91E-17
Ir-182	3.39E-17	3.12E-17	2.94E-17	2.81E-17	2.60E-17	2.55E-17
Ir-183	2.58E-17	2.39E-17	2.25E-17	2.17E-17	2.01E-17	1.98E-17
Ir-184	4.38E-17	4.05E-17	3.83E-17	3.67E-17	3.39E-17	3.33E-17
Ir-185	1.81E-17	1.68E-17	1.58E-17	1.53E-17	1.42E-17	1.39E-17
Ir-186	3.67E-17	3.39E-17	3.20E-17	3.07E-17	2.84E-17	2.79E-17
Ir-186m	2.75E-17	2.55E-17	2.41E-17	2.31E-17	2.15E-17	2.11E-17
Ir-187	7.05E-18	6.46E-18	6.09E-18	5.78E-18	5.30E-18	5.20E-18
Ir-188	4.44E-17	4.14E-17	3.92E-17	3.80E-17	3.55E-17	3.49E-17
Ir-189	1.37E-18	1.21E-18	1.12E-18	1.06E-18	9.31E-19	9.09E-19
Ir-190	3.36E-17	3.09E-17	2.89E-17	2.77E-17	2.55E-17	2.50E-17
Ir-190m	7.09E-23	4.89E-23	3.02E-23	2.76E-23	9.55E-24	8.77E-24
Ir-190n	9.24E-19	8.13E-19	7.41E-19	6.99E-19	6.07E-19	5.92E-19
Ir-191m	1.35E-18	1.22E-18	1.12E-18	1.07E-18	9.41E-19	9.21E-19
Ir-192	1.90E-17	1.74E-17	1.63E-17	1.56E-17	1.44E-17	1.41E-17
Ir-192m	1.51E-21	1.31E-21	1.17E-21	1.10E-21	9.45E-22	9.23E-22
Ir-192n	1.11E-20	9.85E-21	8.91E-21	8.46E-21	7.29E-21	7.13E-21
Ir-193m	5.10E-21	4.47E-21	4.06E-21	3.83E-21	3.29E-21	3.20E-21
Ir-194	3.38E-18	3.12E-18	2.97E-18	2.83E-18	2.63E-18	2.58E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	5.39E-17	4.95E-17	4.64E-17	4.45E-17	4.10E-17	4.02E-17
Ir-195	1.39E-18	1.26E-18	1.17E-18	1.11E-18	9.93E-19	9.72E-19
Ir-195m	8.62E-18	7.89E-18	7.39E-18	7.06E-18	6.48E-18	6.35E-18
Ir-196	7.42E-18	6.86E-18	6.51E-18	6.22E-18	5.77E-18	5.67E-18
Ir-196m	5.72E-17	5.26E-17	4.92E-17	4.72E-17	4.35E-17	4.26E-17
<b>Platinum</b>						
Pt-184	1.56E-17	1.42E-17	1.33E-17	1.27E-17	1.16E-17	1.13E-17
Pt-186	1.52E-17	1.40E-17	1.32E-17	1.25E-17	1.15E-17	1.13E-17
Pt-187	1.34E-17	1.23E-17	1.16E-17	1.11E-17	1.01E-17	9.94E-18
Pt-188	4.17E-18	3.78E-18	3.51E-18	3.35E-18	3.02E-18	2.95E-18
Pt-189	1.04E-17	9.52E-18	8.93E-18	8.52E-18	7.80E-18	7.65E-18
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	6.11E-18	5.55E-18	5.15E-18	4.92E-18	4.46E-18	4.36E-18
Pt-193	1.72E-22	1.20E-22	7.64E-23	7.03E-23	2.43E-23	2.23E-23
Pt-193m	1.73E-19	1.53E-19	1.40E-19	1.33E-19	1.15E-19	1.12E-19
Pt-195m	1.23E-18	1.09E-18	1.00E-18	9.51E-19	8.30E-19	8.10E-19
Pt-197	6.42E-19	5.84E-19	5.47E-19	5.20E-19	4.69E-19	4.59E-19
Pt-197m	1.62E-18	1.47E-18	1.36E-18	1.30E-18	1.17E-18	1.14E-18
Pt-199	5.30E-18	4.88E-18	4.59E-18	4.39E-18	4.05E-18	3.97E-18
Pt-200	1.30E-18	1.18E-18	1.10E-18	1.05E-18	9.44E-19	9.24E-19
Pt-202	9.76E-19	9.10E-19	8.74E-19	8.33E-19	7.78E-19	7.66E-19
<b>Gold</b>						
Au-186	3.59E-17	3.31E-17	3.12E-17	2.99E-17	2.77E-17	2.71E-17
Au-187	2.31E-17	2.15E-17	2.03E-17	1.95E-17	1.81E-17	1.78E-17
Au-190	5.05E-17	4.70E-17	4.45E-17	4.32E-17	4.03E-17	3.96E-17
Au-191	1.31E-17	1.20E-17	1.13E-17	1.08E-17	9.87E-18	9.68E-18
Au-192	4.15E-17	3.86E-17	3.65E-17	3.53E-17	3.29E-17	3.24E-17
Au-193	3.30E-18	2.99E-18	2.77E-18	2.64E-18	2.37E-18	2.32E-18
Au-193m	4.38E-18	3.98E-18	3.74E-18	3.57E-18	3.26E-18	3.19E-18
Au-194	2.26E-17	2.09E-17	1.98E-17	1.90E-17	1.76E-17	1.73E-17
Au-195	1.36E-18	1.21E-18	1.11E-18	1.05E-18	9.14E-19	8.92E-19
Au-195m	4.45E-18	4.05E-18	3.81E-18	3.63E-18	3.32E-18	3.25E-18
Au-196	1.06E-17	9.68E-18	9.04E-18	8.65E-18	7.92E-18	7.75E-18
Au-196m	4.97E-18	4.55E-18	4.21E-18	4.03E-18	3.62E-18	3.55E-18
Au-198	9.71E-18	8.91E-18	8.32E-18	7.98E-18	7.35E-18	7.20E-18
Au-198m	1.15E-17	1.04E-17	9.76E-18	9.31E-18	8.45E-18	8.28E-18
Au-199	2.08E-18	1.92E-18	1.78E-18	1.71E-18	1.54E-18	1.51E-18
Au-200	7.26E-18	6.73E-18	6.41E-18	6.13E-18	5.69E-18	5.60E-18
Au-200m	4.56E-17	4.20E-17	3.95E-17	3.77E-17	3.47E-17	3.40E-17
Au-201	1.31E-18	1.21E-18	1.15E-18	1.10E-18	1.01E-18	9.95E-19
Au-202	5.79E-18	5.37E-18	5.12E-18	4.89E-18	4.55E-18	4.47E-18
<b>Mercury</b>						
Hg-190	3.95E-18	3.62E-18	3.33E-18	3.19E-18	2.85E-18	2.79E-18
Hg-191m	3.31E-17	3.05E-17	2.88E-17	2.76E-17	2.55E-17	2.50E-17
Hg-192	5.73E-18	5.21E-18	4.86E-18	4.63E-18	4.19E-18	4.10E-18
Hg-193	1.82E-17	1.68E-17	1.59E-17	1.52E-17	1.41E-17	1.38E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	2.26E-17	2.09E-17	1.98E-17	1.89E-17	1.75E-17	1.72E-17
Hg-194	2.61E-22	1.91E-22	1.28E-22	1.19E-22	4.12E-23	3.77E-23
Hg-195	4.10E-18	3.75E-18	3.53E-18	3.35E-18	3.06E-18	3.00E-18
Hg-195m	4.31E-18	3.93E-18	3.68E-18	3.51E-18	3.21E-18	3.14E-18
Hg-197	1.21E-18	1.07E-18	9.84E-19	9.35E-19	8.14E-19	7.93E-19
Hg-197m	1.89E-18	1.73E-18	1.60E-18	1.53E-18	1.37E-18	1.34E-18
Hg-199m	3.80E-18	3.49E-18	3.23E-18	3.10E-18	2.79E-18	2.74E-18
Hg-203	5.46E-18	4.98E-18	4.68E-18	4.47E-18	4.09E-18	4.01E-18
Hg-205	8.67E-19	8.05E-19	7.71E-19	7.34E-19	6.83E-19	6.71E-19
Hg-206	3.25E-18	2.98E-18	2.80E-18	2.68E-18	2.46E-18	2.41E-18
Hg-207	5.88E-17	5.47E-17	5.20E-17	5.01E-17	4.67E-17	4.59E-17
<b>Thallium</b>						
Tl-190	3.32E-17	3.06E-17	2.88E-17	2.76E-17	2.55E-17	2.50E-17
Tl-190m	5.77E-17	5.32E-17	5.01E-17	4.79E-17	4.42E-17	4.34E-17
Tl-194	2.21E-17	2.03E-17	1.90E-17	1.82E-17	1.68E-17	1.65E-17
Tl-194m	5.77E-17	5.32E-17	5.01E-17	4.78E-17	4.41E-17	4.33E-17
Tl-195	2.63E-17	2.45E-17	2.32E-17	2.23E-17	2.07E-17	2.04E-17
Tl-196	4.12E-17	3.82E-17	3.61E-17	3.48E-17	3.24E-17	3.18E-17
Tl-197	9.89E-18	9.11E-18	8.58E-18	8.21E-18	7.55E-18	7.41E-18
Tl-198	4.36E-17	4.05E-17	3.83E-17	3.70E-17	3.44E-17	3.38E-17
Tl-198m	2.77E-17	2.54E-17	2.38E-17	2.28E-17	2.10E-17	2.06E-17
Tl-199	5.31E-18	4.84E-18	4.53E-18	4.32E-18	3.93E-18	3.84E-18
Tl-200	2.91E-17	2.69E-17	2.55E-17	2.43E-17	2.25E-17	2.21E-17
Tl-201	1.65E-18	1.49E-18	1.37E-18	1.30E-18	1.15E-18	1.12E-18
Tl-202	1.04E-17	9.55E-18	8.88E-18	8.52E-18	7.81E-18	7.65E-18
Tl-204	2.69E-19	2.49E-19	2.38E-19	2.26E-19	2.09E-19	2.06E-19
Tl-206	7.54E-19	7.02E-19	6.74E-19	6.41E-19	5.98E-19	5.89E-19
Tl-206m	5.51E-17	5.07E-17	4.80E-17	4.57E-17	4.22E-17	4.14E-17
Tl-207	7.23E-19	6.73E-19	6.46E-19	6.14E-19	5.73E-19	5.63E-19
Tl-208	7.03E-17	6.58E-17	6.23E-17	6.08E-17	5.69E-17	5.61E-17
Tl-209	4.77E-17	4.44E-17	4.19E-17	4.05E-17	3.77E-17	3.70E-17
Tl-210	6.29E-17	5.84E-17	5.56E-17	5.33E-17	4.96E-17	4.88E-17
<b>Lead</b>						
Pb-194	2.37E-17	2.19E-17	2.07E-17	1.99E-17	1.84E-17	1.81E-17
Pb-195m	3.76E-17	3.46E-17	3.27E-17	3.12E-17	2.88E-17	2.82E-17
Pb-196	1.08E-17	9.92E-18	9.29E-18	8.88E-18	8.12E-18	7.95E-18
Pb-197	3.36E-17	3.11E-17	2.95E-17	2.83E-17	2.63E-17	2.58E-17
Pb-197m	2.63E-17	2.42E-17	2.28E-17	2.18E-17	2.01E-17	1.97E-17
Pb-198	9.59E-18	8.77E-18	8.21E-18	7.84E-18	7.16E-18	7.02E-18
Pb-199	2.28E-17	2.11E-17	1.99E-17	1.91E-17	1.77E-17	1.74E-17
Pb-200	4.18E-18	3.82E-18	3.54E-18	3.38E-18	3.04E-18	2.97E-18
Pb-201	1.68E-17	1.55E-17	1.46E-17	1.39E-17	1.28E-17	1.26E-17
Pb-201m	8.29E-18	7.63E-18	7.17E-18	6.85E-18	6.31E-18	6.19E-18
Pb-202	2.95E-22	2.02E-22	1.25E-22	1.14E-22	4.01E-23	3.68E-23
Pb-202m	4.53E-17	4.18E-17	3.97E-17	3.78E-17	3.49E-17	3.43E-17
Pb-203	6.82E-18	6.20E-18	5.81E-18	5.54E-18	5.04E-18	4.93E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	4.68E-17	4.32E-17	4.12E-17	3.91E-17	3.62E-17	3.56E-17
Pb-205	2.99E-22	2.04E-22	1.26E-22	1.16E-22	4.06E-23	3.72E-23
Pb-209	1.89E-19	1.75E-19	1.68E-19	1.60E-19	1.48E-19	1.46E-19
Pb-210	2.44E-20	1.95E-20	1.68E-20	1.51E-20	1.24E-20	1.21E-20
Pb-211	2.06E-18	1.91E-18	1.81E-18	1.73E-18	1.60E-18	1.57E-18
Pb-212	3.23E-18	2.94E-18	2.76E-18	2.63E-18	2.39E-18	2.34E-18
Pb-214	5.95E-18	5.44E-18	5.10E-18	4.88E-18	4.47E-18	4.38E-18
<b>Bismuth</b>						
Bi-197	3.81E-17	3.52E-17	3.35E-17	3.20E-17	2.97E-17	2.91E-17
Bi-200	5.54E-17	5.10E-17	4.83E-17	4.60E-17	4.25E-17	4.17E-17
Bi-201	3.78E-17	3.51E-17	3.34E-17	3.20E-17	2.97E-17	2.92E-17
Bi-202	6.19E-17	5.72E-17	5.43E-17	5.18E-17	4.79E-17	4.71E-17
Bi-203	5.18E-17	4.82E-17	4.58E-17	4.40E-17	4.10E-17	4.03E-17
Bi-204	6.49E-17	6.01E-17	5.72E-17	5.45E-17	5.05E-17	4.97E-17
Bi-205	3.67E-17	3.41E-17	3.24E-17	3.11E-17	2.90E-17	2.85E-17
Bi-206	7.31E-17	6.77E-17	6.42E-17	6.13E-17	5.69E-17	5.59E-17
Bi-207	3.43E-17	3.17E-17	3.01E-17	2.87E-17	2.66E-17	2.61E-17
Bi-208	5.28E-17	4.97E-17	4.71E-17	4.62E-17	4.35E-17	4.29E-17
Bi-210	4.82E-19	4.48E-19	4.30E-19	4.09E-19	3.81E-19	3.74E-19
Bi-210m	5.95E-18	5.43E-18	5.10E-18	4.88E-18	4.47E-18	4.38E-18
Bi-211	1.09E-18	9.92E-19	9.27E-19	8.89E-19	8.15E-19	7.98E-19
Bi-212	3.09E-18	2.87E-18	2.73E-18	2.61E-18	2.43E-18	2.38E-18
Bi-212n	7.45E-19	6.94E-19	6.66E-19	6.34E-19	5.92E-19	5.82E-19
Bi-213	3.50E-18	3.22E-18	3.02E-18	2.89E-18	2.66E-18	2.61E-18
Bi-214	3.33E-17	3.10E-17	2.94E-17	2.84E-17	2.64E-17	2.60E-17
Bi-215	6.61E-18	6.09E-18	5.76E-18	5.50E-18	5.08E-18	4.98E-18
Bi-216	1.96E-17	1.80E-17	1.69E-17	1.62E-17	1.50E-17	1.47E-17
<b>Polonium</b>						
Po-203	3.61E-17	3.35E-17	3.19E-17	3.04E-17	2.82E-17	2.77E-17
Po-204	2.56E-17	2.36E-17	2.24E-17	2.13E-17	1.96E-17	1.92E-17
Po-205	3.50E-17	3.24E-17	3.09E-17	2.94E-17	2.73E-17	2.68E-17
Po-206	2.66E-17	2.45E-17	2.32E-17	2.21E-17	2.04E-17	2.00E-17
Po-207	2.85E-17	2.64E-17	2.52E-17	2.39E-17	2.21E-17	2.18E-17
Po-208	4.77E-22	4.39E-22	4.13E-22	3.94E-22	3.63E-22	3.56E-22
Po-209	1.38E-19	1.27E-19	1.20E-19	1.14E-19	1.05E-19	1.03E-19
Po-210	2.21E-22	2.05E-22	1.95E-22	1.85E-22	1.71E-22	1.68E-22
Po-211	1.86E-19	1.72E-19	1.63E-19	1.55E-19	1.44E-19	1.41E-19
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	1.62E-18	1.52E-18	1.44E-18	1.41E-18	1.32E-18	1.30E-18
Po-213	8.54E-22	7.90E-22	7.52E-22	7.13E-22	6.60E-22	6.48E-22
Po-214	1.89E-21	1.75E-21	1.67E-21	1.58E-21	1.46E-21	1.44E-21
Po-215	4.10E-21	3.76E-21	3.50E-21	3.36E-21	3.10E-21	3.04E-21
Po-216	3.48E-22	3.22E-22	3.07E-22	2.91E-22	2.70E-22	2.65E-22
Po-218	8.47E-24	7.85E-24	7.54E-24	7.14E-24	6.63E-24	6.52E-24
<b>Astatine</b>						
At-204	5.40E-17	4.97E-17	4.67E-17	4.47E-17	4.12E-17	4.04E-17

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	2.58E-17	2.39E-17	2.26E-17	2.16E-17	2.00E-17	1.96E-17
At-206	5.67E-17	5.23E-17	4.94E-17	4.72E-17	4.36E-17	4.28E-17
At-207	4.43E-17	4.11E-17	3.90E-17	3.73E-17	3.46E-17	3.40E-17
At-208	6.79E-17	6.28E-17	5.95E-17	5.69E-17	5.27E-17	5.18E-17
At-209	5.14E-17	4.74E-17	4.49E-17	4.28E-17	3.96E-17	3.88E-17
At-210	6.46E-17	6.00E-17	5.72E-17	5.48E-17	5.10E-17	5.02E-17
At-211	6.42E-19	5.78E-19	5.34E-19	5.08E-19	4.49E-19	4.39E-19
At-215	3.95E-21	3.62E-21	3.38E-21	3.24E-21	2.98E-21	2.92E-21
At-216	4.86E-20	4.40E-20	4.08E-20	3.90E-20	3.49E-20	3.41E-20
At-217	5.48E-21	5.00E-21	4.70E-21	4.48E-21	4.10E-21	4.02E-21
At-218	1.96E-21	1.83E-21	1.76E-21	1.68E-21	1.57E-21	1.55E-21
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	1.25E-17	1.15E-17	1.08E-17	1.03E-17	9.54E-18	9.35E-18
<b>Radon</b>						
Rn-207	2.26E-17	2.08E-17	1.96E-17	1.87E-17	1.73E-17	1.70E-17
Rn-209	2.66E-17	2.46E-17	2.32E-17	2.22E-17	2.06E-17	2.02E-17
Rn-210	1.36E-18	1.26E-18	1.19E-18	1.13E-18	1.04E-18	1.02E-18
Rn-211	4.17E-17	3.86E-17	3.67E-17	3.50E-17	3.25E-17	3.19E-17
Rn-212	7.77E-21	7.17E-21	6.78E-21	6.45E-21	5.97E-21	5.86E-21
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	1.75E-20	1.61E-20	1.51E-20	1.45E-20	1.34E-20	1.31E-20
Rn-219	1.35E-18	1.23E-18	1.15E-18	1.10E-18	1.01E-18	9.92E-19
Rn-220	1.45E-20	1.34E-20	1.25E-20	1.20E-20	1.11E-20	1.09E-20
Rn-222	9.02E-21	8.30E-21	7.74E-21	7.43E-21	6.85E-21	6.72E-21
Rn-223	8.40E-18	7.75E-18	7.31E-18	6.98E-18	6.45E-18	6.33E-18
<b>Francium</b>						
Fr-212	2.51E-17	2.33E-17	2.22E-17	2.12E-17	1.96E-17	1.93E-17
Fr-219	8.19E-20	7.51E-20	7.01E-20	6.72E-20	6.17E-20	6.05E-20
Fr-220	1.80E-19	1.63E-19	1.51E-19	1.44E-19	1.28E-19	1.26E-19
Fr-221	6.54E-19	5.97E-19	5.60E-19	5.34E-19	4.87E-19	4.77E-19
Fr-222	4.84E-18	4.46E-18	4.21E-18	4.01E-18	3.69E-18	3.62E-18
Fr-223	1.40E-18	1.26E-18	1.18E-18	1.11E-18	1.01E-18	9.87E-19
Fr-224	1.35E-17	1.25E-17	1.19E-17	1.14E-17	1.06E-17	1.04E-17
Fr-227	1.10E-17	1.01E-17	9.50E-18	9.08E-18	8.35E-18	8.19E-18
<b>Radium</b>						
Ra-219	3.84E-18	3.51E-18	3.29E-18	3.14E-18	2.88E-18	2.82E-18
Ra-220	1.08E-19	9.97E-20	9.29E-20	8.92E-20	8.22E-20	8.05E-20
Ra-221	7.46E-19	6.88E-19	6.35E-19	6.09E-19	5.47E-19	5.37E-19
Ra-222	2.12E-19	1.94E-19	1.82E-19	1.74E-19	1.60E-19	1.56E-19
Ra-223	2.96E-18	2.70E-18	2.52E-18	2.41E-18	2.18E-18	2.14E-18
Ra-224	2.36E-19	2.15E-19	2.02E-19	1.93E-19	1.76E-19	1.73E-19
Ra-225	1.69E-19	1.40E-19	1.24E-19	1.13E-19	9.76E-20	9.53E-20
Ra-226	1.62E-19	1.48E-19	1.39E-19	1.32E-19	1.20E-19	1.18E-19
Ra-227	3.65E-18	3.35E-18	3.14E-18	3.01E-18	2.76E-18	2.71E-18

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	1.62E-21	1.27E-21	1.05E-21	1.01E-21	5.59E-22	5.28E-22
Ra-230	1.85E-18	1.69E-18	1.58E-18	1.51E-18	1.38E-18	1.35E-18
<b>Actinium</b>						
Ac-223	3.78E-19	3.45E-19	3.22E-19	3.08E-19	2.81E-19	2.75E-19
Ac-224	4.81E-18	4.40E-18	4.10E-18	3.91E-18	3.54E-18	3.47E-18
Ac-225	2.90E-19	2.65E-19	2.46E-19	2.35E-19	2.11E-19	2.07E-19
Ac-226	3.17E-18	2.91E-18	2.73E-18	2.60E-18	2.37E-18	2.33E-18
Ac-227	2.44E-21	2.15E-21	1.96E-21	1.87E-21	1.61E-21	1.58E-21
Ac-228	1.98E-17	1.83E-17	1.75E-17	1.66E-17	1.54E-17	1.51E-17
Ac-230	1.33E-17	1.24E-17	1.18E-17	1.13E-17	1.06E-17	1.04E-17
Ac-231	1.02E-17	9.30E-18	8.73E-18	8.34E-18	7.64E-18	7.48E-18
Ac-232	2.64E-17	2.46E-17	2.33E-17	2.26E-17	2.11E-17	2.08E-17
Ac-233	1.29E-17	1.19E-17	1.11E-17	1.07E-17	9.86E-18	9.67E-18
<b>Thorium</b>						
Th-223	1.41E-18	1.28E-18	1.19E-18	1.13E-18	1.01E-18	9.95E-19
Th-224	5.06E-19	4.66E-19	4.34E-19	4.15E-19	3.78E-19	3.71E-19
Th-226	1.64E-19	1.50E-19	1.39E-19	1.33E-19	1.20E-19	1.18E-19
Th-227	2.73E-18	2.48E-18	2.33E-18	2.22E-18	2.02E-18	1.98E-18
Th-228	4.21E-20	3.82E-20	3.54E-20	3.38E-20	3.02E-20	2.96E-20
Th-229	1.69E-18	1.54E-18	1.43E-18	1.36E-18	1.22E-18	1.19E-18
Th-230	7.68E-21	6.82E-21	6.21E-21	5.92E-21	5.07E-21	4.95E-21
Th-231	2.70E-19	2.42E-19	2.24E-19	2.13E-19	1.88E-19	1.84E-19
Th-232	3.96E-21	3.43E-21	3.08E-21	2.92E-21	2.41E-21	2.34E-21
Th-233	1.27E-18	1.17E-18	1.11E-18	1.06E-18	9.76E-19	9.59E-19
Th-234	1.81E-19	1.63E-19	1.50E-19	1.43E-19	1.26E-19	1.24E-19
Th-235	2.23E-18	2.07E-18	1.97E-18	1.87E-18	1.74E-18	1.71E-18
Th-236	1.16E-18	1.07E-18	1.01E-18	9.66E-19	8.90E-19	8.74E-19
<b>Protactinium</b>						
Pa-227	3.63E-19	3.26E-19	3.00E-19	2.86E-19	2.53E-19	2.48E-19
Pa-228	3.01E-17	2.79E-17	2.65E-17	2.52E-17	2.34E-17	2.30E-17
Pa-229	1.18E-18	1.07E-18	9.88E-19	9.43E-19	8.41E-19	8.24E-19
Pa-230	1.48E-17	1.37E-17	1.30E-17	1.23E-17	1.14E-17	1.12E-17
Pa-231	7.58E-19	6.88E-19	6.43E-19	6.15E-19	5.61E-19	5.49E-19
Pa-232	2.11E-17	1.95E-17	1.86E-17	1.77E-17	1.64E-17	1.61E-17
Pa-233	4.86E-18	4.43E-18	4.15E-18	3.97E-18	3.62E-18	3.55E-18
Pa-234	3.28E-17	3.04E-17	2.89E-17	2.75E-17	2.54E-17	2.50E-17
Pa-234m	1.68E-18	1.56E-18	1.50E-18	1.43E-18	1.33E-18	1.31E-18
Pa-235	6.36E-19	5.92E-19	5.68E-19	5.41E-19	5.04E-19	4.96E-19
Pa-236	2.12E-17	1.97E-17	1.86E-17	1.79E-17	1.67E-17	1.64E-17
Pa-237	1.47E-17	1.36E-17	1.29E-17	1.23E-17	1.14E-17	1.12E-17
<b>Uranium</b>						
U-227	2.50E-18	2.28E-18	2.13E-18	2.04E-18	1.85E-18	1.81E-18
U-228	8.14E-20	7.40E-20	6.88E-20	6.57E-20	5.90E-20	5.78E-20
U-230	2.32E-20	2.10E-20	1.93E-20	1.85E-20	1.63E-20	1.59E-20
U-231	1.34E-18	1.21E-18	1.12E-18	1.07E-18	9.53E-19	9.34E-19
U-232	5.33E-21	4.61E-21	4.12E-21	3.91E-21	3.22E-21	3.14E-21

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	5.35E-21	4.74E-21	4.33E-21	4.12E-21	3.60E-21	3.52E-21
U-234	2.99E-21	2.50E-21	2.19E-21	2.07E-21	1.61E-21	1.57E-21
U-235	3.57E-18	3.29E-18	3.07E-18	2.93E-18	2.66E-18	2.61E-18
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	1.80E-21	1.45E-21	1.24E-21	1.18E-21	8.37E-22	8.07E-22
U-237	2.74E-18	2.48E-18	2.30E-18	2.19E-18	1.97E-18	1.93E-18
U-238	1.51E-21	1.23E-21	1.06E-21	1.00E-21	7.30E-22	7.06E-22
U-239	1.41E-18	1.29E-18	1.21E-18	1.15E-18	1.03E-18	1.01E-18
U-240	1.59E-19	1.45E-19	1.36E-19	1.29E-19	1.17E-19	1.15E-19
U-242	1.35E-18	1.24E-18	1.17E-18	1.11E-18	1.02E-18	1.00E-18
<b>Neptunium</b>						
Np-232	2.67E-17	2.46E-17	2.34E-17	2.22E-17	2.05E-17	2.01E-17
Np-233	1.72E-18	1.56E-18	1.45E-18	1.38E-18	1.24E-18	1.22E-18
Np-234	2.38E-17	2.21E-17	2.10E-17	2.03E-17	1.89E-17	1.86E-17
Np-235	1.38E-20	1.19E-20	1.07E-20	1.02E-20	8.37E-21	8.16E-21
Np-236	2.83E-18	2.60E-18	2.40E-18	2.30E-18	2.06E-18	2.03E-18
Np-236m	1.01E-18	9.22E-19	8.58E-19	8.19E-19	7.38E-19	7.24E-19
Np-237	4.31E-19	3.86E-19	3.55E-19	3.38E-19	2.99E-19	2.93E-19
Np-238	1.33E-17	1.23E-17	1.18E-17	1.12E-17	1.04E-17	1.02E-17
Np-239	3.85E-18	3.51E-18	3.28E-18	3.13E-18	2.84E-18	2.79E-18
Np-240	2.38E-17	2.20E-17	2.09E-17	1.99E-17	1.84E-17	1.80E-17
Np-240m	8.19E-18	7.57E-18	7.16E-18	6.85E-18	6.34E-18	6.23E-18
Np-241	1.29E-18	1.19E-18	1.12E-18	1.06E-18	9.73E-19	9.56E-19
Np-242	7.33E-18	6.83E-18	6.51E-18	6.24E-18	5.82E-18	5.72E-18
Np-242m	2.12E-17	1.96E-17	1.86E-17	1.77E-17	1.64E-17	1.61E-17
<b>Plutonium</b>						
Pu-232	1.17E-18	1.06E-18	9.85E-19	9.42E-19	8.43E-19	8.27E-19
Pu-234	1.26E-18	1.15E-18	1.06E-18	1.02E-18	9.11E-19	8.93E-19
Pu-235	1.75E-18	1.59E-18	1.48E-18	1.41E-18	1.27E-18	1.24E-18
Pu-236	1.98E-21	1.52E-21	1.27E-21	1.21E-21	7.86E-22	7.51E-22
Pu-237	9.05E-19	8.21E-19	7.59E-19	7.25E-19	6.48E-19	6.35E-19
Pu-238	1.50E-21	1.12E-21	9.11E-22	8.76E-22	5.13E-22	4.85E-22
Pu-239	1.85E-21	1.58E-21	1.40E-21	1.34E-21	1.09E-21	1.07E-21
Pu-240	1.47E-21	1.11E-21	9.07E-22	8.70E-22	5.22E-22	4.95E-22
Pu-241	6.36E-23	5.85E-23	5.52E-23	5.25E-23	4.79E-23	4.70E-23
Pu-242	2.92E-21	2.49E-21	2.25E-21	2.16E-21	1.77E-21	1.73E-21
Pu-243	5.93E-19	5.38E-19	5.02E-19	4.78E-19	4.29E-19	4.20E-19
Pu-244	4.48E-19	4.17E-19	3.97E-19	3.82E-19	3.57E-19	3.51E-19
Pu-245	9.32E-18	8.58E-18	8.11E-18	7.73E-18	7.12E-18	6.99E-18
Pu-246	2.81E-18	2.56E-18	2.38E-18	2.27E-18	2.05E-18	2.01E-18
<b>Americium</b>						
Am-237	8.03E-18	7.35E-18	6.88E-18	6.58E-18	6.01E-18	5.89E-18
Am-238	1.98E-17	1.84E-17	1.75E-17	1.66E-17	1.54E-17	1.51E-17
Am-239	4.80E-18	4.38E-18	4.08E-18	3.90E-18	3.52E-18	3.45E-18
Am-240	2.28E-17	2.11E-17	2.02E-17	1.91E-17	1.77E-17	1.74E-17
Am-241	3.41E-19	2.92E-19	2.62E-19	2.44E-19	2.08E-19	2.02E-19

**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	4.19E-19	3.84E-19	3.59E-19	3.43E-19	3.11E-19	3.05E-19
Am-242m	9.14E-21	7.38E-21	6.41E-21	6.13E-21	4.66E-21	4.51E-21
Am-243	9.67E-19	8.61E-19	7.90E-19	7.51E-19	6.54E-19	6.38E-19
Am-244	1.79E-17	1.66E-17	1.57E-17	1.49E-17	1.38E-17	1.36E-17
Am-244m	1.00E-18	9.33E-19	8.95E-19	8.51E-19	7.92E-19	7.79E-19
Am-245	9.47E-19	8.69E-19	8.19E-19	7.80E-19	7.14E-19	7.00E-19
Am-246	1.69E-17	1.56E-17	1.48E-17	1.40E-17	1.29E-17	1.27E-17
Am-246m	2.24E-17	2.08E-17	1.99E-17	1.89E-17	1.76E-17	1.73E-17
Am-247	3.47E-18	3.18E-18	2.98E-18	2.85E-18	2.60E-18	2.56E-18
<b>Curium</b>						
Cm-238	1.55E-18	1.41E-18	1.31E-18	1.25E-18	1.12E-18	1.10E-18
Cm-239	5.41E-18	4.96E-18	4.62E-18	4.41E-18	4.00E-18	3.92E-18
Cm-240	1.97E-21	1.46E-21	1.19E-21	1.15E-21	6.98E-22	6.63E-22
Cm-241	1.10E-17	1.01E-17	9.42E-18	9.04E-18	8.29E-18	8.13E-18
Cm-242	1.68E-21	1.22E-21	9.95E-22	9.58E-22	5.63E-22	5.32E-22
Cm-243	2.75E-18	2.50E-18	2.34E-18	2.23E-18	2.03E-18	1.99E-18
Cm-244	1.74E-21	1.33E-21	1.12E-21	1.08E-21	7.27E-22	6.96E-22
Cm-245	2.03E-18	1.86E-18	1.72E-18	1.65E-18	1.48E-18	1.45E-18
Cm-246	8.19E-20	7.61E-20	7.21E-20	6.96E-20	6.47E-20	6.36E-20
Cm-247	7.28E-18	6.67E-18	6.22E-18	5.97E-18	5.49E-18	5.38E-18
Cm-248	2.96E-17	2.75E-17	2.61E-17	2.52E-17	2.35E-17	2.31E-17
Cm-249	7.36E-19	6.80E-19	6.44E-19	6.14E-19	5.68E-19	5.58E-19
Cm-250	3.02E-16	2.81E-16	2.67E-16	2.58E-16	2.40E-16	2.36E-16
Cm-251	3.07E-18	2.83E-18	2.66E-18	2.55E-18	2.35E-18	2.31E-18
<b>Berkelium</b>						
Bk-245	4.77E-18	4.36E-18	4.06E-18	3.88E-18	3.51E-18	3.44E-18
Bk-246	1.88E-17	1.74E-17	1.66E-17	1.57E-17	1.45E-17	1.43E-17
Bk-247	3.09E-18	2.81E-18	2.62E-18	2.51E-18	2.27E-18	2.22E-18
Bk-248m	1.31E-18	1.20E-18	1.12E-18	1.08E-18	9.83E-19	9.64E-19
Bk-249	1.08E-20	1.00E-20	9.64E-21	9.13E-21	8.48E-21	8.34E-21
Bk-250	2.03E-17	1.88E-17	1.81E-17	1.71E-17	1.59E-17	1.56E-17
Bk-251	2.04E-18	1.88E-18	1.75E-18	1.67E-18	1.51E-18	1.49E-18
<b>Californium</b>						
Cf-244	1.77E-21	1.22E-21	9.68E-22	9.32E-22	5.02E-22	4.68E-22
Cf-246	2.13E-21	1.68E-21	1.45E-21	1.39E-21	1.03E-21	9.99E-22
Cf-247	1.82E-18	1.67E-18	1.54E-18	1.47E-18	1.32E-18	1.30E-18
Cf-248	8.99E-21	8.00E-21	7.42E-21	7.15E-21	6.35E-21	6.23E-21
Cf-249	7.50E-18	6.87E-18	6.41E-18	6.15E-18	5.65E-18	5.54E-18
Cf-250	2.20E-19	2.05E-19	1.95E-19	1.88E-19	1.75E-19	1.72E-19
Cf-251	2.47E-18	2.26E-18	2.10E-18	2.01E-18	1.82E-18	1.78E-18
Cf-252	1.02E-17	9.53E-18	9.05E-18	8.73E-18	8.14E-18	8.01E-18
Cf-253	5.10E-20	4.58E-20	4.31E-20	4.08E-20	3.68E-20	3.61E-20
Cf-254	3.80E-16	3.54E-16	3.36E-16	3.24E-16	3.03E-16	2.98E-16
Cf-255	2.17E-19	2.02E-19	1.94E-19	1.83E-19	1.71E-19	1.68E-19
<b>Einsteinium</b>						
Es-249	9.02E-18	8.29E-18	7.78E-18	7.43E-18	6.82E-18	6.69E-18



**Table 4-3. Reference person effective dose rate coefficients for soil to 5 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	2.64E-17	2.43E-17	2.30E-17	2.19E-17	2.01E-17	1.98E-17
Es-250m	1.20E-17	1.11E-17	1.06E-17	1.01E-17	9.31E-18	9.15E-18
Es-251	1.82E-18	1.67E-18	1.54E-18	1.48E-18	1.33E-18	1.30E-18
Es-253	7.67E-21	6.90E-21	6.37E-21	6.10E-21	5.50E-21	5.38E-21
Es-254	7.24E-20	6.15E-20	5.52E-20	5.24E-20	4.41E-20	4.29E-20
Es-254m	1.10E-17	1.01E-17	9.54E-18	9.10E-18	8.41E-18	8.26E-18
Es-255	6.12E-20	5.68E-20	5.44E-20	5.18E-20	4.81E-20	4.73E-20
Es-256	8.19E-19	7.62E-19	7.31E-19	6.96E-19	6.49E-19	6.39E-19
<b>Fermium</b>						
Fm-251	3.21E-18	2.96E-18	2.76E-18	2.64E-18	2.40E-18	2.36E-18
Fm-252	7.62E-21	6.66E-21	6.13E-21	5.89E-21	5.16E-21	5.06E-21
Fm-253	1.18E-18	1.08E-18	9.98E-19	9.57E-19	8.60E-19	8.44E-19
Fm-254	1.58E-19	1.47E-19	1.39E-19	1.34E-19	1.25E-19	1.23E-19
Fm-255	4.47E-20	3.71E-20	3.28E-20	3.11E-20	2.51E-20	2.43E-20
Fm-256	2.78E-16	2.59E-16	2.46E-16	2.37E-16	2.21E-16	2.18E-16
Fm-257	3.00E-18	2.76E-18	2.58E-18	2.47E-18	2.25E-18	2.21E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm.**

**Explanation of entries**

For each radionuclide, values for the age-dependent effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>14</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ), that is, the effective dose per unit time-integrated exposure to a radionuclide

$w_T$ : The tissue weighting factor

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-4 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to a source per unit mass basis ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{kg}$ ), multiply table entries by  $1.6 \times 10^3$ .

To convert from SI units ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{cm}^3$ ), multiply table entries by  $1.168 \times 10^{23}$ .

To convert from SI units from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units for a source per unit mass basis ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{g}$ ), multiply table entries by  $1.868 \times 10^{23}$ .

**Radionuclide dose rate coefficients for soil contaminated to a finite depth cannot be scaled to account for a different soil density.**

<sup>14</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	3.88E-23	3.58E-23	3.40E-23	3.22E-23	2.98E-23	2.93E-23
<b>Beryllium</b>						
Be-7	1.79E-18	1.64E-18	1.52E-18	1.46E-18	1.34E-18	1.31E-18
Be-10	4.11E-19	3.79E-19	3.60E-19	3.42E-19	3.16E-19	3.11E-19
<b>Carbon</b>						
C-10	6.51E-17	5.98E-17	5.58E-17	5.34E-17	4.90E-17	4.81E-17
C-11	3.75E-17	3.44E-17	3.19E-17	3.07E-17	2.81E-17	2.76E-17
C-14	3.57E-20	3.29E-20	3.12E-20	2.97E-20	2.74E-20	2.70E-20
<b>Nitrogen</b>						
N-13	3.78E-17	3.47E-17	3.22E-17	3.09E-17	2.83E-17	2.78E-17
N-16	1.57E-16	1.50E-16	1.45E-16	1.42E-16	1.36E-16	1.34E-16
<b>Oxygen</b>						
O-14	1.19E-16	1.11E-16	1.04E-16	1.01E-16	9.40E-17	9.25E-17
O-15	3.86E-17	3.54E-17	3.29E-17	3.16E-17	2.89E-17	2.84E-17
O-19	3.92E-17	3.62E-17	3.43E-17	3.28E-17	3.04E-17	2.99E-17
<b>Fluorine</b>						
F-17	3.86E-17	3.54E-17	3.29E-17	3.16E-17	2.89E-17	2.84E-17
F-18	3.60E-17	3.30E-17	3.07E-17	2.95E-17	2.70E-17	2.65E-17
<b>Neon</b>						
Ne-19	3.94E-17	3.61E-17	3.36E-17	3.22E-17	2.96E-17	2.90E-17
Ne-24	2.15E-17	1.98E-17	1.84E-17	1.76E-17	1.62E-17	1.59E-17
<b>Sodium</b>						
Na-22	7.94E-17	7.32E-17	6.88E-17	6.59E-17	6.08E-17	5.98E-17
Na-24	1.45E-16	1.35E-16	1.29E-16	1.25E-16	1.17E-16	1.15E-16
<b>Magnesium</b>						
Mg-27	3.40E-17	3.14E-17	2.97E-17	2.82E-17	2.60E-17	2.56E-17
Mg-28	4.89E-17	4.52E-17	4.27E-17	4.09E-17	3.78E-17	3.72E-17
<b>Aluminum</b>						
Al-26	9.66E-17	8.94E-17	8.41E-17	8.13E-17	7.55E-17	7.43E-17
Al-28	6.71E-17	6.23E-17	5.90E-17	5.71E-17	5.33E-17	5.25E-17
Al-29	5.22E-17	4.84E-17	4.59E-17	4.40E-17	4.09E-17	4.02E-17
<b>Silicon</b>						
Si-31	1.38E-18	1.28E-18	1.21E-18	1.16E-18	1.07E-18	1.06E-18
Si-32	6.29E-20	5.81E-20	5.51E-20	5.23E-20	4.84E-20	4.76E-20
<b>Phosphorus</b>						
P-30	4.13E-17	3.79E-17	3.53E-17	3.38E-17	3.11E-17	3.05E-17
P-32	1.66E-18	1.54E-18	1.46E-18	1.39E-18	1.30E-18	1.28E-18
P-33	7.48E-20	6.91E-20	6.55E-20	6.22E-20	5.75E-20	5.66E-20
<b>Sulfur</b>						
S-35	3.59E-20	3.31E-20	3.14E-20	2.98E-20	2.76E-20	2.71E-20
S-37	1.02E-16	9.52E-17	9.06E-17	8.85E-17	8.30E-17	8.19E-17
S-38	6.12E-17	5.69E-17	5.39E-17	5.24E-17	4.90E-17	4.82E-17
<b>Chlorine</b>						
Cl-34	4.40E-17	4.05E-17	3.77E-17	3.62E-17	3.33E-17	3.27E-17
Cl-34m	7.53E-17	6.99E-17	6.59E-17	6.38E-17	5.93E-17	5.84E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	4.77E-19	4.41E-19	4.18E-19	3.97E-19	3.68E-19	3.62E-19
Cl-38	5.66E-17	5.26E-17	4.99E-17	4.84E-17	4.52E-17	4.45E-17
Cl-39	5.42E-17	5.01E-17	4.75E-17	4.55E-17	4.22E-17	4.15E-17
Cl-40	1.47E-16	1.37E-16	1.30E-16	1.26E-16	1.18E-16	1.16E-16
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	3.45E-19	3.19E-19	3.02E-19	2.87E-19	2.66E-19	2.61E-19
Ar-41	4.73E-17	4.38E-17	4.15E-17	3.97E-17	3.69E-17	3.62E-17
Ar-42	3.75E-19	3.47E-19	3.29E-19	3.12E-19	2.89E-19	2.84E-19
Ar-43	5.91E-17	5.48E-17	5.19E-17	4.99E-17	4.64E-17	4.57E-17
Ar-44	7.00E-17	6.48E-17	6.14E-17	5.93E-17	5.52E-17	5.43E-17
<b>Potassium</b>						
K-38	1.17E-16	1.08E-16	1.02E-16	9.86E-17	9.17E-17	9.02E-17
K-40	6.81E-18	6.31E-18	5.98E-18	5.74E-18	5.34E-18	5.25E-18
K-42	1.45E-17	1.35E-17	1.28E-17	1.23E-17	1.14E-17	1.12E-17
K-43	3.52E-17	3.23E-17	3.01E-17	2.88E-17	2.64E-17	2.59E-17
K-44	8.93E-17	8.30E-17	7.88E-17	7.60E-17	7.08E-17	6.98E-17
K-45	6.76E-17	6.27E-17	5.94E-17	5.74E-17	5.34E-17	5.26E-17
K-46	1.09E-16	1.02E-16	9.69E-17	9.36E-17	8.74E-17	8.62E-17
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	7.64E-20	7.06E-20	6.69E-20	6.36E-20	5.88E-20	5.78E-20
Ca-47	3.87E-17	3.58E-17	3.39E-17	3.24E-17	3.01E-17	2.96E-17
Ca-49	1.10E-16	1.03E-16	9.78E-17	9.55E-17	8.96E-17	8.85E-17
<b>Scandium</b>						
Sc-42m	1.55E-16	1.43E-16	1.35E-16	1.29E-16	1.20E-16	1.17E-16
Sc-43	3.63E-17	3.33E-17	3.09E-17	2.97E-17	2.72E-17	2.67E-17
Sc-44	7.85E-17	7.23E-17	6.80E-17	6.50E-17	5.99E-17	5.89E-17
Sc-44m	9.55E-18	8.67E-18	8.15E-18	7.76E-18	7.10E-18	6.96E-18
Sc-46	7.29E-17	6.73E-17	6.38E-17	6.06E-17	5.61E-17	5.51E-17
Sc-47	3.62E-18	3.36E-18	3.10E-18	2.97E-18	2.68E-18	2.64E-18
Sc-48	1.22E-16	1.12E-16	1.07E-16	1.01E-16	9.40E-17	9.24E-17
Sc-49	2.11E-18	1.96E-18	1.86E-18	1.77E-18	1.65E-18	1.62E-18
Sc-50	1.21E-16	1.12E-16	1.05E-16	1.01E-16	9.39E-17	9.23E-17
<b>Titanium</b>						
Ti-44	2.91E-18	2.58E-18	2.36E-18	2.23E-18	1.94E-18	1.90E-18
Ti-45	3.21E-17	2.95E-17	2.74E-17	2.63E-17	2.41E-17	2.36E-17
Ti-51	1.53E-17	1.40E-17	1.31E-17	1.25E-17	1.15E-17	1.13E-17
Ti-52	5.39E-18	4.98E-18	4.63E-18	4.43E-18	4.02E-18	3.95E-18
<b>Vanadium</b>						
V-47	3.79E-17	3.48E-17	3.23E-17	3.10E-17	2.84E-17	2.79E-17
V-48	1.05E-16	9.74E-17	9.20E-17	8.78E-17	8.13E-17	7.99E-17
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	5.11E-17	4.74E-17	4.49E-17	4.32E-17	4.02E-17	3.95E-17
V-52	5.50E-17	5.09E-17	4.83E-17	4.64E-17	4.31E-17	4.24E-17
V-53	4.03E-17	3.73E-17	3.53E-17	3.36E-17	3.11E-17	3.06E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	1.44E-17	1.31E-17	1.22E-17	1.17E-17	1.06E-17	1.04E-17
Cr-49	3.84E-17	3.52E-17	3.27E-17	3.13E-17	2.87E-17	2.81E-17
Cr-51	1.12E-18	1.01E-18	9.46E-19	9.04E-19	8.26E-19	8.10E-19
Cr-55	3.12E-18	2.89E-18	2.75E-18	2.63E-18	2.44E-18	2.40E-18
Cr-56	3.20E-18	2.90E-18	2.70E-18	2.57E-18	2.31E-18	2.27E-18
<b>Manganese</b>						
Mn-50m	1.72E-16	1.59E-16	1.50E-16	1.43E-16	1.32E-16	1.30E-16
Mn-51	3.84E-17	3.53E-17	3.28E-17	3.15E-17	2.89E-17	2.83E-17
Mn-52	1.25E-16	1.15E-16	1.09E-16	1.04E-16	9.64E-17	9.48E-17
Mn-52m	8.99E-17	8.30E-17	7.80E-17	7.49E-17	6.93E-17	6.81E-17
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	3.03E-17	2.79E-17	2.63E-17	2.50E-17	2.31E-17	2.27E-17
Mn-56	6.29E-17	5.82E-17	5.51E-17	5.29E-17	4.92E-17	4.84E-17
Mn-57	6.39E-18	5.91E-18	5.57E-18	5.32E-18	4.92E-18	4.84E-18
Mn-58m	9.17E-17	8.48E-17	8.02E-17	7.68E-17	7.12E-17	7.00E-17
<b>Iron</b>						
Fe-52	2.63E-17	2.41E-17	2.24E-17	2.15E-17	1.96E-17	1.93E-17
Fe-53	4.55E-17	4.17E-17	3.88E-17	3.72E-17	3.42E-17	3.35E-17
Fe-53m	1.10E-16	1.02E-16	9.63E-17	9.20E-17	8.53E-17	8.39E-17
Fe-55	4.64E-27	4.29E-27	3.94E-27	3.77E-27	3.39E-27	3.33E-27
Fe-59	4.30E-17	3.98E-17	3.78E-17	3.60E-17	3.34E-17	3.28E-17
Fe-60	5.53E-20	5.11E-20	4.85E-20	4.60E-20	4.26E-20	4.19E-20
Fe-61	5.30E-17	4.91E-17	4.65E-17	4.44E-17	4.12E-17	4.05E-17
Fe-62	2.03E-17	1.87E-17	1.74E-17	1.67E-17	1.53E-17	1.50E-17
<b>Cobalt</b>						
Co-54m	1.49E-16	1.37E-16	1.29E-16	1.24E-16	1.14E-16	1.12E-16
Co-55	7.30E-17	6.72E-17	6.31E-17	6.03E-17	5.56E-17	5.46E-17
Co-56	1.30E-16	1.20E-16	1.14E-16	1.09E-16	1.02E-16	1.00E-16
Co-57	3.45E-18	3.18E-18	2.93E-18	2.80E-18	2.51E-18	2.47E-18
Co-58	3.53E-17	3.25E-17	3.06E-17	2.91E-17	2.68E-17	2.64E-17
Co-58m	2.43E-23	1.64E-23	1.28E-23	1.16E-23	7.81E-24	7.41E-24
Co-60	9.05E-17	8.37E-17	7.94E-17	7.59E-17	7.04E-17	6.93E-17
Co-60m	1.42E-19	1.30E-19	1.22E-19	1.16E-19	1.07E-19	1.05E-19
Co-61	3.50E-18	3.19E-18	2.98E-18	2.83E-18	2.56E-18	2.51E-18
Co-62	6.27E-17	5.82E-17	5.52E-17	5.30E-17	4.93E-17	4.85E-17
Co-62m	9.99E-17	9.25E-17	8.77E-17	8.40E-17	7.81E-17	7.68E-17
<b>Nickel</b>						
Ni-56	6.12E-17	5.64E-17	5.30E-17	5.05E-17	4.65E-17	4.57E-17
Ni-57	6.97E-17	6.45E-17	6.08E-17	5.85E-17	5.42E-17	5.33E-17
Ni-59	5.60E-22	5.14E-22	4.77E-22	4.58E-22	4.19E-22	4.11E-22
Ni-63	4.65E-21	4.30E-21	4.07E-21	3.87E-21	3.58E-21	3.52E-21
Ni-65	2.16E-17	2.00E-17	1.90E-17	1.82E-17	1.69E-17	1.66E-17
Ni-66	7.10E-20	6.56E-20	6.22E-20	5.90E-20	5.46E-20	5.37E-20
<b>Copper</b>						
Cu-57	5.87E-17	5.43E-17	5.09E-17	4.90E-17	4.52E-17	4.45E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	5.68E-17	5.22E-17	4.88E-17	4.68E-17	4.31E-17	4.23E-17
Cu-60	1.42E-16	1.32E-16	1.24E-16	1.19E-16	1.11E-16	1.09E-16
Cu-61	3.02E-17	2.77E-17	2.58E-17	2.48E-17	2.27E-17	2.23E-17
Cu-62	4.01E-17	3.68E-17	3.43E-17	3.29E-17	3.02E-17	2.96E-17
Cu-64	6.84E-18	6.27E-18	5.83E-18	5.60E-18	5.13E-18	5.03E-18
Cu-66	6.52E-18	6.04E-18	5.73E-18	5.46E-18	5.06E-18	4.98E-18
Cu-67	3.76E-18	3.43E-18	3.20E-18	3.04E-18	2.76E-18	2.71E-18
Cu-69	2.15E-17	1.98E-17	1.88E-17	1.79E-17	1.65E-17	1.63E-17
<b>Zinc</b>						
Zn-60	5.80E-17	5.33E-17	4.96E-17	4.75E-17	4.36E-17	4.28E-17
Zn-61	6.14E-17	5.66E-17	5.30E-17	5.09E-17	4.70E-17	4.61E-17
Zn-62	1.56E-17	1.43E-17	1.33E-17	1.27E-17	1.17E-17	1.15E-17
Zn-63	4.20E-17	3.86E-17	3.59E-17	3.45E-17	3.16E-17	3.11E-17
Zn-65	2.09E-17	1.94E-17	1.83E-17	1.75E-17	1.62E-17	1.59E-17
Zn-69	5.91E-19	5.47E-19	5.18E-19	4.93E-19	4.57E-19	4.49E-19
Zn-69m	1.49E-17	1.36E-17	1.26E-17	1.21E-17	1.11E-17	1.09E-17
Zn-71	1.43E-17	1.31E-17	1.23E-17	1.18E-17	1.09E-17	1.07E-17
Zn-71m	5.73E-17	5.26E-17	4.90E-17	4.70E-17	4.31E-17	4.23E-17
Zn-72	4.51E-18	4.18E-18	3.85E-18	3.68E-18	3.32E-18	3.26E-18
<b>Gallium</b>						
Ga-64	1.25E-16	1.16E-16	1.10E-16	1.06E-16	9.80E-17	9.64E-17
Ga-65	4.32E-17	3.97E-17	3.69E-17	3.54E-17	3.24E-17	3.18E-17
Ga-66	9.02E-17	8.39E-17	7.93E-17	7.67E-17	7.14E-17	7.04E-17
Ga-67	4.92E-18	4.47E-18	4.17E-18	3.97E-18	3.60E-18	3.53E-18
Ga-68	3.60E-17	3.31E-17	3.08E-17	2.95E-17	2.71E-17	2.66E-17
Ga-70	1.77E-18	1.64E-18	1.56E-18	1.49E-18	1.38E-18	1.36E-18
Ga-72	9.77E-17	9.06E-17	8.57E-17	8.25E-17	7.66E-17	7.54E-17
Ga-73	1.30E-17	1.18E-17	1.11E-17	1.06E-17	9.68E-18	9.50E-18
Ga-74	1.15E-16	1.06E-16	1.00E-16	9.71E-17	9.04E-17	8.90E-17
<b>Germanium</b>						
Ge-66	2.36E-17	2.16E-17	2.01E-17	1.93E-17	1.77E-17	1.73E-17
Ge-67	5.41E-17	4.98E-17	4.65E-17	4.46E-17	4.10E-17	4.02E-17
Ge-68	5.58E-23	3.58E-23	2.04E-23	1.84E-23	6.64E-24	6.13E-24
Ge-69	3.45E-17	3.18E-17	2.99E-17	2.86E-17	2.64E-17	2.59E-17
Ge-71	5.67E-23	3.63E-23	2.07E-23	1.87E-23	6.74E-24	6.22E-24
Ge-75	2.07E-18	1.89E-18	1.78E-18	1.69E-18	1.56E-18	1.53E-18
Ge-77	3.98E-17	3.66E-17	3.44E-17	3.28E-17	3.02E-17	2.97E-17
Ge-78	1.00E-17	9.08E-18	8.51E-18	8.11E-18	7.41E-18	7.26E-18
<b>Arsenic</b>						
As-68	1.40E-16	1.30E-16	1.22E-16	1.17E-16	1.08E-16	1.06E-16
As-69	4.46E-17	4.10E-17	3.82E-17	3.67E-17	3.37E-17	3.31E-17
As-70	1.55E-16	1.43E-16	1.35E-16	1.30E-16	1.20E-16	1.18E-16
As-71	2.02E-17	1.86E-17	1.73E-17	1.66E-17	1.52E-17	1.49E-17
As-72	6.72E-17	6.19E-17	5.80E-17	5.55E-17	5.11E-17	5.02E-17
As-73	8.38E-20	6.96E-20	6.14E-20	5.61E-20	4.75E-20	4.63E-20
As-74	2.79E-17	2.56E-17	2.38E-17	2.28E-17	2.10E-17	2.06E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	1.81E-17	1.67E-17	1.56E-17	1.50E-17	1.38E-17	1.36E-17
As-77	6.52E-19	5.99E-19	5.64E-19	5.37E-19	4.94E-19	4.85E-19
As-78	5.09E-17	4.70E-17	4.43E-17	4.25E-17	3.94E-17	3.87E-17
As-79	3.50E-18	3.24E-18	3.06E-18	2.92E-18	2.71E-18	2.66E-18
<b>Selenium</b>						
Se-70	2.54E-17	2.33E-17	2.16E-17	2.07E-17	1.90E-17	1.86E-17
Se-71	6.17E-17	5.68E-17	5.32E-17	5.09E-17	4.68E-17	4.60E-17
Se-72	3.15E-19	2.51E-19	2.15E-19	1.94E-19	1.60E-19	1.56E-19
Se-73	3.91E-17	3.57E-17	3.32E-17	3.18E-17	2.91E-17	2.86E-17
Se-73m	9.71E-18	8.91E-18	8.29E-18	7.95E-18	7.29E-18	7.15E-18
Se-75	1.27E-17	1.16E-17	1.08E-17	1.03E-17	9.38E-18	9.20E-18
Se-77m	2.70E-18	2.50E-18	2.31E-18	2.21E-18	1.99E-18	1.96E-18
Se-79	3.97E-20	3.67E-20	3.47E-20	3.30E-20	3.05E-20	3.00E-20
Se-79m	2.31E-19	2.08E-19	1.92E-19	1.82E-19	1.62E-19	1.59E-19
Se-81	1.69E-18	1.56E-18	1.48E-18	1.41E-18	1.31E-18	1.29E-18
Se-81m	3.65E-19	3.30E-19	3.05E-19	2.90E-19	2.59E-19	2.54E-19
Se-83	9.49E-17	8.76E-17	8.26E-17	7.92E-17	7.33E-17	7.21E-17
Se-83m	3.92E-17	3.62E-17	3.43E-17	3.28E-17	3.04E-17	2.99E-17
Se-84	1.62E-17	1.48E-17	1.38E-17	1.32E-17	1.21E-17	1.19E-17
<b>Bromine</b>						
Br-72	1.18E-16	1.09E-16	1.03E-16	9.82E-17	9.08E-17	8.92E-17
Br-73	5.52E-17	5.07E-17	4.73E-17	4.53E-17	4.16E-17	4.08E-17
Br-74	1.63E-16	1.52E-16	1.44E-16	1.39E-16	1.29E-16	1.28E-16
Br-74m	1.51E-16	1.40E-16	1.32E-16	1.27E-16	1.18E-16	1.16E-16
Br-75	4.40E-17	4.03E-17	3.75E-17	3.59E-17	3.29E-17	3.23E-17
Br-76	1.01E-16	9.35E-17	8.80E-17	8.49E-17	7.88E-17	7.75E-17
Br-76m	6.02E-19	5.15E-19	4.62E-19	4.30E-19	3.76E-19	3.68E-19
Br-77	1.12E-17	1.02E-17	9.55E-18	9.13E-18	8.36E-18	8.20E-18
Br-77m	3.93E-19	3.57E-19	3.29E-19	3.13E-19	2.80E-19	2.75E-19
Br-78	4.01E-17	3.68E-17	3.43E-17	3.29E-17	3.02E-17	2.96E-17
Br-80	4.55E-18	4.20E-18	3.94E-18	3.77E-18	3.48E-18	3.42E-18
Br-80m	1.11E-19	8.39E-20	6.81E-20	6.05E-20	4.77E-20	4.61E-20
Br-82	9.57E-17	8.82E-17	8.30E-17	7.92E-17	7.31E-17	7.18E-17
Br-82m	1.94E-19	1.79E-19	1.69E-19	1.61E-19	1.49E-19	1.47E-19
Br-83	8.51E-19	7.85E-19	7.40E-19	7.06E-19	6.52E-19	6.41E-19
Br-84	6.56E-17	6.11E-17	5.79E-17	5.60E-17	5.22E-17	5.14E-17
Br-84m	1.02E-16	9.42E-17	8.90E-17	8.52E-17	7.89E-17	7.75E-17
Br-85	5.27E-18	4.88E-18	4.62E-18	4.41E-18	4.09E-18	4.02E-18
<b>Krypton</b>						
Kr-74	3.85E-17	3.52E-17	3.28E-17	3.14E-17	2.87E-17	2.82E-17
Kr-75	5.01E-17	4.61E-17	4.29E-17	4.12E-17	3.78E-17	3.71E-17
Kr-76	1.45E-17	1.32E-17	1.23E-17	1.18E-17	1.08E-17	1.06E-17
Kr-77	3.79E-17	3.49E-17	3.24E-17	3.11E-17	2.84E-17	2.79E-17
Kr-79	8.89E-18	8.14E-18	7.60E-18	7.27E-18	6.66E-18	6.54E-18
Kr-81	2.97E-20	2.67E-20	2.48E-20	2.36E-20	2.12E-20	2.08E-20
Kr-81m	4.21E-18	3.84E-18	3.59E-18	3.41E-18	3.10E-18	3.05E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	5.86E-22	4.43E-22	3.18E-22	2.96E-22	1.20E-22	1.10E-22
Kr-85	5.02E-19	4.63E-19	4.38E-19	4.17E-19	3.85E-19	3.79E-19
Kr-85m	5.38E-18	4.97E-18	4.60E-18	4.41E-18	3.99E-18	3.92E-18
Kr-87	3.20E-17	2.97E-17	2.80E-17	2.71E-17	2.52E-17	2.48E-17
Kr-88	6.96E-17	6.47E-17	6.13E-17	5.94E-17	5.55E-17	5.46E-17
Kr-89	7.25E-17	6.72E-17	6.37E-17	6.14E-17	5.71E-17	5.62E-17
<b>Rubidium</b>						
Rb-77	6.03E-17	5.55E-17	5.18E-17	4.97E-17	4.56E-17	4.48E-17
Rb-78	1.46E-16	1.36E-16	1.28E-16	1.24E-16	1.16E-16	1.14E-16
Rb-78m	1.20E-16	1.11E-16	1.04E-16	1.00E-16	9.25E-17	9.09E-17
Rb-79	5.35E-17	4.91E-17	4.58E-17	4.39E-17	4.02E-17	3.95E-17
Rb-80	5.02E-17	4.61E-17	4.30E-17	4.13E-17	3.79E-17	3.72E-17
Rb-81	1.83E-17	1.68E-17	1.56E-17	1.50E-17	1.38E-17	1.35E-17
Rb-81m	8.21E-19	7.52E-19	7.02E-19	6.71E-19	6.14E-19	6.03E-19
Rb-82	4.43E-17	4.07E-17	3.80E-17	3.64E-17	3.34E-17	3.28E-17
Rb-82m	1.06E-16	9.73E-17	9.15E-17	8.74E-17	8.06E-17	7.92E-17
Rb-83	1.75E-17	1.60E-17	1.49E-17	1.43E-17	1.31E-17	1.28E-17
Rb-84	3.30E-17	3.04E-17	2.86E-17	2.72E-17	2.51E-17	2.47E-17
Rb-84m	1.33E-17	1.21E-17	1.13E-17	1.08E-17	9.83E-18	9.64E-18
Rb-86	4.98E-18	4.61E-18	4.38E-18	4.16E-18	3.86E-18	3.80E-18
Rb-86m	1.97E-17	1.81E-17	1.69E-17	1.62E-17	1.48E-17	1.45E-17
Rb-87	1.36E-19	1.26E-19	1.19E-19	1.13E-19	1.05E-19	1.03E-19
Rb-88	3.04E-17	2.83E-17	2.68E-17	2.59E-17	2.41E-17	2.38E-17
Rb-89	8.28E-17	7.68E-17	7.28E-17	6.99E-17	6.50E-17	6.40E-17
Rb-90	7.67E-17	7.18E-17	6.84E-17	6.64E-17	6.22E-17	6.13E-17
Rb-90m	1.18E-16	1.10E-16	1.04E-16	1.01E-16	9.38E-17	9.24E-17
<b>Strontium</b>						
Sr-79	4.80E-17	4.40E-17	4.10E-17	3.93E-17	3.61E-17	3.54E-17
Sr-80	1.55E-17	1.42E-17	1.32E-17	1.27E-17	1.16E-17	1.14E-17
Sr-81	5.19E-17	4.77E-17	4.44E-17	4.26E-17	3.91E-17	3.83E-17
Sr-82	2.46E-21	1.90E-21	1.40E-21	1.33E-21	4.75E-22	4.31E-22
Sr-83	2.95E-17	2.71E-17	2.54E-17	2.43E-17	2.24E-17	2.20E-17
Sr-85	1.77E-17	1.63E-17	1.51E-17	1.45E-17	1.33E-17	1.30E-17
Sr-85m	7.27E-18	6.60E-18	6.19E-18	5.88E-18	5.36E-18	5.26E-18
Sr-87m	1.13E-17	1.03E-17	9.61E-18	9.22E-18	8.42E-18	8.26E-18
Sr-89	1.34E-18	1.24E-18	1.18E-18	1.12E-18	1.04E-18	1.03E-18
Sr-90	2.99E-19	2.76E-19	2.62E-19	2.49E-19	2.30E-19	2.26E-19
Sr-91	2.72E-17	2.51E-17	2.37E-17	2.26E-17	2.09E-17	2.05E-17
Sr-92	4.85E-17	4.49E-17	4.25E-17	4.08E-17	3.79E-17	3.73E-17
Sr-93	8.32E-17	7.68E-17	7.24E-17	6.94E-17	6.43E-17	6.32E-17
Sr-94	5.35E-17	4.96E-17	4.70E-17	4.51E-17	4.19E-17	4.12E-17
<b>Yttrium</b>						
Y-81	4.77E-17	4.38E-17	4.08E-17	3.92E-17	3.59E-17	3.53E-17
Y-83	5.20E-17	4.78E-17	4.47E-17	4.28E-17	3.94E-17	3.87E-17
Y-83m	3.21E-17	2.94E-17	2.74E-17	2.63E-17	2.41E-17	2.36E-17
Y-84m	1.47E-16	1.36E-16	1.28E-16	1.22E-16	1.13E-16	1.11E-16



**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	4.00E-17	3.67E-17	3.41E-17	3.27E-17	3.00E-17	2.95E-17
Y-85m	4.88E-17	4.50E-17	4.22E-17	4.06E-17	3.75E-17	3.68E-17
Y-86	1.29E-16	1.19E-16	1.12E-16	1.08E-16	9.97E-17	9.80E-17
Y-86m	7.39E-18	6.72E-18	6.31E-18	6.00E-18	5.47E-18	5.37E-18
Y-87	1.57E-17	1.44E-17	1.34E-17	1.28E-17	1.18E-17	1.15E-17
Y-87m	1.09E-17	9.90E-18	9.21E-18	8.83E-18	8.07E-18	7.91E-18
Y-88	9.62E-17	8.91E-17	8.44E-17	8.13E-17	7.57E-17	7.45E-17
Y-89m	3.27E-17	3.02E-17	2.85E-17	2.71E-17	2.50E-17	2.46E-17
Y-90	2.51E-18	2.33E-18	2.21E-18	2.11E-18	1.96E-18	1.93E-18
Y-90m	2.22E-17	2.03E-17	1.89E-17	1.81E-17	1.66E-17	1.62E-17
Y-91	1.51E-18	1.40E-18	1.33E-18	1.26E-18	1.17E-18	1.15E-18
Y-91m	1.91E-17	1.75E-17	1.63E-17	1.56E-17	1.43E-17	1.41E-17
Y-92	1.37E-17	1.27E-17	1.20E-17	1.15E-17	1.06E-17	1.04E-17
Y-93	6.84E-18	6.33E-18	6.00E-18	5.75E-18	5.34E-18	5.25E-18
Y-94	3.41E-17	3.16E-17	2.99E-17	2.85E-17	2.65E-17	2.60E-17
Y-95	4.35E-17	4.05E-17	3.85E-17	3.73E-17	3.48E-17	3.43E-17
<b>Zirconium</b>						
Zr-85	5.70E-17	5.24E-17	4.88E-17	4.69E-17	4.31E-17	4.23E-17
Zr-86	9.37E-18	8.50E-18	7.97E-18	7.59E-18	6.93E-18	6.79E-18
Zr-87	3.55E-17	3.27E-17	3.04E-17	2.92E-17	2.68E-17	2.63E-17
Zr-88	1.36E-17	1.24E-17	1.15E-17	1.11E-17	1.01E-17	9.92E-18
Zr-89	4.18E-17	3.86E-17	3.63E-17	3.46E-17	3.19E-17	3.13E-17
Zr-89m	2.29E-17	2.11E-17	1.97E-17	1.89E-17	1.74E-17	1.70E-17
Zr-93	5.51E-21	5.09E-21	4.82E-21	4.58E-21	4.24E-21	4.16E-21
Zr-95	2.67E-17	2.46E-17	2.31E-17	2.20E-17	2.03E-17	1.99E-17
Zr-97	3.36E-17	3.09E-17	2.91E-17	2.77E-17	2.56E-17	2.51E-17
<b>Niobium</b>						
Nb-87	4.84E-17	4.44E-17	4.14E-17	3.97E-17	3.64E-17	3.57E-17
Nb-88	1.56E-16	1.44E-16	1.35E-16	1.29E-16	1.19E-16	1.17E-16
Nb-88m	1.53E-16	1.41E-16	1.32E-16	1.27E-16	1.17E-16	1.15E-16
Nb-89	5.19E-17	4.79E-17	4.50E-17	4.33E-17	4.01E-17	3.94E-17
Nb-89m	4.91E-17	4.51E-17	4.19E-17	4.02E-17	3.69E-17	3.62E-17
Nb-90	1.50E-16	1.39E-16	1.31E-16	1.27E-16	1.18E-16	1.16E-16
Nb-91	6.38E-20	5.75E-20	5.28E-20	5.07E-20	4.49E-20	4.39E-20
Nb-91m	9.02E-19	8.33E-19	7.89E-19	7.52E-19	6.96E-19	6.84E-19
Nb-92	5.42E-17	4.99E-17	4.69E-17	4.47E-17	4.12E-17	4.05E-17
Nb-92m	3.47E-17	3.21E-17	3.04E-17	2.88E-17	2.66E-17	2.62E-17
Nb-93m	1.29E-21	9.33E-22	7.42E-22	7.30E-22	3.32E-22	3.04E-22
Nb-94	5.68E-17	5.23E-17	4.93E-17	4.69E-17	4.32E-17	4.24E-17
Nb-94m	1.69E-19	1.55E-19	1.45E-19	1.38E-19	1.26E-19	1.24E-19
Nb-95	2.78E-17	2.56E-17	2.41E-17	2.29E-17	2.11E-17	2.07E-17
Nb-95m	2.17E-18	1.97E-18	1.85E-18	1.75E-18	1.60E-18	1.57E-18
Nb-96	8.95E-17	8.25E-17	7.76E-17	7.40E-17	6.83E-17	6.71E-17
Nb-97	2.51E-17	2.31E-17	2.16E-17	2.06E-17	1.90E-17	1.87E-17
Nb-98m	1.04E-16	9.56E-17	9.02E-17	8.62E-17	7.98E-17	7.84E-17
Nb-99	9.31E-18	8.62E-18	8.05E-18	7.70E-18	7.04E-18	6.92E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	3.10E-17	2.88E-17	2.73E-17	2.64E-17	2.46E-17	2.42E-17
<b>Molybdenum</b>						
Mo-89	5.08E-17	4.67E-17	4.36E-17	4.19E-17	3.85E-17	3.78E-17
Mo-90	2.87E-17	2.63E-17	2.46E-17	2.35E-17	2.16E-17	2.11E-17
Mo-91	3.97E-17	3.65E-17	3.40E-17	3.26E-17	3.00E-17	2.94E-17
Mo-91m	5.15E-17	4.75E-17	4.46E-17	4.28E-17	3.95E-17	3.88E-17
Mo-93	7.24E-21	5.22E-21	4.15E-21	4.09E-21	1.86E-21	1.70E-21
Mo-93m	8.32E-17	7.68E-17	7.25E-17	6.95E-17	6.44E-17	6.33E-17
Mo-99	6.05E-18	5.57E-18	5.24E-18	4.99E-18	4.59E-18	4.51E-18
Mo-101	5.39E-17	4.98E-17	4.70E-17	4.51E-17	4.18E-17	4.11E-17
Mo-102	1.27E-18	1.17E-18	1.10E-18	1.04E-18	9.59E-19	9.42E-19
<b>Technetium</b>						
Tc-91	9.42E-17	8.72E-17	8.21E-17	7.92E-17	7.34E-17	7.22E-17
Tc-91m	5.78E-17	5.32E-17	4.96E-17	4.76E-17	4.38E-17	4.30E-17
Tc-92	1.43E-16	1.32E-16	1.24E-16	1.19E-16	1.10E-16	1.08E-16
Tc-93	5.61E-17	5.19E-17	4.92E-17	4.72E-17	4.39E-17	4.32E-17
Tc-93m	3.32E-17	3.08E-17	2.91E-17	2.82E-17	2.62E-17	2.58E-17
Tc-94	9.62E-17	8.86E-17	8.35E-17	7.94E-17	7.32E-17	7.19E-17
Tc-94m	7.23E-17	6.67E-17	6.27E-17	6.00E-17	5.54E-17	5.44E-17
Tc-95	2.85E-17	2.62E-17	2.47E-17	2.35E-17	2.16E-17	2.13E-17
Tc-95m	2.42E-17	2.22E-17	2.08E-17	1.98E-17	1.82E-17	1.79E-17
Tc-96	9.04E-17	8.33E-17	7.86E-17	7.47E-17	6.89E-17	6.77E-17
Tc-96m	1.51E-18	1.39E-18	1.31E-18	1.25E-18	1.15E-18	1.13E-18
Tc-97	9.17E-21	6.43E-21	5.13E-21	5.05E-21	2.45E-21	2.26E-21
Tc-97m	1.66E-20	1.30E-20	1.13E-20	1.09E-20	7.89E-21	7.60E-21
Tc-98	5.15E-17	4.73E-17	4.44E-17	4.23E-17	3.89E-17	3.82E-17
Tc-99	1.15E-19	1.06E-19	1.01E-19	9.55E-20	8.83E-20	8.68E-20
Tc-99m	3.74E-18	3.48E-18	3.19E-18	3.06E-18	2.75E-18	2.71E-18
Tc-101	1.28E-17	1.17E-17	1.09E-17	1.04E-17	9.53E-18	9.34E-18
Tc-102	9.70E-18	8.99E-18	8.52E-18	8.16E-18	7.58E-18	7.46E-18
Tc-102m	9.05E-17	8.37E-17	7.89E-17	7.60E-17	7.05E-17	6.93E-17
Tc-104	8.48E-17	7.85E-17	7.42E-17	7.15E-17	6.64E-17	6.53E-17
Tc-105	3.16E-17	2.91E-17	2.74E-17	2.63E-17	2.42E-17	2.38E-17
<b>Ruthenium</b>						
Ru-92	7.42E-17	6.81E-17	6.39E-17	6.12E-17	5.64E-17	5.54E-17
Ru-94	1.82E-17	1.66E-17	1.56E-17	1.49E-17	1.37E-17	1.34E-17
Ru-95	4.43E-17	4.08E-17	3.84E-17	3.67E-17	3.39E-17	3.33E-17
Ru-97	7.72E-18	7.00E-18	6.56E-18	6.24E-18	5.69E-18	5.58E-18
Ru-103	1.79E-17	1.64E-17	1.53E-17	1.46E-17	1.34E-17	1.31E-17
Ru-105	2.77E-17	2.54E-17	2.38E-17	2.27E-17	2.09E-17	2.05E-17
Ru-106	9.82E-22	9.07E-22	8.60E-22	8.17E-22	7.55E-22	7.43E-22
Ru-107	1.54E-17	1.42E-17	1.34E-17	1.28E-17	1.18E-17	1.16E-17
Ru-108	2.87E-18	2.66E-18	2.48E-18	2.36E-18	2.15E-18	2.12E-18
<b>Rhodium</b>						
Rh-94	1.47E-16	1.36E-16	1.28E-16	1.23E-16	1.14E-16	1.12E-16
Rh-95	9.42E-17	8.70E-17	8.20E-17	7.86E-17	7.28E-17	7.15E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	3.19E-17	2.96E-17	2.77E-17	2.68E-17	2.48E-17	2.44E-17
Rh-96	1.44E-16	1.32E-16	1.24E-16	1.19E-16	1.10E-16	1.08E-16
Rh-96m	4.76E-17	4.39E-17	4.13E-17	3.97E-17	3.67E-17	3.61E-17
Rh-97	5.30E-17	4.87E-17	4.56E-17	4.37E-17	4.02E-17	3.95E-17
Rh-97m	7.79E-17	7.22E-17	6.82E-17	6.59E-17	6.12E-17	6.03E-17
Rh-98	6.94E-17	6.39E-17	5.97E-17	5.72E-17	5.27E-17	5.17E-17
Rh-99	1.92E-17	1.76E-17	1.64E-17	1.57E-17	1.44E-17	1.41E-17
Rh-99m	2.29E-17	2.10E-17	1.97E-17	1.88E-17	1.73E-17	1.70E-17
Rh-100	9.74E-17	9.02E-17	8.51E-17	8.22E-17	7.63E-17	7.51E-17
Rh-100m	1.50E-18	1.37E-18	1.28E-18	1.23E-18	1.12E-18	1.10E-18
Rh-101	8.74E-18	7.98E-18	7.43E-18	7.08E-18	6.42E-18	6.30E-18
Rh-101m	9.62E-18	8.74E-18	8.16E-18	7.79E-18	7.12E-18	6.98E-18
Rh-102	1.83E-17	1.68E-17	1.56E-17	1.50E-17	1.37E-17	1.35E-17
Rh-102m	7.74E-17	7.12E-17	6.68E-17	6.38E-17	5.87E-17	5.76E-17
Rh-103m	2.27E-21	1.54E-21	1.23E-21	1.17E-21	7.04E-22	6.62E-22
Rh-104	3.12E-18	2.89E-18	2.74E-18	2.61E-18	2.43E-18	2.39E-18
Rh-104m	5.13E-19	4.30E-19	3.82E-19	3.53E-19	3.01E-19	2.94E-19
Rh-105	2.92E-18	2.66E-18	2.49E-18	2.37E-18	2.17E-18	2.13E-18
Rh-106	1.18E-17	1.09E-17	1.02E-17	9.81E-18	9.06E-18	8.90E-18
Rh-106m	1.04E-16	9.55E-17	8.98E-17	8.58E-17	7.92E-17	7.78E-17
Rh-107	1.19E-17	1.08E-17	1.01E-17	9.68E-18	8.86E-18	8.69E-18
Rh-108	1.76E-17	1.62E-17	1.52E-17	1.46E-17	1.34E-17	1.32E-17
Rh-109	1.28E-17	1.17E-17	1.09E-17	1.04E-17	9.57E-18	9.39E-18
<b>Palladium</b>						
Pd-96	5.15E-17	4.75E-17	4.45E-17	4.25E-17	3.91E-17	3.84E-17
Pd-97	8.69E-17	8.02E-17	7.54E-17	7.26E-17	6.71E-17	6.60E-17
Pd-98	1.36E-17	1.25E-17	1.17E-17	1.11E-17	1.02E-17	1.00E-17
Pd-99	4.62E-17	4.26E-17	3.99E-17	3.83E-17	3.53E-17	3.46E-17
Pd-100	2.24E-18	2.01E-18	1.84E-18	1.74E-18	1.53E-18	1.50E-18
Pd-101	1.17E-17	1.07E-17	1.00E-17	9.61E-18	8.83E-18	8.66E-18
Pd-103	2.30E-20	1.63E-20	1.34E-20	1.29E-20	8.43E-21	8.02E-21
Pd-107	7.76E-22	7.16E-22	6.79E-22	6.45E-22	5.96E-22	5.86E-22
Pd-109	8.08E-19	7.41E-19	7.00E-19	6.65E-19	6.12E-19	6.01E-19
Pd-109m	3.45E-18	3.15E-18	2.94E-18	2.80E-18	2.54E-18	2.50E-18
Pd-111	3.88E-18	3.59E-18	3.39E-18	3.24E-18	3.00E-18	2.96E-18
Pd-112	8.09E-20	7.36E-20	6.93E-20	6.59E-20	6.00E-20	5.89E-20
Pd-114	2.01E-18	1.85E-18	1.74E-18	1.66E-18	1.53E-18	1.50E-18
<b>Silver</b>						
Ag-99	8.66E-17	7.98E-17	7.50E-17	7.19E-17	6.64E-17	6.52E-17
Ag-100m	1.08E-16	1.00E-16	9.39E-17	9.02E-17	8.33E-17	8.19E-17
Ag-101	5.84E-17	5.37E-17	5.03E-17	4.82E-17	4.43E-17	4.35E-17
Ag-102	1.25E-16	1.15E-16	1.08E-16	1.04E-16	9.60E-17	9.43E-17
Ag-102m	7.15E-17	6.63E-17	6.25E-17	6.05E-17	5.62E-17	5.53E-17
Ag-103	2.98E-17	2.74E-17	2.56E-17	2.45E-17	2.26E-17	2.22E-17
Ag-104	9.75E-17	8.99E-17	8.46E-17	8.08E-17	7.46E-17	7.33E-17
Ag-104m	6.64E-17	6.12E-17	5.73E-17	5.52E-17	5.10E-17	5.01E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	1.75E-17	1.60E-17	1.50E-17	1.43E-17	1.31E-17	1.28E-17
Ag-105m	3.50E-20	3.19E-20	2.99E-20	2.85E-20	2.61E-20	2.56E-20
Ag-106	2.62E-17	2.41E-17	2.24E-17	2.15E-17	1.97E-17	1.93E-17
Ag-106m	1.01E-16	9.29E-17	8.73E-17	8.35E-17	7.70E-17	7.57E-17
Ag-108	2.07E-18	1.91E-18	1.81E-18	1.72E-18	1.59E-18	1.57E-18
Ag-108m	5.80E-17	5.33E-17	4.98E-17	4.76E-17	4.37E-17	4.29E-17
Ag-109m	9.02E-20	7.79E-20	7.05E-20	6.67E-20	5.73E-20	5.59E-20
Ag-110	4.54E-18	4.20E-18	3.98E-18	3.80E-18	3.53E-18	3.47E-18
Ag-110m	1.00E-16	9.23E-17	8.69E-17	8.29E-17	7.66E-17	7.53E-17
Ag-111	1.60E-18	1.47E-18	1.38E-18	1.32E-18	1.21E-18	1.19E-18
Ag-111m	1.25E-19	1.12E-19	1.04E-19	9.90E-20	8.93E-20	8.75E-20
Ag-112	2.91E-17	2.69E-17	2.53E-17	2.43E-17	2.26E-17	2.22E-17
Ag-113	4.45E-18	4.09E-18	3.85E-18	3.68E-18	3.39E-18	3.33E-18
Ag-113m	7.94E-18	7.26E-18	6.78E-18	6.48E-18	5.94E-18	5.82E-18
Ag-114	1.70E-17	1.57E-17	1.49E-17	1.43E-17	1.32E-17	1.30E-17
Ag-115	2.02E-17	1.87E-17	1.77E-17	1.70E-17	1.58E-17	1.55E-17
Ag-116	8.20E-17	7.61E-17	7.19E-17	6.95E-17	6.46E-17	6.36E-17
Ag-117	4.96E-17	4.61E-17	4.36E-17	4.22E-17	3.93E-17	3.87E-17
<b>Cadmium</b>						
Cd-101	9.14E-17	8.44E-17	7.94E-17	7.64E-17	7.07E-17	6.95E-17
Cd-102	2.96E-17	2.72E-17	2.54E-17	2.43E-17	2.24E-17	2.20E-17
Cd-103	7.48E-17	6.93E-17	6.54E-17	6.31E-17	5.86E-17	5.77E-17
Cd-104	7.79E-18	7.14E-18	6.66E-18	6.35E-18	5.81E-18	5.70E-18
Cd-105	4.66E-17	4.31E-17	4.06E-17	3.91E-17	3.62E-17	3.56E-17
Cd-107	3.19E-19	2.80E-19	2.56E-19	2.44E-19	2.15E-19	2.10E-19
Cd-109	1.18E-19	9.64E-20	8.50E-20	8.03E-20	6.58E-20	6.40E-20
Cd-111m	9.25E-18	8.40E-18	7.86E-18	7.49E-18	6.82E-18	6.69E-18
Cd-113	1.03E-19	9.48E-20	8.99E-20	8.54E-20	7.90E-20	7.77E-20
Cd-113m	2.79E-19	2.58E-19	2.45E-19	2.32E-19	2.15E-19	2.11E-19
Cd-115	7.49E-18	6.88E-18	6.40E-18	6.13E-18	5.63E-18	5.52E-18
Cd-115m	2.59E-18	2.39E-18	2.27E-18	2.16E-18	2.01E-18	1.97E-18
Cd-117	3.96E-17	3.65E-17	3.45E-17	3.31E-17	3.06E-17	3.01E-17
Cd-117m	7.34E-17	6.80E-17	6.44E-17	6.20E-17	5.77E-17	5.67E-17
Cd-118	2.30E-19	2.12E-19	2.01E-19	1.91E-19	1.77E-19	1.74E-19
Cd-119	6.04E-17	5.59E-17	5.29E-17	5.10E-17	4.74E-17	4.66E-17
Cd-119m	8.39E-17	7.78E-17	7.36E-17	7.08E-17	6.58E-17	6.48E-17
<b>Indium</b>						
In-103	1.03E-16	9.51E-17	8.94E-17	8.59E-17	7.94E-17	7.81E-17
In-105	7.17E-17	6.61E-17	6.20E-17	5.95E-17	5.49E-17	5.39E-17
In-106	1.32E-16	1.21E-16	1.14E-16	1.09E-16	1.00E-16	9.83E-17
In-106m	1.06E-16	9.80E-17	9.20E-17	8.87E-17	8.21E-17	8.07E-17
In-107	5.49E-17	5.06E-17	4.76E-17	4.58E-17	4.24E-17	4.17E-17
In-108	1.41E-16	1.30E-16	1.23E-16	1.17E-16	1.08E-16	1.06E-16
In-108m	9.91E-17	9.19E-17	8.67E-17	8.38E-17	7.78E-17	7.66E-17
In-109	2.22E-17	2.04E-17	1.91E-17	1.83E-17	1.68E-17	1.65E-17
In-109m	2.20E-17	2.03E-17	1.89E-17	1.81E-17	1.66E-17	1.63E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	1.12E-16	1.03E-16	9.69E-17	9.22E-17	8.51E-17	8.36E-17
In-110m	5.82E-17	5.36E-17	5.01E-17	4.81E-17	4.43E-17	4.35E-17
In-111	1.29E-17	1.17E-17	1.10E-17	1.04E-17	9.49E-18	9.30E-18
In-111m	1.69E-17	1.55E-17	1.44E-17	1.38E-17	1.27E-17	1.24E-17
In-112	9.94E-18	9.12E-18	8.49E-18	8.14E-18	7.47E-18	7.33E-18
In-112m	6.67E-19	6.11E-19	5.60E-19	5.35E-19	4.79E-19	4.71E-19
In-113m	9.06E-18	8.27E-18	7.69E-18	7.37E-18	6.73E-18	6.60E-18
In-114	2.02E-18	1.88E-18	1.78E-18	1.70E-18	1.58E-18	1.55E-18
In-114m	2.50E-18	2.28E-18	2.13E-18	2.03E-18	1.86E-18	1.82E-18
In-115	2.12E-19	1.96E-19	1.86E-19	1.77E-19	1.64E-19	1.61E-19
In-115m	5.48E-18	4.98E-18	4.64E-18	4.44E-18	4.05E-18	3.97E-18
In-116m	8.93E-17	8.27E-17	7.83E-17	7.50E-17	6.96E-17	6.85E-17
In-117	2.47E-17	2.27E-17	2.11E-17	2.02E-17	1.85E-17	1.82E-17
In-117m	3.74E-18	3.43E-18	3.20E-18	3.06E-18	2.80E-18	2.75E-18
In-118	9.30E-18	8.63E-18	8.20E-18	7.85E-18	7.31E-18	7.19E-18
In-118m	1.02E-16	9.42E-17	8.91E-17	8.50E-17	7.87E-17	7.74E-17
In-119	2.92E-17	2.69E-17	2.53E-17	2.41E-17	2.22E-17	2.18E-17
In-119m	5.13E-18	4.74E-18	4.50E-18	4.29E-18	3.98E-18	3.92E-18
In-121	3.62E-17	3.34E-17	3.16E-17	3.00E-17	2.77E-17	2.73E-17
In-121m	6.51E-18	6.02E-18	5.71E-18	5.45E-18	5.06E-18	4.98E-18
<b>Tin</b>						
Sn-106	4.28E-17	3.93E-17	3.68E-17	3.52E-17	3.23E-17	3.17E-17
Sn-108	2.34E-17	2.14E-17	2.00E-17	1.91E-17	1.75E-17	1.71E-17
Sn-109	7.85E-17	7.26E-17	6.87E-17	6.60E-17	6.14E-17	6.04E-17
Sn-110	9.53E-18	8.63E-18	8.08E-18	7.70E-18	7.03E-18	6.89E-18
Sn-111	1.76E-17	1.62E-17	1.52E-17	1.46E-17	1.34E-17	1.32E-17
Sn-113	2.29E-19	1.97E-19	1.80E-19	1.71E-19	1.51E-19	1.47E-19
Sn-113m	4.37E-20	3.16E-20	2.56E-20	2.35E-20	1.74E-20	1.67E-20
Sn-117m	4.40E-18	4.08E-18	3.76E-18	3.59E-18	3.24E-18	3.18E-18
Sn-119m	3.70E-20	2.52E-20	1.96E-20	1.78E-20	1.21E-20	1.15E-20
Sn-121	1.42E-19	1.32E-19	1.25E-19	1.19E-19	1.10E-19	1.08E-19
Sn-121m	5.24E-20	4.44E-20	4.00E-20	3.75E-20	3.29E-20	3.22E-20
Sn-123	1.41E-18	1.30E-18	1.24E-18	1.18E-18	1.09E-18	1.07E-18
Sn-123m	5.26E-18	4.88E-18	4.53E-18	4.33E-18	3.93E-18	3.86E-18
Sn-125	1.42E-17	1.31E-17	1.24E-17	1.19E-17	1.10E-17	1.08E-17
Sn-125m	1.42E-17	1.30E-17	1.22E-17	1.16E-17	1.07E-17	1.05E-17
Sn-126	1.19E-18	1.07E-18	9.80E-19	9.27E-19	8.19E-19	8.01E-19
Sn-127	6.97E-17	6.44E-17	6.09E-17	5.82E-17	5.39E-17	5.30E-17
Sn-127m	2.36E-17	2.17E-17	2.03E-17	1.95E-17	1.79E-17	1.76E-17
Sn-128	2.02E-17	1.85E-17	1.72E-17	1.65E-17	1.51E-17	1.48E-17
Sn-129	4.02E-17	3.71E-17	3.49E-17	3.34E-17	3.08E-17	3.03E-17
Sn-130	3.33E-17	3.06E-17	2.87E-17	2.73E-17	2.51E-17	2.46E-17
Sn-130m	3.55E-17	3.28E-17	3.09E-17	2.95E-17	2.73E-17	2.68E-17
<b>Antimony</b>						
Sb-111	5.71E-17	5.25E-17	4.89E-17	4.69E-17	4.30E-17	4.23E-17
Sb-113	4.73E-17	4.34E-17	4.04E-17	3.88E-17	3.56E-17	3.49E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	1.01E-16	9.28E-17	8.74E-17	8.38E-17	7.75E-17	7.62E-17
Sb-115	3.21E-17	2.95E-17	2.74E-17	2.63E-17	2.41E-17	2.36E-17
Sb-116	8.29E-17	7.66E-17	7.23E-17	6.94E-17	6.43E-17	6.32E-17
Sb-116m	1.11E-16	1.02E-16	9.65E-17	9.21E-17	8.51E-17	8.37E-17
Sb-117	5.32E-18	4.92E-18	4.54E-18	4.35E-18	3.93E-18	3.86E-18
Sb-118	3.13E-17	2.87E-17	2.68E-17	2.57E-17	2.36E-17	2.31E-17
Sb-118m	9.25E-17	8.54E-17	8.09E-17	7.70E-17	7.13E-17	7.00E-17
Sb-119	6.05E-20	4.12E-20	3.20E-20	2.90E-20	1.99E-20	1.89E-20
Sb-120	1.66E-17	1.53E-17	1.42E-17	1.36E-17	1.25E-17	1.23E-17
Sb-120m	8.70E-17	8.03E-17	7.60E-17	7.23E-17	6.68E-17	6.57E-17
Sb-122	1.74E-17	1.60E-17	1.49E-17	1.43E-17	1.31E-17	1.29E-17
Sb-122m	9.92E-19	8.53E-19	7.67E-19	7.17E-19	6.14E-19	5.99E-19
Sb-124	6.75E-17	6.23E-17	5.87E-17	5.65E-17	5.24E-17	5.15E-17
Sb-124m	1.61E-17	1.48E-17	1.38E-17	1.32E-17	1.21E-17	1.19E-17
Sb-124n	2.26E-24	1.54E-24	1.19E-24	1.08E-24	7.45E-25	7.08E-25
Sb-125	1.53E-17	1.40E-17	1.30E-17	1.25E-17	1.14E-17	1.12E-17
Sb-126	1.00E-16	9.23E-17	8.65E-17	8.25E-17	7.59E-17	7.45E-17
Sb-126m	5.75E-17	5.28E-17	4.94E-17	4.72E-17	4.34E-17	4.26E-17
Sb-127	2.55E-17	2.35E-17	2.20E-17	2.10E-17	1.93E-17	1.89E-17
Sb-128	1.13E-16	1.04E-16	9.74E-17	9.29E-17	8.55E-17	8.40E-17
Sb-128m	7.14E-17	6.56E-17	6.17E-17	5.88E-17	5.41E-17	5.31E-17
Sb-129	5.35E-17	4.94E-17	4.66E-17	4.45E-17	4.12E-17	4.05E-17
Sb-130	1.19E-16	1.10E-16	1.04E-16	9.88E-17	9.11E-17	8.95E-17
Sb-130m	1.01E-16	9.27E-17	8.75E-17	8.33E-17	7.69E-17	7.55E-17
Sb-131	7.59E-17	7.02E-17	6.63E-17	6.35E-17	5.89E-17	5.79E-17
Sb-133	9.97E-17	9.23E-17	8.75E-17	8.41E-17	7.81E-17	7.69E-17
<b>Tellurium</b>						
Te-113	8.55E-17	7.90E-17	7.42E-17	7.13E-17	6.59E-17	6.47E-17
Te-114	4.51E-17	4.16E-17	3.92E-17	3.77E-17	3.49E-17	3.43E-17
Te-115	8.29E-17	7.64E-17	7.19E-17	6.89E-17	6.36E-17	6.25E-17
Te-115m	9.54E-17	8.81E-17	8.29E-17	7.96E-17	7.36E-17	7.24E-17
Te-116	2.63E-18	2.38E-18	2.21E-18	2.10E-18	1.90E-18	1.87E-18
Te-117	5.56E-17	5.14E-17	4.84E-17	4.65E-17	4.30E-17	4.23E-17
Te-118	6.14E-20	4.24E-20	3.29E-20	2.95E-20	2.09E-20	1.99E-20
Te-119	2.71E-17	2.50E-17	2.34E-17	2.24E-17	2.06E-17	2.02E-17
Te-119m	5.30E-17	4.89E-17	4.63E-17	4.42E-17	4.09E-17	4.02E-17
Te-121	2.02E-17	1.85E-17	1.72E-17	1.65E-17	1.51E-17	1.49E-17
Te-121m	6.90E-18	6.27E-18	5.88E-18	5.59E-18	5.10E-18	5.00E-18
Te-123	1.07E-22	7.38E-23	5.72E-23	5.12E-23	3.63E-23	3.46E-23
Te-123m	4.20E-18	3.89E-18	3.58E-18	3.43E-18	3.09E-18	3.04E-18
Te-125m	1.39E-19	9.99E-20	7.89E-20	7.07E-20	5.29E-20	5.07E-20
Te-127	5.37E-19	4.94E-19	4.65E-19	4.43E-19	4.09E-19	4.02E-19
Te-127m	5.78E-20	4.45E-20	3.74E-20	3.43E-20	2.78E-20	2.69E-20
Te-129	3.22E-18	2.96E-18	2.78E-18	2.65E-18	2.44E-18	2.40E-18
Te-129m	1.59E-18	1.46E-18	1.37E-18	1.30E-18	1.20E-18	1.18E-18
Te-131	1.61E-17	1.49E-17	1.39E-17	1.33E-17	1.22E-17	1.20E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	5.22E-17	4.82E-17	4.54E-17	4.33E-17	4.00E-17	3.93E-17
Te-132	7.16E-18	6.46E-18	6.05E-18	5.74E-18	5.23E-18	5.12E-18
Te-133	4.46E-17	4.11E-17	3.87E-17	3.71E-17	3.44E-17	3.38E-17
Te-133m	6.74E-17	6.22E-17	5.87E-17	5.60E-17	5.18E-17	5.09E-17
Te-134	3.09E-17	2.83E-17	2.65E-17	2.53E-17	2.32E-17	2.28E-17
<b>Iodine</b>						
I-118	7.98E-17	7.35E-17	6.88E-17	6.60E-17	6.07E-17	5.97E-17
I-118m	1.39E-16	1.28E-16	1.20E-16	1.14E-16	1.05E-16	1.03E-16
I-119	3.33E-17	3.05E-17	2.85E-17	2.73E-17	2.50E-17	2.45E-17
I-120	9.82E-17	9.08E-17	8.54E-17	8.24E-17	7.64E-17	7.51E-17
I-120m	1.29E-16	1.19E-16	1.12E-16	1.07E-16	9.88E-17	9.71E-17
I-121	1.33E-17	1.22E-17	1.14E-17	1.08E-17	9.92E-18	9.73E-18
I-122	3.79E-17	3.48E-17	3.24E-17	3.11E-17	2.86E-17	2.80E-17
I-123	4.77E-18	4.40E-18	4.05E-18	3.88E-18	3.50E-18	3.44E-18
I-124	4.00E-17	3.69E-17	3.46E-17	3.32E-17	3.07E-17	3.01E-17
I-125	1.57E-19	1.10E-19	8.58E-20	7.65E-20	5.60E-20	5.35E-20
I-126	1.56E-17	1.43E-17	1.34E-17	1.28E-17	1.17E-17	1.15E-17
I-128	4.27E-18	3.93E-18	3.69E-18	3.53E-18	3.25E-18	3.19E-18
I-129	1.60E-19	1.24E-19	1.03E-19	9.36E-20	7.65E-20	7.41E-20
I-130	7.78E-17	7.16E-17	6.69E-17	6.40E-17	5.88E-17	5.77E-17
I-130m	4.18E-18	3.84E-18	3.58E-18	3.44E-18	3.16E-18	3.10E-18
I-131	1.38E-17	1.26E-17	1.17E-17	1.12E-17	1.03E-17	1.01E-17
I-132	8.30E-17	7.65E-17	7.19E-17	6.86E-17	6.33E-17	6.22E-17
I-132m	1.21E-17	1.11E-17	1.04E-17	9.89E-18	9.09E-18	8.92E-18
I-133	2.29E-17	2.11E-17	1.97E-17	1.88E-17	1.73E-17	1.70E-17
I-134	9.51E-17	8.77E-17	8.28E-17	7.89E-17	7.29E-17	7.17E-17
I-134m	9.28E-18	8.41E-18	7.88E-18	7.49E-18	6.85E-18	6.71E-18
I-135	5.75E-17	5.32E-17	5.04E-17	4.83E-17	4.49E-17	4.42E-17
<b>Xenon</b>						
Xe-120	1.29E-17	1.18E-17	1.10E-17	1.05E-17	9.62E-18	9.44E-18
Xe-121	5.31E-17	4.91E-17	4.61E-17	4.45E-17	4.12E-17	4.05E-17
Xe-122	1.64E-18	1.48E-18	1.37E-18	1.30E-18	1.18E-18	1.16E-18
Xe-123	2.22E-17	2.04E-17	1.91E-17	1.83E-17	1.68E-17	1.66E-17
Xe-125	8.24E-18	7.49E-18	7.00E-18	6.66E-18	6.07E-18	5.95E-18
Xe-127	8.59E-18	7.82E-18	7.28E-18	6.94E-18	6.31E-18	6.19E-18
Xe-127m	4.63E-18	4.25E-18	3.92E-18	3.74E-18	3.37E-18	3.31E-18
Xe-129m	4.97E-19	4.15E-19	3.67E-19	3.42E-19	2.96E-19	2.89E-19
Xe-131m	1.76E-19	1.47E-19	1.28E-19	1.20E-19	1.02E-19	9.98E-20
Xe-133	9.02E-19	7.98E-19	7.29E-19	6.88E-19	6.05E-19	5.91E-19
Xe-133m	8.69E-19	7.72E-19	7.16E-19	6.78E-19	6.13E-19	6.00E-19
Xe-135	9.05E-18	8.21E-18	7.71E-18	7.34E-18	6.71E-18	6.58E-18
Xe-135m	1.52E-17	1.39E-17	1.30E-17	1.24E-17	1.14E-17	1.12E-17
Xe-137	1.24E-17	1.15E-17	1.08E-17	1.04E-17	9.60E-18	9.43E-18
Xe-138	4.13E-17	3.82E-17	3.61E-17	3.49E-17	3.25E-17	3.19E-17
<b>Cesium</b>						
Cs-121	4.78E-17	4.39E-17	4.10E-17	3.93E-17	3.61E-17	3.54E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	4.63E-17	4.25E-17	3.97E-17	3.80E-17	3.49E-17	3.42E-17
Cs-123	4.11E-17	3.78E-17	3.52E-17	3.37E-17	3.10E-17	3.04E-17
Cs-124	4.89E-17	4.49E-17	4.20E-17	4.03E-17	3.71E-17	3.64E-17
Cs-125	2.75E-17	2.52E-17	2.35E-17	2.26E-17	2.07E-17	2.03E-17
Cs-126	4.56E-17	4.19E-17	3.90E-17	3.75E-17	3.44E-17	3.38E-17
Cs-127	1.46E-17	1.34E-17	1.24E-17	1.19E-17	1.09E-17	1.07E-17
Cs-128	3.44E-17	3.16E-17	2.94E-17	2.82E-17	2.59E-17	2.54E-17
Cs-129	8.91E-18	8.10E-18	7.52E-18	7.20E-18	6.57E-18	6.44E-18
Cs-130	1.87E-17	1.71E-17	1.59E-17	1.53E-17	1.40E-17	1.38E-17
Cs-130m	1.23E-18	1.09E-18	9.86E-19	9.31E-19	8.18E-19	8.00E-19
Cs-131	1.01E-19	7.26E-20	5.67E-20	5.03E-20	3.78E-20	3.62E-20
Cs-132	2.52E-17	2.32E-17	2.17E-17	2.07E-17	1.90E-17	1.87E-17
Cs-134	5.66E-17	5.21E-17	4.88E-17	4.66E-17	4.29E-17	4.21E-17
Cs-134m	5.14E-19	4.65E-19	4.23E-19	4.03E-19	3.58E-19	3.52E-19
Cs-135	9.54E-20	8.81E-20	8.35E-20	7.93E-20	7.34E-20	7.22E-20
Cs-135m	5.79E-17	5.34E-17	5.03E-17	4.78E-17	4.41E-17	4.33E-17
Cs-136	7.67E-17	7.07E-17	6.68E-17	6.35E-17	5.86E-17	5.76E-17
Cs-137	2.90E-19	2.68E-19	2.55E-19	2.42E-19	2.24E-19	2.20E-19
Cs-138	8.80E-17	8.15E-17	7.72E-17	7.43E-17	6.90E-17	6.79E-17
Cs-138m	1.52E-17	1.40E-17	1.32E-17	1.26E-17	1.17E-17	1.15E-17
Cs-139	1.63E-17	1.51E-17	1.44E-17	1.38E-17	1.29E-17	1.27E-17
Cs-140	6.98E-17	6.48E-17	6.14E-17	5.93E-17	5.52E-17	5.43E-17
<b>Barium</b>						
Ba-124	2.00E-17	1.83E-17	1.72E-17	1.64E-17	1.51E-17	1.48E-17
Ba-126	1.99E-17	1.83E-17	1.72E-17	1.64E-17	1.51E-17	1.48E-17
Ba-127	2.71E-17	2.49E-17	2.32E-17	2.23E-17	2.04E-17	2.01E-17
Ba-128	1.57E-18	1.40E-18	1.30E-18	1.23E-18	1.12E-18	1.09E-18
Ba-129	1.14E-17	1.05E-17	9.78E-18	9.38E-18	8.62E-18	8.46E-18
Ba-129m	5.57E-17	5.13E-17	4.83E-17	4.62E-17	4.26E-17	4.18E-17
Ba-131	1.57E-17	1.44E-17	1.33E-17	1.28E-17	1.17E-17	1.15E-17
Ba-131m	1.73E-18	1.56E-18	1.43E-18	1.36E-18	1.21E-18	1.19E-18
Ba-133	1.26E-17	1.14E-17	1.06E-17	1.02E-17	9.24E-18	9.06E-18
Ba-133m	1.80E-18	1.62E-18	1.50E-18	1.43E-18	1.30E-18	1.27E-18
Ba-135m	1.54E-18	1.38E-18	1.28E-18	1.22E-18	1.11E-18	1.08E-18
Ba-137m	2.16E-17	1.98E-17	1.85E-17	1.77E-17	1.63E-17	1.60E-17
Ba-139	3.77E-18	3.49E-18	3.29E-18	3.14E-18	2.89E-18	2.84E-18
Ba-140	6.84E-18	6.27E-18	5.83E-18	5.59E-18	5.12E-18	5.02E-18
Ba-141	3.53E-17	3.25E-17	3.06E-17	2.92E-17	2.70E-17	2.65E-17
Ba-142	3.81E-17	3.51E-17	3.31E-17	3.15E-17	2.91E-17	2.86E-17
<b>Lanthanum</b>						
La-128	1.06E-16	9.72E-17	9.12E-17	8.73E-17	8.04E-17	7.90E-17
La-129	3.40E-17	3.11E-17	2.90E-17	2.78E-17	2.55E-17	2.50E-17
La-130	8.33E-17	7.67E-17	7.19E-17	6.89E-17	6.35E-17	6.24E-17
La-131	2.30E-17	2.11E-17	1.96E-17	1.88E-17	1.72E-17	1.69E-17
La-132	7.25E-17	6.69E-17	6.28E-17	6.04E-17	5.58E-17	5.49E-17
La-132m	2.33E-17	2.14E-17	2.00E-17	1.91E-17	1.75E-17	1.72E-17



**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	5.06E-18	4.62E-18	4.29E-18	4.10E-18	3.76E-18	3.69E-18
La-134	2.78E-17	2.55E-17	2.38E-17	2.28E-17	2.09E-17	2.06E-17
La-135	5.06E-19	4.38E-19	3.93E-19	3.71E-19	3.30E-19	3.23E-19
La-136	1.49E-17	1.36E-17	1.27E-17	1.22E-17	1.12E-17	1.09E-17
La-137	1.35E-19	9.87E-20	7.82E-20	6.92E-20	5.34E-20	5.14E-20
La-138	4.40E-17	4.07E-17	3.85E-17	3.69E-17	3.43E-17	3.37E-17
La-140	8.39E-17	7.76E-17	7.33E-17	7.06E-17	6.55E-17	6.44E-17
La-141	3.66E-18	3.40E-18	3.23E-18	3.08E-18	2.87E-18	2.82E-18
La-142	8.60E-17	7.99E-17	7.57E-17	7.33E-17	6.84E-17	6.74E-17
La-143	1.34E-17	1.24E-17	1.17E-17	1.13E-17	1.05E-17	1.03E-17
<b>Cerium</b>						
Ce-130	1.64E-17	1.51E-17	1.41E-17	1.34E-17	1.23E-17	1.21E-17
Ce-131	5.92E-17	5.44E-17	5.10E-17	4.89E-17	4.51E-17	4.42E-17
Ce-132	8.24E-18	7.51E-18	6.98E-18	6.65E-18	6.04E-18	5.93E-18
Ce-133	1.85E-17	1.69E-17	1.57E-17	1.50E-17	1.37E-17	1.35E-17
Ce-133m	6.09E-17	5.62E-17	5.28E-17	5.06E-17	4.68E-17	4.60E-17
Ce-134	2.08E-19	1.62E-19	1.36E-19	1.23E-19	1.01E-19	9.83E-20
Ce-135	2.85E-17	2.61E-17	2.44E-17	2.33E-17	2.14E-17	2.10E-17
Ce-137	5.54E-19	4.79E-19	4.30E-19	4.05E-19	3.60E-19	3.52E-19
Ce-137m	1.35E-18	1.21E-18	1.12E-18	1.06E-18	9.61E-19	9.42E-19
Ce-139	4.30E-18	3.94E-18	3.63E-18	3.46E-18	3.12E-18	3.07E-18
Ce-141	2.37E-18	2.20E-18	2.02E-18	1.93E-18	1.74E-18	1.71E-18
Ce-143	9.93E-18	9.04E-18	8.46E-18	8.06E-18	7.38E-18	7.24E-18
Ce-144	5.72E-19	5.26E-19	4.83E-19	4.61E-19	4.14E-19	4.07E-19
Ce-145	2.98E-17	2.74E-17	2.57E-17	2.45E-17	2.25E-17	2.21E-17
<b>Praseodymium</b>						
Pr-134	1.16E-16	1.07E-16	1.00E-16	9.57E-17	8.80E-17	8.64E-17
Pr-134m	8.78E-17	8.09E-17	7.58E-17	7.30E-17	6.74E-17	6.62E-17
Pr-135	3.19E-17	2.92E-17	2.73E-17	2.61E-17	2.40E-17	2.35E-17
Pr-136	7.88E-17	7.27E-17	6.81E-17	6.54E-17	6.03E-17	5.93E-17
Pr-137	1.31E-17	1.20E-17	1.12E-17	1.08E-17	9.87E-18	9.68E-18
Pr-138	3.28E-17	3.01E-17	2.81E-17	2.69E-17	2.47E-17	2.43E-17
Pr-138m	8.90E-17	8.20E-17	7.72E-17	7.35E-17	6.78E-17	6.66E-17
Pr-139	4.00E-18	3.65E-18	3.38E-18	3.24E-18	2.97E-18	2.91E-18
Pr-140	2.08E-17	1.91E-17	1.77E-17	1.70E-17	1.56E-17	1.53E-17
Pr-142	4.19E-18	3.88E-18	3.68E-18	3.53E-18	3.29E-18	3.24E-18
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	5.79E-19	5.35E-19	5.08E-19	4.83E-19	4.47E-19	4.40E-19
Pr-144	4.57E-18	4.24E-18	4.03E-18	3.86E-18	3.59E-18	3.53E-18
Pr-144m	1.41E-19	1.16E-19	1.02E-19	9.41E-20	8.14E-20	7.94E-20
Pr-145	2.28E-18	2.11E-18	2.00E-18	1.91E-18	1.77E-18	1.74E-18
Pr-146	4.03E-17	3.73E-17	3.52E-17	3.38E-17	3.14E-17	3.08E-17
Pr-147	1.84E-17	1.69E-17	1.58E-17	1.51E-17	1.39E-17	1.37E-17
Pr-148	4.09E-17	3.77E-17	3.56E-17	3.42E-17	3.16E-17	3.11E-17
Pr-148m	3.88E-17	3.56E-17	3.34E-17	3.19E-17	2.94E-17	2.89E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	1.83E-17	1.68E-17	1.56E-17	1.49E-17	1.37E-17	1.34E-17
Nd-135	4.70E-17	4.31E-17	4.02E-17	3.85E-17	3.53E-17	3.46E-17
Nd-136	8.35E-18	7.61E-18	7.07E-18	6.74E-18	6.15E-18	6.03E-18
Nd-137	4.19E-17	3.86E-17	3.62E-17	3.46E-17	3.19E-17	3.14E-17
Nd-138	7.08E-19	6.11E-19	5.51E-19	5.18E-19	4.59E-19	4.49E-19
Nd-139	1.58E-17	1.45E-17	1.35E-17	1.30E-17	1.19E-17	1.17E-17
Nd-139m	5.58E-17	5.14E-17	4.84E-17	4.61E-17	4.26E-17	4.18E-17
Nd-140	2.07E-19	1.56E-19	1.27E-19	1.12E-19	8.94E-20	8.64E-20
Nd-141	1.95E-18	1.76E-18	1.63E-18	1.55E-18	1.41E-18	1.39E-18
Nd-141m	2.52E-17	2.32E-17	2.18E-17	2.07E-17	1.91E-17	1.87E-17
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	4.64E-18	4.23E-18	3.92E-18	3.74E-18	3.41E-18	3.34E-18
Nd-149	1.34E-17	1.22E-17	1.14E-17	1.09E-17	9.94E-18	9.76E-18
Nd-151	3.13E-17	2.88E-17	2.71E-17	2.59E-17	2.39E-17	2.34E-17
Nd-152	6.18E-18	5.61E-18	5.26E-18	5.01E-18	4.58E-18	4.50E-18
<b>Promethium</b>						
Pm-136	1.06E-16	9.74E-17	9.11E-17	8.71E-17	8.01E-17	7.87E-17
Pm-137m	6.57E-17	6.03E-17	5.63E-17	5.39E-17	4.95E-17	4.86E-17
Pm-139	3.67E-17	3.37E-17	3.14E-17	3.02E-17	2.77E-17	2.72E-17
Pm-140	4.54E-17	4.17E-17	3.90E-17	3.74E-17	3.44E-17	3.38E-17
Pm-140m	1.12E-16	1.03E-16	9.70E-17	9.25E-17	8.52E-17	8.37E-17
Pm-141	2.77E-17	2.55E-17	2.38E-17	2.29E-17	2.10E-17	2.06E-17
Pm-142	3.49E-17	3.21E-17	2.99E-17	2.87E-17	2.64E-17	2.59E-17
Pm-143	1.06E-17	9.73E-18	9.12E-18	8.67E-18	7.97E-18	7.83E-18
Pm-144	5.58E-17	5.12E-17	4.78E-17	4.57E-17	4.20E-17	4.12E-17
Pm-145	2.67E-19	2.08E-19	1.73E-19	1.56E-19	1.27E-19	1.23E-19
Pm-146	2.67E-17	2.45E-17	2.29E-17	2.19E-17	2.01E-17	1.97E-17
Pm-147	5.46E-20	5.04E-20	4.78E-20	4.54E-20	4.20E-20	4.13E-20
Pm-148	2.26E-17	2.09E-17	1.97E-17	1.89E-17	1.75E-17	1.72E-17
Pm-148m	7.21E-17	6.62E-17	6.20E-17	5.92E-17	5.44E-17	5.34E-17
Pm-149	1.12E-18	1.03E-18	9.72E-19	9.26E-19	8.54E-19	8.39E-19
Pm-150	5.48E-17	5.06E-17	4.78E-17	4.57E-17	4.23E-17	4.16E-17
Pm-151	1.16E-17	1.06E-17	9.91E-18	9.46E-18	8.65E-18	8.48E-18
Pm-152	1.41E-17	1.30E-17	1.23E-17	1.17E-17	1.09E-17	1.07E-17
Pm-152m	5.57E-17	5.13E-17	4.84E-17	4.62E-17	4.27E-17	4.20E-17
Pm-153	3.61E-18	3.32E-18	3.10E-18	2.95E-18	2.69E-18	2.65E-18
Pm-154	6.57E-17	6.09E-17	5.77E-17	5.56E-17	5.17E-17	5.09E-17
Pm-154m	6.59E-17	6.09E-17	5.75E-17	5.51E-17	5.11E-17	5.02E-17
<b>Samarium</b>						
Sm-139	5.51E-17	5.06E-17	4.73E-17	4.53E-17	4.17E-17	4.09E-17
Sm-140	1.98E-17	1.82E-17	1.71E-17	1.63E-17	1.50E-17	1.48E-17
Sm-141	5.22E-17	4.80E-17	4.50E-17	4.32E-17	3.98E-17	3.91E-17
Sm-141m	7.00E-17	6.44E-17	6.05E-17	5.79E-17	5.34E-17	5.24E-17
Sm-142	3.25E-18	2.95E-18	2.72E-18	2.60E-18	2.37E-18	2.32E-18
Sm-143	1.99E-17	1.83E-17	1.70E-17	1.63E-17	1.50E-17	1.47E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	2.48E-17	2.28E-17	2.14E-17	2.04E-17	1.88E-17	1.85E-17
Sm-145	6.14E-19	4.84E-19	4.09E-19	3.69E-19	3.03E-19	2.94E-19
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	6.29E-21	5.81E-21	5.51E-21	5.23E-21	4.84E-21	4.75E-21
Sm-153	1.60E-18	1.42E-18	1.30E-18	1.23E-18	1.10E-18	1.07E-18
Sm-155	3.96E-18	3.61E-18	3.36E-18	3.20E-18	2.90E-18	2.85E-18
Sm-156	3.66E-18	3.33E-18	3.10E-18	2.95E-18	2.67E-18	2.62E-18
Sm-157	1.63E-17	1.50E-17	1.41E-17	1.35E-17	1.24E-17	1.21E-17
<b>Europium</b>						
Eu-142	5.49E-17	5.06E-17	4.74E-17	4.55E-17	4.20E-17	4.13E-17
Eu-142m	1.30E-16	1.20E-16	1.12E-16	1.07E-16	9.90E-17	9.72E-17
Eu-143	4.47E-17	4.12E-17	3.85E-17	3.70E-17	3.41E-17	3.35E-17
Eu-144	4.70E-17	4.33E-17	4.05E-17	3.89E-17	3.59E-17	3.52E-17
Eu-145	4.52E-17	4.17E-17	3.94E-17	3.77E-17	3.49E-17	3.44E-17
Eu-146	8.59E-17	7.92E-17	7.44E-17	7.12E-17	6.58E-17	6.46E-17
Eu-147	1.55E-17	1.43E-17	1.34E-17	1.27E-17	1.17E-17	1.15E-17
Eu-148	7.96E-17	7.32E-17	6.85E-17	6.56E-17	6.04E-17	5.93E-17
Eu-149	1.43E-18	1.26E-18	1.16E-18	1.09E-18	9.81E-19	9.61E-19
Eu-150	5.49E-17	5.03E-17	4.70E-17	4.50E-17	4.13E-17	4.05E-17
Eu-150m	2.26E-18	2.07E-18	1.94E-18	1.85E-18	1.71E-18	1.67E-18
Eu-152	4.14E-17	3.82E-17	3.60E-17	3.43E-17	3.17E-17	3.12E-17
Eu-152m	1.16E-17	1.07E-17	1.01E-17	9.56E-18	8.83E-18	8.68E-18
Eu-152n	1.64E-18	1.47E-18	1.35E-18	1.27E-18	1.13E-18	1.10E-18
Eu-154	4.49E-17	4.14E-17	3.91E-17	3.73E-17	3.45E-17	3.39E-17
Eu-154m	1.30E-18	1.14E-18	1.04E-18	9.76E-19	8.53E-19	8.34E-19
Eu-155	1.40E-18	1.25E-18	1.15E-18	1.08E-18	9.60E-19	9.41E-19
Eu-156	4.50E-17	4.17E-17	3.95E-17	3.79E-17	3.52E-17	3.46E-17
Eu-157	1.02E-17	9.24E-18	8.59E-18	8.21E-18	7.49E-18	7.35E-18
Eu-158	4.87E-17	4.50E-17	4.26E-17	4.06E-17	3.76E-17	3.70E-17
Eu-159	1.16E-17	1.06E-17	9.96E-18	9.49E-18	8.71E-18	8.55E-18
<b>Gadolinium</b>						
Gd-142	3.92E-17	3.60E-17	3.37E-17	3.23E-17	2.98E-17	2.92E-17
Gd-143m	7.91E-17	7.27E-17	6.82E-17	6.54E-17	6.03E-17	5.92E-17
Gd-144	3.36E-17	3.10E-17	2.90E-17	2.80E-17	2.58E-17	2.54E-17
Gd-145	8.63E-17	8.00E-17	7.56E-17	7.32E-17	6.81E-17	6.70E-17
Gd-145m	2.48E-17	2.28E-17	2.14E-17	2.04E-17	1.87E-17	1.84E-17
Gd-146	5.79E-18	5.23E-18	4.77E-18	4.53E-18	4.03E-18	3.96E-18
Gd-147	4.92E-17	4.51E-17	4.24E-17	4.04E-17	3.72E-17	3.65E-17
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	1.73E-17	1.58E-17	1.47E-17	1.41E-17	1.28E-17	1.26E-17
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	1.45E-18	1.28E-18	1.16E-18	1.10E-18	9.78E-19	9.58E-19
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	1.87E-18	1.63E-18	1.47E-18	1.38E-18	1.21E-18	1.18E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	2.22E-18	2.02E-18	1.88E-18	1.80E-18	1.64E-18	1.61E-18
Gd-162	1.54E-17	1.41E-17	1.31E-17	1.26E-17	1.15E-17	1.13E-17
<b>Terbium</b>						
Tb-146	1.35E-16	1.24E-16	1.18E-16	1.13E-16	1.05E-16	1.03E-16
Tb-147	7.83E-17	7.23E-17	6.82E-17	6.52E-17	6.03E-17	5.92E-17
Tb-147m	6.87E-17	6.36E-17	6.00E-17	5.78E-17	5.36E-17	5.27E-17
Tb-148	8.67E-17	8.01E-17	7.53E-17	7.23E-17	6.69E-17	6.57E-17
Tb-148m	1.13E-16	1.04E-16	9.79E-17	9.34E-17	8.59E-17	8.44E-17
Tb-149	4.78E-17	4.41E-17	4.15E-17	3.98E-17	3.67E-17	3.61E-17
Tb-149m	4.95E-17	4.55E-17	4.27E-17	4.07E-17	3.75E-17	3.68E-17
Tb-150	8.65E-17	8.02E-17	7.56E-17	7.29E-17	6.77E-17	6.66E-17
Tb-150m	9.03E-17	8.29E-17	7.74E-17	7.40E-17	6.79E-17	6.67E-17
Tb-151	3.39E-17	3.10E-17	2.90E-17	2.77E-17	2.54E-17	2.49E-17
Tb-151m	2.46E-18	2.24E-18	2.09E-18	1.99E-18	1.82E-18	1.78E-18
Tb-152	5.30E-17	4.89E-17	4.60E-17	4.42E-17	4.09E-17	4.02E-17
Tb-152m	2.57E-17	2.34E-17	2.19E-17	2.09E-17	1.91E-17	1.88E-17
Tb-153	1.02E-17	9.28E-18	8.66E-18	8.23E-18	7.51E-18	7.37E-18
Tb-154	7.98E-17	7.40E-17	7.00E-17	6.76E-17	6.30E-17	6.20E-17
Tb-155	4.30E-18	3.85E-18	3.54E-18	3.36E-18	3.00E-18	2.94E-18
Tb-156	6.80E-17	6.26E-17	5.90E-17	5.64E-17	5.21E-17	5.12E-17
Tb-156m	4.90E-19	3.99E-19	3.48E-19	3.15E-19	2.64E-19	2.58E-19
Tb-156n	5.49E-20	4.63E-20	4.11E-20	3.80E-20	3.26E-20	3.19E-20
Tb-157	4.98E-20	3.94E-20	3.35E-20	3.01E-20	2.48E-20	2.41E-20
Tb-158	2.80E-17	2.58E-17	2.43E-17	2.31E-17	2.13E-17	2.09E-17
Tb-160	4.05E-17	3.74E-17	3.53E-17	3.36E-17	3.10E-17	3.05E-17
Tb-161	6.85E-19	5.94E-19	5.39E-19	5.03E-19	4.42E-19	4.32E-19
Tb-162	4.04E-17	3.71E-17	3.50E-17	3.32E-17	3.06E-17	3.00E-17
Tb-163	2.86E-17	2.62E-17	2.44E-17	2.34E-17	2.14E-17	2.10E-17
Tb-164	8.90E-17	8.21E-17	7.73E-17	7.40E-17	6.84E-17	6.72E-17
Tb-165	3.23E-17	2.99E-17	2.83E-17	2.71E-17	2.52E-17	2.48E-17
<b>Dysprosium</b>						
Dy-148	2.51E-17	2.30E-17	2.15E-17	2.05E-17	1.88E-17	1.85E-17
Dy-149	5.70E-17	5.26E-17	4.96E-17	4.75E-17	4.40E-17	4.33E-17
Dy-150	9.34E-18	8.49E-18	7.88E-18	7.54E-18	6.88E-18	6.75E-18
Dy-151	4.84E-17	4.45E-17	4.19E-17	4.01E-17	3.71E-17	3.64E-17
Dy-152	9.02E-18	8.12E-18	7.60E-18	7.21E-18	6.56E-18	6.43E-18
Dy-153	2.90E-17	2.66E-17	2.50E-17	2.38E-17	2.19E-17	2.15E-17
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	2.26E-17	2.07E-17	1.95E-17	1.86E-17	1.71E-17	1.68E-17
Dy-157	1.12E-17	1.02E-17	9.46E-18	9.03E-18	8.23E-18	8.06E-18
Dy-159	5.18E-19	4.14E-19	3.56E-19	3.21E-19	2.66E-19	2.59E-19
Dy-165	1.73E-18	1.59E-18	1.49E-18	1.42E-18	1.30E-18	1.28E-18
Dy-165m	5.22E-19	4.72E-19	4.35E-19	4.15E-19	3.75E-19	3.68E-19
Dy-166	9.12E-19	7.96E-19	7.24E-19	6.78E-19	5.98E-19	5.85E-19
Dy-167	2.02E-17	1.85E-17	1.73E-17	1.65E-17	1.51E-17	1.48E-17
Dy-168	1.42E-17	1.29E-17	1.20E-17	1.15E-17	1.05E-17	1.03E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	7.56E-17	6.96E-17	6.52E-17	6.23E-17	5.74E-17	5.63E-17
Ho-153	3.75E-17	3.44E-17	3.22E-17	3.07E-17	2.82E-17	2.77E-17
Ho-153m	3.88E-17	3.56E-17	3.32E-17	3.17E-17	2.91E-17	2.85E-17
Ho-154	7.06E-17	6.49E-17	6.08E-17	5.82E-17	5.36E-17	5.26E-17
Ho-154m	8.82E-17	8.08E-17	7.55E-17	7.22E-17	6.63E-17	6.51E-17
Ho-155	2.11E-17	1.93E-17	1.81E-17	1.73E-17	1.59E-17	1.56E-17
Ho-156	7.58E-17	6.99E-17	6.57E-17	6.30E-17	5.82E-17	5.72E-17
Ho-157	1.89E-17	1.72E-17	1.61E-17	1.53E-17	1.40E-17	1.38E-17
Ho-159	1.12E-17	1.01E-17	9.41E-18	8.94E-18	8.11E-18	7.95E-18
Ho-160	6.00E-17	5.52E-17	5.20E-17	4.94E-17	4.55E-17	4.47E-17
Ho-161	7.37E-19	6.13E-19	5.40E-19	4.97E-19	4.23E-19	4.13E-19
Ho-162	4.80E-18	4.37E-18	4.07E-18	3.88E-18	3.55E-18	3.49E-18
Ho-162m	1.88E-17	1.72E-17	1.63E-17	1.55E-17	1.43E-17	1.40E-17
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	6.21E-19	5.34E-19	4.84E-19	4.49E-19	3.95E-19	3.87E-19
Ho-164m	5.57E-19	4.52E-19	3.93E-19	3.57E-19	2.99E-19	2.91E-19
Ho-166	2.47E-18	2.28E-18	2.16E-18	2.06E-18	1.90E-18	1.87E-18
Ho-166m	5.76E-17	5.30E-17	4.97E-17	4.73E-17	4.35E-17	4.27E-17
Ho-167	1.29E-17	1.17E-17	1.09E-17	1.04E-17	9.53E-18	9.34E-18
Ho-168	3.34E-17	3.07E-17	2.90E-17	2.76E-17	2.54E-17	2.50E-17
Ho-168m	7.92E-20	6.43E-20	5.59E-20	5.06E-20	4.24E-20	4.13E-20
Ho-170	6.23E-17	5.74E-17	5.42E-17	5.15E-17	4.75E-17	4.67E-17
<b>Erbium</b>						
Er-154	1.55E-18	1.36E-18	1.24E-18	1.17E-18	1.05E-18	1.02E-18
Er-156	1.04E-18	8.89E-19	7.96E-19	7.40E-19	6.46E-19	6.31E-19
Er-159	3.37E-17	3.10E-17	2.91E-17	2.78E-17	2.56E-17	2.52E-17
Er-161	3.46E-17	3.18E-17	3.00E-17	2.86E-17	2.63E-17	2.59E-17
Er-163	5.30E-19	4.34E-19	3.80E-19	3.45E-19	2.92E-19	2.85E-19
Er-165	4.75E-19	3.85E-19	3.35E-19	3.04E-19	2.54E-19	2.48E-19
Er-167m	3.01E-18	2.72E-18	2.54E-18	2.41E-18	2.19E-18	2.15E-18
Er-169	1.15E-19	1.06E-19	1.00E-19	9.52E-20	8.81E-20	8.66E-20
Er-171	1.30E-17	1.18E-17	1.10E-17	1.05E-17	9.56E-18	9.38E-18
Er-172	1.79E-17	1.63E-17	1.52E-17	1.45E-17	1.33E-17	1.30E-17
Er-173	2.98E-17	2.74E-17	2.58E-17	2.45E-17	2.25E-17	2.21E-17
<b>Thulium</b>						
Tm-161	4.37E-17	4.02E-17	3.78E-17	3.64E-17	3.36E-17	3.31E-17
Tm-162	6.88E-17	6.36E-17	6.00E-17	5.78E-17	5.36E-17	5.27E-17
Tm-163	4.53E-17	4.17E-17	3.93E-17	3.77E-17	3.48E-17	3.42E-17
Tm-164	2.89E-17	2.66E-17	2.49E-17	2.39E-17	2.20E-17	2.16E-17
Tm-165	1.85E-17	1.68E-17	1.57E-17	1.50E-17	1.37E-17	1.35E-17
Tm-166	6.95E-17	6.42E-17	6.06E-17	5.82E-17	5.40E-17	5.31E-17
Tm-167	3.89E-18	3.48E-18	3.22E-18	3.04E-18	2.74E-18	2.69E-18
Tm-168	4.32E-17	3.97E-17	3.72E-17	3.54E-17	3.26E-17	3.20E-17
Tm-170	6.60E-19	6.07E-19	5.73E-19	5.44E-19	5.01E-19	4.92E-19
Tm-171	1.96E-20	1.74E-20	1.60E-20	1.50E-20	1.34E-20	1.31E-20

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	1.80E-17	1.66E-17	1.58E-17	1.51E-17	1.40E-17	1.38E-17
Tm-173	1.42E-17	1.30E-17	1.21E-17	1.16E-17	1.06E-17	1.04E-17
Tm-174	6.34E-17	5.82E-17	5.48E-17	5.21E-17	4.80E-17	4.71E-17
Tm-175	3.98E-17	3.66E-17	3.43E-17	3.28E-17	3.02E-17	2.97E-17
Tm-176	7.16E-17	6.62E-17	6.26E-17	6.00E-17	5.56E-17	5.47E-17
<b>Ytterbium</b>						
Yb-162	7.33E-18	6.69E-18	6.18E-18	5.89E-18	5.33E-18	5.23E-18
Yb-163	2.58E-17	2.37E-17	2.23E-17	2.13E-17	1.96E-17	1.93E-17
Yb-164	1.00E-18	8.66E-19	7.82E-19	7.29E-19	6.41E-19	6.27E-19
Yb-165	1.02E-17	9.25E-18	8.63E-18	8.21E-18	7.50E-18	7.36E-18
Yb-166	1.31E-18	1.10E-18	9.81E-19	9.03E-19	7.71E-19	7.52E-19
Yb-167	6.33E-18	5.67E-18	5.20E-18	4.92E-18	4.39E-18	4.30E-18
Yb-169	8.12E-18	7.25E-18	6.67E-18	6.31E-18	5.64E-18	5.52E-18
Yb-175	1.48E-18	1.35E-18	1.26E-18	1.20E-18	1.10E-18	1.08E-18
Yb-177	7.54E-18	6.96E-18	6.57E-18	6.25E-18	5.76E-18	5.67E-18
Yb-178	1.63E-18	1.49E-18	1.39E-18	1.33E-18	1.21E-18	1.19E-18
Yb-179	3.64E-17	3.34E-17	3.12E-17	2.98E-17	2.74E-17	2.69E-17
<b>Lutetium</b>						
Lu-165	3.88E-17	3.57E-17	3.34E-17	3.21E-17	2.95E-17	2.90E-17
Lu-167	5.90E-17	5.45E-17	5.15E-17	4.95E-17	4.59E-17	4.52E-17
Lu-169	4.58E-17	4.22E-17	3.99E-17	3.81E-17	3.53E-17	3.47E-17
Lu-169m	1.52E-23	9.78E-24	5.71E-24	5.14E-24	2.08E-24	1.93E-24
Lu-170	8.96E-17	8.32E-17	7.89E-17	7.61E-17	7.09E-17	6.98E-17
Lu-171	2.17E-17	1.99E-17	1.87E-17	1.78E-17	1.63E-17	1.60E-17
Lu-171m	5.60E-21	4.84E-21	4.36E-21	4.07E-21	3.50E-21	3.41E-21
Lu-172	6.90E-17	6.36E-17	6.01E-17	5.72E-17	5.28E-17	5.19E-17
Lu-172m	2.03E-23	1.52E-23	1.19E-23	1.07E-23	7.91E-24	7.65E-24
Lu-173	4.45E-18	3.95E-18	3.64E-18	3.43E-18	3.07E-18	3.01E-18
Lu-174	3.10E-18	2.81E-18	2.62E-18	2.48E-18	2.27E-18	2.22E-18
Lu-174m	1.06E-18	9.18E-19	8.30E-19	7.72E-19	6.74E-19	6.59E-19
Lu-176	1.62E-17	1.47E-17	1.37E-17	1.31E-17	1.19E-17	1.17E-17
Lu-176m	1.19E-18	1.09E-18	1.03E-18	9.75E-19	8.93E-19	8.78E-19
Lu-177	1.24E-18	1.13E-18	1.06E-18	1.00E-18	9.10E-19	8.93E-19
Lu-177m	3.25E-17	2.95E-17	2.75E-17	2.62E-17	2.38E-17	2.34E-17
Lu-178	6.20E-18	5.73E-18	5.43E-18	5.19E-18	4.82E-18	4.74E-18
Lu-178m	3.59E-17	3.27E-17	3.04E-17	2.91E-17	2.65E-17	2.60E-17
Lu-179	2.03E-18	1.86E-18	1.76E-18	1.67E-18	1.54E-18	1.51E-18
Lu-180	5.53E-17	5.10E-17	4.82E-17	4.60E-17	4.26E-17	4.19E-17
Lu-181	2.18E-17	2.00E-17	1.87E-17	1.78E-17	1.64E-17	1.61E-17
<b>Hafnium</b>						
Hf-167	2.28E-17	2.08E-17	1.94E-17	1.86E-17	1.70E-17	1.67E-17
Hf-169	2.23E-17	2.04E-17	1.89E-17	1.82E-17	1.66E-17	1.63E-17
Hf-170	1.40E-17	1.28E-17	1.18E-17	1.13E-17	1.03E-17	1.01E-17
Hf-172	1.83E-18	1.59E-18	1.44E-18	1.34E-18	1.17E-18	1.14E-18
Hf-173	1.18E-17	1.08E-17	9.99E-18	9.52E-18	8.62E-18	8.45E-18
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	1.14E-17	1.03E-17	9.56E-18	9.12E-18	8.30E-18	8.14E-18
Hf-177m	7.65E-17	6.95E-17	6.49E-17	6.19E-17	5.64E-17	5.53E-17
Hf-178m	7.75E-17	7.07E-17	6.58E-17	6.30E-17	5.75E-17	5.64E-17
Hf-179m	3.05E-17	2.78E-17	2.58E-17	2.47E-17	2.25E-17	2.21E-17
Hf-180m	3.36E-17	3.06E-17	2.85E-17	2.72E-17	2.49E-17	2.44E-17
Hf-181	1.84E-17	1.69E-17	1.56E-17	1.50E-17	1.37E-17	1.34E-17
Hf-182	8.07E-18	7.31E-18	6.85E-18	6.52E-18	5.94E-18	5.83E-18
Hf-182m	3.12E-17	2.85E-17	2.67E-17	2.54E-17	2.33E-17	2.29E-17
Hf-183	2.81E-17	2.59E-17	2.43E-17	2.31E-17	2.13E-17	2.09E-17
Hf-184	7.87E-18	7.18E-18	6.67E-18	6.37E-18	5.78E-18	5.68E-18
<b>Tantalum</b>						
Ta-170	4.30E-17	3.95E-17	3.69E-17	3.53E-17	3.25E-17	3.19E-17
Ta-172	6.10E-17	5.62E-17	5.29E-17	5.06E-17	4.67E-17	4.59E-17
Ta-173	1.93E-17	1.77E-17	1.66E-17	1.59E-17	1.46E-17	1.44E-17
Ta-174	3.46E-17	3.18E-17	2.99E-17	2.86E-17	2.64E-17	2.59E-17
Ta-175	3.80E-17	3.50E-17	3.30E-17	3.16E-17	2.92E-17	2.87E-17
Ta-176	7.84E-17	7.26E-17	6.87E-17	6.62E-17	6.15E-17	6.05E-17
Ta-177	1.34E-18	1.18E-18	1.07E-18	1.00E-18	8.83E-19	8.64E-19
Ta-178	3.29E-18	2.97E-18	2.77E-18	2.63E-18	2.39E-18	2.35E-18
Ta-178m	3.81E-17	3.46E-17	3.22E-17	3.08E-17	2.80E-17	2.75E-17
Ta-179	3.86E-19	3.27E-19	2.92E-19	2.69E-19	2.30E-19	2.24E-19
Ta-180	8.44E-19	7.25E-19	6.53E-19	6.07E-19	5.24E-19	5.12E-19
Ta-182	4.55E-17	4.20E-17	3.97E-17	3.79E-17	3.50E-17	3.44E-17
Ta-182m	7.44E-18	6.79E-18	6.27E-18	5.97E-18	5.37E-18	5.27E-18
Ta-183	9.02E-18	8.16E-18	7.59E-18	7.22E-18	6.54E-18	6.41E-18
Ta-184	5.62E-17	5.16E-17	4.84E-17	4.61E-17	4.24E-17	4.16E-17
Ta-185	6.03E-18	5.52E-18	5.15E-18	4.91E-18	4.47E-18	4.39E-18
Ta-186	5.28E-17	4.85E-17	4.54E-17	4.34E-17	3.98E-17	3.91E-17
<b>Tungsten</b>						
W-177	3.04E-17	2.78E-17	2.61E-17	2.48E-17	2.27E-17	2.23E-17
W-178	2.42E-19	2.06E-19	1.85E-19	1.71E-19	1.47E-19	1.43E-19
W-179	8.02E-19	6.82E-19	6.09E-19	5.64E-19	4.81E-19	4.69E-19
W-179m	1.28E-18	1.13E-18	1.04E-18	9.82E-19	8.72E-19	8.53E-19
W-181	6.44E-19	5.50E-19	4.93E-19	4.57E-19	3.91E-19	3.81E-19
W-185	1.65E-19	1.52E-19	1.44E-19	1.37E-19	1.27E-19	1.25E-19
W-185m	6.14E-19	5.57E-19	5.11E-19	4.86E-19	4.33E-19	4.25E-19
W-187	1.62E-17	1.49E-17	1.39E-17	1.33E-17	1.22E-17	1.19E-17
W-188	1.76E-19	1.61E-19	1.52E-19	1.44E-19	1.33E-19	1.30E-19
W-190	4.27E-18	3.88E-18	3.57E-18	3.40E-18	3.04E-18	2.98E-18
<b>Rhenium</b>						
Re-178	6.06E-17	5.61E-17	5.29E-17	5.09E-17	4.72E-17	4.64E-17
Re-179	3.74E-17	3.44E-17	3.22E-17	3.09E-17	2.85E-17	2.79E-17
Re-180	4.24E-17	3.90E-17	3.68E-17	3.50E-17	3.22E-17	3.17E-17
Re-181	2.73E-17	2.49E-17	2.33E-17	2.23E-17	2.04E-17	2.00E-17
Re-182	6.11E-17	5.62E-17	5.30E-17	5.05E-17	4.65E-17	4.57E-17
Re-182m	4.20E-17	3.88E-17	3.66E-17	3.50E-17	3.23E-17	3.18E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	3.67E-18	3.29E-18	3.02E-18	2.86E-18	2.54E-18	2.49E-18
Re-184	3.10E-17	2.86E-17	2.69E-17	2.55E-17	2.35E-17	2.31E-17
Re-184m	1.24E-17	1.13E-17	1.06E-17	1.01E-17	9.23E-18	9.06E-18
Re-186	1.14E-18	1.05E-18	9.82E-19	9.35E-19	8.52E-19	8.37E-19
Re-186m	2.39E-19	2.04E-19	1.83E-19	1.70E-19	1.45E-19	1.42E-19
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	3.94E-18	3.64E-18	3.42E-18	3.27E-18	3.01E-18	2.96E-18
Re-188m	1.35E-18	1.19E-18	1.08E-18	1.02E-18	8.89E-19	8.68E-19
Re-189	2.37E-18	2.16E-18	2.03E-18	1.93E-18	1.76E-18	1.73E-18
Re-190	4.91E-17	4.50E-17	4.21E-17	4.02E-17	3.69E-17	3.63E-17
Re-190m	3.33E-17	3.05E-17	2.85E-17	2.72E-17	2.49E-17	2.45E-17
<b>Osmium</b>						
Os-180	3.34E-18	3.02E-18	2.79E-18	2.65E-18	2.39E-18	2.34E-18
Os-181	4.80E-17	4.41E-17	4.16E-17	3.98E-17	3.67E-17	3.60E-17
Os-182	1.41E-17	1.29E-17	1.19E-17	1.14E-17	1.04E-17	1.02E-17
Os-183	2.04E-17	1.86E-17	1.73E-17	1.65E-17	1.50E-17	1.48E-17
Os-183m	3.54E-17	3.27E-17	3.09E-17	2.94E-17	2.72E-17	2.67E-17
Os-185	2.42E-17	2.22E-17	2.07E-17	1.98E-17	1.82E-17	1.78E-17
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	6.40E-23	4.30E-23	2.59E-23	2.36E-23	8.35E-24	7.69E-24
Os-190m	5.64E-17	5.16E-17	4.81E-17	4.60E-17	4.22E-17	4.14E-17
Os-191	1.91E-18	1.73E-18	1.58E-18	1.51E-18	1.33E-18	1.30E-18
Os-191m	1.04E-19	9.11E-20	8.24E-20	7.73E-20	6.66E-20	6.49E-20
Os-193	2.82E-18	2.58E-18	2.40E-18	2.30E-18	2.10E-18	2.06E-18
Os-194	3.02E-20	2.44E-20	2.11E-20	1.91E-20	1.61E-20	1.57E-20
Os-196	3.33E-18	3.04E-18	2.84E-18	2.71E-18	2.48E-18	2.43E-18
<b>Iridium</b>						
Ir-180	6.04E-17	5.55E-17	5.19E-17	4.96E-17	4.55E-17	4.47E-17
Ir-182	5.28E-17	4.85E-17	4.54E-17	4.34E-17	3.99E-17	3.92E-17
Ir-183	4.12E-17	3.79E-17	3.57E-17	3.43E-17	3.17E-17	3.11E-17
Ir-184	6.94E-17	6.39E-17	6.01E-17	5.75E-17	5.31E-17	5.21E-17
Ir-185	2.90E-17	2.67E-17	2.52E-17	2.42E-17	2.24E-17	2.20E-17
Ir-186	5.80E-17	5.34E-17	5.02E-17	4.81E-17	4.44E-17	4.36E-17
Ir-186m	4.41E-17	4.07E-17	3.83E-17	3.67E-17	3.39E-17	3.34E-17
Ir-187	1.07E-17	9.74E-18	9.12E-18	8.67E-18	7.93E-18	7.78E-18
Ir-188	7.33E-17	6.80E-17	6.42E-17	6.21E-17	5.78E-17	5.68E-17
Ir-189	1.72E-18	1.52E-18	1.40E-18	1.32E-18	1.17E-18	1.14E-18
Ir-190	5.17E-17	4.73E-17	4.41E-17	4.22E-17	3.86E-17	3.79E-17
Ir-190m	7.09E-23	4.89E-23	3.02E-23	2.76E-23	9.55E-24	8.77E-24
Ir-190n	1.08E-18	9.53E-19	8.66E-19	8.14E-19	7.08E-19	6.91E-19
Ir-191m	1.70E-18	1.54E-18	1.41E-18	1.34E-18	1.18E-18	1.16E-18
Ir-192	2.90E-17	2.65E-17	2.47E-17	2.36E-17	2.16E-17	2.12E-17
Ir-192m	2.04E-21	1.79E-21	1.61E-21	1.52E-21	1.33E-21	1.30E-21
Ir-192n	1.35E-20	1.20E-20	1.08E-20	1.03E-20	8.89E-21	8.69E-21
Ir-193m	5.82E-21	5.09E-21	4.60E-21	4.33E-21	3.72E-21	3.62E-21
Ir-194	5.30E-18	4.88E-18	4.60E-18	4.39E-18	4.05E-18	3.98E-18



**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	8.35E-17	7.65E-17	7.13E-17	6.83E-17	6.26E-17	6.14E-17
Ir-195	1.85E-18	1.67E-18	1.55E-18	1.47E-18	1.32E-18	1.29E-18
Ir-195m	1.30E-17	1.19E-17	1.11E-17	1.06E-17	9.66E-18	9.47E-18
Ir-196	1.17E-17	1.08E-17	1.01E-17	9.68E-18	8.93E-18	8.78E-18
Ir-196m	8.86E-17	8.12E-17	7.56E-17	7.24E-17	6.64E-17	6.51E-17
<b>Platinum</b>						
Pt-184	2.29E-17	2.09E-17	1.94E-17	1.85E-17	1.68E-17	1.65E-17
Pt-186	2.34E-17	2.15E-17	2.00E-17	1.91E-17	1.75E-17	1.72E-17
Pt-187	2.03E-17	1.86E-17	1.74E-17	1.66E-17	1.52E-17	1.49E-17
Pt-188	5.81E-18	5.25E-18	4.87E-18	4.63E-18	4.18E-18	4.09E-18
Pt-189	1.56E-17	1.43E-17	1.33E-17	1.27E-17	1.16E-17	1.14E-17
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	8.74E-18	7.93E-18	7.34E-18	7.01E-18	6.34E-18	6.21E-18
Pt-193	1.72E-22	1.20E-22	7.64E-23	7.03E-23	2.43E-23	2.23E-23
Pt-193m	2.00E-19	1.77E-19	1.61E-19	1.52E-19	1.31E-19	1.28E-19
Pt-195m	1.47E-18	1.30E-18	1.19E-18	1.13E-18	9.82E-19	9.59E-19
Pt-197	8.90E-19	8.09E-19	7.54E-19	7.16E-19	6.46E-19	6.33E-19
Pt-197m	2.26E-18	2.04E-18	1.89E-18	1.80E-18	1.62E-18	1.58E-18
Pt-199	8.22E-18	7.55E-18	7.05E-18	6.74E-18	6.19E-18	6.08E-18
Pt-200	1.79E-18	1.62E-18	1.51E-18	1.43E-18	1.29E-18	1.26E-18
Pt-202	1.56E-18	1.44E-18	1.37E-18	1.31E-18	1.21E-18	1.19E-18
<b>Gold</b>						
Au-186	5.63E-17	5.17E-17	4.85E-17	4.64E-17	4.27E-17	4.19E-17
Au-187	3.72E-17	3.44E-17	3.24E-17	3.11E-17	2.88E-17	2.83E-17
Au-190	8.32E-17	7.71E-17	7.28E-17	7.05E-17	6.55E-17	6.45E-17
Au-191	1.98E-17	1.81E-17	1.69E-17	1.61E-17	1.47E-17	1.44E-17
Au-192	6.79E-17	6.28E-17	5.93E-17	5.73E-17	5.32E-17	5.23E-17
Au-193	4.50E-18	4.06E-18	3.76E-18	3.58E-18	3.21E-18	3.14E-18
Au-193m	6.44E-18	5.83E-18	5.46E-18	5.19E-18	4.73E-18	4.64E-18
Au-194	3.61E-17	3.32E-17	3.13E-17	3.01E-17	2.78E-17	2.73E-17
Au-195	1.61E-18	1.42E-18	1.30E-18	1.23E-18	1.07E-18	1.04E-18
Au-195m	6.56E-18	5.93E-18	5.56E-18	5.29E-18	4.82E-18	4.72E-18
Au-196	1.58E-17	1.44E-17	1.34E-17	1.28E-17	1.17E-17	1.14E-17
Au-196m	6.84E-18	6.24E-18	5.78E-18	5.50E-18	4.95E-18	4.85E-18
Au-198	1.49E-17	1.36E-17	1.27E-17	1.22E-17	1.11E-17	1.09E-17
Au-198m	1.63E-17	1.48E-17	1.38E-17	1.31E-17	1.19E-17	1.16E-17
Au-199	2.93E-18	2.69E-18	2.49E-18	2.38E-18	2.15E-18	2.11E-18
Au-200	1.17E-17	1.08E-17	1.02E-17	9.71E-18	8.99E-18	8.84E-18
Au-200m	7.06E-17	6.47E-17	6.04E-17	5.77E-17	5.29E-17	5.19E-17
Au-201	2.06E-18	1.89E-18	1.78E-18	1.70E-18	1.56E-18	1.54E-18
Au-202	9.24E-18	8.54E-18	8.06E-18	7.70E-18	7.13E-18	7.01E-18
<b>Mercury</b>						
Hg-190	5.26E-18	4.83E-18	4.43E-18	4.23E-18	3.78E-18	3.70E-18
Hg-191m	5.19E-17	4.77E-17	4.48E-17	4.28E-17	3.94E-17	3.87E-17
Hg-192	8.11E-18	7.33E-18	6.82E-18	6.49E-18	5.87E-18	5.75E-18
Hg-193	2.87E-17	2.65E-17	2.49E-17	2.39E-17	2.20E-17	2.16E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	3.59E-17	3.30E-17	3.10E-17	2.97E-17	2.74E-17	2.69E-17
Hg-194	2.61E-22	1.91E-22	1.28E-22	1.19E-22	4.12E-23	3.77E-23
Hg-195	6.06E-18	5.54E-18	5.18E-18	4.93E-18	4.49E-18	4.40E-18
Hg-195m	6.36E-18	5.78E-18	5.39E-18	5.14E-18	4.68E-18	4.59E-18
Hg-197	1.42E-18	1.26E-18	1.15E-18	1.09E-18	9.49E-19	9.25E-19
Hg-197m	2.55E-18	2.33E-18	2.15E-18	2.05E-18	1.83E-18	1.80E-18
Hg-199m	5.33E-18	4.88E-18	4.51E-18	4.31E-18	3.88E-18	3.81E-18
Hg-203	8.15E-18	7.38E-18	6.92E-18	6.59E-18	6.01E-18	5.89E-18
Hg-205	1.37E-18	1.26E-18	1.20E-18	1.14E-18	1.06E-18	1.04E-18
Hg-206	4.94E-18	4.50E-18	4.21E-18	4.02E-18	3.68E-18	3.61E-18
Hg-207	9.65E-17	8.93E-17	8.44E-17	8.12E-17	7.54E-17	7.42E-17
<b>Thallium</b>						
Tl-190	5.19E-17	4.77E-17	4.45E-17	4.27E-17	3.92E-17	3.85E-17
Tl-190m	9.04E-17	8.30E-17	7.76E-17	7.42E-17	6.82E-17	6.69E-17
Tl-194	3.41E-17	3.13E-17	2.92E-17	2.79E-17	2.56E-17	2.51E-17
Tl-194m	9.02E-17	8.28E-17	7.74E-17	7.40E-17	6.79E-17	6.67E-17
Tl-195	4.27E-17	3.94E-17	3.72E-17	3.58E-17	3.31E-17	3.26E-17
Tl-196	6.65E-17	6.14E-17	5.78E-17	5.57E-17	5.15E-17	5.06E-17
Tl-197	1.52E-17	1.40E-17	1.31E-17	1.25E-17	1.15E-17	1.13E-17
Tl-198	7.09E-17	6.55E-17	6.17E-17	5.94E-17	5.51E-17	5.42E-17
Tl-198m	4.26E-17	3.90E-17	3.64E-17	3.48E-17	3.19E-17	3.13E-17
Tl-199	7.69E-18	6.99E-18	6.51E-18	6.20E-18	5.63E-18	5.52E-18
Tl-200	4.61E-17	4.24E-17	3.99E-17	3.81E-17	3.52E-17	3.45E-17
Tl-201	2.05E-18	1.84E-18	1.69E-18	1.60E-18	1.41E-18	1.38E-18
Tl-202	1.57E-17	1.43E-17	1.33E-17	1.27E-17	1.16E-17	1.14E-17
Tl-204	4.26E-19	3.93E-19	3.72E-19	3.53E-19	3.26E-19	3.21E-19
Tl-206	1.20E-18	1.12E-18	1.06E-18	1.01E-18	9.36E-19	9.21E-19
Tl-206m	8.61E-17	7.90E-17	7.42E-17	7.07E-17	6.50E-17	6.38E-17
Tl-207	1.16E-18	1.07E-18	1.02E-18	9.68E-19	8.98E-19	8.84E-19
Tl-208	1.19E-16	1.10E-16	1.04E-16	1.01E-16	9.46E-17	9.32E-17
Tl-209	7.74E-17	7.15E-17	6.74E-17	6.49E-17	6.01E-17	5.91E-17
Tl-210	1.02E-16	9.45E-17	8.94E-17	8.57E-17	7.94E-17	7.81E-17
<b>Lead</b>						
Pb-194	3.75E-17	3.45E-17	3.25E-17	3.11E-17	2.87E-17	2.82E-17
Pb-195m	5.86E-17	5.38E-17	5.04E-17	4.81E-17	4.42E-17	4.34E-17
Pb-196	1.62E-17	1.47E-17	1.37E-17	1.31E-17	1.20E-17	1.17E-17
Pb-197	5.40E-17	4.98E-17	4.70E-17	4.50E-17	4.17E-17	4.09E-17
Pb-197m	4.08E-17	3.74E-17	3.50E-17	3.35E-17	3.07E-17	3.02E-17
Pb-198	1.42E-17	1.29E-17	1.21E-17	1.15E-17	1.05E-17	1.03E-17
Pb-199	3.63E-17	3.34E-17	3.15E-17	3.02E-17	2.79E-17	2.74E-17
Pb-200	5.72E-18	5.21E-18	4.82E-18	4.59E-18	4.12E-18	4.04E-18
Pb-201	2.59E-17	2.37E-17	2.23E-17	2.12E-17	1.95E-17	1.91E-17
Pb-201m	1.29E-17	1.18E-17	1.10E-17	1.05E-17	9.67E-18	9.49E-18
Pb-202	2.95E-22	2.02E-22	1.25E-22	1.14E-22	4.01E-23	3.68E-23
Pb-202m	7.17E-17	6.60E-17	6.20E-17	5.91E-17	5.44E-17	5.34E-17
Pb-203	9.89E-18	8.94E-18	8.35E-18	7.95E-18	7.22E-18	7.07E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	7.44E-17	6.86E-17	6.47E-17	6.15E-17	5.67E-17	5.57E-17
Pb-205	2.99E-22	2.04E-22	1.26E-22	1.16E-22	4.06E-23	3.72E-23
Pb-209	3.06E-19	2.83E-19	2.68E-19	2.55E-19	2.36E-19	2.32E-19
Pb-210	2.51E-20	2.01E-20	1.73E-20	1.56E-20	1.28E-20	1.25E-20
Pb-211	3.26E-18	3.00E-18	2.82E-18	2.69E-18	2.48E-18	2.44E-18
Pb-212	4.66E-18	4.22E-18	3.95E-18	3.75E-18	3.41E-18	3.34E-18
Pb-214	8.96E-18	8.16E-18	7.61E-18	7.27E-18	6.64E-18	6.51E-18
<b>Bismuth</b>						
Bi-197	6.09E-17	5.62E-17	5.30E-17	5.06E-17	4.68E-17	4.60E-17
Bi-200	8.67E-17	7.97E-17	7.47E-17	7.13E-17	6.56E-17	6.44E-17
Bi-201	6.12E-17	5.66E-17	5.35E-17	5.12E-17	4.74E-17	4.67E-17
Bi-202	9.84E-17	9.06E-17	8.53E-17	8.14E-17	7.50E-17	7.37E-17
Bi-203	8.45E-17	7.82E-17	7.39E-17	7.09E-17	6.58E-17	6.47E-17
Bi-204	1.04E-16	9.58E-17	9.04E-17	8.62E-17	7.96E-17	7.82E-17
Bi-205	5.98E-17	5.53E-17	5.22E-17	5.02E-17	4.65E-17	4.58E-17
Bi-206	1.17E-16	1.08E-16	1.01E-16	9.69E-17	8.94E-17	8.79E-17
Bi-207	5.46E-17	5.03E-17	4.73E-17	4.52E-17	4.17E-17	4.10E-17
Bi-208	9.10E-17	8.50E-17	8.07E-17	7.88E-17	7.38E-17	7.28E-17
Bi-210	7.74E-19	7.16E-19	6.80E-19	6.47E-19	6.00E-19	5.90E-19
Bi-210m	8.93E-18	8.10E-18	7.59E-18	7.23E-18	6.60E-18	6.47E-18
Bi-211	1.64E-18	1.49E-18	1.39E-18	1.33E-18	1.21E-18	1.19E-18
Bi-212	4.96E-18	4.58E-18	4.32E-18	4.13E-18	3.83E-18	3.76E-18
Bi-212n	1.19E-18	1.10E-18	1.05E-18	9.98E-19	9.26E-19	9.11E-19
Bi-213	5.41E-18	4.96E-18	4.62E-18	4.43E-18	4.06E-18	3.99E-18
Bi-214	5.47E-17	5.06E-17	4.78E-17	4.59E-17	4.26E-17	4.19E-17
Bi-215	1.03E-17	9.39E-18	8.84E-18	8.43E-18	7.75E-18	7.61E-18
Bi-216	3.05E-17	2.80E-17	2.61E-17	2.50E-17	2.30E-17	2.25E-17
<b>Polonium</b>						
Po-203	5.79E-17	5.34E-17	5.04E-17	4.81E-17	4.44E-17	4.37E-17
Po-204	3.97E-17	3.65E-17	3.43E-17	3.26E-17	3.00E-17	2.95E-17
Po-205	5.61E-17	5.17E-17	4.88E-17	4.66E-17	4.30E-17	4.23E-17
Po-206	4.16E-17	3.82E-17	3.59E-17	3.42E-17	3.14E-17	3.09E-17
Po-207	4.54E-17	4.18E-17	3.95E-17	3.75E-17	3.46E-17	3.40E-17
Po-208	7.35E-22	6.73E-22	6.29E-22	6.01E-22	5.50E-22	5.40E-22
Po-209	2.14E-19	1.96E-19	1.85E-19	1.75E-19	1.61E-19	1.58E-19
Po-210	3.53E-22	3.25E-22	3.06E-22	2.91E-22	2.69E-22	2.64E-22
Po-211	2.96E-19	2.72E-19	2.56E-19	2.44E-19	2.25E-19	2.21E-19
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	2.76E-18	2.57E-18	2.43E-18	2.37E-18	2.21E-18	2.18E-18
Po-213	1.36E-21	1.25E-21	1.18E-21	1.12E-21	1.03E-21	1.01E-21
Po-214	3.01E-21	2.78E-21	2.61E-21	2.49E-21	2.29E-21	2.25E-21
Po-215	6.30E-21	5.76E-21	5.35E-21	5.13E-21	4.70E-21	4.61E-21
Po-216	5.55E-22	5.12E-22	4.82E-22	4.58E-22	4.23E-22	4.15E-22
Po-218	1.37E-23	1.27E-23	1.20E-23	1.14E-23	1.05E-23	1.04E-23
<b>Astatine</b>						
At-204	8.42E-17	7.73E-17	7.22E-17	6.90E-17	6.34E-17	6.22E-17

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	4.08E-17	3.76E-17	3.53E-17	3.38E-17	3.11E-17	3.06E-17
At-206	8.92E-17	8.20E-17	7.68E-17	7.35E-17	6.76E-17	6.64E-17
At-207	7.12E-17	6.57E-17	6.19E-17	5.93E-17	5.48E-17	5.38E-17
At-208	1.08E-16	9.97E-17	9.38E-17	8.96E-17	8.27E-17	8.13E-17
At-209	8.09E-17	7.44E-17	6.99E-17	6.66E-17	6.13E-17	6.02E-17
At-210	1.05E-16	9.72E-17	9.20E-17	8.81E-17	8.17E-17	8.03E-17
At-211	7.98E-19	7.17E-19	6.60E-19	6.25E-19	5.52E-19	5.40E-19
At-215	6.03E-21	5.50E-21	5.11E-21	4.90E-21	4.48E-21	4.39E-21
At-216	6.45E-20	5.82E-20	5.39E-20	5.12E-20	4.58E-20	4.48E-20
At-217	8.16E-21	7.42E-21	6.94E-21	6.61E-21	6.03E-21	5.91E-21
At-218	3.12E-21	2.90E-21	2.75E-21	2.63E-21	2.45E-21	2.41E-21
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	1.91E-17	1.75E-17	1.64E-17	1.56E-17	1.43E-17	1.41E-17
<b>Radon</b>						
Rn-207	3.52E-17	3.23E-17	3.02E-17	2.89E-17	2.65E-17	2.60E-17
Rn-209	4.21E-17	3.88E-17	3.64E-17	3.49E-17	3.21E-17	3.16E-17
Rn-210	2.12E-18	1.95E-18	1.82E-18	1.74E-18	1.60E-18	1.57E-18
Rn-211	6.67E-17	6.15E-17	5.80E-17	5.54E-17	5.11E-17	5.03E-17
Rn-212	1.23E-20	1.13E-20	1.06E-20	1.01E-20	9.28E-21	9.11E-21
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	2.74E-20	2.52E-20	2.35E-20	2.25E-20	2.06E-20	2.03E-20
Rn-219	2.03E-18	1.85E-18	1.72E-18	1.65E-18	1.50E-18	1.48E-18
Rn-220	2.27E-20	2.08E-20	1.94E-20	1.86E-20	1.70E-20	1.67E-20
Rn-222	1.40E-20	1.28E-20	1.19E-20	1.14E-20	1.05E-20	1.03E-20
Rn-223	1.31E-17	1.20E-17	1.13E-17	1.08E-17	9.91E-18	9.73E-18
<b>Francium</b>						
Fr-212	4.01E-17	3.70E-17	3.50E-17	3.34E-17	3.08E-17	3.03E-17
Fr-219	1.24E-19	1.13E-19	1.06E-19	1.01E-19	9.23E-20	9.06E-20
Fr-220	2.35E-19	2.13E-19	1.96E-19	1.87E-19	1.66E-19	1.63E-19
Fr-221	9.52E-19	8.63E-19	8.08E-19	7.68E-19	6.99E-19	6.85E-19
Fr-222	7.29E-18	6.68E-18	6.28E-18	5.98E-18	5.48E-18	5.38E-18
Fr-223	1.98E-18	1.79E-18	1.66E-18	1.58E-18	1.43E-18	1.40E-18
Fr-224	2.15E-17	1.99E-17	1.88E-17	1.79E-17	1.66E-17	1.63E-17
Fr-227	1.67E-17	1.53E-17	1.43E-17	1.37E-17	1.25E-17	1.23E-17
<b>Radium</b>						
Ra-219	5.75E-18	5.22E-18	4.87E-18	4.65E-18	4.24E-18	4.16E-18
Ra-220	1.67E-19	1.53E-19	1.42E-19	1.37E-19	1.25E-19	1.23E-19
Ra-221	1.02E-18	9.40E-19	8.66E-19	8.27E-19	7.43E-19	7.29E-19
Ra-222	3.21E-19	2.92E-19	2.72E-19	2.60E-19	2.38E-19	2.33E-19
Ra-223	4.20E-18	3.82E-18	3.55E-18	3.38E-18	3.06E-18	3.00E-18
Ra-224	3.48E-19	3.16E-19	2.96E-19	2.82E-19	2.57E-19	2.52E-19
Ra-225	2.08E-19	1.76E-19	1.57E-19	1.45E-19	1.27E-19	1.24E-19
Ra-226	2.32E-19	2.12E-19	1.97E-19	1.88E-19	1.70E-19	1.67E-19
Ra-227	5.56E-18	5.07E-18	4.74E-18	4.52E-18	4.14E-18	4.06E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	1.82E-21	1.45E-21	1.21E-21	1.17E-21	7.06E-22	6.72E-22
Ra-230	2.71E-18	2.47E-18	2.29E-18	2.19E-18	1.99E-18	1.95E-18
<b>Actinium</b>						
Ac-223	5.49E-19	5.00E-19	4.65E-19	4.44E-19	4.03E-19	3.95E-19
Ac-224	6.71E-18	6.10E-18	5.68E-18	5.40E-18	4.87E-18	4.78E-18
Ac-225	3.97E-19	3.62E-19	3.35E-19	3.19E-19	2.86E-19	2.81E-19
Ac-226	4.63E-18	4.22E-18	3.95E-18	3.76E-18	3.42E-18	3.35E-18
Ac-227	3.29E-21	2.92E-21	2.68E-21	2.54E-21	2.22E-21	2.17E-21
Ac-228	3.17E-17	2.92E-17	2.76E-17	2.63E-17	2.43E-17	2.39E-17
Ac-230	2.18E-17	2.02E-17	1.91E-17	1.83E-17	1.70E-17	1.67E-17
Ac-231	1.51E-17	1.38E-17	1.29E-17	1.23E-17	1.12E-17	1.10E-17
Ac-232	4.36E-17	4.04E-17	3.82E-17	3.69E-17	3.43E-17	3.38E-17
Ac-233	2.01E-17	1.85E-17	1.72E-17	1.65E-17	1.51E-17	1.49E-17
<b>Thorium</b>						
Th-223	1.85E-18	1.68E-18	1.55E-18	1.48E-18	1.32E-18	1.29E-18
Th-224	7.32E-19	6.70E-19	6.23E-19	5.95E-19	5.40E-19	5.29E-19
Th-226	2.26E-19	2.05E-19	1.91E-19	1.81E-19	1.63E-19	1.60E-19
Th-227	3.99E-18	3.61E-18	3.38E-18	3.21E-18	2.92E-18	2.87E-18
Th-228	5.63E-20	5.09E-20	4.71E-20	4.48E-20	4.00E-20	3.92E-20
Th-229	2.25E-18	2.04E-18	1.88E-18	1.79E-18	1.60E-18	1.57E-18
Th-230	9.48E-21	8.44E-21	7.68E-21	7.29E-21	6.29E-21	6.15E-21
Th-231	3.53E-19	3.17E-19	2.92E-19	2.77E-19	2.46E-19	2.40E-19
Th-232	4.57E-21	3.98E-21	3.56E-21	3.36E-21	2.80E-21	2.73E-21
Th-233	1.97E-18	1.81E-18	1.70E-18	1.62E-18	1.49E-18	1.47E-18
Th-234	2.30E-19	2.06E-19	1.90E-19	1.80E-19	1.59E-19	1.56E-19
Th-235	3.52E-18	3.25E-18	3.06E-18	2.92E-18	2.70E-18	2.65E-18
Th-236	1.79E-18	1.64E-18	1.54E-18	1.47E-18	1.35E-18	1.32E-18
<b>Protactinium</b>						
Pa-227	4.54E-19	4.07E-19	3.74E-19	3.54E-19	3.13E-19	3.06E-19
Pa-228	4.78E-17	4.40E-17	4.15E-17	3.96E-17	3.65E-17	3.59E-17
Pa-229	1.51E-18	1.36E-18	1.26E-18	1.20E-18	1.06E-18	1.04E-18
Pa-230	2.32E-17	2.14E-17	2.01E-17	1.92E-17	1.76E-17	1.73E-17
Pa-231	1.12E-18	1.02E-18	9.47E-19	9.03E-19	8.22E-19	8.05E-19
Pa-232	3.36E-17	3.10E-17	2.92E-17	2.78E-17	2.56E-17	2.51E-17
Pa-233	7.17E-18	6.51E-18	6.07E-18	5.80E-18	5.28E-18	5.17E-18
Pa-234	5.20E-17	4.79E-17	4.52E-17	4.30E-17	3.97E-17	3.90E-17
Pa-234m	2.67E-18	2.48E-18	2.35E-18	2.24E-18	2.08E-18	2.05E-18
Pa-235	1.02E-18	9.43E-19	8.95E-19	8.52E-19	7.91E-19	7.78E-19
Pa-236	3.44E-17	3.18E-17	3.00E-17	2.88E-17	2.67E-17	2.62E-17
Pa-237	2.33E-17	2.15E-17	2.02E-17	1.93E-17	1.77E-17	1.74E-17
<b>Uranium</b>						
U-227	3.58E-18	3.24E-18	3.02E-18	2.88E-18	2.61E-18	2.56E-18
U-228	1.11E-19	1.01E-19	9.34E-20	8.88E-20	7.97E-20	7.82E-20
U-230	3.09E-20	2.79E-20	2.57E-20	2.45E-20	2.17E-20	2.12E-20
U-231	1.73E-18	1.56E-18	1.43E-18	1.36E-18	1.21E-18	1.19E-18
U-232	6.48E-21	5.64E-21	5.06E-21	4.80E-21	4.01E-21	3.92E-21

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	7.17E-21	6.38E-21	5.85E-21	5.56E-21	4.88E-21	4.78E-21
U-234	3.45E-21	2.91E-21	2.56E-21	2.43E-21	1.92E-21	1.87E-21
U-235	5.11E-18	4.68E-18	4.35E-18	4.15E-18	3.76E-18	3.69E-18
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	1.99E-21	1.62E-21	1.39E-21	1.32E-21	9.62E-22	9.29E-22
U-237	3.72E-18	3.36E-18	3.11E-18	2.96E-18	2.66E-18	2.61E-18
U-238	1.74E-21	1.43E-21	1.25E-21	1.18E-21	8.94E-22	8.66E-22
U-239	1.98E-18	1.80E-18	1.68E-18	1.59E-18	1.44E-18	1.41E-18
U-240	2.30E-19	2.10E-19	1.96E-19	1.86E-19	1.68E-19	1.65E-19
U-242	2.05E-18	1.88E-18	1.76E-18	1.68E-18	1.53E-18	1.51E-18
<b>Neptunium</b>						
Np-232	4.18E-17	3.84E-17	3.61E-17	3.43E-17	3.16E-17	3.10E-17
Np-233	2.28E-18	2.06E-18	1.91E-18	1.81E-18	1.62E-18	1.59E-18
Np-234	3.89E-17	3.59E-17	3.40E-17	3.27E-17	3.03E-17	2.98E-17
Np-235	1.69E-20	1.47E-20	1.32E-20	1.26E-20	1.05E-20	1.02E-20
Np-236	3.83E-18	3.50E-18	3.23E-18	3.08E-18	2.76E-18	2.71E-18
Np-236m	1.38E-18	1.26E-18	1.17E-18	1.11E-18	9.98E-19	9.80E-19
Np-237	5.49E-19	4.92E-19	4.51E-19	4.28E-19	3.79E-19	3.71E-19
Np-238	2.14E-17	1.98E-17	1.88E-17	1.78E-17	1.65E-17	1.62E-17
Np-239	5.45E-18	4.95E-18	4.61E-18	4.39E-18	3.97E-18	3.89E-18
Np-240	3.76E-17	3.46E-17	3.25E-17	3.10E-17	2.85E-17	2.80E-17
Np-240m	1.30E-17	1.20E-17	1.12E-17	1.07E-17	9.89E-18	9.71E-18
Np-241	1.89E-18	1.74E-18	1.62E-18	1.55E-18	1.41E-18	1.39E-18
Np-242	1.19E-17	1.11E-17	1.05E-17	1.00E-17	9.31E-18	9.15E-18
Np-242m	3.35E-17	3.09E-17	2.91E-17	2.77E-17	2.55E-17	2.51E-17
<b>Plutonium</b>						
Pu-232	1.53E-18	1.39E-18	1.28E-18	1.22E-18	1.09E-18	1.07E-18
Pu-234	1.65E-18	1.50E-18	1.38E-18	1.32E-18	1.17E-18	1.15E-18
Pu-235	2.34E-18	2.12E-18	1.96E-18	1.87E-18	1.67E-18	1.64E-18
Pu-236	2.13E-21	1.65E-21	1.39E-21	1.33E-21	8.88E-22	8.51E-22
Pu-237	1.18E-18	1.06E-18	9.81E-19	9.33E-19	8.31E-19	8.15E-19
Pu-238	1.56E-21	1.17E-21	9.63E-22	9.25E-22	5.56E-22	5.27E-22
Pu-239	2.35E-21	2.03E-21	1.82E-21	1.74E-21	1.45E-21	1.41E-21
Pu-240	1.54E-21	1.17E-21	9.64E-22	9.23E-22	5.69E-22	5.41E-22
Pu-241	9.36E-23	8.59E-23	8.04E-23	7.65E-23	6.97E-23	6.85E-23
Pu-242	4.08E-21	3.56E-21	3.24E-21	3.12E-21	2.66E-21	2.60E-21
Pu-243	8.04E-19	7.29E-19	6.77E-19	6.43E-19	5.78E-19	5.66E-19
Pu-244	7.37E-19	6.83E-19	6.46E-19	6.22E-19	5.78E-19	5.68E-19
Pu-245	1.45E-17	1.33E-17	1.24E-17	1.19E-17	1.09E-17	1.07E-17
Pu-246	3.92E-18	3.55E-18	3.30E-18	3.14E-18	2.83E-18	2.78E-18
<b>Americium</b>						
Am-237	1.19E-17	1.08E-17	1.01E-17	9.62E-18	8.76E-18	8.59E-18
Am-238	3.15E-17	2.90E-17	2.74E-17	2.61E-17	2.40E-17	2.36E-17
Am-239	6.66E-18	6.04E-18	5.61E-18	5.34E-18	4.82E-18	4.73E-18
Am-240	3.63E-17	3.35E-17	3.17E-17	3.01E-17	2.78E-17	2.73E-17
Am-241	3.74E-19	3.19E-19	2.86E-19	2.65E-19	2.26E-19	2.20E-19

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	5.96E-19	5.45E-19	5.08E-19	4.83E-19	4.37E-19	4.30E-19
Am-242m	1.06E-20	8.67E-21	7.60E-21	7.24E-21	5.65E-21	5.48E-21
Am-243	1.14E-18	1.02E-18	9.30E-19	8.78E-19	7.66E-19	7.47E-19
Am-244	2.84E-17	2.61E-17	2.46E-17	2.34E-17	2.15E-17	2.12E-17
Am-244m	1.61E-18	1.49E-18	1.41E-18	1.34E-18	1.24E-18	1.22E-18
Am-245	1.40E-18	1.28E-18	1.20E-18	1.14E-18	1.04E-18	1.02E-18
Am-246	2.63E-17	2.42E-17	2.27E-17	2.16E-17	1.98E-17	1.95E-17
Am-246m	3.62E-17	3.34E-17	3.16E-17	3.01E-17	2.78E-17	2.74E-17
Am-247	5.08E-18	4.64E-18	4.34E-18	4.13E-18	3.76E-18	3.69E-18
<b>Curium</b>						
Cm-238	2.04E-18	1.86E-18	1.72E-18	1.64E-18	1.46E-18	1.44E-18
Cm-239	7.57E-18	6.92E-18	6.43E-18	6.12E-18	5.53E-18	5.43E-18
Cm-240	2.08E-21	1.55E-21	1.28E-21	1.23E-21	7.71E-22	7.34E-22
Cm-241	1.66E-17	1.52E-17	1.41E-17	1.35E-17	1.23E-17	1.21E-17
Cm-242	1.75E-21	1.29E-21	1.06E-21	1.02E-21	6.15E-22	5.83E-22
Cm-243	3.90E-18	3.54E-18	3.30E-18	3.14E-18	2.84E-18	2.79E-18
Cm-244	2.01E-21	1.58E-21	1.36E-21	1.31E-21	9.35E-22	9.01E-22
Cm-245	2.72E-18	2.48E-18	2.29E-18	2.18E-18	1.96E-18	1.92E-18
Cm-246	1.34E-19	1.24E-19	1.17E-19	1.13E-19	1.05E-19	1.03E-19
Cm-247	1.11E-17	1.01E-17	9.43E-18	9.04E-18	8.27E-18	8.11E-18
Cm-248	4.86E-17	4.50E-17	4.26E-17	4.10E-17	3.81E-17	3.75E-17
Cm-249	1.16E-18	1.07E-18	1.01E-18	9.60E-19	8.84E-19	8.69E-19
Cm-250	4.96E-16	4.60E-16	4.35E-16	4.19E-16	3.89E-16	3.83E-16
Cm-251	4.77E-18	4.39E-18	4.10E-18	3.92E-18	3.60E-18	3.54E-18
<b>Berkelium</b>						
Bk-245	6.67E-18	6.07E-18	5.64E-18	5.37E-18	4.85E-18	4.76E-18
Bk-246	2.98E-17	2.74E-17	2.59E-17	2.46E-17	2.26E-17	2.22E-17
Bk-247	4.34E-18	3.93E-18	3.66E-18	3.49E-18	3.15E-18	3.09E-18
Bk-248m	1.94E-18	1.78E-18	1.65E-18	1.58E-18	1.44E-18	1.41E-18
Bk-249	1.75E-20	1.62E-20	1.53E-20	1.46E-20	1.35E-20	1.33E-20
Bk-250	3.28E-17	3.03E-17	2.87E-17	2.73E-17	2.52E-17	2.48E-17
Bk-251	2.85E-18	2.62E-18	2.43E-18	2.32E-18	2.09E-18	2.06E-18
<b>Californium</b>						
Cf-244	1.77E-21	1.22E-21	9.68E-22	9.31E-22	5.02E-22	4.68E-22
Cf-246	2.58E-21	2.09E-21	1.83E-21	1.76E-21	1.37E-21	1.33E-21
Cf-247	2.46E-18	2.25E-18	2.07E-18	1.98E-18	1.77E-18	1.74E-18
Cf-248	1.37E-20	1.23E-20	1.15E-20	1.10E-20	9.92E-21	9.74E-21
Cf-249	1.14E-17	1.04E-17	9.68E-18	9.27E-18	8.47E-18	8.31E-18
Cf-250	3.62E-19	3.35E-19	3.16E-19	3.05E-19	2.83E-19	2.78E-19
Cf-251	3.43E-18	3.13E-18	2.91E-18	2.77E-18	2.50E-18	2.45E-18
Cf-252	1.68E-17	1.56E-17	1.47E-17	1.42E-17	1.32E-17	1.30E-17
Cf-253	7.79E-20	7.04E-20	6.60E-20	6.26E-20	5.69E-20	5.58E-20
Cf-254	6.25E-16	5.79E-16	5.48E-16	5.28E-16	4.90E-16	4.83E-16
Cf-255	3.52E-19	3.25E-19	3.08E-19	2.93E-19	2.71E-19	2.67E-19
<b>Einsteinium</b>						
Es-249	1.36E-17	1.25E-17	1.16E-17	1.11E-17	1.02E-17	9.97E-18

**Table 4-4. Reference person effective dose rate coefficients for soil to 15 cm. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	4.07E-17	3.74E-17	3.51E-17	3.34E-17	3.06E-17	3.00E-17
Es-250m	1.89E-17	1.75E-17	1.65E-17	1.57E-17	1.45E-17	1.42E-17
Es-251	2.45E-18	2.25E-18	2.07E-18	1.98E-18	1.77E-18	1.74E-18
Es-253	1.12E-20	1.01E-20	9.31E-21	8.91E-21	8.03E-21	7.87E-21
Es-254	9.12E-20	7.82E-20	7.06E-20	6.69E-20	5.72E-20	5.57E-20
Es-254m	1.73E-17	1.59E-17	1.49E-17	1.42E-17	1.31E-17	1.28E-17
Es-255	9.95E-20	9.20E-20	8.72E-20	8.31E-20	7.70E-20	7.57E-20
Es-256	1.31E-18	1.21E-18	1.15E-18	1.09E-18	1.01E-18	9.97E-19
<b>Fermium</b>						
Fm-251	4.65E-18	4.28E-18	3.97E-18	3.79E-18	3.44E-18	3.38E-18
Fm-252	1.12E-20	9.95E-21	9.21E-21	8.85E-21	7.89E-21	7.73E-21
Fm-253	1.61E-18	1.47E-18	1.36E-18	1.30E-18	1.16E-18	1.14E-18
Fm-254	2.58E-19	2.39E-19	2.26E-19	2.17E-19	2.01E-19	1.98E-19
Fm-255	5.18E-20	4.34E-20	3.85E-20	3.65E-20	2.98E-20	2.90E-20
Fm-256	4.57E-16	4.24E-16	4.01E-16	3.86E-16	3.58E-16	3.53E-16
Fm-257	4.35E-18	3.99E-18	3.71E-18	3.55E-18	3.23E-18	3.17E-18



**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth.**

**Explanation of entries**

For each radionuclide, values for the age-dependent effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>15</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ), that is, the effective dose per unit time-integrated exposure to a radionuclide

$w_T$ : The tissue weighting factor

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-5 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to a source per unit mass basis ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{kg}$ ), multiply table entries by  $1.6 \times 10^3$ .

To convert from SI units ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{cm}^3$ ), multiply table entries by  $1.168 \times 10^{23}$ .

To convert from SI units from a source per unit volume ( $\text{Sv Bq}^{-1} \text{s}^{-1} \text{m}^3$ ) to conventional units for a source per unit mass basis ( $\text{mrem } \mu\text{Ci}^{-1} \text{y}^{-1} \text{g}$ ), multiply table entries by  $1.868 \times 10^{23}$ .

To derive coefficients for a soil density other than  $1.6 \times 10^3 \text{ kg m}^{-3}$ , multiply coefficients (in any units) by  $(1.6 \times 10^3 / \rho)$ , where  $\rho$  is the soil density in  $\text{kg m}^{-3}$ .

<sup>15</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	4.55E-23	4.19E-23	3.96E-23	3.76E-23	3.47E-23	3.41E-23
<b>Beryllium</b>						
Be-7	1.96E-18	1.80E-18	1.66E-18	1.60E-18	1.46E-18	1.44E-18
Be-10	4.84E-19	4.45E-19	4.21E-19	4.00E-19	3.69E-19	3.63E-19
<b>Carbon</b>						
C-10	7.26E-17	6.67E-17	6.21E-17	5.94E-17	5.45E-17	5.35E-17
C-11	4.13E-17	3.79E-17	3.51E-17	3.37E-17	3.09E-17	3.03E-17
C-14	4.19E-20	3.86E-20	3.64E-20	3.46E-20	3.19E-20	3.14E-20
<b>Nitrogen</b>						
N-13	4.16E-17	3.82E-17	3.54E-17	3.40E-17	3.11E-17	3.05E-17
N-16	2.36E-16	2.26E-16	2.17E-16	2.12E-16	2.02E-16	2.00E-16
<b>Oxygen</b>						
O-14	1.48E-16	1.37E-16	1.29E-16	1.25E-16	1.16E-16	1.14E-16
O-15	4.26E-17	3.91E-17	3.62E-17	3.47E-17	3.19E-17	3.13E-17
O-19	4.65E-17	4.28E-17	4.04E-17	3.87E-17	3.57E-17	3.51E-17
<b>Fluorine</b>						
F-17	4.26E-17	3.91E-17	3.62E-17	3.47E-17	3.19E-17	3.13E-17
F-18	3.97E-17	3.64E-17	3.37E-17	3.23E-17	2.96E-17	2.91E-17
<b>Neon</b>						
Ne-19	4.35E-17	3.99E-17	3.71E-17	3.55E-17	3.26E-17	3.20E-17
Ne-24	2.38E-17	2.19E-17	2.04E-17	1.95E-17	1.79E-17	1.76E-17
<b>Sodium</b>						
Na-22	9.22E-17	8.49E-17	7.96E-17	7.62E-17	7.02E-17	6.90E-17
Na-24	1.88E-16	1.75E-16	1.65E-16	1.60E-16	1.49E-16	1.47E-16
<b>Magnesium</b>						
Mg-27	3.94E-17	3.63E-17	3.41E-17	3.25E-17	2.99E-17	2.94E-17
Mg-28	5.81E-17	5.36E-17	5.05E-17	4.83E-17	4.46E-17	4.38E-17
<b>Aluminum</b>						
Al-26	1.17E-16	1.08E-16	1.02E-16	9.80E-17	9.07E-17	8.91E-17
Al-28	8.43E-17	7.81E-17	7.37E-17	7.13E-17	6.62E-17	6.51E-17
Al-29	6.36E-17	5.88E-17	5.55E-17	5.32E-17	4.93E-17	4.85E-17
<b>Silicon</b>						
Si-31	1.63E-18	1.50E-18	1.42E-18	1.35E-18	1.25E-18	1.23E-18
Si-32	7.40E-20	6.81E-20	6.43E-20	6.11E-20	5.64E-20	5.54E-20
<b>Phosphorus</b>						
P-30	4.58E-17	4.21E-17	3.91E-17	3.74E-17	3.44E-17	3.37E-17
P-32	1.96E-18	1.81E-18	1.71E-18	1.63E-18	1.51E-18	1.49E-18
P-33	8.79E-20	8.09E-20	7.64E-20	7.26E-20	6.70E-20	6.59E-20
<b>Sulfur</b>						
S-35	4.21E-20	3.88E-20	3.66E-20	3.48E-20	3.21E-20	3.16E-20
S-37	1.38E-16	1.29E-16	1.22E-16	1.19E-16	1.11E-16	1.09E-16
S-38	7.81E-17	7.24E-17	6.84E-17	6.63E-17	6.17E-17	6.07E-17
<b>Chlorine</b>						
Cl-34	4.92E-17	4.52E-17	4.21E-17	4.04E-17	3.71E-17	3.64E-17
Cl-34m	9.33E-17	8.65E-17	8.14E-17	7.87E-17	7.30E-17	7.18E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	5.61E-19	5.17E-19	4.88E-19	4.64E-19	4.29E-19	4.21E-19
Cl-38	7.19E-17	6.67E-17	6.30E-17	6.10E-17	5.68E-17	5.58E-17
Cl-39	6.52E-17	6.01E-17	5.68E-17	5.44E-17	5.03E-17	4.95E-17
Cl-40	1.91E-16	1.78E-16	1.69E-16	1.64E-16	1.53E-16	1.50E-16
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	4.06E-19	3.74E-19	3.53E-19	3.36E-19	3.10E-19	3.05E-19
Ar-41	5.71E-17	5.27E-17	4.98E-17	4.76E-17	4.40E-17	4.33E-17
Ar-42	4.42E-19	4.07E-19	3.85E-19	3.66E-19	3.37E-19	3.32E-19
Ar-43	7.24E-17	6.70E-17	6.32E-17	6.07E-17	5.63E-17	5.54E-17
Ar-44	8.66E-17	8.01E-17	7.55E-17	7.29E-17	6.76E-17	6.65E-17
<b>Potassium</b>						
K-38	1.43E-16	1.33E-16	1.25E-16	1.21E-16	1.12E-16	1.10E-16
K-40	8.30E-18	7.67E-18	7.24E-18	6.95E-18	6.43E-18	6.33E-18
K-42	1.77E-17	1.64E-17	1.55E-17	1.49E-17	1.38E-17	1.36E-17
K-43	3.88E-17	3.56E-17	3.31E-17	3.17E-17	2.90E-17	2.85E-17
K-44	1.12E-16	1.04E-16	9.85E-17	9.49E-17	8.82E-17	8.68E-17
K-45	8.40E-17	7.78E-17	7.34E-17	7.08E-17	6.57E-17	6.46E-17
K-46	1.41E-16	1.31E-16	1.24E-16	1.20E-16	1.11E-16	1.10E-16
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	8.99E-20	8.27E-20	7.81E-20	7.43E-20	6.85E-20	6.74E-20
Ca-47	4.65E-17	4.29E-17	4.05E-17	3.87E-17	3.58E-17	3.52E-17
Ca-49	1.49E-16	1.39E-16	1.32E-16	1.28E-16	1.20E-16	1.18E-16
<b>Scandium</b>						
Sc-42m	1.82E-16	1.68E-16	1.58E-16	1.51E-16	1.40E-16	1.37E-16
Sc-43	3.99E-17	3.66E-17	3.39E-17	3.25E-17	2.98E-17	2.93E-17
Sc-44	9.04E-17	8.32E-17	7.79E-17	7.45E-17	6.86E-17	6.73E-17
Sc-44m	1.02E-17	9.30E-18	8.72E-18	8.31E-18	7.60E-18	7.45E-18
Sc-46	8.56E-17	7.88E-17	7.44E-17	7.07E-17	6.52E-17	6.41E-17
Sc-47	3.73E-18	3.46E-18	3.20E-18	3.06E-18	2.76E-18	2.72E-18
Sc-48	1.44E-16	1.33E-16	1.26E-16	1.20E-16	1.11E-16	1.09E-16
Sc-49	2.49E-18	2.30E-18	2.18E-18	2.08E-18	1.93E-18	1.90E-18
Sc-50	1.45E-16	1.34E-16	1.26E-16	1.21E-16	1.12E-16	1.10E-16
<b>Titanium</b>						
Ti-44	2.90E-18	2.58E-18	2.36E-18	2.23E-18	1.94E-18	1.90E-18
Ti-45	3.54E-17	3.25E-17	3.01E-17	2.89E-17	2.65E-17	2.60E-17
Ti-51	1.68E-17	1.53E-17	1.43E-17	1.37E-17	1.26E-17	1.23E-17
Ti-52	5.75E-18	5.31E-18	4.94E-18	4.72E-18	4.28E-18	4.21E-18
<b>Vanadium</b>						
V-47	4.19E-17	3.84E-17	3.57E-17	3.42E-17	3.14E-17	3.08E-17
V-48	1.24E-16	1.14E-16	1.08E-16	1.03E-16	9.49E-17	9.33E-17
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	6.28E-17	5.81E-17	5.48E-17	5.27E-17	4.88E-17	4.80E-17
V-52	6.72E-17	6.21E-17	5.86E-17	5.63E-17	5.21E-17	5.13E-17
V-53	4.75E-17	4.37E-17	4.13E-17	3.93E-17	3.62E-17	3.56E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	1.52E-17	1.38E-17	1.28E-17	1.23E-17	1.12E-17	1.09E-17
Cr-49	4.21E-17	3.86E-17	3.58E-17	3.43E-17	3.14E-17	3.08E-17
Cr-51	1.19E-18	1.08E-18	1.01E-18	9.60E-19	8.78E-19	8.60E-19
Cr-55	3.69E-18	3.41E-18	3.23E-18	3.09E-18	2.86E-18	2.81E-18
Cr-56	3.44E-18	3.12E-18	2.90E-18	2.76E-18	2.48E-18	2.44E-18
<b>Manganese</b>						
Mn-50m	2.02E-16	1.86E-16	1.75E-16	1.67E-16	1.54E-16	1.52E-16
Mn-51	4.25E-17	3.90E-17	3.62E-17	3.47E-17	3.18E-17	3.12E-17
Mn-52	1.47E-16	1.36E-16	1.28E-16	1.22E-16	1.13E-16	1.11E-16
Mn-52m	1.06E-16	9.73E-17	9.12E-17	8.75E-17	8.08E-17	7.94E-17
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	3.48E-17	3.20E-17	3.01E-17	2.86E-17	2.63E-17	2.59E-17
Mn-56	7.63E-17	7.05E-17	6.65E-17	6.38E-17	5.91E-17	5.81E-17
Mn-57	7.37E-18	6.80E-18	6.39E-18	6.11E-18	5.64E-18	5.54E-18
Mn-58m	1.10E-16	1.01E-16	9.53E-17	9.13E-17	8.44E-17	8.30E-17
<b>Iron</b>						
Fe-52	2.85E-17	2.62E-17	2.43E-17	2.33E-17	2.13E-17	2.09E-17
Fe-53	5.03E-17	4.62E-17	4.29E-17	4.11E-17	3.77E-17	3.70E-17
Fe-53m	1.31E-16	1.21E-16	1.14E-16	1.09E-16	1.01E-16	9.91E-17
Fe-55	4.69E-27	4.33E-27	3.98E-27	3.81E-27	3.42E-27	3.36E-27
Fe-59	5.14E-17	4.74E-17	4.48E-17	4.27E-17	3.95E-17	3.88E-17
Fe-60	6.50E-20	5.99E-20	5.65E-20	5.37E-20	4.96E-20	4.87E-20
Fe-61	6.35E-17	5.85E-17	5.52E-17	5.28E-17	4.88E-17	4.80E-17
Fe-62	2.25E-17	2.07E-17	1.92E-17	1.84E-17	1.69E-17	1.66E-17
<b>Cobalt</b>						
Co-54m	1.74E-16	1.60E-16	1.50E-16	1.44E-16	1.33E-16	1.30E-16
Co-55	8.37E-17	7.70E-17	7.21E-17	6.89E-17	6.34E-17	6.23E-17
Co-56	1.60E-16	1.48E-16	1.39E-16	1.34E-16	1.24E-16	1.22E-16
Co-57	3.48E-18	3.21E-18	2.96E-18	2.83E-18	2.54E-18	2.49E-18
Co-58	4.03E-17	3.70E-17	3.47E-17	3.31E-17	3.04E-17	2.99E-17
Co-58m	2.43E-23	1.64E-23	1.28E-23	1.16E-23	7.81E-24	7.41E-24
Co-60	1.09E-16	1.01E-16	9.50E-17	9.08E-17	8.39E-17	8.25E-17
Co-60m	1.67E-19	1.53E-19	1.44E-19	1.37E-19	1.26E-19	1.24E-19
Co-61	3.90E-18	3.55E-18	3.31E-18	3.14E-18	2.85E-18	2.80E-18
Co-62	7.70E-17	7.12E-17	6.73E-17	6.45E-17	5.98E-17	5.88E-17
Co-62m	1.21E-16	1.12E-16	1.06E-16	1.01E-16	9.39E-17	9.23E-17
<b>Nickel</b>						
Ni-56	6.95E-17	6.40E-17	5.99E-17	5.72E-17	5.26E-17	5.16E-17
Ni-57	8.36E-17	7.71E-17	7.25E-17	6.97E-17	6.44E-17	6.33E-17
Ni-59	6.16E-22	5.65E-22	5.24E-22	5.02E-22	4.60E-22	4.52E-22
Ni-63	5.46E-21	5.03E-21	4.75E-21	4.51E-21	4.16E-21	4.09E-21
Ni-65	2.62E-17	2.42E-17	2.28E-17	2.19E-17	2.02E-17	1.99E-17
Ni-66	8.35E-20	7.68E-20	7.26E-20	6.90E-20	6.36E-20	6.26E-20
<b>Copper</b>						
Cu-57	6.89E-17	6.38E-17	5.98E-17	5.74E-17	5.32E-17	5.23E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	6.41E-17	5.90E-17	5.50E-17	5.27E-17	4.84E-17	4.76E-17
Cu-60	1.72E-16	1.59E-16	1.49E-16	1.44E-16	1.33E-16	1.31E-16
Cu-61	3.35E-17	3.08E-17	2.86E-17	2.74E-17	2.51E-17	2.46E-17
Cu-62	4.45E-17	4.08E-17	3.79E-17	3.63E-17	3.34E-17	3.27E-17
Cu-64	7.56E-18	6.94E-18	6.44E-18	6.17E-18	5.66E-18	5.55E-18
Cu-66	7.70E-18	7.10E-18	6.71E-18	6.39E-18	5.91E-18	5.81E-18
Cu-67	3.88E-18	3.54E-18	3.30E-18	3.14E-18	2.85E-18	2.79E-18
Cu-69	2.51E-17	2.31E-17	2.18E-17	2.08E-17	1.92E-17	1.88E-17
<b>Zinc</b>						
Zn-60	6.44E-17	5.91E-17	5.49E-17	5.26E-17	4.83E-17	4.74E-17
Zn-61	7.07E-17	6.51E-17	6.08E-17	5.84E-17	5.38E-17	5.29E-17
Zn-62	1.72E-17	1.58E-17	1.47E-17	1.40E-17	1.29E-17	1.26E-17
Zn-63	4.68E-17	4.30E-17	3.99E-17	3.82E-17	3.51E-17	3.44E-17
Zn-65	2.48E-17	2.29E-17	2.16E-17	2.05E-17	1.90E-17	1.87E-17
Zn-69	6.96E-19	6.42E-19	6.06E-19	5.77E-19	5.33E-19	5.24E-19
Zn-69m	1.62E-17	1.48E-17	1.37E-17	1.32E-17	1.20E-17	1.18E-17
Zn-71	1.62E-17	1.49E-17	1.40E-17	1.34E-17	1.23E-17	1.21E-17
Zn-71m	6.37E-17	5.84E-17	5.44E-17	5.20E-17	4.78E-17	4.69E-17
Zn-72	4.60E-18	4.26E-18	3.93E-18	3.76E-18	3.39E-18	3.33E-18
<b>Gallium</b>						
Ga-64	1.53E-16	1.41E-16	1.33E-16	1.28E-16	1.19E-16	1.17E-16
Ga-65	4.79E-17	4.39E-17	4.08E-17	3.91E-17	3.59E-17	3.52E-17
Ga-66	1.13E-16	1.05E-16	9.93E-17	9.59E-17	8.92E-17	8.78E-17
Ga-67	5.13E-18	4.66E-18	4.34E-18	4.14E-18	3.76E-18	3.68E-18
Ga-68	3.99E-17	3.66E-17	3.40E-17	3.26E-17	2.99E-17	2.93E-17
Ga-70	2.09E-18	1.93E-18	1.82E-18	1.74E-18	1.61E-18	1.58E-18
Ga-72	1.20E-16	1.11E-16	1.04E-16	1.00E-16	9.30E-17	9.15E-17
Ga-73	1.41E-17	1.28E-17	1.20E-17	1.14E-17	1.05E-17	1.03E-17
Ga-74	1.42E-16	1.32E-16	1.24E-16	1.20E-16	1.11E-16	1.10E-16
<b>Germanium</b>						
Ge-66	2.59E-17	2.37E-17	2.21E-17	2.11E-17	1.93E-17	1.90E-17
Ge-67	6.08E-17	5.59E-17	5.21E-17	5.00E-17	4.59E-17	4.51E-17
Ge-68	5.58E-23	3.58E-23	2.04E-23	1.84E-23	6.64E-24	6.13E-24
Ge-69	3.99E-17	3.67E-17	3.45E-17	3.29E-17	3.03E-17	2.98E-17
Ge-71	5.67E-23	3.63E-23	2.07E-23	1.87E-23	6.74E-24	6.22E-24
Ge-75	2.28E-18	2.08E-18	1.96E-18	1.87E-18	1.71E-18	1.68E-18
Ge-77	4.49E-17	4.12E-17	3.86E-17	3.69E-17	3.39E-17	3.33E-17
Ge-78	1.06E-17	9.60E-18	9.00E-18	8.57E-18	7.83E-18	7.68E-18
<b>Arsenic</b>						
As-68	1.66E-16	1.53E-16	1.44E-16	1.38E-16	1.27E-16	1.25E-16
As-69	4.99E-17	4.59E-17	4.27E-17	4.09E-17	3.76E-17	3.69E-17
As-70	1.83E-16	1.69E-16	1.59E-16	1.52E-16	1.40E-16	1.38E-16
As-71	2.22E-17	2.04E-17	1.90E-17	1.81E-17	1.66E-17	1.63E-17
As-72	7.65E-17	7.03E-17	6.57E-17	6.28E-17	5.78E-17	5.68E-17
As-73	8.38E-20	6.96E-20	6.14E-20	5.61E-20	4.75E-20	4.63E-20
As-74	3.10E-17	2.85E-17	2.64E-17	2.53E-17	2.32E-17	2.28E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	2.08E-17	1.91E-17	1.79E-17	1.71E-17	1.58E-17	1.55E-17
As-77	7.36E-19	6.74E-19	6.34E-19	6.04E-19	5.55E-19	5.45E-19
As-78	6.04E-17	5.58E-17	5.24E-17	5.03E-17	4.65E-17	4.57E-17
As-79	4.06E-18	3.74E-18	3.53E-18	3.37E-18	3.11E-18	3.06E-18
<b>Selenium</b>						
Se-70	2.78E-17	2.55E-17	2.36E-17	2.26E-17	2.07E-17	2.03E-17
Se-71	6.98E-17	6.43E-17	6.00E-17	5.74E-17	5.28E-17	5.18E-17
Se-72	3.15E-19	2.51E-19	2.15E-19	1.94E-19	1.60E-19	1.56E-19
Se-73	4.27E-17	3.90E-17	3.62E-17	3.47E-17	3.17E-17	3.11E-17
Se-73m	1.07E-17	9.84E-18	9.14E-18	8.76E-18	8.03E-18	7.88E-18
Se-75	1.33E-17	1.21E-17	1.13E-17	1.08E-17	9.81E-18	9.62E-18
Se-77m	2.75E-18	2.55E-18	2.36E-18	2.26E-18	2.04E-18	2.00E-18
Se-79	4.66E-20	4.29E-20	4.05E-20	3.85E-20	3.55E-20	3.49E-20
Se-79m	2.31E-19	2.08E-19	1.92E-19	1.83E-19	1.62E-19	1.59E-19
Se-81	1.97E-18	1.82E-18	1.72E-18	1.64E-18	1.51E-18	1.49E-18
Se-81m	3.66E-19	3.31E-19	3.06E-19	2.91E-19	2.60E-19	2.55E-19
Se-83	1.12E-16	1.03E-16	9.71E-17	9.31E-17	8.60E-17	8.45E-17
Se-83m	4.68E-17	4.31E-17	4.07E-17	3.89E-17	3.60E-17	3.54E-17
Se-84	1.76E-17	1.61E-17	1.50E-17	1.44E-17	1.32E-17	1.29E-17
<b>Bromine</b>						
Br-72	1.38E-16	1.27E-16	1.20E-16	1.15E-16	1.06E-16	1.04E-16
Br-73	6.15E-17	5.65E-17	5.26E-17	5.03E-17	4.62E-17	4.53E-17
Br-74	2.06E-16	1.92E-16	1.81E-16	1.75E-16	1.63E-16	1.60E-16
Br-74m	1.83E-16	1.69E-16	1.59E-16	1.53E-16	1.42E-16	1.39E-16
Br-75	4.82E-17	4.42E-17	4.11E-17	3.93E-17	3.60E-17	3.53E-17
Br-76	1.22E-16	1.13E-16	1.06E-16	1.02E-16	9.48E-17	9.32E-17
Br-76m	6.32E-19	5.43E-19	4.87E-19	4.54E-19	3.98E-19	3.89E-19
Br-77	1.22E-17	1.12E-17	1.04E-17	9.95E-18	9.12E-18	8.95E-18
Br-77m	3.94E-19	3.57E-19	3.30E-19	3.14E-19	2.81E-19	2.75E-19
Br-78	4.44E-17	4.08E-17	3.79E-17	3.63E-17	3.33E-17	3.27E-17
Br-80	5.19E-18	4.78E-18	4.48E-18	4.28E-18	3.94E-18	3.87E-18
Br-80m	1.11E-19	8.39E-20	6.81E-20	6.05E-20	4.77E-20	4.61E-20
Br-82	1.11E-16	1.02E-16	9.54E-17	9.11E-17	8.39E-17	8.24E-17
Br-82m	2.27E-19	2.09E-19	1.97E-19	1.88E-19	1.73E-19	1.70E-19
Br-83	9.84E-19	9.06E-19	8.51E-19	8.12E-19	7.48E-19	7.35E-19
Br-84	8.33E-17	7.73E-17	7.31E-17	7.05E-17	6.56E-17	6.46E-17
Br-84m	1.21E-16	1.11E-16	1.05E-16	1.00E-16	9.26E-17	9.10E-17
Br-85	6.21E-18	5.73E-18	5.41E-18	5.16E-18	4.77E-18	4.69E-18
<b>Krypton</b>						
Kr-74	4.21E-17	3.86E-17	3.58E-17	3.43E-17	3.14E-17	3.08E-17
Kr-75	5.57E-17	5.12E-17	4.76E-17	4.56E-17	4.19E-17	4.11E-17
Kr-76	1.56E-17	1.42E-17	1.32E-17	1.26E-17	1.15E-17	1.13E-17
Kr-77	4.15E-17	3.81E-17	3.54E-17	3.39E-17	3.10E-17	3.04E-17
Kr-79	9.76E-18	8.93E-18	8.32E-18	7.95E-18	7.29E-18	7.15E-18
Kr-81	3.12E-20	2.81E-20	2.60E-20	2.48E-20	2.23E-20	2.18E-20
Kr-81m	4.34E-18	3.96E-18	3.70E-18	3.52E-18	3.20E-18	3.14E-18

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	5.86E-22	4.43E-22	3.18E-22	2.96E-22	1.20E-22	1.10E-22
Kr-85	5.85E-19	5.39E-19	5.07E-19	4.83E-19	4.45E-19	4.38E-19
Kr-85m	5.61E-18	5.18E-18	4.80E-18	4.59E-18	4.16E-18	4.08E-18
Kr-87	3.93E-17	3.64E-17	3.43E-17	3.30E-17	3.07E-17	3.01E-17
Kr-88	8.83E-17	8.20E-17	7.74E-17	7.49E-17	6.96E-17	6.85E-17
Kr-89	8.97E-17	8.32E-17	7.84E-17	7.55E-17	7.01E-17	6.90E-17
<b>Rubidium</b>						
Rb-77	6.79E-17	6.24E-17	5.82E-17	5.57E-17	5.12E-17	5.02E-17
Rb-78	1.84E-16	1.71E-16	1.61E-16	1.56E-16	1.45E-16	1.43E-16
Rb-78m	1.41E-16	1.30E-16	1.22E-16	1.17E-16	1.08E-16	1.06E-16
Rb-79	5.93E-17	5.45E-17	5.06E-17	4.85E-17	4.45E-17	4.36E-17
Rb-80	5.61E-17	5.16E-17	4.80E-17	4.60E-17	4.23E-17	4.15E-17
Rb-81	2.03E-17	1.86E-17	1.73E-17	1.65E-17	1.52E-17	1.49E-17
Rb-81m	9.18E-19	8.41E-19	7.83E-19	7.49E-19	6.85E-19	6.73E-19
Rb-82	4.94E-17	4.54E-17	4.22E-17	4.04E-17	3.71E-17	3.64E-17
Rb-82m	1.22E-16	1.12E-16	1.05E-16	1.00E-16	9.24E-17	9.08E-17
Rb-83	1.93E-17	1.77E-17	1.64E-17	1.57E-17	1.44E-17	1.42E-17
Rb-84	3.77E-17	3.46E-17	3.25E-17	3.09E-17	2.85E-17	2.80E-17
Rb-84m	1.41E-17	1.29E-17	1.20E-17	1.14E-17	1.05E-17	1.03E-17
Rb-86	5.89E-18	5.43E-18	5.13E-18	4.88E-18	4.51E-18	4.44E-18
Rb-86m	2.19E-17	2.01E-17	1.86E-17	1.78E-17	1.64E-17	1.61E-17
Rb-87	1.60E-19	1.47E-19	1.39E-19	1.32E-19	1.22E-19	1.20E-19
Rb-88	3.79E-17	3.51E-17	3.32E-17	3.20E-17	2.97E-17	2.93E-17
Rb-89	1.02E-16	9.41E-17	8.88E-17	8.53E-17	7.90E-17	7.77E-17
Rb-90	1.02E-16	9.55E-17	9.05E-17	8.76E-17	8.19E-17	8.08E-17
Rb-90m	1.50E-16	1.39E-16	1.31E-16	1.27E-16	1.18E-16	1.16E-16
<b>Strontium</b>						
Sr-79	5.32E-17	4.88E-17	4.54E-17	4.35E-17	3.99E-17	3.92E-17
Sr-80	1.71E-17	1.57E-17	1.46E-17	1.39E-17	1.28E-17	1.25E-17
Sr-81	5.74E-17	5.28E-17	4.91E-17	4.70E-17	4.31E-17	4.23E-17
Sr-82	2.46E-21	1.90E-21	1.40E-21	1.33E-21	4.75E-22	4.31E-22
Sr-83	3.35E-17	3.07E-17	2.87E-17	2.75E-17	2.53E-17	2.48E-17
Sr-85	1.95E-17	1.79E-17	1.66E-17	1.59E-17	1.46E-17	1.43E-17
Sr-85m	7.56E-18	6.86E-18	6.43E-18	6.12E-18	5.58E-18	5.47E-18
Sr-87m	1.22E-17	1.11E-17	1.03E-17	9.91E-18	9.07E-18	8.89E-18
Sr-89	1.58E-18	1.46E-18	1.38E-18	1.31E-18	1.22E-18	1.20E-18
Sr-90	3.52E-19	3.24E-19	3.06E-19	2.91E-19	2.69E-19	2.64E-19
Sr-91	3.16E-17	2.91E-17	2.74E-17	2.61E-17	2.40E-17	2.36E-17
Sr-92	5.89E-17	5.43E-17	5.13E-17	4.92E-17	4.55E-17	4.48E-17
Sr-93	9.85E-17	9.08E-17	8.54E-17	8.18E-17	7.56E-17	7.43E-17
Sr-94	6.53E-17	6.03E-17	5.69E-17	5.46E-17	5.06E-17	4.97E-17
<b>Yttrium</b>						
Y-81	5.29E-17	4.86E-17	4.52E-17	4.33E-17	3.97E-17	3.90E-17
Y-83	5.87E-17	5.40E-17	5.03E-17	4.82E-17	4.43E-17	4.35E-17
Y-83m	3.53E-17	3.23E-17	3.00E-17	2.88E-17	2.64E-17	2.59E-17
Y-84m	1.70E-16	1.57E-16	1.47E-16	1.40E-16	1.29E-16	1.27E-16

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	4.43E-17	4.06E-17	3.77E-17	3.61E-17	3.32E-17	3.25E-17
Y-85m	5.69E-17	5.24E-17	4.90E-17	4.71E-17	4.35E-17	4.27E-17
Y-86	1.53E-16	1.41E-16	1.33E-16	1.27E-16	1.17E-16	1.15E-16
Y-86m	7.77E-18	7.06E-18	6.62E-18	6.30E-18	5.74E-18	5.63E-18
Y-87	1.72E-17	1.58E-17	1.46E-17	1.40E-17	1.29E-17	1.26E-17
Y-87m	1.17E-17	1.07E-17	9.91E-18	9.49E-18	8.68E-18	8.51E-18
Y-88	1.19E-16	1.10E-16	1.03E-16	9.96E-17	9.23E-17	9.08E-17
Y-89m	3.79E-17	3.49E-17	3.29E-17	3.12E-17	2.88E-17	2.83E-17
Y-90	2.96E-18	2.74E-18	2.59E-18	2.47E-18	2.29E-18	2.26E-18
Y-90m	2.40E-17	2.19E-17	2.04E-17	1.95E-17	1.78E-17	1.75E-17
Y-91	1.78E-18	1.64E-18	1.55E-18	1.48E-18	1.37E-18	1.35E-18
Y-91m	2.11E-17	1.94E-17	1.80E-17	1.72E-17	1.58E-17	1.55E-17
Y-92	1.62E-17	1.49E-17	1.41E-17	1.35E-17	1.24E-17	1.22E-17
Y-93	8.14E-18	7.51E-18	7.09E-18	6.80E-18	6.29E-18	6.19E-18
Y-94	4.05E-17	3.74E-17	3.53E-17	3.37E-17	3.11E-17	3.06E-17
Y-95	5.57E-17	5.17E-17	4.89E-17	4.73E-17	4.40E-17	4.33E-17
<b>Zirconium</b>						
Zr-85	6.38E-17	5.87E-17	5.46E-17	5.23E-17	4.81E-17	4.72E-17
Zr-86	9.89E-18	8.97E-18	8.41E-18	8.00E-18	7.30E-18	7.16E-18
Zr-87	3.96E-17	3.64E-17	3.38E-17	3.24E-17	2.98E-17	2.92E-17
Zr-88	1.47E-17	1.34E-17	1.24E-17	1.19E-17	1.09E-17	1.07E-17
Zr-89	4.81E-17	4.42E-17	4.15E-17	3.95E-17	3.64E-17	3.58E-17
Zr-89m	2.59E-17	2.38E-17	2.22E-17	2.12E-17	1.95E-17	1.92E-17
Zr-93	6.47E-21	5.95E-21	5.62E-21	5.34E-21	4.93E-21	4.84E-21
Zr-95	3.04E-17	2.79E-17	2.61E-17	2.49E-17	2.29E-17	2.25E-17
Zr-97	3.85E-17	3.54E-17	3.32E-17	3.16E-17	2.91E-17	2.86E-17
<b>Niobium</b>						
Nb-87	5.33E-17	4.89E-17	4.55E-17	4.35E-17	3.99E-17	3.92E-17
Nb-88	1.79E-16	1.65E-16	1.55E-16	1.48E-16	1.36E-16	1.33E-16
Nb-88m	1.77E-16	1.63E-16	1.53E-16	1.46E-16	1.35E-16	1.32E-16
Nb-89	6.12E-17	5.65E-17	5.29E-17	5.09E-17	4.70E-17	4.62E-17
Nb-89m	5.43E-17	4.99E-17	4.63E-17	4.43E-17	4.07E-17	3.99E-17
Nb-90	1.85E-16	1.71E-16	1.62E-16	1.56E-16	1.45E-16	1.42E-16
Nb-91	6.96E-20	6.29E-20	5.77E-20	5.54E-20	4.91E-20	4.81E-20
Nb-91m	1.08E-18	9.91E-19	9.35E-19	8.92E-19	8.23E-19	8.09E-19
Nb-92	6.19E-17	5.69E-17	5.34E-17	5.08E-17	4.68E-17	4.60E-17
Nb-92m	4.05E-17	3.72E-17	3.51E-17	3.34E-17	3.08E-17	3.02E-17
Nb-93m	1.29E-21	9.33E-22	7.42E-22	7.30E-22	3.32E-22	3.04E-22
Nb-94	6.50E-17	5.97E-17	5.60E-17	5.33E-17	4.91E-17	4.82E-17
Nb-94m	1.94E-19	1.77E-19	1.66E-19	1.58E-19	1.45E-19	1.42E-19
Nb-95	3.17E-17	2.91E-17	2.73E-17	2.60E-17	2.39E-17	2.35E-17
Nb-95m	2.27E-18	2.06E-18	1.93E-18	1.83E-18	1.67E-18	1.64E-18
Nb-96	1.03E-16	9.47E-17	8.89E-17	8.47E-17	7.80E-17	7.66E-17
Nb-97	2.83E-17	2.60E-17	2.43E-17	2.32E-17	2.13E-17	2.09E-17
Nb-98m	1.22E-16	1.12E-16	1.05E-16	1.01E-16	9.30E-17	9.14E-17
Nb-99	1.02E-17	9.45E-18	8.83E-18	8.44E-18	7.71E-18	7.58E-18



**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	3.87E-17	3.59E-17	3.39E-17	3.27E-17	3.04E-17	2.99E-17
<b>Molybdenum</b>						
Mo-89	5.74E-17	5.28E-17	4.92E-17	4.72E-17	4.34E-17	4.26E-17
Mo-90	3.16E-17	2.90E-17	2.70E-17	2.58E-17	2.37E-17	2.32E-17
Mo-91	4.43E-17	4.07E-17	3.78E-17	3.62E-17	3.33E-17	3.27E-17
Mo-91m	5.98E-17	5.51E-17	5.16E-17	4.94E-17	4.55E-17	4.47E-17
Mo-93	7.24E-21	5.22E-21	4.15E-21	4.09E-21	1.86E-21	1.70E-21
Mo-93m	9.89E-17	9.11E-17	8.57E-17	8.22E-17	7.59E-17	7.46E-17
Mo-99	6.84E-18	6.29E-18	5.89E-18	5.61E-18	5.16E-18	5.07E-18
Mo-101	6.41E-17	5.91E-17	5.56E-17	5.34E-17	4.93E-17	4.85E-17
Mo-102	1.41E-18	1.29E-18	1.21E-18	1.16E-18	1.06E-18	1.04E-18
<b>Technetium</b>						
Tc-91	1.14E-16	1.05E-16	9.86E-17	9.51E-17	8.80E-17	8.65E-17
Tc-91m	6.50E-17	5.98E-17	5.57E-17	5.34E-17	4.91E-17	4.81E-17
Tc-92	1.66E-16	1.53E-16	1.44E-16	1.38E-16	1.27E-16	1.25E-16
Tc-93	6.82E-17	6.30E-17	5.94E-17	5.70E-17	5.28E-17	5.19E-17
Tc-93m	4.15E-17	3.85E-17	3.62E-17	3.50E-17	3.26E-17	3.20E-17
Tc-94	1.10E-16	1.01E-16	9.52E-17	9.06E-17	8.34E-17	8.19E-17
Tc-94m	8.40E-17	7.74E-17	7.25E-17	6.94E-17	6.40E-17	6.29E-17
Tc-95	3.25E-17	2.99E-17	2.81E-17	2.67E-17	2.46E-17	2.41E-17
Tc-95m	2.70E-17	2.48E-17	2.32E-17	2.21E-17	2.03E-17	1.99E-17
Tc-96	1.04E-16	9.55E-17	8.98E-17	8.54E-17	7.86E-17	7.72E-17
Tc-96m	1.76E-18	1.62E-18	1.52E-18	1.45E-18	1.34E-18	1.31E-18
Tc-97	9.17E-21	6.43E-21	5.13E-21	5.05E-21	2.45E-21	2.26E-21
Tc-97m	1.66E-20	1.30E-20	1.13E-20	1.09E-20	7.89E-21	7.60E-21
Tc-98	5.82E-17	5.35E-17	5.00E-17	4.77E-17	4.38E-17	4.30E-17
Tc-99	1.35E-19	1.24E-19	1.17E-19	1.12E-19	1.03E-19	1.01E-19
Tc-99m	3.79E-18	3.53E-18	3.24E-18	3.11E-18	2.79E-18	2.75E-18
Tc-101	1.38E-17	1.25E-17	1.17E-17	1.12E-17	1.02E-17	1.00E-17
Tc-102	1.15E-17	1.07E-17	1.01E-17	9.65E-18	8.94E-18	8.80E-18
Tc-102m	1.09E-16	1.01E-16	9.45E-17	9.09E-17	8.41E-17	8.27E-17
Tc-104	1.03E-16	9.55E-17	8.99E-17	8.66E-17	8.02E-17	7.89E-17
Tc-105	3.65E-17	3.36E-17	3.16E-17	3.03E-17	2.79E-17	2.74E-17
<b>Ruthenium</b>						
Ru-92	8.42E-17	7.74E-17	7.24E-17	6.94E-17	6.38E-17	6.26E-17
Ru-94	2.02E-17	1.85E-17	1.73E-17	1.65E-17	1.51E-17	1.48E-17
Ru-95	5.11E-17	4.69E-17	4.40E-17	4.21E-17	3.88E-17	3.81E-17
Ru-97	8.07E-18	7.32E-18	6.86E-18	6.52E-18	5.94E-18	5.83E-18
Ru-103	1.97E-17	1.81E-17	1.67E-17	1.60E-17	1.47E-17	1.44E-17
Ru-105	3.11E-17	2.85E-17	2.66E-17	2.54E-17	2.34E-17	2.29E-17
Ru-106	1.15E-21	1.06E-21	1.00E-21	9.52E-22	8.78E-22	8.64E-22
Ru-107	1.78E-17	1.64E-17	1.54E-17	1.47E-17	1.36E-17	1.34E-17
Ru-108	3.09E-18	2.85E-18	2.66E-18	2.54E-18	2.31E-18	2.27E-18
<b>Rhodium</b>						
Rh-94	1.75E-16	1.62E-16	1.52E-16	1.46E-16	1.35E-16	1.33E-16
Rh-95	1.12E-16	1.03E-16	9.66E-17	9.26E-17	8.56E-17	8.41E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	3.83E-17	3.55E-17	3.33E-17	3.20E-17	2.97E-17	2.92E-17
Rh-96	1.66E-16	1.53E-16	1.43E-16	1.37E-16	1.26E-16	1.24E-16
Rh-96m	5.61E-17	5.17E-17	4.85E-17	4.65E-17	4.30E-17	4.22E-17
Rh-97	6.02E-17	5.53E-17	5.16E-17	4.95E-17	4.55E-17	4.47E-17
Rh-97m	9.60E-17	8.88E-17	8.36E-17	8.07E-17	7.48E-17	7.36E-17
Rh-98	7.87E-17	7.24E-17	6.75E-17	6.47E-17	5.95E-17	5.84E-17
Rh-99	2.12E-17	1.94E-17	1.80E-17	1.73E-17	1.58E-17	1.55E-17
Rh-99m	2.56E-17	2.35E-17	2.20E-17	2.10E-17	1.93E-17	1.89E-17
Rh-100	1.19E-16	1.10E-16	1.04E-16	9.99E-17	9.25E-17	9.10E-17
Rh-100m	1.72E-18	1.58E-18	1.47E-18	1.41E-18	1.29E-18	1.26E-18
Rh-101	9.01E-18	8.23E-18	7.66E-18	7.30E-18	6.62E-18	6.50E-18
Rh-101m	1.02E-17	9.30E-18	8.68E-18	8.28E-18	7.57E-18	7.42E-18
Rh-102	2.03E-17	1.86E-17	1.73E-17	1.66E-17	1.52E-17	1.49E-17
Rh-102m	8.79E-17	8.08E-17	7.55E-17	7.21E-17	6.63E-17	6.51E-17
Rh-103m	2.27E-21	1.54E-21	1.23E-21	1.17E-21	7.04E-22	6.62E-22
Rh-104	3.66E-18	3.38E-18	3.19E-18	3.05E-18	2.82E-18	2.77E-18
Rh-104m	5.17E-19	4.34E-19	3.86E-19	3.56E-19	3.04E-19	2.97E-19
Rh-105	3.13E-18	2.85E-18	2.66E-18	2.54E-18	2.32E-18	2.28E-18
Rh-106	1.36E-17	1.25E-17	1.17E-17	1.12E-17	1.03E-17	1.01E-17
Rh-106m	1.20E-16	1.10E-16	1.03E-16	9.88E-17	9.11E-17	8.94E-17
Rh-107	1.28E-17	1.17E-17	1.09E-17	1.04E-17	9.52E-18	9.33E-18
Rh-108	2.00E-17	1.84E-17	1.72E-17	1.65E-17	1.52E-17	1.49E-17
Rh-109	1.39E-17	1.27E-17	1.19E-17	1.13E-17	1.04E-17	1.02E-17
<b>Palladium</b>						
Pd-96	5.85E-17	5.38E-17	5.03E-17	4.80E-17	4.41E-17	4.33E-17
Pd-97	1.03E-16	9.47E-17	8.88E-17	8.53E-17	7.88E-17	7.75E-17
Pd-98	1.51E-17	1.38E-17	1.29E-17	1.23E-17	1.13E-17	1.11E-17
Pd-99	5.30E-17	4.88E-17	4.56E-17	4.38E-17	4.03E-17	3.96E-17
Pd-100	2.25E-18	2.01E-18	1.84E-18	1.75E-18	1.53E-18	1.50E-18
Pd-101	1.31E-17	1.20E-17	1.12E-17	1.07E-17	9.85E-18	9.67E-18
Pd-103	2.32E-20	1.65E-20	1.36E-20	1.31E-20	8.64E-21	8.22E-21
Pd-107	9.10E-22	8.38E-22	7.91E-22	7.52E-22	6.94E-22	6.82E-22
Pd-109	9.33E-19	8.55E-19	8.05E-19	7.66E-19	7.03E-19	6.91E-19
Pd-109m	3.56E-18	3.24E-18	3.03E-18	2.88E-18	2.62E-18	2.57E-18
Pd-111	4.55E-18	4.19E-18	3.95E-18	3.78E-18	3.49E-18	3.43E-18
Pd-112	9.43E-20	8.57E-20	8.05E-20	7.66E-20	6.97E-20	6.84E-20
Pd-114	2.26E-18	2.07E-18	1.95E-18	1.86E-18	1.71E-18	1.67E-18
<b>Silver</b>						
Ag-99	1.00E-16	9.25E-17	8.66E-17	8.31E-17	7.66E-17	7.52E-17
Ag-100m	1.26E-16	1.17E-16	1.09E-16	1.05E-16	9.66E-17	9.49E-17
Ag-101	6.62E-17	6.08E-17	5.68E-17	5.44E-17	5.00E-17	4.91E-17
Ag-102	1.47E-16	1.35E-16	1.27E-16	1.22E-16	1.12E-16	1.10E-16
Ag-102m	8.83E-17	8.18E-17	7.69E-17	7.43E-17	6.89E-17	6.78E-17
Ag-103	3.37E-17	3.10E-17	2.89E-17	2.77E-17	2.54E-17	2.50E-17
Ag-104	1.13E-16	1.04E-16	9.75E-17	9.32E-17	8.58E-17	8.43E-17
Ag-104m	7.76E-17	7.16E-17	6.69E-17	6.44E-17	5.94E-17	5.83E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	1.91E-17	1.75E-17	1.63E-17	1.56E-17	1.43E-17	1.40E-17
Ag-105m	3.82E-20	3.48E-20	3.25E-20	3.10E-20	2.84E-20	2.79E-20
Ag-106	2.90E-17	2.66E-17	2.47E-17	2.37E-17	2.17E-17	2.13E-17
Ag-106m	1.16E-16	1.07E-16	1.00E-16	9.59E-17	8.83E-17	8.67E-17
Ag-108	2.40E-18	2.21E-18	2.08E-18	1.98E-18	1.83E-18	1.80E-18
Ag-108m	6.48E-17	5.94E-17	5.54E-17	5.29E-17	4.86E-17	4.77E-17
Ag-109m	9.01E-20	7.78E-20	7.05E-20	6.67E-20	5.73E-20	5.59E-20
Ag-110	5.31E-18	4.91E-18	4.63E-18	4.42E-18	4.09E-18	4.02E-18
Ag-110m	1.16E-16	1.07E-16	1.00E-16	9.58E-17	8.83E-17	8.67E-17
Ag-111	1.79E-18	1.63E-18	1.53E-18	1.46E-18	1.34E-18	1.32E-18
Ag-111m	1.34E-19	1.20E-19	1.12E-19	1.06E-19	9.59E-20	9.40E-20
Ag-112	3.46E-17	3.20E-17	3.00E-17	2.88E-17	2.67E-17	2.62E-17
Ag-113	5.03E-18	4.62E-18	4.35E-18	4.15E-18	3.82E-18	3.75E-18
Ag-113m	8.66E-18	7.91E-18	7.38E-18	7.05E-18	6.46E-18	6.34E-18
Ag-114	2.03E-17	1.88E-17	1.77E-17	1.70E-17	1.57E-17	1.55E-17
Ag-115	2.43E-17	2.24E-17	2.11E-17	2.03E-17	1.88E-17	1.85E-17
Ag-116	1.01E-16	9.40E-17	8.86E-17	8.55E-17	7.93E-17	7.80E-17
Ag-117	6.18E-17	5.73E-17	5.40E-17	5.22E-17	4.85E-17	4.77E-17
<b>Cadmium</b>						
Cd-101	1.08E-16	9.98E-17	9.37E-17	9.00E-17	8.31E-17	8.17E-17
Cd-102	3.33E-17	3.06E-17	2.85E-17	2.73E-17	2.50E-17	2.46E-17
Cd-103	9.13E-17	8.44E-17	7.94E-17	7.65E-17	7.09E-17	6.97E-17
Cd-104	8.65E-18	7.92E-18	7.38E-18	7.03E-18	6.43E-18	6.31E-18
Cd-105	5.59E-17	5.16E-17	4.85E-17	4.67E-17	4.31E-17	4.24E-17
Cd-107	3.39E-19	2.98E-19	2.73E-19	2.60E-19	2.30E-19	2.25E-19
Cd-109	1.18E-19	9.63E-20	8.50E-20	8.03E-20	6.58E-20	6.39E-20
Cd-111m	9.63E-18	8.75E-18	8.19E-18	7.79E-18	7.10E-18	6.96E-18
Cd-113	1.21E-19	1.11E-19	1.05E-19	9.98E-20	9.20E-20	9.05E-20
Cd-113m	3.29E-19	3.03E-19	2.86E-19	2.72E-19	2.51E-19	2.47E-19
Cd-115	8.29E-18	7.61E-18	7.06E-18	6.76E-18	6.20E-18	6.09E-18
Cd-115m	3.05E-18	2.81E-18	2.66E-18	2.53E-18	2.34E-18	2.30E-18
Cd-117	4.70E-17	4.32E-17	4.07E-17	3.90E-17	3.60E-17	3.54E-17
Cd-117m	9.02E-17	8.34E-17	7.86E-17	7.57E-17	7.01E-17	6.90E-17
Cd-118	2.71E-19	2.49E-19	2.35E-19	2.24E-19	2.07E-19	2.03E-19
Cd-119	7.38E-17	6.82E-17	6.43E-17	6.19E-17	5.74E-17	5.64E-17
Cd-119m	1.03E-16	9.49E-17	8.95E-17	8.61E-17	7.97E-17	7.84E-17
<b>Indium</b>						
In-103	1.21E-16	1.12E-16	1.05E-16	1.01E-16	9.31E-17	9.16E-17
In-105	8.28E-17	7.63E-17	7.14E-17	6.85E-17	6.31E-17	6.20E-17
In-106	1.50E-16	1.38E-16	1.29E-16	1.23E-16	1.14E-16	1.12E-16
In-106m	1.26E-16	1.17E-16	1.09E-16	1.05E-16	9.73E-17	9.56E-17
In-107	6.50E-17	5.99E-17	5.62E-17	5.41E-17	4.99E-17	4.91E-17
In-108	1.64E-16	1.51E-16	1.42E-16	1.36E-16	1.25E-16	1.23E-16
In-108m	1.22E-16	1.13E-16	1.07E-16	1.03E-16	9.55E-17	9.39E-17
In-109	2.51E-17	2.31E-17	2.16E-17	2.07E-17	1.90E-17	1.86E-17
In-109m	2.47E-17	2.27E-17	2.12E-17	2.02E-17	1.86E-17	1.83E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	1.28E-16	1.18E-16	1.11E-16	1.05E-16	9.70E-17	9.54E-17
In-110m	6.67E-17	6.14E-17	5.73E-17	5.50E-17	5.06E-17	4.97E-17
In-111	1.34E-17	1.22E-17	1.14E-17	1.08E-17	9.84E-18	9.65E-18
In-111m	1.87E-17	1.71E-17	1.59E-17	1.52E-17	1.40E-17	1.37E-17
In-112	1.10E-17	1.01E-17	9.39E-18	9.00E-18	8.25E-18	8.10E-18
In-112m	6.80E-19	6.23E-19	5.71E-19	5.46E-19	4.88E-19	4.80E-19
In-113m	9.77E-18	8.92E-18	8.28E-18	7.93E-18	7.25E-18	7.11E-18
In-114	2.39E-18	2.21E-18	2.09E-18	1.99E-18	1.84E-18	1.81E-18
In-114m	2.71E-18	2.48E-18	2.31E-18	2.21E-18	2.02E-18	1.98E-18
In-115	2.50E-19	2.30E-19	2.17E-19	2.07E-19	1.91E-19	1.87E-19
In-115m	5.85E-18	5.31E-18	4.95E-18	4.73E-18	4.32E-18	4.24E-18
In-116m	1.08E-16	9.94E-17	9.38E-17	8.99E-17	8.31E-17	8.17E-17
In-117	2.70E-17	2.48E-17	2.30E-17	2.21E-17	2.02E-17	1.98E-17
In-117m	4.04E-18	3.70E-18	3.45E-18	3.30E-18	3.01E-18	2.96E-18
In-118	1.12E-17	1.03E-17	9.79E-18	9.37E-18	8.69E-18	8.55E-18
In-118m	1.21E-16	1.11E-16	1.05E-16	1.00E-16	9.23E-17	9.07E-17
In-119	3.33E-17	3.06E-17	2.87E-17	2.73E-17	2.52E-17	2.47E-17
In-119m	6.05E-18	5.58E-18	5.28E-18	5.03E-18	4.66E-18	4.58E-18
In-121	4.20E-17	3.87E-17	3.64E-17	3.46E-17	3.19E-17	3.14E-17
In-121m	7.75E-18	7.15E-18	6.75E-18	6.45E-18	5.97E-18	5.88E-18
<b>Tin</b>						
Sn-106	4.81E-17	4.41E-17	4.13E-17	3.94E-17	3.62E-17	3.56E-17
Sn-108	2.55E-17	2.33E-17	2.17E-17	2.07E-17	1.90E-17	1.86E-17
Sn-109	9.55E-17	8.83E-17	8.32E-17	7.99E-17	7.40E-17	7.28E-17
Sn-110	1.01E-17	9.10E-18	8.52E-18	8.12E-18	7.41E-18	7.26E-18
Sn-111	2.02E-17	1.86E-17	1.73E-17	1.67E-17	1.53E-17	1.50E-17
Sn-113	2.38E-19	2.05E-19	1.88E-19	1.78E-19	1.57E-19	1.54E-19
Sn-113m	4.37E-20	3.16E-20	2.56E-20	2.35E-20	1.74E-20	1.67E-20
Sn-117m	4.50E-18	4.16E-18	3.83E-18	3.67E-18	3.31E-18	3.25E-18
Sn-119m	3.70E-20	2.52E-20	1.96E-20	1.78E-20	1.21E-20	1.15E-20
Sn-121	1.68E-19	1.54E-19	1.46E-19	1.39E-19	1.28E-19	1.26E-19
Sn-121m	5.84E-20	4.99E-20	4.51E-20	4.23E-20	3.73E-20	3.65E-20
Sn-123	1.66E-18	1.53E-18	1.45E-18	1.38E-18	1.27E-18	1.25E-18
Sn-123m	5.53E-18	5.12E-18	4.75E-18	4.54E-18	4.12E-18	4.05E-18
Sn-125	1.68E-17	1.55E-17	1.47E-17	1.40E-17	1.29E-17	1.27E-17
Sn-125m	1.55E-17	1.42E-17	1.32E-17	1.26E-17	1.16E-17	1.14E-17
Sn-126	1.21E-18	1.08E-18	9.92E-19	9.39E-19	8.29E-19	8.11E-19
Sn-127	8.29E-17	7.64E-17	7.20E-17	6.89E-17	6.36E-17	6.25E-17
Sn-127m	2.67E-17	2.46E-17	2.29E-17	2.20E-17	2.02E-17	1.99E-17
Sn-128	2.22E-17	2.04E-17	1.89E-17	1.81E-17	1.65E-17	1.62E-17
Sn-129	4.66E-17	4.29E-17	4.02E-17	3.85E-17	3.54E-17	3.48E-17
Sn-130	3.72E-17	3.41E-17	3.19E-17	3.04E-17	2.79E-17	2.73E-17
Sn-130m	4.16E-17	3.83E-17	3.60E-17	3.44E-17	3.17E-17	3.12E-17
<b>Antimony</b>						
Sb-111	6.36E-17	5.85E-17	5.44E-17	5.21E-17	4.78E-17	4.69E-17
Sb-113	5.26E-17	4.83E-17	4.49E-17	4.30E-17	3.94E-17	3.87E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	1.18E-16	1.09E-16	1.02E-16	9.81E-17	9.05E-17	8.90E-17
Sb-115	3.55E-17	3.26E-17	3.02E-17	2.90E-17	2.66E-17	2.61E-17
Sb-116	9.89E-17	9.12E-17	8.58E-17	8.23E-17	7.61E-17	7.48E-17
Sb-116m	1.30E-16	1.19E-16	1.12E-16	1.07E-16	9.88E-17	9.71E-17
Sb-117	5.54E-18	5.12E-18	4.73E-18	4.52E-18	4.09E-18	4.02E-18
Sb-118	3.48E-17	3.19E-17	2.97E-17	2.84E-17	2.61E-17	2.56E-17
Sb-118m	1.09E-16	1.00E-16	9.46E-17	9.01E-17	8.32E-17	8.17E-17
Sb-119	6.05E-20	4.12E-20	3.20E-20	2.90E-20	1.99E-20	1.89E-20
Sb-120	1.84E-17	1.69E-17	1.57E-17	1.50E-17	1.38E-17	1.35E-17
Sb-120m	1.02E-16	9.38E-17	8.85E-17	8.42E-17	7.76E-17	7.63E-17
Sb-122	1.94E-17	1.79E-17	1.66E-17	1.59E-17	1.46E-17	1.43E-17
Sb-122m	9.92E-19	8.53E-19	7.67E-19	7.17E-19	6.14E-19	5.98E-19
Sb-124	8.07E-17	7.44E-17	6.99E-17	6.72E-17	6.21E-17	6.11E-17
Sb-124m	1.80E-17	1.65E-17	1.54E-17	1.47E-17	1.35E-17	1.32E-17
Sb-124n	2.26E-24	1.54E-24	1.19E-24	1.08E-24	7.45E-25	7.08E-25
Sb-125	1.68E-17	1.54E-17	1.43E-17	1.37E-17	1.26E-17	1.23E-17
Sb-126	1.13E-16	1.04E-16	9.70E-17	9.25E-17	8.50E-17	8.35E-17
Sb-126m	6.44E-17	5.91E-17	5.51E-17	5.27E-17	4.84E-17	4.75E-17
Sb-127	2.86E-17	2.63E-17	2.45E-17	2.34E-17	2.15E-17	2.11E-17
Sb-128	1.28E-16	1.17E-16	1.10E-16	1.05E-16	9.63E-17	9.46E-17
Sb-128m	8.08E-17	7.41E-17	6.95E-17	6.62E-17	6.09E-17	5.98E-17
Sb-129	6.28E-17	5.78E-17	5.44E-17	5.20E-17	4.80E-17	4.71E-17
Sb-130	1.37E-16	1.26E-16	1.18E-16	1.13E-16	1.04E-16	1.02E-16
Sb-130m	1.16E-16	1.07E-16	1.01E-16	9.59E-17	8.83E-17	8.67E-17
Sb-131	9.07E-17	8.36E-17	7.88E-17	7.55E-17	6.97E-17	6.86E-17
Sb-133	1.22E-16	1.13E-16	1.07E-16	1.02E-16	9.48E-17	9.32E-17
<b>Tellurium</b>						
Te-113	1.00E-16	9.24E-17	8.67E-17	8.32E-17	7.67E-17	7.54E-17
Te-114	5.35E-17	4.93E-17	4.63E-17	4.44E-17	4.10E-17	4.03E-17
Te-115	9.66E-17	8.90E-17	8.34E-17	7.99E-17	7.37E-17	7.24E-17
Te-115m	1.13E-16	1.04E-16	9.76E-17	9.36E-17	8.64E-17	8.49E-17
Te-116	2.84E-18	2.57E-18	2.38E-18	2.27E-18	2.06E-18	2.02E-18
Te-117	6.60E-17	6.09E-17	5.72E-17	5.49E-17	5.07E-17	4.98E-17
Te-118	6.14E-20	4.24E-20	3.29E-20	2.95E-20	2.09E-20	1.99E-20
Te-119	3.09E-17	2.84E-17	2.65E-17	2.54E-17	2.33E-17	2.29E-17
Te-119m	6.25E-17	5.76E-17	5.43E-17	5.19E-17	4.79E-17	4.71E-17
Te-121	2.24E-17	2.05E-17	1.90E-17	1.82E-17	1.67E-17	1.64E-17
Te-121m	7.31E-18	6.64E-18	6.23E-18	5.92E-18	5.40E-18	5.30E-18
Te-123	1.07E-22	7.38E-23	5.72E-23	5.12E-23	3.63E-23	3.46E-23
Te-123m	4.29E-18	3.97E-18	3.66E-18	3.50E-18	3.15E-18	3.10E-18
Te-125m	1.40E-19	1.00E-19	7.90E-20	7.08E-20	5.29E-20	5.08E-20
Te-127	6.15E-19	5.65E-19	5.31E-19	5.06E-19	4.66E-19	4.58E-19
Te-127m	6.00E-20	4.66E-20	3.93E-20	3.61E-20	2.95E-20	2.85E-20
Te-129	3.64E-18	3.35E-18	3.13E-18	2.99E-18	2.75E-18	2.70E-18
Te-129m	1.82E-18	1.67E-18	1.56E-18	1.49E-18	1.37E-18	1.34E-18
Te-131	1.81E-17	1.66E-17	1.55E-17	1.49E-17	1.36E-17	1.34E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	6.05E-17	5.56E-17	5.23E-17	4.99E-17	4.59E-17	4.51E-17
Te-132	7.45E-18	6.72E-18	6.30E-18	5.98E-18	5.44E-18	5.33E-18
Te-133	5.24E-17	4.82E-17	4.53E-17	4.34E-17	4.01E-17	3.94E-17
Te-133m	7.87E-17	7.25E-17	6.81E-17	6.51E-17	6.00E-17	5.89E-17
Te-134	3.42E-17	3.13E-17	2.93E-17	2.79E-17	2.56E-17	2.51E-17
<b>Iodine</b>						
I-118	9.10E-17	8.37E-17	7.81E-17	7.49E-17	6.89E-17	6.77E-17
I-118m	1.58E-16	1.45E-16	1.35E-16	1.29E-16	1.19E-16	1.17E-16
I-119	3.66E-17	3.35E-17	3.12E-17	2.99E-17	2.74E-17	2.68E-17
I-120	1.18E-16	1.09E-16	1.03E-16	9.88E-17	9.14E-17	8.99E-17
I-120m	1.49E-16	1.38E-16	1.29E-16	1.23E-16	1.14E-16	1.12E-16
I-121	1.44E-17	1.31E-17	1.22E-17	1.17E-17	1.07E-17	1.05E-17
I-122	4.22E-17	3.88E-17	3.60E-17	3.46E-17	3.17E-17	3.11E-17
I-123	4.91E-18	4.53E-18	4.17E-18	3.99E-18	3.60E-18	3.54E-18
I-124	4.65E-17	4.28E-17	4.01E-17	3.85E-17	3.55E-17	3.48E-17
I-125	1.57E-19	1.10E-19	8.58E-20	7.65E-20	5.60E-20	5.35E-20
I-126	1.74E-17	1.59E-17	1.48E-17	1.42E-17	1.30E-17	1.27E-17
I-128	4.83E-18	4.44E-18	4.16E-18	3.98E-18	3.66E-18	3.60E-18
I-129	1.67E-19	1.29E-19	1.09E-19	9.88E-20	8.12E-20	7.88E-20
I-130	8.76E-17	8.05E-17	7.51E-17	7.17E-17	6.59E-17	6.47E-17
I-130m	4.72E-18	4.33E-18	4.03E-18	3.87E-18	3.55E-18	3.49E-18
I-131	1.49E-17	1.36E-17	1.27E-17	1.21E-17	1.11E-17	1.09E-17
I-132	9.54E-17	8.77E-17	8.22E-17	7.85E-17	7.23E-17	7.10E-17
I-132m	1.35E-17	1.24E-17	1.16E-17	1.11E-17	1.02E-17	9.96E-18
I-133	2.57E-17	2.36E-17	2.20E-17	2.10E-17	1.93E-17	1.90E-17
I-134	1.11E-16	1.02E-16	9.59E-17	9.14E-17	8.43E-17	8.28E-17
I-134m	9.91E-18	8.98E-18	8.41E-18	8.00E-18	7.31E-18	7.16E-18
I-135	6.96E-17	6.42E-17	6.06E-17	5.81E-17	5.38E-17	5.29E-17
<b>Xenon</b>						
Xe-120	1.43E-17	1.31E-17	1.22E-17	1.17E-17	1.07E-17	1.05E-17
Xe-121	6.33E-17	5.85E-17	5.48E-17	5.28E-17	4.88E-17	4.79E-17
Xe-122	1.74E-18	1.57E-18	1.45E-18	1.38E-18	1.26E-18	1.23E-18
Xe-123	2.52E-17	2.32E-17	2.17E-17	2.08E-17	1.91E-17	1.88E-17
Xe-125	8.75E-18	7.95E-18	7.43E-18	7.07E-18	6.44E-18	6.32E-18
Xe-127	8.96E-18	8.15E-18	7.59E-18	7.23E-18	6.58E-18	6.45E-18
Xe-127m	4.70E-18	4.32E-18	3.98E-18	3.80E-18	3.42E-18	3.36E-18
Xe-129m	5.07E-19	4.24E-19	3.75E-19	3.50E-19	3.03E-19	2.95E-19
Xe-131m	1.78E-19	1.49E-19	1.30E-19	1.21E-19	1.04E-19	1.01E-19
Xe-133	9.22E-19	8.17E-19	7.46E-19	7.04E-19	6.20E-19	6.05E-19
Xe-133m	9.03E-19	8.03E-19	7.45E-19	7.05E-19	6.37E-19	6.24E-19
Xe-135	9.60E-18	8.71E-18	8.17E-18	7.77E-18	7.10E-18	6.97E-18
Xe-135m	1.68E-17	1.54E-17	1.43E-17	1.37E-17	1.25E-17	1.23E-17
Xe-137	1.44E-17	1.33E-17	1.25E-17	1.20E-17	1.11E-17	1.09E-17
Xe-138	5.06E-17	4.68E-17	4.40E-17	4.25E-17	3.94E-17	3.87E-17
<b>Cesium</b>						
Cs-121	5.34E-17	4.90E-17	4.56E-17	4.37E-17	4.02E-17	3.94E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	5.14E-17	4.72E-17	4.40E-17	4.21E-17	3.86E-17	3.79E-17
Cs-123	4.58E-17	4.21E-17	3.92E-17	3.75E-17	3.44E-17	3.38E-17
Cs-124	5.51E-17	5.06E-17	4.72E-17	4.52E-17	4.16E-17	4.09E-17
Cs-125	3.08E-17	2.83E-17	2.63E-17	2.52E-17	2.31E-17	2.27E-17
Cs-126	5.09E-17	4.68E-17	4.35E-17	4.17E-17	3.83E-17	3.76E-17
Cs-127	1.60E-17	1.46E-17	1.36E-17	1.30E-17	1.19E-17	1.17E-17
Cs-128	3.82E-17	3.51E-17	3.26E-17	3.12E-17	2.87E-17	2.81E-17
Cs-129	9.61E-18	8.75E-18	8.11E-18	7.76E-18	7.09E-18	6.95E-18
Cs-130	2.07E-17	1.90E-17	1.76E-17	1.69E-17	1.55E-17	1.52E-17
Cs-130m	1.25E-18	1.10E-18	1.00E-18	9.45E-19	8.30E-19	8.12E-19
Cs-131	1.01E-19	7.26E-20	5.67E-20	5.03E-20	3.78E-20	3.62E-20
Cs-132	2.84E-17	2.61E-17	2.43E-17	2.32E-17	2.13E-17	2.09E-17
Cs-134	6.41E-17	5.90E-17	5.51E-17	5.26E-17	4.83E-17	4.75E-17
Cs-134m	5.19E-19	4.70E-19	4.27E-19	4.07E-19	3.62E-19	3.55E-19
Cs-135	1.12E-19	1.03E-19	9.75E-20	9.27E-20	8.55E-20	8.41E-20
Cs-135m	6.65E-17	6.11E-17	5.74E-17	5.46E-17	5.03E-17	4.94E-17
Cs-136	8.87E-17	8.16E-17	7.68E-17	7.31E-17	6.73E-17	6.62E-17
Cs-137	3.42E-19	3.15E-19	2.98E-19	2.83E-19	2.61E-19	2.57E-19
Cs-138	1.08E-16	9.95E-17	9.38E-17	9.02E-17	8.36E-17	8.22E-17
Cs-138m	1.79E-17	1.64E-17	1.55E-17	1.48E-17	1.37E-17	1.34E-17
Cs-139	2.01E-17	1.86E-17	1.76E-17	1.69E-17	1.57E-17	1.54E-17
Cs-140	8.70E-17	8.06E-17	7.60E-17	7.34E-17	6.81E-17	6.70E-17
<b>Barium</b>						
Ba-124	2.24E-17	2.06E-17	1.92E-17	1.84E-17	1.69E-17	1.65E-17
Ba-126	2.26E-17	2.07E-17	1.94E-17	1.85E-17	1.70E-17	1.67E-17
Ba-127	3.04E-17	2.79E-17	2.60E-17	2.49E-17	2.29E-17	2.25E-17
Ba-128	1.65E-18	1.47E-18	1.36E-18	1.29E-18	1.17E-18	1.15E-18
Ba-129	1.28E-17	1.18E-17	1.10E-17	1.05E-17	9.65E-18	9.48E-18
Ba-129m	6.43E-17	5.92E-17	5.55E-17	5.31E-17	4.88E-17	4.80E-17
Ba-131	1.70E-17	1.56E-17	1.45E-17	1.38E-17	1.26E-17	1.24E-17
Ba-131m	1.73E-18	1.56E-18	1.44E-18	1.36E-18	1.21E-18	1.19E-18
Ba-133	1.34E-17	1.22E-17	1.13E-17	1.08E-17	9.83E-18	9.63E-18
Ba-133m	1.89E-18	1.70E-18	1.58E-18	1.50E-18	1.37E-18	1.34E-18
Ba-135m	1.62E-18	1.45E-18	1.35E-18	1.28E-18	1.16E-18	1.14E-18
Ba-137m	2.42E-17	2.23E-17	2.08E-17	1.98E-17	1.82E-17	1.79E-17
Ba-139	4.26E-18	3.94E-18	3.70E-18	3.53E-18	3.25E-18	3.20E-18
Ba-140	7.52E-18	6.90E-18	6.41E-18	6.13E-18	5.62E-18	5.51E-18
Ba-141	4.04E-17	3.71E-17	3.49E-17	3.33E-17	3.07E-17	3.01E-17
Ba-142	4.41E-17	4.06E-17	3.82E-17	3.64E-17	3.35E-17	3.29E-17
<b>Lanthanum</b>						
La-128	1.21E-16	1.11E-16	1.04E-16	9.91E-17	9.12E-17	8.96E-17
La-129	3.75E-17	3.44E-17	3.20E-17	3.06E-17	2.81E-17	2.76E-17
La-130	9.55E-17	8.78E-17	8.21E-17	7.87E-17	7.24E-17	7.11E-17
La-131	2.53E-17	2.32E-17	2.15E-17	2.06E-17	1.89E-17	1.85E-17
La-132	8.52E-17	7.86E-17	7.36E-17	7.08E-17	6.53E-17	6.42E-17
La-132m	2.59E-17	2.37E-17	2.21E-17	2.11E-17	1.94E-17	1.90E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	5.60E-18	5.11E-18	4.74E-18	4.53E-18	4.15E-18	4.07E-18
La-134	3.10E-17	2.84E-17	2.64E-17	2.53E-17	2.33E-17	2.28E-17
La-135	5.44E-19	4.73E-19	4.26E-19	4.02E-19	3.58E-19	3.50E-19
La-136	1.65E-17	1.51E-17	1.40E-17	1.34E-17	1.23E-17	1.21E-17
La-137	1.35E-19	9.87E-20	7.82E-20	6.92E-20	5.34E-20	5.14E-20
La-138	5.31E-17	4.90E-17	4.62E-17	4.43E-17	4.10E-17	4.03E-17
La-140	1.02E-16	9.38E-17	8.83E-17	8.49E-17	7.86E-17	7.73E-17
La-141	4.37E-18	4.04E-18	3.82E-18	3.65E-18	3.38E-18	3.33E-18
La-142	1.09E-16	1.01E-16	9.54E-17	9.22E-17	8.57E-17	8.44E-17
La-143	1.62E-17	1.50E-17	1.41E-17	1.36E-17	1.26E-17	1.24E-17
<b>Cerium</b>						
Ce-130	1.83E-17	1.68E-17	1.57E-17	1.49E-17	1.37E-17	1.34E-17
Ce-131	6.77E-17	6.23E-17	5.82E-17	5.58E-17	5.13E-17	5.04E-17
Ce-132	8.59E-18	7.83E-18	7.27E-18	6.93E-18	6.29E-18	6.17E-18
Ce-133	2.03E-17	1.85E-17	1.72E-17	1.64E-17	1.50E-17	1.47E-17
Ce-133m	7.13E-17	6.56E-17	6.15E-17	5.90E-17	5.44E-17	5.35E-17
Ce-134	2.10E-19	1.64E-19	1.37E-19	1.25E-19	1.03E-19	9.95E-20
Ce-135	3.16E-17	2.90E-17	2.70E-17	2.58E-17	2.37E-17	2.32E-17
Ce-137	5.92E-19	5.14E-19	4.61E-19	4.35E-19	3.87E-19	3.79E-19
Ce-137m	1.43E-18	1.28E-18	1.19E-18	1.12E-18	1.02E-18	9.99E-19
Ce-139	4.39E-18	4.03E-18	3.71E-18	3.54E-18	3.19E-18	3.13E-18
Ce-141	2.44E-18	2.26E-18	2.08E-18	1.99E-18	1.79E-18	1.76E-18
Ce-143	1.09E-17	9.90E-18	9.24E-18	8.81E-18	8.06E-18	7.91E-18
Ce-144	5.93E-19	5.44E-19	5.01E-19	4.77E-19	4.29E-19	4.22E-19
Ce-145	3.38E-17	3.10E-17	2.91E-17	2.77E-17	2.55E-17	2.50E-17
<b>Praseodymium</b>						
Pr-134	1.32E-16	1.21E-16	1.13E-16	1.08E-16	9.94E-17	9.76E-17
Pr-134m	1.02E-16	9.40E-17	8.79E-17	8.45E-17	7.79E-17	7.65E-17
Pr-135	3.55E-17	3.26E-17	3.03E-17	2.91E-17	2.67E-17	2.62E-17
Pr-136	9.13E-17	8.41E-17	7.86E-17	7.55E-17	6.96E-17	6.83E-17
Pr-137	1.47E-17	1.35E-17	1.26E-17	1.20E-17	1.10E-17	1.08E-17
Pr-138	3.66E-17	3.36E-17	3.12E-17	2.99E-17	2.75E-17	2.70E-17
Pr-138m	1.02E-16	9.38E-17	8.81E-17	8.39E-17	7.72E-17	7.58E-17
Pr-139	4.47E-18	4.08E-18	3.78E-18	3.62E-18	3.31E-18	3.25E-18
Pr-140	2.30E-17	2.11E-17	1.96E-17	1.88E-17	1.72E-17	1.69E-17
Pr-142	5.07E-18	4.68E-18	4.43E-18	4.25E-18	3.94E-18	3.87E-18
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	6.82E-19	6.29E-19	5.94E-19	5.65E-19	5.22E-19	5.13E-19
Pr-144	5.47E-18	5.06E-18	4.79E-18	4.58E-18	4.25E-18	4.18E-18
Pr-144m	1.52E-19	1.26E-19	1.11E-19	1.03E-19	8.95E-20	8.74E-20
Pr-145	2.68E-18	2.47E-18	2.33E-18	2.22E-18	2.05E-18	2.02E-18
Pr-146	4.83E-17	4.46E-17	4.19E-17	4.03E-17	3.73E-17	3.66E-17
Pr-147	2.10E-17	1.93E-17	1.80E-17	1.72E-17	1.58E-17	1.55E-17
Pr-148	4.84E-17	4.46E-17	4.20E-17	4.03E-17	3.72E-17	3.66E-17
Pr-148m	4.36E-17	4.00E-17	3.74E-17	3.57E-17	3.29E-17	3.23E-17



**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	1.99E-17	1.82E-17	1.70E-17	1.62E-17	1.48E-17	1.45E-17
Nd-135	5.20E-17	4.77E-17	4.44E-17	4.25E-17	3.90E-17	3.82E-17
Nd-136	9.16E-18	8.36E-18	7.75E-18	7.39E-18	6.74E-18	6.61E-18
Nd-137	4.82E-17	4.43E-17	4.14E-17	3.97E-17	3.65E-17	3.59E-17
Nd-138	7.37E-19	6.38E-19	5.76E-19	5.41E-19	4.80E-19	4.70E-19
Nd-139	1.77E-17	1.63E-17	1.51E-17	1.45E-17	1.33E-17	1.30E-17
Nd-139m	6.45E-17	5.93E-17	5.57E-17	5.31E-17	4.89E-17	4.81E-17
Nd-140	2.07E-19	1.56E-19	1.27E-19	1.12E-19	8.94E-20	8.64E-20
Nd-141	2.20E-18	1.99E-18	1.84E-18	1.75E-18	1.60E-18	1.56E-18
Nd-141m	2.86E-17	2.63E-17	2.47E-17	2.35E-17	2.16E-17	2.12E-17
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	5.06E-18	4.60E-18	4.26E-18	4.07E-18	3.71E-18	3.64E-18
Nd-149	1.45E-17	1.32E-17	1.23E-17	1.17E-17	1.07E-17	1.05E-17
Nd-151	3.60E-17	3.31E-17	3.11E-17	2.97E-17	2.73E-17	2.68E-17
Nd-152	6.62E-18	6.01E-18	5.63E-18	5.36E-18	4.90E-18	4.81E-18
<b>Promethium</b>						
Pm-136	1.19E-16	1.09E-16	1.02E-16	9.77E-17	8.98E-17	8.81E-17
Pm-137m	7.32E-17	6.72E-17	6.27E-17	5.99E-17	5.50E-17	5.40E-17
Pm-139	4.11E-17	3.78E-17	3.52E-17	3.37E-17	3.10E-17	3.04E-17
Pm-140	5.11E-17	4.70E-17	4.38E-17	4.20E-17	3.87E-17	3.79E-17
Pm-140m	1.28E-16	1.18E-16	1.10E-16	1.05E-16	9.67E-17	9.49E-17
Pm-141	3.15E-17	2.90E-17	2.70E-17	2.59E-17	2.38E-17	2.34E-17
Pm-142	3.91E-17	3.60E-17	3.35E-17	3.21E-17	2.95E-17	2.90E-17
Pm-143	1.20E-17	1.10E-17	1.03E-17	9.79E-18	8.99E-18	8.82E-18
Pm-144	6.24E-17	5.73E-17	5.34E-17	5.10E-17	4.68E-17	4.59E-17
Pm-145	2.67E-19	2.08E-19	1.73E-19	1.56E-19	1.27E-19	1.23E-19
Pm-146	2.98E-17	2.74E-17	2.55E-17	2.43E-17	2.23E-17	2.19E-17
Pm-147	6.42E-20	5.91E-20	5.58E-20	5.30E-20	4.89E-20	4.81E-20
Pm-148	2.68E-17	2.47E-17	2.32E-17	2.23E-17	2.06E-17	2.02E-17
Pm-148m	8.09E-17	7.43E-17	6.93E-17	6.62E-17	6.08E-17	5.97E-17
Pm-149	1.28E-18	1.17E-18	1.10E-18	1.05E-18	9.67E-19	9.51E-19
Pm-150	6.47E-17	5.96E-17	5.61E-17	5.37E-17	4.96E-17	4.88E-17
Pm-151	1.26E-17	1.15E-17	1.08E-17	1.03E-17	9.38E-18	9.21E-18
Pm-152	1.66E-17	1.53E-17	1.44E-17	1.38E-17	1.27E-17	1.25E-17
Pm-152m	6.47E-17	5.95E-17	5.60E-17	5.35E-17	4.93E-17	4.85E-17
Pm-153	3.96E-18	3.63E-18	3.38E-18	3.23E-18	2.94E-18	2.89E-18
Pm-154	8.11E-17	7.50E-17	7.08E-17	6.81E-17	6.31E-17	6.21E-17
Pm-154m	7.84E-17	7.23E-17	6.80E-17	6.52E-17	6.02E-17	5.92E-17
<b>Samarium</b>						
Sm-139	6.20E-17	5.69E-17	5.31E-17	5.08E-17	4.67E-17	4.58E-17
Sm-140	2.27E-17	2.08E-17	1.94E-17	1.86E-17	1.71E-17	1.68E-17
Sm-141	5.97E-17	5.49E-17	5.13E-17	4.92E-17	4.53E-17	4.44E-17
Sm-141m	8.05E-17	7.40E-17	6.93E-17	6.63E-17	6.11E-17	6.00E-17
Sm-142	3.58E-18	3.25E-18	3.00E-18	2.86E-18	2.61E-18	2.56E-18
Sm-143	2.22E-17	2.04E-17	1.89E-17	1.81E-17	1.66E-17	1.63E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	2.82E-17	2.59E-17	2.43E-17	2.31E-17	2.13E-17	2.09E-17
Sm-145	6.14E-19	4.84E-19	4.09E-19	3.69E-19	3.03E-19	2.94E-19
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	7.39E-21	6.80E-21	6.42E-21	6.10E-21	5.62E-21	5.53E-21
Sm-153	1.67E-18	1.48E-18	1.36E-18	1.29E-18	1.15E-18	1.12E-18
Sm-155	4.22E-18	3.85E-18	3.58E-18	3.41E-18	3.09E-18	3.04E-18
Sm-156	3.81E-18	3.46E-18	3.23E-18	3.07E-18	2.78E-18	2.73E-18
Sm-157	1.83E-17	1.68E-17	1.58E-17	1.50E-17	1.38E-17	1.36E-17
<b>Europium</b>						
Eu-142	6.33E-17	5.84E-17	5.46E-17	5.24E-17	4.84E-17	4.75E-17
Eu-142m	1.49E-16	1.37E-16	1.28E-16	1.22E-16	1.12E-16	1.10E-16
Eu-143	5.14E-17	4.73E-17	4.41E-17	4.24E-17	3.90E-17	3.83E-17
Eu-144	5.37E-17	4.95E-17	4.62E-17	4.43E-17	4.08E-17	4.01E-17
Eu-145	5.39E-17	4.96E-17	4.67E-17	4.47E-17	4.13E-17	4.06E-17
Eu-146	1.00E-16	9.21E-17	8.64E-17	8.27E-17	7.62E-17	7.49E-17
Eu-147	1.76E-17	1.61E-17	1.51E-17	1.43E-17	1.31E-17	1.29E-17
Eu-148	9.06E-17	8.32E-17	7.77E-17	7.44E-17	6.84E-17	6.71E-17
Eu-149	1.51E-18	1.33E-18	1.22E-18	1.15E-18	1.04E-18	1.02E-18
Eu-150	6.12E-17	5.61E-17	5.23E-17	5.00E-17	4.59E-17	4.50E-17
Eu-150m	2.55E-18	2.34E-18	2.19E-18	2.09E-18	1.92E-18	1.89E-18
Eu-152	4.83E-17	4.44E-17	4.18E-17	3.99E-17	3.68E-17	3.61E-17
Eu-152m	1.34E-17	1.23E-17	1.16E-17	1.10E-17	1.01E-17	9.97E-18
Eu-152n	1.64E-18	1.47E-18	1.35E-18	1.27E-18	1.13E-18	1.10E-18
Eu-154	5.25E-17	4.83E-17	4.55E-17	4.34E-17	4.00E-17	3.93E-17
Eu-154m	1.30E-18	1.14E-18	1.04E-18	9.77E-19	8.54E-19	8.34E-19
Eu-155	1.40E-18	1.26E-18	1.15E-18	1.09E-18	9.66E-19	9.46E-19
Eu-156	5.48E-17	5.06E-17	4.78E-17	4.59E-17	4.25E-17	4.18E-17
Eu-157	1.11E-17	1.01E-17	9.38E-18	8.96E-18	8.18E-18	8.03E-18
Eu-158	5.77E-17	5.32E-17	5.02E-17	4.79E-17	4.42E-17	4.35E-17
Eu-159	1.32E-17	1.21E-17	1.13E-17	1.08E-17	9.88E-18	9.70E-18
<b>Gadolinium</b>						
Gd-142	4.46E-17	4.10E-17	3.83E-17	3.67E-17	3.38E-17	3.32E-17
Gd-143m	9.07E-17	8.33E-17	7.80E-17	7.47E-17	6.88E-17	6.75E-17
Gd-144	3.94E-17	3.64E-17	3.40E-17	3.27E-17	3.02E-17	2.97E-17
Gd-145	1.07E-16	9.94E-17	9.36E-17	9.05E-17	8.39E-17	8.25E-17
Gd-145m	2.80E-17	2.57E-17	2.40E-17	2.29E-17	2.10E-17	2.07E-17
Gd-146	5.85E-18	5.28E-18	4.82E-18	4.58E-18	4.07E-18	4.00E-18
Gd-147	5.57E-17	5.10E-17	4.78E-17	4.56E-17	4.19E-17	4.12E-17
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	1.89E-17	1.72E-17	1.60E-17	1.53E-17	1.40E-17	1.37E-17
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	1.49E-18	1.31E-18	1.20E-18	1.13E-18	1.01E-18	9.87E-19
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	1.87E-18	1.63E-18	1.47E-18	1.38E-18	1.21E-18	1.18E-18

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	2.43E-18	2.21E-18	2.06E-18	1.96E-18	1.80E-18	1.76E-18
Gd-162	1.67E-17	1.53E-17	1.42E-17	1.36E-17	1.25E-17	1.22E-17
<b>Terbium</b>						
Tb-146	1.63E-16	1.50E-16	1.41E-16	1.36E-16	1.26E-16	1.24E-16
Tb-147	9.22E-17	8.50E-17	7.99E-17	7.64E-17	7.05E-17	6.93E-17
Tb-147m	8.34E-17	7.70E-17	7.25E-17	6.97E-17	6.45E-17	6.34E-17
Tb-148	1.02E-16	9.44E-17	8.86E-17	8.50E-17	7.85E-17	7.71E-17
Tb-148m	1.29E-16	1.18E-16	1.10E-16	1.05E-16	9.69E-17	9.52E-17
Tb-149	5.60E-17	5.16E-17	4.84E-17	4.64E-17	4.28E-17	4.20E-17
Tb-149m	5.62E-17	5.16E-17	4.82E-17	4.60E-17	4.23E-17	4.15E-17
Tb-150	1.06E-16	9.80E-17	9.21E-17	8.87E-17	8.22E-17	8.09E-17
Tb-150m	1.01E-16	9.24E-17	8.60E-17	8.22E-17	7.54E-17	7.40E-17
Tb-151	3.77E-17	3.45E-17	3.22E-17	3.07E-17	2.82E-17	2.76E-17
Tb-151m	2.72E-18	2.48E-18	2.30E-18	2.19E-18	2.00E-18	1.96E-18
Tb-152	6.27E-17	5.78E-17	5.43E-17	5.21E-17	4.81E-17	4.73E-17
Tb-152m	2.81E-17	2.56E-17	2.38E-17	2.28E-17	2.08E-17	2.04E-17
Tb-153	1.11E-17	1.01E-17	9.43E-18	8.97E-18	8.18E-18	8.02E-18
Tb-154	9.95E-17	9.21E-17	8.69E-17	8.38E-17	7.77E-17	7.65E-17
Tb-155	4.41E-18	3.95E-18	3.64E-18	3.44E-18	3.08E-18	3.02E-18
Tb-156	7.94E-17	7.30E-17	6.86E-17	6.56E-17	6.04E-17	5.94E-17
Tb-156m	4.90E-19	3.99E-19	3.48E-19	3.15E-19	2.64E-19	2.58E-19
Tb-156n	5.49E-20	4.63E-20	4.11E-20	3.80E-20	3.26E-20	3.18E-20
Tb-157	4.98E-20	3.94E-20	3.35E-20	3.01E-20	2.48E-20	2.41E-20
Tb-158	3.24E-17	2.97E-17	2.80E-17	2.66E-17	2.45E-17	2.40E-17
Tb-160	4.71E-17	4.33E-17	4.08E-17	3.89E-17	3.58E-17	3.52E-17
Tb-161	7.25E-19	6.30E-19	5.72E-19	5.35E-19	4.71E-19	4.61E-19
Tb-162	4.57E-17	4.19E-17	3.93E-17	3.74E-17	3.44E-17	3.38E-17
Tb-163	3.12E-17	2.86E-17	2.65E-17	2.54E-17	2.33E-17	2.28E-17
Tb-164	1.04E-16	9.57E-17	8.99E-17	8.60E-17	7.93E-17	7.79E-17
Tb-165	3.88E-17	3.58E-17	3.38E-17	3.24E-17	2.99E-17	2.94E-17
<b>Dysprosium</b>						
Dy-148	2.81E-17	2.58E-17	2.40E-17	2.29E-17	2.10E-17	2.06E-17
Dy-149	6.78E-17	6.25E-17	5.87E-17	5.63E-17	5.20E-17	5.11E-17
Dy-150	1.01E-17	9.15E-18	8.48E-18	8.11E-18	7.41E-18	7.26E-18
Dy-151	5.65E-17	5.19E-17	4.87E-17	4.66E-17	4.30E-17	4.22E-17
Dy-152	9.44E-18	8.50E-18	7.95E-18	7.55E-18	6.87E-18	6.73E-18
Dy-153	3.33E-17	3.05E-17	2.85E-17	2.73E-17	2.50E-17	2.46E-17
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	2.58E-17	2.36E-17	2.21E-17	2.11E-17	1.94E-17	1.90E-17
Dy-157	1.19E-17	1.08E-17	1.01E-17	9.58E-18	8.74E-18	8.56E-18
Dy-159	5.18E-19	4.14E-19	3.56E-19	3.21E-19	2.66E-19	2.59E-19
Dy-165	1.97E-18	1.80E-18	1.69E-18	1.61E-18	1.48E-18	1.45E-18
Dy-165m	5.58E-19	5.05E-19	4.65E-19	4.43E-19	4.02E-19	3.94E-19
Dy-166	9.51E-19	8.32E-19	7.57E-19	7.09E-19	6.27E-19	6.13E-19
Dy-167	2.22E-17	2.03E-17	1.90E-17	1.81E-17	1.66E-17	1.63E-17
Dy-168	1.54E-17	1.41E-17	1.31E-17	1.25E-17	1.15E-17	1.13E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	8.57E-17	7.88E-17	7.36E-17	7.03E-17	6.47E-17	6.35E-17
Ho-153	4.18E-17	3.83E-17	3.58E-17	3.42E-17	3.14E-17	3.08E-17
Ho-153m	4.29E-17	3.93E-17	3.66E-17	3.50E-17	3.21E-17	3.15E-17
Ho-154	8.00E-17	7.35E-17	6.87E-17	6.58E-17	6.05E-17	5.94E-17
Ho-154m	9.79E-17	8.97E-17	8.36E-17	8.00E-17	7.34E-17	7.20E-17
Ho-155	2.38E-17	2.18E-17	2.04E-17	1.95E-17	1.79E-17	1.76E-17
Ho-156	8.85E-17	8.15E-17	7.64E-17	7.33E-17	6.76E-17	6.64E-17
Ho-157	2.09E-17	1.90E-17	1.77E-17	1.69E-17	1.55E-17	1.52E-17
Ho-159	1.19E-17	1.08E-17	1.00E-17	9.54E-18	8.65E-18	8.49E-18
Ho-160	6.87E-17	6.31E-17	5.92E-17	5.63E-17	5.18E-17	5.09E-17
Ho-161	7.41E-19	6.16E-19	5.43E-19	4.99E-19	4.25E-19	4.15E-19
Ho-162	5.51E-18	5.01E-18	4.67E-18	4.45E-18	4.07E-18	3.99E-18
Ho-162m	2.17E-17	1.99E-17	1.87E-17	1.78E-17	1.64E-17	1.61E-17
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	6.61E-19	5.71E-19	5.18E-19	4.82E-19	4.25E-19	4.16E-19
Ho-164m	5.57E-19	4.52E-19	3.93E-19	3.57E-19	2.99E-19	2.91E-19
Ho-166	2.91E-18	2.68E-18	2.53E-18	2.41E-18	2.22E-18	2.19E-18
Ho-166m	6.47E-17	5.93E-17	5.55E-17	5.29E-17	4.86E-17	4.77E-17
Ho-167	1.38E-17	1.25E-17	1.17E-17	1.11E-17	1.02E-17	9.98E-18
Ho-168	3.83E-17	3.53E-17	3.31E-17	3.15E-17	2.90E-17	2.85E-17
Ho-168m	7.92E-20	6.43E-20	5.59E-20	5.06E-20	4.24E-20	4.13E-20
Ho-170	7.17E-17	6.59E-17	6.21E-17	5.90E-17	5.43E-17	5.34E-17
<b>Erbium</b>						
Er-154	1.65E-18	1.46E-18	1.33E-18	1.25E-18	1.12E-18	1.10E-18
Er-156	1.07E-18	9.12E-19	8.17E-19	7.60E-19	6.64E-19	6.49E-19
Er-159	3.89E-17	3.57E-17	3.34E-17	3.20E-17	2.95E-17	2.89E-17
Er-161	4.00E-17	3.67E-17	3.45E-17	3.28E-17	3.02E-17	2.97E-17
Er-163	5.35E-19	4.39E-19	3.84E-19	3.50E-19	2.95E-19	2.88E-19
Er-165	4.75E-19	3.85E-19	3.35E-19	3.04E-19	2.54E-19	2.48E-19
Er-167m	3.11E-18	2.81E-18	2.63E-18	2.50E-18	2.27E-18	2.22E-18
Er-169	1.35E-19	1.24E-19	1.17E-19	1.11E-19	1.03E-19	1.01E-19
Er-171	1.38E-17	1.25E-17	1.17E-17	1.12E-17	1.02E-17	9.98E-18
Er-172	1.96E-17	1.79E-17	1.67E-17	1.59E-17	1.46E-17	1.43E-17
Er-173	3.35E-17	3.07E-17	2.88E-17	2.74E-17	2.51E-17	2.47E-17
<b>Thulium</b>						
Tm-161	5.20E-17	4.78E-17	4.49E-17	4.31E-17	3.98E-17	3.91E-17
Tm-162	8.33E-17	7.70E-17	7.24E-17	6.96E-17	6.44E-17	6.34E-17
Tm-163	5.37E-17	4.94E-17	4.64E-17	4.45E-17	4.10E-17	4.03E-17
Tm-164	3.33E-17	3.06E-17	2.86E-17	2.74E-17	2.53E-17	2.48E-17
Tm-165	2.04E-17	1.85E-17	1.73E-17	1.65E-17	1.51E-17	1.48E-17
Tm-166	8.38E-17	7.73E-17	7.27E-17	6.99E-17	6.46E-17	6.35E-17
Tm-167	4.03E-18	3.60E-18	3.34E-18	3.15E-18	2.84E-18	2.78E-18
Tm-168	4.86E-17	4.45E-17	4.17E-17	3.97E-17	3.64E-17	3.58E-17
Tm-170	7.64E-19	7.01E-19	6.60E-19	6.27E-19	5.76E-19	5.66E-19
Tm-171	2.14E-20	1.90E-20	1.75E-20	1.64E-20	1.47E-20	1.44E-20

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	2.18E-17	2.01E-17	1.90E-17	1.82E-17	1.68E-17	1.65E-17
Tm-173	1.54E-17	1.41E-17	1.31E-17	1.25E-17	1.15E-17	1.12E-17
Tm-174	7.13E-17	6.54E-17	6.14E-17	5.84E-17	5.37E-17	5.27E-17
Tm-175	4.53E-17	4.16E-17	3.90E-17	3.72E-17	3.42E-17	3.36E-17
Tm-176	8.59E-17	7.93E-17	7.47E-17	7.17E-17	6.63E-17	6.52E-17
<b>Ytterbium</b>						
Yb-162	7.77E-18	7.09E-18	6.55E-18	6.24E-18	5.65E-18	5.54E-18
Yb-163	2.98E-17	2.74E-17	2.56E-17	2.45E-17	2.26E-17	2.22E-17
Yb-164	1.05E-18	9.06E-19	8.19E-19	7.64E-19	6.72E-19	6.58E-19
Yb-165	1.15E-17	1.04E-17	9.72E-18	9.25E-18	8.45E-18	8.29E-18
Yb-166	1.31E-18	1.10E-18	9.81E-19	9.03E-19	7.71E-19	7.52E-19
Yb-167	6.52E-18	5.84E-18	5.36E-18	5.07E-18	4.52E-18	4.44E-18
Yb-169	8.31E-18	7.42E-18	6.84E-18	6.46E-18	5.78E-18	5.66E-18
Yb-175	1.60E-18	1.46E-18	1.36E-18	1.30E-18	1.19E-18	1.16E-18
Yb-177	8.72E-18	8.04E-18	7.56E-18	7.20E-18	6.62E-18	6.51E-18
Yb-178	1.78E-18	1.62E-18	1.51E-18	1.45E-18	1.32E-18	1.30E-18
Yb-179	4.05E-17	3.72E-17	3.46E-17	3.31E-17	3.04E-17	2.98E-17
<b>Lutetium</b>						
Lu-165	4.47E-17	4.11E-17	3.84E-17	3.69E-17	3.39E-17	3.33E-17
Lu-167	7.13E-17	6.58E-17	6.19E-17	5.95E-17	5.50E-17	5.41E-17
Lu-169	5.44E-17	5.00E-17	4.71E-17	4.51E-17	4.16E-17	4.09E-17
Lu-169m	1.52E-23	9.78E-24	5.71E-24	5.14E-24	2.08E-24	1.93E-24
Lu-170	1.12E-16	1.04E-16	9.84E-17	9.48E-17	8.80E-17	8.66E-17
Lu-171	2.46E-17	2.25E-17	2.10E-17	2.00E-17	1.83E-17	1.80E-17
Lu-171m	5.60E-21	4.84E-21	4.36E-21	4.07E-21	3.50E-21	3.41E-21
Lu-172	8.05E-17	7.40E-17	6.97E-17	6.64E-17	6.12E-17	6.01E-17
Lu-172m	2.03E-23	1.52E-23	1.19E-23	1.07E-23	7.91E-24	7.65E-24
Lu-173	4.63E-18	4.11E-18	3.78E-18	3.57E-18	3.20E-18	3.13E-18
Lu-174	3.58E-18	3.24E-18	3.02E-18	2.86E-18	2.61E-18	2.56E-18
Lu-174m	1.10E-18	9.53E-19	8.63E-19	8.03E-19	7.02E-19	6.86E-19
Lu-176	1.70E-17	1.55E-17	1.44E-17	1.38E-17	1.25E-17	1.23E-17
Lu-176m	1.35E-18	1.24E-18	1.16E-18	1.10E-18	1.01E-18	9.93E-19
Lu-177	1.30E-18	1.18E-18	1.11E-18	1.05E-18	9.56E-19	9.37E-19
Lu-177m	3.42E-17	3.11E-17	2.89E-17	2.76E-17	2.51E-17	2.46E-17
Lu-178	7.42E-18	6.84E-18	6.46E-18	6.18E-18	5.71E-18	5.61E-18
Lu-178m	3.83E-17	3.48E-17	3.24E-17	3.09E-17	2.82E-17	2.77E-17
Lu-179	2.26E-18	2.07E-18	1.95E-18	1.86E-18	1.71E-18	1.68E-18
Lu-180	6.50E-17	5.98E-17	5.64E-17	5.39E-17	4.97E-17	4.88E-17
Lu-181	2.43E-17	2.23E-17	2.08E-17	1.98E-17	1.82E-17	1.79E-17
<b>Hafnium</b>						
Hf-167	2.49E-17	2.27E-17	2.11E-17	2.02E-17	1.85E-17	1.81E-17
Hf-169	2.44E-17	2.24E-17	2.07E-17	1.98E-17	1.81E-17	1.78E-17
Hf-170	1.52E-17	1.39E-17	1.28E-17	1.22E-17	1.12E-17	1.09E-17
Hf-172	1.84E-18	1.60E-18	1.44E-18	1.35E-18	1.17E-18	1.14E-18
Hf-173	1.24E-17	1.13E-17	1.05E-17	9.99E-18	9.05E-18	8.88E-18
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	1.21E-17	1.09E-17	1.02E-17	9.69E-18	8.83E-18	8.65E-18
Hf-177m	8.11E-17	7.37E-17	6.88E-17	6.56E-17	5.98E-17	5.86E-17
Hf-178m	8.37E-17	7.64E-17	7.10E-17	6.79E-17	6.21E-17	6.09E-17
Hf-179m	3.25E-17	2.97E-17	2.75E-17	2.63E-17	2.40E-17	2.35E-17
Hf-180m	3.60E-17	3.28E-17	3.05E-17	2.91E-17	2.66E-17	2.60E-17
Hf-181	1.99E-17	1.83E-17	1.69E-17	1.62E-17	1.48E-17	1.45E-17
Hf-182	8.47E-18	7.68E-18	7.18E-18	6.84E-18	6.24E-18	6.11E-18
Hf-182m	3.43E-17	3.14E-17	2.93E-17	2.79E-17	2.55E-17	2.51E-17
Hf-183	3.19E-17	2.93E-17	2.74E-17	2.61E-17	2.40E-17	2.36E-17
Hf-184	8.31E-18	7.59E-18	7.04E-18	6.72E-18	6.11E-18	5.99E-18
<b>Tantalum</b>						
Ta-170	4.83E-17	4.44E-17	4.14E-17	3.96E-17	3.64E-17	3.57E-17
Ta-172	7.09E-17	6.52E-17	6.13E-17	5.86E-17	5.40E-17	5.30E-17
Ta-173	2.23E-17	2.05E-17	1.92E-17	1.83E-17	1.68E-17	1.65E-17
Ta-174	4.00E-17	3.67E-17	3.44E-17	3.30E-17	3.04E-17	2.98E-17
Ta-175	4.49E-17	4.13E-17	3.88E-17	3.72E-17	3.43E-17	3.37E-17
Ta-176	9.64E-17	8.91E-17	8.40E-17	8.08E-17	7.48E-17	7.36E-17
Ta-177	1.39E-18	1.22E-18	1.11E-18	1.04E-18	9.15E-19	8.95E-19
Ta-178	3.73E-18	3.38E-18	3.15E-18	2.99E-18	2.72E-18	2.67E-18
Ta-178m	4.05E-17	3.68E-17	3.42E-17	3.27E-17	2.98E-17	2.92E-17
Ta-179	3.86E-19	3.27E-19	2.92E-19	2.69E-19	2.30E-19	2.24E-19
Ta-180	8.52E-19	7.33E-19	6.60E-19	6.14E-19	5.31E-19	5.18E-19
Ta-182	5.37E-17	4.95E-17	4.67E-17	4.45E-17	4.10E-17	4.03E-17
Ta-182m	7.62E-18	6.95E-18	6.42E-18	6.11E-18	5.50E-18	5.40E-18
Ta-183	9.43E-18	8.53E-18	7.94E-18	7.55E-18	6.84E-18	6.70E-18
Ta-184	6.29E-17	5.76E-17	5.39E-17	5.14E-17	4.72E-17	4.63E-17
Ta-185	6.49E-18	5.94E-18	5.54E-18	5.27E-18	4.80E-18	4.71E-18
Ta-186	5.88E-17	5.39E-17	5.04E-17	4.81E-17	4.41E-17	4.33E-17
<b>Tungsten</b>						
W-177	3.40E-17	3.11E-17	2.91E-17	2.77E-17	2.54E-17	2.49E-17
W-178	2.42E-19	2.06E-19	1.85E-19	1.71E-19	1.47E-19	1.43E-19
W-179	8.02E-19	6.82E-19	6.09E-19	5.64E-19	4.81E-19	4.69E-19
W-179m	1.31E-18	1.16E-18	1.07E-18	1.00E-18	8.92E-19	8.73E-19
W-181	6.44E-19	5.50E-19	4.93E-19	4.57E-19	3.91E-19	3.81E-19
W-185	1.94E-19	1.78E-19	1.68E-19	1.60E-19	1.48E-19	1.45E-19
W-185m	6.22E-19	5.65E-19	5.19E-19	4.93E-19	4.40E-19	4.31E-19
W-187	1.80E-17	1.66E-17	1.54E-17	1.47E-17	1.35E-17	1.32E-17
W-188	1.99E-19	1.82E-19	1.71E-19	1.63E-19	1.50E-19	1.47E-19
W-190	4.42E-18	4.02E-18	3.70E-18	3.52E-18	3.15E-18	3.09E-18
<b>Rhenium</b>						
Re-178	7.35E-17	6.80E-17	6.39E-17	6.15E-17	5.70E-17	5.60E-17
Re-179	4.29E-17	3.94E-17	3.68E-17	3.53E-17	3.25E-17	3.19E-17
Re-180	4.88E-17	4.49E-17	4.22E-17	4.01E-17	3.69E-17	3.63E-17
Re-181	3.04E-17	2.77E-17	2.59E-17	2.47E-17	2.26E-17	2.22E-17
Re-182	7.05E-17	6.47E-17	6.09E-17	5.81E-17	5.34E-17	5.25E-17
Re-182m	4.98E-17	4.58E-17	4.32E-17	4.12E-17	3.80E-17	3.73E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	3.74E-18	3.36E-18	3.08E-18	2.92E-18	2.59E-18	2.54E-18
Re-184	3.55E-17	3.26E-17	3.06E-17	2.91E-17	2.67E-17	2.63E-17
Re-184m	1.37E-17	1.25E-17	1.17E-17	1.12E-17	1.02E-17	1.00E-17
Re-186	1.26E-18	1.16E-18	1.08E-18	1.03E-18	9.36E-19	9.20E-19
Re-186m	2.39E-19	2.04E-19	1.83E-19	1.70E-19	1.45E-19	1.42E-19
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	4.48E-18	4.13E-18	3.88E-18	3.70E-18	3.41E-18	3.35E-18
Re-188m	1.35E-18	1.19E-18	1.09E-18	1.02E-18	8.90E-19	8.69E-19
Re-189	2.56E-18	2.34E-18	2.19E-18	2.08E-18	1.90E-18	1.87E-18
Re-190	5.46E-17	5.01E-17	4.67E-17	4.46E-17	4.10E-17	4.02E-17
Re-190m	3.68E-17	3.37E-17	3.14E-17	3.00E-17	2.75E-17	2.70E-17
<b>Osmium</b>						
Os-180	3.60E-18	3.25E-18	3.00E-18	2.85E-18	2.57E-18	2.52E-18
Os-181	5.59E-17	5.13E-17	4.83E-17	4.61E-17	4.25E-17	4.17E-17
Os-182	1.52E-17	1.39E-17	1.29E-17	1.23E-17	1.12E-17	1.10E-17
Os-183	2.21E-17	2.02E-17	1.88E-17	1.79E-17	1.63E-17	1.60E-17
Os-183m	4.17E-17	3.84E-17	3.62E-17	3.44E-17	3.18E-17	3.12E-17
Os-185	2.71E-17	2.49E-17	2.32E-17	2.21E-17	2.03E-17	1.99E-17
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	6.40E-23	4.30E-23	2.59E-23	2.36E-23	8.35E-24	7.69E-24
Os-190m	6.17E-17	5.65E-17	5.25E-17	5.03E-17	4.60E-17	4.51E-17
Os-191	1.93E-18	1.75E-18	1.60E-18	1.52E-18	1.34E-18	1.32E-18
Os-191m	1.04E-19	9.11E-20	8.24E-20	7.73E-20	6.66E-20	6.49E-20
Os-193	3.09E-18	2.82E-18	2.63E-18	2.51E-18	2.29E-18	2.25E-18
Os-194	3.09E-20	2.51E-20	2.17E-20	1.98E-20	1.67E-20	1.62E-20
Os-196	3.64E-18	3.32E-18	3.10E-18	2.96E-18	2.70E-18	2.65E-18
<b>Iridium</b>						
Ir-180	6.75E-17	6.20E-17	5.79E-17	5.53E-17	5.07E-17	4.98E-17
Ir-182	5.93E-17	5.45E-17	5.09E-17	4.86E-17	4.47E-17	4.39E-17
Ir-183	4.86E-17	4.48E-17	4.20E-17	4.04E-17	3.72E-17	3.66E-17
Ir-184	8.04E-17	7.39E-17	6.94E-17	6.64E-17	6.11E-17	6.01E-17
Ir-185	3.48E-17	3.20E-17	3.01E-17	2.90E-17	2.67E-17	2.63E-17
Ir-186	6.73E-17	6.19E-17	5.80E-17	5.56E-17	5.12E-17	5.03E-17
Ir-186m	5.20E-17	4.79E-17	4.50E-17	4.31E-17	3.98E-17	3.91E-17
Ir-187	1.19E-17	1.09E-17	1.02E-17	9.66E-18	8.83E-18	8.66E-18
Ir-188	9.08E-17	8.40E-17	7.91E-17	7.64E-17	7.08E-17	6.97E-17
Ir-189	1.75E-18	1.55E-18	1.43E-18	1.35E-18	1.19E-18	1.16E-18
Ir-190	5.68E-17	5.20E-17	4.83E-17	4.62E-17	4.23E-17	4.15E-17
Ir-190m	7.09E-23	4.89E-23	3.02E-23	2.76E-23	9.55E-24	8.77E-24
Ir-190n	1.09E-18	9.57E-19	8.69E-19	8.18E-19	7.11E-19	6.94E-19
Ir-191m	1.71E-18	1.55E-18	1.42E-18	1.35E-18	1.19E-18	1.17E-18
Ir-192	3.13E-17	2.86E-17	2.66E-17	2.54E-17	2.33E-17	2.28E-17
Ir-192m	2.16E-21	1.89E-21	1.70E-21	1.61E-21	1.41E-21	1.38E-21
Ir-192n	1.36E-20	1.21E-20	1.09E-20	1.03E-20	8.95E-21	8.75E-21
Ir-193m	5.82E-21	5.09E-21	4.60E-21	4.33E-21	3.72E-21	3.62E-21
Ir-194	6.04E-18	5.55E-18	5.22E-18	4.98E-18	4.59E-18	4.51E-18

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	9.19E-17	8.42E-17	7.83E-17	7.49E-17	6.87E-17	6.74E-17
Ir-195	1.97E-18	1.78E-18	1.65E-18	1.56E-18	1.40E-18	1.37E-18
Ir-195m	1.41E-17	1.29E-17	1.20E-17	1.14E-17	1.04E-17	1.02E-17
Ir-196	1.34E-17	1.23E-17	1.15E-17	1.10E-17	1.01E-17	9.98E-18
Ir-196m	9.75E-17	8.94E-17	8.31E-17	7.95E-17	7.29E-17	7.15E-17
<b>Platinum</b>						
Pt-184	2.46E-17	2.25E-17	2.09E-17	1.99E-17	1.81E-17	1.78E-17
Pt-186	2.61E-17	2.39E-17	2.23E-17	2.12E-17	1.94E-17	1.91E-17
Pt-187	2.26E-17	2.07E-17	1.93E-17	1.84E-17	1.68E-17	1.65E-17
Pt-188	6.04E-18	5.47E-18	5.07E-18	4.82E-18	4.35E-18	4.26E-18
Pt-189	1.73E-17	1.58E-17	1.47E-17	1.41E-17	1.29E-17	1.26E-17
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	9.33E-18	8.48E-18	7.84E-18	7.48E-18	6.77E-18	6.64E-18
Pt-193	1.72E-22	1.20E-22	7.64E-23	7.03E-23	2.43E-23	2.23E-23
Pt-193m	2.00E-19	1.77E-19	1.61E-19	1.52E-19	1.31E-19	1.28E-19
Pt-195m	1.47E-18	1.30E-18	1.19E-18	1.13E-18	9.83E-19	9.60E-19
Pt-197	9.52E-19	8.65E-19	8.06E-19	7.65E-19	6.91E-19	6.77E-19
Pt-197m	2.37E-18	2.13E-18	1.98E-18	1.88E-18	1.70E-18	1.66E-18
Pt-199	9.13E-18	8.38E-18	7.81E-18	7.47E-18	6.85E-18	6.73E-18
Pt-200	1.88E-18	1.70E-18	1.58E-18	1.50E-18	1.35E-18	1.32E-18
Pt-202	1.84E-18	1.70E-18	1.60E-18	1.53E-18	1.42E-18	1.39E-18
<b>Gold</b>						
Au-186	6.38E-17	5.86E-17	5.48E-17	5.25E-17	4.83E-17	4.74E-17
Au-187	4.44E-17	4.09E-17	3.84E-17	3.69E-17	3.41E-17	3.35E-17
Au-190	1.03E-16	9.54E-17	8.99E-17	8.69E-17	8.06E-17	7.92E-17
Au-191	2.16E-17	1.97E-17	1.84E-17	1.75E-17	1.60E-17	1.57E-17
Au-192	8.31E-17	7.67E-17	7.23E-17	6.97E-17	6.45E-17	6.35E-17
Au-193	4.68E-18	4.22E-18	3.91E-18	3.71E-18	3.34E-18	3.27E-18
Au-193m	6.74E-18	6.10E-18	5.71E-18	5.43E-18	4.95E-18	4.85E-18
Au-194	4.26E-17	3.92E-17	3.68E-17	3.54E-17	3.26E-17	3.20E-17
Au-195	1.61E-18	1.42E-18	1.30E-18	1.23E-18	1.07E-18	1.04E-18
Au-195m	6.87E-18	6.21E-18	5.82E-18	5.53E-18	5.04E-18	4.94E-18
Au-196	1.69E-17	1.54E-17	1.43E-17	1.36E-17	1.24E-17	1.22E-17
Au-196m	7.00E-18	6.39E-18	5.91E-18	5.64E-18	5.07E-18	4.97E-18
Au-198	1.62E-17	1.48E-17	1.38E-17	1.32E-17	1.21E-17	1.18E-17
Au-198m	1.68E-17	1.52E-17	1.42E-17	1.35E-17	1.22E-17	1.20E-17
Au-199	3.00E-18	2.76E-18	2.56E-18	2.44E-18	2.20E-18	2.16E-18
Au-200	1.37E-17	1.26E-17	1.19E-17	1.13E-17	1.05E-17	1.03E-17
Au-200m	7.77E-17	7.12E-17	6.64E-17	6.34E-17	5.81E-17	5.70E-17
Au-201	2.33E-18	2.14E-18	2.01E-18	1.92E-18	1.76E-18	1.73E-18
Au-202	1.08E-17	9.94E-18	9.36E-18	8.94E-18	8.25E-18	8.11E-18
<b>Mercury</b>						
Hg-190	5.35E-18	4.91E-18	4.51E-18	4.30E-18	3.84E-18	3.77E-18
Hg-191m	5.92E-17	5.43E-17	5.09E-17	4.87E-17	4.47E-17	4.39E-17
Hg-192	8.44E-18	7.63E-18	7.10E-18	6.76E-18	6.11E-18	5.99E-18
Hg-193	3.36E-17	3.09E-17	2.90E-17	2.78E-17	2.56E-17	2.51E-17



**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	4.15E-17	3.81E-17	3.58E-17	3.42E-17	3.15E-17	3.09E-17
Hg-194	2.61E-22	1.91E-22	1.28E-22	1.19E-22	4.12E-23	3.77E-23
Hg-195	6.75E-18	6.17E-18	5.76E-18	5.48E-18	4.99E-18	4.90E-18
Hg-195m	6.83E-18	6.21E-18	5.79E-18	5.51E-18	5.02E-18	4.92E-18
Hg-197	1.42E-18	1.26E-18	1.15E-18	1.09E-18	9.50E-19	9.27E-19
Hg-197m	2.60E-18	2.37E-18	2.19E-18	2.09E-18	1.87E-18	1.83E-18
Hg-199m	5.52E-18	5.05E-18	4.67E-18	4.46E-18	4.02E-18	3.94E-18
Hg-203	8.59E-18	7.78E-18	7.28E-18	6.93E-18	6.33E-18	6.20E-18
Hg-205	1.59E-18	1.46E-18	1.38E-18	1.32E-18	1.22E-18	1.20E-18
Hg-206	5.36E-18	4.88E-18	4.56E-18	4.35E-18	3.98E-18	3.91E-18
Hg-207	1.17E-16	1.08E-16	1.02E-16	9.80E-17	9.07E-17	8.91E-17
<b>Thallium</b>						
Tl-190	5.82E-17	5.35E-17	4.98E-17	4.77E-17	4.38E-17	4.30E-17
Tl-190m	1.01E-16	9.31E-17	8.68E-17	8.30E-17	7.62E-17	7.48E-17
Tl-194	3.78E-17	3.47E-17	3.22E-17	3.09E-17	2.83E-17	2.78E-17
Tl-194m	1.01E-16	9.26E-17	8.63E-17	8.25E-17	7.57E-17	7.43E-17
Tl-195	5.13E-17	4.74E-17	4.46E-17	4.28E-17	3.96E-17	3.89E-17
Tl-196	7.92E-17	7.30E-17	6.85E-17	6.60E-17	6.09E-17	5.99E-17
Tl-197	1.73E-17	1.59E-17	1.48E-17	1.42E-17	1.30E-17	1.28E-17
Tl-198	8.52E-17	7.87E-17	7.40E-17	7.12E-17	6.58E-17	6.47E-17
Tl-198m	4.69E-17	4.30E-17	4.00E-17	3.82E-17	3.50E-17	3.43E-17
Tl-199	8.22E-18	7.48E-18	6.96E-18	6.63E-18	6.02E-18	5.90E-18
Tl-200	5.32E-17	4.88E-17	4.59E-17	4.38E-17	4.03E-17	3.96E-17
Tl-201	2.06E-18	1.86E-18	1.70E-18	1.62E-18	1.42E-18	1.39E-18
Tl-202	1.70E-17	1.55E-17	1.43E-17	1.37E-17	1.25E-17	1.23E-17
Tl-204	4.98E-19	4.58E-19	4.32E-19	4.10E-19	3.78E-19	3.71E-19
Tl-206	1.42E-18	1.31E-18	1.24E-18	1.18E-18	1.09E-18	1.07E-18
Tl-206m	9.65E-17	8.85E-17	8.28E-17	7.90E-17	7.25E-17	7.12E-17
Tl-207	1.36E-18	1.26E-18	1.19E-18	1.13E-18	1.05E-18	1.03E-18
Tl-208	1.51E-16	1.41E-16	1.33E-16	1.29E-16	1.20E-16	1.18E-16
Tl-209	9.27E-17	8.55E-17	8.04E-17	7.73E-17	7.15E-17	7.03E-17
Tl-210	1.22E-16	1.13E-16	1.06E-16	1.02E-16	9.43E-17	9.27E-17
<b>Lead</b>						
Pb-194	4.36E-17	4.01E-17	3.76E-17	3.60E-17	3.32E-17	3.26E-17
Pb-195m	6.56E-17	6.02E-17	5.62E-17	5.37E-17	4.93E-17	4.83E-17
Pb-196	1.75E-17	1.59E-17	1.48E-17	1.41E-17	1.29E-17	1.26E-17
Pb-197	6.39E-17	5.89E-17	5.53E-17	5.31E-17	4.90E-17	4.81E-17
Pb-197m	4.56E-17	4.18E-17	3.90E-17	3.73E-17	3.42E-17	3.36E-17
Pb-198	1.52E-17	1.39E-17	1.29E-17	1.23E-17	1.12E-17	1.10E-17
Pb-199	4.26E-17	3.92E-17	3.68E-17	3.53E-17	3.25E-17	3.19E-17
Pb-200	5.90E-18	5.37E-18	4.96E-18	4.73E-18	4.25E-18	4.17E-18
Pb-201	2.89E-17	2.64E-17	2.47E-17	2.36E-17	2.16E-17	2.12E-17
Pb-201m	1.44E-17	1.32E-17	1.23E-17	1.17E-17	1.07E-17	1.05E-17
Pb-202	2.95E-22	2.02E-22	1.25E-22	1.14E-22	4.01E-23	3.68E-23
Pb-202m	8.16E-17	7.49E-17	7.02E-17	6.69E-17	6.15E-17	6.04E-17
Pb-203	1.04E-17	9.38E-18	8.76E-18	8.34E-18	7.57E-18	7.42E-18

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	8.53E-17	7.83E-17	7.37E-17	7.00E-17	6.45E-17	6.33E-17
Pb-205	2.99E-22	2.04E-22	1.26E-22	1.16E-22	4.06E-23	3.72E-23
Pb-209	3.61E-19	3.32E-19	3.14E-19	2.98E-19	2.75E-19	2.71E-19
Pb-210	2.52E-20	2.02E-20	1.74E-20	1.57E-20	1.29E-20	1.26E-20
Pb-211	3.71E-18	3.41E-18	3.20E-18	3.05E-18	2.81E-18	2.76E-18
Pb-212	4.86E-18	4.40E-18	4.11E-18	3.91E-18	3.55E-18	3.48E-18
Pb-214	9.61E-18	8.74E-18	8.15E-18	7.78E-18	7.11E-18	6.97E-18
<b>Bismuth</b>						
Bi-197	7.12E-17	6.56E-17	6.16E-17	5.89E-17	5.43E-17	5.33E-17
Bi-200	9.78E-17	8.97E-17	8.40E-17	8.01E-17	7.36E-17	7.22E-17
Bi-201	7.31E-17	6.74E-17	6.35E-17	6.08E-17	5.62E-17	5.52E-17
Bi-202	1.13E-16	1.04E-16	9.77E-17	9.33E-17	8.59E-17	8.44E-17
Bi-203	1.02E-16	9.40E-17	8.86E-17	8.50E-17	7.86E-17	7.73E-17
Bi-204	1.21E-16	1.11E-16	1.05E-16	1.00E-16	9.21E-17	9.05E-17
Bi-205	7.21E-17	6.65E-17	6.26E-17	6.01E-17	5.56E-17	5.46E-17
Bi-206	1.36E-16	1.25E-16	1.17E-16	1.12E-16	1.03E-16	1.01E-16
Bi-207	6.31E-17	5.81E-17	5.45E-17	5.20E-17	4.79E-17	4.71E-17
Bi-208	1.21E-16	1.12E-16	1.06E-16	1.03E-16	9.64E-17	9.50E-17
Bi-210	9.12E-19	8.41E-19	7.95E-19	7.57E-19	6.99E-19	6.88E-19
Bi-210m	9.47E-18	8.60E-18	8.04E-18	7.66E-18	7.00E-18	6.86E-18
Bi-211	1.75E-18	1.59E-18	1.48E-18	1.42E-18	1.30E-18	1.27E-18
Bi-212	5.82E-18	5.36E-18	5.04E-18	4.82E-18	4.45E-18	4.37E-18
Bi-212n	1.40E-18	1.30E-18	1.22E-18	1.17E-18	1.08E-18	1.06E-18
Bi-213	5.97E-18	5.48E-18	5.10E-18	4.88E-18	4.47E-18	4.39E-18
Bi-214	6.61E-17	6.10E-17	5.75E-17	5.52E-17	5.11E-17	5.02E-17
Bi-215	1.15E-17	1.05E-17	9.88E-18	9.42E-18	8.65E-18	8.49E-18
Bi-216	3.39E-17	3.11E-17	2.90E-17	2.77E-17	2.55E-17	2.50E-17
<b>Polonium</b>						
Po-203	6.78E-17	6.24E-17	5.88E-17	5.61E-17	5.17E-17	5.08E-17
Po-204	4.49E-17	4.12E-17	3.87E-17	3.68E-17	3.38E-17	3.31E-17
Po-205	6.57E-17	6.04E-17	5.69E-17	5.43E-17	5.00E-17	4.92E-17
Po-206	4.71E-17	4.32E-17	4.05E-17	3.86E-17	3.54E-17	3.48E-17
Po-207	5.25E-17	4.83E-17	4.54E-17	4.32E-17	3.98E-17	3.91E-17
Po-208	8.14E-22	7.45E-22	6.95E-22	6.63E-22	6.08E-22	5.96E-22
Po-209	2.40E-19	2.20E-19	2.07E-19	1.97E-19	1.80E-19	1.77E-19
Po-210	4.04E-22	3.72E-22	3.49E-22	3.32E-22	3.05E-22	3.00E-22
Po-211	3.37E-19	3.10E-19	2.90E-19	2.77E-19	2.55E-19	2.50E-19
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	3.57E-18	3.32E-18	3.14E-18	3.04E-18	2.84E-18	2.79E-18
Po-213	1.55E-21	1.43E-21	1.34E-21	1.27E-21	1.17E-21	1.15E-21
Po-214	3.45E-21	3.17E-21	2.97E-21	2.83E-21	2.60E-21	2.56E-21
Po-215	6.84E-21	6.27E-21	5.81E-21	5.57E-21	5.10E-21	5.00E-21
Po-216	6.36E-22	5.85E-22	5.49E-22	5.22E-22	4.81E-22	4.72E-22
Po-218	1.61E-23	1.48E-23	1.40E-23	1.33E-23	1.23E-23	1.21E-23
<b>Astatine</b>						
At-204	9.38E-17	8.61E-17	8.02E-17	7.66E-17	7.03E-17	6.90E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	4.69E-17	4.32E-17	4.04E-17	3.87E-17	3.56E-17	3.49E-17
At-206	1.01E-16	9.28E-17	8.67E-17	8.29E-17	7.62E-17	7.48E-17
At-207	8.37E-17	7.71E-17	7.24E-17	6.94E-17	6.40E-17	6.29E-17
At-208	1.25E-16	1.15E-16	1.08E-16	1.03E-16	9.52E-17	9.35E-17
At-209	9.19E-17	8.44E-17	7.90E-17	7.54E-17	6.93E-17	6.81E-17
At-210	1.26E-16	1.16E-16	1.10E-16	1.05E-16	9.71E-17	9.54E-17
At-211	8.06E-19	7.24E-19	6.67E-19	6.32E-19	5.58E-19	5.46E-19
At-215	6.50E-21	5.94E-21	5.51E-21	5.28E-21	4.82E-21	4.73E-21
At-216	6.59E-20	5.95E-20	5.51E-20	5.23E-20	4.68E-20	4.59E-20
At-217	8.70E-21	7.91E-21	7.39E-21	7.04E-21	6.42E-21	6.30E-21
At-218	3.70E-21	3.42E-21	3.24E-21	3.09E-21	2.87E-21	2.82E-21
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	2.09E-17	1.91E-17	1.79E-17	1.70E-17	1.56E-17	1.53E-17
<b>Radon</b>						
Rn-207	3.93E-17	3.60E-17	3.37E-17	3.21E-17	2.95E-17	2.89E-17
Rn-209	4.86E-17	4.47E-17	4.18E-17	4.01E-17	3.69E-17	3.62E-17
Rn-210	2.38E-18	2.18E-18	2.04E-18	1.94E-18	1.78E-18	1.75E-18
Rn-211	7.77E-17	7.15E-17	6.71E-17	6.41E-17	5.91E-17	5.80E-17
Rn-212	1.38E-20	1.27E-20	1.19E-20	1.13E-20	1.04E-20	1.02E-20
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	3.06E-20	2.81E-20	2.61E-20	2.50E-20	2.30E-20	2.25E-20
Rn-219	2.16E-18	1.97E-18	1.83E-18	1.75E-18	1.60E-18	1.57E-18
Rn-220	2.51E-20	2.30E-20	2.14E-20	2.05E-20	1.88E-20	1.84E-20
Rn-222	1.54E-20	1.41E-20	1.31E-20	1.25E-20	1.15E-20	1.13E-20
Rn-223	1.48E-17	1.36E-17	1.27E-17	1.21E-17	1.11E-17	1.09E-17
<b>Francium</b>						
Fr-212	4.70E-17	4.32E-17	4.07E-17	3.89E-17	3.58E-17	3.52E-17
Fr-219	1.34E-19	1.22E-19	1.13E-19	1.09E-19	9.92E-20	9.73E-20
Fr-220	2.38E-19	2.16E-19	1.99E-19	1.89E-19	1.69E-19	1.65E-19
Fr-221	9.87E-19	8.95E-19	8.38E-19	7.97E-19	7.25E-19	7.10E-19
Fr-222	7.98E-18	7.29E-18	6.85E-18	6.52E-18	5.97E-18	5.86E-18
Fr-223	2.16E-18	1.95E-18	1.82E-18	1.72E-18	1.56E-18	1.53E-18
Fr-224	2.52E-17	2.32E-17	2.18E-17	2.09E-17	1.93E-17	1.89E-17
Fr-227	1.85E-17	1.70E-17	1.58E-17	1.51E-17	1.38E-17	1.36E-17
<b>Radium</b>						
Ra-219	6.11E-18	5.55E-18	5.18E-18	4.94E-18	4.51E-18	4.42E-18
Ra-220	1.83E-19	1.67E-19	1.55E-19	1.49E-19	1.36E-19	1.34E-19
Ra-221	1.04E-18	9.57E-19	8.82E-19	8.42E-19	7.56E-19	7.42E-19
Ra-222	3.42E-19	3.10E-19	2.90E-19	2.77E-19	2.53E-19	2.48E-19
Ra-223	4.37E-18	3.97E-18	3.69E-18	3.52E-18	3.18E-18	3.12E-18
Ra-224	3.64E-19	3.29E-19	3.09E-19	2.94E-19	2.68E-19	2.63E-19
Ra-225	2.26E-19	1.92E-19	1.71E-19	1.59E-19	1.39E-19	1.36E-19
Ra-226	2.38E-19	2.17E-19	2.03E-19	1.93E-19	1.75E-19	1.72E-19
Ra-227	6.05E-18	5.52E-18	5.15E-18	4.92E-18	4.50E-18	4.41E-18

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	1.91E-21	1.53E-21	1.29E-21	1.24E-21	7.70E-22	7.36E-22
Ra-230	2.90E-18	2.64E-18	2.45E-18	2.34E-18	2.13E-18	2.09E-18
<b>Actinium</b>						
Ac-223	5.78E-19	5.26E-19	4.89E-19	4.67E-19	4.24E-19	4.16E-19
Ac-224	6.87E-18	6.24E-18	5.81E-18	5.53E-18	4.99E-18	4.89E-18
Ac-225	4.07E-19	3.71E-19	3.43E-19	3.27E-19	2.94E-19	2.88E-19
Ac-226	4.85E-18	4.43E-18	4.14E-18	3.94E-18	3.58E-18	3.51E-18
Ac-227	3.49E-21	3.11E-21	2.85E-21	2.71E-21	2.37E-21	2.32E-21
Ac-228	3.69E-17	3.39E-17	3.19E-17	3.04E-17	2.80E-17	2.76E-17
Ac-230	2.63E-17	2.43E-17	2.29E-17	2.20E-17	2.04E-17	2.00E-17
Ac-231	1.61E-17	1.46E-17	1.37E-17	1.30E-17	1.19E-17	1.17E-17
Ac-232	5.37E-17	4.97E-17	4.68E-17	4.51E-17	4.18E-17	4.11E-17
Ac-233	2.23E-17	2.05E-17	1.91E-17	1.83E-17	1.68E-17	1.65E-17
<b>Thorium</b>						
Th-223	1.87E-18	1.70E-18	1.57E-18	1.49E-18	1.33E-18	1.31E-18
Th-224	7.58E-19	6.94E-19	6.45E-19	6.16E-19	5.59E-19	5.48E-19
Th-226	2.30E-19	2.09E-19	1.94E-19	1.85E-19	1.67E-19	1.64E-19
Th-227	4.18E-18	3.78E-18	3.54E-18	3.36E-18	3.06E-18	3.00E-18
Th-228	5.72E-20	5.17E-20	4.79E-20	4.55E-20	4.07E-20	3.98E-20
Th-229	2.27E-18	2.06E-18	1.91E-18	1.81E-18	1.62E-18	1.59E-18
Th-230	9.58E-21	8.53E-21	7.76E-21	7.37E-21	6.36E-21	6.21E-21
Th-231	3.67E-19	3.29E-19	3.04E-19	2.88E-19	2.56E-19	2.51E-19
Th-232	4.59E-21	3.99E-21	3.57E-21	3.37E-21	2.81E-21	2.74E-21
Th-233	2.22E-18	2.04E-18	1.91E-18	1.83E-18	1.68E-18	1.65E-18
Th-234	2.36E-19	2.11E-19	1.95E-19	1.84E-19	1.63E-19	1.60E-19
Th-235	4.04E-18	3.72E-18	3.49E-18	3.33E-18	3.07E-18	3.01E-18
Th-236	1.99E-18	1.83E-18	1.71E-18	1.63E-18	1.49E-18	1.47E-18
<b>Protactinium</b>						
Pa-227	4.54E-19	4.08E-19	3.74E-19	3.55E-19	3.13E-19	3.07E-19
Pa-228	5.52E-17	5.08E-17	4.77E-17	4.56E-17	4.19E-17	4.12E-17
Pa-229	1.51E-18	1.37E-18	1.26E-18	1.20E-18	1.06E-18	1.04E-18
Pa-230	2.65E-17	2.43E-17	2.29E-17	2.18E-17	2.00E-17	1.96E-17
Pa-231	1.18E-18	1.07E-18	9.99E-19	9.53E-19	8.67E-19	8.50E-19
Pa-232	3.85E-17	3.54E-17	3.32E-17	3.16E-17	2.91E-17	2.86E-17
Pa-233	7.57E-18	6.87E-18	6.40E-18	6.11E-18	5.57E-18	5.46E-18
Pa-234	5.97E-17	5.49E-17	5.16E-17	4.92E-17	4.52E-17	4.44E-17
Pa-234m	3.15E-18	2.91E-18	2.75E-18	2.62E-18	2.43E-18	2.39E-18
Pa-235	1.20E-18	1.11E-18	1.05E-18	9.97E-19	9.22E-19	9.07E-19
Pa-236	4.11E-17	3.79E-17	3.56E-17	3.42E-17	3.16E-17	3.11E-17
Pa-237	2.66E-17	2.45E-17	2.30E-17	2.19E-17	2.01E-17	1.98E-17
<b>Uranium</b>						
U-227	3.70E-18	3.35E-18	3.13E-18	2.98E-18	2.70E-18	2.65E-18
U-228	1.13E-19	1.03E-19	9.52E-20	9.06E-20	8.13E-20	7.97E-20
U-230	3.16E-20	2.85E-20	2.63E-20	2.50E-20	2.21E-20	2.17E-20
U-231	1.73E-18	1.56E-18	1.44E-18	1.37E-18	1.21E-18	1.19E-18
U-232	6.54E-21	5.70E-21	5.11E-21	4.85E-21	4.06E-21	3.96E-21

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	7.38E-21	6.57E-21	6.02E-21	5.73E-21	5.04E-21	4.93E-21
U-234	3.46E-21	2.93E-21	2.57E-21	2.44E-21	1.93E-21	1.88E-21
U-235	5.25E-18	4.80E-18	4.47E-18	4.26E-18	3.86E-18	3.78E-18
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	1.99E-21	1.62E-21	1.39E-21	1.32E-21	9.64E-22	9.32E-22
U-237	3.80E-18	3.43E-18	3.19E-18	3.02E-18	2.72E-18	2.66E-18
U-238	1.81E-21	1.50E-21	1.31E-21	1.24E-21	9.48E-22	9.20E-22
U-239	2.17E-18	1.97E-18	1.84E-18	1.74E-18	1.58E-18	1.55E-18
U-240	2.51E-19	2.29E-19	2.13E-19	2.03E-19	1.84E-19	1.80E-19
U-242	2.29E-18	2.10E-18	1.96E-18	1.87E-18	1.71E-18	1.68E-18
<b>Neptunium</b>						
Np-232	4.71E-17	4.32E-17	4.06E-17	3.86E-17	3.55E-17	3.48E-17
Np-233	2.30E-18	2.09E-18	1.93E-18	1.84E-18	1.64E-18	1.61E-18
Np-234	4.71E-17	4.35E-17	4.10E-17	3.94E-17	3.64E-17	3.58E-17
Np-235	1.69E-20	1.47E-20	1.32E-20	1.26E-20	1.05E-20	1.02E-20
Np-236	3.87E-18	3.54E-18	3.27E-18	3.12E-18	2.80E-18	2.74E-18
Np-236m	1.44E-18	1.31E-18	1.21E-18	1.15E-18	1.04E-18	1.02E-18
Np-237	5.51E-19	4.94E-19	4.54E-19	4.30E-19	3.81E-19	3.73E-19
Np-238	2.51E-17	2.31E-17	2.18E-17	2.07E-17	1.91E-17	1.88E-17
Np-239	5.63E-18	5.11E-18	4.76E-18	4.53E-18	4.10E-18	4.02E-18
Np-240	4.27E-17	3.93E-17	3.68E-17	3.51E-17	3.23E-17	3.17E-17
Np-240m	1.48E-17	1.36E-17	1.28E-17	1.22E-17	1.12E-17	1.10E-17
Np-241	2.07E-18	1.90E-18	1.77E-18	1.69E-18	1.54E-18	1.51E-18
Np-242	1.43E-17	1.32E-17	1.25E-17	1.20E-17	1.11E-17	1.09E-17
Np-242m	3.84E-17	3.53E-17	3.31E-17	3.15E-17	2.90E-17	2.85E-17
<b>Plutonium</b>						
Pu-232	1.53E-18	1.39E-18	1.28E-18	1.22E-18	1.09E-18	1.07E-18
Pu-234	1.66E-18	1.50E-18	1.39E-18	1.32E-18	1.18E-18	1.15E-18
Pu-235	2.39E-18	2.17E-18	2.01E-18	1.91E-18	1.71E-18	1.68E-18
Pu-236	2.14E-21	1.67E-21	1.40E-21	1.34E-21	8.99E-22	8.62E-22
Pu-237	1.18E-18	1.07E-18	9.84E-19	9.35E-19	8.33E-19	8.17E-19
Pu-238	1.56E-21	1.18E-21	9.65E-22	9.27E-22	5.58E-22	5.29E-22
Pu-239	2.42E-21	2.10E-21	1.88E-21	1.80E-21	1.50E-21	1.47E-21
Pu-240	1.55E-21	1.18E-21	9.70E-22	9.29E-22	5.74E-22	5.46E-22
Pu-241	1.03E-22	9.43E-23	8.82E-23	8.39E-23	7.64E-23	7.51E-23
Pu-242	4.73E-21	4.16E-21	3.80E-21	3.66E-21	3.15E-21	3.08E-21
Pu-243	8.52E-19	7.72E-19	7.17E-19	6.81E-19	6.12E-19	6.00E-19
Pu-244	9.03E-19	8.36E-19	7.88E-19	7.58E-19	7.03E-19	6.91E-19
Pu-245	1.61E-17	1.47E-17	1.38E-17	1.32E-17	1.21E-17	1.18E-17
Pu-246	4.02E-18	3.64E-18	3.38E-18	3.22E-18	2.90E-18	2.85E-18
<b>Americium</b>						
Am-237	1.26E-17	1.15E-17	1.07E-17	1.02E-17	9.31E-18	9.13E-18
Am-238	3.64E-17	3.35E-17	3.15E-17	3.00E-17	2.76E-17	2.72E-17
Am-239	6.81E-18	6.18E-18	5.74E-18	5.47E-18	4.93E-18	4.84E-18
Am-240	4.21E-17	3.87E-17	3.65E-17	3.47E-17	3.19E-17	3.14E-17
Am-241	3.74E-19	3.19E-19	2.86E-19	2.65E-19	2.26E-19	2.20E-19

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	6.40E-19	5.85E-19	5.45E-19	5.19E-19	4.70E-19	4.61E-19
Am-242m	1.06E-20	8.72E-21	7.65E-21	7.29E-21	5.69E-21	5.52E-21
Am-243	1.14E-18	1.02E-18	9.30E-19	8.79E-19	7.66E-19	7.47E-19
Am-244	3.23E-17	2.97E-17	2.79E-17	2.65E-17	2.44E-17	2.39E-17
Am-244m	1.89E-18	1.74E-18	1.64E-18	1.56E-18	1.44E-18	1.42E-18
Am-245	1.51E-18	1.38E-18	1.29E-18	1.23E-18	1.12E-18	1.10E-18
Am-246	2.94E-17	2.70E-17	2.52E-17	2.40E-17	2.20E-17	2.17E-17
Am-246m	4.24E-17	3.91E-17	3.68E-17	3.51E-17	3.23E-17	3.18E-17
Am-247	5.41E-18	4.93E-18	4.61E-18	4.39E-18	4.00E-18	3.93E-18
<b>Curium</b>						
Cm-238	2.05E-18	1.87E-18	1.72E-18	1.64E-18	1.47E-18	1.44E-18
Cm-239	7.73E-18	7.06E-18	6.56E-18	6.25E-18	5.64E-18	5.54E-18
Cm-240	2.09E-21	1.56E-21	1.29E-21	1.24E-21	7.77E-22	7.40E-22
Cm-241	1.79E-17	1.64E-17	1.52E-17	1.45E-17	1.33E-17	1.30E-17
Cm-242	1.77E-21	1.30E-21	1.07E-21	1.03E-21	6.26E-22	5.93E-22
Cm-243	4.02E-18	3.65E-18	3.40E-18	3.24E-18	2.93E-18	2.88E-18
Cm-244	2.15E-21	1.71E-21	1.48E-21	1.42E-21	1.04E-21	1.00E-21
Cm-245	2.75E-18	2.50E-18	2.31E-18	2.20E-18	1.97E-18	1.94E-18
Cm-246	1.64E-19	1.52E-19	1.43E-19	1.37E-19	1.27E-19	1.25E-19
Cm-247	1.20E-17	1.09E-17	1.02E-17	9.73E-18	8.90E-18	8.73E-18
Cm-248	5.96E-17	5.51E-17	5.20E-17	5.00E-17	4.64E-17	4.56E-17
Cm-249	1.32E-18	1.22E-18	1.14E-18	1.09E-18	1.00E-18	9.83E-19
Cm-250	6.08E-16	5.63E-16	5.31E-16	5.11E-16	4.74E-16	4.66E-16
Cm-251	5.33E-18	4.89E-18	4.56E-18	4.36E-18	4.00E-18	3.93E-18
<b>Berkelium</b>						
Bk-245	6.84E-18	6.23E-18	5.79E-18	5.51E-18	4.98E-18	4.89E-18
Bk-246	3.41E-17	3.14E-17	2.94E-17	2.80E-17	2.58E-17	2.53E-17
Bk-247	4.49E-18	4.06E-18	3.78E-18	3.60E-18	3.26E-18	3.19E-18
Bk-248m	2.10E-18	1.93E-18	1.79E-18	1.71E-18	1.56E-18	1.53E-18
Bk-249	2.06E-20	1.89E-20	1.79E-20	1.70E-20	1.57E-20	1.54E-20
Bk-250	3.85E-17	3.54E-17	3.35E-17	3.18E-17	2.93E-17	2.88E-17
Bk-251	2.97E-18	2.73E-18	2.53E-18	2.41E-18	2.18E-18	2.14E-18
<b>Californium</b>						
Cf-244	1.77E-21	1.22E-21	9.68E-22	9.31E-22	5.02E-22	4.68E-22
Cf-246	2.78E-21	2.27E-21	2.00E-21	1.92E-21	1.52E-21	1.47E-21
Cf-247	2.49E-18	2.28E-18	2.10E-18	2.01E-18	1.80E-18	1.76E-18
Cf-248	1.63E-20	1.47E-20	1.37E-20	1.32E-20	1.19E-20	1.17E-20
Cf-249	1.22E-17	1.12E-17	1.04E-17	9.93E-18	9.08E-18	8.91E-18
Cf-250	4.43E-19	4.09E-19	3.86E-19	3.71E-19	3.44E-19	3.38E-19
Cf-251	3.50E-18	3.20E-18	2.97E-18	2.83E-18	2.55E-18	2.50E-18
Cf-252	2.06E-17	1.91E-17	1.80E-17	1.73E-17	1.60E-17	1.58E-17
Cf-253	9.02E-20	8.15E-20	7.63E-20	7.24E-20	6.57E-20	6.46E-20
Cf-254	7.66E-16	7.09E-16	6.69E-16	6.43E-16	5.97E-16	5.87E-16
Cf-255	4.14E-19	3.81E-19	3.60E-19	3.43E-19	3.16E-19	3.11E-19
<b>Einsteinium</b>						
Es-249	1.48E-17	1.36E-17	1.27E-17	1.21E-17	1.11E-17	1.09E-17

**Table 4-5. Reference person effective dose rate coefficients for soil to infinite depth. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	4.53E-17	4.16E-17	3.89E-17	3.71E-17	3.40E-17	3.34E-17
Es-250m	2.19E-17	2.02E-17	1.90E-17	1.81E-17	1.67E-17	1.64E-17
Es-251	2.47E-18	2.26E-18	2.09E-18	1.99E-18	1.78E-18	1.75E-18
Es-253	1.19E-20	1.08E-20	9.93E-21	9.50E-21	8.57E-21	8.39E-21
Es-254	9.40E-20	8.08E-20	7.31E-20	6.92E-20	5.93E-20	5.78E-20
Es-254m	1.95E-17	1.79E-17	1.67E-17	1.60E-17	1.47E-17	1.44E-17
Es-255	1.18E-19	1.09E-19	1.03E-19	9.81E-20	9.06E-20	8.91E-20
Es-256	1.54E-18	1.42E-18	1.34E-18	1.28E-18	1.18E-18	1.16E-18
<b>Fermium</b>						
Fm-251	4.96E-18	4.56E-18	4.23E-18	4.04E-18	3.66E-18	3.60E-18
Fm-252	1.31E-20	1.17E-20	1.09E-20	1.04E-20	9.34E-21	9.16E-21
Fm-253	1.63E-18	1.50E-18	1.38E-18	1.32E-18	1.18E-18	1.16E-18
Fm-254	3.16E-19	2.92E-19	2.75E-19	2.64E-19	2.45E-19	2.41E-19
Fm-255	5.21E-20	4.37E-20	3.88E-20	3.67E-20	3.00E-20	2.92E-20
Fm-256	5.60E-16	5.18E-16	4.89E-16	4.70E-16	4.36E-16	4.29E-16
Fm-257	4.67E-18	4.28E-18	3.98E-18	3.81E-18	3.46E-18	3.40E-18

**Table 4-6. Reference person effective dose rate coefficients for air submersion.**

**Explanation of entries**

For each radionuclide, values for the reference person effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. The coefficients are for air at a density of  $1.2 \text{ kg m}^{-3}$ . Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>16</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ), that is, the effective dose per unit time-integrated exposure to a radionuclide

$w_T$ : The tissue weighting factor

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-6 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from a source per unit volume ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) to a source per unit mass basis ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ kg}$ ), multiply table entries by 1.2.

To convert from SI units ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{ y}^{-1} \text{ cm}^3$ ), multiply table entries by  $1.168 \times 10^{23}$ .

To convert from SI units for a source per unit volume ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) to conventional units for a source per unit mass basis ( $\text{mrem } \mu\text{Ci}^{-1} \text{ y}^{-1} \text{ g}$ ), multiply table entries by  $1.401 \times 10^{20}$ .

To derive coefficients for an air density other than  $1.2 \text{ kg m}^{-3}$ , multiply coefficients (in any units) by  $(1.2/\rho)$ , where  $\rho$  is the air density in  $\text{kg m}^{-3}$ .

<sup>16</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>



**Table 4-6. Reference person effective dose rate coefficients for air submersion.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	4.91E-20	4.73E-20	4.48E-20	4.27E-20	3.96E-20	3.80E-20
<b>Beryllium</b>						
Be-7	2.94E-15	2.76E-15	2.62E-15	2.49E-15	2.28E-15	2.18E-15
Be-10	6.81E-16	6.62E-16	6.33E-16	6.10E-16	5.76E-16	5.57E-16
<b>Carbon</b>						
C-10	1.06E-13	1.01E-13	9.55E-14	9.08E-14	8.36E-14	8.00E-14
C-11	6.14E-14	5.78E-14	5.49E-14	5.21E-14	4.79E-14	4.58E-14
C-14	4.92E-17	4.76E-17	4.51E-17	4.31E-17	4.02E-17	3.86E-17
<b>Nitrogen</b>						
N-13	6.19E-14	5.83E-14	5.53E-14	5.26E-14	4.83E-14	4.62E-14
N-16	3.21E-13	3.15E-13	3.06E-13	2.97E-13	2.86E-13	2.78E-13
<b>Oxygen</b>						
O-14	2.04E-13	1.96E-13	1.88E-13	1.80E-13	1.69E-13	1.63E-13
O-15	6.31E-14	5.94E-14	5.64E-14	5.36E-14	4.93E-14	4.72E-14
O-19	6.55E-14	6.27E-14	5.94E-14	5.69E-14	5.31E-14	5.11E-14
<b>Fluorine</b>						
F-17	6.31E-14	5.94E-14	5.64E-14	5.36E-14	4.93E-14	4.72E-14
F-18	5.90E-14	5.55E-14	5.27E-14	5.01E-14	4.60E-14	4.40E-14
<b>Neon</b>						
Ne-19	6.43E-14	6.06E-14	5.75E-14	5.47E-14	5.03E-14	4.81E-14
Ne-24	3.52E-14	3.32E-14	3.15E-14	3.00E-14	2.76E-14	2.64E-14
<b>Sodium</b>						
Na-22	1.31E-13	1.25E-13	1.19E-13	1.13E-13	1.05E-13	1.01E-13
Na-24	2.54E-13	2.46E-13	2.37E-13	2.28E-13	2.16E-13	2.08E-13
<b>Magnesium</b>						
Mg-27	5.57E-14	5.36E-14	5.07E-14	4.83E-14	4.47E-14	4.29E-14
Mg-28	8.15E-14	7.83E-14	7.43E-14	7.09E-14	6.61E-14	6.34E-14
<b>Aluminum</b>						
Al-26	1.62E-13	1.56E-13	1.49E-13	1.42E-13	1.33E-13	1.28E-13
Al-28	1.13E-13	1.10E-13	1.05E-13	1.01E-13	9.52E-14	9.17E-14
Al-29	8.71E-14	8.42E-14	8.01E-14	7.67E-14	7.19E-14	6.91E-14
<b>Silicon</b>						
Si-31	2.21E-15	2.15E-15	2.05E-15	1.98E-15	1.86E-15	1.80E-15
Si-32	9.30E-17	9.01E-17	8.58E-17	8.22E-17	7.71E-17	7.43E-17
<b>Phosphorus</b>						
P-30	6.71E-14	6.33E-14	6.02E-14	5.72E-14	5.27E-14	5.05E-14
P-32	2.64E-15	2.56E-15	2.45E-15	2.36E-15	2.23E-15	2.15E-15
P-33	1.13E-16	1.09E-16	1.04E-16	9.98E-17	9.37E-17	9.03E-17
<b>Sulfur</b>						
S-35	4.99E-17	4.83E-17	4.58E-17	4.38E-17	4.09E-17	3.93E-17
S-37	1.86E-13	1.80E-13	1.74E-13	1.68E-13	1.60E-13	1.55E-13
S-38	1.05E-13	1.01E-13	9.73E-14	9.36E-14	8.85E-14	8.54E-14
<b>Chlorine</b>						
Cl-34	7.14E-14	6.75E-14	6.41E-14	6.10E-14	5.63E-14	5.39E-14
Cl-34m	1.30E-13	1.25E-13	1.19E-13	1.15E-13	1.08E-13	1.04E-13

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	7.88E-16	7.66E-16	7.32E-16	7.05E-16	6.66E-16	6.44E-16
Cl-38	9.62E-14	9.30E-14	8.93E-14	8.58E-14	8.12E-14	7.83E-14
Cl-39	9.05E-14	8.71E-14	8.27E-14	7.92E-14	7.40E-14	7.12E-14
Cl-40	2.59E-13	2.51E-13	2.41E-13	2.32E-13	2.20E-13	2.13E-13
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	5.70E-16	5.54E-16	5.29E-16	5.10E-16	4.81E-16	4.66E-16
Ar-41	7.85E-14	7.59E-14	7.21E-14	6.90E-14	6.45E-14	6.20E-14
Ar-42	6.21E-16	6.03E-16	5.77E-16	5.56E-16	5.25E-16	5.08E-16
Ar-43	9.93E-14	9.58E-14	9.13E-14	8.75E-14	8.21E-14	7.90E-14
Ar-44	1.19E-13	1.14E-13	1.09E-13	1.05E-13	9.87E-14	9.50E-14
<b>Potassium</b>						
K-38	1.98E-13	1.90E-13	1.82E-13	1.74E-13	1.64E-13	1.58E-13
K-40	1.13E-14	1.09E-14	1.04E-14	1.00E-14	9.39E-15	9.04E-15
K-42	2.37E-14	2.29E-14	2.19E-14	2.10E-14	1.98E-14	1.91E-14
K-43	5.80E-14	5.46E-14	5.16E-14	4.91E-14	4.51E-14	4.32E-14
K-44	1.53E-13	1.48E-13	1.41E-13	1.36E-13	1.28E-13	1.23E-13
K-45	1.16E-13	1.11E-13	1.06E-13	1.02E-13	9.59E-14	9.24E-14
K-46	1.90E-13	1.85E-13	1.77E-13	1.70E-13	1.61E-13	1.55E-13
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	1.16E-16	1.12E-16	1.07E-16	1.03E-16	9.63E-17	9.29E-17
Ca-47	6.42E-14	6.20E-14	5.89E-14	5.63E-14	5.26E-14	5.05E-14
Ca-49	2.01E-13	1.95E-13	1.88E-13	1.82E-13	1.73E-13	1.68E-13
<b>Scandium</b>						
Sc-42m	2.57E-13	2.46E-13	2.34E-13	2.23E-13	2.08E-13	1.99E-13
Sc-43	5.95E-14	5.60E-14	5.31E-14	5.05E-14	4.63E-14	4.43E-14
Sc-44	1.29E-13	1.23E-13	1.17E-13	1.12E-13	1.03E-13	9.90E-14
Sc-44m	1.64E-14	1.52E-14	1.41E-14	1.34E-14	1.23E-14	1.19E-14
Sc-46	1.20E-13	1.16E-13	1.09E-13	1.04E-13	9.69E-14	9.29E-14
Sc-47	6.80E-15	6.22E-15	5.80E-15	5.57E-15	4.99E-15	4.83E-15
Sc-48	2.01E-13	1.94E-13	1.84E-13	1.75E-13	1.63E-13	1.57E-13
Sc-49	3.32E-15	3.23E-15	3.09E-15	2.97E-15	2.80E-15	2.71E-15
Sc-50	2.00E-13	1.93E-13	1.83E-13	1.75E-13	1.64E-13	1.57E-13
<b>Titanium</b>						
Ti-44	6.84E-15	6.12E-15	5.35E-15	5.21E-15	4.20E-15	3.75E-15
Ti-45	5.26E-14	4.95E-14	4.70E-14	4.47E-14	4.10E-14	3.92E-14
Ti-51	2.55E-14	2.39E-14	2.24E-14	2.14E-14	1.97E-14	1.89E-14
Ti-52	1.03E-14	9.44E-15	8.85E-15	8.43E-15	7.62E-15	7.39E-15
<b>Vanadium</b>						
V-47	6.20E-14	5.84E-14	5.54E-14	5.27E-14	4.84E-14	4.64E-14
V-48	1.74E-13	1.68E-13	1.59E-13	1.52E-13	1.41E-13	1.35E-13
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	8.57E-14	8.27E-14	7.89E-14	7.56E-14	7.10E-14	6.83E-14
V-52	9.15E-14	8.85E-14	8.43E-14	8.07E-14	7.58E-14	7.29E-14
V-53	6.62E-14	6.39E-14	6.05E-14	5.77E-14	5.37E-14	5.15E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	2.59E-14	2.37E-14	2.21E-14	2.09E-14	1.91E-14	1.83E-14
Cr-49	6.42E-14	6.01E-14	5.69E-14	5.41E-14	4.95E-14	4.73E-14
Cr-51	1.89E-15	1.75E-15	1.63E-15	1.55E-15	1.42E-15	1.36E-15
Cr-55	4.84E-15	4.70E-15	4.49E-15	4.32E-15	4.08E-15	3.94E-15
Cr-56	6.53E-15	5.95E-15	5.43E-15	5.22E-15	4.55E-15	4.27E-15
<b>Manganese</b>						
Mn-50m	2.84E-13	2.72E-13	2.59E-13	2.47E-13	2.29E-13	2.20E-13
Mn-51	6.28E-14	5.92E-14	5.62E-14	5.34E-14	4.91E-14	4.70E-14
Mn-52	2.07E-13	1.99E-13	1.88E-13	1.80E-13	1.67E-13	1.60E-13
Mn-52m	1.49E-13	1.42E-13	1.35E-13	1.29E-13	1.20E-13	1.15E-13
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	4.96E-14	4.76E-14	4.50E-14	4.28E-14	3.96E-14	3.79E-14
Mn-56	1.05E-13	1.01E-13	9.66E-14	9.25E-14	8.66E-14	8.32E-14
Mn-57	1.05E-14	1.00E-14	9.51E-15	9.10E-15	8.46E-15	8.15E-15
Mn-58m	1.52E-13	1.46E-13	1.39E-13	1.33E-13	1.24E-13	1.19E-13
<b>Iron</b>						
Fe-52	4.43E-14	4.14E-14	3.91E-14	3.72E-14	3.40E-14	3.26E-14
Fe-53	7.45E-14	7.01E-14	6.65E-14	6.33E-14	5.82E-14	5.57E-14
Fe-53m	1.83E-13	1.76E-13	1.67E-13	1.60E-13	1.49E-13	1.43E-13
Fe-55	9.59E-24	8.60E-24	8.00E-24	7.59E-24	6.73E-24	6.54E-24
Fe-59	7.13E-14	6.89E-14	6.53E-14	6.24E-14	5.82E-14	5.58E-14
Fe-60	7.94E-17	7.69E-17	7.31E-17	7.00E-17	6.54E-17	6.30E-17
Fe-61	8.82E-14	8.50E-14	8.06E-14	7.71E-14	7.20E-14	6.91E-14
Fe-62	3.32E-14	3.13E-14	2.97E-14	2.83E-14	2.60E-14	2.49E-14
<b>Cobalt</b>						
Co-54m	2.45E-13	2.35E-13	2.23E-13	2.13E-13	1.98E-13	1.90E-13
Co-55	1.20E-13	1.15E-13	1.09E-13	1.03E-13	9.57E-14	9.17E-14
Co-56	2.20E-13	2.12E-13	2.03E-13	1.94E-13	1.82E-13	1.75E-13
Co-57	7.16E-15	6.41E-15	5.96E-15	5.65E-15	5.01E-15	4.87E-15
Co-58	5.78E-14	5.53E-14	5.23E-14	4.98E-14	4.59E-14	4.40E-14
Co-58m	1.40E-19	9.34E-20	7.92E-20	7.22E-20	4.92E-20	4.29E-20
Co-60	1.50E-13	1.45E-13	1.38E-13	1.32E-13	1.23E-13	1.18E-13
Co-60m	2.56E-16	2.42E-16	2.25E-16	2.16E-16	1.97E-16	1.87E-16
Co-61	6.60E-15	6.18E-15	5.66E-15	5.46E-15	4.80E-15	4.49E-15
Co-62	1.05E-13	1.02E-13	9.67E-14	9.27E-14	8.70E-14	8.36E-14
Co-62m	1.67E-13	1.61E-13	1.53E-13	1.47E-13	1.37E-13	1.32E-13
<b>Nickel</b>						
Ni-56	1.02E-13	9.70E-14	9.17E-14	8.74E-14	8.06E-14	7.73E-14
Ni-57	1.17E-13	1.12E-13	1.07E-13	1.02E-13	9.51E-14	9.14E-14
Ni-59	9.17E-19	8.63E-19	8.19E-19	7.78E-19	7.14E-19	6.83E-19
Ni-63	5.97E-18	5.76E-18	5.45E-18	5.20E-18	4.82E-18	4.62E-18
Ni-65	3.60E-14	3.47E-14	3.30E-14	3.16E-14	2.96E-14	2.84E-14
Ni-66	1.07E-16	1.04E-16	9.86E-17	9.47E-17	8.88E-17	8.57E-17
<b>Copper</b>						
Cu-57	9.63E-14	9.18E-14	8.75E-14	8.37E-14	7.78E-14	7.48E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	9.29E-14	8.80E-14	8.36E-14	7.96E-14	7.35E-14	7.04E-14
Cu-60	2.39E-13	2.29E-13	2.19E-13	2.09E-13	1.96E-13	1.88E-13
Cu-61	4.97E-14	4.68E-14	4.44E-14	4.22E-14	3.88E-14	3.71E-14
Cu-62	6.53E-14	6.16E-14	5.85E-14	5.57E-14	5.12E-14	4.90E-14
Cu-64	1.12E-14	1.06E-14	1.00E-14	9.53E-15	8.76E-15	8.38E-15
Cu-66	1.05E-14	1.01E-14	9.62E-15	9.21E-15	8.61E-15	8.29E-15
Cu-67	7.07E-15	6.45E-15	5.95E-15	5.67E-15	5.10E-15	4.92E-15
Cu-69	3.52E-14	3.39E-14	3.21E-14	3.06E-14	2.85E-14	2.73E-14
<b>Zinc</b>						
Zn-60	9.51E-14	8.97E-14	8.50E-14	8.09E-14	7.43E-14	7.11E-14
Zn-61	1.01E-13	9.60E-14	9.14E-14	8.72E-14	8.09E-14	7.76E-14
Zn-62	2.58E-14	2.42E-14	2.29E-14	2.18E-14	2.00E-14	1.91E-14
Zn-63	6.87E-14	6.49E-14	6.16E-14	5.86E-14	5.39E-14	5.16E-14
Zn-65	3.46E-14	3.34E-14	3.16E-14	3.02E-14	2.81E-14	2.69E-14
Zn-69	9.72E-16	9.44E-16	9.03E-16	8.70E-16	8.21E-16	7.95E-16
Zn-69m	2.46E-14	2.30E-14	2.18E-14	2.07E-14	1.90E-14	1.81E-14
Zn-71	2.32E-14	2.21E-14	2.10E-14	2.00E-14	1.85E-14	1.78E-14
Zn-71m	9.43E-14	8.90E-14	8.43E-14	8.02E-14	7.38E-14	7.06E-14
Zn-72	8.77E-15	7.96E-15	7.40E-15	7.08E-15	6.30E-15	6.10E-15
<b>Gallium</b>						
Ga-64	2.13E-13	2.05E-13	1.95E-13	1.87E-13	1.75E-13	1.69E-13
Ga-65	7.19E-14	6.76E-14	6.41E-14	6.09E-14	5.59E-14	5.36E-14
Ga-66	1.57E-13	1.51E-13	1.45E-13	1.39E-13	1.31E-13	1.26E-13
Ga-67	9.11E-15	8.32E-15	7.69E-15	7.30E-15	6.59E-15	6.32E-15
Ga-68	5.89E-14	5.56E-14	5.28E-14	5.02E-14	4.61E-14	4.42E-14
Ga-70	2.84E-15	2.75E-15	2.63E-15	2.53E-15	2.38E-15	2.30E-15
Ga-72	1.65E-13	1.59E-13	1.52E-13	1.45E-13	1.36E-13	1.31E-13
Ga-73	2.20E-14	2.05E-14	1.92E-14	1.82E-14	1.68E-14	1.61E-14
Ga-74	1.95E-13	1.88E-13	1.80E-13	1.73E-13	1.62E-13	1.56E-13
<b>Germanium</b>						
Ge-66	3.98E-14	3.72E-14	3.51E-14	3.33E-14	3.06E-14	2.92E-14
Ge-67	8.98E-14	8.49E-14	8.05E-14	7.67E-14	7.07E-14	6.78E-14
Ge-68	8.14E-19	3.96E-19	3.50E-19	3.27E-19	8.87E-20	7.64E-20
Ge-69	5.68E-14	5.43E-14	5.15E-14	4.91E-14	4.55E-14	4.36E-14
Ge-71	8.26E-19	4.02E-19	3.56E-19	3.32E-19	9.00E-20	7.75E-20
Ge-75	3.48E-15	3.28E-15	3.08E-15	2.95E-15	2.73E-15	2.63E-15
Ge-77	6.67E-14	6.31E-14	5.95E-14	5.67E-14	5.24E-14	5.03E-14
Ge-78	1.72E-14	1.59E-14	1.47E-14	1.40E-14	1.29E-14	1.24E-14
<b>Arsenic</b>						
As-68	2.33E-13	2.23E-13	2.12E-13	2.03E-13	1.89E-13	1.81E-13
As-69	7.32E-14	6.91E-14	6.56E-14	6.25E-14	5.76E-14	5.52E-14
As-70	2.58E-13	2.47E-13	2.35E-13	2.24E-13	2.09E-13	2.00E-13
As-71	3.42E-14	3.21E-14	3.02E-14	2.88E-14	2.64E-14	2.53E-14
As-72	1.10E-13	1.05E-13	9.96E-14	9.49E-14	8.76E-14	8.40E-14
As-73	2.44E-16	2.07E-16	1.74E-16	1.64E-16	1.32E-16	1.18E-16
As-74	4.56E-14	4.30E-14	4.09E-14	3.88E-14	3.57E-14	3.42E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	2.94E-14	2.81E-14	2.67E-14	2.55E-14	2.36E-14	2.26E-14
As-77	1.10E-15	1.04E-15	9.86E-16	9.45E-16	8.80E-16	8.48E-16
As-78	8.42E-14	8.08E-14	7.69E-14	7.35E-14	6.86E-14	6.59E-14
As-79	5.59E-15	5.38E-15	5.12E-15	4.91E-15	4.59E-15	4.42E-15
<b>Selenium</b>						
Se-70	4.24E-14	3.97E-14	3.75E-14	3.56E-14	3.27E-14	3.12E-14
Se-71	1.02E-13	9.65E-14	9.16E-14	8.72E-14	8.05E-14	7.72E-14
Se-72	1.05E-15	8.62E-16	7.18E-16	6.56E-16	5.30E-16	4.77E-16
Se-73	6.51E-14	6.10E-14	5.76E-14	5.47E-14	5.00E-14	4.78E-14
Se-73m	1.60E-14	1.51E-14	1.43E-14	1.36E-14	1.25E-14	1.19E-14
Se-75	2.28E-14	2.09E-14	1.94E-14	1.85E-14	1.68E-14	1.61E-14
Se-77m	5.12E-15	4.67E-15	4.34E-15	4.17E-15	3.73E-15	3.61E-15
Se-79	5.49E-17	5.31E-17	5.04E-17	4.82E-17	4.49E-17	4.32E-17
Se-79m	5.39E-16	4.73E-16	4.32E-16	4.05E-16	3.52E-16	3.37E-16
Se-81	2.72E-15	2.63E-15	2.51E-15	2.41E-15	2.26E-15	2.18E-15
Se-81m	8.25E-16	7.27E-16	6.70E-16	6.27E-16	5.52E-16	5.34E-16
Se-83	1.59E-13	1.52E-13	1.44E-13	1.38E-13	1.28E-13	1.23E-13
Se-83m	6.49E-14	6.24E-14	5.93E-14	5.67E-14	5.30E-14	5.09E-14
Se-84	2.68E-14	2.51E-14	2.37E-14	2.25E-14	2.07E-14	1.98E-14
<b>Bromine</b>						
Br-72	1.95E-13	1.86E-13	1.77E-13	1.69E-13	1.57E-13	1.51E-13
Br-73	9.07E-14	8.57E-14	8.12E-14	7.72E-14	7.10E-14	6.80E-14
Br-74	2.87E-13	2.76E-13	2.65E-13	2.54E-13	2.39E-13	2.31E-13
Br-74m	2.56E-13	2.46E-13	2.35E-13	2.25E-13	2.10E-13	2.02E-13
Br-75	7.28E-14	6.84E-14	6.46E-14	6.14E-14	5.64E-14	5.40E-14
Br-76	1.71E-13	1.64E-13	1.57E-13	1.50E-13	1.40E-13	1.35E-13
Br-76m	1.53E-15	1.31E-15	1.14E-15	1.07E-15	8.98E-16	8.26E-16
Br-77	1.87E-14	1.75E-14	1.65E-14	1.57E-14	1.44E-14	1.38E-14
Br-77m	8.87E-16	7.83E-16	7.22E-16	6.76E-16	5.96E-16	5.77E-16
Br-78	6.54E-14	6.17E-14	5.86E-14	5.57E-14	5.13E-14	4.91E-14
Br-80	7.33E-15	7.01E-15	6.67E-15	6.37E-15	5.92E-15	5.69E-15
Br-80m	4.61E-16	3.56E-16	2.92E-16	2.67E-16	2.03E-16	1.84E-16
Br-82	1.57E-13	1.50E-13	1.43E-13	1.36E-13	1.26E-13	1.21E-13
Br-82m	3.22E-16	3.05E-16	2.89E-16	2.76E-16	2.54E-16	2.44E-16
Br-83	1.40E-15	1.34E-15	1.28E-15	1.23E-15	1.15E-15	1.11E-15
Br-84	1.14E-13	1.10E-13	1.05E-13	1.01E-13	9.53E-14	9.19E-14
Br-84m	1.69E-13	1.62E-13	1.54E-13	1.47E-13	1.37E-13	1.32E-13
Br-85	8.41E-15	8.13E-15	7.74E-15	7.42E-15	6.95E-15	6.69E-15
<b>Krypton</b>						
Kr-74	6.44E-14	6.03E-14	5.70E-14	5.41E-14	4.96E-14	4.74E-14
Kr-75	8.31E-14	7.83E-14	7.42E-14	7.07E-14	6.49E-14	6.23E-14
Kr-76	2.47E-14	2.30E-14	2.15E-14	2.04E-14	1.87E-14	1.79E-14
Kr-77	6.39E-14	5.98E-14	5.66E-14	5.38E-14	4.92E-14	4.72E-14
Kr-79	1.48E-14	1.39E-14	1.31E-14	1.24E-14	1.14E-14	1.09E-14
Kr-81	6.38E-17	5.46E-17	4.93E-17	4.66E-17	3.86E-17	3.69E-17
Kr-81m	7.69E-15	7.04E-15	6.49E-15	6.19E-15	5.61E-15	5.41E-15

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	5.72E-18	3.89E-18	3.01E-18	2.74E-18	1.04E-18	9.20E-19
Kr-85	8.28E-16	8.01E-16	7.65E-16	7.35E-16	6.91E-16	6.67E-16
Kr-85m	9.94E-15	9.12E-15	8.51E-15	8.15E-15	7.34E-15	7.09E-15
Kr-87	5.43E-14	5.21E-14	4.98E-14	4.78E-14	4.49E-14	4.33E-14
Kr-88	1.20E-13	1.16E-13	1.11E-13	1.07E-13	1.01E-13	9.73E-14
Kr-89	1.24E-13	1.19E-13	1.14E-13	1.09E-13	1.03E-13	9.89E-14
<b>Rubidium</b>						
Rb-77	9.95E-14	9.42E-14	8.92E-14	8.50E-14	7.83E-14	7.49E-14
Rb-78	2.56E-13	2.46E-13	2.36E-13	2.27E-13	2.13E-13	2.06E-13
Rb-78m	2.00E-13	1.91E-13	1.82E-13	1.74E-13	1.61E-13	1.55E-13
Rb-79	8.87E-14	8.35E-14	7.91E-14	7.53E-14	6.92E-14	6.63E-14
Rb-80	8.14E-14	7.70E-14	7.32E-14	6.96E-14	6.42E-14	6.15E-14
Rb-81	3.01E-14	2.84E-14	2.69E-14	2.56E-14	2.35E-14	2.25E-14
Rb-81m	1.45E-15	1.35E-15	1.27E-15	1.21E-15	1.09E-15	1.04E-15
Rb-82	7.22E-14	6.82E-14	6.48E-14	6.16E-14	5.68E-14	5.44E-14
Rb-82m	1.74E-13	1.66E-13	1.57E-13	1.50E-13	1.39E-13	1.33E-13
Rb-83	2.86E-14	2.69E-14	2.56E-14	2.43E-14	2.23E-14	2.13E-14
Rb-84	5.42E-14	5.17E-14	4.90E-14	4.66E-14	4.30E-14	4.12E-14
Rb-84m	2.26E-14	2.10E-14	1.96E-14	1.86E-14	1.71E-14	1.64E-14
Rb-86	8.11E-15	7.85E-15	7.45E-15	7.13E-15	6.66E-15	6.40E-15
Rb-86m	3.23E-14	3.04E-14	2.89E-14	2.74E-14	2.52E-14	2.41E-14
Rb-87	2.15E-16	2.09E-16	1.99E-16	1.92E-16	1.80E-16	1.74E-16
Rb-88	5.06E-14	4.89E-14	4.68E-14	4.50E-14	4.24E-14	4.09E-14
Rb-89	1.40E-13	1.35E-13	1.29E-13	1.23E-13	1.15E-13	1.11E-13
Rb-90	1.39E-13	1.35E-13	1.30E-13	1.25E-13	1.19E-13	1.15E-13
Rb-90m	2.05E-13	1.98E-13	1.90E-13	1.82E-13	1.72E-13	1.66E-13
<b>Strontium</b>						
Sr-79	7.88E-14	7.42E-14	7.03E-14	6.69E-14	6.15E-14	5.89E-14
Sr-80	2.55E-14	2.40E-14	2.28E-14	2.16E-14	1.99E-14	1.90E-14
Sr-81	8.61E-14	8.10E-14	7.68E-14	7.31E-14	6.71E-14	6.43E-14
Sr-82	2.42E-17	1.70E-17	1.30E-17	1.17E-17	4.45E-18	3.93E-18
Sr-83	4.86E-14	4.62E-14	4.37E-14	4.16E-14	3.84E-14	3.68E-14
Sr-85	2.91E-14	2.73E-14	2.60E-14	2.47E-14	2.26E-14	2.16E-14
Sr-85m	1.29E-14	1.19E-14	1.09E-14	1.04E-14	9.49E-15	9.14E-15
Sr-87m	1.89E-14	1.76E-14	1.66E-14	1.58E-14	1.45E-14	1.38E-14
Sr-89	2.14E-15	2.08E-15	1.99E-15	1.91E-15	1.81E-15	1.75E-15
Sr-90	4.93E-16	4.79E-16	4.58E-16	4.41E-16	4.16E-16	4.03E-16
Sr-91	4.47E-14	4.29E-14	4.06E-14	3.87E-14	3.59E-14	3.44E-14
Sr-92	8.08E-14	7.80E-14	7.42E-14	7.10E-14	6.65E-14	6.39E-14
Sr-93	1.39E-13	1.33E-13	1.26E-13	1.21E-13	1.12E-13	1.08E-13
Sr-94	8.92E-14	8.61E-14	8.20E-14	7.86E-14	7.37E-14	7.08E-14
<b>Yttrium</b>						
Y-81	7.88E-14	7.41E-14	7.03E-14	6.69E-14	6.14E-14	5.88E-14
Y-83	8.53E-14	8.08E-14	7.67E-14	7.31E-14	6.74E-14	6.46E-14
Y-83m	5.29E-14	4.97E-14	4.70E-14	4.47E-14	4.11E-14	3.93E-14
Y-84m	2.42E-13	2.32E-13	2.20E-13	2.09E-13	1.94E-13	1.86E-13

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	6.55E-14	6.17E-14	5.86E-14	5.57E-14	5.12E-14	4.90E-14
Y-85m	8.13E-14	7.74E-14	7.36E-14	7.03E-14	6.53E-14	6.27E-14
Y-86	2.15E-13	2.06E-13	1.96E-13	1.87E-13	1.74E-13	1.67E-13
Y-86m	1.31E-14	1.21E-14	1.12E-14	1.06E-14	9.71E-15	9.35E-15
Y-87	2.59E-14	2.43E-14	2.30E-14	2.19E-14	2.00E-14	1.92E-14
Y-87m	1.81E-14	1.69E-14	1.59E-14	1.51E-14	1.39E-14	1.33E-14
Y-88	1.62E-13	1.56E-13	1.49E-13	1.43E-13	1.34E-13	1.29E-13
Y-89m	5.36E-14	5.16E-14	4.88E-14	4.65E-14	4.30E-14	4.12E-14
Y-90	3.91E-15	3.79E-15	3.63E-15	3.49E-15	3.29E-15	3.18E-15
Y-90m	3.76E-14	3.50E-14	3.29E-14	3.13E-14	2.86E-14	2.75E-14
Y-91	2.41E-15	2.34E-15	2.24E-15	2.15E-15	2.03E-15	1.96E-15
Y-91m	3.12E-14	2.94E-14	2.79E-14	2.65E-14	2.44E-14	2.33E-14
Y-92	2.21E-14	2.13E-14	2.03E-14	1.94E-14	1.81E-14	1.74E-14
Y-93	1.11E-14	1.07E-14	1.01E-14	9.73E-15	9.14E-15	8.81E-15
Y-94	5.58E-14	5.38E-14	5.11E-14	4.89E-14	4.56E-14	4.38E-14
Y-95	7.52E-14	7.28E-14	6.98E-14	6.71E-14	6.35E-14	6.12E-14
<b>Zirconium</b>						
Zr-85	9.34E-14	8.82E-14	8.38E-14	7.97E-14	7.35E-14	7.04E-14
Zr-86	1.64E-14	1.51E-14	1.40E-14	1.33E-14	1.21E-14	1.17E-14
Zr-87	5.82E-14	5.49E-14	5.22E-14	4.96E-14	4.57E-14	4.38E-14
Zr-88	2.27E-14	2.11E-14	1.99E-14	1.89E-14	1.73E-14	1.66E-14
Zr-89	6.87E-14	6.58E-14	6.22E-14	5.93E-14	5.48E-14	5.25E-14
Zr-89m	3.76E-14	3.56E-14	3.39E-14	3.22E-14	2.97E-14	2.85E-14
Zr-93	7.07E-18	6.82E-18	6.45E-18	6.15E-18	5.71E-18	5.47E-18
Zr-95	4.36E-14	4.17E-14	3.95E-14	3.75E-14	3.46E-14	3.31E-14
Zr-97	5.49E-14	5.25E-14	4.98E-14	4.74E-14	4.38E-14	4.20E-14
<b>Niobium</b>						
Nb-87	8.02E-14	7.53E-14	7.12E-14	6.78E-14	6.23E-14	5.97E-14
Nb-88	2.57E-13	2.45E-13	2.32E-13	2.21E-13	2.05E-13	1.96E-13
Nb-88m	2.52E-13	2.41E-13	2.28E-13	2.18E-13	2.02E-13	1.94E-13
Nb-89	8.69E-14	8.28E-14	7.90E-14	7.55E-14	7.03E-14	6.75E-14
Nb-89m	8.03E-14	7.57E-14	7.18E-14	6.83E-14	6.28E-14	6.01E-14
Nb-90	2.56E-13	2.46E-13	2.35E-13	2.26E-13	2.12E-13	2.04E-13
Nb-91	1.42E-16	1.21E-16	1.11E-16	1.04E-16	8.51E-17	8.05E-17
Nb-91m	1.55E-15	1.48E-15	1.40E-15	1.33E-15	1.23E-15	1.18E-15
Nb-92	8.88E-14	8.49E-14	8.04E-14	7.65E-14	7.06E-14	6.76E-14
Nb-92m	5.71E-14	5.50E-14	5.20E-14	4.95E-14	4.59E-14	4.40E-14
Nb-93m	1.01E-17	6.67E-18	5.70E-18	4.91E-18	2.52E-18	2.22E-18
Nb-94	9.29E-14	8.89E-14	8.41E-14	8.01E-14	7.40E-14	7.08E-14
Nb-94m	3.07E-16	2.83E-16	2.66E-16	2.51E-16	2.25E-16	2.14E-16
Nb-95	4.54E-14	4.34E-14	4.11E-14	3.91E-14	3.61E-14	3.45E-14
Nb-95m	3.91E-15	3.60E-15	3.32E-15	3.16E-15	2.89E-15	2.79E-15
Nb-96	1.47E-13	1.41E-13	1.33E-13	1.27E-13	1.17E-13	1.12E-13
Nb-97	4.09E-14	3.89E-14	3.70E-14	3.51E-14	3.24E-14	3.10E-14
Nb-98m	1.71E-13	1.64E-13	1.56E-13	1.49E-13	1.38E-13	1.33E-13
Nb-99	1.68E-14	1.56E-14	1.47E-14	1.40E-14	1.28E-14	1.23E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	5.29E-14	5.10E-14	4.88E-14	4.68E-14	4.41E-14	4.26E-14
<b>Molybdenum</b>						
Mo-89	8.27E-14	7.84E-14	7.45E-14	7.10E-14	6.56E-14	6.28E-14
Mo-90	4.91E-14	4.60E-14	4.32E-14	4.11E-14	3.78E-14	3.62E-14
Mo-91	6.47E-14	6.11E-14	5.81E-14	5.52E-14	5.09E-14	4.87E-14
Mo-91m	8.49E-14	8.11E-14	7.71E-14	7.35E-14	6.82E-14	6.54E-14
Mo-93	5.66E-17	3.73E-17	3.19E-17	2.75E-17	1.41E-17	1.24E-17
Mo-93m	1.39E-13	1.33E-13	1.26E-13	1.21E-13	1.13E-13	1.08E-13
Mo-99	1.00E-14	9.55E-15	9.03E-15	8.60E-15	7.94E-15	7.62E-15
Mo-101	9.00E-14	8.63E-14	8.20E-14	7.84E-14	7.31E-14	7.02E-14
Mo-102	2.19E-15	2.06E-15	1.94E-15	1.86E-15	1.72E-15	1.67E-15
<b>Technetium</b>						
Tc-91	1.59E-13	1.52E-13	1.45E-13	1.39E-13	1.30E-13	1.25E-13
Tc-91m	9.42E-14	8.92E-14	8.48E-14	8.07E-14	7.45E-14	7.13E-14
Tc-92	2.37E-13	2.26E-13	2.15E-13	2.05E-13	1.91E-13	1.83E-13
Tc-93	9.38E-14	9.04E-14	8.61E-14	8.24E-14	7.72E-14	7.41E-14
Tc-93m	5.79E-14	5.55E-14	5.31E-14	5.10E-14	4.80E-14	4.63E-14
Tc-94	1.58E-13	1.51E-13	1.43E-13	1.36E-13	1.26E-13	1.20E-13
Tc-94m	1.20E-13	1.14E-13	1.09E-13	1.04E-13	9.61E-14	9.21E-14
Tc-95	4.66E-14	4.46E-14	4.22E-14	4.01E-14	3.71E-14	3.55E-14
Tc-95m	4.03E-14	3.81E-14	3.59E-14	3.42E-14	3.14E-14	3.01E-14
Tc-96	1.48E-13	1.42E-13	1.34E-13	1.28E-13	1.18E-13	1.13E-13
Tc-96m	2.52E-15	2.40E-15	2.27E-15	2.17E-15	2.00E-15	1.92E-15
Tc-97	6.87E-17	4.41E-17	3.86E-17	3.29E-17	1.80E-17	1.58E-17
Tc-97m	8.43E-17	5.87E-17	5.29E-17	4.67E-17	3.22E-17	2.96E-17
Tc-98	8.40E-14	8.00E-14	7.58E-14	7.21E-14	6.65E-14	6.36E-14
Tc-99	1.80E-16	1.75E-16	1.67E-16	1.60E-16	1.51E-16	1.46E-16
Tc-99m	7.41E-15	6.69E-15	6.24E-15	5.97E-15	5.30E-15	5.14E-15
Tc-101	2.16E-14	2.01E-14	1.88E-14	1.79E-14	1.65E-14	1.58E-14
Tc-102	1.52E-14	1.47E-14	1.40E-14	1.35E-14	1.26E-14	1.22E-14
Tc-102m	1.52E-13	1.46E-13	1.39E-13	1.33E-13	1.24E-13	1.19E-13
Tc-104	1.44E-13	1.38E-13	1.32E-13	1.26E-13	1.18E-13	1.14E-13
Tc-105	5.32E-14	5.05E-14	4.78E-14	4.57E-14	4.24E-14	4.07E-14
<b>Ruthenium</b>						
Ru-92	1.26E-13	1.19E-13	1.12E-13	1.07E-13	9.87E-14	9.47E-14
Ru-94	3.02E-14	2.85E-14	2.68E-14	2.55E-14	2.35E-14	2.25E-14
Ru-95	7.37E-14	7.02E-14	6.64E-14	6.33E-14	5.87E-14	5.63E-14
Ru-97	1.37E-14	1.25E-14	1.16E-14	1.10E-14	1.00E-14	9.67E-15
Ru-103	2.94E-14	2.76E-14	2.62E-14	2.49E-14	2.28E-14	2.18E-14
Ru-105	4.56E-14	4.32E-14	4.09E-14	3.89E-14	3.58E-14	3.43E-14
Ru-106	1.25E-18	1.20E-18	1.14E-18	1.09E-18	1.01E-18	9.66E-19
Ru-107	2.53E-14	2.42E-14	2.29E-14	2.19E-14	2.03E-14	1.95E-14
Ru-108	5.20E-15	4.83E-15	4.52E-15	4.34E-15	3.95E-15	3.82E-15
<b>Rhodium</b>						
Rh-94	2.45E-13	2.35E-13	2.23E-13	2.13E-13	1.99E-13	1.91E-13
Rh-95	1.57E-13	1.51E-13	1.43E-13	1.37E-13	1.27E-13	1.22E-13



**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	5.48E-14	5.23E-14	5.00E-14	4.78E-14	4.46E-14	4.28E-14
Rh-96	2.37E-13	2.26E-13	2.14E-13	2.04E-13	1.89E-13	1.81E-13
Rh-96m	7.90E-14	7.56E-14	7.19E-14	6.87E-14	6.39E-14	6.13E-14
Rh-97	8.77E-14	8.31E-14	7.89E-14	7.51E-14	6.94E-14	6.65E-14
Rh-97m	1.33E-13	1.28E-13	1.22E-13	1.17E-13	1.10E-13	1.06E-13
Rh-98	1.14E-13	1.08E-13	1.03E-13	9.76E-14	9.02E-14	8.64E-14
Rh-99	3.23E-14	3.03E-14	2.85E-14	2.71E-14	2.49E-14	2.38E-14
Rh-99m	3.81E-14	3.59E-14	3.39E-14	3.23E-14	2.98E-14	2.85E-14
Rh-100	1.65E-13	1.58E-13	1.51E-13	1.45E-13	1.36E-13	1.31E-13
Rh-100m	2.74E-15	2.53E-15	2.37E-15	2.26E-15	2.04E-15	1.94E-15
Rh-101	1.63E-14	1.49E-14	1.38E-14	1.31E-14	1.18E-14	1.14E-14
Rh-101m	1.64E-14	1.52E-14	1.41E-14	1.34E-14	1.23E-14	1.18E-14
Rh-102	3.00E-14	2.83E-14	2.69E-14	2.55E-14	2.35E-14	2.25E-14
Rh-102m	1.27E-13	1.21E-13	1.15E-13	1.09E-13	1.01E-13	9.63E-14
Rh-103m	1.44E-17	9.21E-18	8.10E-18	7.04E-18	4.45E-18	3.90E-18
Rh-104	4.89E-15	4.73E-15	4.52E-15	4.34E-15	4.08E-15	3.94E-15
Rh-104m	1.48E-15	1.24E-15	1.06E-15	9.89E-16	8.07E-16	7.31E-16
Rh-105	4.94E-15	4.60E-15	4.29E-15	4.08E-15	3.75E-15	3.60E-15
Rh-106	1.89E-14	1.81E-14	1.72E-14	1.64E-14	1.53E-14	1.47E-14
Rh-106m	1.71E-13	1.63E-13	1.55E-13	1.48E-13	1.37E-13	1.31E-13
Rh-107	2.00E-14	1.87E-14	1.75E-14	1.66E-14	1.53E-14	1.47E-14
Rh-108	2.82E-14	2.68E-14	2.55E-14	2.43E-14	2.26E-14	2.17E-14
Rh-109	2.15E-14	2.01E-14	1.88E-14	1.79E-14	1.65E-14	1.59E-14
<b>Palladium</b>						
Pd-96	8.57E-14	8.13E-14	7.70E-14	7.33E-14	6.76E-14	6.48E-14
Pd-97	1.46E-13	1.39E-13	1.32E-13	1.27E-13	1.18E-13	1.13E-13
Pd-98	2.37E-14	2.22E-14	2.09E-14	1.98E-14	1.81E-14	1.74E-14
Pd-99	7.78E-14	7.37E-14	6.99E-14	6.67E-14	6.17E-14	5.92E-14
Pd-100	5.27E-15	4.64E-15	4.13E-15	3.97E-15	3.29E-15	3.02E-15
Pd-101	1.96E-14	1.84E-14	1.74E-14	1.66E-14	1.52E-14	1.46E-14
Pd-103	1.34E-16	8.59E-17	7.63E-17	6.66E-17	4.28E-17	3.77E-17
Pd-107	9.84E-19	9.49E-19	8.97E-19	8.56E-19	7.94E-19	7.61E-19
Pd-109	1.44E-15	1.35E-15	1.28E-15	1.23E-15	1.13E-15	1.09E-15
Pd-109m	6.36E-15	5.81E-15	5.36E-15	5.11E-15	4.63E-15	4.46E-15
Pd-111	6.24E-15	6.01E-15	5.72E-15	5.49E-15	5.14E-15	4.95E-15
Pd-112	1.49E-16	1.33E-16	1.26E-16	1.19E-16	1.06E-16	1.01E-16
Pd-114	3.40E-15	3.22E-15	3.04E-15	2.91E-15	2.70E-15	2.61E-15
<b>Silver</b>						
Ag-99	1.44E-13	1.37E-13	1.30E-13	1.24E-13	1.15E-13	1.11E-13
Ag-100m	1.79E-13	1.71E-13	1.62E-13	1.55E-13	1.44E-13	1.38E-13
Ag-101	9.67E-14	9.16E-14	8.68E-14	8.27E-14	7.64E-14	7.32E-14
Ag-102	2.07E-13	1.98E-13	1.89E-13	1.80E-13	1.68E-13	1.61E-13
Ag-102m	1.22E-13	1.17E-13	1.12E-13	1.08E-13	1.01E-13	9.74E-14
Ag-103	5.02E-14	4.74E-14	4.49E-14	4.27E-14	3.94E-14	3.78E-14
Ag-104	1.61E-13	1.54E-13	1.46E-13	1.39E-13	1.29E-13	1.23E-13
Ag-104m	1.11E-13	1.05E-13	1.01E-13	9.60E-14	8.92E-14	8.56E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	2.95E-14	2.76E-14	2.59E-14	2.46E-14	2.26E-14	2.16E-14
Ag-105m	5.91E-17	5.52E-17	5.17E-17	4.91E-17	4.51E-17	4.32E-17
Ag-106	4.30E-14	4.05E-14	3.84E-14	3.65E-14	3.35E-14	3.21E-14
Ag-106m	1.66E-13	1.59E-13	1.51E-13	1.44E-13	1.33E-13	1.27E-13
Ag-108	3.33E-15	3.20E-15	3.05E-15	2.93E-15	2.74E-15	2.64E-15
Ag-108m	9.52E-14	9.01E-14	8.53E-14	8.11E-14	7.46E-14	7.13E-14
Ag-109m	2.63E-16	2.13E-16	1.90E-16	1.77E-16	1.43E-16	1.32E-16
Ag-110	7.11E-15	6.86E-15	6.55E-15	6.28E-15	5.89E-15	5.68E-15
Ag-110m	1.64E-13	1.58E-13	1.49E-13	1.42E-13	1.32E-13	1.27E-13
Ag-111	2.68E-15	2.53E-15	2.39E-15	2.28E-15	2.12E-15	2.04E-15
Ag-111m	2.51E-16	2.20E-16	2.03E-16	1.91E-16	1.68E-16	1.59E-16
Ag-112	4.79E-14	4.60E-14	4.39E-14	4.20E-14	3.92E-14	3.77E-14
Ag-113	7.27E-15	6.92E-15	6.54E-15	6.25E-15	5.81E-15	5.60E-15
Ag-113m	1.33E-14	1.24E-14	1.17E-14	1.11E-14	1.02E-14	9.79E-15
Ag-114	2.73E-14	2.63E-14	2.51E-14	2.40E-14	2.25E-14	2.17E-14
Ag-115	3.40E-14	3.25E-14	3.10E-14	2.97E-14	2.78E-14	2.67E-14
Ag-116	1.39E-13	1.34E-13	1.28E-13	1.23E-13	1.16E-13	1.11E-13
Ag-117	8.51E-14	8.18E-14	7.83E-14	7.52E-14	7.07E-14	6.82E-14
<b>Cadmium</b>						
Cd-101	1.53E-13	1.46E-13	1.39E-13	1.33E-13	1.24E-13	1.19E-13
Cd-102	4.91E-14	4.64E-14	4.40E-14	4.18E-14	3.85E-14	3.69E-14
Cd-103	1.27E-13	1.22E-13	1.16E-13	1.11E-13	1.04E-13	1.00E-13
Cd-104	1.35E-14	1.27E-14	1.19E-14	1.13E-14	1.02E-14	9.74E-15
Cd-105	7.82E-14	7.49E-14	7.14E-14	6.83E-14	6.38E-14	6.13E-14
Cd-107	7.96E-16	6.57E-16	6.00E-16	5.59E-16	4.69E-16	4.40E-16
Cd-109	4.33E-16	3.22E-16	2.85E-16	2.62E-16	1.98E-16	1.80E-16
Cd-111m	1.65E-14	1.51E-14	1.40E-14	1.33E-14	1.21E-14	1.17E-14
Cd-113	1.60E-16	1.55E-16	1.48E-16	1.42E-16	1.34E-16	1.29E-16
Cd-113m	4.60E-16	4.46E-16	4.27E-16	4.11E-16	3.88E-16	3.75E-16
Cd-115	1.23E-14	1.16E-14	1.10E-14	1.05E-14	9.62E-15	9.22E-15
Cd-115m	4.19E-15	4.06E-15	3.86E-15	3.70E-15	3.47E-15	3.34E-15
Cd-117	6.61E-14	6.34E-14	6.01E-14	5.75E-14	5.36E-14	5.15E-14
Cd-117m	1.24E-13	1.19E-13	1.14E-13	1.09E-13	1.02E-13	9.85E-14
Cd-118	3.76E-16	3.65E-16	3.49E-16	3.36E-16	3.17E-16	3.07E-16
Cd-119	1.02E-13	9.82E-14	9.36E-14	8.97E-14	8.42E-14	8.10E-14
Cd-119m	1.41E-13	1.36E-13	1.30E-13	1.24E-13	1.17E-13	1.12E-13
<b>Indium</b>						
In-103	1.73E-13	1.65E-13	1.57E-13	1.50E-13	1.39E-13	1.34E-13
In-105	1.20E-13	1.14E-13	1.08E-13	1.03E-13	9.55E-14	9.16E-14
In-106	2.16E-13	2.06E-13	1.95E-13	1.86E-13	1.72E-13	1.64E-13
In-106m	1.78E-13	1.70E-13	1.62E-13	1.55E-13	1.45E-13	1.39E-13
In-107	9.25E-14	8.82E-14	8.39E-14	8.02E-14	7.48E-14	7.18E-14
In-108	2.33E-13	2.24E-13	2.12E-13	2.02E-13	1.88E-13	1.80E-13
In-108m	1.71E-13	1.64E-13	1.57E-13	1.50E-13	1.41E-13	1.36E-13
In-109	3.76E-14	3.55E-14	3.34E-14	3.19E-14	2.94E-14	2.82E-14
In-109m	3.60E-14	3.42E-14	3.24E-14	3.08E-14	2.84E-14	2.71E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	1.83E-13	1.75E-13	1.66E-13	1.58E-13	1.46E-13	1.40E-13
In-110m	9.62E-14	9.14E-14	8.69E-14	8.28E-14	7.66E-14	7.34E-14
In-111	2.32E-14	2.13E-14	1.96E-14	1.87E-14	1.70E-14	1.64E-14
In-111m	2.77E-14	2.61E-14	2.48E-14	2.36E-14	2.16E-14	2.07E-14
In-112	1.63E-14	1.54E-14	1.46E-14	1.39E-14	1.28E-14	1.22E-14
In-112m	1.43E-15	1.26E-15	1.17E-15	1.11E-15	9.76E-16	9.40E-16
In-113m	1.52E-14	1.42E-14	1.33E-14	1.27E-14	1.16E-14	1.11E-14
In-114	3.20E-15	3.10E-15	2.96E-15	2.85E-15	2.69E-15	2.60E-15
In-114m	4.40E-15	4.09E-15	3.83E-15	3.65E-15	3.33E-15	3.19E-15
In-115	3.46E-16	3.36E-16	3.22E-16	3.10E-16	2.92E-16	2.82E-16
In-115m	9.39E-15	8.70E-15	8.14E-15	7.73E-15	7.08E-15	6.79E-15
In-116m	1.49E-13	1.44E-13	1.37E-13	1.31E-13	1.22E-13	1.17E-13
In-117	4.15E-14	3.89E-14	3.68E-14	3.51E-14	3.20E-14	3.07E-14
In-117m	6.51E-15	6.05E-15	5.67E-15	5.42E-15	4.96E-15	4.78E-15
In-118	1.46E-14	1.41E-14	1.35E-14	1.30E-14	1.22E-14	1.18E-14
In-118m	1.68E-13	1.62E-13	1.54E-13	1.47E-13	1.37E-13	1.31E-13
In-119	4.77E-14	4.56E-14	4.32E-14	4.11E-14	3.80E-14	3.63E-14
In-119m	8.22E-15	7.94E-15	7.55E-15	7.24E-15	6.78E-15	6.53E-15
In-121	5.93E-14	5.70E-14	5.39E-14	5.14E-14	4.77E-14	4.57E-14
In-121m	1.05E-14	1.01E-14	9.60E-15	9.23E-15	8.61E-15	8.28E-15
<b>Tin</b>						
Sn-106	7.13E-14	6.74E-14	6.37E-14	6.06E-14	5.58E-14	5.35E-14
Sn-108	3.96E-14	3.70E-14	3.48E-14	3.30E-14	3.03E-14	2.90E-14
Sn-109	1.32E-13	1.27E-13	1.21E-13	1.16E-13	1.09E-13	1.04E-13
Sn-110	1.65E-14	1.52E-14	1.41E-14	1.34E-14	1.22E-14	1.18E-14
Sn-111	2.93E-14	2.77E-14	2.64E-14	2.51E-14	2.32E-14	2.23E-14
Sn-113	5.71E-16	4.64E-16	4.16E-16	3.90E-16	3.26E-16	3.06E-16
Sn-113m	2.16E-16	1.51E-16	1.28E-16	1.18E-16	8.39E-17	7.37E-17
Sn-117m	8.59E-15	7.77E-15	7.22E-15	6.92E-15	6.15E-15	5.95E-15
Sn-119m	2.09E-16	1.41E-16	1.19E-16	1.09E-16	7.49E-17	6.54E-17
Sn-121	2.28E-16	2.21E-16	2.11E-16	2.03E-16	1.91E-16	1.85E-16
Sn-121m	1.46E-16	1.18E-16	1.05E-16	9.85E-17	8.20E-17	7.63E-17
Sn-123	2.27E-15	2.20E-15	2.10E-15	2.02E-15	1.90E-15	1.83E-15
Sn-123m	9.74E-15	8.96E-15	8.38E-15	8.04E-15	7.25E-15	7.02E-15
Sn-125	2.33E-14	2.25E-14	2.14E-14	2.04E-14	1.90E-14	1.83E-14
Sn-125m	2.37E-14	2.22E-14	2.09E-14	1.99E-14	1.83E-14	1.76E-14
Sn-126	2.79E-15	2.46E-15	2.20E-15	2.10E-15	1.77E-15	1.64E-15
Sn-127	1.16E-13	1.12E-13	1.06E-13	1.01E-13	9.44E-14	9.06E-14
Sn-127m	3.86E-14	3.66E-14	3.48E-14	3.32E-14	3.07E-14	2.94E-14
Sn-128	3.42E-14	3.19E-14	3.01E-14	2.86E-14	2.61E-14	2.49E-14
Sn-129	6.58E-14	6.29E-14	5.98E-14	5.70E-14	5.29E-14	5.07E-14
Sn-130	5.61E-14	5.30E-14	4.98E-14	4.74E-14	4.35E-14	4.16E-14
Sn-130m	5.89E-14	5.64E-14	5.34E-14	5.10E-14	4.74E-14	4.55E-14
<b>Antimony</b>						
Sb-111	9.42E-14	8.89E-14	8.42E-14	8.02E-14	7.38E-14	7.07E-14
Sb-113	7.77E-14	7.33E-14	6.95E-14	6.61E-14	6.08E-14	5.82E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	1.66E-13	1.59E-13	1.51E-13	1.45E-13	1.35E-13	1.29E-13
Sb-115	5.28E-14	4.97E-14	4.71E-14	4.48E-14	4.11E-14	3.94E-14
Sb-116	1.38E-13	1.33E-13	1.26E-13	1.21E-13	1.13E-13	1.08E-13
Sb-116m	1.84E-13	1.77E-13	1.67E-13	1.59E-13	1.48E-13	1.42E-13
Sb-117	1.01E-14	9.16E-15	8.54E-15	8.17E-15	7.30E-15	7.05E-15
Sb-118	5.11E-14	4.82E-14	4.58E-14	4.36E-14	4.01E-14	3.84E-14
Sb-118m	1.54E-13	1.48E-13	1.40E-13	1.34E-13	1.24E-13	1.19E-13
Sb-119	3.39E-16	2.30E-16	1.94E-16	1.77E-16	1.23E-16	1.07E-16
Sb-120	2.74E-14	2.58E-14	2.44E-14	2.32E-14	2.13E-14	2.04E-14
Sb-120m	1.46E-13	1.40E-13	1.32E-13	1.26E-13	1.17E-13	1.12E-13
Sb-122	2.84E-14	2.69E-14	2.55E-14	2.43E-14	2.24E-14	2.14E-14
Sb-122m	2.66E-15	2.29E-15	1.96E-15	1.89E-15	1.49E-15	1.32E-15
Sb-124	1.12E-13	1.08E-13	1.03E-13	9.82E-14	9.17E-14	8.81E-14
Sb-124m	2.63E-14	2.49E-14	2.37E-14	2.25E-14	2.07E-14	1.98E-14
Sb-124n	1.26E-20	8.57E-21	7.20E-21	6.61E-21	4.60E-21	4.02E-21
Sb-125	2.54E-14	2.38E-14	2.25E-14	2.14E-14	1.96E-14	1.88E-14
Sb-126	1.64E-13	1.56E-13	1.48E-13	1.41E-13	1.30E-13	1.24E-13
Sb-126m	9.40E-14	8.92E-14	8.45E-14	8.03E-14	7.40E-14	7.08E-14
Sb-127	4.19E-14	3.98E-14	3.76E-14	3.58E-14	3.30E-14	3.15E-14
Sb-128	1.85E-13	1.76E-13	1.67E-13	1.59E-13	1.46E-13	1.40E-13
Sb-128m	1.17E-13	1.12E-13	1.05E-13	1.00E-13	9.26E-14	8.86E-14
Sb-129	8.85E-14	8.49E-14	8.06E-14	7.69E-14	7.14E-14	6.85E-14
Sb-130	1.98E-13	1.89E-13	1.78E-13	1.70E-13	1.57E-13	1.51E-13
Sb-130m	1.65E-13	1.59E-13	1.50E-13	1.43E-13	1.33E-13	1.27E-13
Sb-131	1.26E-13	1.22E-13	1.16E-13	1.10E-13	1.03E-13	9.89E-14
Sb-133	1.68E-13	1.62E-13	1.55E-13	1.48E-13	1.39E-13	1.33E-13
<b>Tellurium</b>						
Te-113	1.42E-13	1.35E-13	1.29E-13	1.23E-13	1.14E-13	1.10E-13
Te-114	7.59E-14	7.25E-14	6.89E-14	6.58E-14	6.12E-14	5.88E-14
Te-115	1.37E-13	1.31E-13	1.24E-13	1.19E-13	1.10E-13	1.06E-13
Te-115m	1.58E-13	1.52E-13	1.44E-13	1.38E-13	1.28E-13	1.23E-13
Te-116	5.23E-15	4.70E-15	4.35E-15	4.11E-15	3.65E-15	3.48E-15
Te-117	9.29E-14	8.89E-14	8.47E-14	8.09E-14	7.53E-14	7.23E-14
Te-118	3.30E-16	2.29E-16	1.91E-16	1.76E-16	1.25E-16	1.09E-16
Te-119	4.47E-14	4.25E-14	4.03E-14	3.84E-14	3.54E-14	3.39E-14
Te-119m	8.92E-14	8.55E-14	8.09E-14	7.73E-14	7.18E-14	6.89E-14
Te-121	3.32E-14	3.13E-14	2.97E-14	2.82E-14	2.59E-14	2.47E-14
Te-121m	1.23E-14	1.14E-14	1.05E-14	9.98E-15	9.10E-15	8.75E-15
Te-123	5.73E-19	3.98E-19	3.32E-19	3.06E-19	2.17E-19	1.90E-19
Te-123m	8.15E-15	7.37E-15	6.84E-15	6.56E-15	5.83E-15	5.64E-15
Te-125m	6.91E-16	4.98E-16	4.16E-16	3.85E-16	2.83E-16	2.52E-16
Te-127	8.88E-16	8.52E-16	8.11E-16	7.78E-16	7.27E-16	7.01E-16
Te-127m	2.35E-16	1.75E-16	1.49E-16	1.39E-16	1.06E-16	9.54E-17
Te-129	5.33E-15	5.05E-15	4.79E-15	4.57E-15	4.23E-15	4.07E-15
Te-129m	2.68E-15	2.53E-15	2.39E-15	2.28E-15	2.10E-15	2.01E-15
Te-131	2.74E-14	2.59E-14	2.44E-14	2.33E-14	2.14E-14	2.06E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	8.67E-14	8.29E-14	7.84E-14	7.48E-14	6.92E-14	6.64E-14
Te-132	1.31E-14	1.19E-14	1.09E-14	1.04E-14	9.42E-15	9.04E-15
Te-133	7.46E-14	7.12E-14	6.75E-14	6.45E-14	6.01E-14	5.77E-14
Te-133m	1.12E-13	1.07E-13	1.02E-13	9.69E-14	8.99E-14	8.62E-14
Te-134	5.16E-14	4.87E-14	4.58E-14	4.36E-14	4.00E-14	3.83E-14
<b>Iodine</b>						
I-118	1.31E-13	1.24E-13	1.18E-13	1.12E-13	1.04E-13	9.95E-14
I-118m	2.27E-13	2.16E-13	2.05E-13	1.95E-13	1.80E-13	1.73E-13
I-119	5.55E-14	5.21E-14	4.91E-14	4.67E-14	4.29E-14	4.11E-14
I-120	1.66E-13	1.59E-13	1.52E-13	1.45E-13	1.36E-13	1.30E-13
I-120m	2.14E-13	2.04E-13	1.94E-13	1.85E-13	1.71E-13	1.64E-13
I-121	2.30E-14	2.14E-14	2.00E-14	1.90E-14	1.74E-14	1.66E-14
I-122	6.18E-14	5.84E-14	5.55E-14	5.28E-14	4.86E-14	4.65E-14
I-123	9.20E-15	8.32E-15	7.73E-15	7.40E-15	6.58E-15	6.35E-15
I-124	6.64E-14	6.32E-14	6.02E-14	5.74E-14	5.32E-14	5.10E-14
I-125	7.97E-16	5.68E-16	4.71E-16	4.35E-16	3.14E-16	2.78E-16
I-126	2.58E-14	2.43E-14	2.30E-14	2.19E-14	2.01E-14	1.92E-14
I-128	6.91E-15	6.58E-15	6.25E-15	5.97E-15	5.54E-15	5.33E-15
I-129	6.18E-16	4.70E-16	3.93E-16	3.64E-16	2.81E-16	2.54E-16
I-130	1.27E-13	1.21E-13	1.15E-13	1.09E-13	1.00E-13	9.61E-14
I-130m	6.90E-15	6.52E-15	6.19E-15	5.89E-15	5.43E-15	5.20E-15
I-131	2.31E-14	2.15E-14	2.02E-14	1.92E-14	1.76E-14	1.69E-14
I-132	1.36E-13	1.30E-13	1.23E-13	1.18E-13	1.09E-13	1.04E-13
I-132m	2.00E-14	1.89E-14	1.79E-14	1.70E-14	1.56E-14	1.50E-14
I-133	3.76E-14	3.56E-14	3.38E-14	3.21E-14	2.96E-14	2.83E-14
I-134	1.57E-13	1.50E-13	1.42E-13	1.36E-13	1.26E-13	1.21E-13
I-134m	1.63E-14	1.50E-14	1.39E-14	1.32E-14	1.21E-14	1.16E-14
I-135	9.61E-14	9.26E-14	8.81E-14	8.43E-14	7.88E-14	7.58E-14
<b>Xenon</b>						
Xe-120	2.21E-14	2.07E-14	1.94E-14	1.85E-14	1.69E-14	1.61E-14
Xe-121	9.03E-14	8.60E-14	8.20E-14	7.84E-14	7.31E-14	7.02E-14
Xe-122	3.12E-15	2.79E-15	2.58E-15	2.45E-15	2.18E-15	2.08E-15
Xe-123	3.78E-14	3.57E-14	3.37E-14	3.22E-14	2.97E-14	2.85E-14
Xe-125	1.49E-14	1.37E-14	1.26E-14	1.20E-14	1.09E-14	1.05E-14
Xe-127	1.56E-14	1.43E-14	1.32E-14	1.26E-14	1.14E-14	1.09E-14
Xe-127m	9.39E-15	8.42E-15	7.79E-15	7.41E-15	6.59E-15	6.38E-15
Xe-129m	1.54E-15	1.25E-15	1.09E-15	1.02E-15	8.47E-16	7.91E-16
Xe-131m	5.95E-16	4.81E-16	4.21E-16	3.98E-16	3.29E-16	3.08E-16
Xe-133	2.18E-15	1.90E-15	1.68E-15	1.61E-15	1.34E-15	1.22E-15
Xe-133m	1.85E-15	1.64E-15	1.49E-15	1.41E-15	1.26E-15	1.21E-15
Xe-135	1.56E-14	1.45E-14	1.34E-14	1.28E-14	1.17E-14	1.13E-14
Xe-135m	2.50E-14	2.35E-14	2.23E-14	2.12E-14	1.95E-14	1.86E-14
Xe-137	1.99E-14	1.91E-14	1.81E-14	1.74E-14	1.62E-14	1.56E-14
Xe-138	7.03E-14	6.74E-14	6.43E-14	6.17E-14	5.79E-14	5.58E-14
<b>Cesium</b>						
Cs-121	7.83E-14	7.39E-14	7.01E-14	6.67E-14	6.15E-14	5.89E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	7.64E-14	7.20E-14	6.81E-14	6.49E-14	5.97E-14	5.72E-14
Cs-123	6.79E-14	6.40E-14	6.07E-14	5.77E-14	5.31E-14	5.08E-14
Cs-124	7.97E-14	7.54E-14	7.16E-14	6.82E-14	6.30E-14	6.04E-14
Cs-125	4.55E-14	4.29E-14	4.07E-14	3.87E-14	3.56E-14	3.41E-14
Cs-126	7.46E-14	7.05E-14	6.69E-14	6.36E-14	5.86E-14	5.62E-14
Cs-127	2.48E-14	2.31E-14	2.17E-14	2.06E-14	1.89E-14	1.81E-14
Cs-128	5.63E-14	5.31E-14	5.04E-14	4.80E-14	4.41E-14	4.22E-14
Cs-129	1.53E-14	1.41E-14	1.33E-14	1.26E-14	1.15E-14	1.10E-14
Cs-130	3.07E-14	2.89E-14	2.75E-14	2.61E-14	2.40E-14	2.30E-14
Cs-130m	3.02E-15	2.61E-15	2.31E-15	2.20E-15	1.83E-15	1.69E-15
Cs-131	4.89E-16	3.58E-16	2.94E-16	2.72E-16	2.01E-16	1.79E-16
Cs-132	4.15E-14	3.93E-14	3.72E-14	3.54E-14	3.26E-14	3.11E-14
Cs-134	9.25E-14	8.82E-14	8.36E-14	7.95E-14	7.33E-14	7.02E-14
Cs-134m	1.20E-15	1.04E-15	9.54E-16	9.03E-16	7.85E-16	7.56E-16
Cs-135	1.47E-16	1.43E-16	1.36E-16	1.31E-16	1.23E-16	1.19E-16
Cs-135m	9.48E-14	9.09E-14	8.60E-14	8.18E-14	7.56E-14	7.24E-14
Cs-136	1.27E-13	1.22E-13	1.15E-13	1.09E-13	1.01E-13	9.71E-14
Cs-137	4.76E-16	4.62E-16	4.42E-16	4.26E-16	4.02E-16	3.89E-16
Cs-138	1.48E-13	1.43E-13	1.36E-13	1.30E-13	1.22E-13	1.18E-13
Cs-138m	2.55E-14	2.43E-14	2.31E-14	2.20E-14	2.05E-14	1.97E-14
Cs-139	2.68E-14	2.60E-14	2.48E-14	2.38E-14	2.24E-14	2.16E-14
Cs-140	1.19E-13	1.14E-13	1.09E-13	1.05E-13	9.88E-14	9.52E-14
<b>Barium</b>						
Ba-124	3.36E-14	3.17E-14	2.99E-14	2.85E-14	2.62E-14	2.51E-14
Ba-126	3.36E-14	3.18E-14	2.99E-14	2.85E-14	2.63E-14	2.52E-14
Ba-127	4.50E-14	4.24E-14	4.02E-14	3.83E-14	3.53E-14	3.38E-14
Ba-128	3.05E-15	2.72E-15	2.47E-15	2.34E-15	2.09E-15	2.00E-15
Ba-129	1.94E-14	1.82E-14	1.72E-14	1.64E-14	1.51E-14	1.44E-14
Ba-129m	9.33E-14	8.88E-14	8.40E-14	8.01E-14	7.41E-14	7.11E-14
Ba-131	2.70E-14	2.51E-14	2.36E-14	2.24E-14	2.04E-14	1.96E-14
Ba-131m	4.00E-15	3.49E-15	3.20E-15	2.99E-15	2.62E-15	2.53E-15
Ba-133	2.22E-14	2.04E-14	1.90E-14	1.80E-14	1.63E-14	1.56E-14
Ba-133m	3.48E-15	3.15E-15	2.89E-15	2.74E-15	2.48E-15	2.38E-15
Ba-135m	3.03E-15	2.73E-15	2.50E-15	2.38E-15	2.15E-15	2.05E-15
Ba-137m	3.52E-14	3.35E-14	3.17E-14	3.02E-14	2.78E-14	2.66E-14
Ba-139	6.33E-15	6.00E-15	5.67E-15	5.45E-15	5.05E-15	4.88E-15
Ba-140	1.14E-14	1.07E-14	1.01E-14	9.62E-15	8.82E-15	8.45E-15
Ba-141	5.92E-14	5.62E-14	5.30E-14	5.06E-14	4.69E-14	4.50E-14
Ba-142	6.34E-14	6.07E-14	5.73E-14	5.46E-14	5.06E-14	4.85E-14
<b>Lanthanum</b>						
La-128	1.74E-13	1.66E-13	1.57E-13	1.50E-13	1.38E-13	1.33E-13
La-129	5.65E-14	5.31E-14	5.02E-14	4.77E-14	4.38E-14	4.20E-14
La-130	1.38E-13	1.31E-13	1.24E-13	1.19E-13	1.10E-13	1.05E-13
La-131	3.90E-14	3.64E-14	3.43E-14	3.26E-14	2.99E-14	2.86E-14
La-132	1.21E-13	1.16E-13	1.10E-13	1.05E-13	9.79E-14	9.40E-14
La-132m	3.93E-14	3.70E-14	3.49E-14	3.32E-14	3.04E-14	2.91E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	8.71E-15	8.10E-15	7.61E-15	7.22E-15	6.59E-15	6.29E-15
La-134	4.56E-14	4.30E-14	4.08E-14	3.88E-14	3.57E-14	3.42E-14
La-135	1.23E-15	1.04E-15	9.22E-16	8.66E-16	7.37E-16	6.89E-16
La-136	2.46E-14	2.31E-14	2.19E-14	2.08E-14	1.91E-14	1.83E-14
La-137	6.04E-16	4.54E-16	3.72E-16	3.43E-16	2.59E-16	2.33E-16
La-138	7.35E-14	7.08E-14	6.73E-14	6.43E-14	6.01E-14	5.77E-14
La-140	1.41E-13	1.35E-13	1.29E-13	1.23E-13	1.15E-13	1.11E-13
La-141	5.81E-15	5.63E-15	5.38E-15	5.17E-15	4.87E-15	4.70E-15
La-142	1.48E-13	1.43E-13	1.37E-13	1.32E-13	1.24E-13	1.20E-13
La-143	2.19E-14	2.12E-14	2.02E-14	1.94E-14	1.82E-14	1.75E-14
<b>Cerium</b>						
Ce-130	2.86E-14	2.68E-14	2.51E-14	2.39E-14	2.19E-14	2.10E-14
Ce-131	9.85E-14	9.35E-14	8.86E-14	8.45E-14	7.81E-14	7.49E-14
Ce-132	1.52E-14	1.39E-14	1.28E-14	1.22E-14	1.10E-14	1.06E-14
Ce-133	3.18E-14	2.96E-14	2.79E-14	2.64E-14	2.41E-14	2.30E-14
Ce-133m	1.02E-13	9.76E-14	9.26E-14	8.83E-14	8.19E-14	7.86E-14
Ce-134	7.73E-16	6.03E-16	5.03E-16	4.66E-16	3.65E-16	3.34E-16
Ce-135	4.79E-14	4.50E-14	4.23E-14	4.03E-14	3.70E-14	3.54E-14
Ce-137	1.34E-15	1.14E-15	1.01E-15	9.46E-16	8.06E-16	7.54E-16
Ce-137m	2.75E-15	2.47E-15	2.25E-15	2.14E-15	1.92E-15	1.83E-15
Ce-139	8.49E-15	7.63E-15	7.03E-15	6.72E-15	5.97E-15	5.75E-15
Ce-141	4.66E-15	4.22E-15	3.93E-15	3.76E-15	3.34E-15	3.24E-15
Ce-143	1.71E-14	1.60E-14	1.49E-14	1.42E-14	1.30E-14	1.24E-14
Ce-144	1.17E-15	1.05E-15	9.71E-16	9.25E-16	8.18E-16	7.88E-16
Ce-145	4.96E-14	4.71E-14	4.44E-14	4.23E-14	3.90E-14	3.73E-14
<b>Praseodymium</b>						
Pr-134	1.92E-13	1.82E-13	1.72E-13	1.64E-13	1.52E-13	1.45E-13
Pr-134m	1.46E-13	1.39E-13	1.32E-13	1.26E-13	1.17E-13	1.12E-13
Pr-135	5.32E-14	5.01E-14	4.73E-14	4.50E-14	4.14E-14	3.96E-14
Pr-136	1.31E-13	1.25E-13	1.19E-13	1.13E-13	1.05E-13	1.01E-13
Pr-137	2.19E-14	2.06E-14	1.95E-14	1.86E-14	1.71E-14	1.63E-14
Pr-138	5.35E-14	5.05E-14	4.80E-14	4.57E-14	4.20E-14	4.03E-14
Pr-138m	1.47E-13	1.41E-13	1.33E-13	1.26E-13	1.17E-13	1.12E-13
Pr-139	7.01E-15	6.50E-15	6.11E-15	5.80E-15	5.28E-15	5.04E-15
Pr-140	3.42E-14	3.22E-14	3.05E-14	2.90E-14	2.66E-14	2.55E-14
Pr-142	6.80E-15	6.58E-15	6.29E-15	6.04E-15	5.69E-15	5.49E-15
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	9.51E-16	9.24E-16	8.84E-16	8.51E-16	8.03E-16	7.77E-16
Pr-144	7.21E-15	6.98E-15	6.68E-15	6.42E-15	6.05E-15	5.84E-15
Pr-144m	4.26E-16	3.49E-16	2.99E-16	2.78E-16	2.29E-16	2.12E-16
Pr-145	3.67E-15	3.54E-15	3.38E-15	3.24E-15	3.04E-15	2.93E-15
Pr-146	6.71E-14	6.44E-14	6.13E-14	5.87E-14	5.48E-14	5.27E-14
Pr-147	3.13E-14	2.95E-14	2.78E-14	2.65E-14	2.44E-14	2.34E-14
Pr-148	6.79E-14	6.50E-14	6.17E-14	5.90E-14	5.51E-14	5.30E-14
Pr-148m	6.38E-14	6.04E-14	5.70E-14	5.43E-14	5.02E-14	4.82E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	3.18E-14	2.96E-14	2.77E-14	2.64E-14	2.40E-14	2.31E-14
Nd-135	7.83E-14	7.35E-14	6.95E-14	6.61E-14	6.07E-14	5.82E-14
Nd-136	1.52E-14	1.40E-14	1.31E-14	1.24E-14	1.12E-14	1.07E-14
Nd-137	7.02E-14	6.66E-14	6.31E-14	6.01E-14	5.55E-14	5.32E-14
Nd-138	1.70E-15	1.45E-15	1.28E-15	1.20E-15	1.03E-15	9.64E-16
Nd-139	2.64E-14	2.48E-14	2.35E-14	2.23E-14	2.05E-14	1.97E-14
Nd-139m	9.32E-14	8.90E-14	8.41E-14	8.01E-14	7.41E-14	7.10E-14
Nd-140	8.30E-16	6.46E-16	5.30E-16	4.86E-16	3.77E-16	3.42E-16
Nd-141	3.70E-15	3.38E-15	3.12E-15	2.95E-15	2.66E-15	2.53E-15
Nd-141m	4.12E-14	3.93E-14	3.72E-14	3.54E-14	3.27E-14	3.13E-14
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	8.39E-15	7.74E-15	7.23E-15	6.85E-15	6.20E-15	5.91E-15
Nd-149	2.32E-14	2.16E-14	2.02E-14	1.92E-14	1.75E-14	1.68E-14
Nd-151	5.28E-14	5.02E-14	4.74E-14	4.52E-14	4.18E-14	4.01E-14
Nd-152	1.06E-14	9.85E-15	9.16E-15	8.72E-15	8.01E-15	7.69E-15
<b>Promethium</b>						
Pm-136	1.73E-13	1.64E-13	1.56E-13	1.48E-13	1.37E-13	1.31E-13
Pm-137m	1.10E-13	1.03E-13	9.77E-14	9.29E-14	8.55E-14	8.19E-14
Pm-139	6.03E-14	5.69E-14	5.40E-14	5.14E-14	4.74E-14	4.54E-14
Pm-140	7.37E-14	6.98E-14	6.63E-14	6.32E-14	5.83E-14	5.59E-14
Pm-140m	1.84E-13	1.76E-13	1.66E-13	1.58E-13	1.46E-13	1.40E-13
Pm-141	4.58E-14	4.34E-14	4.12E-14	3.92E-14	3.62E-14	3.47E-14
Pm-142	5.70E-14	5.39E-14	5.12E-14	4.87E-14	4.49E-14	4.30E-14
Pm-143	1.78E-14	1.69E-14	1.59E-14	1.51E-14	1.39E-14	1.32E-14
Pm-144	9.16E-14	8.67E-14	8.22E-14	7.81E-14	7.18E-14	6.86E-14
Pm-145	9.85E-16	7.85E-16	6.48E-16	5.97E-16	4.68E-16	4.23E-16
Pm-146	4.41E-14	4.17E-14	3.94E-14	3.75E-14	3.44E-14	3.29E-14
Pm-147	8.02E-17	7.76E-17	7.38E-17	7.08E-17	6.63E-17	6.39E-17
Pm-148	3.73E-14	3.58E-14	3.41E-14	3.26E-14	3.04E-14	2.92E-14
Pm-148m	1.18E-13	1.12E-13	1.06E-13	1.01E-13	9.30E-14	8.90E-14
Pm-149	1.86E-15	1.78E-15	1.68E-15	1.61E-15	1.51E-15	1.45E-15
Pm-150	9.13E-14	8.75E-14	8.30E-14	7.93E-14	7.39E-14	7.10E-14
Pm-151	2.00E-14	1.86E-14	1.74E-14	1.66E-14	1.52E-14	1.45E-14
Pm-152	2.32E-14	2.22E-14	2.11E-14	2.02E-14	1.88E-14	1.81E-14
Pm-152m	9.38E-14	8.95E-14	8.45E-14	8.06E-14	7.48E-14	7.18E-14
Pm-153	6.66E-15	6.15E-15	5.75E-15	5.49E-15	4.99E-15	4.81E-15
Pm-154	1.11E-13	1.07E-13	1.02E-13	9.82E-14	9.21E-14	8.86E-14
Pm-154m	1.11E-13	1.06E-13	1.01E-13	9.64E-14	8.98E-14	8.63E-14
<b>Samarium</b>						
Sm-139	9.11E-14	8.61E-14	8.15E-14	7.76E-14	7.16E-14	6.87E-14
Sm-140	3.36E-14	3.17E-14	3.00E-14	2.85E-14	2.63E-14	2.52E-14
Sm-141	8.66E-14	8.21E-14	7.79E-14	7.43E-14	6.87E-14	6.59E-14
Sm-141m	1.17E-13	1.11E-13	1.05E-13	1.00E-13	9.28E-14	8.90E-14
Sm-142	5.86E-15	5.39E-15	5.02E-15	4.75E-15	4.29E-15	4.09E-15
Sm-143	3.29E-14	3.10E-14	2.94E-14	2.79E-14	2.57E-14	2.46E-14



**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	4.06E-14	3.87E-14	3.67E-14	3.49E-14	3.22E-14	3.08E-14
Sm-145	2.15E-15	1.74E-15	1.44E-15	1.33E-15	1.05E-15	9.48E-16
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	8.16E-18	7.85E-18	7.42E-18	7.07E-18	6.56E-18	6.28E-18
Sm-153	3.69E-15	3.25E-15	2.94E-15	2.75E-15	2.41E-15	2.29E-15
Sm-155	7.88E-15	7.16E-15	6.66E-15	6.28E-15	5.67E-15	5.47E-15
Sm-156	6.94E-15	6.33E-15	5.81E-15	5.54E-15	4.97E-15	4.76E-15
Sm-157	2.79E-14	2.63E-14	2.47E-14	2.35E-14	2.17E-14	2.09E-14
<b>Europium</b>						
Eu-142	8.96E-14	8.52E-14	8.11E-14	7.74E-14	7.18E-14	6.89E-14
Eu-142m	2.13E-13	2.03E-13	1.92E-13	1.83E-13	1.69E-13	1.62E-13
Eu-143	7.36E-14	6.99E-14	6.65E-14	6.34E-14	5.87E-14	5.63E-14
Eu-144	7.68E-14	7.28E-14	6.93E-14	6.61E-14	6.12E-14	5.87E-14
Eu-145	7.58E-14	7.27E-14	6.90E-14	6.59E-14	6.14E-14	5.89E-14
Eu-146	1.42E-13	1.36E-13	1.29E-13	1.23E-13	1.14E-13	1.09E-13
Eu-147	2.70E-14	2.54E-14	2.38E-14	2.26E-14	2.07E-14	1.98E-14
Eu-148	1.31E-13	1.25E-13	1.18E-13	1.13E-13	1.04E-13	9.95E-14
Eu-149	3.01E-15	2.66E-15	2.39E-15	2.24E-15	1.97E-15	1.86E-15
Eu-150	9.14E-14	8.61E-14	8.13E-14	7.73E-14	7.11E-14	6.81E-14
Eu-150m	3.81E-15	3.60E-15	3.40E-15	3.24E-15	3.00E-15	2.88E-15
Eu-152	6.96E-14	6.65E-14	6.28E-14	5.99E-14	5.55E-14	5.33E-14
Eu-152m	1.92E-14	1.84E-14	1.74E-14	1.66E-14	1.53E-14	1.47E-14
Eu-152n	3.90E-15	3.43E-15	3.08E-15	2.90E-15	2.48E-15	2.33E-15
Eu-154	7.49E-14	7.18E-14	6.79E-14	6.48E-14	6.01E-14	5.76E-14
Eu-154m	3.23E-15	2.81E-15	2.49E-15	2.35E-15	1.96E-15	1.82E-15
Eu-155	3.27E-15	2.87E-15	2.59E-15	2.44E-15	2.10E-15	1.98E-15
Eu-156	7.57E-14	7.30E-14	6.95E-14	6.65E-14	6.23E-14	5.98E-14
Eu-157	1.76E-14	1.64E-14	1.53E-14	1.45E-14	1.32E-14	1.26E-14
Eu-158	8.08E-14	7.78E-14	7.38E-14	7.05E-14	6.56E-14	6.29E-14
Eu-159	2.02E-14	1.91E-14	1.78E-14	1.70E-14	1.55E-14	1.48E-14
<b>Gadolinium</b>						
Gd-142	6.50E-14	6.16E-14	5.84E-14	5.56E-14	5.14E-14	4.93E-14
Gd-143m	1.32E-13	1.25E-13	1.18E-13	1.13E-13	1.04E-13	1.00E-13
Gd-144	5.65E-14	5.37E-14	5.12E-14	4.89E-14	4.54E-14	4.36E-14
Gd-145	1.48E-13	1.42E-13	1.36E-13	1.30E-13	1.23E-13	1.18E-13
Gd-145m	4.06E-14	3.86E-14	3.66E-14	3.48E-14	3.21E-14	3.07E-14
Gd-146	1.30E-14	1.14E-14	1.04E-14	9.80E-15	8.57E-15	8.22E-15
Gd-147	8.25E-14	7.82E-14	7.36E-14	7.00E-14	6.46E-14	6.18E-14
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	3.02E-14	2.81E-14	2.63E-14	2.50E-14	2.28E-14	2.18E-14
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	3.23E-15	2.83E-15	2.52E-15	2.37E-15	2.07E-15	1.95E-15
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	4.90E-15	4.19E-15	3.71E-15	3.44E-15	2.93E-15	2.77E-15

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	3.89E-15	3.62E-15	3.38E-15	3.21E-15	2.94E-15	2.81E-15
Gd-162	2.55E-14	2.39E-14	2.26E-14	2.14E-14	1.97E-14	1.88E-14
<b>Terbium</b>						
Tb-146	2.26E-13	2.17E-13	2.07E-13	1.98E-13	1.85E-13	1.78E-13
Tb-147	1.31E-13	1.25E-13	1.19E-13	1.14E-13	1.05E-13	1.01E-13
Tb-147m	1.16E-13	1.11E-13	1.06E-13	1.01E-13	9.48E-14	9.11E-14
Tb-148	1.45E-13	1.39E-13	1.32E-13	1.26E-13	1.17E-13	1.12E-13
Tb-148m	1.87E-13	1.78E-13	1.68E-13	1.60E-13	1.47E-13	1.41E-13
Tb-149	8.09E-14	7.70E-14	7.30E-14	6.97E-14	6.47E-14	6.21E-14
Tb-149m	8.16E-14	7.77E-14	7.35E-14	6.99E-14	6.44E-14	6.16E-14
Tb-150	1.48E-13	1.42E-13	1.36E-13	1.30E-13	1.22E-13	1.17E-13
Tb-150m	1.49E-13	1.41E-13	1.33E-13	1.26E-13	1.16E-13	1.11E-13
Tb-151	5.78E-14	5.42E-14	5.10E-14	4.84E-14	4.44E-14	4.26E-14
Tb-151m	4.33E-15	4.03E-15	3.76E-15	3.56E-15	3.24E-15	3.08E-15
Tb-152	8.99E-14	8.56E-14	8.13E-14	7.77E-14	7.23E-14	6.95E-14
Tb-152m	4.41E-14	4.11E-14	3.85E-14	3.66E-14	3.34E-14	3.20E-14
Tb-153	1.85E-14	1.71E-14	1.58E-14	1.50E-14	1.36E-14	1.30E-14
Tb-154	1.37E-13	1.32E-13	1.26E-13	1.21E-13	1.14E-13	1.10E-13
Tb-155	9.20E-15	8.17E-15	7.39E-15	6.97E-15	6.12E-15	5.81E-15
Tb-156	1.14E-13	1.09E-13	1.03E-13	9.84E-14	9.12E-14	8.75E-14
Tb-156m	1.51E-15	1.27E-15	1.06E-15	9.81E-16	8.00E-16	7.16E-16
Tb-156n	1.59E-16	1.35E-16	1.16E-16	1.08E-16	8.96E-17	8.22E-17
Tb-157	1.70E-16	1.39E-16	1.15E-16	1.05E-16	8.50E-17	7.67E-17
Tb-158	4.70E-14	4.50E-14	4.23E-14	4.03E-14	3.72E-14	3.56E-14
Tb-160	6.74E-14	6.46E-14	6.10E-14	5.82E-14	5.39E-14	5.16E-14
Tb-161	1.69E-15	1.48E-15	1.29E-15	1.22E-15	1.03E-15	9.46E-16
Tb-162	6.72E-14	6.40E-14	6.02E-14	5.73E-14	5.28E-14	5.06E-14
Tb-163	4.76E-14	4.46E-14	4.20E-14	3.99E-14	3.66E-14	3.51E-14
Tb-164	1.49E-13	1.42E-13	1.35E-13	1.28E-13	1.19E-13	1.14E-13
Tb-165	5.37E-14	5.17E-14	4.92E-14	4.71E-14	4.40E-14	4.23E-14
<b>Dysprosium</b>						
Dy-148	4.17E-14	3.94E-14	3.72E-14	3.54E-14	3.25E-14	3.10E-14
Dy-149	9.62E-14	9.21E-14	8.73E-14	8.34E-14	7.76E-14	7.45E-14
Dy-150	1.60E-14	1.48E-14	1.39E-14	1.31E-14	1.20E-14	1.14E-14
Dy-151	8.10E-14	7.73E-14	7.32E-14	6.98E-14	6.47E-14	6.20E-14
Dy-152	1.63E-14	1.49E-14	1.36E-14	1.29E-14	1.18E-14	1.13E-14
Dy-153	5.03E-14	4.74E-14	4.45E-14	4.24E-14	3.90E-14	3.73E-14
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	3.89E-14	3.67E-14	3.44E-14	3.28E-14	3.02E-14	2.90E-14
Dy-157	1.97E-14	1.82E-14	1.68E-14	1.59E-14	1.45E-14	1.39E-14
Dy-159	1.70E-15	1.41E-15	1.17E-15	1.07E-15	8.69E-16	7.82E-16
Dy-165	2.96E-15	2.81E-15	2.65E-15	2.53E-15	2.34E-15	2.24E-15
Dy-165m	1.01E-15	9.18E-16	8.49E-16	8.02E-16	7.20E-16	6.86E-16
Dy-166	2.16E-15	1.90E-15	1.67E-15	1.58E-15	1.34E-15	1.24E-15
Dy-167	3.38E-14	3.17E-14	2.99E-14	2.84E-14	2.61E-14	2.50E-14
Dy-168	2.41E-14	2.25E-14	2.11E-14	2.01E-14	1.84E-14	1.76E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	1.23E-13	1.17E-13	1.11E-13	1.06E-13	9.76E-14	9.35E-14
Ho-153	6.26E-14	5.90E-14	5.57E-14	5.29E-14	4.87E-14	4.66E-14
Ho-153m	6.50E-14	6.10E-14	5.76E-14	5.48E-14	5.02E-14	4.81E-14
Ho-154	1.17E-13	1.11E-13	1.05E-13	9.98E-14	9.22E-14	8.84E-14
Ho-154m	1.46E-13	1.38E-13	1.30E-13	1.24E-13	1.14E-13	1.09E-13
Ho-155	3.63E-14	3.41E-14	3.21E-14	3.05E-14	2.81E-14	2.69E-14
Ho-156	1.28E-13	1.22E-13	1.15E-13	1.10E-13	1.02E-13	9.82E-14
Ho-157	3.32E-14	3.09E-14	2.88E-14	2.74E-14	2.50E-14	2.39E-14
Ho-159	2.13E-14	1.94E-14	1.79E-14	1.69E-14	1.52E-14	1.46E-14
Ho-160	9.96E-14	9.51E-14	8.97E-14	8.54E-14	7.87E-14	7.53E-14
Ho-161	2.18E-15	1.83E-15	1.56E-15	1.44E-15	1.19E-15	1.08E-15
Ho-162	8.85E-15	8.24E-15	7.64E-15	7.26E-15	6.59E-15	6.26E-15
Ho-162m	3.24E-14	3.07E-14	2.88E-14	2.75E-14	2.53E-14	2.42E-14
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	1.56E-15	1.36E-15	1.19E-15	1.11E-15	9.53E-16	8.81E-16
Ho-164m	1.74E-15	1.45E-15	1.22E-15	1.13E-15	9.12E-16	8.17E-16
Ho-166	4.17E-15	3.99E-15	3.78E-15	3.63E-15	3.37E-15	3.24E-15
Ho-166m	9.60E-14	9.10E-14	8.58E-14	8.16E-14	7.51E-14	7.18E-14
Ho-167	2.20E-14	2.04E-14	1.90E-14	1.81E-14	1.65E-14	1.58E-14
Ho-168	5.49E-14	5.25E-14	4.97E-14	4.73E-14	4.38E-14	4.19E-14
Ho-168m	2.47E-16	2.07E-16	1.73E-16	1.60E-16	1.30E-16	1.16E-16
Ho-170	1.04E-13	9.92E-14	9.35E-14	8.91E-14	8.24E-14	7.90E-14
<b>Erbium</b>						
Er-154	3.35E-15	2.96E-15	2.66E-15	2.49E-15	2.17E-15	2.03E-15
Er-156	2.69E-15	2.30E-15	1.99E-15	1.86E-15	1.57E-15	1.45E-15
Er-159	5.67E-14	5.38E-14	5.09E-14	4.85E-14	4.49E-14	4.30E-14
Er-161	5.80E-14	5.54E-14	5.22E-14	4.97E-14	4.59E-14	4.39E-14
Er-163	1.60E-15	1.35E-15	1.13E-15	1.05E-15	8.57E-16	7.71E-16
Er-165	1.48E-15	1.24E-15	1.04E-15	9.58E-16	7.79E-16	6.98E-16
Er-167m	5.59E-15	5.10E-15	4.67E-15	4.45E-15	4.03E-15	3.87E-15
Er-169	1.80E-16	1.75E-16	1.67E-16	1.61E-16	1.51E-16	1.46E-16
Er-171	2.28E-14	2.11E-14	1.96E-14	1.86E-14	1.70E-14	1.63E-14
Er-172	3.01E-14	2.82E-14	2.65E-14	2.52E-14	2.30E-14	2.20E-14
Er-173	5.12E-14	4.84E-14	4.53E-14	4.32E-14	3.96E-14	3.80E-14
<b>Thulium</b>						
Tm-161	7.62E-14	7.22E-14	6.83E-14	6.53E-14	6.05E-14	5.80E-14
Tm-162	1.17E-13	1.12E-13	1.07E-13	1.02E-13	9.56E-14	9.19E-14
Tm-163	7.74E-14	7.39E-14	6.98E-14	6.66E-14	6.18E-14	5.93E-14
Tm-164	4.83E-14	4.58E-14	4.35E-14	4.14E-14	3.83E-14	3.67E-14
Tm-165	3.22E-14	3.00E-14	2.80E-14	2.66E-14	2.43E-14	2.32E-14
Tm-166	1.18E-13	1.13E-13	1.07E-13	1.03E-13	9.57E-14	9.19E-14
Tm-167	7.82E-15	7.03E-15	6.34E-15	6.01E-15	5.35E-15	5.07E-15
Tm-168	7.27E-14	6.88E-14	6.47E-14	6.16E-14	5.66E-14	5.41E-14
Tm-170	1.15E-15	1.10E-15	1.04E-15	9.97E-16	9.25E-16	8.89E-16
Tm-171	3.94E-17	3.53E-17	3.11E-17	2.96E-17	2.53E-17	2.32E-17

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	3.01E-14	2.90E-14	2.76E-14	2.64E-14	2.47E-14	2.37E-14
Tm-173	2.37E-14	2.22E-14	2.09E-14	1.99E-14	1.82E-14	1.74E-14
Tm-174	1.07E-13	1.01E-13	9.49E-14	9.04E-14	8.33E-14	7.98E-14
Tm-175	6.57E-14	6.25E-14	5.92E-14	5.64E-14	5.21E-14	4.98E-14
Tm-176	1.22E-13	1.17E-13	1.11E-13	1.06E-13	9.89E-14	9.51E-14
<b>Ytterbium</b>						
Yb-162	1.40E-14	1.28E-14	1.18E-14	1.12E-14	1.00E-14	9.58E-15
Yb-163	4.35E-14	4.13E-14	3.91E-14	3.73E-14	3.44E-14	3.29E-14
Yb-164	2.42E-15	2.12E-15	1.85E-15	1.74E-15	1.47E-15	1.35E-15
Yb-165	1.86E-14	1.73E-14	1.60E-14	1.53E-14	1.38E-14	1.31E-14
Yb-166	3.68E-15	3.15E-15	2.68E-15	2.52E-15	2.06E-15	1.84E-15
Yb-167	1.40E-14	1.24E-14	1.12E-14	1.06E-14	9.23E-15	8.75E-15
Yb-169	1.71E-14	1.53E-14	1.37E-14	1.30E-14	1.14E-14	1.07E-14
Yb-175	2.55E-15	2.37E-15	2.22E-15	2.11E-15	1.93E-15	1.85E-15
Yb-177	1.29E-14	1.23E-14	1.16E-14	1.11E-14	1.02E-14	9.82E-15
Yb-178	2.72E-15	2.55E-15	2.40E-15	2.29E-15	2.11E-15	2.02E-15
Yb-179	5.98E-14	5.65E-14	5.36E-14	5.09E-14	4.68E-14	4.48E-14
<b>Lutetium</b>						
Lu-165	6.63E-14	6.27E-14	5.93E-14	5.65E-14	5.22E-14	5.00E-14
Lu-167	1.01E-13	9.63E-14	9.15E-14	8.76E-14	8.18E-14	7.85E-14
Lu-169	7.76E-14	7.43E-14	7.02E-14	6.71E-14	6.23E-14	5.97E-14
Lu-169m	2.12E-19	1.04E-19	9.20E-20	8.60E-20	2.47E-20	2.13E-20
Lu-170	1.55E-13	1.49E-13	1.42E-13	1.37E-13	1.28E-13	1.24E-13
Lu-171	3.69E-14	3.49E-14	3.28E-14	3.12E-14	2.85E-14	2.72E-14
Lu-171m	1.46E-17	1.27E-17	1.09E-17	1.05E-17	8.36E-18	7.41E-18
Lu-172	1.15E-13	1.11E-13	1.04E-13	9.96E-14	9.22E-14	8.83E-14
Lu-172m	1.26E-19	8.00E-20	6.77E-20	6.23E-20	3.47E-20	3.11E-20
Lu-173	9.27E-15	8.30E-15	7.43E-15	7.05E-15	6.16E-15	5.76E-15
Lu-174	6.02E-15	5.59E-15	5.11E-15	4.87E-15	4.37E-15	4.11E-15
Lu-174m	2.65E-15	2.32E-15	2.01E-15	1.90E-15	1.58E-15	1.44E-15
Lu-176	2.86E-14	2.63E-14	2.43E-14	2.32E-14	2.11E-14	2.02E-14
Lu-176m	2.16E-15	2.04E-15	1.90E-15	1.83E-15	1.67E-15	1.60E-15
Lu-177	2.32E-15	2.12E-15	1.96E-15	1.86E-15	1.68E-15	1.62E-15
Lu-177m	5.80E-14	5.34E-14	4.94E-14	4.70E-14	4.26E-14	4.08E-14
Lu-178	1.03E-14	9.94E-15	9.44E-15	9.04E-15	8.45E-15	8.12E-15
Lu-178m	6.23E-14	5.77E-14	5.38E-14	5.11E-14	4.66E-14	4.45E-14
Lu-179	3.44E-15	3.25E-15	3.06E-15	2.93E-15	2.72E-15	2.62E-15
Lu-180	9.23E-14	8.85E-14	8.38E-14	8.00E-14	7.44E-14	7.14E-14
Lu-181	3.64E-14	3.44E-14	3.24E-14	3.08E-14	2.83E-14	2.71E-14
<b>Hafnium</b>						
Hf-167	3.82E-14	3.57E-14	3.36E-14	3.19E-14	2.93E-14	2.80E-14
Hf-169	3.75E-14	3.51E-14	3.31E-14	3.14E-14	2.87E-14	2.74E-14
Hf-170	2.48E-14	2.30E-14	2.15E-14	2.04E-14	1.85E-14	1.76E-14
Hf-172	4.64E-15	4.03E-15	3.51E-15	3.34E-15	2.77E-15	2.53E-15
Hf-173	2.25E-14	2.05E-14	1.89E-14	1.80E-14	1.61E-14	1.54E-14
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	2.00E-14	1.85E-14	1.71E-14	1.62E-14	1.47E-14	1.40E-14
Hf-177m	1.34E-13	1.24E-13	1.15E-13	1.09E-13	9.94E-14	9.52E-14
Hf-178m	1.31E-13	1.22E-13	1.15E-13	1.09E-13	9.98E-14	9.55E-14
Hf-179m	5.33E-14	4.93E-14	4.60E-14	4.38E-14	3.97E-14	3.80E-14
Hf-180m	5.77E-14	5.35E-14	5.00E-14	4.75E-14	4.33E-14	4.15E-14
Hf-181	3.14E-14	2.92E-14	2.75E-14	2.62E-14	2.39E-14	2.28E-14
Hf-182	1.41E-14	1.30E-14	1.20E-14	1.15E-14	1.05E-14	1.00E-14
Hf-182m	5.34E-14	5.00E-14	4.69E-14	4.46E-14	4.08E-14	3.90E-14
Hf-183	4.68E-14	4.45E-14	4.20E-14	4.00E-14	3.68E-14	3.51E-14
Hf-184	1.43E-14	1.31E-14	1.22E-14	1.16E-14	1.05E-14	1.01E-14
<b>Tantalum</b>						
Ta-170	7.08E-14	6.69E-14	6.34E-14	6.03E-14	5.56E-14	5.32E-14
Ta-172	1.02E-13	9.77E-14	9.24E-14	8.81E-14	8.16E-14	7.82E-14
Ta-173	3.37E-14	3.19E-14	2.99E-14	2.86E-14	2.62E-14	2.50E-14
Ta-174	5.91E-14	5.60E-14	5.29E-14	5.05E-14	4.66E-14	4.47E-14
Ta-175	6.53E-14	6.22E-14	5.87E-14	5.61E-14	5.20E-14	4.98E-14
Ta-176	1.34E-13	1.29E-13	1.22E-13	1.17E-13	1.10E-13	1.06E-13
Ta-177	3.17E-15	2.80E-15	2.46E-15	2.34E-15	1.97E-15	1.81E-15
Ta-178	6.39E-15	5.91E-15	5.41E-15	5.16E-15	4.60E-15	4.33E-15
Ta-178m	6.68E-14	6.17E-14	5.74E-14	5.45E-14	4.95E-14	4.73E-14
Ta-179	1.05E-15	9.08E-16	7.70E-16	7.35E-16	5.90E-16	5.24E-16
Ta-180	2.19E-15	1.91E-15	1.64E-15	1.56E-15	1.28E-15	1.15E-15
Ta-182	7.66E-14	7.36E-14	6.95E-14	6.64E-14	6.15E-14	5.89E-14
Ta-182m	1.46E-14	1.33E-14	1.21E-14	1.16E-14	1.03E-14	9.82E-15
Ta-183	1.69E-14	1.54E-14	1.42E-14	1.35E-14	1.21E-14	1.15E-14
Ta-184	9.42E-14	8.91E-14	8.38E-14	7.97E-14	7.34E-14	7.03E-14
Ta-185	1.10E-14	1.02E-14	9.44E-15	9.04E-15	8.16E-15	7.81E-15
Ta-186	8.83E-14	8.33E-14	7.85E-14	7.47E-14	6.87E-14	6.59E-14
<b>Tungsten</b>						
W-177	5.29E-14	4.97E-14	4.66E-14	4.43E-14	4.04E-14	3.86E-14
W-178	6.42E-16	5.60E-16	4.76E-16	4.57E-16	3.65E-16	3.23E-16
W-179	2.18E-15	1.89E-15	1.60E-15	1.53E-15	1.22E-15	1.08E-15
W-179m	2.80E-15	2.52E-15	2.23E-15	2.14E-15	1.84E-15	1.70E-15
W-181	1.71E-15	1.49E-15	1.27E-15	1.22E-15	9.73E-16	8.62E-16
W-185	2.66E-16	2.58E-16	2.47E-16	2.37E-16	2.24E-16	2.16E-16
W-185m	1.31E-15	1.18E-15	1.07E-15	1.03E-15	8.90E-16	8.41E-16
W-187	2.70E-14	2.55E-14	2.41E-14	2.29E-14	2.10E-14	2.00E-14
W-188	2.89E-16	2.75E-16	2.59E-16	2.48E-16	2.30E-16	2.22E-16
W-190	8.77E-15	7.96E-15	7.23E-15	6.96E-15	6.03E-15	5.69E-15
<b>Rhenium</b>						
Re-178	1.05E-13	1.00E-13	9.55E-14	9.15E-14	8.54E-14	8.21E-14
Re-179	6.37E-14	6.02E-14	5.68E-14	5.42E-14	5.00E-14	4.79E-14
Re-180	7.09E-14	6.78E-14	6.39E-14	6.09E-14	5.61E-14	5.36E-14
Re-181	4.65E-14	4.38E-14	4.10E-14	3.91E-14	3.57E-14	3.41E-14
Re-182	1.05E-13	9.99E-14	9.38E-14	8.96E-14	8.25E-14	7.90E-14
Re-182m	7.16E-14	6.86E-14	6.47E-14	6.19E-14	5.72E-14	5.47E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	7.87E-15	7.05E-15	6.31E-15	6.04E-15	5.18E-15	4.84E-15
Re-184	5.21E-14	4.97E-14	4.67E-14	4.45E-14	4.09E-14	3.91E-14
Re-184m	2.18E-14	2.05E-14	1.90E-14	1.81E-14	1.65E-14	1.57E-14
Re-186	2.12E-15	1.98E-15	1.85E-15	1.78E-15	1.61E-15	1.54E-15
Re-186m	6.46E-16	5.57E-16	4.76E-16	4.54E-16	3.66E-16	3.28E-16
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	6.59E-15	6.27E-15	5.94E-15	5.69E-15	5.26E-15	5.07E-15
Re-188m	3.28E-15	2.90E-15	2.54E-15	2.44E-15	2.00E-15	1.82E-15
Re-189	4.15E-15	3.87E-15	3.60E-15	3.44E-15	3.15E-15	3.03E-15
Re-190	8.15E-14	7.70E-14	7.27E-14	6.91E-14	6.36E-14	6.09E-14
Re-190m	5.57E-14	5.24E-14	4.94E-14	4.70E-14	4.31E-14	4.13E-14
<b>Osmium</b>						
Os-180	6.40E-15	5.88E-15	5.36E-15	5.13E-15	4.49E-15	4.19E-15
Os-181	8.15E-14	7.76E-14	7.32E-14	6.99E-14	6.46E-14	6.18E-14
Os-182	2.46E-14	2.28E-14	2.13E-14	2.03E-14	1.84E-14	1.75E-14
Os-183	3.58E-14	3.33E-14	3.10E-14	2.95E-14	2.67E-14	2.54E-14
Os-183m	5.93E-14	5.70E-14	5.38E-14	5.13E-14	4.75E-14	4.55E-14
Os-185	4.02E-14	3.81E-14	3.59E-14	3.42E-14	3.13E-14	2.99E-14
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	8.67E-19	4.58E-19	3.90E-19	3.63E-19	1.03E-19	8.95E-20
Os-190m	9.37E-14	8.79E-14	8.30E-14	7.89E-14	7.23E-14	6.92E-14
Os-191	4.23E-15	3.78E-15	3.40E-15	3.27E-15	2.77E-15	2.58E-15
Os-191m	2.62E-16	2.31E-16	1.99E-16	1.93E-16	1.53E-16	1.35E-16
Os-193	4.90E-15	4.58E-15	4.30E-15	4.11E-15	3.73E-15	3.57E-15
Os-194	9.56E-17	7.84E-17	6.57E-17	6.02E-17	4.86E-17	4.41E-17
Os-196	5.77E-15	5.40E-15	5.05E-15	4.82E-15	4.40E-15	4.21E-15
<b>Iridium</b>						
Ir-180	1.00E-13	9.46E-14	8.94E-14	8.51E-14	7.82E-14	7.49E-14
Ir-182	8.81E-14	8.33E-14	7.86E-14	7.49E-14	6.89E-14	6.60E-14
Ir-183	7.03E-14	6.70E-14	6.34E-14	6.06E-14	5.62E-14	5.38E-14
Ir-184	1.17E-13	1.11E-13	1.05E-13	1.01E-13	9.30E-14	8.92E-14
Ir-185	5.02E-14	4.78E-14	4.53E-14	4.34E-14	4.03E-14	3.86E-14
Ir-186	9.87E-14	9.37E-14	8.86E-14	8.46E-14	7.82E-14	7.50E-14
Ir-186m	7.45E-14	7.12E-14	6.75E-14	6.45E-14	5.98E-14	5.73E-14
Ir-187	1.86E-14	1.75E-14	1.63E-14	1.56E-14	1.41E-14	1.34E-14
Ir-188	1.26E-13	1.21E-13	1.15E-13	1.11E-13	1.04E-13	9.99E-14
Ir-189	3.75E-15	3.37E-15	2.97E-15	2.86E-15	2.40E-15	2.19E-15
Ir-190	8.65E-14	8.12E-14	7.65E-14	7.28E-14	6.66E-14	6.37E-14
Ir-190m	9.24E-19	5.12E-19	4.27E-19	3.95E-19	1.15E-19	1.00E-19
Ir-190n	2.60E-15	2.31E-15	2.01E-15	1.95E-15	1.58E-15	1.42E-15
Ir-191m	3.78E-15	3.38E-15	3.04E-15	2.92E-15	2.47E-15	2.30E-15
Ir-192	4.87E-14	4.54E-14	4.26E-14	4.05E-14	3.71E-14	3.56E-14
Ir-192m	6.48E-18	4.84E-18	4.27E-18	4.02E-18	2.79E-18	2.61E-18
Ir-192n	8.09E-17	7.50E-17	7.13E-17	7.03E-17	6.43E-17	6.26E-17
Ir-193m	1.55E-17	1.35E-17	1.17E-17	1.13E-17	8.85E-18	7.86E-18
Ir-194	8.66E-15	8.26E-15	7.81E-15	7.47E-15	6.95E-15	6.68E-15

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	1.38E-13	1.30E-13	1.23E-13	1.17E-13	1.07E-13	1.02E-13
Ir-195	3.84E-15	3.51E-15	3.18E-15	3.06E-15	2.64E-15	2.46E-15
Ir-195m	2.23E-14	2.08E-14	1.95E-14	1.85E-14	1.69E-14	1.61E-14
Ir-196	1.90E-14	1.81E-14	1.72E-14	1.64E-14	1.52E-14	1.46E-14
Ir-196m	1.46E-13	1.38E-13	1.30E-13	1.24E-13	1.14E-13	1.09E-13
<b>Platinum</b>						
Pt-184	4.08E-14	3.79E-14	3.52E-14	3.36E-14	3.01E-14	2.86E-14
Pt-186	3.95E-14	3.72E-14	3.50E-14	3.33E-14	3.04E-14	2.90E-14
Pt-187	3.55E-14	3.33E-14	3.11E-14	2.96E-14	2.69E-14	2.56E-14
Pt-188	1.11E-14	1.01E-14	9.23E-15	8.85E-15	7.78E-15	7.34E-15
Pt-189	2.74E-14	2.57E-14	2.40E-14	2.29E-14	2.07E-14	1.96E-14
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	1.60E-14	1.48E-14	1.36E-14	1.30E-14	1.15E-14	1.09E-14
Pt-193	2.17E-18	1.24E-18	1.02E-18	9.40E-19	2.83E-19	2.46E-19
Pt-193m	5.09E-16	4.57E-16	3.99E-16	3.90E-16	3.15E-16	2.83E-16
Pt-195m	3.49E-15	3.11E-15	2.74E-15	2.64E-15	2.16E-15	1.97E-15
Pt-197	1.74E-15	1.60E-15	1.46E-15	1.41E-15	1.24E-15	1.16E-15
Pt-197m	4.43E-15	4.07E-15	3.71E-15	3.57E-15	3.13E-15	2.94E-15
Pt-199	1.36E-14	1.29E-14	1.22E-14	1.16E-14	1.07E-14	1.02E-14
Pt-200	3.52E-15	3.22E-15	2.93E-15	2.81E-15	2.46E-15	2.31E-15
Pt-202	2.47E-15	2.40E-15	2.29E-15	2.21E-15	2.08E-15	2.02E-15
<b>Gold</b>						
Au-186	9.39E-14	8.89E-14	8.40E-14	8.01E-14	7.39E-14	7.08E-14
Au-187	6.33E-14	6.05E-14	5.73E-14	5.49E-14	5.10E-14	4.88E-14
Au-190	1.45E-13	1.38E-13	1.32E-13	1.27E-13	1.19E-13	1.15E-13
Au-191	3.41E-14	3.19E-14	2.98E-14	2.84E-14	2.58E-14	2.45E-14
Au-192	1.17E-13	1.12E-13	1.06E-13	1.02E-13	9.54E-14	9.18E-14
Au-193	8.84E-15	8.06E-15	7.30E-15	7.01E-15	6.09E-15	5.70E-15
Au-193m	1.14E-14	1.05E-14	9.67E-15	9.21E-15	8.37E-15	8.01E-15
Au-194	6.15E-14	5.86E-14	5.54E-14	5.30E-14	4.92E-14	4.72E-14
Au-195	3.84E-15	3.42E-15	2.99E-15	2.89E-15	2.34E-15	2.11E-15
Au-195m	1.16E-14	1.07E-14	9.84E-15	9.37E-15	8.52E-15	8.15E-15
Au-196	2.73E-14	2.53E-14	2.36E-14	2.24E-14	2.03E-14	1.94E-14
Au-196m	1.34E-14	1.22E-14	1.12E-14	1.07E-14	9.42E-15	8.96E-15
Au-198	2.47E-14	2.32E-14	2.19E-14	2.08E-14	1.91E-14	1.83E-14
Au-198m	3.06E-14	2.79E-14	2.56E-14	2.44E-14	2.19E-14	2.09E-14
Au-199	5.60E-15	5.11E-15	4.72E-15	4.53E-15	4.02E-15	3.86E-15
Au-200	1.92E-14	1.84E-14	1.75E-14	1.67E-14	1.56E-14	1.50E-14
Au-200m	1.18E-13	1.11E-13	1.04E-13	9.92E-14	9.10E-14	8.71E-14
Au-201	3.39E-15	3.23E-15	3.07E-15	2.93E-15	2.72E-15	2.61E-15
Au-202	1.50E-14	1.44E-14	1.37E-14	1.31E-14	1.22E-14	1.17E-14
<b>Mercury</b>						
Hg-190	1.08E-14	9.78E-15	8.92E-15	8.59E-15	7.42E-15	7.02E-15
Hg-191m	8.78E-14	8.31E-14	7.83E-14	7.47E-14	6.89E-14	6.59E-14
Hg-192	1.51E-14	1.39E-14	1.27E-14	1.21E-14	1.07E-14	1.02E-14
Hg-193	4.90E-14	4.67E-14	4.41E-14	4.21E-14	3.89E-14	3.72E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	6.03E-14	5.74E-14	5.42E-14	5.18E-14	4.78E-14	4.57E-14
Hg-194	3.01E-18	1.87E-18	1.49E-18	1.36E-18	4.43E-19	3.88E-19
Hg-195	1.09E-14	1.02E-14	9.48E-15	9.08E-15	8.11E-15	7.64E-15
Hg-195m	1.13E-14	1.05E-14	9.69E-15	9.25E-15	8.33E-15	7.92E-15
Hg-197	3.35E-15	3.00E-15	2.61E-15	2.55E-15	2.05E-15	1.83E-15
Hg-197m	5.23E-15	4.73E-15	4.33E-15	4.15E-15	3.62E-15	3.44E-15
Hg-199m	1.03E-14	9.43E-15	8.70E-15	8.36E-15	7.38E-15	7.03E-15
Hg-203	1.41E-14	1.30E-14	1.21E-14	1.15E-14	1.05E-14	1.01E-14
Hg-205	2.23E-15	2.15E-15	2.05E-15	1.97E-15	1.85E-15	1.78E-15
Hg-206	8.41E-15	7.86E-15	7.34E-15	7.00E-15	6.43E-15	6.16E-15
Hg-207	1.63E-13	1.56E-13	1.49E-13	1.43E-13	1.33E-13	1.28E-13
<b>Thallium</b>						
Tl-190	8.51E-14	8.04E-14	7.62E-14	7.26E-14	6.69E-14	6.40E-14
Tl-190m	1.49E-13	1.41E-13	1.33E-13	1.27E-13	1.17E-13	1.12E-13
Tl-194	5.64E-14	5.32E-14	5.03E-14	4.78E-14	4.39E-14	4.19E-14
Tl-194m	1.49E-13	1.41E-13	1.34E-13	1.27E-13	1.17E-13	1.12E-13
Tl-195	7.26E-14	6.96E-14	6.61E-14	6.33E-14	5.89E-14	5.65E-14
Tl-196	1.12E-13	1.07E-13	1.02E-13	9.76E-14	9.08E-14	8.72E-14
Tl-197	2.64E-14	2.49E-14	2.34E-14	2.23E-14	2.04E-14	1.94E-14
Tl-198	1.20E-13	1.15E-13	1.09E-13	1.05E-13	9.76E-14	9.37E-14
Tl-198m	7.12E-14	6.69E-14	6.31E-14	6.00E-14	5.49E-14	5.24E-14
Tl-199	1.40E-14	1.29E-14	1.19E-14	1.14E-14	1.02E-14	9.62E-15
Tl-200	7.73E-14	7.36E-14	6.95E-14	6.64E-14	6.13E-14	5.87E-14
Tl-201	4.55E-15	4.09E-15	3.63E-15	3.52E-15	2.92E-15	2.67E-15
Tl-202	2.67E-14	2.49E-14	2.34E-14	2.23E-14	2.02E-14	1.92E-14
Tl-204	7.19E-16	6.94E-16	6.60E-16	6.36E-16	5.94E-16	5.72E-16
Tl-206	1.93E-15	1.88E-15	1.79E-15	1.73E-15	1.63E-15	1.58E-15
Tl-206m	1.43E-13	1.36E-13	1.28E-13	1.22E-13	1.12E-13	1.07E-13
Tl-207	1.87E-15	1.81E-15	1.73E-15	1.66E-15	1.57E-15	1.52E-15
Tl-208	2.07E-13	2.00E-13	1.92E-13	1.84E-13	1.74E-13	1.68E-13
Tl-209	1.31E-13	1.25E-13	1.19E-13	1.14E-13	1.06E-13	1.02E-13
Tl-210	1.71E-13	1.65E-13	1.56E-13	1.49E-13	1.40E-13	1.34E-13
<b>Lead</b>						
Pb-194	6.37E-14	6.06E-14	5.72E-14	5.47E-14	5.05E-14	4.83E-14
Pb-195m	9.77E-14	9.24E-14	8.71E-14	8.30E-14	7.62E-14	7.28E-14
Pb-196	2.83E-14	2.63E-14	2.45E-14	2.34E-14	2.11E-14	2.01E-14
Pb-197	9.11E-14	8.71E-14	8.26E-14	7.90E-14	7.33E-14	7.03E-14
Pb-197m	6.88E-14	6.49E-14	6.11E-14	5.82E-14	5.34E-14	5.10E-14
Pb-198	2.50E-14	2.32E-14	2.16E-14	2.06E-14	1.86E-14	1.77E-14
Pb-199	6.15E-14	5.86E-14	5.54E-14	5.30E-14	4.91E-14	4.70E-14
Pb-200	1.13E-14	1.03E-14	9.36E-15	9.00E-15	7.84E-15	7.40E-15
Pb-201	4.41E-14	4.15E-14	3.89E-14	3.71E-14	3.39E-14	3.24E-14
Pb-201m	2.15E-14	2.03E-14	1.92E-14	1.83E-14	1.68E-14	1.60E-14
Pb-202	3.91E-18	2.12E-18	1.78E-18	1.65E-18	4.83E-19	4.19E-19
Pb-202m	1.18E-13	1.13E-13	1.06E-13	1.01E-13	9.35E-14	8.95E-14
Pb-203	1.78E-14	1.64E-14	1.51E-14	1.44E-14	1.29E-14	1.23E-14



**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	1.23E-13	1.17E-13	1.11E-13	1.05E-13	9.75E-14	9.33E-14
Pb-205	3.96E-18	2.14E-18	1.81E-18	1.67E-18	4.90E-19	4.25E-19
Pb-209	5.04E-16	4.90E-16	4.68E-16	4.51E-16	4.25E-16	4.12E-16
Pb-210	8.57E-17	6.97E-17	5.80E-17	5.31E-17	4.17E-17	3.75E-17
Pb-211	5.35E-15	5.11E-15	4.84E-15	4.62E-15	4.29E-15	4.12E-15
Pb-212	8.52E-15	7.82E-15	7.17E-15	6.84E-15	6.16E-15	5.87E-15
Pb-214	1.54E-14	1.43E-14	1.33E-14	1.27E-14	1.16E-14	1.11E-14
<b>Bismuth</b>						
Bi-197	1.02E-13	9.73E-14	9.21E-14	8.79E-14	8.14E-14	7.80E-14
Bi-200	1.44E-13	1.37E-13	1.29E-13	1.23E-13	1.13E-13	1.08E-13
Bi-201	1.03E-13	9.89E-14	9.38E-14	8.97E-14	8.34E-14	8.00E-14
Bi-202	1.64E-13	1.56E-13	1.48E-13	1.41E-13	1.30E-13	1.25E-13
Bi-203	1.42E-13	1.37E-13	1.30E-13	1.24E-13	1.16E-13	1.11E-13
Bi-204	1.73E-13	1.66E-13	1.57E-13	1.50E-13	1.38E-13	1.33E-13
Bi-205	1.01E-13	9.68E-14	9.20E-14	8.81E-14	8.21E-14	7.88E-14
Bi-206	1.94E-13	1.86E-13	1.76E-13	1.68E-13	1.55E-13	1.49E-13
Bi-207	9.08E-14	8.68E-14	8.21E-14	7.83E-14	7.23E-14	6.92E-14
Bi-208	1.63E-13	1.57E-13	1.51E-13	1.46E-13	1.39E-13	1.34E-13
Bi-210	1.26E-15	1.22E-15	1.17E-15	1.13E-15	1.06E-15	1.03E-15
Bi-210m	1.54E-14	1.43E-14	1.32E-14	1.26E-14	1.15E-14	1.10E-14
Bi-211	2.78E-15	2.58E-15	2.42E-15	2.30E-15	2.10E-15	2.01E-15
Bi-212	8.10E-15	7.78E-15	7.40E-15	7.07E-15	6.59E-15	6.33E-15
Bi-212n	1.91E-15	1.85E-15	1.77E-15	1.71E-15	1.61E-15	1.56E-15
Bi-213	8.96E-15	8.44E-15	7.99E-15	7.61E-15	7.00E-15	6.71E-15
Bi-214	9.14E-14	8.79E-14	8.38E-14	8.02E-14	7.50E-14	7.21E-14
Bi-215	1.73E-14	1.63E-14	1.53E-14	1.46E-14	1.35E-14	1.29E-14
Bi-216	4.97E-14	4.69E-14	4.45E-14	4.23E-14	3.90E-14	3.74E-14
<b>Polonium</b>						
Po-203	9.71E-14	9.30E-14	8.79E-14	8.39E-14	7.77E-14	7.45E-14
Po-204	6.76E-14	6.41E-14	6.02E-14	5.74E-14	5.25E-14	5.01E-14
Po-205	9.38E-14	8.99E-14	8.50E-14	8.12E-14	7.51E-14	7.19E-14
Po-206	6.98E-14	6.63E-14	6.24E-14	5.94E-14	5.46E-14	5.22E-14
Po-207	7.57E-14	7.25E-14	6.84E-14	6.52E-14	6.02E-14	5.76E-14
Po-208	1.24E-18	1.17E-18	1.10E-18	1.04E-18	9.55E-19	9.11E-19
Po-209	3.62E-16	3.44E-16	3.22E-16	3.06E-16	2.81E-16	2.69E-16
Po-210	5.77E-19	5.53E-19	5.23E-19	4.98E-19	4.60E-19	4.40E-19
Po-211	4.85E-16	4.63E-16	4.38E-16	4.17E-16	3.85E-16	3.68E-16
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	4.85E-15	4.68E-15	4.51E-15	4.34E-15	4.11E-15	3.96E-15
Po-213	2.22E-18	2.13E-18	2.01E-18	1.92E-18	1.77E-18	1.69E-18
Po-214	4.93E-18	4.72E-18	4.46E-18	4.25E-18	3.92E-18	3.75E-18
Po-215	1.04E-17	9.74E-18	9.22E-18	8.75E-18	8.02E-18	7.67E-18
Po-216	9.09E-19	8.71E-19	8.23E-19	7.83E-19	7.24E-19	6.93E-19
Po-218	2.06E-20	2.00E-20	1.90E-20	1.83E-20	1.71E-20	1.65E-20
<b>Astatine</b>						
At-204	1.39E-13	1.31E-13	1.24E-13	1.18E-13	1.08E-13	1.04E-13

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	6.84E-14	6.50E-14	6.15E-14	5.87E-14	5.41E-14	5.18E-14
At-206	1.48E-13	1.40E-13	1.33E-13	1.26E-13	1.17E-13	1.12E-13
At-207	1.20E-13	1.14E-13	1.08E-13	1.04E-13	9.61E-14	9.21E-14
At-208	1.80E-13	1.72E-13	1.63E-13	1.56E-13	1.44E-13	1.38E-13
At-209	1.35E-13	1.28E-13	1.21E-13	1.15E-13	1.06E-13	1.01E-13
At-210	1.77E-13	1.70E-13	1.61E-13	1.54E-13	1.44E-13	1.38E-13
At-211	1.80E-15	1.61E-15	1.44E-15	1.38E-15	1.15E-15	1.06E-15
At-215	1.01E-17	9.42E-18	8.87E-18	8.43E-18	7.70E-18	7.37E-18
At-216	1.33E-16	1.20E-16	1.09E-16	1.04E-16	8.99E-17	8.41E-17
At-217	1.43E-17	1.32E-17	1.23E-17	1.17E-17	1.06E-17	1.01E-17
At-218	4.83E-18	4.69E-18	4.48E-18	4.32E-18	4.07E-18	3.94E-18
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	3.20E-14	3.00E-14	2.81E-14	2.68E-14	2.46E-14	2.37E-14
<b>Radon</b>						
Rn-207	5.87E-14	5.55E-14	5.23E-14	4.98E-14	4.57E-14	4.37E-14
Rn-209	7.10E-14	6.74E-14	6.38E-14	6.09E-14	5.62E-14	5.39E-14
Rn-210	3.56E-15	3.37E-15	3.17E-15	3.02E-15	2.77E-15	2.65E-15
Rn-211	1.11E-13	1.06E-13	1.01E-13	9.59E-14	8.88E-14	8.51E-14
Rn-212	2.00E-17	1.91E-17	1.81E-17	1.72E-17	1.58E-17	1.51E-17
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	4.48E-17	4.24E-17	4.02E-17	3.82E-17	3.51E-17	3.36E-17
Rn-219	3.46E-15	3.21E-15	3.00E-15	2.85E-15	2.61E-15	2.50E-15
Rn-220	3.71E-17	3.50E-17	3.32E-17	3.16E-17	2.90E-17	2.77E-17
Rn-222	2.30E-17	2.16E-17	2.05E-17	1.95E-17	1.79E-17	1.71E-17
Rn-223	2.20E-14	2.08E-14	1.97E-14	1.87E-14	1.72E-14	1.65E-14
<b>Francium</b>						
Fr-212	6.78E-14	6.48E-14	6.12E-14	5.84E-14	5.41E-14	5.19E-14
Fr-219	2.10E-16	1.96E-16	1.84E-16	1.75E-16	1.60E-16	1.53E-16
Fr-220	5.05E-16	4.52E-16	4.09E-16	3.91E-16	3.36E-16	3.16E-16
Fr-221	1.72E-15	1.58E-15	1.45E-15	1.38E-15	1.25E-15	1.20E-15
Fr-222	1.28E-14	1.20E-14	1.11E-14	1.06E-14	9.76E-15	9.40E-15
Fr-223	3.86E-15	3.54E-15	3.24E-15	3.09E-15	2.76E-15	2.62E-15
Fr-224	3.63E-14	3.46E-14	3.28E-14	3.13E-14	2.91E-14	2.80E-14
Fr-227	2.89E-14	2.70E-14	2.54E-14	2.42E-14	2.21E-14	2.11E-14
<b>Radium</b>						
Ra-219	9.97E-15	9.23E-15	8.59E-15	8.17E-15	7.45E-15	7.12E-15
Ra-220	2.76E-16	2.59E-16	2.45E-16	2.33E-16	2.13E-16	2.04E-16
Ra-221	2.06E-15	1.86E-15	1.72E-15	1.64E-15	1.45E-15	1.39E-15
Ra-222	5.45E-16	5.05E-16	4.71E-16	4.48E-16	4.10E-16	3.93E-16
Ra-223	7.94E-15	7.25E-15	6.67E-15	6.36E-15	5.67E-15	5.40E-15
Ra-224	6.15E-16	5.66E-16	5.22E-16	4.97E-16	4.53E-16	4.36E-16
Ra-225	5.64E-16	4.76E-16	4.11E-16	3.82E-16	3.22E-16	3.00E-16
Ra-226	4.31E-16	3.94E-16	3.63E-16	3.46E-16	3.12E-16	3.00E-16
Ra-227	9.54E-15	8.89E-15	8.34E-15	7.93E-15	7.27E-15	6.97E-15

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	1.15E-17	8.08E-18	6.71E-18	5.92E-18	3.02E-18	2.71E-18
Ra-230	4.91E-15	4.53E-15	4.22E-15	4.02E-15	3.62E-15	3.45E-15
<b>Actinium</b>						
Ac-223	1.00E-15	9.20E-16	8.53E-16	8.11E-16	7.30E-16	6.98E-16
Ac-224	1.31E-14	1.19E-14	1.09E-14	1.04E-14	9.23E-15	8.85E-15
Ac-225	8.06E-16	7.25E-16	6.66E-16	6.33E-16	5.57E-16	5.32E-16
Ac-226	8.42E-15	7.74E-15	7.16E-15	6.83E-15	6.20E-15	5.96E-15
Ac-227	8.16E-18	6.77E-18	6.04E-18	5.64E-18	4.49E-18	4.22E-18
Ac-228	5.26E-14	5.04E-14	4.77E-14	4.55E-14	4.22E-14	4.04E-14
Ac-230	3.63E-14	3.49E-14	3.33E-14	3.19E-14	2.99E-14	2.87E-14
Ac-231	2.65E-14	2.45E-14	2.28E-14	2.17E-14	1.98E-14	1.90E-14
Ac-232	7.33E-14	7.06E-14	6.75E-14	6.47E-14	6.08E-14	5.85E-14
Ac-233	3.28E-14	3.09E-14	2.94E-14	2.80E-14	2.58E-14	2.47E-14
<b>Thorium</b>						
Th-223	4.00E-15	3.57E-15	3.26E-15	3.09E-15	2.69E-15	2.56E-15
Th-224	1.35E-15	1.23E-15	1.14E-15	1.09E-15	9.83E-16	9.47E-16
Th-226	4.59E-16	4.12E-16	3.80E-16	3.59E-16	3.20E-16	3.09E-16
Th-227	7.19E-15	6.59E-15	6.08E-15	5.77E-15	5.24E-15	5.01E-15
Th-228	1.20E-16	1.07E-16	9.65E-17	9.20E-17	7.92E-17	7.49E-17
Th-229	4.78E-15	4.27E-15	3.89E-15	3.69E-15	3.22E-15	3.07E-15
Th-230	2.43E-17	2.08E-17	1.83E-17	1.75E-17	1.37E-17	1.25E-17
Th-231	8.09E-16	7.07E-16	6.38E-16	6.06E-16	5.12E-16	4.79E-16
Th-232	1.40E-17	1.16E-17	9.91E-18	9.40E-18	6.88E-18	6.19E-18
Th-233	3.34E-15	3.16E-15	2.99E-15	2.86E-15	2.64E-15	2.53E-15
Th-234	5.16E-16	4.58E-16	4.12E-16	3.91E-16	3.33E-16	3.11E-16
Th-235	5.71E-15	5.47E-15	5.20E-15	4.97E-15	4.63E-15	4.45E-15
Th-236	3.08E-15	2.90E-15	2.74E-15	2.61E-15	2.41E-15	2.32E-15
<b>Protactinium</b>						
Pa-227	1.06E-15	9.33E-16	8.40E-16	7.95E-16	6.77E-16	6.36E-16
Pa-228	8.06E-14	7.67E-14	7.25E-14	6.91E-14	6.39E-14	6.13E-14
Pa-229	3.45E-15	3.04E-15	2.78E-15	2.61E-15	2.27E-15	2.17E-15
Pa-230	3.92E-14	3.73E-14	3.52E-14	3.34E-14	3.08E-14	2.95E-14
Pa-231	2.02E-15	1.84E-15	1.70E-15	1.62E-15	1.46E-15	1.40E-15
Pa-232	5.55E-14	5.31E-14	5.02E-14	4.78E-14	4.41E-14	4.22E-14
Pa-233	1.28E-14	1.18E-14	1.09E-14	1.04E-14	9.44E-15	9.06E-15
Pa-234	8.71E-14	8.30E-14	7.85E-14	7.47E-14	6.90E-14	6.62E-14
Pa-234m	4.25E-15	4.12E-15	3.93E-15	3.77E-15	3.55E-15	3.42E-15
Pa-235	1.64E-15	1.59E-15	1.52E-15	1.47E-15	1.39E-15	1.34E-15
Pa-236	5.74E-14	5.50E-14	5.24E-14	5.01E-14	4.68E-14	4.49E-14
Pa-237	3.82E-14	3.65E-14	3.46E-14	3.29E-14	3.04E-14	2.91E-14
<b>Uranium</b>						
U-227	6.76E-15	6.15E-15	5.67E-15	5.37E-15	4.84E-15	4.65E-15
U-228	2.31E-16	2.06E-16	1.89E-16	1.78E-16	1.57E-16	1.50E-16
U-230	6.82E-17	6.00E-17	5.40E-17	5.16E-17	4.31E-17	4.04E-17
U-231	3.98E-15	3.49E-15	3.18E-15	2.99E-15	2.59E-15	2.47E-15
U-232	2.03E-17	1.63E-17	1.43E-17	1.33E-17	9.92E-18	9.20E-18

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	1.75E-17	1.48E-17	1.33E-17	1.24E-17	1.02E-17	9.70E-18
U-234	1.34E-17	1.03E-17	8.85E-18	8.06E-18	5.59E-18	5.15E-18
U-235	9.57E-15	8.72E-15	8.05E-15	7.68E-15	6.91E-15	6.67E-15
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	9.60E-18	7.01E-18	5.96E-18	5.34E-18	3.38E-18	3.08E-18
U-237	7.65E-15	6.86E-15	6.26E-15	5.93E-15	5.24E-15	5.01E-15
U-238	7.88E-18	5.82E-18	4.98E-18	4.48E-18	2.90E-18	2.65E-18
U-239	3.81E-15	3.55E-15	3.24E-15	3.13E-15	2.74E-15	2.56E-15
U-240	4.52E-16	4.10E-16	3.81E-16	3.60E-16	3.23E-16	3.11E-16
U-242	3.53E-15	3.33E-15	3.13E-15	2.99E-15	2.74E-15	2.61E-15
<b>Neptunium</b>						
Np-232	7.03E-14	6.67E-14	6.28E-14	5.97E-14	5.50E-14	5.27E-14
Np-233	4.95E-15	4.40E-15	4.05E-15	3.79E-15	3.35E-15	3.23E-15
Np-234	6.60E-14	6.34E-14	6.03E-14	5.77E-14	5.39E-14	5.18E-14
Np-235	5.69E-17	4.45E-17	3.94E-17	3.60E-17	2.69E-17	2.53E-17
Np-236	8.07E-15	7.20E-15	6.65E-15	6.29E-15	5.56E-15	5.37E-15
Np-236m	2.89E-15	2.59E-15	2.40E-15	2.25E-15	2.01E-15	1.93E-15
Np-237	1.29E-15	1.13E-15	1.02E-15	9.61E-16	8.17E-16	7.70E-16
Np-238	3.53E-14	3.40E-14	3.22E-14	3.07E-14	2.85E-14	2.73E-14
Np-239	1.06E-14	9.57E-15	8.85E-15	8.36E-15	7.53E-15	7.26E-15
Np-240	6.26E-14	5.96E-14	5.63E-14	5.36E-14	4.94E-14	4.73E-14
Np-240m	2.13E-14	2.03E-14	1.93E-14	1.84E-14	1.70E-14	1.63E-14
Np-241	3.52E-15	3.26E-15	3.06E-15	2.91E-15	2.66E-15	2.57E-15
Np-242	1.97E-14	1.89E-14	1.81E-14	1.73E-14	1.62E-14	1.56E-14
Np-242m	5.56E-14	5.31E-14	5.02E-14	4.78E-14	4.41E-14	4.23E-14
<b>Plutonium</b>						
Pu-232	3.43E-15	3.02E-15	2.78E-15	2.60E-15	2.29E-15	2.22E-15
Pu-234	3.71E-15	3.27E-15	3.01E-15	2.82E-15	2.48E-15	2.39E-15
Pu-235	5.07E-15	4.51E-15	4.16E-15	3.90E-15	3.45E-15	3.32E-15
Pu-236	1.19E-17	8.31E-18	7.10E-18	6.27E-18	3.76E-18	3.38E-18
Pu-237	2.66E-15	2.34E-15	2.15E-15	2.01E-15	1.77E-15	1.70E-15
Pu-238	1.00E-17	6.83E-18	5.80E-18	5.08E-18	2.87E-18	2.55E-18
Pu-239	7.55E-18	5.89E-18	5.21E-18	4.76E-18	3.54E-18	3.30E-18
Pu-240	9.65E-18	6.60E-18	5.62E-18	4.93E-18	2.82E-18	2.52E-18
Pu-241	1.57E-19	1.44E-19	1.34E-19	1.27E-19	1.14E-19	1.10E-19
Pu-242	1.29E-17	1.01E-17	9.09E-18	8.33E-18	6.28E-18	5.87E-18
Pu-243	1.65E-15	1.50E-15	1.37E-15	1.31E-15	1.14E-15	1.08E-15
Pu-244	1.26E-15	1.21E-15	1.16E-15	1.11E-15	1.04E-15	9.98E-16
Pu-245	2.44E-14	2.30E-14	2.17E-14	2.06E-14	1.90E-14	1.82E-14
Pu-246	7.79E-15	7.01E-15	6.43E-15	6.08E-15	5.44E-15	5.24E-15
<b>Americium</b>						
Am-237	2.14E-14	1.97E-14	1.83E-14	1.74E-14	1.58E-14	1.52E-14
Am-238	5.31E-14	5.07E-14	4.79E-14	4.56E-14	4.21E-14	4.04E-14
Am-239	1.34E-14	1.21E-14	1.11E-14	1.05E-14	9.39E-15	9.06E-15
Am-240	6.08E-14	5.82E-14	5.50E-14	5.23E-14	4.84E-14	4.64E-14
Am-241	1.01E-15	8.75E-16	7.44E-16	7.14E-16	5.65E-16	5.00E-16

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	1.20E-15	1.09E-15	1.02E-15	9.62E-16	8.67E-16	8.38E-16
Am-242m	4.38E-17	3.18E-17	2.80E-17	2.51E-17	1.75E-17	1.60E-17
Am-243	2.70E-15	2.41E-15	2.11E-15	2.05E-15	1.65E-15	1.48E-15
Am-244	4.69E-14	4.48E-14	4.23E-14	4.03E-14	3.71E-14	3.56E-14
Am-244m	2.63E-15	2.54E-15	2.42E-15	2.32E-15	2.18E-15	2.10E-15
Am-245	2.57E-15	2.38E-15	2.22E-15	2.11E-15	1.93E-15	1.87E-15
Am-246	4.42E-14	4.18E-14	3.94E-14	3.75E-14	3.45E-14	3.30E-14
Am-246m	5.97E-14	5.75E-14	5.44E-14	5.19E-14	4.82E-14	4.62E-14
Am-247	9.32E-15	8.57E-15	7.99E-15	7.58E-15	6.91E-15	6.67E-15
<b>Curium</b>						
Cm-238	4.50E-15	3.98E-15	3.68E-15	3.45E-15	3.05E-15	2.95E-15
Cm-239	1.48E-14	1.34E-14	1.24E-14	1.17E-14	1.05E-14	1.02E-14
Cm-240	1.27E-17	8.55E-18	7.37E-18	6.45E-18	3.83E-18	3.41E-18
Cm-241	2.88E-14	2.67E-14	2.52E-14	2.39E-14	2.17E-14	2.08E-14
Cm-242	1.11E-17	7.44E-18	6.40E-18	5.59E-18	3.26E-18	2.89E-18
Cm-243	7.51E-15	6.80E-15	6.28E-15	5.94E-15	5.35E-15	5.16E-15
Cm-244	1.04E-17	7.19E-18	6.27E-18	5.54E-18	3.50E-18	3.16E-18
Cm-245	5.85E-15	5.20E-15	4.80E-15	4.51E-15	4.00E-15	3.87E-15
Cm-246	2.35E-16	2.23E-16	2.12E-16	2.03E-16	1.89E-16	1.82E-16
Cm-247	1.85E-14	1.73E-14	1.63E-14	1.55E-14	1.42E-14	1.36E-14
Cm-248	8.30E-14	7.98E-14	7.61E-14	7.29E-14	6.84E-14	6.58E-14
Cm-249	1.92E-15	1.83E-15	1.74E-15	1.66E-15	1.55E-15	1.49E-15
Cm-250	8.47E-13	8.14E-13	7.77E-13	7.44E-13	6.98E-13	6.72E-13
Cm-251	7.94E-15	7.51E-15	7.12E-15	6.78E-15	6.25E-15	6.00E-15
<b>Berkelium</b>						
Bk-245	1.32E-14	1.19E-14	1.10E-14	1.04E-14	9.34E-15	9.03E-15
Bk-246	4.99E-14	4.76E-14	4.49E-14	4.27E-14	3.94E-14	3.78E-14
Bk-247	8.36E-15	7.59E-15	6.97E-15	6.62E-15	5.92E-15	5.65E-15
Bk-248m	3.54E-15	3.26E-15	3.07E-15	2.91E-15	2.64E-15	2.55E-15
Bk-249	2.32E-17	2.24E-17	2.12E-17	2.02E-17	1.88E-17	1.80E-17
Bk-250	5.41E-14	5.22E-14	4.93E-14	4.70E-14	4.36E-14	4.18E-14
Bk-251	5.75E-15	5.20E-15	4.84E-15	4.59E-15	4.12E-15	3.99E-15
<b>Californium</b>						
Cf-244	1.24E-17	8.05E-18	6.94E-18	6.04E-18	3.49E-18	3.05E-18
Cf-246	1.12E-17	7.95E-18	7.04E-18	6.31E-18	4.36E-18	3.99E-18
Cf-247	5.23E-15	4.64E-15	4.31E-15	4.05E-15	3.59E-15	3.47E-15
Cf-248	3.15E-17	2.69E-17	2.50E-17	2.34E-17	2.01E-17	1.91E-17
Cf-249	1.92E-14	1.79E-14	1.68E-14	1.59E-14	1.46E-14	1.40E-14
Cf-250	6.24E-16	5.97E-16	5.69E-16	5.45E-16	5.09E-16	4.90E-16
Cf-251	6.88E-15	6.20E-15	5.73E-15	5.43E-15	4.86E-15	4.70E-15
Cf-252	2.87E-14	2.76E-14	2.63E-14	2.52E-14	2.37E-14	2.28E-14
Cf-253	1.48E-16	1.32E-16	1.22E-16	1.16E-16	1.03E-16	9.78E-17
Cf-254	1.07E-12	1.03E-12	9.79E-13	9.38E-13	8.79E-13	8.46E-13
Cf-255	5.79E-16	5.63E-16	5.38E-16	5.18E-16	4.89E-16	4.73E-16
<b>Einsteinium</b>						
Es-249	2.39E-14	2.22E-14	2.09E-14	1.98E-14	1.81E-14	1.73E-14

**Table 4-6. Reference person effective dose rate coefficients for air submersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	6.98E-14	6.57E-14	6.18E-14	5.87E-14	5.38E-14	5.16E-14
Es-250m	3.25E-14	3.09E-14	2.92E-14	2.78E-14	2.56E-14	2.46E-14
Es-251	5.22E-15	4.64E-15	4.30E-15	4.06E-15	3.59E-15	3.48E-15
Es-253	2.22E-17	1.96E-17	1.82E-17	1.71E-17	1.50E-17	1.43E-17
Es-254	2.59E-16	2.08E-16	1.84E-16	1.71E-16	1.33E-16	1.22E-16
Es-254m	2.83E-14	2.69E-14	2.55E-14	2.43E-14	2.23E-14	2.14E-14
Es-255	1.57E-16	1.52E-16	1.45E-16	1.39E-16	1.30E-16	1.26E-16
Es-256	2.10E-15	2.03E-15	1.94E-15	1.87E-15	1.76E-15	1.70E-15
<b>Fermium</b>						
Fm-251	8.83E-15	8.08E-15	7.56E-15	7.16E-15	6.45E-15	6.23E-15
Fm-252	2.79E-17	2.32E-17	2.14E-17	2.00E-17	1.68E-17	1.59E-17
Fm-253	3.38E-15	3.00E-15	2.78E-15	2.63E-15	2.33E-15	2.25E-15
Fm-254	4.50E-16	4.29E-16	4.08E-16	3.91E-16	3.64E-16	3.50E-16
Fm-255	1.82E-16	1.39E-16	1.22E-16	1.12E-16	8.26E-17	7.47E-17
Fm-256	7.81E-13	7.51E-13	7.16E-13	6.86E-13	6.43E-13	6.19E-13
Fm-257	8.39E-15	7.65E-15	7.13E-15	6.77E-15	6.12E-15	5.91E-15

**Table 4-7. Reference person effective dose rate coefficients for water immersion.**

**Explanation of entries**

For each radionuclide, values for the reference person effective dose rate coefficients  $e$ , based on the weighting factors of Table 3-1, are given in SI units. The coefficients are for water at a density of  $1 \times 10^3 \text{ kg m}^{-3}$ . Reference person organ equivalent dose coefficients  $h_T$  are provided electronically.<sup>17</sup>

$e$ : The effective dose rate coefficient ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ), that is, the effective dose per unit time-integrated exposure to a radionuclide

$w_T$ : The tissue weighting factor

$$e = \sum_T w_T h_T$$

where  $h_T$  is the equivalent dose rate coefficient ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) for tissue  $T$ .

The dose rate coefficients provided in Table 4-7 are based on the radiations emitted by the indicated radionuclide and do not include the radiations emitted by radioactive decay products. Radioactive decay products for each radionuclide are identified in Appendix A.

To convert from a source per unit volume ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) to a source per unit mass basis ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ kg}$ ), multiply table entries by  $1 \times 10^3$ .

To convert from SI units ( $\text{Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^3$ ) to conventional units ( $\text{mrem } \mu\text{Ci}^{-1} \text{ y}^{-1} \text{ cm}^3$  or  $\text{mrem } \mu\text{Ci}^{-1} \text{ y}^{-1} \text{ g}$ ), multiply table entries by  $1.168 \times 10^{23}$ .

To derive coefficients for a water density other than  $1 \times 10^3 \text{ kg m}^{-3}$ , multiply coefficients (in any units) by  $(1 \times 10^3/\rho)$ , where  $\rho$  is the water density in  $\text{kg m}^{-3}$ .

<sup>17</sup> <https://www.epa.gov/radiation/federal-guidance-report-no-15-external-exposure-radionuclides-air-water-and-soil>

**Table 4-7. Reference person effective dose rate coefficients for water immersion.**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Hydrogen</b>						
H-3	4.56E-26	2.79E-26	2.39E-26	2.04E-26	6.89E-27	6.15E-27
<b>Beryllium</b>						
Be-7	6.25E-18	5.71E-18	5.25E-18	5.07E-18	4.53E-18	4.46E-18
Be-10	1.64E-19	1.59E-19	1.56E-19	1.55E-19	1.53E-19	1.52E-19
<b>Carbon</b>						
C-10	2.22E-16	2.04E-16	1.88E-16	1.82E-16	1.63E-16	1.61E-16
C-11	1.28E-16	1.18E-16	1.08E-16	1.05E-16	9.37E-17	9.23E-17
C-14	3.18E-21	3.01E-21	2.93E-21	2.91E-21	2.83E-21	2.82E-21
<b>Nitrogen</b>						
N-13	1.29E-16	1.18E-16	1.08E-16	1.05E-16	9.38E-17	9.24E-17
N-16	6.51E-16	6.28E-16	5.90E-16	5.90E-16	5.56E-16	5.53E-16
<b>Oxygen</b>						
O-14	4.50E-16	4.14E-16	3.85E-16	3.77E-16	3.46E-16	3.42E-16
O-15	1.29E-16	1.18E-16	1.09E-16	1.05E-16	9.42E-17	9.28E-17
O-19	1.28E-16	1.17E-16	1.08E-16	1.05E-16	9.57E-17	9.44E-17
<b>Fluorine</b>						
F-17	1.29E-16	1.18E-16	1.09E-16	1.05E-16	9.42E-17	9.28E-17
F-18	1.24E-16	1.14E-16	1.05E-16	1.01E-16	9.07E-17	8.93E-17
<b>Neon</b>						
Ne-19	1.29E-16	1.18E-16	1.09E-16	1.05E-16	9.45E-17	9.31E-17
Ne-24	6.92E-17	6.33E-17	5.83E-17	5.63E-17	5.05E-17	4.97E-17
<b>Sodium</b>						
Na-22	2.86E-16	2.63E-16	2.44E-16	2.38E-16	2.15E-16	2.12E-16
Na-24	5.72E-16	5.29E-16	4.94E-16	4.86E-16	4.50E-16	4.45E-16
<b>Magnesium</b>						
Mg-27	1.17E-16	1.08E-16	1.00E-16	9.80E-17	8.81E-17	8.69E-17
Mg-28	1.80E-16	1.66E-16	1.54E-16	1.50E-16	1.36E-16	1.34E-16
<b>Aluminum</b>						
Al-26	3.59E-16	3.29E-16	3.06E-16	2.99E-16	2.73E-16	2.69E-16
Al-28	2.47E-16	2.26E-16	2.11E-16	2.07E-16	1.91E-16	1.88E-16
Al-29	1.87E-16	1.72E-16	1.61E-16	1.58E-16	1.44E-16	1.42E-16
<b>Silicon</b>						
Si-31	6.90E-19	6.56E-19	6.30E-19	6.22E-19	5.99E-19	5.95E-19
Si-32	1.21E-20	1.17E-20	1.15E-20	1.14E-20	1.13E-20	1.12E-20
<b>Phosphorus</b>						
P-30	1.30E-16	1.19E-16	1.10E-16	1.06E-16	9.54E-17	9.40E-17
P-32	7.10E-19	6.77E-19	6.54E-19	6.46E-19	6.26E-19	6.23E-19
P-33	1.66E-20	1.61E-20	1.58E-20	1.57E-20	1.55E-20	1.55E-20
<b>Sulfur</b>						
S-35	3.70E-21	3.52E-21	3.44E-21	3.42E-21	3.33E-21	3.32E-21
S-37	4.13E-16	3.86E-16	3.61E-16	3.57E-16	3.33E-16	3.30E-16
S-38	2.36E-16	2.16E-16	2.01E-16	1.98E-16	1.83E-16	1.81E-16
<b>Chlorine</b>						
Cl-34	1.32E-16	1.21E-16	1.11E-16	1.08E-16	9.66E-17	9.51E-17
Cl-34m	2.86E-16	2.63E-16	2.45E-16	2.40E-16	2.20E-16	2.17E-16



**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cl-36	2.09E-19	2.02E-19	1.96E-19	1.94E-19	1.90E-19	1.89E-19
Cl-38	2.03E-16	1.86E-16	1.74E-16	1.71E-16	1.58E-16	1.56E-16
Cl-39	1.96E-16	1.79E-16	1.67E-16	1.63E-16	1.49E-16	1.47E-16
Cl-40	5.69E-16	5.28E-16	4.93E-16	4.87E-16	4.51E-16	4.46E-16
<b>Argon</b>						
Ar-37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ar-39	1.35E-19	1.31E-19	1.29E-19	1.28E-19	1.26E-19	1.25E-19
Ar-41	1.73E-16	1.59E-16	1.48E-16	1.45E-16	1.32E-16	1.30E-16
Ar-42	1.49E-19	1.45E-19	1.41E-19	1.41E-19	1.38E-19	1.38E-19
Ar-43	2.09E-16	1.93E-16	1.79E-16	1.76E-16	1.61E-16	1.59E-16
Ar-44	2.65E-16	2.42E-16	2.25E-16	2.21E-16	2.02E-16	2.00E-16
<b>Potassium</b>						
K-38	4.32E-16	3.96E-16	3.68E-16	3.60E-16	3.31E-16	3.27E-16
K-40	2.17E-17	2.00E-17	1.86E-17	1.83E-17	1.67E-17	1.65E-17
K-42	4.01E-17	3.68E-17	3.44E-17	3.37E-17	3.09E-17	3.05E-17
K-43	1.22E-16	1.11E-16	1.03E-16	9.92E-17	8.87E-17	8.74E-17
K-44	3.28E-16	3.03E-16	2.83E-16	2.78E-16	2.56E-16	2.53E-16
K-45	2.52E-16	2.31E-16	2.15E-16	2.10E-16	1.93E-16	1.91E-16
K-46	4.00E-16	3.72E-16	3.47E-16	3.43E-16	3.16E-16	3.13E-16
<b>Calcium</b>						
Ca-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca-45	1.75E-20	1.70E-20	1.67E-20	1.66E-20	1.64E-20	1.63E-20
Ca-47	1.41E-16	1.30E-16	1.21E-16	1.18E-16	1.08E-16	1.06E-16
Ca-49	4.47E-16	4.17E-16	3.90E-16	3.86E-16	3.60E-16	3.57E-16
<b>Scandium</b>						
Sc-42m	5.56E-16	5.10E-16	4.73E-16	4.61E-16	4.18E-16	4.13E-16
Sc-43	1.24E-16	1.13E-16	1.04E-16	1.01E-16	9.02E-17	8.89E-17
Sc-44	2.78E-16	2.55E-16	2.36E-16	2.30E-16	2.08E-16	2.05E-16
Sc-44m	3.50E-17	3.11E-17	2.84E-17	2.72E-17	2.41E-17	2.38E-17
Sc-46	2.64E-16	2.44E-16	2.27E-16	2.22E-16	2.00E-16	1.98E-16
Sc-47	1.37E-17	1.20E-17	1.09E-17	1.03E-17	8.98E-18	8.82E-18
Sc-48	4.45E-16	4.10E-16	3.81E-16	3.74E-16	3.38E-16	3.34E-16
Sc-49	1.04E-18	9.86E-19	9.45E-19	9.31E-19	8.95E-19	8.89E-19
Sc-50	4.30E-16	3.96E-16	3.68E-16	3.60E-16	3.28E-16	3.23E-16
<b>Titanium</b>						
Ti-44	1.58E-17	1.30E-17	1.03E-17	1.03E-17	9.15E-18	8.74E-18
Ti-45	1.10E-16	1.00E-16	9.25E-17	8.94E-17	8.00E-17	7.88E-17
Ti-51	4.79E-17	4.31E-17	3.94E-17	3.80E-17	3.38E-17	3.33E-17
Ti-52	1.62E-17	1.40E-17	1.22E-17	1.13E-17	1.05E-17	1.02E-17
<b>Vanadium</b>						
V-47	1.26E-16	1.15E-16	1.06E-16	1.03E-16	9.20E-17	9.07E-17
V-48	3.84E-16	3.54E-16	3.28E-16	3.21E-16	2.90E-16	2.86E-16
V-49	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-50	1.93E-16	1.77E-16	1.65E-16	1.62E-16	1.48E-16	1.46E-16
V-52	1.97E-16	1.81E-16	1.69E-16	1.65E-16	1.51E-16	1.49E-16
V-53	1.38E-16	1.27E-16	1.18E-16	1.16E-16	1.05E-16	1.03E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Chromium</b>						
Cr-48	5.45E-17	4.82E-17	4.30E-17	4.08E-17	3.68E-17	3.61E-17
Cr-49	1.32E-16	1.20E-16	1.10E-16	1.06E-16	9.53E-17	9.38E-17
Cr-51	4.01E-18	3.58E-18	3.26E-18	3.12E-18	2.77E-18	2.73E-18
Cr-55	1.48E-18	1.39E-18	1.33E-18	1.31E-18	1.26E-18	1.25E-18
Cr-56	1.03E-17	8.59E-18	6.87E-18	6.76E-18	6.21E-18	5.96E-18
<b>Manganese</b>						
Mn-50m	6.11E-16	5.62E-16	5.22E-16	5.10E-16	4.61E-16	4.55E-16
Mn-51	1.26E-16	1.16E-16	1.07E-16	1.03E-16	9.24E-17	9.10E-17
Mn-52	4.56E-16	4.20E-16	3.90E-16	3.81E-16	3.45E-16	3.40E-16
Mn-52m	3.18E-16	2.92E-16	2.71E-16	2.64E-16	2.39E-16	2.36E-16
Mn-53	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	1.08E-16	9.99E-17	9.27E-17	9.05E-17	8.13E-17	8.01E-17
Mn-56	2.28E-16	2.10E-16	1.95E-16	1.91E-16	1.75E-16	1.72E-16
Mn-57	1.38E-17	1.25E-17	1.15E-17	1.11E-17	1.01E-17	9.99E-18
Mn-58m	3.20E-16	2.95E-16	2.74E-16	2.68E-16	2.44E-16	2.40E-16
<b>Iron</b>						
Fe-52	9.31E-17	8.44E-17	7.75E-17	7.45E-17	6.64E-17	6.54E-17
Fe-53	1.50E-16	1.37E-16	1.26E-16	1.22E-16	1.09E-16	1.07E-16
Fe-53m	4.05E-16	3.74E-16	3.47E-16	3.40E-16	3.08E-16	3.04E-16
Fe-55	1.99E-26	1.72E-26	1.50E-26	1.38E-26	1.28E-26	1.24E-26
Fe-59	1.58E-16	1.46E-16	1.36E-16	1.33E-16	1.21E-16	1.19E-16
Fe-60	8.13E-21	7.81E-21	7.66E-21	7.62E-21	7.48E-21	7.45E-21
Fe-61	1.87E-16	1.72E-16	1.60E-16	1.56E-16	1.42E-16	1.40E-16
Fe-62	6.45E-17	5.90E-17	5.44E-17	5.26E-17	4.71E-17	4.64E-17
<b>Cobalt</b>						
Co-54m	5.19E-16	4.76E-16	4.41E-16	4.31E-16	3.89E-16	3.84E-16
Co-55	2.58E-16	2.38E-16	2.20E-16	2.14E-16	1.93E-16	1.90E-16
Co-56	4.91E-16	4.53E-16	4.22E-16	4.14E-16	3.78E-16	3.74E-16
Co-57	1.48E-17	1.28E-17	1.11E-17	1.02E-17	9.51E-18	9.24E-18
Co-58	1.25E-16	1.16E-16	1.07E-16	1.04E-16	9.37E-17	9.24E-17
Co-58m	3.32E-22	2.12E-22	1.75E-22	1.64E-22	1.16E-22	1.08E-22
Co-60	3.35E-16	3.09E-16	2.87E-16	2.82E-16	2.56E-16	2.53E-16
Co-60m	5.68E-19	5.07E-19	4.61E-19	4.52E-19	4.06E-19	3.98E-19
Co-61	1.19E-17	1.03E-17	8.88E-18	8.88E-18	7.82E-18	7.61E-18
Co-62	2.19E-16	2.02E-16	1.89E-16	1.85E-16	1.69E-16	1.67E-16
Co-62m	3.64E-16	3.35E-16	3.12E-16	3.06E-16	2.79E-16	2.75E-16
<b>Nickel</b>						
Ni-56	2.22E-16	2.03E-16	1.88E-16	1.82E-16	1.64E-16	1.61E-16
Ni-57	2.58E-16	2.37E-16	2.20E-16	2.15E-16	1.96E-16	1.93E-16
Ni-59	1.95E-21	1.79E-21	1.65E-21	1.59E-21	1.42E-21	1.40E-21
Ni-63	2.59E-23	1.67E-23	1.42E-23	1.32E-23	8.38E-24	7.81E-24
Ni-65	7.58E-17	6.97E-17	6.48E-17	6.35E-17	5.79E-17	5.71E-17
Ni-66	1.57E-20	1.52E-20	1.49E-20	1.49E-20	1.46E-20	1.46E-20
<b>Copper</b>						
Cu-57	1.54E-16	1.41E-16	1.30E-16	1.26E-16	1.14E-16	1.12E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cu-59	1.87E-16	1.71E-16	1.58E-16	1.53E-16	1.38E-16	1.36E-16
Cu-60	5.24E-16	4.82E-16	4.47E-16	4.38E-16	3.99E-16	3.94E-16
Cu-61	1.04E-16	9.53E-17	8.79E-17	8.50E-17	7.62E-17	7.50E-17
Cu-62	1.28E-16	1.17E-16	1.08E-16	1.05E-16	9.38E-17	9.24E-17
Cu-64	2.33E-17	2.13E-17	1.97E-17	1.90E-17	1.70E-17	1.68E-17
Cu-66	1.42E-17	1.32E-17	1.23E-17	1.20E-17	1.09E-17	1.08E-17
Cu-67	1.44E-17	1.25E-17	1.11E-17	1.05E-17	9.38E-18	9.19E-18
Cu-69	7.03E-17	6.49E-17	6.02E-17	5.89E-17	5.32E-17	5.25E-17
<b>Zinc</b>						
Zn-60	1.94E-16	1.78E-16	1.64E-16	1.58E-16	1.42E-16	1.40E-16
Zn-61	2.01E-16	1.84E-16	1.70E-16	1.65E-16	1.49E-16	1.47E-16
Zn-62	5.49E-17	5.02E-17	4.62E-17	4.46E-17	3.99E-17	3.93E-17
Zn-63	1.40E-16	1.28E-16	1.18E-16	1.14E-16	1.02E-16	1.01E-16
Zn-65	7.66E-17	7.07E-17	6.57E-17	6.44E-17	5.82E-17	5.74E-17
Zn-69	2.44E-19	2.35E-19	2.29E-19	2.27E-19	2.23E-19	2.22E-19
Zn-69m	5.22E-17	4.74E-17	4.36E-17	4.20E-17	3.75E-17	3.69E-17
Zn-71	4.16E-17	3.82E-17	3.53E-17	3.43E-17	3.09E-17	3.05E-17
Zn-71m	1.98E-16	1.81E-16	1.67E-16	1.62E-16	1.45E-16	1.43E-16
Zn-72	1.83E-17	1.59E-17	1.43E-17	1.34E-17	1.18E-17	1.16E-17
<b>Gallium</b>						
Ga-64	4.53E-16	4.19E-16	3.89E-16	3.81E-16	3.48E-16	3.44E-16
Ga-65	1.47E-16	1.35E-16	1.23E-16	1.19E-16	1.07E-16	1.05E-16
Ga-66	3.39E-16	3.15E-16	2.93E-16	2.88E-16	2.65E-16	2.62E-16
Ga-67	1.93E-17	1.69E-17	1.49E-17	1.42E-17	1.28E-17	1.25E-17
Ga-68	1.20E-16	1.10E-16	1.01E-16	9.81E-17	8.79E-17	8.66E-17
Ga-70	1.60E-18	1.49E-18	1.41E-18	1.38E-18	1.29E-18	1.27E-18
Ga-72	3.65E-16	3.36E-16	3.13E-16	3.07E-16	2.80E-16	2.77E-16
Ga-73	4.42E-17	3.96E-17	3.61E-17	3.47E-17	3.08E-17	3.04E-17
Ga-74	4.29E-16	3.95E-16	3.68E-16	3.61E-16	3.31E-16	3.27E-16
<b>Germanium</b>						
Ge-66	8.46E-17	7.66E-17	7.02E-17	6.76E-17	6.05E-17	5.95E-17
Ge-67	1.83E-16	1.67E-16	1.54E-16	1.49E-16	1.34E-16	1.32E-16
Ge-68	2.17E-21	1.37E-21	1.10E-21	9.14E-22	2.87E-22	2.53E-22
Ge-69	1.23E-16	1.14E-16	1.05E-16	1.03E-16	9.26E-17	9.13E-17
Ge-71	2.20E-21	1.39E-21	1.11E-21	9.27E-22	2.91E-22	2.57E-22
Ge-75	4.82E-18	4.29E-18	3.92E-18	3.75E-18	3.34E-18	3.30E-18
Ge-77	1.40E-16	1.27E-16	1.17E-16	1.13E-16	1.02E-16	1.00E-16
Ge-78	3.54E-17	3.13E-17	2.85E-17	2.72E-17	2.40E-17	2.37E-17
<b>Arsenic</b>						
As-68	4.92E-16	4.52E-16	4.20E-16	4.10E-16	3.72E-16	3.67E-16
As-69	1.47E-16	1.34E-16	1.24E-16	1.20E-16	1.07E-16	1.06E-16
As-70	5.61E-16	5.16E-16	4.79E-16	4.67E-16	4.24E-16	4.18E-16
As-71	7.27E-17	6.58E-17	6.05E-17	5.82E-17	5.20E-17	5.12E-17
As-72	2.30E-16	2.11E-16	1.96E-16	1.90E-16	1.71E-16	1.69E-16
As-73	5.62E-19	4.38E-19	3.68E-19	3.48E-19	2.88E-19	2.75E-19
As-74	9.57E-17	8.79E-17	8.11E-17	7.85E-17	7.04E-17	6.93E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
As-76	5.49E-17	5.05E-17	4.68E-17	4.55E-17	4.10E-17	4.05E-17
As-77	1.20E-18	1.08E-18	9.88E-19	9.51E-19	8.57E-19	8.45E-19
As-78	1.75E-16	1.61E-16	1.49E-16	1.46E-16	1.32E-16	1.31E-16
As-79	5.31E-18	4.89E-18	4.55E-18	4.43E-18	4.03E-18	3.98E-18
<b>Selenium</b>						
Se-70	8.92E-17	8.10E-17	7.43E-17	7.16E-17	6.39E-17	6.30E-17
Se-71	2.07E-16	1.90E-16	1.75E-16	1.70E-16	1.53E-16	1.51E-16
Se-72	2.38E-18	1.80E-18	1.55E-18	1.40E-18	1.14E-18	1.09E-18
Se-73	1.37E-16	1.24E-16	1.13E-16	1.10E-16	9.77E-17	9.62E-17
Se-73m	3.31E-17	3.03E-17	2.78E-17	2.69E-17	2.41E-17	2.37E-17
Se-75	4.82E-17	4.25E-17	3.83E-17	3.63E-17	3.24E-17	3.18E-17
Se-77m	1.08E-17	9.47E-18	8.62E-18	8.10E-18	7.09E-18	6.96E-18
Se-79	3.71E-21	3.52E-21	3.43E-21	3.40E-21	3.31E-21	3.30E-21
Se-79m	1.12E-18	9.43E-19	7.57E-19	7.08E-19	6.78E-19	6.51E-19
Se-81	1.62E-18	1.50E-18	1.40E-18	1.36E-18	1.26E-18	1.25E-18
Se-81m	1.69E-18	1.44E-18	1.17E-18	1.08E-18	1.05E-18	1.01E-18
Se-83	3.47E-16	3.18E-16	2.95E-16	2.88E-16	2.61E-16	2.58E-16
Se-83m	1.33E-16	1.22E-16	1.13E-16	1.11E-16	1.01E-16	9.96E-17
Se-84	5.32E-17	4.83E-17	4.43E-17	4.26E-17	3.80E-17	3.75E-17
<b>Bromine</b>						
Br-72	3.92E-16	3.61E-16	3.34E-16	3.26E-16	2.95E-16	2.91E-16
Br-73	1.83E-16	1.67E-16	1.54E-16	1.49E-16	1.34E-16	1.32E-16
Br-74	6.27E-16	5.82E-16	5.42E-16	5.33E-16	4.90E-16	4.85E-16
Br-74m	5.53E-16	5.11E-16	4.74E-16	4.64E-16	4.24E-16	4.18E-16
Br-75	1.52E-16	1.38E-16	1.27E-16	1.22E-16	1.09E-16	1.07E-16
Br-76	3.73E-16	3.43E-16	3.19E-16	3.12E-16	2.85E-16	2.81E-16
Br-76m	3.40E-18	2.72E-18	2.38E-18	2.22E-18	1.87E-18	1.81E-18
Br-77	3.99E-17	3.61E-17	3.32E-17	3.20E-17	2.85E-17	2.81E-17
Br-77m	1.82E-18	1.55E-18	1.27E-18	1.17E-18	1.13E-18	1.09E-18
Br-78	1.31E-16	1.20E-16	1.11E-16	1.07E-16	9.60E-17	9.45E-17
Br-80	1.04E-17	9.55E-18	8.85E-18	8.59E-18	7.75E-18	7.64E-18
Br-80m	1.07E-18	7.63E-19	6.44E-19	5.80E-19	4.54E-19	4.31E-19
Br-82	3.43E-16	3.16E-16	2.93E-16	2.86E-16	2.57E-16	2.54E-16
Br-82m	4.41E-19	3.95E-19	3.66E-19	3.55E-19	3.12E-19	3.07E-19
Br-83	1.11E-18	1.03E-18	9.64E-19	9.37E-19	8.59E-19	8.49E-19
Br-84	2.43E-16	2.25E-16	2.10E-16	2.07E-16	1.90E-16	1.88E-16
Br-84m	3.68E-16	3.38E-16	3.13E-16	3.06E-16	2.78E-16	2.74E-16
Br-85	9.96E-18	9.21E-18	8.59E-18	8.41E-18	7.66E-18	7.56E-18
<b>Krypton</b>						
Kr-74	1.33E-16	1.21E-16	1.10E-16	1.06E-16	9.53E-17	9.38E-17
Kr-75	1.64E-16	1.49E-16	1.37E-16	1.32E-16	1.19E-16	1.17E-16
Kr-76	5.27E-17	4.71E-17	4.30E-17	4.12E-17	3.66E-17	3.61E-17
Kr-77	1.31E-16	1.19E-16	1.09E-16	1.05E-16	9.38E-17	9.23E-17
Kr-79	3.16E-17	2.86E-17	2.63E-17	2.54E-17	2.27E-17	2.23E-17
Kr-81	1.47E-19	1.18E-19	1.06E-19	9.91E-20	7.70E-20	7.53E-20
Kr-81m	1.64E-17	1.42E-17	1.29E-17	1.22E-17	1.07E-17	1.05E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Kr-83m	1.63E-20	9.86E-21	8.76E-21	7.68E-21	2.91E-21	2.64E-21
Kr-85	4.50E-19	4.21E-19	3.97E-19	3.87E-19	3.61E-19	3.57E-19
Kr-85m	1.98E-17	1.74E-17	1.58E-17	1.49E-17	1.31E-17	1.29E-17
Kr-87	1.09E-16	9.99E-17	9.29E-17	9.09E-17	8.34E-17	8.24E-17
Kr-88	2.69E-16	2.47E-16	2.31E-16	2.26E-16	2.09E-16	2.06E-16
Kr-89	2.63E-16	2.43E-16	2.26E-16	2.22E-16	2.03E-16	2.01E-16
<b>Rubidium</b>						
Rb-77	1.99E-16	1.81E-16	1.67E-16	1.62E-16	1.45E-16	1.43E-16
Rb-78	5.55E-16	5.15E-16	4.79E-16	4.71E-16	4.33E-16	4.28E-16
Rb-78m	4.24E-16	3.89E-16	3.61E-16	3.51E-16	3.19E-16	3.14E-16
Rb-79	1.84E-16	1.68E-16	1.54E-16	1.49E-16	1.34E-16	1.32E-16
Rb-80	1.53E-16	1.41E-16	1.30E-16	1.25E-16	1.13E-16	1.11E-16
Rb-81	6.36E-17	5.81E-17	5.36E-17	5.18E-17	4.64E-17	4.57E-17
Rb-81m	3.11E-18	2.79E-18	2.51E-18	2.44E-18	2.19E-18	2.15E-18
Rb-82	1.42E-16	1.30E-16	1.20E-16	1.16E-16	1.04E-16	1.02E-16
Rb-82m	3.79E-16	3.49E-16	3.23E-16	3.15E-16	2.84E-16	2.80E-16
Rb-83	6.10E-17	5.58E-17	5.15E-17	4.98E-17	4.46E-17	4.39E-17
Rb-84	1.17E-16	1.07E-16	9.94E-17	9.69E-17	8.70E-17	8.57E-17
Rb-84m	4.81E-17	4.29E-17	3.92E-17	3.75E-17	3.33E-17	3.28E-17
Rb-86	1.30E-17	1.20E-17	1.12E-17	1.10E-17	9.95E-18	9.82E-18
Rb-86m	6.88E-17	6.31E-17	5.82E-17	5.64E-17	5.05E-17	4.98E-17
Rb-87	4.10E-20	3.98E-20	3.92E-20	3.90E-20	3.85E-20	3.84E-20
Rb-88	9.13E-17	8.40E-17	7.83E-17	7.69E-17	7.08E-17	6.99E-17
Rb-89	3.04E-16	2.81E-16	2.61E-16	2.56E-16	2.34E-16	2.31E-16
Rb-90	2.86E-16	2.69E-16	2.51E-16	2.49E-16	2.31E-16	2.29E-16
Rb-90m	4.45E-16	4.13E-16	3.85E-16	3.79E-16	3.49E-16	3.45E-16
<b>Strontium</b>						
Sr-79	1.50E-16	1.37E-16	1.26E-16	1.21E-16	1.09E-16	1.07E-16
Sr-80	5.43E-17	4.96E-17	4.57E-17	4.42E-17	3.95E-17	3.89E-17
Sr-81	1.76E-16	1.61E-16	1.48E-16	1.43E-16	1.28E-16	1.26E-16
Sr-82	7.01E-20	4.19E-20	3.79E-20	3.37E-20	1.26E-20	1.14E-20
Sr-83	1.04E-16	9.57E-17	8.85E-17	8.60E-17	7.73E-17	7.62E-17
Sr-85	6.19E-17	5.66E-17	5.22E-17	5.04E-17	4.51E-17	4.44E-17
Sr-85m	2.75E-17	2.41E-17	2.18E-17	2.07E-17	1.82E-17	1.80E-17
Sr-87m	4.01E-17	3.62E-17	3.32E-17	3.19E-17	2.84E-17	2.80E-17
Sr-89	5.78E-19	5.52E-19	5.33E-19	5.27E-19	5.12E-19	5.09E-19
Sr-90	1.16E-19	1.12E-19	1.10E-19	1.09E-19	1.08E-19	1.07E-19
Sr-91	9.29E-17	8.57E-17	7.96E-17	7.77E-17	7.00E-17	6.91E-17
Sr-92	1.80E-16	1.66E-16	1.54E-16	1.51E-16	1.38E-16	1.36E-16
Sr-93	3.00E-16	2.76E-16	2.56E-16	2.50E-16	2.27E-16	2.24E-16
Sr-94	1.94E-16	1.78E-16	1.66E-16	1.63E-16	1.48E-16	1.47E-16
<b>Yttrium</b>						
Y-81	1.49E-16	1.36E-16	1.24E-16	1.20E-16	1.08E-16	1.06E-16
Y-83	1.72E-16	1.58E-16	1.46E-16	1.41E-16	1.27E-16	1.25E-16
Y-83m	1.06E-16	9.64E-17	8.86E-17	8.54E-17	7.63E-17	7.52E-17
Y-84m	5.18E-16	4.77E-16	4.42E-16	4.31E-16	3.89E-16	3.83E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Y-85	1.36E-16	1.25E-16	1.15E-16	1.11E-16	9.97E-17	9.82E-17
Y-85m	1.73E-16	1.59E-16	1.47E-16	1.43E-16	1.30E-16	1.28E-16
Y-86	4.73E-16	4.35E-16	4.04E-16	3.95E-16	3.58E-16	3.53E-16
Y-86m	2.80E-17	2.46E-17	2.23E-17	2.12E-17	1.87E-17	1.84E-17
Y-87	5.50E-17	5.02E-17	4.62E-17	4.46E-17	3.99E-17	3.93E-17
Y-87m	3.84E-17	3.47E-17	3.18E-17	3.05E-17	2.72E-17	2.68E-17
Y-88	3.65E-16	3.35E-16	3.12E-16	3.06E-16	2.80E-16	2.76E-16
Y-89m	1.18E-16	1.09E-16	1.01E-16	9.87E-17	8.87E-17	8.75E-17
Y-90	1.10E-18	1.05E-18	1.01E-18	9.91E-19	9.54E-19	9.48E-19
Y-90m	7.99E-17	7.20E-17	6.59E-17	6.32E-17	5.63E-17	5.54E-17
Y-91	1.01E-18	9.51E-19	9.05E-19	8.92E-19	8.44E-19	8.36E-19
Y-91m	6.65E-17	6.11E-17	5.63E-17	5.45E-17	4.88E-17	4.81E-17
Y-92	3.53E-17	3.26E-17	3.03E-17	2.97E-17	2.69E-17	2.65E-17
Y-93	1.44E-17	1.32E-17	1.23E-17	1.20E-17	1.10E-17	1.08E-17
Y-94	1.05E-16	9.70E-17	9.02E-17	8.83E-17	7.99E-17	7.89E-17
Y-95	1.55E-16	1.44E-16	1.34E-16	1.32E-16	1.22E-16	1.21E-16
<b>Zirconium</b>						
Zr-85	1.89E-16	1.73E-16	1.59E-16	1.54E-16	1.38E-16	1.36E-16
Zr-86	3.50E-17	3.08E-17	2.80E-17	2.67E-17	2.35E-17	2.32E-17
Zr-87	1.18E-16	1.08E-16	9.97E-17	9.65E-17	8.66E-17	8.53E-17
Zr-88	4.81E-17	4.34E-17	3.98E-17	3.83E-17	3.41E-17	3.35E-17
Zr-89	1.49E-16	1.38E-16	1.28E-16	1.25E-16	1.12E-16	1.10E-16
Zr-89m	8.10E-17	7.44E-17	6.88E-17	6.68E-17	6.00E-17	5.92E-17
Zr-93	3.09E-23	2.02E-23	1.73E-23	1.61E-23	1.04E-23	9.75E-24
Zr-95	9.41E-17	8.68E-17	8.04E-17	7.83E-17	7.03E-17	6.93E-17
Zr-97	1.14E-16	1.05E-16	9.75E-17	9.51E-17	8.55E-17	8.43E-17
<b>Niobium</b>						
Nb-87	1.55E-16	1.41E-16	1.29E-16	1.25E-16	1.11E-16	1.10E-16
Nb-88	5.47E-16	5.03E-16	4.65E-16	4.53E-16	4.08E-16	4.02E-16
Nb-88m	5.37E-16	4.93E-16	4.57E-16	4.46E-16	4.02E-16	3.97E-16
Nb-89	1.80E-16	1.66E-16	1.54E-16	1.50E-16	1.36E-16	1.34E-16
Nb-89m	1.65E-16	1.51E-16	1.39E-16	1.35E-16	1.21E-16	1.19E-16
Nb-90	5.70E-16	5.24E-16	4.88E-16	4.78E-16	4.38E-16	4.33E-16
Nb-91	3.31E-19	2.63E-19	2.40E-19	2.31E-19	1.77E-19	1.72E-19
Nb-91m	3.45E-18	3.14E-18	2.91E-18	2.85E-18	2.56E-18	2.52E-18
Nb-92	1.93E-16	1.78E-16	1.65E-16	1.61E-16	1.44E-16	1.42E-16
Nb-92m	1.26E-16	1.16E-16	1.08E-16	1.05E-16	9.48E-17	9.35E-17
Nb-93m	2.70E-20	1.63E-20	1.46E-20	1.41E-20	6.77E-21	6.12E-21
Nb-94	2.01E-16	1.86E-16	1.72E-16	1.68E-16	1.51E-16	1.49E-16
Nb-94m	6.77E-19	5.92E-19	5.47E-19	5.34E-19	4.57E-19	4.49E-19
Nb-95	9.85E-17	9.08E-17	8.42E-17	8.21E-17	7.36E-17	7.26E-17
Nb-95m	8.15E-18	7.12E-18	6.46E-18	6.15E-18	5.41E-18	5.33E-18
Nb-96	3.19E-16	2.94E-16	2.73E-16	2.66E-16	2.39E-16	2.36E-16
Nb-97	8.52E-17	7.84E-17	7.26E-17	7.05E-17	6.33E-17	6.24E-17
Nb-98m	3.71E-16	3.42E-16	3.17E-16	3.10E-16	2.80E-16	2.77E-16
Nb-99	2.28E-17	1.98E-17	1.74E-17	1.64E-17	1.50E-17	1.46E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Nb-99m	1.05E-16	9.70E-17	9.02E-17	8.86E-17	8.16E-17	8.06E-17
<b>Molybdenum</b>						
Mo-89	1.58E-16	1.45E-16	1.34E-16	1.30E-16	1.17E-16	1.15E-16
Mo-90	1.05E-16	9.43E-17	8.62E-17	8.29E-17	7.44E-17	7.32E-17
Mo-91	1.25E-16	1.15E-16	1.06E-16	1.02E-16	9.16E-17	9.02E-17
Mo-91m	1.81E-16	1.66E-16	1.54E-16	1.50E-16	1.36E-16	1.34E-16
Mo-93	1.51E-19	9.13E-20	8.17E-20	7.88E-20	3.79E-20	3.43E-20
Mo-93m	3.08E-16	2.82E-16	2.62E-16	2.56E-16	2.32E-16	2.29E-16
Mo-99	1.93E-17	1.76E-17	1.63E-17	1.58E-17	1.42E-17	1.40E-17
Mo-101	1.96E-16	1.79E-16	1.67E-16	1.63E-16	1.48E-16	1.46E-16
Mo-102	2.61E-18	2.30E-18	2.10E-18	2.00E-18	1.79E-18	1.76E-18
<b>Technetium</b>						
Tc-91	3.33E-16	3.07E-16	2.85E-16	2.78E-16	2.54E-16	2.51E-16
Tc-91m	1.84E-16	1.68E-16	1.55E-16	1.50E-16	1.35E-16	1.33E-16
Tc-92	5.04E-16	4.61E-16	4.27E-16	4.16E-16	3.76E-16	3.71E-16
Tc-93	2.10E-16	1.93E-16	1.80E-16	1.76E-16	1.60E-16	1.58E-16
Tc-93m	1.29E-16	1.18E-16	1.10E-16	1.08E-16	9.92E-17	9.80E-17
Tc-94	3.43E-16	3.16E-16	2.93E-16	2.86E-16	2.57E-16	2.53E-16
Tc-94m	2.55E-16	2.35E-16	2.18E-16	2.12E-16	1.92E-16	1.89E-16
Tc-95	1.01E-16	9.35E-17	8.66E-17	8.45E-17	7.58E-17	7.47E-17
Tc-95m	8.70E-17	7.93E-17	7.31E-17	7.09E-17	6.34E-17	6.24E-17
Tc-96	3.23E-16	2.98E-16	2.76E-16	2.70E-16	2.42E-16	2.39E-16
Tc-96m	5.55E-18	5.08E-18	4.71E-18	4.60E-18	4.13E-18	4.07E-18
Tc-97	1.78E-19	1.08E-19	9.56E-20	9.35E-20	4.77E-20	4.32E-20
Tc-97m	2.00E-19	1.32E-19	1.14E-19	1.11E-19	7.13E-20	6.62E-20
Tc-98	1.81E-16	1.67E-16	1.54E-16	1.50E-16	1.35E-16	1.33E-16
Tc-99	3.31E-20	3.21E-20	3.16E-20	3.14E-20	3.10E-20	3.09E-20
Tc-99m	1.56E-17	1.36E-17	1.22E-17	1.13E-17	1.01E-17	9.86E-18
Tc-101	4.29E-17	3.84E-17	3.51E-17	3.36E-17	2.99E-17	2.95E-17
Tc-102	1.39E-17	1.28E-17	1.19E-17	1.16E-17	1.06E-17	1.05E-17
Tc-102m	3.31E-16	3.04E-16	2.82E-16	2.76E-16	2.51E-16	2.48E-16
Tc-104	3.04E-16	2.79E-16	2.59E-16	2.54E-16	2.32E-16	2.29E-16
Tc-105	1.05E-16	9.59E-17	8.84E-17	8.58E-17	7.76E-17	7.65E-17
<b>Ruthenium</b>						
Ru-92	2.68E-16	2.42E-16	2.23E-16	2.16E-16	1.94E-16	1.92E-16
Ru-94	6.50E-17	5.91E-17	5.44E-17	5.27E-17	4.71E-17	4.64E-17
Ru-95	1.61E-16	1.47E-16	1.36E-16	1.32E-16	1.19E-16	1.18E-16
Ru-97	2.91E-17	2.55E-17	2.31E-17	2.20E-17	1.94E-17	1.91E-17
Ru-103	6.23E-17	5.70E-17	5.25E-17	5.07E-17	4.54E-17	4.47E-17
Ru-105	9.56E-17	8.76E-17	8.09E-17	7.85E-17	7.04E-17	6.93E-17
Ru-106	2.62E-24	1.60E-24	1.39E-24	1.29E-24	6.25E-25	5.69E-25
Ru-107	4.64E-17	4.25E-17	3.93E-17	3.83E-17	3.46E-17	3.41E-17
Ru-108	8.08E-18	7.06E-18	6.41E-18	6.05E-18	5.35E-18	5.25E-18
<b>Rhodium</b>						
Rh-94	5.03E-16	4.63E-16	4.29E-16	4.19E-16	3.81E-16	3.75E-16
Rh-95	3.38E-16	3.11E-16	2.89E-16	2.82E-16	2.56E-16	2.53E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Rh-95m	1.18E-16	1.09E-16	1.01E-16	9.91E-17	9.02E-17	8.91E-17
Rh-96	5.10E-16	4.69E-16	4.35E-16	4.23E-16	3.82E-16	3.77E-16
Rh-96m	1.69E-16	1.55E-16	1.44E-16	1.40E-16	1.27E-16	1.26E-16
Rh-97	1.86E-16	1.70E-16	1.57E-16	1.52E-16	1.37E-16	1.35E-16
Rh-97m	2.97E-16	2.72E-16	2.53E-16	2.48E-16	2.27E-16	2.24E-16
Rh-98	2.33E-16	2.14E-16	1.98E-16	1.92E-16	1.73E-16	1.70E-16
Rh-99	6.91E-17	6.27E-17	5.73E-17	5.54E-17	4.96E-17	4.88E-17
Rh-99m	8.21E-17	7.47E-17	6.88E-17	6.66E-17	5.97E-17	5.88E-17
Rh-100	3.67E-16	3.38E-16	3.14E-16	3.07E-16	2.81E-16	2.78E-16
Rh-100m	6.07E-18	5.35E-18	4.85E-18	4.74E-18	4.21E-18	4.13E-18
Rh-101	3.46E-17	3.01E-17	2.69E-17	2.54E-17	2.26E-17	2.22E-17
Rh-101m	3.49E-17	3.11E-17	2.83E-17	2.71E-17	2.40E-17	2.36E-17
Rh-102	6.32E-17	5.78E-17	5.33E-17	5.16E-17	4.62E-17	4.55E-17
Rh-102m	2.75E-16	2.53E-16	2.34E-16	2.28E-16	2.05E-16	2.02E-16
Rh-103m	3.51E-20	2.18E-20	1.86E-20	1.82E-20	1.11E-20	1.02E-20
Rh-104	2.75E-18	2.56E-18	2.40E-18	2.34E-18	2.17E-18	2.15E-18
Rh-104m	3.34E-18	2.60E-18	2.19E-18	2.06E-18	1.72E-18	1.64E-18
Rh-105	9.83E-18	8.77E-18	8.00E-18	7.66E-18	6.80E-18	6.70E-18
Rh-106	2.83E-17	2.60E-17	2.41E-17	2.34E-17	2.11E-17	2.08E-17
Rh-106m	3.72E-16	3.42E-16	3.16E-16	3.08E-16	2.78E-16	2.74E-16
Rh-107	3.99E-17	3.57E-17	3.26E-17	3.13E-17	2.78E-17	2.74E-17
Rh-108	4.30E-17	3.94E-17	3.63E-17	3.51E-17	3.16E-17	3.11E-17
Rh-109	3.86E-17	3.45E-17	3.15E-17	3.01E-17	2.68E-17	2.64E-17
<b>Palladium</b>						
Pd-96	1.84E-16	1.69E-16	1.56E-16	1.51E-16	1.36E-16	1.34E-16
Pd-97	3.14E-16	2.88E-16	2.67E-16	2.60E-16	2.36E-16	2.33E-16
Pd-98	5.08E-17	4.59E-17	4.16E-17	4.01E-17	3.63E-17	3.56E-17
Pd-99	1.66E-16	1.51E-16	1.40E-16	1.35E-16	1.22E-16	1.21E-16
Pd-100	1.18E-17	9.71E-18	7.80E-18	7.68E-18	6.86E-18	6.57E-18
Pd-101	4.22E-17	3.83E-17	3.53E-17	3.42E-17	3.06E-17	3.01E-17
Pd-103	3.25E-19	2.04E-19	1.75E-19	1.71E-19	1.06E-19	9.72E-20
Pd-107	1.78E-24	1.08E-24	9.47E-25	8.69E-25	3.92E-25	3.55E-25
Pd-109	9.56E-19	8.00E-19	7.00E-19	6.82E-19	6.20E-19	6.03E-19
Pd-109m	1.35E-17	1.18E-17	1.06E-17	1.01E-17	8.82E-18	8.68E-18
Pd-111	7.16E-18	6.60E-18	6.13E-18	5.99E-18	5.46E-18	5.39E-18
Pd-112	1.02E-19	6.87E-20	6.21E-20	6.15E-20	4.04E-20	3.82E-20
Pd-114	3.73E-18	3.31E-18	3.01E-18	2.87E-18	2.60E-18	2.56E-18
<b>Silver</b>						
Ag-99	3.02E-16	2.77E-16	2.56E-16	2.49E-16	2.25E-16	2.22E-16
Ag-100m	3.72E-16	3.41E-16	3.16E-16	3.08E-16	2.79E-16	2.75E-16
Ag-101	2.02E-16	1.85E-16	1.70E-16	1.65E-16	1.49E-16	1.47E-16
Ag-102	4.48E-16	4.12E-16	3.82E-16	3.73E-16	3.38E-16	3.33E-16
Ag-102m	2.69E-16	2.48E-16	2.30E-16	2.26E-16	2.07E-16	2.05E-16
Ag-103	1.07E-16	9.78E-17	9.00E-17	8.72E-17	7.85E-17	7.73E-17
Ag-104	3.51E-16	3.23E-16	2.99E-16	2.92E-16	2.63E-16	2.60E-16
Ag-104m	2.36E-16	2.16E-16	2.00E-16	1.95E-16	1.77E-16	1.75E-16



**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ag-105	6.33E-17	5.70E-17	5.22E-17	5.04E-17	4.48E-17	4.42E-17
Ag-105m	1.27E-19	1.14E-19	1.04E-19	1.00E-19	8.93E-20	8.80E-20
Ag-106	8.78E-17	8.04E-17	7.41E-17	7.16E-17	6.41E-17	6.31E-17
Ag-106m	3.64E-16	3.34E-16	3.09E-16	3.01E-16	2.72E-16	2.68E-16
Ag-108	2.91E-18	2.69E-18	2.51E-18	2.44E-18	2.23E-18	2.20E-18
Ag-108m	2.04E-16	1.87E-16	1.73E-16	1.68E-16	1.50E-16	1.48E-16
Ag-109m	5.85E-19	4.47E-19	3.60E-19	3.47E-19	2.98E-19	2.83E-19
Ag-110	5.47E-18	5.07E-18	4.73E-18	4.62E-18	4.23E-18	4.18E-18
Ag-110m	3.60E-16	3.32E-16	3.08E-16	3.01E-16	2.71E-16	2.67E-16
Ag-111	3.61E-18	3.25E-18	2.98E-18	2.86E-18	2.57E-18	2.53E-18
Ag-111m	5.45E-19	4.55E-19	4.08E-19	3.93E-19	3.35E-19	3.27E-19
Ag-112	9.34E-17	8.59E-17	7.98E-17	7.80E-17	7.10E-17	7.00E-17
Ag-113	1.00E-17	9.07E-18	8.35E-18	8.07E-18	7.25E-18	7.15E-18
Ag-113m	2.70E-17	2.44E-17	2.24E-17	2.15E-17	1.92E-17	1.89E-17
Ag-114	3.80E-17	3.50E-17	3.25E-17	3.18E-17	2.90E-17	2.86E-17
Ag-115	6.61E-17	6.04E-17	5.60E-17	5.47E-17	4.99E-17	4.93E-17
Ag-116	2.93E-16	2.70E-16	2.52E-16	2.47E-16	2.26E-16	2.24E-16
Ag-117	1.79E-16	1.65E-16	1.53E-16	1.50E-16	1.38E-16	1.36E-16
<b>Cadmium</b>						
Cd-101	3.28E-16	3.01E-16	2.79E-16	2.72E-16	2.47E-16	2.44E-16
Cd-102	1.06E-16	9.64E-17	8.89E-17	8.62E-17	7.74E-17	7.62E-17
Cd-103	2.80E-16	2.57E-16	2.39E-16	2.34E-16	2.14E-16	2.11E-16
Cd-104	2.94E-17	2.65E-17	2.39E-17	2.32E-17	2.09E-17	2.05E-17
Cd-105	1.72E-16	1.58E-16	1.46E-16	1.43E-16	1.30E-16	1.29E-16
Cd-107	1.76E-18	1.39E-18	1.19E-18	1.15E-18	9.70E-19	9.34E-19
Cd-109	9.94E-19	7.02E-19	5.74E-19	5.53E-19	4.33E-19	4.07E-19
Cd-111m	3.51E-17	3.08E-17	2.79E-17	2.65E-17	2.33E-17	2.29E-17
Cd-113	2.86E-20	2.78E-20	2.73E-20	2.72E-20	2.68E-20	2.68E-20
Cd-113m	1.14E-19	1.10E-19	1.07E-19	1.06E-19	1.04E-19	1.03E-19
Cd-115	2.44E-17	2.23E-17	2.05E-17	1.98E-17	1.78E-17	1.75E-17
Cd-115m	4.93E-18	4.57E-18	4.26E-18	4.18E-18	3.81E-18	3.76E-18
Cd-117	1.44E-16	1.32E-16	1.22E-16	1.19E-16	1.08E-16	1.07E-16
Cd-117m	2.76E-16	2.54E-16	2.37E-16	2.32E-16	2.12E-16	2.09E-16
Cd-118	8.46E-20	8.21E-20	8.05E-20	8.01E-20	7.90E-20	7.87E-20
Cd-119	2.22E-16	2.04E-16	1.89E-16	1.85E-16	1.69E-16	1.67E-16
Cd-119m	3.11E-16	2.86E-16	2.66E-16	2.61E-16	2.39E-16	2.36E-16
<b>Indium</b>						
In-103	3.64E-16	3.34E-16	3.10E-16	3.02E-16	2.74E-16	2.70E-16
In-105	2.51E-16	2.30E-16	2.13E-16	2.07E-16	1.87E-16	1.84E-16
In-106	4.59E-16	4.22E-16	3.91E-16	3.80E-16	3.42E-16	3.37E-16
In-106m	3.75E-16	3.45E-16	3.20E-16	3.12E-16	2.84E-16	2.81E-16
In-107	2.02E-16	1.84E-16	1.71E-16	1.66E-16	1.51E-16	1.49E-16
In-108	5.12E-16	4.70E-16	4.36E-16	4.26E-16	3.84E-16	3.79E-16
In-108m	3.71E-16	3.43E-16	3.19E-16	3.13E-16	2.87E-16	2.83E-16
In-109	8.18E-17	7.41E-17	6.82E-17	6.61E-17	5.93E-17	5.85E-17
In-109m	7.73E-17	7.12E-17	6.58E-17	6.39E-17	5.73E-17	5.65E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
In-110	3.99E-16	3.68E-16	3.41E-16	3.33E-16	2.99E-16	2.95E-16
In-110m	2.03E-16	1.87E-16	1.73E-16	1.68E-16	1.52E-16	1.49E-16
In-111	4.95E-17	4.32E-17	3.92E-17	3.72E-17	3.26E-17	3.21E-17
In-111m	5.90E-17	5.41E-17	4.99E-17	4.82E-17	4.32E-17	4.26E-17
In-112	3.33E-17	3.05E-17	2.81E-17	2.72E-17	2.43E-17	2.40E-17
In-112m	3.06E-18	2.56E-18	2.31E-18	2.17E-18	1.87E-18	1.82E-18
In-113m	3.22E-17	2.91E-17	2.66E-17	2.56E-17	2.28E-17	2.25E-17
In-114	1.14E-18	1.07E-18	1.02E-18	1.01E-18	9.61E-19	9.53E-19
In-114m	9.41E-18	8.39E-18	7.68E-18	7.38E-18	6.54E-18	6.44E-18
In-115	7.69E-20	7.47E-20	7.32E-20	7.28E-20	7.19E-20	7.16E-20
In-115m	1.98E-17	1.77E-17	1.61E-17	1.55E-17	1.37E-17	1.35E-17
In-116m	3.31E-16	3.04E-16	2.83E-16	2.77E-16	2.52E-16	2.49E-16
In-117	8.72E-17	7.93E-17	7.29E-17	7.02E-17	6.26E-17	6.16E-17
In-117m	1.14E-17	1.01E-17	9.19E-18	8.76E-18	7.76E-18	7.64E-18
In-118	1.36E-17	1.26E-17	1.18E-17	1.15E-17	1.06E-17	1.05E-17
In-118m	3.68E-16	3.39E-16	3.15E-16	3.09E-16	2.79E-16	2.75E-16
In-119	9.94E-17	9.16E-17	8.49E-17	8.28E-17	7.43E-17	7.33E-17
In-119m	9.78E-18	9.01E-18	8.39E-18	8.21E-18	7.48E-18	7.38E-18
In-121	1.22E-16	1.13E-16	1.05E-16	1.02E-16	9.19E-17	9.06E-17
In-121m	9.46E-18	8.52E-18	7.83E-18	7.69E-18	6.99E-18	6.88E-18
<b>Tin</b>						
Sn-106	1.53E-16	1.40E-16	1.29E-16	1.25E-16	1.12E-16	1.10E-16
Sn-108	8.47E-17	7.63E-17	6.98E-17	6.72E-17	5.99E-17	5.90E-17
Sn-109	2.95E-16	2.71E-16	2.52E-16	2.47E-16	2.25E-16	2.22E-16
Sn-110	3.52E-17	3.10E-17	2.82E-17	2.69E-17	2.37E-17	2.34E-17
Sn-111	6.23E-17	5.70E-17	5.27E-17	5.12E-17	4.62E-17	4.55E-17
Sn-113	1.28E-18	9.82E-19	8.60E-19	8.16E-19	6.68E-19	6.47E-19
Sn-113m	5.11E-19	3.38E-19	2.76E-19	2.61E-19	1.94E-19	1.82E-19
Sn-117m	1.82E-17	1.58E-17	1.43E-17	1.35E-17	1.17E-17	1.15E-17
Sn-119m	4.98E-19	3.19E-19	2.63E-19	2.47E-19	1.76E-19	1.65E-19
Sn-121	4.59E-20	4.46E-20	4.38E-20	4.36E-20	4.31E-20	4.29E-20
Sn-121m	2.25E-19	1.54E-19	1.29E-19	1.19E-19	9.29E-20	8.82E-20
Sn-123	1.40E-18	1.31E-18	1.23E-18	1.21E-18	1.13E-18	1.12E-18
Sn-123m	1.78E-17	1.55E-17	1.42E-17	1.33E-17	1.17E-17	1.15E-17
Sn-125	4.52E-17	4.17E-17	3.88E-17	3.80E-17	3.44E-17	3.40E-17
Sn-125m	4.47E-17	4.01E-17	3.67E-17	3.52E-17	3.14E-17	3.09E-17
Sn-126	5.84E-18	4.82E-18	3.83E-18	3.71E-18	3.41E-18	3.27E-18
Sn-127	2.53E-16	2.33E-16	2.16E-16	2.12E-16	1.92E-16	1.89E-16
Sn-127m	7.40E-17	6.78E-17	6.26E-17	6.07E-17	5.47E-17	5.39E-17
Sn-128	7.23E-17	6.54E-17	5.99E-17	5.79E-17	5.16E-17	5.08E-17
Sn-129	1.33E-16	1.22E-16	1.13E-16	1.10E-16	9.96E-17	9.82E-17
Sn-130	1.19E-16	1.08E-16	9.90E-17	9.60E-17	8.58E-17	8.44E-17
Sn-130m	1.17E-16	1.07E-16	9.94E-17	9.70E-17	8.77E-17	8.65E-17
<b>Antimony</b>						
Sb-111	1.90E-16	1.73E-16	1.60E-16	1.54E-16	1.38E-16	1.36E-16
Sb-113	1.60E-16	1.47E-16	1.35E-16	1.31E-16	1.17E-16	1.16E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sb-114	3.55E-16	3.26E-16	3.03E-16	2.96E-16	2.68E-16	2.64E-16
Sb-115	1.11E-16	1.02E-16	9.35E-17	9.04E-17	8.10E-17	7.97E-17
Sb-116	3.02E-16	2.78E-16	2.58E-16	2.52E-16	2.29E-16	2.26E-16
Sb-116m	4.05E-16	3.72E-16	3.45E-16	3.36E-16	3.04E-16	3.00E-16
Sb-117	2.15E-17	1.87E-17	1.70E-17	1.61E-17	1.41E-17	1.38E-17
Sb-118	1.02E-16	9.34E-17	8.61E-17	8.33E-17	7.47E-17	7.35E-17
Sb-118m	3.42E-16	3.13E-16	2.91E-16	2.84E-16	2.56E-16	2.53E-16
Sb-119	8.05E-19	5.18E-19	4.26E-19	3.99E-19	2.87E-19	2.69E-19
Sb-120	5.62E-17	5.14E-17	4.73E-17	4.58E-17	4.10E-17	4.04E-17
Sb-120m	3.22E-16	2.95E-16	2.73E-16	2.67E-16	2.41E-16	2.38E-16
Sb-122	5.68E-17	5.22E-17	4.82E-17	4.67E-17	4.20E-17	4.13E-17
Sb-122m	6.23E-18	4.91E-18	3.93E-18	3.93E-18	3.31E-18	3.16E-18
Sb-124	2.47E-16	2.27E-16	2.10E-16	2.06E-16	1.87E-16	1.85E-16
Sb-124m	5.58E-17	5.12E-17	4.73E-17	4.58E-17	4.11E-17	4.05E-17
Sb-124n	2.98E-23	1.92E-23	1.58E-23	1.47E-23	1.07E-23	1.00E-23
Sb-125	5.39E-17	4.91E-17	4.51E-17	4.36E-17	3.89E-17	3.84E-17
Sb-126	3.52E-16	3.24E-16	2.99E-16	2.91E-16	2.61E-16	2.57E-16
Sb-126m	1.98E-16	1.81E-16	1.68E-16	1.63E-16	1.46E-16	1.44E-16
Sb-127	8.84E-17	8.11E-17	7.49E-17	7.27E-17	6.51E-17	6.42E-17
Sb-128	3.97E-16	3.65E-16	3.38E-16	3.28E-16	2.95E-16	2.91E-16
Sb-128m	2.46E-16	2.26E-16	2.09E-16	2.03E-16	1.82E-16	1.79E-16
Sb-129	1.92E-16	1.77E-16	1.64E-16	1.60E-16	1.45E-16	1.43E-16
Sb-130	4.26E-16	3.90E-16	3.61E-16	3.52E-16	3.16E-16	3.12E-16
Sb-130m	3.54E-16	3.26E-16	3.02E-16	2.95E-16	2.66E-16	2.62E-16
Sb-131	2.76E-16	2.54E-16	2.36E-16	2.31E-16	2.10E-16	2.07E-16
Sb-133	3.71E-16	3.42E-16	3.18E-16	3.12E-16	2.85E-16	2.81E-16
<b>Tellurium</b>						
Te-113	2.93E-16	2.69E-16	2.50E-16	2.43E-16	2.21E-16	2.18E-16
Te-114	1.67E-16	1.53E-16	1.42E-16	1.38E-16	1.25E-16	1.24E-16
Te-115	2.94E-16	2.70E-16	2.50E-16	2.44E-16	2.20E-16	2.17E-16
Te-115m	3.44E-16	3.16E-16	2.93E-16	2.86E-16	2.59E-16	2.56E-16
Te-116	1.12E-17	9.69E-18	8.46E-18	8.10E-18	7.34E-18	7.15E-18
Te-117	2.03E-16	1.87E-16	1.73E-16	1.69E-16	1.54E-16	1.52E-16
Te-118	7.80E-19	5.10E-19	4.18E-19	3.88E-19	2.88E-19	2.71E-19
Te-119	9.69E-17	8.89E-17	8.23E-17	8.00E-17	7.19E-17	7.09E-17
Te-119m	1.97E-16	1.81E-16	1.68E-16	1.64E-16	1.48E-16	1.46E-16
Te-121	7.10E-17	6.50E-17	5.99E-17	5.79E-17	5.19E-17	5.11E-17
Te-121m	2.65E-17	2.32E-17	2.11E-17	2.01E-17	1.77E-17	1.74E-17
Te-123	1.36E-21	8.86E-22	7.26E-22	6.74E-22	5.01E-22	4.71E-22
Te-123m	1.73E-17	1.50E-17	1.36E-17	1.28E-17	1.12E-17	1.09E-17
Te-125m	1.61E-18	1.08E-18	8.91E-19	8.21E-19	6.33E-19	5.99E-19
Te-127	7.54E-19	6.91E-19	6.41E-19	6.21E-19	5.66E-19	5.59E-19
Te-127m	5.13E-19	3.50E-19	2.89E-19	2.69E-19	2.09E-19	1.98E-19
Te-129	7.97E-18	7.24E-18	6.68E-18	6.46E-18	5.80E-18	5.72E-18
Te-129m	4.33E-18	3.91E-18	3.60E-18	3.50E-18	3.13E-18	3.08E-18
Te-131	5.41E-17	4.91E-17	4.52E-17	4.36E-17	3.91E-17	3.85E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Te-131m	1.89E-16	1.74E-16	1.61E-16	1.57E-16	1.41E-16	1.39E-16
Te-132	2.78E-17	2.40E-17	2.17E-17	2.05E-17	1.80E-17	1.77E-17
Te-133	1.59E-16	1.45E-16	1.35E-16	1.31E-16	1.19E-16	1.17E-16
Te-133m	2.44E-16	2.24E-16	2.08E-16	2.03E-16	1.83E-16	1.80E-16
Te-134	1.10E-16	1.00E-16	9.20E-17	8.91E-17	7.96E-17	7.84E-17
<b>Iodine</b>						
I-118	2.62E-16	2.40E-16	2.22E-16	2.16E-16	1.94E-16	1.91E-16
I-118m	4.82E-16	4.43E-16	4.10E-16	3.99E-16	3.59E-16	3.53E-16
I-119	1.15E-16	1.04E-16	9.56E-17	9.21E-17	8.23E-17	8.11E-17
I-120	3.54E-16	3.26E-16	3.03E-16	2.96E-16	2.70E-16	2.67E-16
I-120m	4.58E-16	4.21E-16	3.89E-16	3.79E-16	3.43E-16	3.38E-16
I-121	4.90E-17	4.37E-17	3.99E-17	3.82E-17	3.39E-17	3.34E-17
I-122	1.23E-16	1.12E-16	1.03E-16	1.00E-16	8.98E-17	8.85E-17
I-123	1.96E-17	1.70E-17	1.54E-17	1.45E-17	1.27E-17	1.24E-17
I-124	1.44E-16	1.32E-16	1.22E-16	1.19E-16	1.08E-16	1.06E-16
I-125	1.88E-18	1.25E-18	1.03E-18	9.44E-19	7.20E-19	6.79E-19
I-126	5.44E-17	4.97E-17	4.58E-17	4.43E-17	3.97E-17	3.91E-17
I-128	9.20E-18	8.40E-18	7.75E-18	7.49E-18	6.75E-18	6.65E-18
I-129	1.33E-18	9.13E-19	7.55E-19	6.89E-19	5.42E-19	5.14E-19
I-130	2.73E-16	2.51E-16	2.32E-16	2.25E-16	2.02E-16	1.99E-16
I-130m	1.37E-17	1.25E-17	1.15E-17	1.12E-17	1.00E-17	9.88E-18
I-131	4.82E-17	4.35E-17	3.98E-17	3.83E-17	3.41E-17	3.36E-17
I-132	2.93E-16	2.70E-16	2.50E-16	2.44E-16	2.20E-16	2.17E-16
I-132m	4.26E-17	3.90E-17	3.60E-17	3.49E-17	3.13E-17	3.08E-17
I-133	7.81E-17	7.16E-17	6.62E-17	6.41E-17	5.76E-17	5.67E-17
I-134	3.40E-16	3.13E-16	2.91E-16	2.84E-16	2.56E-16	2.52E-16
I-134m	3.47E-17	3.06E-17	2.78E-17	2.66E-17	2.35E-17	2.31E-17
I-135	2.13E-16	1.95E-16	1.82E-16	1.78E-16	1.62E-16	1.60E-16
<b>Xenon</b>						
Xe-120	4.78E-17	4.31E-17	3.95E-17	3.82E-17	3.41E-17	3.35E-17
Xe-121	1.94E-16	1.78E-16	1.65E-16	1.60E-16	1.46E-16	1.44E-16
Xe-122	6.73E-18	5.77E-18	5.19E-18	4.94E-18	4.33E-18	4.24E-18
Xe-123	8.12E-17	7.36E-17	6.79E-17	6.57E-17	5.91E-17	5.82E-17
Xe-125	3.20E-17	2.80E-17	2.54E-17	2.42E-17	2.13E-17	2.10E-17
Xe-127	3.34E-17	2.91E-17	2.63E-17	2.50E-17	2.19E-17	2.16E-17
Xe-127m	1.97E-17	1.70E-17	1.50E-17	1.39E-17	1.26E-17	1.23E-17
Xe-129m	3.40E-18	2.56E-18	2.20E-18	2.05E-18	1.70E-18	1.64E-18
Xe-131m	1.30E-18	9.75E-19	8.39E-19	7.80E-19	6.47E-19	6.24E-19
Xe-133	4.54E-18	3.66E-18	2.91E-18	2.85E-18	2.55E-18	2.44E-18
Xe-133m	3.93E-18	3.28E-18	2.93E-18	2.77E-18	2.41E-18	2.36E-18
Xe-135	3.17E-17	2.79E-17	2.54E-17	2.42E-17	2.14E-17	2.11E-17
Xe-135m	5.32E-17	4.87E-17	4.48E-17	4.33E-17	3.88E-17	3.82E-17
Xe-137	2.71E-17	2.49E-17	2.30E-17	2.23E-17	2.02E-17	1.99E-17
Xe-138	1.53E-16	1.39E-16	1.29E-16	1.27E-16	1.16E-16	1.14E-16
<b>Cesium</b>						
Cs-121	1.51E-16	1.38E-16	1.27E-16	1.23E-16	1.10E-16	1.08E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Cs-121m	1.51E-16	1.37E-16	1.27E-16	1.22E-16	1.09E-16	1.08E-16
Cs-123	1.37E-16	1.26E-16	1.15E-16	1.12E-16	1.00E-16	9.88E-17
Cs-124	1.51E-16	1.38E-16	1.27E-16	1.23E-16	1.10E-16	1.09E-16
Cs-125	9.51E-17	8.69E-17	8.00E-17	7.75E-17	6.96E-17	6.86E-17
Cs-126	1.48E-16	1.35E-16	1.25E-16	1.20E-16	1.08E-16	1.06E-16
Cs-127	5.28E-17	4.76E-17	4.36E-17	4.19E-17	3.74E-17	3.69E-17
Cs-128	1.13E-16	1.03E-16	9.52E-17	9.21E-17	8.25E-17	8.13E-17
Cs-129	3.27E-17	2.92E-17	2.66E-17	2.55E-17	2.27E-17	2.23E-17
Cs-130	6.28E-17	5.73E-17	5.28E-17	5.11E-17	4.58E-17	4.51E-17
Cs-130m	6.76E-18	5.46E-18	4.52E-18	4.35E-18	3.82E-18	3.67E-18
Cs-131	1.15E-18	7.79E-19	6.40E-19	5.86E-19	4.57E-19	4.33E-19
Cs-132	8.94E-17	8.21E-17	7.58E-17	7.37E-17	6.60E-17	6.50E-17
Cs-134	1.99E-16	1.84E-16	1.70E-16	1.65E-16	1.48E-16	1.46E-16
Cs-134m	2.54E-18	2.11E-18	1.82E-18	1.68E-18	1.51E-18	1.47E-18
Cs-135	2.49E-20	2.42E-20	2.38E-20	2.37E-20	2.34E-20	2.33E-20
Cs-135m	2.07E-16	1.91E-16	1.77E-16	1.73E-16	1.55E-16	1.53E-16
Cs-136	2.78E-16	2.55E-16	2.36E-16	2.31E-16	2.08E-16	2.05E-16
Cs-137	1.12E-19	1.08E-19	1.06E-19	1.05E-19	1.03E-19	1.03E-19
Cs-138	3.20E-16	2.95E-16	2.74E-16	2.69E-16	2.46E-16	2.42E-16
Cs-138m	5.42E-17	4.93E-17	4.56E-17	4.44E-17	4.03E-17	3.97E-17
Cs-139	4.40E-17	4.06E-17	3.79E-17	3.72E-17	3.42E-17	3.38E-17
Cs-140	2.44E-16	2.25E-16	2.09E-16	2.06E-16	1.89E-16	1.87E-16
<b>Barium</b>						
Ba-124	7.17E-17	6.51E-17	5.99E-17	5.80E-17	5.20E-17	5.12E-17
Ba-126	7.32E-17	6.65E-17	6.13E-17	5.95E-17	5.33E-17	5.25E-17
Ba-127	9.22E-17	8.40E-17	7.74E-17	7.48E-17	6.73E-17	6.63E-17
Ba-128	6.61E-18	5.59E-18	5.00E-18	4.74E-18	4.13E-18	4.05E-18
Ba-129	4.11E-17	3.72E-17	3.42E-17	3.30E-17	2.97E-17	2.92E-17
Ba-129m	2.04E-16	1.87E-16	1.73E-16	1.68E-16	1.51E-16	1.49E-16
Ba-131	5.77E-17	5.18E-17	4.72E-17	4.53E-17	4.05E-17	3.98E-17
Ba-131m	8.31E-18	6.97E-18	5.74E-18	5.28E-18	5.03E-18	4.85E-18
Ba-133	4.76E-17	4.20E-17	3.78E-17	3.63E-17	3.22E-17	3.16E-17
Ba-133m	7.39E-18	6.35E-18	5.72E-18	5.44E-18	4.77E-18	4.69E-18
Ba-135m	6.45E-18	5.51E-18	4.95E-18	4.70E-18	4.12E-18	4.05E-18
Ba-137m	7.58E-17	6.98E-17	6.45E-17	6.27E-17	5.62E-17	5.54E-17
Ba-139	6.71E-18	5.95E-18	5.47E-18	5.21E-18	4.65E-18	4.58E-18
Ba-140	2.27E-17	2.06E-17	1.89E-17	1.83E-17	1.63E-17	1.61E-17
Ba-141	1.22E-16	1.11E-16	1.02E-16	9.89E-17	8.91E-17	8.78E-17
Ba-142	1.37E-16	1.25E-16	1.16E-16	1.13E-16	1.02E-16	1.00E-16
<b>Lanthanum</b>						
La-128	3.66E-16	3.35E-16	3.10E-16	3.01E-16	2.71E-16	2.67E-16
La-129	1.16E-16	1.05E-16	9.69E-17	9.35E-17	8.37E-17	8.25E-17
La-130	2.89E-16	2.65E-16	2.45E-16	2.38E-16	2.15E-16	2.12E-16
La-131	8.21E-17	7.42E-17	6.79E-17	6.54E-17	5.86E-17	5.77E-17
La-132	2.61E-16	2.40E-16	2.22E-16	2.16E-16	1.96E-16	1.94E-16
La-132m	8.41E-17	7.65E-17	7.03E-17	6.79E-17	6.08E-17	5.99E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
La-133	1.86E-17	1.67E-17	1.53E-17	1.47E-17	1.31E-17	1.29E-17
La-134	9.11E-17	8.33E-17	7.68E-17	7.43E-17	6.66E-17	6.56E-17
La-135	2.74E-18	2.19E-18	1.92E-18	1.81E-18	1.54E-18	1.50E-18
La-136	5.04E-17	4.60E-17	4.23E-17	4.09E-17	3.66E-17	3.61E-17
La-137	1.41E-18	9.77E-19	8.09E-19	7.36E-19	5.84E-19	5.55E-19
La-138	1.64E-16	1.51E-16	1.40E-16	1.37E-16	1.25E-16	1.23E-16
La-140	3.11E-16	2.85E-16	2.65E-16	2.59E-16	2.36E-16	2.33E-16
La-141	4.82E-18	4.47E-18	4.19E-18	4.11E-18	3.81E-18	3.77E-18
La-142	3.26E-16	3.01E-16	2.81E-16	2.76E-16	2.54E-16	2.51E-16
La-143	3.73E-17	3.43E-17	3.20E-17	3.13E-17	2.87E-17	2.84E-17
<b>Cerium</b>						
Ce-130	6.18E-17	5.55E-17	5.08E-17	4.89E-17	4.38E-17	4.31E-17
Ce-131	2.10E-16	1.91E-16	1.77E-16	1.72E-16	1.55E-16	1.53E-16
Ce-132	3.25E-17	2.83E-17	2.56E-17	2.43E-17	2.13E-17	2.09E-17
Ce-133	6.55E-17	5.89E-17	5.35E-17	5.15E-17	4.63E-17	4.54E-17
Ce-133m	2.25E-16	2.06E-16	1.90E-16	1.85E-16	1.68E-16	1.65E-16
Ce-134	1.78E-18	1.28E-18	1.08E-18	9.84E-19	7.99E-19	7.63E-19
Ce-135	1.03E-16	9.34E-17	8.59E-17	8.30E-17	7.42E-17	7.30E-17
Ce-137	2.99E-18	2.39E-18	2.10E-18	1.97E-18	1.68E-18	1.63E-18
Ce-137m	5.88E-18	5.00E-18	4.49E-18	4.27E-18	3.73E-18	3.66E-18
Ce-139	1.82E-17	1.56E-17	1.41E-17	1.32E-17	1.15E-17	1.13E-17
Ce-141	9.26E-18	8.01E-18	7.22E-18	6.75E-18	5.94E-18	5.82E-18
Ce-143	3.43E-17	3.06E-17	2.79E-17	2.69E-17	2.38E-17	2.35E-17
Ce-144	2.22E-18	1.89E-18	1.66E-18	1.54E-18	1.38E-18	1.35E-18
Ce-145	1.03E-16	9.43E-17	8.70E-17	8.46E-17	7.59E-17	7.47E-17
<b>Praseodymium</b>						
Pr-134	4.06E-16	3.71E-16	3.43E-16	3.33E-16	2.99E-16	2.95E-16
Pr-134m	3.03E-16	2.77E-16	2.57E-16	2.50E-16	2.26E-16	2.23E-16
Pr-135	1.10E-16	9.99E-17	9.18E-17	8.88E-17	7.96E-17	7.84E-17
Pr-136	2.79E-16	2.56E-16	2.37E-16	2.30E-16	2.08E-16	2.05E-16
Pr-137	4.58E-17	4.17E-17	3.84E-17	3.72E-17	3.34E-17	3.28E-17
Pr-138	1.04E-16	9.51E-17	8.77E-17	8.48E-17	7.60E-17	7.49E-17
Pr-138m	3.20E-16	2.94E-16	2.72E-16	2.65E-16	2.38E-16	2.35E-16
Pr-139	1.49E-17	1.33E-17	1.22E-17	1.18E-17	1.05E-17	1.03E-17
Pr-140	6.86E-17	6.26E-17	5.77E-17	5.57E-17	4.99E-17	4.91E-17
Pr-142	8.86E-18	8.15E-18	7.62E-18	7.48E-18	6.90E-18	6.81E-18
Pr-142m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pr-143	2.38E-19	2.29E-19	2.23E-19	2.21E-19	2.17E-19	2.16E-19
Pr-144	5.52E-18	5.11E-18	4.80E-18	4.71E-18	4.37E-18	4.32E-18
Pr-144m	9.70E-19	7.39E-19	6.40E-19	5.91E-19	4.95E-19	4.77E-19
Pr-145	3.09E-18	2.87E-18	2.68E-18	2.62E-18	2.40E-18	2.37E-18
Pr-146	1.36E-16	1.25E-16	1.16E-16	1.14E-16	1.04E-16	1.02E-16
Pr-147	6.18E-17	5.59E-17	5.13E-17	4.98E-17	4.48E-17	4.40E-17
Pr-148	1.34E-16	1.23E-16	1.14E-16	1.11E-16	1.01E-16	9.92E-17
Pr-148m	1.22E-16	1.11E-16	1.02E-16	9.87E-17	8.85E-17	8.72E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Neodymium</b>						
Nd-134	6.69E-17	6.00E-17	5.48E-17	5.26E-17	4.68E-17	4.60E-17
Nd-135	1.59E-16	1.44E-16	1.33E-16	1.28E-16	1.15E-16	1.13E-16
Nd-136	3.25E-17	2.88E-17	2.61E-17	2.49E-17	2.24E-17	2.20E-17
Nd-137	1.51E-16	1.38E-16	1.27E-16	1.24E-16	1.11E-16	1.10E-16
Nd-138	3.77E-18	3.01E-18	2.65E-18	2.47E-18	2.10E-18	2.04E-18
Nd-139	5.53E-17	5.04E-17	4.64E-17	4.49E-17	4.03E-17	3.97E-17
Nd-139m	2.04E-16	1.87E-16	1.73E-16	1.68E-16	1.52E-16	1.50E-16
Nd-140	1.91E-18	1.37E-18	1.15E-18	1.04E-18	8.38E-19	7.98E-19
Nd-141	8.08E-18	7.04E-18	6.40E-18	6.14E-18	5.43E-18	5.33E-18
Nd-141m	8.93E-17	8.23E-17	7.63E-17	7.43E-17	6.67E-17	6.57E-17
Nd-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.67E-17	1.48E-17	1.33E-17	1.27E-17	1.14E-17	1.12E-17
Nd-149	4.66E-17	4.16E-17	3.78E-17	3.61E-17	3.22E-17	3.17E-17
Nd-151	1.11E-16	1.01E-16	9.33E-17	9.07E-17	8.19E-17	8.07E-17
Nd-152	2.08E-17	1.84E-17	1.68E-17	1.60E-17	1.42E-17	1.40E-17
<b>Promethium</b>						
Pm-136	3.50E-16	3.21E-16	2.96E-16	2.87E-16	2.57E-16	2.54E-16
Pm-137m	2.27E-16	2.06E-16	1.89E-16	1.83E-16	1.64E-16	1.62E-16
Pm-139	1.20E-16	1.10E-16	1.01E-16	9.79E-17	8.79E-17	8.66E-17
Pm-140	1.37E-16	1.25E-16	1.15E-16	1.12E-16	1.00E-16	9.88E-17
Pm-140m	3.92E-16	3.60E-16	3.33E-16	3.24E-16	2.91E-16	2.87E-16
Pm-141	9.41E-17	8.60E-17	7.95E-17	7.71E-17	6.94E-17	6.84E-17
Pm-142	1.10E-16	1.01E-16	9.28E-17	8.97E-17	8.06E-17	7.94E-17
Pm-143	3.88E-17	3.54E-17	3.26E-17	3.17E-17	2.83E-17	2.79E-17
Pm-144	1.97E-16	1.81E-16	1.67E-16	1.62E-16	1.45E-16	1.43E-16
Pm-145	2.26E-18	1.66E-18	1.39E-18	1.27E-18	1.04E-18	9.86E-19
Pm-146	9.45E-17	8.64E-17	7.97E-17	7.73E-17	6.92E-17	6.81E-17
Pm-147	1.04E-20	9.95E-21	9.71E-21	9.64E-21	9.47E-21	9.43E-21
Pm-148	7.69E-17	7.07E-17	6.57E-17	6.42E-17	5.83E-17	5.76E-17
Pm-148m	2.54E-16	2.33E-16	2.15E-16	2.09E-16	1.87E-16	1.85E-16
Pm-149	1.80E-18	1.63E-18	1.50E-18	1.45E-18	1.31E-18	1.30E-18
Pm-150	1.95E-16	1.79E-16	1.66E-16	1.62E-16	1.47E-16	1.45E-16
Pm-151	4.12E-17	3.69E-17	3.37E-17	3.24E-17	2.88E-17	2.84E-17
Pm-152	3.93E-17	3.61E-17	3.34E-17	3.26E-17	2.96E-17	2.92E-17
Pm-152m	2.00E-16	1.82E-16	1.68E-16	1.64E-16	1.48E-16	1.46E-16
Pm-153	9.45E-18	8.17E-18	7.21E-18	6.78E-18	6.17E-18	6.02E-18
Pm-154	2.43E-16	2.24E-16	2.08E-16	2.04E-16	1.87E-16	1.85E-16
Pm-154m	2.39E-16	2.19E-16	2.03E-16	1.98E-16	1.80E-16	1.77E-16
<b>Samarium</b>						
Sm-139	1.87E-16	1.70E-16	1.57E-16	1.52E-16	1.36E-16	1.34E-16
Sm-140	7.20E-17	6.54E-17	6.03E-17	5.85E-17	5.26E-17	5.18E-17
Sm-141	1.82E-16	1.66E-16	1.54E-16	1.49E-16	1.34E-16	1.33E-16
Sm-141m	2.52E-16	2.31E-16	2.13E-16	2.07E-16	1.87E-16	1.84E-16
Sm-142	1.24E-17	1.10E-17	1.00E-17	9.58E-18	8.49E-18	8.33E-18
Sm-143	6.65E-17	6.07E-17	5.59E-17	5.41E-17	4.85E-17	4.77E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Sm-143m	8.79E-17	8.11E-17	7.51E-17	7.32E-17	6.57E-17	6.47E-17
Sm-145	4.94E-18	3.66E-18	3.09E-18	2.84E-18	2.31E-18	2.21E-18
Sm-146	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-147	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151	2.05E-22	1.28E-22	1.08E-22	1.05E-22	6.62E-23	6.10E-23
Sm-153	6.75E-18	5.53E-18	4.60E-18	4.26E-18	3.92E-18	3.77E-18
Sm-155	1.28E-17	1.10E-17	9.21E-18	8.57E-18	8.15E-18	7.89E-18
Sm-156	1.40E-17	1.21E-17	1.07E-17	1.01E-17	9.02E-18	8.83E-18
Sm-157	5.39E-17	4.84E-17	4.43E-17	4.27E-17	3.82E-17	3.77E-17
<b>Europium</b>						
Eu-142	1.59E-16	1.46E-16	1.35E-16	1.31E-16	1.18E-16	1.16E-16
Eu-142m	4.44E-16	4.09E-16	3.78E-16	3.68E-16	3.31E-16	3.26E-16
Eu-143	1.46E-16	1.34E-16	1.24E-16	1.20E-16	1.09E-16	1.07E-16
Eu-144	1.43E-16	1.31E-16	1.21E-16	1.17E-16	1.06E-16	1.04E-16
Eu-145	1.68E-16	1.54E-16	1.43E-16	1.40E-16	1.27E-16	1.25E-16
Eu-146	3.12E-16	2.87E-16	2.66E-16	2.59E-16	2.34E-16	2.31E-16
Eu-147	5.87E-17	5.30E-17	4.86E-17	4.70E-17	4.21E-17	4.15E-17
Eu-148	2.85E-16	2.61E-16	2.42E-16	2.35E-16	2.11E-16	2.08E-16
Eu-149	6.57E-18	5.48E-18	4.90E-18	4.60E-18	3.98E-18	3.88E-18
Eu-150	1.97E-16	1.79E-16	1.65E-16	1.60E-16	1.43E-16	1.41E-16
Eu-150m	6.38E-18	5.77E-18	5.31E-18	5.13E-18	4.61E-18	4.54E-18
Eu-152	1.53E-16	1.40E-16	1.29E-16	1.26E-16	1.14E-16	1.12E-16
Eu-152m	3.86E-17	3.54E-17	3.27E-17	3.19E-17	2.87E-17	2.83E-17
Eu-152n	8.34E-18	6.94E-18	5.55E-18	5.28E-18	4.96E-18	4.75E-18
Eu-154	1.64E-16	1.50E-16	1.39E-16	1.36E-16	1.23E-16	1.21E-16
Eu-154m	7.13E-18	5.81E-18	4.69E-18	4.51E-18	4.05E-18	3.88E-18
Eu-155	6.87E-18	5.72E-18	4.63E-18	4.36E-18	4.09E-18	3.92E-18
Eu-156	1.66E-16	1.53E-16	1.42E-16	1.39E-16	1.27E-16	1.25E-16
Eu-157	3.56E-17	3.18E-17	2.89E-17	2.79E-17	2.48E-17	2.43E-17
Eu-158	1.72E-16	1.59E-16	1.47E-16	1.44E-16	1.31E-16	1.29E-16
Eu-159	3.77E-17	3.38E-17	3.07E-17	2.98E-17	2.67E-17	2.62E-17
<b>Gadolinium</b>						
Gd-142	1.34E-16	1.23E-16	1.13E-16	1.10E-16	9.90E-17	9.76E-17
Gd-143m	2.75E-16	2.51E-16	2.32E-16	2.25E-16	2.03E-16	2.00E-16
Gd-144	1.19E-16	1.09E-16	1.01E-16	9.79E-17	8.88E-17	8.76E-17
Gd-145	3.29E-16	3.02E-16	2.81E-16	2.75E-16	2.53E-16	2.50E-16
Gd-145m	8.69E-17	7.99E-17	7.39E-17	7.19E-17	6.44E-17	6.35E-17
Gd-146	2.76E-17	2.31E-17	2.01E-17	1.85E-17	1.66E-17	1.61E-17
Gd-147	1.79E-16	1.63E-16	1.51E-16	1.46E-16	1.31E-16	1.29E-16
Gd-148	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-149	6.50E-17	5.81E-17	5.32E-17	5.10E-17	4.53E-17	4.45E-17
Gd-150	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-151	7.05E-18	5.80E-18	5.16E-18	4.80E-18	4.12E-18	4.01E-18
Gd-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gd-153	1.05E-17	8.47E-18	7.00E-18	6.44E-18	5.87E-18	5.62E-18



**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Gd-159	6.61E-18	5.84E-18	5.31E-18	5.08E-18	4.50E-18	4.43E-18
Gd-162	5.24E-17	4.75E-17	4.36E-17	4.20E-17	3.75E-17	3.69E-17
<b>Terbium</b>						
Tb-146	4.87E-16	4.48E-16	4.16E-16	4.07E-16	3.71E-16	3.66E-16
Tb-147	2.86E-16	2.63E-16	2.44E-16	2.38E-16	2.16E-16	2.13E-16
Tb-147m	2.56E-16	2.35E-16	2.18E-16	2.14E-16	1.95E-16	1.92E-16
Tb-148	3.10E-16	2.86E-16	2.65E-16	2.58E-16	2.34E-16	2.31E-16
Tb-148m	4.02E-16	3.69E-16	3.41E-16	3.32E-16	2.98E-16	2.94E-16
Tb-149	1.77E-16	1.62E-16	1.50E-16	1.46E-16	1.32E-16	1.30E-16
Tb-149m	1.75E-16	1.61E-16	1.49E-16	1.45E-16	1.30E-16	1.28E-16
Tb-150	3.26E-16	3.00E-16	2.79E-16	2.73E-16	2.50E-16	2.47E-16
Tb-150m	3.18E-16	2.92E-16	2.69E-16	2.61E-16	2.33E-16	2.30E-16
Tb-151	1.25E-16	1.13E-16	1.03E-16	9.95E-17	8.91E-17	8.77E-17
Tb-151m	9.37E-18	8.38E-18	7.66E-18	7.37E-18	6.54E-18	6.43E-18
Tb-152	1.96E-16	1.79E-16	1.66E-16	1.62E-16	1.47E-16	1.45E-16
Tb-152m	9.47E-17	8.49E-17	7.77E-17	7.47E-17	6.64E-17	6.54E-17
Tb-153	4.00E-17	3.53E-17	3.20E-17	3.07E-17	2.73E-17	2.68E-17
Tb-154	3.09E-16	2.83E-16	2.64E-16	2.58E-16	2.37E-16	2.34E-16
Tb-155	1.98E-17	1.66E-17	1.44E-17	1.35E-17	1.21E-17	1.17E-17
Tb-156	2.52E-16	2.30E-16	2.13E-16	2.07E-16	1.87E-16	1.85E-16
Tb-156m	3.43E-18	2.64E-18	2.26E-18	2.08E-18	1.72E-18	1.64E-18
Tb-156n	3.50E-19	2.75E-19	2.30E-19	2.13E-19	1.85E-19	1.77E-19
Tb-157	3.86E-19	2.90E-19	2.49E-19	2.25E-19	1.84E-19	1.75E-19
Tb-158	1.03E-16	9.44E-17	8.73E-17	8.52E-17	7.65E-17	7.53E-17
Tb-160	1.47E-16	1.35E-16	1.25E-16	1.22E-16	1.10E-16	1.09E-16
Tb-161	3.14E-18	2.46E-18	2.06E-18	1.96E-18	1.66E-18	1.59E-18
Tb-162	1.43E-16	1.31E-16	1.20E-16	1.17E-16	1.05E-16	1.03E-16
Tb-163	9.93E-17	9.01E-17	8.27E-17	7.96E-17	7.11E-17	7.00E-17
Tb-164	3.21E-16	2.94E-16	2.72E-16	2.65E-16	2.40E-16	2.36E-16
Tb-165	1.13E-16	1.04E-16	9.63E-17	9.42E-17	8.58E-17	8.46E-17
<b>Dysprosium</b>						
Dy-148	8.96E-17	8.19E-17	7.55E-17	7.32E-17	6.55E-17	6.45E-17
Dy-149	2.13E-16	1.95E-16	1.80E-16	1.76E-16	1.60E-16	1.58E-16
Dy-150	3.40E-17	3.04E-17	2.78E-17	2.67E-17	2.37E-17	2.33E-17
Dy-151	1.78E-16	1.63E-16	1.51E-16	1.47E-16	1.33E-16	1.31E-16
Dy-152	3.49E-17	3.03E-17	2.74E-17	2.60E-17	2.29E-17	2.25E-17
Dy-153	1.10E-16	9.95E-17	9.14E-17	8.86E-17	7.96E-17	7.83E-17
Dy-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dy-155	8.52E-17	7.68E-17	7.07E-17	6.85E-17	6.13E-17	6.04E-17
Dy-157	4.21E-17	3.72E-17	3.38E-17	3.22E-17	2.85E-17	2.80E-17
Dy-159	3.87E-18	2.93E-18	2.51E-18	2.29E-18	1.88E-18	1.79E-18
Dy-165	3.58E-18	3.20E-18	2.90E-18	2.80E-18	2.54E-18	2.49E-18
Dy-165m	2.11E-18	1.84E-18	1.64E-18	1.55E-18	1.39E-18	1.36E-18
Dy-166	4.34E-18	3.51E-18	2.96E-18	2.81E-18	2.44E-18	2.34E-18
Dy-167	6.77E-17	6.12E-17	5.62E-17	5.42E-17	4.83E-17	4.76E-17
Dy-168	4.92E-17	4.43E-17	4.06E-17	3.90E-17	3.48E-17	3.42E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
<b>Holmium</b>						
Ho-150	2.44E-16	2.24E-16	2.07E-16	2.01E-16	1.81E-16	1.78E-16
Ho-153	1.31E-16	1.19E-16	1.09E-16	1.06E-16	9.45E-17	9.31E-17
Ho-153m	1.34E-16	1.21E-16	1.11E-16	1.08E-16	9.63E-17	9.48E-17
Ho-154	2.43E-16	2.22E-16	2.05E-16	1.99E-16	1.78E-16	1.76E-16
Ho-154m	3.09E-16	2.82E-16	2.60E-16	2.51E-16	2.25E-16	2.21E-16
Ho-155	7.74E-17	6.99E-17	6.42E-17	6.20E-17	5.57E-17	5.48E-17
Ho-156	2.76E-16	2.52E-16	2.33E-16	2.26E-16	2.05E-16	2.02E-16
Ho-157	7.17E-17	6.40E-17	5.84E-17	5.62E-17	5.00E-17	4.92E-17
Ho-159	4.58E-17	3.99E-17	3.57E-17	3.39E-17	3.02E-17	2.96E-17
Ho-160	2.17E-16	1.99E-16	1.84E-16	1.80E-16	1.61E-16	1.59E-16
Ho-161	4.90E-18	3.79E-18	3.22E-18	2.97E-18	2.50E-18	2.39E-18
Ho-162	1.95E-17	1.72E-17	1.57E-17	1.52E-17	1.35E-17	1.33E-17
Ho-162m	7.14E-17	6.47E-17	5.96E-17	5.79E-17	5.20E-17	5.12E-17
Ho-163	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ho-164	2.77E-18	2.16E-18	1.84E-18	1.71E-18	1.44E-18	1.38E-18
Ho-164m	3.97E-18	3.04E-18	2.59E-18	2.39E-18	1.97E-18	1.88E-18
Ho-166	4.36E-18	3.90E-18	3.55E-18	3.47E-18	3.18E-18	3.12E-18
Ho-166m	2.08E-16	1.89E-16	1.75E-16	1.69E-16	1.52E-16	1.49E-16
Ho-167	4.58E-17	4.09E-17	3.72E-17	3.57E-17	3.17E-17	3.12E-17
Ho-168	1.14E-16	1.05E-16	9.70E-17	9.46E-17	8.51E-17	8.39E-17
Ho-168m	5.62E-19	4.31E-19	3.69E-19	3.39E-19	2.80E-19	2.67E-19
Ho-170	2.22E-16	2.03E-16	1.88E-16	1.83E-16	1.65E-16	1.62E-16
<b>Erbium</b>						
Er-154	7.31E-18	6.09E-18	5.42E-18	5.12E-18	4.42E-18	4.29E-18
Er-156	6.02E-18	4.78E-18	4.16E-18	3.87E-18	3.27E-18	3.15E-18
Er-159	1.24E-16	1.13E-16	1.04E-16	1.01E-16	9.14E-17	9.01E-17
Er-161	1.27E-16	1.16E-16	1.08E-16	1.05E-16	9.43E-17	9.29E-17
Er-163	3.64E-18	2.81E-18	2.41E-18	2.22E-18	1.84E-18	1.76E-18
Er-165	3.37E-18	2.59E-18	2.21E-18	2.04E-18	1.68E-18	1.60E-18
Er-167m	1.19E-17	1.03E-17	9.31E-18	8.81E-18	7.73E-18	7.60E-18
Er-169	3.42E-20	3.32E-20	3.25E-20	3.24E-20	3.20E-20	3.19E-20
Er-171	4.65E-17	4.11E-17	3.71E-17	3.54E-17	3.15E-17	3.10E-17
Er-172	6.40E-17	5.80E-17	5.32E-17	5.13E-17	4.58E-17	4.50E-17
Er-173	1.07E-16	9.64E-17	8.83E-17	8.54E-17	7.66E-17	7.53E-17
<b>Thulium</b>						
Tm-161	1.69E-16	1.52E-16	1.40E-16	1.37E-16	1.24E-16	1.22E-16
Tm-162	2.55E-16	2.34E-16	2.17E-16	2.13E-16	1.94E-16	1.92E-16
Tm-163	1.72E-16	1.57E-16	1.45E-16	1.41E-16	1.28E-16	1.26E-16
Tm-164	1.00E-16	9.15E-17	8.45E-17	8.21E-17	7.41E-17	7.31E-17
Tm-165	6.96E-17	6.23E-17	5.69E-17	5.48E-17	4.87E-17	4.79E-17
Tm-166	2.62E-16	2.40E-16	2.23E-16	2.18E-16	1.98E-16	1.96E-16
Tm-167	1.69E-17	1.44E-17	1.28E-17	1.21E-17	1.05E-17	1.03E-17
Tm-168	1.58E-16	1.44E-16	1.32E-16	1.28E-16	1.15E-16	1.13E-16
Tm-170	6.64E-19	5.77E-19	5.05E-19	4.94E-19	4.59E-19	4.48E-19
Tm-171	6.02E-20	4.74E-20	3.93E-20	3.79E-20	3.17E-20	3.02E-20

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Tm-172	6.40E-17	5.87E-17	5.45E-17	5.35E-17	4.88E-17	4.81E-17
Tm-173	4.88E-17	4.41E-17	4.04E-17	3.89E-17	3.46E-17	3.41E-17
Tm-174	2.29E-16	2.08E-16	1.92E-16	1.86E-16	1.66E-16	1.64E-16
Tm-175	1.40E-16	1.28E-16	1.19E-16	1.15E-16	1.04E-16	1.02E-16
Tm-176	2.63E-16	2.41E-16	2.23E-16	2.18E-16	1.98E-16	1.96E-16
<b>Ytterbium</b>						
Yb-162	3.00E-17	2.62E-17	2.35E-17	2.23E-17	1.98E-17	1.94E-17
Yb-163	9.34E-17	8.51E-17	7.85E-17	7.63E-17	6.88E-17	6.78E-17
Yb-164	5.45E-18	4.43E-18	3.85E-18	3.65E-18	3.10E-18	3.00E-18
Yb-165	4.07E-17	3.61E-17	3.25E-17	3.16E-17	2.82E-17	2.76E-17
Yb-166	8.40E-18	6.61E-18	5.52E-18	5.23E-18	4.42E-18	4.22E-18
Yb-167	3.01E-17	2.53E-17	2.18E-17	2.04E-17	1.83E-17	1.78E-17
Yb-169	3.73E-17	3.13E-17	2.74E-17	2.60E-17	2.27E-17	2.20E-17
Yb-175	4.91E-18	4.38E-18	3.98E-18	3.81E-18	3.40E-18	3.34E-18
Yb-177	2.56E-17	2.33E-17	2.15E-17	2.09E-17	1.88E-17	1.85E-17
Yb-178	4.88E-18	4.40E-18	4.03E-18	3.87E-18	3.45E-18	3.40E-18
Yb-179	1.24E-16	1.13E-16	1.05E-16	1.01E-16	9.07E-17	8.93E-17
<b>Lutetium</b>						
Lu-165	1.43E-16	1.29E-16	1.19E-16	1.16E-16	1.04E-16	1.03E-16
Lu-167	2.25E-16	2.05E-16	1.90E-16	1.85E-16	1.69E-16	1.67E-16
Lu-169	1.73E-16	1.58E-16	1.46E-16	1.43E-16	1.29E-16	1.27E-16
Lu-169m	5.63E-22	3.56E-22	2.85E-22	2.38E-22	7.79E-23	6.90E-23
Lu-170	3.48E-16	3.20E-16	2.98E-16	2.93E-16	2.69E-16	2.65E-16
Lu-171	8.05E-17	7.32E-17	6.72E-17	6.54E-17	5.84E-17	5.74E-17
Lu-171m	3.41E-20	2.73E-20	2.20E-20	2.19E-20	1.84E-20	1.76E-20
Lu-172	2.55E-16	2.33E-16	2.16E-16	2.11E-16	1.90E-16	1.87E-16
Lu-172m	3.15E-22	2.12E-22	1.76E-22	1.52E-22	8.37E-23	7.80E-23
Lu-173	2.04E-17	1.72E-17	1.50E-17	1.43E-17	1.25E-17	1.21E-17
Lu-174	1.36E-17	1.19E-17	1.07E-17	1.04E-17	9.20E-18	8.99E-18
Lu-174m	6.06E-18	4.90E-18	4.15E-18	4.01E-18	3.40E-18	3.27E-18
Lu-176	6.01E-17	5.29E-17	4.78E-17	4.56E-17	4.03E-17	3.96E-17
Lu-176m	1.91E-18	1.62E-18	1.36E-18	1.33E-18	1.22E-18	1.18E-18
Lu-177	4.37E-18	3.79E-18	3.35E-18	3.17E-18	2.83E-18	2.78E-18
Lu-177m	1.24E-16	1.09E-16	9.83E-17	9.37E-17	8.30E-17	8.16E-17
Lu-178	1.74E-17	1.59E-17	1.47E-17	1.44E-17	1.32E-17	1.30E-17
Lu-178m	1.31E-16	1.16E-16	1.05E-16	1.01E-16	8.97E-17	8.82E-17
Lu-179	4.21E-18	3.72E-18	3.40E-18	3.25E-18	2.90E-18	2.86E-18
Lu-180	2.00E-16	1.83E-16	1.70E-16	1.66E-16	1.50E-16	1.48E-16
Lu-181	7.29E-17	6.63E-17	6.09E-17	5.89E-17	5.27E-17	5.19E-17
<b>Hafnium</b>						
Hf-167	7.74E-17	6.99E-17	6.40E-17	6.16E-17	5.49E-17	5.41E-17
Hf-169	7.93E-17	7.19E-17	6.58E-17	6.35E-17	5.67E-17	5.57E-17
Hf-170	5.34E-17	4.76E-17	4.32E-17	4.15E-17	3.69E-17	3.62E-17
Hf-172	1.04E-17	8.43E-18	7.04E-18	6.73E-18	5.80E-18	5.57E-18
Hf-173	4.81E-17	4.19E-17	3.73E-17	3.54E-17	3.16E-17	3.09E-17
Hf-174	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hf-175	4.30E-17	3.79E-17	3.43E-17	3.29E-17	2.91E-17	2.85E-17
Hf-177m	2.85E-16	2.53E-16	2.29E-16	2.19E-16	1.94E-16	1.91E-16
Hf-178m	2.80E-16	2.52E-16	2.30E-16	2.21E-16	1.97E-16	1.94E-16
Hf-179m	1.14E-16	1.01E-16	9.18E-17	8.79E-17	7.80E-17	7.67E-17
Hf-180m	1.23E-16	1.10E-16	9.99E-17	9.59E-17	8.52E-17	8.38E-17
Hf-181	6.62E-17	5.98E-17	5.45E-17	5.24E-17	4.68E-17	4.60E-17
Hf-182	3.01E-17	2.65E-17	2.40E-17	2.29E-17	2.02E-17	1.99E-17
Hf-182m	1.15E-16	1.03E-16	9.43E-17	9.11E-17	8.13E-17	7.99E-17
Hf-183	9.92E-17	9.07E-17	8.34E-17	8.13E-17	7.29E-17	7.18E-17
Hf-184	2.87E-17	2.52E-17	2.27E-17	2.16E-17	1.91E-17	1.88E-17
<b>Tantalum</b>						
Ta-170	1.36E-16	1.25E-16	1.15E-16	1.11E-16	9.95E-17	9.80E-17
Ta-172	2.21E-16	2.02E-16	1.87E-16	1.82E-16	1.64E-16	1.62E-16
Ta-173	7.38E-17	6.66E-17	6.09E-17	5.94E-17	5.34E-17	5.25E-17
Ta-174	1.26E-16	1.15E-16	1.06E-16	1.03E-16	9.26E-17	9.12E-17
Ta-175	1.45E-16	1.32E-16	1.21E-16	1.18E-16	1.07E-16	1.06E-16
Ta-176	3.00E-16	2.75E-16	2.56E-16	2.51E-16	2.29E-16	2.26E-16
Ta-177	7.16E-18	5.88E-18	4.96E-18	4.80E-18	4.15E-18	4.00E-18
Ta-178	1.43E-17	1.25E-17	1.11E-17	1.08E-17	9.63E-18	9.40E-18
Ta-178m	1.43E-16	1.27E-16	1.14E-16	1.09E-16	9.73E-17	9.56E-17
Ta-179	2.44E-18	1.93E-18	1.59E-18	1.55E-18	1.30E-18	1.24E-18
Ta-180	4.85E-18	3.88E-18	3.19E-18	3.09E-18	2.64E-18	2.52E-18
Ta-182	1.70E-16	1.55E-16	1.44E-16	1.41E-16	1.27E-16	1.25E-16
Ta-182m	3.16E-17	2.71E-17	2.42E-17	2.30E-17	2.00E-17	1.96E-17
Ta-183	3.55E-17	3.08E-17	2.73E-17	2.61E-17	2.31E-17	2.26E-17
Ta-184	2.01E-16	1.83E-16	1.68E-16	1.63E-16	1.46E-16	1.44E-16
Ta-185	1.92E-17	1.67E-17	1.50E-17	1.43E-17	1.26E-17	1.24E-17
Ta-186	1.82E-16	1.65E-16	1.52E-16	1.47E-16	1.32E-16	1.30E-16
<b>Tungsten</b>						
W-177	1.15E-16	1.04E-16	9.44E-17	9.15E-17	8.21E-17	8.07E-17
W-178	1.50E-18	1.19E-18	9.75E-19	9.63E-19	8.08E-19	7.71E-19
W-179	5.10E-18	4.03E-18	3.29E-18	3.24E-18	2.71E-18	2.58E-18
W-179m	6.23E-18	5.20E-18	4.44E-18	4.33E-18	3.73E-18	3.62E-18
W-181	4.00E-18	3.18E-18	2.59E-18	2.56E-18	2.15E-18	2.05E-18
W-185	6.11E-20	5.86E-20	5.68E-20	5.64E-20	5.53E-20	5.50E-20
W-185m	2.85E-18	2.41E-18	2.08E-18	2.00E-18	1.75E-18	1.70E-18
W-187	5.66E-17	5.17E-17	4.74E-17	4.60E-17	4.12E-17	4.05E-17
W-188	2.69E-19	2.39E-19	2.18E-19	2.10E-19	1.88E-19	1.85E-19
W-190	1.75E-17	1.48E-17	1.29E-17	1.24E-17	1.08E-17	1.05E-17
<b>Rhenium</b>						
Re-178	2.27E-16	2.09E-16	1.93E-16	1.89E-16	1.72E-16	1.70E-16
Re-179	1.40E-16	1.26E-16	1.16E-16	1.13E-16	1.02E-16	1.00E-16
Re-180	1.55E-16	1.42E-16	1.31E-16	1.28E-16	1.15E-16	1.13E-16
Re-181	1.01E-16	9.12E-17	8.33E-17	8.08E-17	7.22E-17	7.10E-17
Re-182	2.32E-16	2.10E-16	1.93E-16	1.88E-16	1.69E-16	1.66E-16
Re-182m	1.59E-16	1.46E-16	1.34E-16	1.31E-16	1.19E-16	1.17E-16

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Re-183	1.74E-17	1.46E-17	1.26E-17	1.21E-17	1.05E-17	1.02E-17
Re-184	1.14E-16	1.04E-16	9.60E-17	9.38E-17	8.42E-17	8.28E-17
Re-184m	4.76E-17	4.26E-17	3.86E-17	3.74E-17	3.34E-17	3.28E-17
Re-186	2.67E-18	2.30E-18	2.03E-18	1.93E-18	1.73E-18	1.69E-18
Re-186m	1.49E-18	1.18E-18	9.67E-19	9.43E-19	7.96E-19	7.60E-19
Re-187	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Re-188	8.55E-18	7.71E-18	7.09E-18	6.84E-18	6.14E-18	6.04E-18
Re-188m	7.43E-18	6.08E-18	4.90E-18	4.84E-18	4.24E-18	4.06E-18
Re-189	7.14E-18	6.29E-18	5.69E-18	5.45E-18	4.82E-18	4.75E-18
Re-190	1.71E-16	1.56E-16	1.43E-16	1.39E-16	1.24E-16	1.22E-16
Re-190m	1.17E-16	1.06E-16	9.76E-17	9.44E-17	8.44E-17	8.31E-17
<b>Osmium</b>						
Os-180	1.42E-17	1.23E-17	1.08E-17	1.06E-17	9.30E-18	9.07E-18
Os-181	1.80E-16	1.64E-16	1.51E-16	1.47E-16	1.33E-16	1.31E-16
Os-182	5.28E-17	4.72E-17	4.27E-17	4.12E-17	3.66E-17	3.59E-17
Os-183	7.74E-17	6.90E-17	6.23E-17	6.03E-17	5.36E-17	5.26E-17
Os-183m	1.31E-16	1.21E-16	1.12E-16	1.09E-16	9.87E-17	9.73E-17
Os-185	8.71E-17	7.96E-17	7.31E-17	7.12E-17	6.37E-17	6.27E-17
Os-186	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-189m	2.36E-21	1.47E-21	1.21E-21	1.02E-21	3.25E-22	2.88E-22
Os-190m	2.00E-16	1.82E-16	1.67E-16	1.61E-16	1.44E-16	1.42E-16
Os-191	9.27E-18	7.78E-18	6.50E-18	6.31E-18	5.58E-18	5.38E-18
Os-191m	6.16E-19	4.97E-19	4.00E-19	4.00E-19	3.41E-19	3.26E-19
Os-193	8.46E-18	7.54E-18	6.78E-18	6.56E-18	5.85E-18	5.74E-18
Os-194	2.05E-19	1.53E-19	1.31E-19	1.18E-19	9.56E-20	9.11E-20
Os-196	1.02E-17	9.08E-18	8.19E-18	7.90E-18	7.05E-18	6.92E-18
<b>Iridium</b>						
Ir-180	2.04E-16	1.86E-16	1.71E-16	1.66E-16	1.49E-16	1.46E-16
Ir-182	1.81E-16	1.65E-16	1.52E-16	1.47E-16	1.32E-16	1.30E-16
Ir-183	1.56E-16	1.41E-16	1.30E-16	1.27E-16	1.15E-16	1.14E-16
Ir-184	2.56E-16	2.33E-16	2.15E-16	2.09E-16	1.89E-16	1.86E-16
Ir-185	1.13E-16	1.02E-16	9.37E-17	9.17E-17	8.34E-17	8.22E-17
Ir-186	2.16E-16	1.97E-16	1.81E-16	1.76E-16	1.59E-16	1.57E-16
Ir-186m	1.64E-16	1.50E-16	1.39E-16	1.36E-16	1.23E-16	1.21E-16
Ir-187	4.09E-17	3.67E-17	3.32E-17	3.25E-17	2.89E-17	2.84E-17
Ir-188	2.83E-16	2.59E-16	2.41E-16	2.36E-16	2.16E-16	2.14E-16
Ir-189	8.55E-18	7.09E-18	5.91E-18	5.87E-18	5.05E-18	4.87E-18
Ir-190	1.85E-16	1.68E-16	1.54E-16	1.49E-16	1.33E-16	1.31E-16
Ir-190m	2.55E-21	1.57E-21	1.32E-21	1.11E-21	3.57E-22	3.17E-22
Ir-190n	6.03E-18	4.91E-18	4.00E-18	4.00E-18	3.42E-18	3.27E-18
Ir-191m	8.35E-18	7.00E-18	5.85E-18	5.68E-18	5.02E-18	4.85E-18
Ir-192	1.03E-16	9.26E-17	8.47E-17	8.14E-17	7.25E-17	7.14E-17
Ir-192m	1.55E-20	1.12E-20	9.72E-21	8.83E-21	5.65E-21	5.41E-21
Ir-192n	1.33E-19	1.14E-19	1.03E-19	1.01E-19	8.91E-20	8.73E-20
Ir-193m	3.65E-20	2.91E-20	2.33E-20	2.33E-20	1.93E-20	1.85E-20
Ir-194	1.26E-17	1.14E-17	1.05E-17	1.02E-17	9.19E-18	9.07E-18

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ir-194m	2.95E-16	2.69E-16	2.47E-16	2.39E-16	2.13E-16	2.10E-16
Ir-195	6.64E-18	5.53E-18	4.51E-18	4.48E-18	3.97E-18	3.83E-18
Ir-195m	4.69E-17	4.20E-17	3.81E-17	3.68E-17	3.28E-17	3.22E-17
Ir-196	3.14E-17	2.87E-17	2.65E-17	2.57E-17	2.31E-17	2.28E-17
Ir-196m	3.11E-16	2.84E-16	2.61E-16	2.52E-16	2.26E-16	2.22E-16
<b>Platinum</b>						
Pt-184	8.85E-17	7.86E-17	7.05E-17	6.83E-17	6.05E-17	5.94E-17
Pt-186	8.56E-17	7.78E-17	7.10E-17	6.92E-17	6.18E-17	6.07E-17
Pt-187	7.70E-17	6.91E-17	6.25E-17	6.09E-17	5.44E-17	5.34E-17
Pt-188	2.43E-17	2.09E-17	1.83E-17	1.78E-17	1.56E-17	1.52E-17
Pt-189	6.00E-17	5.37E-17	4.84E-17	4.72E-17	4.22E-17	4.14E-17
Pt-190	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pt-191	3.51E-17	3.08E-17	2.72E-17	2.65E-17	2.34E-17	2.29E-17
Pt-193	6.01E-21	3.70E-21	3.12E-21	2.65E-21	8.66E-22	7.72E-22
Pt-193m	1.16E-18	9.51E-19	7.66E-19	7.66E-19	6.68E-19	6.39E-19
Pt-195m	7.91E-18	6.52E-18	5.21E-18	5.21E-18	4.59E-18	4.39E-18
Pt-197	2.90E-18	2.45E-18	2.05E-18	2.02E-18	1.80E-18	1.74E-18
Pt-197m	9.58E-18	8.29E-18	7.21E-18	7.07E-18	6.21E-18	6.06E-18
Pt-199	2.56E-17	2.33E-17	2.14E-17	2.07E-17	1.86E-17	1.83E-17
Pt-200	6.99E-18	5.96E-18	5.09E-18	4.98E-18	4.39E-18	4.27E-18
Pt-202	6.66E-19	6.35E-19	6.13E-19	6.05E-19	5.87E-19	5.84E-19
<b>Gold</b>						
Au-186	1.94E-16	1.76E-16	1.62E-16	1.58E-16	1.42E-16	1.40E-16
Au-187	1.40E-16	1.28E-16	1.18E-16	1.16E-16	1.05E-16	1.03E-16
Au-190	3.22E-16	2.95E-16	2.73E-16	2.68E-16	2.46E-16	2.43E-16
Au-191	7.37E-17	6.61E-17	5.99E-17	5.81E-17	5.17E-17	5.08E-17
Au-192	2.61E-16	2.38E-16	2.20E-16	2.16E-16	1.97E-16	1.95E-16
Au-193	1.95E-17	1.67E-17	1.44E-17	1.41E-17	1.24E-17	1.20E-17
Au-193m	2.45E-17	2.14E-17	1.93E-17	1.84E-17	1.62E-17	1.60E-17
Au-194	1.37E-16	1.24E-16	1.14E-16	1.12E-16	1.01E-16	9.96E-17
Au-195	8.81E-18	7.22E-18	5.76E-18	5.76E-18	5.05E-18	4.84E-18
Au-195m	2.49E-17	2.18E-17	1.96E-17	1.88E-17	1.65E-17	1.63E-17
Au-196	5.85E-17	5.21E-17	4.70E-17	4.54E-17	4.02E-17	3.95E-17
Au-196m	2.91E-17	2.50E-17	2.20E-17	2.11E-17	1.85E-17	1.81E-17
Au-198	5.08E-17	4.60E-17	4.22E-17	4.06E-17	3.63E-17	3.57E-17
Au-198m	6.55E-17	5.68E-17	5.01E-17	4.78E-17	4.25E-17	4.16E-17
Au-199	1.18E-17	1.02E-17	9.11E-18	8.65E-18	7.58E-18	7.42E-18
Au-200	3.68E-17	3.38E-17	3.13E-17	3.06E-17	2.77E-17	2.73E-17
Au-200m	2.51E-16	2.29E-16	2.10E-16	2.03E-16	1.81E-16	1.78E-16
Au-201	4.65E-18	4.25E-18	3.92E-18	3.80E-18	3.42E-18	3.37E-18
Au-202	2.38E-17	2.19E-17	2.03E-17	1.98E-17	1.80E-17	1.77E-17
<b>Mercury</b>						
Hg-190	2.36E-17	2.02E-17	1.74E-17	1.68E-17	1.48E-17	1.44E-17
Hg-191m	1.92E-16	1.74E-16	1.60E-16	1.55E-16	1.40E-16	1.38E-16
Hg-192	3.30E-17	2.85E-17	2.50E-17	2.42E-17	2.13E-17	2.09E-17
Hg-193	1.09E-16	9.88E-17	9.07E-17	8.87E-17	8.01E-17	7.89E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Hg-193m	1.33E-16	1.21E-16	1.11E-16	1.09E-16	9.80E-17	9.65E-17
Hg-194	8.53E-21	5.18E-21	4.50E-21	3.87E-21	1.31E-21	1.18E-21
Hg-195	2.42E-17	2.16E-17	1.92E-17	1.89E-17	1.68E-17	1.65E-17
Hg-195m	2.45E-17	2.16E-17	1.94E-17	1.88E-17	1.66E-17	1.63E-17
Hg-197	7.79E-18	6.39E-18	5.09E-18	5.09E-18	4.48E-18	4.28E-18
Hg-197m	1.13E-17	9.66E-18	8.33E-18	8.00E-18	7.12E-18	6.92E-18
Hg-199m	2.21E-17	1.93E-17	1.71E-17	1.64E-17	1.44E-17	1.41E-17
Hg-203	3.00E-17	2.65E-17	2.39E-17	2.29E-17	2.03E-17	1.99E-17
Hg-205	1.18E-18	1.07E-18	9.91E-19	9.62E-19	8.90E-19	8.81E-19
Hg-206	1.56E-17	1.39E-17	1.26E-17	1.21E-17	1.08E-17	1.06E-17
Hg-207	3.59E-16	3.29E-16	3.05E-16	2.99E-16	2.73E-16	2.69E-16
<b>Thallium</b>						
Tl-190	1.66E-16	1.52E-16	1.40E-16	1.35E-16	1.21E-16	1.20E-16
Tl-190m	3.14E-16	2.87E-16	2.64E-16	2.57E-16	2.30E-16	2.27E-16
Tl-194	1.16E-16	1.05E-16	9.66E-17	9.36E-17	8.38E-17	8.24E-17
Tl-194m	3.20E-16	2.93E-16	2.69E-16	2.61E-16	2.34E-16	2.31E-16
Tl-195	1.62E-16	1.48E-16	1.37E-16	1.34E-16	1.22E-16	1.20E-16
Tl-196	2.48E-16	2.26E-16	2.09E-16	2.05E-16	1.86E-16	1.83E-16
Tl-197	5.80E-17	5.23E-17	4.75E-17	4.64E-17	4.17E-17	4.10E-17
Tl-198	2.67E-16	2.45E-16	2.26E-16	2.21E-16	2.02E-16	1.99E-16
Tl-198m	1.53E-16	1.39E-16	1.27E-16	1.23E-16	1.10E-16	1.08E-16
Tl-199	3.05E-17	2.69E-17	2.38E-17	2.32E-17	2.05E-17	2.01E-17
Tl-200	1.70E-16	1.55E-16	1.43E-16	1.39E-16	1.25E-16	1.24E-16
Tl-201	1.03E-17	8.61E-18	7.03E-18	7.02E-18	6.14E-18	5.91E-18
Tl-202	5.73E-17	5.16E-17	4.67E-17	4.52E-17	4.03E-17	3.96E-17
Tl-204	2.95E-19	2.66E-19	2.39E-19	2.39E-19	2.25E-19	2.21E-19
Tl-206	5.21E-19	4.97E-19	4.80E-19	4.74E-19	4.61E-19	4.58E-19
Tl-206m	3.10E-16	2.83E-16	2.60E-16	2.52E-16	2.26E-16	2.23E-16
Tl-207	7.58E-19	7.15E-19	6.81E-19	6.71E-19	6.35E-19	6.29E-19
Tl-208	4.61E-16	4.26E-16	3.97E-16	3.90E-16	3.60E-16	3.56E-16
Tl-209	2.86E-16	2.62E-16	2.42E-16	2.36E-16	2.16E-16	2.13E-16
Tl-210	3.69E-16	3.39E-16	3.15E-16	3.08E-16	2.80E-16	2.76E-16
<b>Lead</b>						
Pb-194	1.41E-16	1.28E-16	1.17E-16	1.15E-16	1.04E-16	1.02E-16
Pb-195m	2.10E-16	1.92E-16	1.76E-16	1.71E-16	1.53E-16	1.51E-16
Pb-196	6.10E-17	5.44E-17	4.89E-17	4.74E-17	4.22E-17	4.14E-17
Pb-197	2.02E-16	1.84E-16	1.70E-16	1.66E-16	1.51E-16	1.49E-16
Pb-197m	1.49E-16	1.35E-16	1.24E-16	1.20E-16	1.08E-16	1.06E-16
Pb-198	5.41E-17	4.80E-17	4.30E-17	4.17E-17	3.70E-17	3.63E-17
Pb-199	1.36E-16	1.24E-16	1.14E-16	1.11E-16	1.01E-16	9.93E-17
Pb-200	2.46E-17	2.12E-17	1.83E-17	1.78E-17	1.57E-17	1.53E-17
Pb-201	9.58E-17	8.65E-17	7.89E-17	7.67E-17	6.86E-17	6.75E-17
Pb-201m	4.61E-17	4.22E-17	3.87E-17	3.76E-17	3.38E-17	3.32E-17
Pb-202	1.07E-20	6.64E-21	5.50E-21	4.64E-21	1.50E-21	1.34E-21
Pb-202m	2.56E-16	2.36E-16	2.18E-16	2.12E-16	1.90E-16	1.88E-16
Pb-203	3.85E-17	3.37E-17	2.99E-17	2.88E-17	2.55E-17	2.50E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Pb-204m	2.68E-16	2.46E-16	2.28E-16	2.22E-16	1.99E-16	1.97E-16
Pb-205	1.08E-20	6.72E-21	5.58E-21	4.70E-21	1.52E-21	1.35E-21
Pb-209	1.18E-19	1.15E-19	1.12E-19	1.12E-19	1.10E-19	1.10E-19
Pb-210	1.96E-19	1.46E-19	1.26E-19	1.14E-19	8.91E-20	8.47E-20
Pb-211	8.63E-18	7.92E-18	7.32E-18	7.12E-18	6.41E-18	6.32E-18
Pb-212	1.79E-17	1.56E-17	1.38E-17	1.33E-17	1.17E-17	1.15E-17
Pb-214	3.18E-17	2.83E-17	2.56E-17	2.47E-17	2.19E-17	2.16E-17
<b>Bismuth</b>						
Bi-197	2.22E-16	2.04E-16	1.88E-16	1.84E-16	1.66E-16	1.64E-16
Bi-200	3.12E-16	2.85E-16	2.62E-16	2.55E-16	2.28E-16	2.25E-16
Bi-201	2.29E-16	2.10E-16	1.94E-16	1.90E-16	1.73E-16	1.70E-16
Bi-202	3.57E-16	3.27E-16	3.02E-16	2.95E-16	2.66E-16	2.62E-16
Bi-203	3.18E-16	2.91E-16	2.70E-16	2.65E-16	2.41E-16	2.38E-16
Bi-204	3.81E-16	3.50E-16	3.23E-16	3.16E-16	2.85E-16	2.81E-16
Bi-205	2.25E-16	2.06E-16	1.91E-16	1.87E-16	1.71E-16	1.68E-16
Bi-206	4.27E-16	3.92E-16	3.62E-16	3.53E-16	3.19E-16	3.14E-16
Bi-207	1.99E-16	1.83E-16	1.69E-16	1.65E-16	1.48E-16	1.46E-16
Bi-208	3.69E-16	3.41E-16	3.19E-16	3.14E-16	2.92E-16	2.89E-16
Bi-210	3.22E-19	3.09E-19	3.01E-19	2.98E-19	2.91E-19	2.90E-19
Bi-210m	3.29E-17	2.91E-17	2.64E-17	2.53E-17	2.24E-17	2.21E-17
Bi-211	5.92E-18	5.30E-18	4.82E-18	4.63E-18	4.11E-18	4.05E-18
Bi-212	1.40E-17	1.29E-17	1.20E-17	1.17E-17	1.06E-17	1.05E-17
Bi-212n	5.03E-19	4.81E-19	4.66E-19	4.60E-19	4.48E-19	4.46E-19
Bi-213	1.64E-17	1.49E-17	1.37E-17	1.32E-17	1.18E-17	1.16E-17
Bi-214	1.99E-16	1.83E-16	1.70E-16	1.66E-16	1.52E-16	1.50E-16
Bi-215	3.30E-17	2.98E-17	2.72E-17	2.64E-17	2.37E-17	2.33E-17
Bi-216	9.47E-17	8.66E-17	7.98E-17	7.72E-17	6.92E-17	6.81E-17
<b>Polonium</b>						
Po-203	2.14E-16	1.96E-16	1.81E-16	1.77E-16	1.60E-16	1.58E-16
Po-204	1.48E-16	1.34E-16	1.23E-16	1.20E-16	1.07E-16	1.06E-16
Po-205	2.07E-16	1.90E-16	1.75E-16	1.72E-16	1.55E-16	1.53E-16
Po-206	1.52E-16	1.39E-16	1.27E-16	1.24E-16	1.11E-16	1.09E-16
Po-207	1.66E-16	1.53E-16	1.41E-16	1.38E-16	1.24E-16	1.22E-16
Po-208	2.68E-21	2.43E-21	2.21E-21	2.15E-21	1.92E-21	1.89E-21
Po-209	7.91E-19	7.17E-19	6.56E-19	6.39E-19	5.72E-19	5.63E-19
Po-210	1.26E-21	1.16E-21	1.08E-21	1.05E-21	9.42E-22	9.29E-22
Po-211	1.05E-18	9.70E-19	8.98E-19	8.75E-19	7.85E-19	7.74E-19
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212m	1.09E-17	1.01E-17	9.43E-18	9.28E-18	8.60E-18	8.50E-18
Po-213	4.84E-21	4.46E-21	4.13E-21	4.03E-21	3.62E-21	3.56E-21
Po-214	1.07E-20	9.90E-21	9.17E-21	8.95E-21	8.04E-21	7.92E-21
Po-215	2.21E-20	2.01E-20	1.84E-20	1.78E-20	1.59E-20	1.56E-20
Po-216	1.98E-21	1.83E-21	1.69E-21	1.65E-21	1.48E-21	1.46E-21
Po-218	3.02E-24	2.92E-24	2.87E-24	2.86E-24	2.82E-24	2.81E-24
<b>Astatine</b>						
At-204	2.94E-16	2.69E-16	2.48E-16	2.41E-16	2.16E-16	2.12E-16



**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
At-205	1.48E-16	1.35E-16	1.24E-16	1.21E-16	1.09E-16	1.08E-16
At-206	3.18E-16	2.91E-16	2.68E-16	2.61E-16	2.34E-16	2.31E-16
At-207	2.64E-16	2.42E-16	2.23E-16	2.18E-16	1.98E-16	1.95E-16
At-208	3.95E-16	3.62E-16	3.34E-16	3.26E-16	2.94E-16	2.90E-16
At-209	2.93E-16	2.68E-16	2.47E-16	2.40E-16	2.16E-16	2.13E-16
At-210	3.95E-16	3.62E-16	3.35E-16	3.28E-16	2.98E-16	2.94E-16
At-211	4.02E-18	3.36E-18	2.68E-18	2.65E-18	2.41E-18	2.31E-18
At-215	2.14E-20	1.94E-20	1.77E-20	1.70E-20	1.52E-20	1.50E-20
At-216	2.91E-19	2.48E-19	2.07E-19	2.01E-19	1.82E-19	1.76E-19
At-217	3.06E-20	2.71E-20	2.44E-20	2.35E-20	2.09E-20	2.05E-20
At-218	1.41E-21	1.33E-21	1.28E-21	1.26E-21	1.20E-21	1.20E-21
At-219	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
At-220	5.84E-17	5.23E-17	4.77E-17	4.58E-17	4.08E-17	4.02E-17
<b>Radon</b>						
Rn-207	1.25E-16	1.14E-16	1.05E-16	1.02E-16	9.11E-17	8.97E-17
Rn-209	1.55E-16	1.41E-16	1.30E-16	1.26E-16	1.14E-16	1.13E-16
Rn-210	7.71E-18	7.03E-18	6.43E-18	6.25E-18	5.61E-18	5.52E-18
Rn-211	2.44E-16	2.24E-16	2.07E-16	2.02E-16	1.83E-16	1.80E-16
Rn-212	4.32E-20	3.98E-20	3.68E-20	3.58E-20	3.21E-20	3.17E-20
Rn-215	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-217	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rn-218	9.59E-20	8.82E-20	8.14E-20	7.90E-20	7.08E-20	6.98E-20
Rn-219	7.37E-18	6.57E-18	5.98E-18	5.73E-18	5.09E-18	5.01E-18
Rn-220	7.91E-20	7.26E-20	6.69E-20	6.48E-20	5.80E-20	5.72E-20
Rn-222	4.88E-20	4.47E-20	4.12E-20	3.98E-20	3.56E-20	3.51E-20
Rn-223	4.38E-17	3.99E-17	3.66E-17	3.55E-17	3.20E-17	3.15E-17
<b>Francium</b>						
Fr-212	1.49E-16	1.36E-16	1.26E-16	1.23E-16	1.11E-16	1.09E-16
Fr-219	4.47E-19	4.03E-19	3.67E-19	3.53E-19	3.14E-19	3.09E-19
Fr-220	1.09E-18	9.21E-19	7.66E-19	7.38E-19	6.68E-19	6.45E-19
Fr-221	3.68E-18	3.21E-18	2.87E-18	2.74E-18	2.42E-18	2.38E-18
Fr-222	2.31E-17	2.04E-17	1.84E-17	1.76E-17	1.58E-17	1.55E-17
Fr-223	6.36E-18	5.40E-18	4.71E-18	4.51E-18	3.99E-18	3.88E-18
Fr-224	7.34E-17	6.69E-17	6.18E-17	6.01E-17	5.45E-17	5.37E-17
Fr-227	5.67E-17	5.11E-17	4.61E-17	4.46E-17	4.03E-17	3.95E-17
<b>Radium</b>						
Ra-219	2.12E-17	1.89E-17	1.70E-17	1.63E-17	1.46E-17	1.43E-17
Ra-220	5.86E-19	5.34E-19	4.91E-19	4.73E-19	4.23E-19	4.17E-19
Ra-221	4.39E-18	3.79E-18	3.31E-18	3.13E-18	2.80E-18	2.73E-18
Ra-222	1.16E-18	1.03E-18	9.41E-19	9.01E-19	8.00E-19	7.88E-19
Ra-223	1.70E-17	1.48E-17	1.29E-17	1.24E-17	1.11E-17	1.09E-17
Ra-224	1.31E-18	1.15E-18	1.04E-18	9.89E-19	8.73E-19	8.60E-19
Ra-225	9.60E-19	7.06E-19	6.07E-19	5.48E-19	4.45E-19	4.25E-19
Ra-226	9.18E-19	7.98E-19	7.16E-19	6.78E-19	5.97E-19	5.87E-19
Ra-227	1.80E-17	1.61E-17	1.46E-17	1.40E-17	1.25E-17	1.23E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Ra-228	3.02E-20	1.81E-20	1.64E-20	1.54E-20	6.80E-21	6.14E-21
Ra-230	9.63E-18	8.49E-18	7.52E-18	7.23E-18	6.50E-18	6.36E-18
<b>Actinium</b>						
Ac-223	2.14E-18	1.88E-18	1.67E-18	1.59E-18	1.43E-18	1.40E-18
Ac-224	2.79E-17	2.40E-17	2.09E-17	1.98E-17	1.79E-17	1.74E-17
Ac-225	1.72E-18	1.48E-18	1.27E-18	1.20E-18	1.09E-18	1.06E-18
Ac-226	1.65E-17	1.44E-17	1.29E-17	1.22E-17	1.08E-17	1.06E-17
Ac-227	1.62E-20	1.19E-20	1.03E-20	9.68E-21	7.22E-21	6.89E-21
Ac-228	1.13E-16	1.04E-16	9.62E-17	9.38E-17	8.47E-17	8.35E-17
Ac-230	7.37E-17	6.77E-17	6.29E-17	6.16E-17	5.63E-17	5.55E-17
Ac-231	5.27E-17	4.65E-17	4.19E-17	4.00E-17	3.57E-17	3.51E-17
Ac-232	1.57E-16	1.44E-16	1.34E-16	1.32E-16	1.21E-16	1.19E-16
Ac-233	6.36E-17	5.83E-17	5.38E-17	5.20E-17	4.67E-17	4.60E-17
<b>Thorium</b>						
Th-223	8.47E-18	7.21E-18	5.99E-18	5.68E-18	5.27E-18	5.09E-18
Th-224	2.86E-18	2.50E-18	2.26E-18	2.14E-18	1.89E-18	1.86E-18
Th-226	9.61E-19	8.27E-19	7.09E-19	6.63E-19	6.12E-19	5.95E-19
Th-227	1.54E-17	1.34E-17	1.20E-17	1.15E-17	1.02E-17	9.99E-18
Th-228	2.61E-19	2.19E-19	1.85E-19	1.78E-19	1.57E-19	1.53E-19
Th-229	1.02E-17	8.65E-18	7.24E-18	6.88E-18	6.31E-18	6.11E-18
Th-230	5.74E-20	4.49E-20	3.77E-20	3.70E-20	2.93E-20	2.81E-20
Th-231	1.55E-18	1.25E-18	1.01E-18	9.77E-19	8.65E-19	8.29E-19
Th-232	3.43E-20	2.55E-20	2.14E-20	2.09E-20	1.54E-20	1.46E-20
Th-233	4.72E-18	4.27E-18	3.89E-18	3.76E-18	3.40E-18	3.35E-18
Th-234	1.03E-18	8.52E-19	6.83E-19	6.61E-19	6.04E-19	5.79E-19
Th-235	7.52E-18	6.91E-18	6.39E-18	6.21E-18	5.62E-18	5.54E-18
Th-236	4.48E-18	4.02E-18	3.63E-18	3.48E-18	3.17E-18	3.12E-18
<b>Protactinium</b>						
Pa-227	2.28E-18	1.90E-18	1.53E-18	1.47E-18	1.36E-18	1.30E-18
Pa-228	1.76E-16	1.61E-16	1.48E-16	1.44E-16	1.31E-16	1.29E-16
Pa-229	7.21E-18	6.09E-18	4.90E-18	4.60E-18	4.41E-18	4.24E-18
Pa-230	8.52E-17	7.80E-17	7.15E-17	6.96E-17	6.28E-17	6.18E-17
Pa-231	4.31E-18	3.77E-18	3.39E-18	3.24E-18	2.86E-18	2.81E-18
Pa-232	1.21E-16	1.11E-16	1.03E-16	1.00E-16	9.00E-17	8.86E-17
Pa-233	2.69E-17	2.37E-17	2.12E-17	2.02E-17	1.82E-17	1.78E-17
Pa-234	1.89E-16	1.73E-16	1.60E-16	1.55E-16	1.40E-16	1.38E-16
Pa-234m	3.03E-18	2.82E-18	2.64E-18	2.58E-18	2.39E-18	2.36E-18
Pa-235	4.28E-19	4.10E-19	3.97E-19	3.93E-19	3.83E-19	3.81E-19
Pa-236	1.22E-16	1.12E-16	1.04E-16	1.01E-16	9.22E-17	9.09E-17
Pa-237	7.90E-17	7.28E-17	6.74E-17	6.57E-17	5.90E-17	5.82E-17
<b>Uranium</b>						
U-227	1.43E-17	1.24E-17	1.09E-17	1.03E-17	9.33E-18	9.13E-18
U-228	4.90E-19	4.16E-19	3.55E-19	3.36E-19	3.04E-19	2.96E-19
U-230	1.54E-19	1.26E-19	1.09E-19	1.06E-19	8.78E-20	8.51E-20
U-231	8.34E-18	7.00E-18	5.66E-18	5.31E-18	5.04E-18	4.84E-18
U-232	4.87E-20	3.57E-20	3.09E-20	2.93E-20	2.12E-20	2.02E-20

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
U-233	3.95E-20	3.11E-20	2.73E-20	2.57E-20	2.07E-20	2.00E-20
U-234	3.31E-20	2.29E-20	2.00E-20	1.87E-20	1.24E-20	1.16E-20
U-235	2.03E-17	1.77E-17	1.59E-17	1.50E-17	1.32E-17	1.30E-17
U-235m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236	2.44E-20	1.61E-20	1.41E-20	1.32E-20	7.85E-21	7.31E-21
U-237	1.61E-17	1.37E-17	1.17E-17	1.11E-17	1.01E-17	9.77E-18
U-238	2.00E-20	1.33E-20	1.18E-20	1.11E-20	6.70E-21	6.27E-21
U-239	6.10E-18	5.19E-18	4.32E-18	4.32E-18	3.84E-18	3.71E-18
U-240	6.21E-19	5.16E-19	4.40E-19	4.12E-19	3.72E-19	3.60E-19
U-242	5.31E-18	4.75E-18	4.28E-18	4.16E-18	3.72E-18	3.65E-18
<b>Neptunium</b>						
Np-232	1.52E-16	1.39E-16	1.27E-16	1.24E-16	1.11E-16	1.10E-16
Np-233	1.03E-17	8.76E-18	7.23E-18	6.74E-18	6.44E-18	6.21E-18
Np-234	1.48E-16	1.35E-16	1.25E-16	1.22E-16	1.12E-16	1.10E-16
Np-235	1.33E-19	9.62E-20	8.14E-20	7.63E-20	5.64E-20	5.33E-20
Np-236	1.68E-17	1.44E-17	1.24E-17	1.15E-17	1.06E-17	1.03E-17
Np-236m	5.68E-18	4.89E-18	4.08E-18	3.83E-18	3.64E-18	3.52E-18
Np-237	2.79E-18	2.30E-18	1.88E-18	1.79E-18	1.63E-18	1.57E-18
Np-238	7.66E-17	7.08E-17	6.57E-17	6.44E-17	5.80E-17	5.72E-17
Np-239	2.17E-17	1.88E-17	1.63E-17	1.54E-17	1.41E-17	1.38E-17
Np-240	1.34E-16	1.23E-16	1.13E-16	1.10E-16	9.90E-17	9.75E-17
Np-240m	4.15E-17	3.81E-17	3.52E-17	3.42E-17	3.09E-17	3.04E-17
Np-241	4.87E-18	4.24E-18	3.67E-18	3.45E-18	3.23E-18	3.14E-18
Np-242	3.64E-17	3.35E-17	3.12E-17	3.06E-17	2.79E-17	2.75E-17
Np-242m	1.17E-16	1.08E-16	9.98E-17	9.72E-17	8.73E-17	8.60E-17
<b>Plutonium</b>						
Pu-232	7.05E-18	6.00E-18	4.90E-18	4.53E-18	4.38E-18	4.22E-18
Pu-234	7.63E-18	6.49E-18	5.30E-18	4.91E-18	4.74E-18	4.56E-18
Pu-235	1.05E-17	9.00E-18	7.48E-18	6.97E-18	6.65E-18	6.42E-18
Pu-236	3.06E-20	1.95E-20	1.72E-20	1.63E-20	9.14E-21	8.44E-21
Pu-237	5.52E-18	4.67E-18	3.82E-18	3.54E-18	3.39E-18	3.26E-18
Pu-238	2.61E-20	1.63E-20	1.44E-20	1.37E-20	7.21E-21	6.60E-21
Pu-239	1.81E-20	1.30E-20	1.14E-20	1.08E-20	7.63E-21	7.26E-21
Pu-240	2.51E-20	1.57E-20	1.39E-20	1.31E-20	7.04E-21	6.46E-21
Pu-241	1.88E-22	1.60E-22	1.33E-22	1.24E-22	1.17E-22	1.13E-22
Pu-242	3.14E-20	2.26E-20	2.05E-20	1.97E-20	1.37E-20	1.32E-20
Pu-243	2.88E-18	2.43E-18	1.98E-18	1.93E-18	1.77E-18	1.71E-18
Pu-244	2.69E-18	2.47E-18	2.30E-18	2.25E-18	2.06E-18	2.03E-18
Pu-245	5.12E-17	4.65E-17	4.26E-17	4.12E-17	3.70E-17	3.65E-17
Pu-246	1.64E-17	1.40E-17	1.23E-17	1.15E-17	1.04E-17	1.01E-17
<b>Americium</b>						
Am-237	4.52E-17	4.00E-17	3.57E-17	3.40E-17	3.08E-17	3.02E-17
Am-238	1.16E-16	1.06E-16	9.78E-17	9.53E-17	8.63E-17	8.50E-17
Am-239	2.80E-17	2.41E-17	2.07E-17	1.93E-17	1.79E-17	1.75E-17
Am-240	1.33E-16	1.22E-16	1.13E-16	1.10E-16	9.95E-17	9.80E-17
Am-241	2.38E-18	1.88E-18	1.53E-18	1.52E-18	1.26E-18	1.20E-18

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Am-242	1.75E-18	1.49E-18	1.24E-18	1.15E-18	1.10E-18	1.06E-18
Am-242m	1.06E-19	7.18E-20	6.20E-20	5.93E-20	3.95E-20	3.70E-20
Am-243	6.26E-18	5.14E-18	4.08E-18	4.08E-18	3.60E-18	3.44E-18
Am-244	1.02E-16	9.33E-17	8.63E-17	8.40E-17	7.54E-17	7.43E-17
Am-244m	2.40E-18	2.21E-18	2.06E-18	2.02E-18	1.85E-18	1.82E-18
Am-245	4.02E-18	3.51E-18	3.09E-18	2.91E-18	2.67E-18	2.61E-18
Am-246	9.29E-17	8.46E-17	7.78E-17	7.53E-17	6.74E-17	6.64E-17
Am-246m	1.29E-16	1.19E-16	1.10E-16	1.08E-16	9.72E-17	9.58E-17
Am-247	1.66E-17	1.46E-17	1.29E-17	1.21E-17	1.11E-17	1.08E-17
<b>Curium</b>						
Cm-238	9.26E-18	7.90E-18	6.55E-18	6.03E-18	5.79E-18	5.59E-18
Cm-239	3.12E-17	2.70E-17	2.37E-17	2.22E-17	2.01E-17	1.96E-17
Cm-240	3.24E-20	2.03E-20	1.78E-20	1.71E-20	9.50E-21	8.73E-21
Cm-241	6.08E-17	5.48E-17	4.95E-17	4.74E-17	4.28E-17	4.20E-17
Cm-242	2.85E-20	1.77E-20	1.56E-20	1.50E-20	8.20E-21	7.52E-21
Cm-243	1.58E-17	1.37E-17	1.19E-17	1.12E-17	1.03E-17	1.00E-17
Cm-244	2.62E-20	1.69E-20	1.49E-20	1.44E-20	8.46E-21	7.86E-21
Cm-245	1.21E-17	1.04E-17	8.71E-18	8.08E-18	7.61E-18	7.37E-18
Cm-246	5.07E-19	4.61E-19	4.28E-19	4.19E-19	3.80E-19	3.75E-19
Cm-247	3.93E-17	3.55E-17	3.25E-17	3.13E-17	2.79E-17	2.75E-17
Cm-248	1.77E-16	1.63E-16	1.52E-16	1.49E-16	1.36E-16	1.34E-16
Cm-249	2.61E-18	2.40E-18	2.22E-18	2.15E-18	1.95E-18	1.92E-18
Cm-250	1.80E-15	1.66E-15	1.54E-15	1.51E-15	1.38E-15	1.37E-15
Cm-251	1.43E-17	1.30E-17	1.20E-17	1.15E-17	1.04E-17	1.02E-17
<b>Berkelium</b>						
Bk-245	2.76E-17	2.39E-17	2.07E-17	1.93E-17	1.79E-17	1.74E-17
Bk-246	1.09E-16	9.96E-17	9.17E-17	8.93E-17	8.06E-17	7.93E-17
Bk-247	1.78E-17	1.54E-17	1.33E-17	1.27E-17	1.15E-17	1.12E-17
Bk-248m	6.50E-18	5.78E-18	5.11E-18	4.86E-18	4.47E-18	4.36E-18
Bk-249	6.73E-22	5.98E-22	5.66E-22	5.54E-22	5.17E-22	5.11E-22
Bk-250	1.18E-16	1.09E-16	1.01E-16	9.89E-17	8.92E-17	8.79E-17
Bk-251	1.04E-17	8.94E-18	7.71E-18	7.15E-18	6.64E-18	6.45E-18
<b>Californium</b>						
Cf-244	3.16E-20	1.93E-20	1.68E-20	1.62E-20	8.95E-21	8.17E-21
Cf-246	2.73E-20	1.82E-20	1.60E-20	1.54E-20	1.01E-20	9.46E-21
Cf-247	1.08E-17	9.29E-18	7.89E-18	7.30E-18	6.85E-18	6.63E-18
Cf-248	7.19E-20	5.80E-20	5.26E-20	5.13E-20	4.21E-20	4.10E-20
Cf-249	4.07E-17	3.66E-17	3.35E-17	3.21E-17	2.86E-17	2.82E-17
Cf-250	1.35E-18	1.24E-18	1.15E-18	1.12E-18	1.02E-18	1.01E-18
Cf-251	1.44E-17	1.24E-17	1.08E-17	1.01E-17	9.24E-18	9.01E-18
Cf-252	6.16E-17	5.68E-17	5.28E-17	5.17E-17	4.73E-17	4.67E-17
Cf-253	1.18E-19	8.15E-20	7.18E-20	6.87E-20	4.96E-20	4.71E-20
Cf-254	2.28E-15	2.10E-15	1.95E-15	1.91E-15	1.75E-15	1.73E-15
Cf-255	1.38E-19	1.34E-19	1.31E-19	1.30E-19	1.28E-19	1.28E-19
<b>Einsteinium</b>						
Es-249	5.08E-17	4.57E-17	4.13E-17	3.96E-17	3.58E-17	3.51E-17

**Table 4-7. Reference person effective dose rate coefficients for water immersion. (continued)**

Nuclide	Reference Person Coefficients (Sv Bq <sup>-1</sup> s <sup>-1</sup> m <sup>3</sup> )					
	Newborn	1-yr-old	5-yr-old	10-yr-old	15-yr-old	Adult
Es-250	1.50E-16	1.36E-16	1.25E-16	1.20E-16	1.08E-16	1.07E-16
Es-250m	7.10E-17	6.48E-17	5.95E-17	5.78E-17	5.25E-17	5.16E-17
Es-251	1.08E-17	9.28E-18	7.91E-18	7.30E-18	6.82E-18	6.61E-18
Es-253	4.82E-20	4.07E-20	3.66E-20	3.50E-20	3.00E-20	2.93E-20
Es-254	6.07E-19	4.53E-19	3.91E-19	3.79E-19	2.89E-19	2.76E-19
Es-254m	6.00E-17	5.52E-17	5.10E-17	4.96E-17	4.45E-17	4.38E-17
Es-255	1.11E-19	1.03E-19	9.66E-20	9.50E-20	8.81E-20	8.72E-20
Es-256	6.18E-19	5.69E-19	5.45E-19	5.37E-19	5.11E-19	5.06E-19
<b>Fermium</b>						
Fm-251	1.86E-17	1.65E-17	1.46E-17	1.38E-17	1.26E-17	1.23E-17
Fm-252	6.39E-20	5.02E-20	4.50E-20	4.37E-20	3.55E-20	3.44E-20
Fm-253	7.05E-18	6.03E-18	5.19E-18	4.82E-18	4.44E-18	4.31E-18
Fm-254	9.76E-19	8.91E-19	8.26E-19	8.09E-19	7.35E-19	7.26E-19
Fm-255	4.34E-19	3.08E-19	2.59E-19	2.51E-19	1.84E-19	1.74E-19
Fm-256	1.68E-15	1.55E-15	1.44E-15	1.41E-15	1.29E-15	1.27E-15
Fm-257	1.77E-17	1.55E-17	1.37E-17	1.29E-17	1.18E-17	1.16E-17

## CHAPTER 5. APPLICATION CONSIDERATIONS

This chapter discusses some potentially important considerations in applying the dose rate coefficients to obtain realistic estimates of doses to members of the public. Applicability of the coefficients to a specific exposure is influenced by those exposure conditions that differ from the assumptions in the derivation of the coefficients and other factors that may alter the radiation field at the location of the exposed individual. For example, the radiation field within a residence may be substantially different in energy and angular distribution, as well as intensity, from the field outside the residence. Also, radionuclides may be distributed heterogeneously in the environment. Modifying factors have historically been used with dose rate coefficients to estimate the dose for radiation fields that depart substantially from idealized fields. Environmental factors can influence the time-integrated activity that characterizes exposure, and an individual's lifestyle may influence the extent of contact with a radionuclide in the environment. For example, the time-integrated activity of a radionuclide in an urban environment may be substantially different from that in a rural environment where environmental measurements are generally conducted. In prospective assessments, the combined influence of such factors is frequently expressed as a single modifying factor that can be multiplied by a tabulated dose rate coefficient.

### 5.1 Radionuclide decay chains

The tabulations contain separate entries for radionuclide decay chain members addressed in ICRP Publication 107 (2008). The dose rate coefficients tabulated in this report for a given radionuclide do not include contributions to dose from radioactive decay products formed in the spontaneous nuclear transformation of the radionuclide.

Dose rate coefficients for a radionuclide and its progeny should be combined only after consideration of (1) the equations describing production and decay of daughter radionuclides over time and (2) the differences in environmental behavior of the parent and daughters. The information necessary to describe the production and decay of daughters is given in Appendix A.

Various simplifying assumptions often have been made when considering radioactive progeny following an "instantaneous" deposition of the parent nuclide, that is, a deposition that occurs in a time period that is short compared to the half-life of the radionuclide and to the integration time of interest (DOE, 1988; Jacob et al., 1988a). Such assumptions should no longer be necessary, because access to personal computers makes solution of the appropriate equations an easy task. Even for non-trivial time dependencies (see Jacob et al., 1988b) up to and including arbitrary deposition and/or removal rates, convolution methods can be applied readily to the dose rate coefficients tabulated in this report to estimate equivalent doses.

### 5.2 Spontaneous fission

Spontaneous fission (SF) is a decay mode resulting in splitting of the nucleus into lighter nuclei referred to as "fission fragments." The radiations concomitant with SF include fission fragments, neutron, delayed beta, and prompt and delayed gamma emissions. SF occurs to some extent for 28 of the 1,252 radionuclides addressed in this report:  $^{238}\text{U}$ ,  $^{236}\text{Pu}$ ,  $^{238}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{242}\text{Pu}$ ,  $^{244}\text{Pu}$ ,  $^{240}\text{Cm}$ ,  $^{242}\text{Cm}$ ,  $^{244}\text{Cm}$ ,  $^{245}\text{Cm}$ ,  $^{246}\text{Cm}$ ,  $^{248}\text{Cm}$ ,  $^{250}\text{Cm}$ ,  $^{246}\text{Cf}$ ,  $^{248}\text{Cf}$ ,  $^{249}\text{Cf}$ ,  $^{250}\text{Cf}$ ,  $^{252}\text{Cf}$ ,  $^{254}\text{Cf}$ ,  $^{253}\text{Es}$ ,  $^{254}\text{Es}$ ,  $^{254\text{m}}\text{Es}$ ,  $^{255}\text{Es}$ ,  $^{252}\text{Fm}$ ,  $^{254}\text{Fm}$ ,  $^{255}\text{Fm}$ ,

$^{256}\text{Fm}$  and  $^{257}\text{Fm}$ . The SF yield for each of these radionuclides is listed in Table A-1 in Appendix A. The SF yield is extremely low in most cases, but it represents a substantial portion of the emitted energy for four radionuclides:  $^{248}\text{Cm}$  (SF yield, 8.39%),  $^{250}\text{Cm}$  (SF yield, 74.0%),  $^{252}\text{Cf}$  (SF yield, 3.092%) and  $^{254}\text{Cf}$  (SF yield, 99.69%). Empirical relationships describing the continuous energy spectra of photons, electrons and neutrons from spontaneous fission, as needed in dosimetric evaluations, have been developed (Dillman and Jones, 1975; Endo et al., 2005). However, detailed information has not been assembled on the radiation field resulting from distributed sources of neutrons in the environment.

Prompt and delayed emissions (photons and beta particles) following spontaneous fission are included in the decay data tabulations of ICRP Publication 107 (2008) and thus are included in the calculations of dose rate coefficients tabulated in this report. The contribution to dose from neutrons accompanying spontaneous fission is not included. This may result in a substantial underestimate of external dose for  $^{248}\text{Cm}$ ,  $^{250}\text{Cm}$ ,  $^{252}\text{Cf}$  and  $^{254}\text{Cf}$ .

### **5.3 Computational models of the human body**

In Federal Guidance Report No. 12 (EPA, 1993), dose estimates from monoenergetic photon sources were made for 25 tissues. Dose rate coefficients were tabulated in Federal Guidance Report No. 12 for effective dose, the gonad, breast, lung, red marrow, bone surface, thyroid, remainder and skin. The effective dose rate coefficients were based on an adult hermaphrodite phantom (inclusive of both male and female organs and tissues). This report is based on a modification of the ORNL series of stylized age-dependent hermaphrodite phantoms used in the preparation of Federal Guidance Report No. 12. The following modifications were made: (1) previously published stylized models of the head and brain, the extrathoracic-thoracic airways, the kidneys and the rectosigmoid colon were incorporated within the mathematical structure of the ORNL model series; (2) new models of the salivary glands and the mucosa layer of the alimentary tract organs, the respiratory tract airways, and the urinary bladder were designed for each phantom age; and (3) tissue compositions and mass densities published in ICRP Publication 89 (2002) and ICRU Report 46 (1992) were adopted. When mathematical adjustments to organ volumes were feasible as constrained by the boundaries of adjacent organs, these changes were made in order to bring revised organ masses to within  $\approx 10$  percent of their age-dependent values given in ICRP Publication 89. The revised ORNL series then was incorporated within the input structure of the MCNP6 Monte Carlo radiation transport code for simulation of external dose from photon and electron sources. More details about the phantoms as they apply to external dose coefficients in this report are found in Appendix B.

### **5.4 Pathway-specific modifying factors and exposures**

This section discusses modifying factors that can be used with the dose rate coefficients presented in this report to account for the effects of indoor residence, ground roughness, exposure during boating activities and exposure to contaminated shorelines. These modifying factors, or dose-reduction factors, are multiplicative factors less than or equal to unity. They may be applied when using the tabulated dose rate coefficients for particular exposure modes to obtain more realistic estimates of equivalent doses to members of the public. Much of the discussion below is taken from a paper by Kocher (DOE, 1988).

Consider the problem of reconstructing the dose to an individual exposed in a number of different situations to a radionuclide present in the environment; for example, while outdoors or within a residence. The dose equivalent  $H_T$  in tissue  $T$  due to exposures during the period  $t_1$  to  $t_2$  composed of  $n$  different exposure conditions can be expressed as

$$H_T = h_T \sum_{i=1}^n S_i \int_{t_1}^{t_2} R_i(t) C(t) dt \quad (14)$$

where  $S_i$  denotes the strength of the radiation field (e.g., kerma in air) for exposure condition  $i$  relative to the idealized exposure conditions assumed in deriving the dose rate coefficient  $h_T$ ; the function  $R_i(t)$  defines whether exposure condition  $i$  is in effect at time  $t$  (it is a Heaviside function, having a value of 1 at times when condition  $i$  is applicable, and 0 when it is not); and  $C(t)$  is the time-dependent concentration of the radionuclide in the environmental medium responsible for the radiation field. The summation extends over all exposure conditions  $i$ . In prospective assessments, information usually is not available to characterize  $R_i(t)$ . Then, exposure condition  $i$  is assumed, on average, to represent a fraction,  $\bar{R}_i$ , of the exposure period, and Eq. (14) reduces to:

$$H_T = h_T \left[ \int_{t_1}^{t_2} C(t) dt \right] \sum_{i=1}^n S_i \bar{R}_i \quad (15)$$

The factors  $S_i$  and  $\bar{R}_i$  take account of two fundamentally different considerations: (1) the change in dose contribution resulting from modification of the radiation field for a particular exposure situation; for example, shielding by a building; and (2) the fraction of the exposure period associated with the particular exposure situation. Note that the product of  $S_i$  and  $\bar{R}_i$  or, in many cases, the summation of their products, often is represented by a single modifying factor. Such ad hoc factors can be used only for the specific conditions for which they were derived, and should be used with extreme caution when the strength of the radiation field is highly time-dependent; for example, following an acute release of short-lived radionuclides to the environment.

#### 5.4.1 Contaminated shorelines

The dose rate coefficients for exposure to contaminated soil in Tables 4-1 through 4-5 assume that the photons and electrons originate uniformly within the contaminated volume. It is further assumed that the source region is infinite in extent and, thus, is appropriate for large areas that are contaminated by deposition of radionuclides from the atmosphere or by irrigation with contaminated water. Exposure to contaminated soil also may occur during fishing or hiking along shorelines of finite width that are contaminated by deposition of radionuclides from water.



For photon exposure, the U.S. Nuclear Regulatory Commission (NRC) (1977) has recommended the following dose-reduction factors for different types of shorelines:

- 0.1 for discharge canal bank
- 0.2 for river shoreline
- 0.3 for lake shore
- 0.5 for ocean shore
- 1.0 for tidal basin

These shoreline dose-reduction factors do not include consideration of exposure times. As discussed earlier, the dose rate coefficients for exposure to contaminated ground surface include consideration of ground roughness; thus, no additional factors are required.

Dose-reduction factors for exposure to electrons from contaminated shorelines have not been considered in the literature. Due to the relatively short range of electrons in air, the dose rate coefficient from exposure to shorelines of finite width should be about the same as the dose rate coefficient for exposure to an infinite ground surface; that is, the dose-reduction factor should be nearly unity. However, the high moisture content of the shoreline also would reduce the electron dose for these exposures. As discussed earlier, an electron dose-reduction factor for ground roughness, based on an appropriate value for photons, could be taken into account in estimating electron dose rate coefficients for exposure to contaminated shorelines.

Although site-specific data for exposure times to contaminated shorelines can be used when available, NRC (1977) has recommended exposure times in lieu of site-specific information. The values for an adult are 12 hours per year for maximally exposed individuals and 8 hours per year for average individuals in population groups. If other age groups are taken into account, the recommended exposure times are higher. For teenagers, the recommended values are 67 hours per year for maximally exposed individuals and 47 hours per year for average individuals in population groups.

#### **5.4.2 Exposure during boating activities**

The dose rate coefficients for immersion in contaminated water in Table 4-7 assume immersion in an infinite pool and, thus, are appropriate for exposure while swimming. External exposure to contaminated water also can occur during boating activities.

For photon exposure, a dose-reduction factor of 0.5 during boating activities is a reasonable value that is unlikely to underestimate external equivalent doses. This dose-reduction factor takes into account that the source region is effectively semi-infinite in extent for an exposed individual located at the boundary of the air-water interface and assumes that the shielding of photons provided by the typically thin hull of a

boat is negligible. The latter assumption will result in overestimates of external equivalent dose during boating activities for radionuclides that emit mostly low-energy photons.

For electron exposure, it is reasonable to assume a dose-reduction factor of zero during boating activities; that is, that the electron equivalent dose is zero. The hull of a boat should provide complete shielding from electron sources in the water.

The exposure time for boating activities should be estimated on a site-specific basis. For individuals who reside on a boat for all or part of a year, an exposure time of 50 percent or more would be reasonable. For individuals who engage only in recreational boating activities, an exposure time as high as 5 percent (44 hours per year) would be reasonable.

### **5.4.3 Effects of indoor residence**

The dose rate coefficients for air submersion and exposure to contaminated soil tabulated in Chapter 3 relate the organ dose to the time-integrated air or soil concentration, assuming the individual is located in the open without the benefit of shielding from structures. To realistically assess the dose for these exposure modes, consideration must be given to the reduction of the radiation field due to shielding by building structures.

Following the Chernobyl accident, considerable efforts have been devoted to improving the models for assessing external doses from airborne and deposited radionuclides, including evaluation of the reduction in the radiation field by various structures. The results of an extensive study of the shielding factors for selected European single-family and multi-story structures were reported by LeGrand et al. (1991) and Jacob and Meckbach (1991). For an airborne plume, the shielding factor (ratio of kerma in the “shielded” position to that in the open) ranged from about 0.01 to 0.7 for single-family houses. In some cases, it may be more appropriate to assume that individuals are exposed in house basements, schools, apartment houses or office buildings. These structures generally provide significantly greater shielding than living areas in single-family houses. For submersion in contaminated air, representative shielding factors range from 0.6 for the basement of a wood-frame house to 0.2 or less for a large office or industrial building. For contaminated soil exposure, representative shielding factors range from 0.1 for the basement of a house to 0.005 for the basement of large, multi-story structures (Burson and Profio, 1977). LeGrand et al. (1991) estimated the shielding factor for exposure in multi-story structures to an airborne plume. For 0.68 MeV photons, it ranged from 0.01 to 0.1 on the ground floor and from 0.09 to 0.4 on the upper floors, which have decreased shielding.

In an urban setting, for an overhead plume, locations outside of a structure are shielded by neighboring structures at a value of about 0.8, which is rather independent of photon energy. Within a structure, the dependence of the shielding factor on energy is more pronounced at strongly shielded locations like basements and lower floors of multi-story structures. Neighboring structures also can have a large influence (factor of two) on the shielding inside of a structure (LeGrand et al., 1991).

For photon exposures following routine releases from nuclear reactors, NRC (1977) has recommended the following modifying factors for air submersion and exposure to contaminated soil that account for both the shielding provided by structures and the fraction of time individuals spend indoors:

- 0.7 for maximally exposed individuals
- 0.5 for average individuals in population groups

Both modifying factors are based on a shielding factor of 0.5. It should be noted that the values are most appropriate for photon energies greater than a few hundred keV. For photons of lower energy, use of these factors may considerably overestimate the equivalent dose (Kocher, 1980). Note that the difference in the two modifying factors implies a different fraction of time spent indoors; that is, about 60 percent for maximally exposed individuals and effectively 100 percent for average individuals in population groups. In both cases, the individuals are presumed to spend 100 percent of their time at the exposed location. These dose-reduction factors were based on an analysis by Burson and Profio (1977). The National Council on Radiation Protection and Measurements has recommended similar values (NCRP, 1975), based on a compilation by Oakley (1972).

For electron exposures, external dose from electrons during indoor residence can be estimated on the basis of concentrations of radionuclides in indoor air and on the floor of the building (see Kocher, 1980). Electrons emitted by radionuclides outside the building cannot penetrate the structure.

The following discussion of modifying factors for electrons during indoor residence applies primarily to routine (i.e., chronic) releases of radionuclides to the atmosphere, in which case steady-state concentrations of airborne radionuclides inside and outside buildings may be assumed. For acute releases, however, the relationship between indoor and outdoor airborne concentrations of radionuclides will vary with time during and after a release and also will depend on the timing and extent of building ventilation. For such releases, it may be prudent to assume no reduction in external dose from electrons during indoor residence.

For noble gas radionuclides, air submersion is the only external exposure mode of concern. The effects of indoor residence on electron dose to skin should be negligible during chronic releases (i.e., the dose-reduction factor should be essentially unity), unless the range of the emitted electrons in air is somewhat greater than the interior dimensions of building rooms, because the indoor and outdoor air concentrations for noble gases will be about the same. For  $^{85}\text{Kr}$ , for example, the electron energies from beta decay are less than 0.687 MeV, and the corresponding electron ranges in air are less than 2.6 m (NAS–NRC, 1964), which is a representative radius of rooms in single-family houses. Therefore, a dose-reduction factor of unity for indoor exposure to electrons from  $^{85}\text{Kr}$  decay is reasonable. However, if the electron range in air is somewhat greater than the dimensions of building rooms (i.e., if the emitted electron energy is about 1 MeV or greater), then the use of a modifying factor of unity will overestimate the electron dose to skin from exposure to noble gases during indoor residence. The extent of overestimation depends on the electron range in air relative to the dimensions of the building rooms.

For depositing radionuclides (particulates) dispersing in the atmosphere, the indoor air concentration can be considerably less than the outdoor air concentration during chronic releases (Kocher, 1980). If the fractional transfer rates from air to surfaces in the indoor and outdoor environments are comparable, the dose-reduction factors for external exposure to electrons during indoor residence can be substantial for both airborne and deposited activity. The dose-reduction factor for electrons for air submersion or a contaminated soil surface can be assumed to be equal to the ratio of indoor and outdoor concentrations of airborne or deposited radionuclides, respectively, provided the electron range in air is comparable to or less than the dimensions of the building rooms. For greater electron ranges in air, this assumption again overestimates electron skin dose during indoor residence, but by unknown amounts.

Indoor residence times recommended by NRC (1977) for maximally exposed and average individuals are 60 percent and nearly 100 percent, respectively. In prospective assessments, it is generally assumed that both the indoor and outdoor exposures occur at the same locations. For a detailed consideration of activity factors relevant to dose assessment, see Chapter 16 of the EPA Exposure Factors Handbook (EPA, 2011). That handbook suggests that, as median values, children under 12 years of age may spend about 20 percent of their time at school and approximately 20 percent of their time outdoors. Similarly, adults ages 18 to 64 years typically spend about 20 percent of their time outdoors.

Shielding factors for U.S. residential structures applicable to airborne sources and deposited activity recently have been developed by Dickson and colleagues (Dickson and Hamby, 2014; Dickson et al., 2015; Dickson and Hamby, 2016). These investigations address a wide range of housing construction within the United States and provide both floor-specific and average shielding factors. The shielding factors are based on kerma coefficients and, as such, can be applied to both open-field projections and field measurements.

#### **5.4.4 Conclusions**

Application of the dose rate coefficients tabulated in this report typically involves use of modifying factors to reflect exposures of different durations to various radiation fields. It was the intent of the preceding discussion to note the nature of the considerations reflected in these factors, but it was not the intent to establish specific numerical values for such factors. It is useful to keep separate the two aspects of the radiation exposure that are reflected in the modifying factors. To reiterate, these are the change in dose contribution resulting from modification of the radiation field for a particular exposure situation and the fraction of the exposure period associated with the particular exposure situation; see Eqs. (14) and (15). When these two aspects are combined, it is difficult to judge the reasonableness of the resulting single factor.

The modifying factors developed for prospective assessments of chronic low-level exposures generally will not be applicable to exposure following an acute release of radioactivity to the environment. In such cases, the time of day of the release and subsequent time dependence of the radiation field can be important considerations in determining the dose. The adequacy of any modifying factors applied to the dose rate coefficients tabulated in this report must be determined by the user at the time of the dose assessment.

## 5.5 Non-uniform volume source distributions

For photon exposure, the assumption of uniformly contaminated slab sources is appropriate for frequently plowed soils or for use with linear compartment models that describe downward migration of radionuclides in soil (Sjoreen et al., 1984). It may be appropriate to treat volume sources as being non-uniformly distributed when a reasonable approximation to the distribution is known. For example, Beck and de Planque (1968) and Kocher and Sjoreen (1985) have considered sources exponentially distributed in the soil, which may be appropriate for natural infiltration of radionuclides into the soil during a chronic deposition on the surface.

External exposure to electrons from radionuclides distributed in subsurface soil generally can be neglected, because a few centimeters (often, only a few millimeters) of soil provides complete shielding of electrons from radioactive decay for a receptor location 1 m above ground (NAS–NRC, 1964). Therefore, calculations of electron dose from sources deposited on the ground need to consider only those sources that remain on or very near the surface. The tabulations of electron dose rate coefficients for volume sources in this report are based on the conservative assumption of an infinitely thick source. However, bremsstrahlung generated as the emitted electrons stop within the soil does contribute to the dose to skin and other tissues.

## APPENDIX A. NUCLEAR DECAY DATA

Nuclear decay characteristics of each radionuclide considered in this report are summarized in Table A-1. Data are presented for 1,252 nuclides of 97 elements as obtained from ICRP Publication 107 (2008).

Table A-1 contains the following information, intended to aid in the proper use of the radionuclide-specific dose rate coefficients in Tables 4-1 through 4-7. The information for each nuclide is presented on one line. The physical half-life of the radionuclides is given in the third column of the table. The time units are abbreviated as: y for year, d for day, h for hour, m for minute, s for second, ms for millisecond and  $\mu$ s for microsecond. The modes of nuclear transformation applicable to the radionuclide are given in the column headed "Decay mode." The modes are abbreviated as: B- for beta minus decay, B+ for beta plus decay, EC for electron capture, A for alpha decay, IT for isometric transition, and SF for spontaneous fission. The remaining four columns on the extreme right list the kinetic energy per nuclear transformation of emitted alpha particles, electrons and photons, and the total emitted energy.<sup>18</sup> For radionuclides that undergo spontaneous fission, the total entry includes the energy of the fission fragments and that of neutrons accompanying the fission. The entry for electrons includes the kinetic energy of all beta particles (negatron or positron), internal conversion electrons and Auger electrons emitted in the nuclear transformations. Similarly, the photon entry encompasses gamma rays, x-rays and annihilation photons. If nuclear transformations of the radionuclide do not result in emission of a particular radiation, then a dash, "-", is shown in the appropriate column. If, however, radiations of a particular type are emitted, but the total energy per nuclear transformation is less than 0.1 keV, the notation "< E-04" appears in the column.

The identity of radioactive progeny, if any, is shown on a line(s) following the parent; including the fraction of the parent transformations forming that progeny. No attempt is made to identify the fission fragments. The notation "SF" simply indicates that the accompanying branching fraction refers to spontaneous fission. For example, the line following the entry for <sup>24</sup>Ne indicates that <sup>24</sup>Na is formed with a fractional yield of 1 in the decay of <sup>24</sup>Ne. The progeny nucleus is shown only if it is radioactive; that is, not a stable nucleus.

The dose rate coefficients of Tables 4-1 to 4-7 are based on the radiations emitted by the indicated radionuclide and do not include consideration of the radiations emitted by radioactive decay products. For each radionuclide, the radioactive decay products, if formed, are identified in Table A-1. Consider the radionuclide <sup>144</sup>Ce. The <sup>144</sup>Ce entry in Table A-1 indicates that <sup>144</sup>Ce has a half-life of 284.91 days and forms <sup>144</sup>Pr in 99.023 percent of its transformations and <sup>144m</sup>Pr in 0.97699 percent of its transformations. The entry for <sup>144m</sup>Pr, half-life 7.2 m, indicates that it decays (in 99.93% of the transformations) by internal transition to <sup>144</sup>Pr; the remaining transformations form <sup>144</sup>Nd. Nuclear transformations of <sup>144</sup>Pr, half-life 17.28 minutes, also form <sup>144</sup>Nd, a very long-lived radionuclide ( $T_{1/2} = 2.29 \cdot 10^{15}$  y). Through repeated entry into Table A-1 the serial transformations (decay chain) associated with a radionuclide can be assembled. As illustrated by

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<sup>18</sup> The total kinetic energy of radiation type  $R$ ,  $E_{T,R}$ , is computed as  $E_{T,R} = \sum_{i=1}^n y_{i,R} E_{i,R}$ , where  $y_{i,R}$  is the mean number of radiations of type  $R$  emitted per nuclear transformation with unique or mean energy  $E_{i,R}$ . The quantity should not be confused with the mean energy of radiation type  $R$  which is  $\bar{E}_R = E_{T,R} / \sum_{i=1}^n y_{i,R}$

this example, when a radionuclide has multiple modes of transformation, the branch formed by each mode must be followed. In some instances, the branches may converge. It should be noted that the branching fractions may not always add to exactly 1 due to uncertainties in the fractions. The stated values are considered to be appropriate for use in dosimetric calculations.

The serial transformation by radioactive decay of each member of a radioactive series is described by the Bateman equations (ICRP, 1959; Jacquez, 1972; Skrable et al., 1974). Assume that at time 0, the concentration of the parent nuclide on the surface of the ground is  $A_1^0$  (Bq m<sup>-2</sup>) and that the effective dose  $E$  for an exposure period of 1 year is to be estimated. The contribution to effective dose from nuclear transformation of the parent nuclide is given by

$$E = e_{E,1}^{gs} \frac{A_1^0}{\lambda_1} [1 - e^{-\lambda_1 T}] \quad (\text{A-1})$$

where  $e_{E,1}^{gs}$  denotes the effective dose rate coefficient from ground surface exposure for nuclide 1 (Sv Bq<sup>-1</sup> s<sup>-1</sup> m<sup>2</sup>),  $\lambda_1$  is the decay constant, in inverse seconds, for nuclide 1 ( $\lambda_1 = 0.6931.../T_{1/2}$ ), and  $T$  equals  $3.15 \times 10^7$  s (1 year). Using the Bateman equations, the activity at time  $t$  of chain members  $i$ ,  $i = 1, 2, \dots$ , can be expressed as

$$A_i(t) = A_1^0 \prod_{j=1}^{i-1} f_{j,j+1} \lambda_j \sum_{j=1}^i \frac{e^{-\lambda_j t}}{\prod_{\substack{k=1 \\ k \neq j}}^i (\lambda_k - \lambda_j)} \quad (\text{A-2})$$

where

$$\prod_{i=1}^n a_i = a_1 \times a_2 \times a_3 \dots \times a_{xn}, \text{ if } n \geq 1 \text{ or } 1 \text{ if } n = 0.$$

and  $f_{j,j+1}$  denotes the fraction of the nuclear transformations of chain member  $j$  forming member  $j+1$ . The effective dose associated with an exposure period of duration  $T$ , following a contamination event at  $t = 0$  that results in a ground surface concentration of  $A_1^0$ , is

$$E = A_1^0 \sum_{i=1}^n e_{E,i}^{gs} \prod_{j=1}^{i-1} f_{j,j+1} \lambda_j \sum_{j=1}^i \frac{1 - e^{-\lambda_j T}}{\lambda_j \prod_{\substack{k=1 \\ k \neq j}}^i (\lambda_k - \lambda_j)} \quad (\text{A-3})$$

where  $e_{E,i}^{gs}$  denotes the effective dose rate coefficient for ground surface exposure to nuclide  $i$ , and all other factors are as defined above. If the parent radionuclide is long-lived relative to the decay products, then at times  $T$  such that  $\lambda_i T > 5$ ,  $i = 2$  to  $n$ ,  $E$  can be estimated as

$$E = A_1^0 \frac{1 - e^{-\lambda_1 T}}{\lambda_1} \sum_{i=1}^n e_{E,i}^{gs} \prod_{j=1}^{i-1} f_{j,j+1} \quad (\text{A-4})$$

Under these conditions, the activity of the decay products is in secular equilibrium with the parent's activity. For example, application of Eq. (A-4) to  $^{137}\text{Cs}$  and its  $^{137\text{m}}\text{Ba}$  decay product would yield

$$E = A_{\text{Cs-137}}^0 \frac{1 - e^{-\lambda_{\text{Cs-137}} t}}{\lambda_{\text{Cs-137}}} \left[ e_{E,\text{Cs-137}}^{gs} + 0.944 e_{E,\text{Ba-137m}}^{gs} \right] \quad (\text{A-5})$$

where 0.944 is the fraction of the  $^{137}\text{Cs}$  nuclear transformations forming  $^{137\text{m}}\text{Ba}$ . If the decay products are not short-lived relative to the parent, then it is necessary to evaluate Eq. (A-3). In many instances, the mathematical models describing the fate of radionuclides in the environment (e.g., their dispersion following release to the atmosphere) include an evaluation of the ingrowth of each radioactive decay product. The information in Table A-1 should be useful to those implementing such models.



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number.**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Hydrogen	H-3	12.32 y	B-	–	0.005	–	0.0057
Beryllium	Be-7	53.22 d	EC	–	<E-04	0.0499	0.0499
	Be-10	1.51E+6 y	B-	–	0.2525	–	0.2525
Carbon	C-10	19.255 s	ECB+	–	0.8087	1.7443	2.5531
	C-11	20.39 m	ECB+	–	0.3847	1.0196	1.4043
	C-14	5.70E+3 y	B-	–	0.0495	–	0.0495
Nitrogen	N-13	9.965 m	ECB+	–	0.4909	1.0200	1.5109
	N-16	7.13 s	B-	–	2.7646	4.4932	7.2579
Oxygen	O-14	70.606 s	ECB+	–	0.7763	3.3201	4.0965
	O-15	122.24 s	ECB+	–	0.7347	1.0210	1.7557
	O-19	26.464 s	B-	–	1.7608	0.9397	2.7006
Fluorine	F-17	64.49 s	ECB+	–	0.7385	1.0208	1.7593
	F-18	109.77 m	ECB+	–	0.2416	0.9886	1.2302
Neon	Ne-19	17.22 s	ECB+	–	0.9624	1.0210	1.9834
	Ne-24	3.38 m	B-	–	0.8035	0.5419	1.3455
Sodium	Na-24	15.0 h	B-	–	0.5538	4.1232	4.6770
	Na-22	2.6019 y	ECB+	–	0.1941	2.1926	2.3866
Magnesium	Mg-27	9.458 m	B-	–	0.7021	0.8912	1.5933
	Mg-28	20.915 h	B-	–	0.1610	1.3700	1.5310
Aluminum	Al-26	7.17E+5 y	ECB+	–	0.4444	2.6751	3.1195
	Al-28	2.2414 m	B-	–	1.2417	1.7789	3.0205
	Al-29	6.56 m	B-	–	0.9764	1.3794	2.3558
Silicon	Si-31	157.3 m	B-	–	0.5949	0.0009	0.5957
	Si-32	132 y	B-	–	0.0686	–	0.0686
Phosphorus	P-32	14.263 d	B-	–	0.6948	–	0.6948
	P-33	25.34 d	B-	–	0.0764	–	0.0764
	P-30	2.498 m	ECB+	–	1.4389	1.0222	2.4610
Sulfur	S-35	87.51 d	B-	–	0.0487	–	0.0487
	S-37	5.05 m	B-	–	0.7998	2.9311	3.7309
	S-38	170.3 m	B-	–	0.4898	1.6953	2.1851
Chlorine	Cl-38	–	1.00	–	–	–	–
	Cl-34	1.5264 s	ECB+	–	2.0508	1.0212	3.0720
	Cl-34m	32.00 m	ECB+IT	–	0.4596	2.1127	2.5722
	Cl-34	–	4.4600E-01	–	–	–	–
	Cl-36	3.01E+5 y	B-ECB+	–	0.2732	0.0001	0.2733
	Cl-38	37.24 m	B-	–	1.5504	1.4430	2.9934
Argon	Cl-39	55.6 m	B-	–	0.8246	1.4509	2.2755
	Ar-39	–	1.00	–	–	–	–
	Cl-40	1.35 m	B-	–	1.5265	4.0821	5.6085
	Ar-37	35.04 d	EC	–	0.0023	0.0003	0.0025
Argon	Ar-39	269 y	B-	–	0.2188	–	0.2188
	Ar-41	109.61 m	B-	–	0.4637	1.2836	1.7474

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Potassium	Ar-42	32.9 y	B- K-42 1.00	–	0.2325	–	0.2325
	Ar-43	5.37 m	B- K-43 1.00	–	1.3570	1.5352	2.8921
	Ar-44	11.87 m	B- K-44 1.00	–	0.5245	1.9376	2.4621
	K-38	7.636 m	ECB+	–	1.2107	3.1867	4.3974
	K-40	1.251E+9 y	B-ECB+	–	0.5218	0.1567	0.6785
	K-42	12.360 h	B-	–	1.4303	0.2787	1.7090
	K-43	22.3 h	B-	–	0.3097	0.9641	1.2739
	K-44	22.13 m	B-	–	1.4567	2.3846	3.8413
	K-45	17.3 m	B-	–	0.9959	1.8360	2.8319
	Calcium	Ca-45		Ca-45 1.00			
K-46		105 s	B-	–	2.3161	2.8710	5.1871
Ca-41		1.02E+5 y	EC	–	0.0027	0.0005	0.0032
Ca-45		162.67 d	B-	–	0.0772	<E-04	0.0772
Ca-47		4.536 d	B-	–	0.3521	1.0521	1.4042
Scandium	Sc-47		Sc-47 1.00				
	Ca-49	8.718 m	B-	–	0.8693	3.1675	4.0369
	Sc-49		Sc-49 1.00				
	Sc-42m	62.0 s	ECB+	–	1.2565	4.2042	5.4607
	Sc-43	3.891 h	ECB+	–	0.4195	0.9841	1.4035
	Sc-44	3.97 h	ECB+	–	0.5961	2.1369	2.7330
	Sc-44m	58.61 h	ITEC	–	0.0328	0.2743	0.3071
	Sc-44		9.8800E-01				
	Sc-46	83.79 d	B-	–	0.1121	2.0096	2.1217
	Sc-47	3.3492 d	B-	–	0.1624	0.1089	0.2713
Titanium	Sc-48	43.67 h	B-	–	0.2216	3.3529	3.5744
	Sc-49	57.2 m	B-	–	0.8177	0.0010	0.8188
	Sc-50	102.5 s	B-	–	1.6362	3.2022	4.8384
	Ti-44	60.0 y	EC	–	0.0108	0.1396	0.1504
	Sc-44		1.00				
	Ti-45	184.8 m	ECB+	–	0.3728	0.8703	1.2431
	Ti-51	5.76 m	B-	–	0.8692	0.3692	1.2383
	Ti-52	1.7 m	B-	–	0.7530	0.1282	0.8812
Vanadium	V-52		V-52 1.00				
	V-47	32.6 m	ECB+	–	0.8027	0.9951	1.7978
	V-48	15.9735 d	ECB+	–	0.1526	2.9140	3.0666
	V-49	330 d	EC	–	0.0035	0.0009	0.0045
	V-50	1.50E+17 y	ECB-	–	0.0158	1.4235	1.4393
	V-52	3.743 m	B-	–	1.0684	1.4449	2.5133
Chromium	V-53	1.61 m	B-	–	1.0048	1.0382	2.0430
	Cr-48	21.56 h	ECB+	–	0.0086	0.4363	0.4449
	V-48		1.00				
Cr-49	42.3 m	ECB+	–	0.6047	1.0538	1.6584	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		V-49	1.00				
	Cr-51	27.7025 d	EC	–	0.0038	0.0329	0.0367
	Cr-55	3.497 m	B-	–	1.1007	0.0007	1.1013
	Cr-56	5.94 m	B-	–	0.6083	0.0918	0.7000
Manganese	Mn-56		1.00				
	Mn-50m	1.75 m	ECB+	–	1.5243	4.6397	6.1640
	Mn-51	46.2 m	ECB+	–	0.9344	0.9977	1.9321
	Cr-51		1.00				
	Mn-52m	21.1 m	ECB+IT	–	1.1321	2.4086	3.5407
	Mn-52		1.7500E-02				
	Mn-52	5.591 d	ECB+	–	0.0750	3.4585	3.5335
	Mn-53	3.7E+6 y	EC	–	0.0040	0.0014	0.0053
	Mn-54	312.12 d	ECB+B-	–	0.0042	0.8360	0.8402
	Mn-56	2.5789 h	B-	–	0.8299	1.6916	2.5215
Iron	Mn-57	85.4 s	B-	–	1.1013	0.0996	1.2009
	Mn-58m	65.2 s	B-	–	1.7443	2.3854	4.1297
	Fe-52	8.275 h	ECB+	–	0.1917	0.7405	0.9322
	Mn-52m		1.00				
	Fe-53	8.51 m	ECB+	–	1.1013	1.1782	2.2795
	Mn-53		1.00				
	Fe-53m	2.526 m	IT	–	0.0023	3.0547	3.0570
	Fe-53		1.00				
	Fe-55	2.737 y	EC	–	0.0042	0.0017	0.0058
	Fe-59	44.495 d	B-	–	0.1179	1.1883	1.3062
Cobalt	Fe-60	1.5E+6 y	B-	–	0.0647	–	0.0647
	Co-60m		1.00				
	Fe-61	5.98 m	B-	–	1.0934	1.3910	2.4844
	Co-61		1.00				
	Fe-62	68 s	B-	–	0.8258	0.5061	1.3319
	Co-62		1.00				
	Co-54m	1.48 m	ECB+	–	2.0484	3.9306	5.9790
	Co-55	17.53 h	ECB+	–	0.4312	1.9960	2.4272
	Fe-55		1.00				
	Co-56	77.23 d	ECB+	–	0.1198	3.6404	3.7602
Nickel	Co-57	271.74 d	EC	–	0.0186	0.1252	0.1439
	Co-58	70.86 d	ECB+	–	0.0340	0.9749	1.0089
	Co-58m	9.04 h	IT	–	0.0229	0.0020	0.0249
	Co-58		1.00				
	Co-60	5.2713 y	B-	–	0.0969	2.5038	2.6007
	Co-60m	10.467 m	ITB-	–	0.0565	0.0067	0.0632
	Co-60		9.9760E-01				
	Co-61	1.650 h	B-	–	0.4664	0.0970	0.5634
	Co-62	1.50 m	B-	–	1.6336	1.6050	3.2386
	Co-62m	13.91 m	B-	–	1.0974	2.6923	3.7897
Nickel	Ni-56	6.075 d	ECB+	–	0.0073	1.7207	1.7280
	Co-56		1.00				

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Copper	Ni-57	35.60 h	ECB+	–	0.1571	1.9382	2.0953	
		Co-57	1.00					
	Ni-59	1.01E+5 y	ECB+	–	0.0045	0.0024	0.0069	
	Ni-63	100.1 y	B-	–	0.0174	–	0.0174	
	Ni-65	2.51719 h	B-	–	0.6277	0.5583	1.1860	
	Ni-66	54.6 h	B-	–	0.0734	–	0.0734	
		Cu-66	1.00					
		Cu-57	0.1963 s	ECB+	–	3.5987	1.1407	4.7394
		Ni-57	1.00					
		Cu-59	81.5 s	ECB+	–	1.4892	1.4451	2.9342
		Ni-59	1.00					
		Cu-60	23.7 m	ECB+	–	0.8975	3.9111	4.8087
		Cu-61	3.333 h	ECB+	–	0.3090	0.8237	1.1327
		Cu-62	9.673 m	ECB+	–	1.2843	1.0069	2.2912
	Zinc	Cu-64	12.700 h	ECB+B-	–	0.1248	0.1855	0.3102
Cu-66		5.120 m	B-	–	1.0664	0.0978	1.1642	
Cu-67		61.83 h	B-	–	0.1504	0.1154	0.2657	
Cu-69		2.85 m	B-	–	0.8863	0.5284	1.4147	
		Zn-69	1.00					
		Zn-60	2.38 m	ECB+	–	1.1301	1.5282	2.6584
		Cu-60	1.00					
		Zn-61	89.1 s	ECB+	–	1.8571	1.5327	3.3898
		Cu-61	1.00					
		Zn-62	9.186 h	ECB+	–	0.0326	0.4431	0.4757
		Cu-62	1.00					
		Zn-63	38.47 m	ECB+	–	0.9204	1.0967	2.0171
		Zn-65	244.06 d	ECB+	–	0.0069	0.5819	0.5888
		Zn-69m	56.4 m	ITB-	–	0.0226	0.4162	0.4388
Gallium			Zn-69	9.997E-01				
		Zn-69	56.4 m	B-	–	0.3216	<E-04	0.3216
		Zn-71m	2.45 m	B-	–	0.5430	1.5606	2.1037
		Zn-71	3.96 h	B-	–	1.0474	0.3150	1.3624
		Zn-72	46.5 h	B-	–	0.1021	0.1519	0.2541
		Ga-72	1.00					
		Ga-64	2.627 m	ECB+	–	1.7031	3.3726	5.0756
		Ga-65	15.2 m	ECB+	–	0.8158	1.1650	1.9808
		Zn-65	1.00					
		Ga-66	9.49 h	ECB+	–	0.9634	2.4944	3.4577
		Ga-67	3.2612 d	EC	–	0.0363	0.1595	0.1959
		Ga-68	67.71 m	ECB+	–	0.7379	0.9487	1.6866
		Ga-70	21.14 m	B-EC	–	0.6441	0.0073	0.6514
		Ga-72	14.10 h	B-	–	0.5060	2.7071	3.2131
		Ga-73	4.86 h	B-	–	0.4999	0.3520	0.8519
	Ga-74	8.12 m	B-	–	0.9945	3.1540	4.1486	
Germanium	Ge-66	2.26 h	ECB+	–	0.0984	0.6780	0.7764	
	Ga-66	1.00						

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Arsenic	Ge-67	18.9 m	ECB+	–	1.1688	1.4254	2.5942
		Ga-67	1.00				
	Ge-68	270.95 d	EC	–	0.0050	0.0041	0.0091
		Ga-68	1.00				
	Ge-69	39.05 h	ECB+	–	0.1203	0.9505	1.0708
	Ge-71	11.43 d	EC	–	0.0050	0.0042	0.0092
	Ge-75	82.78 m	B-	–	0.4206	0.0352	0.4558
	Ge-77	11.30 h	B-	–	0.6493	1.0787	1.7280
		As-77	1.00				
	Ge-78	88 m	B-	–	0.2273	0.2781	0.5053
		As-78	1.00				
	As-68	151.6 s	ECB+	–	1.9985	3.7113	5.7097
		Ge-68	1.00				
	As-69	15.23 m	ECB+	–	1.2182	1.1431	2.3613
		Ge-69	1.00				
	As-70	52.6 m	ECB+	–	0.8799	4.2528	5.1327
	As-71	65.28 h	ECB+	–	0.1167	0.5765	0.6932
		Ge-71	1.00				
	As-72	26.0 h	ECB+	–	1.0409	1.7832	2.8240
	As-73	80.30 d	EC	–	0.0606	0.0159	0.0765
As-74	17.77 d	ECB+B-	–	0.2658	0.7582	1.0241	
As-76	1.0778 d	B-	–	1.0670	0.4166	1.4836	
As-77	38.83 h	B-	–	0.2258	0.0083	0.2342	
As-78	90.7 m	B-	–	1.2460	1.3066	2.5525	
As-79	9.01 m	B-	–	0.8771	0.0338	0.9109	
Selenium		Se-79m	9.7188E-01				
		Se-79	2.8121E-02				
	Se-70	41.1 m	ECB+	–	0.2375	0.7211	0.9586
		As-70	1.00				
	Se-71	4.74 m	ECB+	–	1.3844	1.6056	2.9900
		As-71	1.00				
	Se-72	8.40 d	EC	–	0.0228	0.0343	0.0571
		As-72	1.00				
	Se-73	7.15 h	ECB+	–	0.3871	1.0924	1.4795
		As-73	1.00				
	Se-73m	39.8 m	ITECB+	–	0.1642	0.2633	0.4275
		Se-73	7.2600E-01				
		As-73	2.7400E-01				
	Se-75	119.779 d	EC	–	0.0144	0.3890	0.4034
	Se-77m	17.36 s	IT	–	0.0737	0.0888	0.1625
	Se-79	2.95E+5 y	B-	–	0.0529	–	0.0529
	Se-79m	3.92 m	ITB-	–	0.0820	0.0138	0.0957
	Se-79	9.9944E-01					
Se-81	18.45 m	B-	–	0.6108	0.0080	0.6188	
Se-81m	57.28 m	ITB-	–	0.0871	0.0183	0.1054	
	Se-81	9.9948E-01					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Bromine	Se-83	22.3 m	B-	–	0.4528	2.6254	3.0782
		Br-83	1.00				
	Se-83m	70.1 s	B-	–	1.2570	0.9849	2.2419
		Br-83	1.00				
	Se-84	3.1 m	B-	–	0.5499	0.4202	0.9701
		Br-84	1.00				
	Br-72	78.6 s	ECB+	–	2.7880	2.9624	5.7504
		Se-72	1.00				
	Br-73	3.4 m	ECB+	–	1.3434	1.4331	2.7765
		Se-73m	9.9881E-01				
		Se-73	1.1920E-03				
	Br-74	25.4 m	ECB+	–	1.0616	4.6130	5.6746
	Br-74m	46 m	ECB+	–	1.2747	4.1467	5.4214
	Br-75	96.7 m	ECB+	–	0.5283	1.1981	1.7263
		Se-75	1.00				
	Br-76	16.2 h	ECB+	–	0.6497	2.7933	3.4430
	Br-76m	1.31 s	ITECB+	–	0.0690	0.0433	0.1123
		Br-76	9.9700E-01				
	Br-77	57.036 h	ECB+	–	0.0094	0.3209	0.3303
	Br-77m	4.28 m	IT	–	0.0876	0.0197	0.1073
	Br-77	1.00					
Br-78	6.46 m	ECB+B-	–	1.0235	1.0336	2.0571	
	Kr-78	1.0000E-04					
Br-80	17.68 m	B-ECB+	–	0.7247	0.0761	0.8007	
Br-80m	4.4205 h	IT	–	0.0617	0.0242	0.0859	
	Br-80	1.00					
Br-82	35.30 h	B-	–	0.1454	2.6389	2.7844	
Br-82m	6.13 m	ITB-	–	0.0704	0.0081	0.0785	
	Br-82	9.7600E-01					
Br-83	2.40 h	B-	–	0.3258	0.0069	0.3326	
	Kr-83m	9.9845E-01					
Br-84	31.80 m	B-	–	1.2364	1.7595	2.9959	
Br-84m	6.0 m	B-	–	0.8983	2.7684	3.6667	
Br-85	2.90 m	B-	–	1.0384	0.0660	1.1045	
	Kr-85m	9.9779E-01					
	Kr-85	2.2112E-03					
Krypton	Kr-74	11.50 m	ECB+	–	0.6006	1.0579	1.6585
		Br-74	1.00				
	Kr-75	4.29 m	ECB+	–	1.5430	1.2800	2.8230
		Br-75	1.00				
	Kr-76	14.8 h	EC	–	0.0154	0.4276	0.4430
		Br-76	9.9189E-01				
		Br-76m	8.1144E-03				
	Kr-77	74.4 m	ECB+	–	0.6744	1.0384	1.7128
		Br-77	9.0386E-01				
		Br-77m	9.6135E-02				

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Rubidium	Kr-79	35.04 h	ECB+	–	0.0237	0.2549	0.2786
	Kr-81	2.29E+5 y	EC	–	0.0052	0.0072	0.0124
	Kr-81m	13.10 s	ITEC	–	0.0596	0.1309	0.1905
		Kr-81	9.9998E-01				
	Kr-83m	1.83 h	IT	–	0.0388	0.0028	0.0416
	Kr-85	10.756 y	B-	–	0.2507	0.0022	0.2529
	Kr-85m	4.480 h	B-IT	–	0.2549	0.1574	0.4123
		Kr-85	2.1400E-01				
	Kr-87	76.3 m	B-	–	1.3281	0.7919	2.1201
		Rb-87	1.00				
	Kr-88	2.84 h	B-	–	0.3689	1.9538	2.3227
		Rb-88	1.00				
	Kr-89	3.15 m	B-	–	1.3705	1.9313	3.3018
		Rb-89	1.00				
	Rb-77	3.77 m	ECB+	–	1.6865	1.5452	3.2318
		Kr-77	1.00				
	Rb-78	17.66 m	ECB+	–	1.2889	4.0918	5.3808
	Rb-78m	5.74 m	ECB+IT	–	1.4992	3.2149	4.7141
		Rb-78	1.0000E-01				
	Rb-79	22.9 m	ECB+	–	0.8099	1.4493	2.2592
		Kr-79	1.00				
	Rb-80	33.4 s	ECB+	–	2.0455	1.1900	3.2355
	Rb-81	4.576 h	ECB+	–	0.1222	0.5081	0.6304
		Kr-81m	9.5691E-01				
		Kr-81	4.3091E-02				
		Rb-81m	30.5 m	ITECB+	–	0.0817	0.0303
	Rb-81m	Rb-81	9.7600E-01				
Kr-81		2.3786E-02					
Kr-81m		2.1355E-04					
Rb-82	1.273 m	ECB+	–	1.4112	1.1083	2.5195	
Rb-82m	6.472 h	ECB+	–	0.0935	2.9212	3.0147	
Rb-83	86.2 d	EC	–	0.0083	0.4914	0.4997	
	Kr-83m	7.4292E-01					
Rb-84	32.77 d	ECB+B-	–	0.1633	0.9077	1.0710	
Rb-84m	20.26 m	IT	–	0.0813	0.3831	0.4644	
	Rb-84	1.00					
Rb-86	18.642 d	B-EC	–	0.6680	0.0930	0.7610	
Rb-86m	1.017 m	IT	–	0.0100	0.5461	0.5561	
	Rb-86	1.00					
Rb-87	4.923E10 y	B-	–	0.1154	–	0.1154	
Rb-88	17.78 m	B-	–	2.0720	0.6370	2.7089	
Rb-89	15.15 m	B-	–	0.9528	2.2430	3.1959	
	Sr-89	1.00					
Rb-90	158 s	B-	–	2.0443	2.0286	4.0729	
	Sr-90	1.00					
Rb-90m	258 s	B-IT	–	1.4104	3.2406	4.6510	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Strontium		Sr-90	9.7400E-01					
		Rb-90	2.6000E-02					
		Sr-79	2.25 m	ECB+	–	1.8572	1.1801	3.0373
			Rb-79	1.00				
		Sr-80	106.3 m	ECB+	–	0.0418	0.4371	0.4789
			Rb-80	1.00				
		Sr-81	22.3 m	ECB+	–	0.9743	1.3866	2.3609
			Rb-81	9.9856E-01				
			Rb-81m	1.4422E-03				
		Sr-82	25.36 d	EC	–	0.0054	0.0079	0.0132
			Rb-82	1.00				
		Sr-83	32.41 h	ECB+	–	0.1604	0.8213	0.9817
			Rb-83	1.00				
		Sr-85	64.84 d	EC	–	0.0089	0.5001	0.5090
		Sr-85m	67.63 m	ITECB+	–	0.0130	0.2177	0.2307
			Sr-85	8.6600E-01				
		Sr-87m	2.815 h	ITEC	–	0.0672	0.3202	0.3874
			Rb-87	3.0000E-03				
		Sr-89	50.53 d	B-	–	0.5845	<E-04	0.5846
		Sr-90	28.79 y	B-	–	0.1957	–	0.1957
			Y-90	1.00				
		Sr-91	9.63 h	B-	–	0.6549	0.7072	1.3621
			Y-91m	5.8247E-01				
		Y-91	4.1753E-01					
	Sr-92	2.66 h	B-	–	0.2025	1.3368	1.5393	
		Y-92	1.00					
	Sr-93	7.423 m	B-	–	0.8094	2.2637	3.0731	
		Y-93	1.00					
	Sr-94	75.3 s	B-	–	0.8381	1.4270	2.2651	
		Y-94	1.00					
Yttrium	Y-81	70.4 s	ECB+	–	1.9658	1.1702	3.1360	
		Sr-81	1.00					
	Y-83	7.08 m	ECB+	–	1.3138	1.3458	2.6596	
		Sr-83	1.00					
	Y-83m	2.85 m	ECB+IT	–	0.8177	0.8370	1.6546	
		Sr-83	6.0000E-01					
		Y-83	4.0000E-01					
	Y-84m	39.5 m	ECB+	–	1.2253	3.9751	5.2003	
	Y-85	2.68 h	ECB+	–	0.4881	1.0795	1.5676	
		Sr-85m	1.00					
	Y-85m	4.86 h	ECB+	–	0.5765	1.3242	1.9007	
		Sr-85	9.6000E-01					
		Sr-85m	3.9998E-02					
	Y-86	14.74 h	ECB+	–	0.2179	3.5777	3.7956	
Y-86m	48 m	ITECB+	–	0.0243	0.2203	0.2446		
	Y-86	9.9310E-01						



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Zirconium	Y-87	79.8 h	ECB+	–	0.0072	0.4462	0.4534
		Sr-87m	1.00				
	Y-87m	13.37 h	ITECB+	–	0.0794	0.3072	0.3866
		Y-87	9.8430E-01				
	Y-88	106.65 d	ECB+	–	0.0067	2.6950	2.7017
	Y-89m	15.663 s	IT	–	0.0077	0.9014	0.9091
	Y-90	64.10 h	B-	–	0.9331	<E-04	0.9331
	Y-90m	3.19 h	ITB-	–	0.0470	0.6354	0.6823
		Y-90	9.9998E-01				
	Y-91	58.51 d	B-	–	0.6032	0.0031	0.6063
	Y-91m	49.71 m	IT	–	0.0279	0.5283	0.5562
		Y-91	1.00				
	Y-92	3.54 h	B-	–	1.4494	0.2517	1.7011
	Y-93	10.18 h	B-	–	1.1721	0.0961	1.2682
		Zr-93	1.00				
	Y-94	18.7 m	B-	–	1.8133	0.7725	2.5858
	Y-95	10.3 m	B-	–	1.4288	1.1080	2.5368
		Zr-95	1.00				
	Zr-85	7.86 m	ECB+	–	1.3252	1.4718	2.7970
		Y-85m	9.6841E-01				
		Y-85	3.1588E-02				
	Zr-86	16.5 h	ECB+	–	0.0310	0.2952	0.3263
		Y-86	1.00				
Zr-87	1.68 h	ECB+	–	0.8218	0.9271	1.7488	
	Y-87m	9.9704E-01					
	Y-87	2.9636E-03					
Zr-88	83.4 d	EC	–	0.0160	0.3918	0.4078	
	Y-88	1.00					
Zr-89	78.41 h	ECB+	–	0.1019	1.1581	1.2600	
Zr-89m	4.161 m	ITECB+	–	0.0318	0.6344	0.6662	
	Zr-89	9.3770E-01					
Zr-93	1.53E+6 y	B-	–	0.0194	–	0.0194	
	Nb-93m	9.7500E-01					
Zr-95	64.032 d	B-	–	0.1185	0.7321	0.8506	
	Nb-95	9.8920E-01					
	Nb-95m	1.0802E-02					
Zr-97	16.744 h	B-	–	0.7212	0.8792	1.6004	
	Nb-97	1.00					
Niobium	Nb-87	3.75 m	ECB+	–	1.7709	1.2202	2.9911
		Zr-87	1.00				
	Nb-88	14.5 m	ECB+	–	1.4555	4.2188	5.6743
		Zr-88	1.00				
	Nb-88m	7.78 m	ECB+	–	1.4589	4.1063	5.5652
		Zr-88	1.00				
	Nb-89	2.03 h	ECB+	–	1.0859	1.3668	2.4527
	Zr-89	9.8772E-01					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Zr-89m	1.2278E-02				
	Nb-89m	66 m	ECB+	–	0.7855	1.3058	2.0913
		Zr-89m	1.00				
	Nb-90	14.60 h	ECB+	–	0.4032	4.2135	4.6167
	Nb-91	680 y	ECB+	–	0.0058	0.0118	0.0176
	Nb-91m	60.86 d	ITECB+	–	0.0963	0.0340	0.1303
		Nb-91	9.6600E-01				
	Nb-92	3.47E+7 y	EC	–	0.0079	1.5055	1.5133
	Nb-92m	10.15 d	ECB+	–	0.0065	0.9689	0.9753
	Nb-93m	16.13 y	IT	–	0.0294	0.0020	0.0314
	Nb-94	2.03E+4 y	B-	–	0.1684	1.5581	1.7265
	Nb-94m	6.263 m	ITB-	–	0.0356	0.0117	0.0473
		Nb-94	9.9500E-01				
	Nb-95	34.991 d	B-	–	0.0446	0.7645	0.8091
	Nb-95m	3.61 d	ITB-	–	0.1800	0.0697	0.2497
		Nb-95	9.4400E-01				
	Nb-96	23.35 h	B-	–	0.2534	2.4614	2.7149
	Nb-97	72.1 m	B-	–	0.4683	0.6650	1.1333
	Nb-98m	51.3 m	B-	–	0.7636	2.8177	3.5813
	Nb-99	15.0 s	B-	–	1.5132	0.1743	1.6875
		Mo-99	1.00				
	Nb-99m	2.6 m	B-IT	–	1.4148	0.7567	2.1714
		Mo-99	9.8000E-01				
		Nb-99	2.0000E-02				
Molybdenum	Mo-89	2.11 m	ECB+	–	1.9620	1.2173	3.1793
		Nb-89	1.00				
	Mo-90	5.56 h	ECB+	–	0.2107	0.8331	1.0438
		Nb-90	1.00				
	Mo-91	15.49 m	ECB+	–	1.4510	0.9773	2.4283
		Nb-91	9.9966E-01				
		Nb-91m	3.4232E-04				
	Mo-91m	64.6 s	ECB+IT	–	0.5559	1.3857	1.9416
		Nb-91m	5.0000E-01				
		Mo-91	5.0000E-01				
	Mo-93	4.0E+3 y	EC	–	0.0056	0.0107	0.0163
		Nb-93m	8.8000E-01				
	Mo-93m	6.85 h	ITEC	–	0.1045	2.3183	2.4228
		Mo-93	9.9880E-01				
	Mo-99	65.94 h	B-	–	0.3929	0.1484	0.5413
		Tc-99m	8.7730E-01				
		Tc-99	1.2270E-01				
	Mo-101	14.61 m	B-	–	0.5524	1.4706	2.0230
		Tc-101	1.00				
	Mo-102	11.3 m	B-	–	0.3509	0.0185	0.3694
		Tc-102	1.00				
Technetium	Tc-91	3.14 m	ECB+	–	1.6985	2.4847	4.1832

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Technetium		Mo-91	9.9302E-01					
		Mo-91m	6.9789E-03					
	Tc-91m	3.3 m	ECB+	–	1.8871	1.4231	3.3102	
		Mo-91m	9.7976E-01					
		Mo-91	2.0245E-02					
	Tc-92	4.25 m	ECB+	–	1.7984	3.8278	5.6263	
	Tc-93	2.75 h	ECB+	–	0.0436	1.5686	1.6122	
		Mo-93	1.00					
	Tc-93m	43.5 m	ITECB+	–	0.1015	0.9522	1.0537	
		Tc-93	7.6600E-01					
		Mo-93	2.3400E-01					
	Tc-94	293 m	ECB+	–	0.0475	2.6608	2.7083	
	Tc-94m	52.0 m	ECB+	–	0.7543	1.9567	2.7110	
	Tc-95	20.0 h	EC	–	0.0069	0.7965	0.8033	
	Tc-95m	61 d	ECB+IT	–	0.0154	0.6887	0.7042	
		Tc-95	3.8800E-02					
	Tc-96	4.28 d	EC	–	0.0089	2.5032	2.5121	
	Tc-96m	51.5 m	ITECB+	–	0.0269	0.0480	0.0749	
		Tc-96	9.8000E-01					
	Tc-97	2.6E+6 y	EC	–	0.0055	0.0114	0.0169	
	Tc-97m	90.1 d	IT	–	0.0869	0.0096	0.0964	
		Tc-97	1.00					
	Tc-98	4.2E+6 y	B-	–	0.1415	1.4127	1.5542	
	Tc-99	2.111E+5 y	B-	–	0.1013	<E-04	0.1013	
	Tc-99m	6.015 h	ITB-	–	0.0162	0.1266	0.1428	
		Tc-99	9.9996E-01					
	Tc-101	14.2 m	B-	–	0.4725	0.3367	0.8092	
	Tc-102	5.28 s	B-	–	1.9441	0.0808	2.0249	
	Tc-102m	4.35 m	B-IT	–	0.7902	2.4744	3.2646	
		Tc-102	2.0000E-02					
	Tc-104	18.3 m	B-	–	1.6014	2.2453	3.8467	
	Tc-105	7.6 m	B-	–	1.2708	0.7981	2.0690	
	Ruthenium		Ru-105	1.00				
		Ru-92	3.65 m	ECB+	–	0.7939	2.0844	2.8783
			Tc-92	1.00				
		Ru-94	51.8 m	ECB+	–	0.0085	0.5197	0.5282
			Tc-94m	1.00				
		Ru-95	1.643 h	ECB+	–	0.0831	1.2419	1.3249
			Tc-95	9.7387E-01				
			Tc-95m	2.6131E-02				
Ru-97		2.9 d	EC	–	0.0132	0.2408	0.2540	
		Tc-97	9.9958E-01					
		Tc-97m	4.2179E-04					
Ru-103		39.26 d	B-	–	0.0660	0.4962	0.5622	
		Rh-103m	9.8755E-01					
Ru-105		4.44 h	B-	–	0.4406	0.7480	1.1886	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Rh-105	1.00				
	Ru-106	373.59 d	B-	–	0.0100	–	0.0100
		Rh-106	1.00				
	Ru-107	3.75 m	B-	–	1.0704	0.3453	1.4157
		Rh-107	1.00				
	Ru-108	4.55 m	B-	–	0.4803	0.0626	0.5429
		Rh-108	1.00				
Rhodium	Rh-94	70.6 s	ECB+	–	2.9012	3.7634	6.6645
		Ru-94	1.00				
	Rh-95	5.02 m	ECB+	–	0.8973	2.5603	3.4576
		Ru-95	1.00				
	Rh-95m	1.96 m	ITECB+	–	0.1822	0.8973	1.0794
		Rh-95	8.8000E-01				
		Ru-95	1.2000E-01				
	Rh-96	9.90 m	ECB+	–	0.7419	3.9266	4.6685
	Rh-96m	1.51 m	ITECB+	–	0.5673	1.2819	1.8492
		Rh-96	6.0000E-01				
	Rh-97	30.7 m	ECB+	–	0.5211	1.4448	1.9660
		Ru-97	1.00				
	Rh-97m	46.2 m	ECB+IT	–	0.1992	2.2017	2.4009
		Ru-97	9.4400E-01				
		Rh-97	5.6000E-02				
	Rh-98	8.7 m	ECB+	–	1.3371	1.8115	3.1486
	Rh-99	16.1 d	ECB+	–	0.0611	0.5627	0.6238
	Rh-99m	4.7 h	ECB+	–	0.0367	0.6511	0.6878
	Rh-100	20.8 h	ECB+	–	0.0494	2.7425	2.7920
	Rh-100m	4.6 m	ITECB+	–	0.0802	0.0637	0.1439
		Rh-100	9.8300E-01				
	Rh-101	3.3 y	EC	–	0.0267	0.2878	0.3145
	Rh-101m	4.34 d	ECIT	–	0.0199	0.2877	0.3076
		Rh-101	6.4000E-02				
	Rh-102	207 d	ECB+B-	–	0.1717	0.5060	0.6777
	Rh-102m	3.742 y	ECB+IT	–	0.0125	2.1536	2.1661
		Rh-102	2.3300E-03				
	Rh-103m	56.114 m	IT	–	0.0377	0.0017	0.0394
	Rh-104	42.3 s	B-EC	–	0.9823	0.0124	0.9947
	Rh-104m	4.34 m	ITB-	–	0.0846	0.0441	0.1287
		Rh-104	9.9870E-01				
	Rh-105	35.36 h	B-	–	0.1533	0.0773	0.2306
Rh-106	29.80 s	B-	–	1.4111	0.2061	1.6172	
Rh-106m	131 m	B-	–	0.3492	2.8526	3.2018	
Rh-107	21.7 m	B-	–	0.4407	0.3133	0.7539	
	Pd-107	1.00					
Rh-108	16.8 s	B-	–	1.8209	0.3172	2.1381	
Rh-109	80 s	B-	–	0.9320	0.2995	1.2315	
	Pd-109	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Palladium	Pd-96	122 s	ECB+	–	0.2257	1.4403	1.6660
		Rh-96m	1.00				
	Pd-97	3.10 m	ECB+	–	0.7524	2.3813	3.1337
		Rh-97	9.8838E-01				
	Pd-98	17.7 m	ECB+	–	0.0455	0.4154	0.4609
		Rh-98	1.00				
	Pd-99	21.4 m	ECB+	–	0.4499	1.2833	1.7331
		Rh-99m	9.6647E-01				
	Pd-100	Rh-99	3.3529E-02				
		3.63 d	EC	–	0.0455	0.1231	0.1686
	Pd-101	Rh-100	1.00				
		8.47 h	ECB+	–	0.0328	0.3518	0.3846
	Pd-103	Rh-101m	9.9730E-01				
		Rh-101	2.7000E-03				
	Pd-107	16.991 d	EC	–	0.0058	0.0146	0.0204
		Rh-103m	9.9875E-01				
	Pd-109	6.5E+6 y	B-	–	0.0096	–	0.0096
	Pd-109m	13.7012 h	B-	–	0.4380	0.0118	0.4497
		4.69 m	IT	–	0.0777	0.1112	0.1889
	Pd-111	Pd-109	1.00				
23.4 m		B-	–	0.8409	0.0478	0.8887	
Pd-112	Ag-111m	9.9756E-01					
	Ag-111	2.4368E-03					
Pd-114	21.03 h	B-	–	0.0900	0.0051	0.0951	
	Ag-112	1.00					
Pd-114	2.42 m	B-	–	0.5317	0.0259	0.5576	
	Ag-114	1.00					
Silver	Ag-99	124 s	ECB+	–	1.3076	2.3092	3.6168
		Pd-99	1.00				
	Ag-100m	2.24 m	ECB+	–	1.9068	2.8248	4.7316
		Pd-100	1.00				
	Ag-101	11.1 m	ECB+	–	0.8396	1.5703	2.4099
		Pd-101	1.00				
	Ag-102	12.9 m	ECB+	–	0.8430	3.4092	4.2522
	Ag-102m	7.7 m	ECB+IT	–	0.3964	1.9933	2.3897
		Ag-102	4.9000E-01				
	Ag-103	65.7 m	ECB+	–	0.1973	0.8440	1.0412
		Pd-103	1.00				
	Ag-104	69.2 m	ECB+	–	0.0917	2.7066	2.7982
	Ag-104m	33.5 m	ECB+IT	–	0.7331	1.8047	2.5377
		Ag-104	7.0000E-04				
	Ag-105	41.29 d	EC	–	0.0192	0.5138	0.5330
	Ag-105m	7.23 m	ITECB+	–	0.0252	0.0013	0.0265
		Ag-105	9.9660E-01				
	Ag-106	23.96 m	ECB+B-	–	0.4967	0.6996	1.1963

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Cadmium	Ag-106m	8.28 d	EC	–	0.0131	2.8091	2.8222
	Ag-108	2.37 m	B-ECB+	–	0.6071	0.0186	0.6256
	Ag-108m	418 y	ECIT	–	0.0159	1.6209	1.6368
		Ag-108	8.7000E-02				
	Ag-109m	39.6 s	IT	–	0.0770	0.0111	0.0880
	Ag-110	24.6 s	B-EC	–	1.1812	0.0307	1.2119
	Ag-110m	249.76 d	B-IT	–	0.0758	2.7606	2.8363
		Ag-110	1.3600E-02				
	Ag-111	7.45 d	B-	–	0.3539	0.0265	0.3804
	Ag-111m	64.8 s	ITB-	–	0.0568	0.0079	0.0646
		Ag-111	9.9300E-01				
	Ag-112	3.130 h	B-	–	1.3540	0.6905	2.0445
	Ag-113	5.37 h	B-	–	0.7614	0.0719	0.8333
		Cd-113	9.8261E-01				
		Cd-113m	1.7388E-02				
	Ag-113m	68.7 s	ITB-	–	0.2278	0.2134	0.4412
		Ag-113	6.4000E-01				
		Cd-113	3.6000E-01				
	Ag-114	4.6 s	B-	–	2.1091	0.2589	2.3681
	Ag-115	20.0 m	B-	–	1.0928	0.4831	1.5760
		Cd-115	9.4210E-01				
		Cd-115m	5.7870E-02				
	Ag-116	2.68 m	B-	–	1.7540	2.1473	3.9014
	Ag-117	73.6 s	B-	–	1.2813	1.3028	2.5841
		Cd-117	8.4703E-01				
		Cd-117m	1.5297E-01				
	Cd-101	1.36 m	ECB+	–	1.0685	2.4853	3.5538
		Ag-101	1.00				
	Cd-102	5.5 m	ECB+	–	0.0756	0.8380	0.9136
		Ag-102m	9.4624E-01				
		Ag-102	5.3762E-02				
	Cd-103	7.3 m	ECB+	–	0.3636	2.0891	2.4527
		Ag-103	1.00				
	Cd-104	57.7 m	EC	–	0.0306	0.2513	0.2819
		Ag-104m	1.00				
	Cd-105	55.5 m	ECB+	–	0.2167	1.2995	1.5161
		Ag-105m	8.2963E-01				
		Ag-105	1.7037E-01				
	Cd-107	6.50 h	ECB+	–	0.0870	0.0337	0.1207
	Cd-109	461.4 d	EC	–	0.0827	0.0265	0.1092
	Cd-111m	48.50 m	IT	–	0.1066	0.2843	0.3908
	Cd-113	7.7E+15 y	B-	–	0.0926	–	0.0926
	Cd-113m	14.1 y	B-IT	–	0.1847	<E-04	0.1848
		Cd-113	1.4000E-03				
	Cd-115	53.46 h	B-	–	0.3182	0.1926	0.5107
		In-115m	1.00				

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Cadmium	Cd-115m	44.6 d	B-	–	0.6045	0.0329	0.6374	
		In-115	9.9989E-01					
	Cd-117	In-115m	1.0578E-04					
		2.49 h	B-	–	0.4379	1.0796	1.5175	
		In-117m	9.1507E-01					
	Cd-117m	In-117	8.4933E-02					
		3.36 h	B-	–	0.2279	2.0437	2.2716	
		In-117	9.9002E-01					
	Cd-118	In-117m	9.9831E-03					
		50.3 m	B-	–	0.1614	–	0.1614	
	Cd-119	In-118	1.00					
		2.69 m	B-	–	0.8186	1.6380	2.4566	
	Cd-119m	In-119m	9.0091E-01					
		In-119	9.9092E-02					
		2.20 m	B-	–	0.6898	2.3021	2.9919	
	Indium	In-103	In-119	9.9787E-01				
			In-119m	2.1328E-03				
		60 s	ECB+	–	1.5404	2.7528	4.2932	
		In-105	Cd-103	1.00				
			5.07 m	ECB+	–	1.0358	1.9307	2.9666
In-106m		Cd-105	1.00					
		6.2 m	ECB+	–	1.5889	2.8243	4.4132	
In-106		In-106	5.2 m	ECB+	–	1.0844	3.5541	4.6385
		In-107	In-107	32.4 m	ECB+	–	0.3263	1.5307
Cd-107			1.00					
In-108m		In-108m	58.0 m	ECB+	–	0.7021	2.7655	3.4675
		In-108	39.6 m	ECB+	–	0.1620	3.9164	4.0784
In-109m		In-109m	4.2 h	IT	–	0.0416	0.6085	0.6501
		Cd-109	1.00					
In-109		In-109	1.34 m	ECB+	–	0.0334	0.6441	0.6775
		In-109	1.00					
In-110m		In-110m	4.9 h	ECB+	–	0.6282	1.5782	2.2065
		In-110	69.1 m	ECB+	–	0.0122	3.0972	3.1094
In-111m		In-111m	2.8047 d	IT	–	0.0675	0.4706	0.5380
		Cd-111m	1.00					
In-111	In-111	2.8047 d	EC	–	0.0348	0.4061	0.4409	
	Cd-115m	4.000E-05						
In-112m	In-112m	20.56 m	IT	–	0.1217	0.0347	0.1564	
	In-122	1.00						
In-112	In-112	14.97 m	ECB+B-	–	0.2452	0.2675	0.5127	
	In-113m	In-113m	1.6579 h	IT	–	0.1361	0.2606	0.3967
In-114m		In-114m	49.51 d	ITEC	–	0.1450	0.0804	0.2254
	In-114	9.675E-01						
In-114	In-114	49.51 d	B-ECB+	–	0.7740	0.0023	0.7764	
	In-115m	In-115m	4.486 h	ITB-	–	0.1748	0.1627	0.3376
In-115		9.5000E-01						

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Tin	In-115	4.41E14 y	B-	–	0.1526	–	0.1526
	In-116m	54.41 m	B-	–	0.3128	2.4691	2.7819
	In-117m	116.2 m	B-IT	–	0.4344	0.0910	0.5254
		In-117m	4.7100E-01				
	In-117	43.2 m	B-	–	0.2673	0.6939	0.9612
		Sn-117m	3.5321E-03				
	In-118m	4.364 m	B-	–	0.6708	2.7765	3.4473
	In-118	5.0 s	B-	–	1.8792	0.0778	1.9570
	In-119m	18.0 m	B-IT	–	1.0221	0.0660	1.0882
		In-119	5.6000E-02				
	In-119	2.4 m	B-	–	0.6148	0.7701	1.3849
		Sn-119m	9.4773E-03				
	In-121m	3.88 m	B-IT	–	1.5288	0.0635	1.5922
		Sn-121	9.8800E-01				
		In-121	1.2000E-02				
	In-121	23.1 s	B-	–	0.9869	0.9266	1.9135
		Sn-121	8.8650E-01				
		Sn-121m	1.1350E-01				
	Sn-106	1.92 m	ECB+	–	0.1279	1.2091	1.3370
		In-106m	1.00				
	Sn-108	10.30 m	ECB+	–	0.0269	0.6847	0.7117
		In-108m	1.00				
	Sn-109	18.0 m	ECB+	–	0.0571	2.2063	2.2634
		In-109	7.1734E-01				
		In-109m	2.8266E-01				
	Sn-110	4.11 h	EC	–	0.0152	0.2918	0.3070
		In-110m	1.00				
	Sn-111	35.3 m	ECB+	–	0.1915	0.4903	0.6818
		In-111	9.9793E-01				
		In-111m	2.0745E-03				
	Sn-113m	115.09 d	ITEC	–	0.0588	0.0137	0.0725
		In-113m	9.1100E-01				
	Sn-113	21.4 m	EC	–	0.0063	0.0237	0.0300
		Sn-113	9.9998E-01				
	Sn-117m	13.76 d	IT	–	0.1616	0.1581	0.3197
	Sn-119m	293.1 d	IT	–	0.0781	0.0151	0.0932
	Sn-121m	43.9 y	ITB-	–	0.0354	0.0052	0.0405
		Sn-121	7.7600E-01				
	Sn-121	27.03 h	B-	–	0.1156	–	0.1156
	Sn-123m	40.06 m	B-	–	0.4788	0.1407	0.6196
Sn-123	129.2 d	B-	–	0.5227	0.0069	0.5296	
Sn-125m	9.52 m	B-	–	0.8070	0.3464	1.1534	
	Sb-125	1.00					
Sn-125	9.64 d	B-	–	0.8037	0.3346	1.1383	
	Sb-125	1.00					
Sn-126	2.30E+5 y	B-	–	0.1380	0.0569	0.1949	



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Antimony		Sb-126m	1.00				
	Sn-127m	2.10 h	B-	–	1.1140	0.5686	1.6826
		Sb-127	1.00				
	Sn-127	4.13 m	B-	–	0.5199	1.9075	2.4274
		Sb-127	1.00				
	Sn-128	59.07 m	B-	–	0.2457	0.6041	0.8498
		Sb-128m	1.00				
	Sn-129	2.23 m	B-	–	1.2576	1.0081	2.2657
		Sb-129	1.00				
	Sn-130m	1.7 m	B-	–	1.4040	0.8861	2.2901
		Sb-130m	8.6005E-01				
		1.7 m	1.3995E-01				
	Sn-130	3.72 m	B-	–	0.4612	0.9372	1.3984
		Sb-130m	1.00				
	Sb-111	75 s	ECB+	–	1.3640	1.4859	2.8499
		Sn-111	1.00				
	Sb-113	6.67 m	ECB+	–	0.7203	1.2683	1.9886
		Sn-113	7.7569E-01				
		Sn-113m	2.2431E-01				
	Sb-114	3.49 m	ECB+	–	1.2184	2.6893	3.9077
	Sb-115	32.1 m	ECB+	–	0.2342	0.8894	1.1236
	Sb-116	15.8 m	ECB+	–	0.5138	2.2788	2.7926
	Sb-116m	60.3 m	ECB+	–	0.1408	3.1029	3.2437
	Sb-117	2.80 h	ECB+	–	0.0298	0.1864	0.2162
	Sb-118	3.6 m	ECB+	–	0.8730	0.8039	1.6769
	Sb-118m	5.00 h	ECB+	–	0.0374	2.6130	2.6504
	Sb-119	38.19 h	EC	–	0.0258	0.0234	0.0492
	Sb-120	15.89 m	ECB+	–	0.3077	0.4521	0.7599
	Sb-120m	5.76 d	EC	–	0.0449	2.4663	2.5112
	Sb-122	2.7238 d	B-ECB+	–	0.5618	0.4453	1.0072
	Sb-122m	4.191 m	IT	–	0.0937	0.0707	0.1644
		Sb-122	1.00				
	Sb-124	60.20 d	B-	–	0.3831	1.8531	2.2362
Sb-124m	93 s	ITB-	–	0.1157	0.4401	0.5558	
	Sb-124	7.5000E-01					
Sb-124n	20.2 m	IT	–	0.0256	0.0004	0.0260	
	Sb-124m	1.00					
Sb-125	2.75856 y	B-	–	0.1010	0.4373	0.5383	
	Te-125m	2.3136E-01					
Sb-126	12.35 d	B-	–	0.3545	2.7552	3.1097	
Sb-126m	19.15 m	B-IT	–	0.6322	1.5483	2.1805	
	Sb-126	1.4000E-01					
Sb-127	3.85 d	B-	–	0.3160	0.6934	1.0094	
	Te-127	8.2320E-01					
	Te-127m	1.7680E-01					
Sb-128	9.01 h	B-	–	0.4999	3.0934	3.5934	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Tellurium	Sb-128m	10.4 m	B-IT	–	0.9580	1.9063	2.8643
		Sb-128	3.6000E-02				
	Sb-129	4.40 h	B-	–	0.3953	1.4601	1.8553
		Te-129	7.7381E-01				
		Te-129m	2.2619E-01				
	Sb-130	39.5 m	B-	–	0.7579	3.2724	4.0303
	Sb-130m	6.3 m	B-	–	1.0290	2.7077	3.7367
	Sb-131	23.03 m	B-	–	0.5867	2.0733	2.6601
		Te-131	9.1793E-01				
		Te-131m	8.2067E-02				
	Sb-133	2.5 m	B-	–	0.6785	2.7434	3.4219
		Te-133	8.2662E-01				
		Te-133m	1.7338E-01				
	Te-113	1.7 m	ECB+	–	1.7023	2.2208	3.9231
		Sb-113	1.00				
	Te-114	15.2 m	ECB+	–	0.1551	1.2817	1.4368
		Sb-114	1.00				
	Te-115	5.8 m	ECB+	–	0.8124	2.2449	3.0572
		Sb-115	1.00				
	Te-115m	6.7 m	ECB+	–	0.6939	2.6041	3.2980
		Sb-115	1.00				
	Te-116	2.49 h	ECB+	–	0.0618	0.1122	0.1740
		Sb-116	1.00				
	Te-117	62 m	ECB+	–	0.2139	1.5492	1.7631
		Sb-117	1.00				
	Te-118	6.00 d	EC	–	0.0061	0.0199	0.0260
		Sb-118	1.00				
	Te-119	16.05 h	ECB+	–	0.0143	0.7679	0.7822
		Sb-119	1.00				
	Te-119m	4.70 d	ECB+	–	0.0180	1.5059	1.5239
		Sb-119	1.00				
	Te-121	19.16 d	EC	–	0.0098	0.5775	0.5872
	Te-121m	154 d	ITEC	–	0.0817	0.2176	0.2993
		Te-121	8.8600E-01				
	Te-123	6.00E+14 y	EC	–	0.0028	0.0004	0.0031
	Te-123m	119.25 d	IT	–	0.0990	0.1477	0.2467
		Te-123	1.00				
	Te-125m	57.40 d	IT	–	0.1091	0.0360	0.1451
	Te-127	9.35 h	B-	–	0.2246	0.0049	0.2294
	Te-127m	109 d	ITB-	–	0.0824	0.0113	0.0937
	Te-127	9.7600E-01					
Te-129	69.6 m	B-	–	0.5436	0.0625	0.6061	
	I-129	1.00					
Te-129m	33.6 d	ITB-	–	0.2709	0.0376	0.3085	
	Te-129	6.3000E-01					
	I-129	3.7000E-01					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Iodine	Te-131	25.0 m	B-	–	0.7122	0.4200	1.1322
		I-131	1.00				
	Te-131m	30 h	B-IT	–	0.1870	1.4545	1.6415
		I-131	7.7800E-01				
		Te-131	2.2200E-01				
	Te-132	3.204 d	B-	–	0.1108	0.2344	0.3453
		I-132	1.00				
	Te-133	12.5 m	B-	–	0.6897	1.2007	1.8904
		I-133	1.00				
	Te-133m	55.4 m	B-IT	–	0.3880	1.8597	2.2477
		I-133	8.2500E-01				
		Te-133	1.7500E-01				
	Te-134	41.8 m	B-	–	0.2266	0.8714	1.0980
		I-134	1.00				
	I-118	13.7 m	ECB+	–	1.9645	2.0163	3.9809
		Te-118	1.00				
	I-118m	8.5 m	ECB+	–	1.1055	3.7513	4.8567
		Te-118	1.00				
	I-119	19.1 m	ECB+	–	0.5116	0.9110	1.4227
		Te-119	9.9046E-01				
		Te-119m	9.5421E-03				
	I-120	81.6 m	ECB+	–	1.1680	2.6611	3.8291
	I-120m	53 m	ECB+	–	0.9070	3.5248	4.4318
	I-121	2.12 h	ECB+	–	0.0665	0.3995	0.4660
		Te-121	9.9714E-01				
		Te-121m	2.8631E-03				
	I-122	3.63 m	ECB+	–	1.1055	0.9619	2.0674
I-123	13.27 h	EC	–	0.0282	0.1730	0.2012	
	Te-123	9.9996E-01					
	Te-123m	4.4420E-05					
I-124	4.1760 d	ECB+	–	0.1943	1.1132	1.3075	
I-125	59.400 d	EC	–	0.0192	0.0428	0.0621	
I-126	12.93 d	ECB+B-	–	0.1606	0.4354	0.5959	
I-128	24.99 m	B-ECB+	–	0.7463	0.0676	0.8139	
I-129	1.57E+7 y	B-	–	0.0651	0.0252	0.0902	
I-130	12.36 h	B-	–	0.2786	2.1372	2.4158	
I-130m	8.84 m	ITB-	–	0.1778	0.1097	0.2875	
	I-130	8.4000E-01					
I-131	8.02070 d	B-	–	0.1918	0.3828	0.5746	
	Xe-131m	1.1759E-02					
I-132	2.295 h	B-	–	0.4930	2.2645	2.7575	
I-132m	1.387 h	ITB-	–	0.1614	0.3403	0.5018	
	I-132	8.6000E-01					
I-133	20.8 h	B-	–	0.4142	0.6120	1.0262	
	Xe-133	9.7115E-01					
	Xe-133m	2.8846E-02					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Xenon	I-134	52.5 m	B-	–	0.5776	2.5953	3.1729	
	I-134m	3.60 m	ITB-	–	0.0913	0.2887	0.3800	
	I-135	I-134		9.7700E-01				
		6.57 h	B-	–	0.3465	1.5815	1.9280	
		Xe-135		8.3432E-01				
	Xe-120	Xe-135m		1.6568E-01				
		40 m	ECB+	–	0.0461	0.4015	0.4476	
	Xe-121	I-120		1.00				
		40.1 m	ECB+	–	0.5819	1.4720	2.0539	
	Xe-122	I-121		1.00				
		20.1 h	EC	–	0.0100	0.0684	0.0784	
	Xe-123	I-122		1.00				
		2.08 h	ECB+	–	0.1875	0.6411	0.8286	
	Xe-125	I-123		1.00				
		16.9 h	ECB+	–	0.0350	0.2723	0.3074	
	Xe-127	I-125		1.00				
		36.4 d	EC	–	0.0325	0.2806	0.3131	
	Xe-127m	69.2 s	IT	–	0.1293	0.1685	0.2978	
		Xe-127		1.00				
	Xe-129m	8.88 d	IT	–	0.1844	0.0517	0.2362	
	Xe-131m	11.84 d	IT	–	0.1470	0.0206	0.1676	
	Xe-133	5.243 d	B-	–	0.1379	0.0474	0.1854	
	Xe-133m	2.19 d	IT	–	0.1924	0.0410	0.2333	
		Xe-133		1.00				
	Xe-135	9.14 h	B-	–	0.3208	0.2483	0.5691	
		Cs-135		1.00				
	Xe-135m	15.29 m	ITB-	–	0.1008	0.4249	0.5257	
Xe-135			9.9400E-01					
Cs-135			6.0000E-03					
Xe-137	3.818 m	B-	–	1.6952	0.1908	1.8859		
	Cs-137		1.00					
Xe-138	14.08 m	B-	–	0.6596	1.1222	1.7818		
	Cs-138		1.00					
Cesium	Cs-121	155 s	ECB+	–	1.7391	1.1733	2.9123	
	Xe-121		1.00					
Cs-121m	122 s	ECB+IT	–	1.3475	1.1821	2.5296		
	Xe-121		8.3000E-01					
	Cs-121		1.7000E-01					
Cs-123	5.88 m	ECB+	–	0.9509	1.0860	2.0369		
	Xe-123		1.00					
Cs-124	30.8 s	ECB+	–	1.9908	1.1607	3.1515		
Cs-125	45 m	ECB+	–	0.3524	0.7550	1.1075		
	Xe-125		1.00					
Cs-126	1.64 m	ECB+	–	1.3193	1.1545	2.4738		
Cs-127	6.25 h	ECB+	–	0.0293	0.4334	0.4627		
	Xe-127		1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Barium	Cs-128	3.640 m	ECB+	–	0.8735	0.8917	1.7651	
	Cs-129	32.06 h	ECB+	–	0.0175	0.2802	0.2977	
	Cs-130	29.21 m	ECB+B-	–	0.3869	0.5026	0.8894	
	Cs-130m	3.46 m	ITEC	–	0.0937	0.0737	0.1674	
		Cs-130	9.9840E-01					
	Cs-131	9.689 d	EC	–	0.0064	0.0232	0.0295	
	Cs-132	6.479 d	ECB+B-	–	0.0143	0.7151	0.7294	
	Cs-134	2.0648 y	B-EC	–	0.1639	1.5551	1.7190	
	Cs-134m	2.903 h	IT	–	0.1122	0.0273	0.1394	
		Cs-134	1.00					
	Cs-135	2.3E+6 y	B-	–	0.0894	–	0.0894	
	Cs-135m	53 m	IT	–	0.0361	1.5972	1.6333	
		Cs-135	1.00					
	Cs-136	13.16 d	B-	–	0.1449	2.1283	2.2732	
	Cs-137	30.1671 y	B-	–	0.1884	<E-04	0.1884	
		Ba-137m	9.4399E-01					
	Cs-138	33.41 m	B-	–	1.2462	2.3611	3.6073	
	Cs-138m	2.91 m	ITB-	–	0.3201	0.4149	0.7350	
		Cs-138	8.1000E-01					
	Cs-139	9.27 m	B-	–	1.6598	0.3030	1.9629	
		Ba-139	1.00					
	Cs-140	63.7 s	B-	–	1.9361	1.7692	3.7054	
		Ba-140	1.00					
		Ba-124	11.0 m	ECB+	–	0.1743	0.5728	0.7471
		Cs-124	1.00					
		Ba-126	100 m	ECB+	–	0.0178	0.5803	0.5981
		Cs-126	1.00					
		Ba-127	12.7 m	ECB+	–	0.5971	0.7282	1.3253
		Cs-127	1.00					
		Ba-128	2.43 d	EC	–	0.0086	0.0665	0.0751
		Cs-128	1.00					
		Ba-129	2.23 h	ECB+	–	0.1270	0.3331	0.4601
		Cs-129	1.00					
		Ba-129m	2.16 h	ECB+	–	0.0419	1.5833	1.6252
		Cs-129	1.00					
		Ba-131	11.50 d	EC	–	0.0455	0.4763	0.5219
		Cs-131	1.00					
		Ba-131m	14.6 m	IT	–	0.1102	0.0773	0.1875
		Ba-131	1.00					
		Ba-133	10.52 y	EC	–	0.0553	0.4030	0.4583
	Ba-133m	38.9 h	ITEC	–	0.2259	0.0686	0.2945	
	Ba-133	9.9990E-01						
	Ba-135m	28.7 h	IT	–	0.2080	0.0602	0.2682	
	Ba-137m	2.552 m	IT	–	0.0653	0.5963	0.6617	
	Ba-139	83.06 m	B-	–	0.9012	0.0457	0.9470	
	Ba-140	12.752 d	B-	–	0.3202	0.1826	0.5029	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Lanthanum		La-140	1.00				
	Ba-141	18.27 m	B-	–	0.9624	0.9271	1.8895
		La-141	1.00				
	Ba-142	10.6 m	B-	–	0.4141	1.0469	1.4610
		La-142	1.00				
	La-128	5.18 m	ECB+	–	1.3340	2.8283	4.1623
		Ba-128	1.00				
	La-129	11.6 m	ECB+	–	0.6135	0.9212	1.5347
		Ba-129	9.2384E-01				
		Ba-129m	7.6164E-02				
	La-130	8.7 m	ECB+	–	1.1113	2.2324	3.3438
	La-131	59 m	ECB+	–	0.1963	0.6633	0.8596
		Ba-131	1.00				
	La-132	4.8 h	ECB+	–	0.5693	1.9952	2.5645
	La-132m	24.3 m	ITECB+	–	0.1126	0.6706	0.7832
		La-132	7.6000E-01				
	La-133	3.912 h	ECB+	–	0.0503	0.1605	0.2108
		Ba-133	1.00				
	La-134	6.45 m	ECB+	–	0.7647	0.7196	1.4844
	La-135	19.5 h	ECB+	–	0.0067	0.0361	0.0428
	La-136	9.87 m	ECB+	–	0.2941	0.4070	0.7011
	La-137	6.0E+4 y	EC	–	0.0065	0.0250	0.0315
	La-138	1.02E+11 y	ECB-	–	0.0377	1.2316	1.2693
La-140	1.6781 d	B-	–	0.5346	2.3084	2.8429	
La-141	3.92 h	B-	–	0.9876	0.0268	1.0144	
	Ce-141	1.00					
La-142	91.1 m	B-	–	0.8697	2.3738	3.2435	
La-143	14.2 m	B-	–	1.2995	0.2631	1.5625	
	Ce-143	1.00					
Cerium	Ce-130	22.9 m	ECB+	–	0.0738	0.5003	0.5741
		La-130	1.00				
	Ce-131	10.2 m	ECB+	–	0.6153	1.6267	2.2420
		La-131	1.00				
	Ce-132	3.51 h	EC	–	0.0180	0.2727	0.2908
		La-132	1.00				
	Ce-133	97 m	ECB+	–	0.3817	0.5430	0.9247
		La-133	1.00				
	Ce-133m	4.9 h	ECB+	–	0.0739	1.7373	1.8112
		La-133	1.00				
	Ce-134	3.16 d	EC	–	0.0072	0.0281	0.0353
		La-134	1.00				
	Ce-135	17.7 h	ECB+	–	0.0296	0.8237	0.8533
		La-135	1.00				
	Ce-137	9.0 h	ECB+	–	0.0165	0.0388	0.0553
	La-137	1.00					
Ce-137m	34.4 h	ITEC	–	0.2067	0.0558	0.2625	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Ce-137	9.9220E-01				
		La-137	7.8000E-03				
	Ce-139	137.641 d	EC	–	0.0355	0.1599	0.1954
	Ce-141	32.508 d	B-	–	0.1710	0.0768	0.2478
	Ce-143	33.039 h	B-	–	0.4364	0.2796	0.7159
		Pr-143	1.00				
	Ce-144	284.91 d	B-	–	0.0916	0.0194	0.1110
		Pr-144	9.9023E-01				
		Pr-144m	9.7699E-03				
	Ce-145	3.01 m	B-	–	0.6794	0.8142	1.4937
		Pr-145	1.00				
Praseodymium	Pr-134	11 m	ECB+	–	1.0801	3.1504	4.2305
		Ce-134	1.00				
	Pr-134m	17 m	ECB+	–	1.5274	2.3101	3.8375
		Ce-134	1.00				
	Pr-135	24 m	ECB+	–	0.5793	0.8741	1.4534
		Ce-135	1.00				
	Pr-136	13.1 m	ECB+	–	0.7545	2.1458	2.9003
	Pr-137	1.28 h	ECB+	–	0.1947	0.3693	0.5640
		Ce-137	1.00				
	Pr-138	1.45 m	ECB+	–	1.1617	0.8153	1.9770
	Pr-138m	2.12 h	ECB+	–	0.2208	2.4776	2.6984
	Pr-139	4.41 h	ECB+	–	0.0478	0.1298	0.1777
		Ce-139	1.00				
	Pr-140	3.39 m	ECB+	–	0.5516	0.5467	1.0983
	Pr-142	19.12 h	B-EC	–	0.8098	0.0581	0.8679
	Pr-142m	14.6 m	IT	–	0.0036	0.0001	0.0037
		Pr-142	1.00				
	Pr-143	13.57 d	B-	–	0.3150	<E-04	0.3150
	Pr-144	17.28 m	B-	–	1.2084	0.0289	1.2373
		Nd-144	1.00				
Pr-144m	7.2 m	ITB-	–	0.0475	0.0134	0.0608	
	Pr-144	9.9930E-01					
	Nd-144	7.0000E-04					
	Pr-145	5.984 h	B-	–	0.6757	0.0186	0.6943
	Pr-146	24.15 m	B-	–	1.3277	1.0105	2.3382
	Pr-147	13.4 m	B-	–	0.8896	0.4887	1.3784
	Nd-147	1.00					
	Pr-148	2.29 m	B-	–	1.6637	0.9905	2.6542
	Pr-148m	2.01 m	B-	–	1.6807	0.9337	2.6144
Neodymium	Nd-134	8.5 m	ECB+	–	0.1728	0.5421	0.7149
		Pr-134m	1.00				
	Nd-135	12.4 m	ECB+	–	1.0551	1.2617	2.3168
		Pr-135	1.00				
	Nd-136	50.65 m	ECB+	–	0.0805	0.2793	0.3598
	Pr-136	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Neodymium	Nd-137	38.5 m	ECB+	–	0.3247	1.1789	1.5036	
		Pr-137	1.00					
	Nd-138	5.04 h	EC	–	0.0082	0.0438	0.0520	
		Pr-138	1.00					
	Nd-139	29.7 m	ECB+	–	0.2084	0.4431	0.6515	
		Pr-139	1.00					
	Nd-139m	5.50 h	ECB+IT	–	0.0795	1.5852	1.6647	
		Pr-139	8.8200E-01					
		Nd-139	1.1800E-01					
	Nd-140	3.37 d	EC	–	0.0069	0.0287	0.0357	
		Pr-140	1.00					
	Nd-141	2.49 h	ECB+	–	0.0165	0.0765	0.0930	
	Nd-141m	62.0 s	ITECB+	–	0.0622	0.6947	0.7569	
		Nd-141	9.9968E-01					
	Nd-144	2.29E+15 y	A	1.9052	–	–	1.9052	
	Nd-147	10.98 d	B-	–	0.2702	0.1408	0.4109	
		Pm-147	1.00					
	Nd-149	1.728 h	B-	–	0.5042	0.3713	0.8756	
		Pm-149	1.00					
	Nd-151	12.44 m	B-	–	0.6195	0.8518	1.4712	
		Pm-151	1.00					
	Nd-152	11.4 m	B-	–	0.3314	0.1644	0.4957	
		Pm-152	1.00					
	Promethium	Pm-136	107 s	ECB+	–	2.1436	2.7178	4.8614
			Nd-136	1.00				
		Pm-137m	2.4 m	ECB+	–	1.1120	1.7835	2.8955
			Nd-137	1.00				
		Pm-139	4.15 m	ECB+	–	1.0416	0.9390	1.9807
		Nd-139	1.00					
Pm-140		9.2 s	ECB+	–	2.0432	1.0506	3.0937	
		Nd-140	1.00					
Pm-140m		5.95 m	ECB+	–	0.9932	3.0324	4.0256	
		Nd-140	1.00					
Pm-141		20.90 m	ECB+	–	0.6054	0.7349	1.3403	
		Nd-141	9.9833E-01					
		Nd-141m	1.6651E-03					
Pm-142		40.5 s	ECB+	–	1.3122	0.8561	2.1683	
Pm-143		265 d	EC	–	0.0083	0.3157	0.3240	
Pm-144		363 d	EC	–	0.0171	1.5631	1.5802	
	Nd-144	1.00						
Pm-145	17.7 y	ECA	<E-04	0.0126	0.0315	0.0441		
Pm-146	5.53 y	ECB-	–	0.0941	0.7512	0.8453		
	Sm-146	3.4000E-01						
Pm-147	2.6234 y	B-	–	0.0619	<E-04	0.0619		
	Sm-147	1.00						
Pm-148	5.368 d	B-	–	0.7284	0.5743	1.3028		



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Samarium		Sm-148	1.00				
	Pm-148m	41.29 d	B-IT	–	0.1699	1.9916	2.1615
		Sm-148	9.5800E-01				
		Pm-148	4.2000E-02				
	Pm-149	53.08 h	B-	–	0.3650	0.0119	0.3769
	Pm-150	2.68 h	B-	–	0.8101	1.4705	2.2806
	Pm-151	28.40 h	B-	–	0.3048	0.3289	0.6337
		Sm-151	1.00				
	Pm-152	4.12 m	B-	–	1.3283	0.2866	1.6149
	Pm-152m	7.52 m	B-	–	0.9055	1.5189	2.4244
	Pm-153	5.25 m	B-	–	0.6881	0.0764	0.7645
		Sm-153	1.00				
	Pm-154	1.73 m	B-	–	0.8706	1.7933	2.6638
	Pm-154m	2.68 m	B-	–	0.9492	1.7996	2.7488
	Sm-139	2.57 m	ECB+	–	1.0871	1.4540	2.5410
		Pm-139	1.00				
	Sm-140	14.82 m	ECB+	–	0.1710	0.5677	0.7387
		Pm-140	1.00				
	Sm-141	10.2 m	ECB+	–	0.7126	1.4089	2.1215
		Pm-141	1.00				
	Sm-141m	22.6 m	ECB+IT	–	0.3995	1.9494	2.3489
		Pm-141	9.9690E-01				
		Sm-141	3.1000E-03				
	Sm-142	72.49 m	ECB+	–	0.0446	0.1105	0.1551
		Pm-142	1.00				
	Sm-143	8.75 m	ECB+	–	0.4978	0.5289	1.0267
		Pm-143	1.00				
	Sm-143m	66 s	ITECB+	–	0.0720	0.6844	0.7564
		Sm-143	9.9760E-01				
		Pm-143	2.4000E-03				
	Sm-145	340 d	EC	–	0.0307	0.0642	0.0950
		Pm-145	1.00				
	Sm-146	1.03E+8 y	A	2.5290	–	–	2.5290
Sm-147	1.060E11 y	A	2.3105	–	–	2.3105	
Sm-148	7E+15 y	A	1.9860	–	–	1.9860	
	Nd-144	1.00					
Sm-151	90 y	B-	–	0.0200	<E-04	0.0200	
Sm-153	46.50 h	B-	–	0.2699	0.0643	0.3341	
Sm-155	22.3 m	B-	–	0.5674	0.1029	0.6703	
	Eu-155	1.00					
Sm-156	9.4 h	B-	–	0.2093	0.1150	0.3242	
	Eu-156	1.00					
Sm-157	8.03 m	B-	–	0.8750	0.4142	1.2892	
	Eu-157	1.00					
Europium	Eu-142	2.34 s	ECB+	–	2.7670	1.1970	3.9641
	Sm-142	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
	Eu-142m	1.223 m	ECB+	–	1.7683	3.4305	5.1987
		Sm-142	1.00				
	Eu-143	2.59 m	ECB+	–	1.3676	1.1227	2.4903
		Sm-143	9.9879E-01				
		Sm-143m	1.2069E-03				
	Eu-144	10.2 s	ECB+	–	2.0761	1.0917	3.1678
	Eu-145	5.93 d	ECB+	–	0.0254	1.2798	1.3052
		Sm-145	1.00				
	Eu-146	4.61 d	ECB+	–	0.0455	2.4007	2.4462
		Sm-146	1.00				
	Eu-147	24.1 d	ECB+A	<E-04	0.0431	0.4721	0.5152
		Sm-147	9.9998E-01				
		Pm-143	2.2000E-05				
	Eu-148	54.5 d	ECB+A	<E-04	0.0224	2.2287	2.2511
		Sm-148	1.00				
		Pm-144	9.4000E-09				
	Eu-149	93.1 d	EC	–	0.0241	0.0661	0.0902
	Eu-150	36.9 y	ECB+	–	0.0285	1.5554	1.5839
	Eu-150m	12.8 h	B-ECB+	–	0.3122	0.0494	0.3615
		Gd-150	8.9000E-01				
	Eu-152	13.537 y	ECB+B-	–	0.1286	1.1759	1.3045
		Gd-152	2.7900E-01				
	Eu-152m	9.3116 h	B-ECB+	–	0.5060	0.2963	0.8023
		Gd-152	7.2000E-01				
	Eu-152n	96 m	IT	–	0.0666	0.0753	0.1419
		Eu-152	1.00				
	Eu-154	8.593 y	B-EC	–	0.2730	1.2493	1.5223
	Eu-154m	46.0 m	IT	–	0.0745	0.0706	0.1451
		Eu-154	1.00				
	Eu-155	4.7611 y	B-	–	0.0647	0.0612	0.1259
	Eu-156	15.19 d	B-	–	0.4579	1.2342	1.6920
	Eu-157	15.18 h	B-	–	0.3961	0.2930	0.6891
	Eu-158	45.9 m	B-	–	0.8920	1.2978	2.1898
	Eu-159	18.1 m	B-	–	0.8923	0.3032	1.1954
		Gd-159	1.00				
Gadolinium	Gd-142	70.2 s	ECB+	–	0.7390	1.0432	1.7822
		Eu-142	1.00				
	Gd-143m	110.0 s	ECB+	–	1.2854	2.1211	3.4065
		Eu-143	1.00				
	Gd-144	4.47 m	ECB+	–	0.5858	0.9086	1.4944
		Eu-144	1.00				
	Gd-145	23.0 m	ECB+	–	0.3456	2.4236	2.7692
		Eu-145	1.00				
	Gd-145m	85 s	ITECB+	–	0.1927	0.6814	0.8741
		Gd-145	9.4300E-01				
		Eu-145	5.7000E-02				

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Gadolinium	Gd-146	48.27 d	EC	–	0.1274	0.2526	0.3800	
		Eu-146	1.00					
	Gd-147	38.1 h	ECB+	–	0.0617	1.4030	1.4647	
		Eu-147	1.00					
	Gd-148	74.6 y	A	3.2712	–	–	3.2712	
		<i>Sm-144</i>	1.00					
	Gd-149	9.28 d	ECB+	–	0.0686	0.5292	0.5978	
		Eu-149	1.00					
	Gd-150	1.79E+6 y	A	2.8090	–	–	2.8090	
		Sm-146	1.00					
	Gd-151	124 d	ECA	<E-04	0.0394	0.0708	0.1102	
		Sm-147	1.0000E-08					
	Gd-152	1.08E+14 y	A	2.2046	–	–	2.2046	
		Sm-148	1.00					
	Gd-153	240.4 d	EC	–	0.0438	0.1057	0.1494	
	Gd-159	18.479 h	B-	–	0.3096	0.0539	0.3635	
	Gd-162	8.4 m	B-	–	0.3387	0.4170	0.7557	
	Terbium	Tb-146	23 s	ECB+	–	1.4644	3.6256	5.0900
			Gd-146	1.00				
Tb-147		1.64 h	ECB+	–	0.2810	2.1845	2.4655	
		Gd-147	1.00					
Tb-147m		1.87 m	ECB+	–	0.3196	1.9116	2.2312	
		Gd-147	1.00					
Tb-148		60 m	ECB+	–	0.8411	2.3590	3.2001	
		Gd-148	1.00					
Tb-148m		2.20 m	ECB+	–	0.3106	3.1390	3.4495	
		Gd-148	1.00					
Tb-149		4.118 h	ECB+A	0.6810	0.0871	1.3612	2.1292	
		Gd-149	8.3300E-01					
		Eu-145	1.6700E-01					
Tb-149m		4.16 m	ECB+A	0.0009	0.2091	1.3748	1.5847	
		Gd-149	9.9978E-01					
		Eu-145	2.2000E-04					
Tb-150		3.48 h	ECB+A	<E-04	0.2890	2.4403	2.7293	
		Gd-150	1.00					
		Eu-146	7.0000E-06					
Tb-150m	5.8 m	ECB+	–	0.1267	2.5202	2.6470		
	Gd-150	1.00						
Tb-151	17.609 h	ECB+A	0.0003	0.0800	0.9941	1.0744		
	Gd-151	1.00						
	Eu-147	9.5000E-05						
Tb-151m	25 s	ITECB+	–	0.0793	0.0808	0.1601		
	Tb-151	9.3400E-01						
	Gd-151	6.6000E-02						
Tb-152	17.5 h	ECB+	–	0.2503	1.4932	1.7436		

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Dysprosium		Gd-152	1.00					
		Tb-152m	4.2 m	ITECB+	–	0.1520	0.7619	0.9139
			Tb-152	7.8800E-01				
			Gd-152	2.1200E-01				
		Tb-153	2.34 d	ECB+	–	0.0481	0.3318	0.3800
			Gd-153	1.00				
		Tb-154	21.5 h	ECB+	–	0.0681	2.2831	2.3512
		Tb-155	5.32 d	EC	–	0.0434	0.1777	0.2211
		Tb-156	5.35 d	EC	–	0.0835	1.9371	2.0206
		Tb-156m	24.4 h	IT	–	0.0171	0.0370	0.0540
			Tb-156	1.00				
		Tb-156n	5.3 h	IT	–	0.0874	0.0048	0.0922
			Tb-156	1.00				
		Tb-157	71 y	EC	–	0.0057	0.0057	0.0114
		Tb-158	180 y	ECB-	–	0.1117	0.8048	0.9165
		Tb-160	72.3 d	B-	–	0.2593	1.1264	1.3856
		Tb-161	6.906 d	B-	–	0.2025	0.0365	0.2390
		Tb-162	7.60 m	B-	–	0.5327	1.1066	1.6393
		Tb-163	19.5 m	B-	–	0.3597	0.7887	1.1484
		Tb-164	3.0 m	B-	–	0.8249	2.4455	3.2704
		Tb-165	2.11 m	B-	–	0.8966	0.8363	1.7330
			Dy-165m	8.9028E-01				
			Dy-165	1.0972E-01				
		Dy-148	3.3 m	ECB+	–	0.0278	0.7170	0.7448
			Tb-148	1.00				
		Dy-149	4.20 m	ECB+	–	0.1120	1.6222	1.7342
			Tb-149	5.6682E-01				
			Tb-149m	4.3318E-01				
		Dy-150	7.17 m	ECB+A	1.5664	0.0070	0.2785	1.8519
			Tb-150	6.4000E-01				
		Gd-146	3.6000E-01					
	Dy-151	17.9 m	ECB+A	0.2341	0.0653	1.3723	1.6717	
		Tb-151	5.3377E-01					
		Tb-151m	4.1023E-01					
		Gd-147	5.6000E-02					
	Dy-152	2.38 h	ECA	0.0037	0.0130	0.2867	0.3034	
		Tb-152	9.9900E-01					
		Gd-148	1.0000E-03					
	Dy-153	6.4 h	ECB+A	0.0003	0.0901	0.8746	0.9651	
		Tb-153	1.00					
		Gd-149	9.4000E-05					
	Dy-154	3.0E+6 y	A	2.9470	–	–	2.9470	
		Gd-150	1.00					
	Dy-155	9.9 h	ECB+	–	0.0272	0.6687	0.6959	
		Tb-155	1.00					
	Dy-157	8.14 h	EC	–	0.0138	0.3472	0.3610	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Tb-157	1.00				
	Dy-159	144.4 d	EC	–	0.0131	0.0456	0.0587
	Dy-165	2.334 h	B-	–	0.4473	0.0267	0.4740
	Dy-165m	1.257 m	ITB-	–	0.1049	0.0192	0.1240
		Dy-165	9.7760E-01				
	Dy-166	81.6 h	B-	–	0.1667	0.0433	0.2100
		Ho-166	1.00				
	Dy-167	6.20 m	B-	–	0.7262	0.5326	1.2589
		Ho-167	1.00				
	Dy-168	8.7 m	B-	–	0.4332	0.3948	0.8280
		Ho-168	1.00				
Holmium	Ho-150	76.8 s	ECB+	–	1.9857	1.8843	3.8701
		Dy-150	1.00				
	Ho-153	2.01 m	ECB+A	0.0020	0.5387	1.0281	1.5689
		Dy-153	9.9949E-01				
		Tb-149m	5.1000E-04				
	Ho-153m	9.3 m	ECB+A	0.0074	0.6952	1.0618	1.7644
		Dy-153	9.9820E-01				
		Tb-149	1.8000E-03				
	Ho-154	11.76 m	ECB+A	0.0008	1.0927	1.8817	2.9752
		Dy-154	9.9981E-01				
		Tb-150	1.9000E-04				
	Ho-154m	3.10 m	ECB+A	<E-04	0.5434	2.4367	2.9801
		Dy-154	1.00				
		Tb-150m	1.0000E-05				
	Ho-155	48 m	ECB+	–	0.2176	0.6142	0.8318
		Dy-155	1.00				
	Ho-156	56 m	ECB+	–	0.6655	2.1064	2.7719
		Dy-156	1.00				
	Ho-157	12.6 m	ECB+	–	0.0929	0.5835	0.6764
		Dy-157	1.00				
	Ho-159	33.05 m	ECB+	–	0.0576	0.3857	0.4433
		Dy-159	1.00				
	Ho-160	25.6 m	ECB+	–	0.0703	1.6950	1.7653
	Ho-161	2.48 h	EC	–	0.0336	0.0582	0.0918
	Ho-162	15.0 m	ECB+	–	0.0598	0.1640	0.2239
	Ho-162m	67.0 m	ITECB+	–	0.0739	0.5614	0.6353
	Ho-162	6.2000E-01					
Ho-163	4570 y	EC	–	0.0005	<E-04	0.0006	
Ho-164	29 m	ECB-	–	0.1470	0.0297	0.1768	
Ho-164m	38.0 m	IT	–	0.0926	0.0472	0.1399	
	Ho-164	1.00					
Ho-166	26.80 h	B-	–	0.6963	0.0301	0.7264	
Ho-166m	1.20E+3 y	B-	–	0.1497	1.6249	1.7746	
Ho-167	3.1 h	B-	–	0.2329	0.3661	0.5990	
Ho-168	2.99 m	B-	–	0.8138	0.8762	1.6901	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Erbium	Ho-168m	132 s	IT	–	0.0518	0.0073	0.0590
		Ho-168	1.00				
	Ho-170	2.76 m	B-	–	0.8366	1.7041	2.5407
	Er-154	3.73 m	ECB+A	0.0201	0.0376	0.0759	0.1336
		Ho-154	9.9530E-01				
		Dy-150	4.7000E-03				
	Er-156	19.5 m	EC	–	0.0943	0.0678	0.1621
		Ho-156	1.00				
	Er-159	36 m	ECB+	–	0.0738	0.9635	1.0373
		Ho-159	1.00				
	Er-161	3.21 h	ECB+	–	0.0522	0.9905	1.0427
		Ho-161	1.00				
	Er-163	75.0 m	ECB+	–	0.0081	0.0403	0.0484
		Ho-163	1.00				
	Er-165	10.36 h	EC	–	0.0080	0.0379	0.0459
	Er-167m	2.269 s	IT	–	0.1111	0.0967	0.2078
	Er-169	9.40 d	B-	–	0.1035	<E-04	0.1035
	Er-171	7.516 h	B-	–	0.4205	0.3731	0.7936
	Thulium		Tm-171	1.00			
Er-172		49.3 h	B-	–	0.1387	0.5166	0.6552
		Tm-172	1.00				
Er-173		1.434 m	B-	–	0.7213	0.8313	1.5526
		Tm-173	1.00				
Tm-161		30.2 m	ECB+	–	0.2308	1.2992	1.5300
		Er-161	1.00				
Tm-162		21.70 m	ECB+	–	0.5648	1.9155	2.4803
Tm-163		1.810 h	ECB+	–	0.0716	1.3200	1.3916
		Er-163	1.00				
Tm-164		2.0 m	ECB+	–	0.5994	0.7760	1.3754
Tm-165		30.06 h	ECB+	–	0.0637	0.5625	0.6262
		Er-165	1.00				
Tm-166		7.70 h	ECB+	–	0.0892	1.9768	2.0660
Tm-167		9.25 d	EC	–	0.1332	0.1482	0.2814
Tm-168		93.1 d	ECB+B-	–	0.0847	1.2432	1.3279
Tm-170		128.6 d	B-EC	–	0.3280	0.0041	0.3321
Tm-171		1.92 y	B-	–	0.0255	0.0006	0.0261
Tm-172		63.6 h	B-	–	0.5327	0.4744	1.0072
Tm-173	8.24 h	B-	–	0.3103	0.3885	0.6988	
Tm-174	5.4 m	B-	–	0.5129	1.7787	2.2915	
Tm-175	15.2 m	B-	–	0.5196	1.0848	1.6044	
Ytterbium		Yb-175	1.00				
	Tm-176	1.85 m	B-	–	0.9972	1.9682	2.9654
	Yb-162	18.87 m	ECB+	–	0.0374	0.2519	0.2893
		Tm-162	1.00				
	Yb-163	11.05 m	ECB+	–	0.2718	0.7277	0.9996
	Tm-163	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Lutetium	Yb-164	75.8 m	EC	–	0.0095	0.0542	0.0637
		Tm-164	1.00				
	Yb-165	9.9 m	ECB+	–	0.1518	0.3390	0.4908
		Tm-165	1.00				
	Yb-166	56.7 h	EC	–	0.0417	0.0868	0.1285
		Tm-166	1.00				
	Yb-167	17.5 m	ECB+	–	0.0952	0.2696	0.3648
		Tm-167	1.00				
	Yb-169	32.026 d	EC	–	0.1471	0.3302	0.4773
	Yb-175	4.185 d	B-	–	0.1308	0.0391	0.1699
	Yb-177	1.911 h	B-	–	0.4358	0.1952	0.6309
		Lu-177	1.00				
	Yb-178	74 m	B-	–	0.1925	0.0381	0.2306
		Lu-178	1.00				
	Yb-179	8.0 m	B-	–	0.7093	0.9743	1.6836
		Lu-179	1.00				
	Lu-165	10.74 m	ECB+	–	0.3751	1.1102	1.4853
		Yb-165	1.00				
	Lu-167	51.5 m	ECB+	–	0.1109	1.6920	1.8030
		Yb-167	1.00				
	Lu-169	34.06 h	ECB+	–	0.0477	1.3166	1.3643
		Yb-169	1.00				
	Lu-169m	160 s	IT	–	0.0274	0.0017	0.0290
		Lu-169	1.00				
	Lu-170	2.012 d	ECB+	–	0.0585	2.5636	2.6220
	Lu-171	8.24 d	ECB+	–	0.0928	0.6503	0.7431
	Lu-171m	79 s	IT	–	0.0691	0.0021	0.0711
		Lu-171	1.00				
	Lu-172	6.70 d	ECB+	–	0.1154	1.9565	2.0718
	Lu-172m	3.7 m	IT	–	0.0404	0.0015	0.0419
		Lu-172	1.00				
	Lu-173	1.37 y	EC	–	0.0526	0.1834	0.2360
	Lu-174	3.31 y	ECB+	–	0.0458	0.1163	0.1621
Lu-174m	142 d	ITEC	–	0.1188	0.0626	0.1814	
	Lu-174	9.9380E-01					
Lu-176	3.85E+10 y	B-	–	0.3026	0.4799	0.7825	
Lu-176m	3.635 h	B-EC	–	0.4783	0.0146	0.4929	
Lu-177	6.647 d	B-	–	0.1479	0.0351	0.1830	
Lu-177m	160.4 d	B-IT	–	0.2687	1.0005	1.2692	
	Lu-177	2.1700E-01					
Lu-178	28.4 m	B-	–	0.7561	0.1256	0.8817	
Lu-178m	23.1 m	B-	–	0.4907	1.0481	1.5389	
Lu-179	4.59 h	B-	–	0.4869	0.0298	0.5167	
Lu-180	5.7 m	B-	–	0.6352	1.5148	2.1499	
Lu-181	3.5 m	B-	–	0.8512	0.5740	1.4252	
	Hf-181	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Hafnium	Hf-167	2.05 m	ECB+	–	0.4952	0.6171	1.1123
		Lu-167	1.00				
	Hf-169	3.24 m	ECB+	–	0.1309	0.6416	0.7725
		Lu-169	9.6904E-01				
	Hf-170	Lu-169m	3.0960E-02				
		16.01 h	EC	–	0.0687	0.4403	0.5090
	Hf-172	Lu-170	1.00				
		1.87 y	EC	–	0.0828	0.1062	0.1890
	Hf-173	Lu-172m	1.00				
		23.6 h	ECB+	–	0.0524	0.3970	0.4494
	Hf-174	Lu-173	1.00				
		2.0E+15 y	A	2.4948	–	–	2.4948
	Hf-175	70 d	EC	–	0.0450	0.3534	0.3984
	Hf-177m	51.4 m	IT	–	0.5078	2.2864	2.7941
	Hf-178m	31 y	IT	–	0.2113	2.2383	2.4496
	Hf-179m	25.05 d	IT	–	0.1897	0.9207	1.1104
	Hf-180m	5.5 h	ITB-	–	0.1437	0.9884	1.1321
	Hf-181	42.39 d	B-	–	0.2052	0.5324	0.7377
		Hf-182	9E+6 y	B-	–	0.0632	0.2397
	Hf-182m		Ta-182	1.00			
		61.5 m	B-IT	–	0.2441	0.9135	1.1575
	Hf-183	Ta-182	4.9070E-01				
		Hf-182	4.2000E-01				
Ta-182m		8.9280E-02					
1.067 h		B-	–	0.4478	0.7749	1.2227	
Hf-184	Ta-183	1.00					
	4.12 h	B-	–	0.4787	0.2387	0.7174	
Tantalum	Ta-170	Ta-184	1.00				
		6.76 m	ECB+	–	1.6049	1.0602	2.6652
Ta-172	Hf-170	1.00					
	36.8 m	ECB+	–	0.5513	1.6967	2.2480	
Ta-173	Hf-172	1.00					
	3.14 h	ECB+	–	0.1686	0.5824	0.7510	
Ta-174	Hf-173	1.00					
	1.14 h	ECB+	–	0.4670	0.9767	1.4438	
Ta-175	Hf-174	1.00					
	10.5 h	ECB+	–	0.0663	1.1126	1.1790	
Ta-176	8.09 h	ECB+	–	0.0849	2.2322	2.3171	
Ta-177	56.56 h	EC	–	0.0240	0.0678	0.0917	
Ta-178	9.31 m	ECB+	–	0.0391	0.1218	0.1609	
Ta-178m	2.36 h	EC	–	0.1616	1.1558	1.3174	
Ta-179	1.82 y	EC	–	0.0078	0.0256	0.0334	
Ta-180	8.152 h	ECB-	–	0.0565	0.0482	0.1048	
Ta-182	114.43 d	B-	–	0.2105	1.2918	1.5023	
Ta-182m	15.84 m	IT	–	0.2665	0.2659	0.5324	



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Ta-182	1.00				
	Ta-183	5.1 d	B-	–	0.3537	0.2963	0.6499
	Ta-184	8.7 h	B-	–	0.5426	1.5727	2.1152
	Ta-185	49.4 m	B-	–	0.7416	0.1547	0.8963
		W-185	1.00				
	Ta-186	10.5 m	B-	–	1.0710	1.4202	2.4912
Tungsten	W-177	132 m	ECB+	–	0.0970	0.9185	1.0155
		Ta-177	1.00				
	W-178	21.6 d	EC	–	0.0075	0.0164	0.0239
		Ta-178	1.00				
	W-179	37.05 m	EC	–	0.0326	0.0554	0.0880
		Ta-179	1.00				
	W-179m	6.40 m	ITEC	–	0.1661	0.0561	0.2221
		W-179	9.9720E-01				
		Ta-179	2.8000E-03				
	W-181	121.2 d	EC	–	0.0129	0.0404	0.0533
	W-185	75.1 d	B-	–	0.1270	<E-04	0.1270
	W-185m	1.597 m	IT	–	0.1738	0.0287	0.2025
		W-185	1.00				
	W-187	23.72 h	B-	–	0.2995	0.4483	0.7478
		Re-187	1.00				
	W-188	69.78 d	B-	–	0.0997	0.0019	0.1016
		Re-188	1.00				
	W-190	30.0 m	B-	–	0.4771	0.1511	0.6282
		Re-190	1.00				
Rhenium	Re-178	13.2 m	ECB+	–	0.6192	1.7085	2.3277
		W-178	1.00				
	Re-179	19.5 m	ECB+	–	0.0668	1.0841	1.1509
		W-179	7.6079E-01				
		W-179m	2.3921E-01				
	Re-180	2.44 m	ECB+	–	0.1720	1.2028	1.3748
	Re-181	19.9 h	ECB+	–	0.1360	0.8044	0.9404
		W-181	1.00				
	Re-182	64.0 h	EC	–	0.2045	1.7982	2.0027
	Re-182m	12.7 h	ECB+	–	0.0922	1.2214	1.3136
	Re-183	70.0 d	EC	–	0.1093	0.1575	0.2667
	Re-184	38.0 d	ECB+	–	0.0562	0.8919	0.9481
	Re-184m	169 d	ITEC	–	0.1413	0.3836	0.5249
		Re-184	7.5400E-01				
	Re-186	3.7183 d	B-EC	–	0.3362	0.0208	0.3570
		Os-186	9.2530E-01				
	Re-186m	2.00E+5 y	IT	–	0.1267	0.0207	0.1474
		Re-186	1.00				
	Re-187	4.12E+10 y	B-	–	0.0006	–	0.0006
	Re-188	17.0040 h	B-	–	0.7793	0.0613	0.8406

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Osmium	Re-188m	18.59 m	IT	–	0.0976	0.0715	0.1692
		Re-188	1.00				
	Re-189	24.3 h	B-	–	0.3260	0.0556	0.3816
		Os-189m	1.2211E-01				
	Re-190	3.1 m	B-	–	0.6863	1.3376	2.0239
	Re-190m	3.2 h	B-IT	–	0.4456	0.9257	1.3714
		Re-190	4.5600E-01				
	Os-180	21.5 m	ECB+	–	0.0298	0.1265	0.1564
		Re-180	1.00				
	Os-181	105 m	ECB+	–	0.0918	1.3835	1.4753
		Re-181	1.00				
	Os-182	22.10 h	EC	–	0.0565	0.4317	0.4882
		Re-182m	1.00				
	Os-183	13.0 h	ECB+	–	0.0792	0.6288	0.7081
		Re-183	1.00				
	Os-183m	9.9 h	ECB+IT	–	0.0416	1.0062	1.0478
		Re-183	8.5000E-01				
		Os-183	1.5000E-01				
	Os-185	93.6 d	EC	–	0.0184	0.6917	0.7101
	Os-186	2.0E+15 y	A	2.8220	–	–	2.8220
Os-189m	5.8 h	IT	–	0.0286	0.0023	0.0309	
Os-190m	9.9 m	IT	–	0.1166	1.5894	1.7059	
Os-191	15.4 d	B-	–	0.1372	0.0843	0.2215	
Os-191m	13.10 h	IT	–	0.0664	0.0080	0.0744	
	Os-191	1.00					
Os-193	30.11 h	B-	–	0.3797	0.0674	0.4471	
	Ir-193m	3.4757E-03					
Os-194	6.0 y	B-	–	0.0453	0.0045	0.0498	
	Ir-194	1.00					
Os-196	34.9 m	B-	–	0.3807	0.0805	0.4612	
	Ir-196	1.00					
Iridium	Ir-180	1.5 m	ECB+	–	1.2439	1.5955	2.8394
		Os-180	1.00				
	Ir-182	15 m	ECB+	–	1.0474	1.4121	2.4595
		Os-182	1.00				
	Ir-183	58 m	ECB+	–	0.1516	1.1889	1.3404
		Os-183m	7.0972E-01				
		Os-183	2.9028E-01				
	Ir-184	3.09 h	ECB+	–	0.3194	1.9644	2.2838
		Os-184	1.00				
	Ir-185	14.4 h	ECB+	–	0.1228	0.8581	0.9809
		Os-185	1.00				
	Ir-186	16.64 h	ECB+	–	0.1453	1.6651	1.8104
		Os-186	1.00				
	Ir-186m	1.92 h	ECB+IT	–	0.1103	1.2523	1.3626
	Os-186	7.5000E-01					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Platinum		Ir-186	2.5000E-01					
		Ir-187	10.5 h	ECB+	–	0.0568	0.3325	0.3892
		Ir-188	41.5 h	ECB+	–	0.0508	2.0974	2.1483
		Ir-189	13.2 d	EC	–	0.0458	0.0793	0.1251
			Os-189m	7.4264E-02				
		Ir-190	11.78 d	EC	–	0.0746	1.4768	1.5514
		Ir-190m	1.120 h	IT	–	0.0240	0.0024	0.0264
			Ir-190	1.00				
		Ir-190n	3.087 h	ECIT	–	0.0289	0.0577	0.0867
			Os-190m	9.1400E-01				
			Ir-190	8.6000E-02				
		Ir-191m	4.94 s	IT	–	0.0971	0.0764	0.1735
		Ir-192	73.827 d	B-EC	–	0.2177	0.8165	1.0342
		Ir-192m	1.45 m	ITB-	–	0.0540	0.0029	0.0569
			Ir-192	9.9983E-01				
		Ir-192n	241 y	IT	–	0.1617	0.0066	0.1682
			Ir-192	1.00				
		Ir-193m	10.53 d	IT	–	0.0776	0.0027	0.0803
		Ir-194	19.28 h	B-	–	0.8105	0.0911	0.9015
		Ir-194m	171 d	B-	–	0.1422	2.3339	2.4761
		Ir-195	2.5 h	B-	–	0.3803	0.0593	0.4397
		Ir-195m	3.8 h	B-IT	–	0.2606	0.3766	0.6372
			Pt-195m	4.3692E-01				
			Ir-195	5.0000E-02				
		Ir-196	52 s	B-	–	1.1738	0.2322	1.4060
		Ir-196m	1.40 h	B-	–	0.3844	2.4677	2.8522
		Pt-184	17.3 m	ECB+A	<E-04	0.2004	0.7266	0.9271
			Ir-184	1.00				
			Os-180	1.7000E-05				
		Pt-186	2.08 h	ECA	<E-04	0.0451	0.6844	0.7296
			Ir-186m	8.1942E-01				
			Ir-186	1.8058E-01				
			Os-182	1.0000E-06				
		Pt-187	2.35 h	ECB+	–	0.1549	0.6183	0.7732
			Ir-187	1.00				
		Pt-188	10.2 d	ECA	<E-04	0.0823	0.2055	0.2878
			Ir-188	1.00				
		Pt-189	10.87 h	ECB+	–	0.0996	0.4870	0.5867
			Ir-189	1.00				
		Pt-190	6.50E+11 y	A	3.2490	–	–	3.2490
		Os-186	1.00					
	Pt-191	2.802 d	EC	–	0.0749	0.2960	0.3709	
	Pt-193	50 y	EC	–	0.0071	0.0026	0.0097	
	Pt-193m	4.33 d	IT	–	0.1377	0.0132	0.1510	
		Pt-193	1.00					
	Pt-195m	4.02 d	IT	–	0.1845	0.0772	0.2617	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Gold	Pt-197	19.8915 h	B-	–	0.2552	0.0256	0.2809	
	Pt-197m	95.41 m	ITB-	–	0.3250	0.0839	0.4089	
		Pt-197	9.6700E-01					
	Pt-199	30.80 m	B-	–	0.5455	0.1995	0.7450	
		Au-199	1.00					
	Pt-200	12.5 h	B-	–	0.2321	0.0605	0.2926	
		Au-200	1.00					
	Pt-202	44 h	B-	–	0.6537	–	0.6537	
		Au-202	1.00					
		Au-186	10.7 m	ECB+	–	1.0751	1.4983	2.5735
		Pt-186	1.00					
		Au-187	8.4 m	ECB+A	0.0001	0.1360	1.0652	1.2014
		Pt-187	1.00					
		Ir-183	3.0000E-05					
		Au-190	42.8 m	ECB+	–	0.2129	2.3807	2.5936
		Pt-190	1.00					
		Au-191	3.18 h	ECB+	–	0.0865	0.5946	0.6811
		Pt-191	1.00					
		Au-192	4.94 h	ECB+	–	0.0904	1.9392	2.0296
		Au-193	17.65 h	EC	–	0.0575	0.1673	0.2249
		Pt-193	1.00					
		Au-193m	3.9 s	ITEC	–	0.0904	0.1979	0.2883
			Au-193	9.9970E-01				
			Pt-193m	3.0000E-04				
		Au-194	38.02 h	ECB+	–	0.0421	1.0386	1.0806
		Au-195	186.098 d	EC	–	0.0520	0.0839	0.1359
		Au-195m	30.5 s	IT	–	0.1172	0.2014	0.3186
			Au-195	1.00				
		Au-196	6.183 d	ECB-	–	0.0372	0.4734	0.5105
		Au-196m	9.6 h	IT	–	0.3760	0.2473	0.6233
		Au-196	1.00					
	Au-198	2.69517 d	B-	–	0.3277	0.4029	0.7306	
	Au-198m	2.27 d	IT	–	0.2748	0.5332	0.8080	
		Au-198	1.00					
	Au-199	3.139 d	B-	–	0.1451	0.0961	0.2412	
	Au-200	48.4 m	B-	–	0.7303	0.2737	1.0041	
	Au-200m	18.7 h	B-IT	–	0.2433	1.9843	2.2276	
		Au-200	1.8000E-01					
	Au-201	26 m	B-	–	0.4259	0.0346	0.4605	
	Au-202	28.8 s	B-	–	1.0749	0.1720	1.2469	
Mercury	Hg-190	20.0 m	ECB+	–	0.0539	0.2018	0.2557	
		Au-190	1.00					
	Hg-191m	50.8 m	ECB+	–	0.1378	1.4895	1.6273	
		Au-191	1.00					
	Hg-192	4.85 h	EC	–	0.0636	0.2749	0.3385	
	Au-192	1.00						

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Mercury	Hg-193	3.80 h	ECB+	–	0.0740	0.8377	0.9117	
		Au-193	9.6459E-01					
		Au-193m	3.5408E-02					
	Hg-193m	11.8 h	ECB+IT	–	0.0470	1.0239	1.0709	
		Au-193m	8.9197E-01					
		Hg-193	7.1000E-02					
		Au-193	3.7027E-02					
	Hg-194	440 y	EC	–	0.0078	0.0027	0.0106	
		Au-194	1.00					
	Hg-195	10.53 h	ECB+	–	0.0650	0.2008	0.2658	
		Au-195	1.00					
	Hg-195m	41.6 h	ITECB+	–	0.1480	0.2047	0.3527	
		Hg-195	5.4200E-01					
		Au-195	4.5800E-01					
	Hg-197	64.94 h	EC	–	0.0702	0.0740	0.1442	
	Hg-197m	23.8 h	ITEC	–	0.2170	0.0977	0.3148	
		Hg-197	9.1400E-01					
	Hg-199m	42.66 m	IT	–	0.3487	0.1836	0.5323	
	Hg-203	46.612 d	B-	–	0.0990	0.2380	0.3370	
	Hg-205	5.2 m	B-	–	0.5390	0.0053	0.5444	
	Hg-206	8.15 m	B-	–	0.4211	0.1215	0.5426	
		Tl-206	1.00					
	Hg-207	2.9 m	B-	–	0.8262	2.6614	3.4876	
		Tl-207	1.00					
	Thallium	Tl-190	2.6 m	ECB+	–	1.5288	1.2914	2.8202
			Hg-190	1.00				
		Tl-190m	3.7 m	ECB+	–	0.7985	2.4550	3.2535
		Hg-190	1.00					
Tl-194		33.0 m	ECB+	–	0.5972	0.9143	1.5115	
		Hg-194	1.00					
Tl-194m		32.8 m	ECB+	–	0.3037	2.5218	2.8255	
		Hg-194	1.00					
Tl-195		1.16 h	ECB+	–	0.0740	1.2250	1.2991	
		Hg-195	9.9656E-01					
		Hg-195m	3.4358E-03					
Tl-196		1.84 h	ECB+	–	0.1782	1.8734	2.0516	
Tl-197		2.84 h	ECB+	–	0.0544	0.4587	0.5130	
		Hg-197	1.00					
Tl-198		5.3 h	ECB+	–	0.0414	2.0108	2.0522	
Tl-198m		1.87 h	ECB+IT	–	0.2006	1.2168	1.4175	
		Tl-198	4.6000E-01					
Tl-199		7.42 h	ECB+	–	0.0600	0.2520	0.3120	
Tl-200		26.1 h	ECB+	–	0.0408	1.3106	1.3514	
Tl-201		72.912 h	EC	–	0.0447	0.0938	0.1385	
Tl-202	12.23 d	EC	–	0.0233	0.4658	0.4891		
Tl-204	3.78 y	B-EC	–	0.2372	0.0013	0.2385		

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Lead	Tl-206	4.200 m	B-	–	0.5398	0.0001	0.5399
	Tl-206m	3.74 m	IT	–	0.2003	2.4192	2.6195
		Tl-206	1.00				
	Tl-207	4.77 m	B-	–	0.4952	0.0024	0.4975
	Tl-208	3.053 m	B-	–	0.6113	3.3603	3.9716
	Tl-209	2.161 m	B-	–	0.6875	2.1426	2.8302
		Pb-209	1.00				
	Tl-210	1.30 m	B-	–	1.2699	2.7632	4.0331
		Pb-210	1.00				
	Pb-194	12.0 m	ECB+A	<E-04	0.0844	1.0832	1.1677
		Tl-194	1.00				
		Hg-190	7.3000E-08				
	Pb-195m	15 m	ECB+	–	0.3167	1.6547	1.9714
		Tl-195	1.00				
	Pb-196	37 m	ECB+	–	0.0969	0.4940	0.5909
		Tl-196	1.00				
	Pb-197	8 m	ECB+	–	0.0818	1.5319	1.6137
		Tl-197	1.00				
	Pb-197m	43 m	ECB+IT	–	0.2477	1.1732	1.4209
		Tl-197	8.1000E-01				
		Pb-197	1.9000E-01				
	Pb-198	2.4 h	EC	–	0.0781	0.4385	0.5166
		Tl-198	1.00				
	Pb-199	90 m	ECB+	–	0.0584	1.0394	1.0978
		Tl-199	1.00				
	Pb-200	21.5 h	EC	–	0.0997	0.2086	0.3083
		Tl-200	1.00				
	Pb-201	9.33 h	ECB+	–	0.0594	0.7562	0.8156
		Tl-201	1.00				
	Pb-201m	61 s	IT	–	0.2633	0.3658	0.6291
		Pb-201	1.00				
	Pb-202	5.25E+4 y	ECA	0.0260	0.0061	0.0025	0.0346
Tl-202		9.9000E-01					
Pb-202m	3.53 h	ITEC	–	0.1321	1.9925	2.1246	
	Pb-202	9.0500E-01					
	Tl-202	9.5000E-02					
Pb-203	51.873 h	EC	–	0.0530	0.3143	0.3672	
Pb-204m	67.2 m	IT	–	0.1030	2.0634	2.1664	
Pb-205	1.53E+7 y	EC	–	0.0062	0.0025	0.0087	
Pb-209	3.253 h	B-	–	0.1974	–	0.1974	
Pb-210	22.20 y	B-A	<E-04	0.0404	0.0053	0.0457	
	Bi-210	1.00					
	Hg-206	1.9000E-08					
Pb-211	36.1 m	B-	–	0.4543	0.0644	0.5187	
	Bi-211	1.00					
Pb-212	10.64 h	B-	–	0.1766	0.1450	0.3217	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Bi-212	1.00				
	Pb-214	26.8 m	B-	–	0.2948	0.2533	0.5481
		Bi-214	1.00				
Bismuth	Bi-197	9.3 m	ECB+	–	0.2887	1.6992	1.9879
		Pb-197	5.6103E-01				
		Pb-197m	4.3897E-01				
	Bi-200	36.4 m	ECB+	–	0.2469	2.4355	2.6825
		Pb-200	1.00				
	Bi-201	108 m	ECB+	–	0.0612	1.7304	1.7916
		Pb-201	5.4833E-01				
		Pb-201m	4.5167E-01				
	Bi-202	1.72 h	ECB+	–	0.1515	2.7561	2.9076
		Pb-202	1.00				
	Bi-203	11.76 h	ECB+	–	0.0809	2.3850	2.4659
		Pb-203	1.00				
	Bi-204	11.22 h	ECB+	–	0.0807	2.9162	2.9968
		Pb-204m	9.8525E-02				
	Bi-205	15.31 d	ECB+	–	0.0346	1.6913	1.7259
		Pb-205	1.00				
	Bi-206	6.243 d	ECB+	–	0.1379	3.2796	3.4175
	Bi-207	32.9 y	ECB+	–	0.1193	1.5370	1.6563
	Bi-208	3.68E+5 y	EC	–	0.0144	2.6460	2.6604
	Bi-210	5.013 d	B-A	<E-04	0.3889	<E-04	0.3889
		Po-210	1.00				
		Tl-206	1.3200E-06				
	Bi-210m	3.04E+6 y	A	5.0064	0.0475	0.2607	5.3146
		Tl-206	1.00				
	Bi-211	2.14 m	A B-	6.6757	0.0100	0.0473	6.7330
		Tl-207	9.9724E-01				
		Po-211	2.7600E-03				
	Bi-212	60.55 m	B-A	2.2164	0.5046	0.1038	2.8247
		Po-212	6.4060E-01				
		Tl-208	3.5940E-01				
	Bi-212n	7.0 m	B-	–	0.5351	–	0.5351
		Po-212m	1.00				
	Bi-213	45.59 m	B-A	0.1245	0.4440	0.1277	0.6963
		Po-213	9.7910E-01				
		Tl-209	2.0900E-02				
	Bi-214	19.9 m	B-A	0.0012	0.6631	1.4793	2.1436
		Po-214	9.9979E-01				
		Tl-210	2.1000E-04				
	Bi-215	7.6 m	B-	–	0.6694	0.2534	0.9228
		Po-215	1.00				
	Bi-216	2.17 m	B-	–	1.3295	0.7385	2.0680
		Po-216	1.00				
Polonium	Po-203	36.7 m	ECB+A	0.0060	0.1672	1.6348	1.8080

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
		Bi-203	9.9890E-01				
		Pb-199	1.1000E-03				
	Po-204	3.53 h	ECA	0.0362	0.1839	1.1650	1.3850
		Bi-204	9.9340E-01				
		Pb-200	6.6000E-03				
	Po-205	1.66 h	ECB+A	0.0021	0.0660	1.5846	1.6527
		Bi-205	9.9900E-01				
		Pb-201	4.0000E-04				
	Po-206	8.8 d	ECA	0.2903	0.1655	1.1928	1.6486
		Bi-206	9.4550E-01				
		Pb-202	5.4500E-02				
	Po-207	5.80 h	ECB+A	0.0011	0.0490	1.2847	1.3347
		Bi-207	9.9979E-01				
		Pb-203	2.1000E-04				
	Po-208	2.898 y	AEC	5.2154	<E-04	<E-04	5.2154
		Bi-208	2.2300E-05				
	Po-209	102 y	AEC	4.9529	0.0030	0.0063	4.9622
		Pb-205	9.9520E-01				
	Po-210	138.376 d	A	5.4075	<E-04	<E-04	5.4075
	Po-211	0.516 s	A	7.5860	0.0002	0.0082	7.5944
	Po-212	2.99E-7 s	A	8.9541	–	–	8.9541
	Po-212m	45.1 s	A	11.772	0.0004	0.0792	11.8551
	Po-213	4.2E-6 s	A	8.5370	<E-04	<E-04	8.5370
		Pb-209	1.00				
	Po-214	1.643E-4 s	A	7.8334	<E-04	<E-04	7.8335
		Pb-210	1.00				
	Po-215	1.781E-3 s	A	7.5261	<E-04	0.0002	7.5263
		Pb-211	1.00				
	Po-216	0.145 s	A	6.9064	<E-04	<E-04	6.9064
		Pb-212	1.00				
	Po-218	3.10 m	A B-	6.1134	<E-04	–	6.1135
		Pb-214	9.9980E-01				
		At-218	2.0000E-04				
Astatine	At-204	9.2 m	ECB+A	0.2307	0.4485	2.3234	3.0025
		Po-204	9.6200E-01				
		Bi-200	3.8000E-02				
	At-205	26.2 m	ECB+A	0.6021	0.2575	1.1444	2.0039
		Po-205	9.0000E-01				
		Bi-201	1.0000E-01				
	At-206	30.6 m	ECB+A	0.0517	0.3324	2.4807	2.8647
		Po-206	9.9110E-01				
		Bi-202	8.9000E-03				
	At-207	1.80 h	ECB+A	0.5049	0.1298	2.0136	2.6483
		Po-207	9.1400E-01				
		Bi-203	8.6000E-02				
	At-208	1.63 h	ECB+A	0.0316	0.1598	3.0408	3.2322



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Radon		Po-208	9.9450E-01					
		Bi-204	5.5000E-03					
		At-209	5.41 h	ECB+A	0.2360	0.1172	2.2846	2.6378
		Po-209		9.5900E-01				
		Bi-205		4.1000E-02				
		At-210	8.1 h	ECB+A	0.0097	0.0796	2.9622	3.0515
		Po-210		9.9825E-01				
		Bi-206		1.7500E-03				
		At-211	7.214 h	ECA	2.4998	0.0059	0.0367	2.5424
		Po-211		5.8200E-01				
		Bi-207		4.1800E-01				
		At-215	1.00E-4 s	A	8.1778	<E-04	0.0002	8.1780
		Bi-211		1.00				
		At-216	3.00E-4 s	A	7.9407	0.0013	0.0025	7.9446
		Bi-212		1.00				
		At-217	3.23E-2 s	A	7.2008	<E-04	0.0002	7.2011
		Bi-213		9.9988E-01				
		At-218	1.5 s	A B-	6.8042	0.0011	–	6.8053
		Bi-214		9.9900E-01				
		Rn-218		1.0000E-03				
		At-219	56 s	A	6.1343	–	–	6.1343
		Bi-215		9.7000E-01				
		At-220	3.71 m	B-A	0.4842	1.2130	0.4497	2.1469
		Rn-220		9.2000E-01				
		Bi-216		8.0000E-02				
		Rn-207	9.25 m	ECB+A	1.3126	0.2197	0.9854	2.5177
		At-207		7.9000E-01				
		Po-203		2.1000E-01				
		Rn-209	28.5 m	ECB+A	1.0466	0.1167	1.1953	2.3586
		At-209		8.3000E-01				
		Po-205		1.7000E-01				
		Rn-210	2.4 h	AEC	5.9121	0.0091	0.0610	5.9821
		Po-206		9.6000E-01				
		At-210		4.0000E-02				
		Rn-211	14.6 h	ECB+A	1.6205	0.0663	1.8727	3.5595
		At-211		7.2600E-01				
		Po-207		2.7400E-01				
		Rn-212	23.9 m	A	6.3847	<E-04	0.0003	6.3850
		Po-208		1.00				
		Rn-215	2.30 us	A	8.8390	–	–	8.8390
		Po-211		1.00				
		Rn-216	4.5E-5 s	A	8.2000	–	–	8.2000
	Po-212		1.00					
	Rn-217	5.40E-4 s	A	7.8856	–	–	7.8856	
	Po-213		1.00					
	Rn-218	3.5E-2 s	A	7.2618	<E-04	0.0008	7.2626	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Francium		Po-214	1.00				
	Rn-219	3.96 s	A	6.8801	0.0068	0.0586	6.9456
		Po-215	1.00				
	Rn-220	55.6 s	A	6.4040	<E-04	0.0006	6.4047
		Po-216	1.00				
	Rn-222	3.8235 d	A	5.5899	<E-04	0.0004	5.5903
		Po-218	1.00				
	Rn-223	24.3 m	B-	–	0.6282	0.3444	0.9726
		Fr-223	1.00				
	Fr-212	20.0 m	ECB+A	2.7731	0.1294	1.1415	4.0440
		Rn-212	5.7000E-01				
		At-208	4.3000E-01				
	Fr-219	2.0E-2 s	A	7.4437	0.0004	0.0036	7.4477
		At-215	1.00				
	Fr-220	27.4 s	A B-	6.7413	0.0163	0.0105	6.7680
		At-216	9.9650E-01				
		Ra-220	3.5000E-03				
	Fr-221	4.9 m	A	6.4199	0.0089	0.0294	6.4582
		At-217	1.00				
	Fr-222	14.2 m	B-	–	0.7145	0.1806	0.8951
	Ra-222	1.00					
Fr-223	22.00 m	B-A	0.0003	0.3829	0.0583	0.4415	
	Ra-223	1.00					
	At-219	6.0000E-05					
Fr-224	3.33 m	B-	–	0.8751	0.5523	1.4274	
	Ra-224	1.00					
Fr-227	2.47 m	B-	–	0.7967	0.4499	1.2466	
	Ra-227	1.00					
Radium	Ra-219	10 ms	A	7.9071	0.0600	0.1702	8.1372
		Rn-215	1.00				
	Ra-220	1.79E-2 s	A	7.5904	0.0002	0.0047	7.5952
		Rn-216	1.00				
	Ra-221	28 s	A	6.7915	0.0690	0.0390	6.8995
		Rn-217	1.00				
	Ra-222	38.0 s	A	6.6710	0.0009	0.0092	6.6811
		Rn-218	1.00				
	Ra-223	11.43 d	A	5.7702	0.0781	0.1413	5.9895
		Rn-219	1.00				
	Ra-224	3.66 d	A	5.7766	0.0023	0.0104	5.7893
		Rn-220	1.00				
Ra-225	14.9 d	B-	–	0.1050	0.0145	0.1194	
	Ac-225	1.00					
Ra-226	1600 y	A	4.8603	0.0039	0.0074	4.8716	
	Rn-222	1.00					
Ra-227	42.2 m	B-	–	0.4511	0.1508	0.6019	
	Ac-227	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Actinium	Ra-228	5.75 y	B-	–	0.0132	0.0031	0.0163
		Ac-228	1.00				
	Ra-230	93 m	B-	–	0.2201	0.0794	0.2995
		Ac-230	1.00				
	Ac-223	2.10 m	A	6.6721	0.0254	0.0190	6.7165
		Fr-219	9.9000E-01				
	Ac-224	2.78 h	ECA	0.5662	0.0490	0.2325	0.8477
		Ra-224	9.0900E-01				
		Fr-220	9.1000E-02				
	Ac-225	10.0 d	A	5.8920	0.0248	0.0171	5.9338
		Fr-221	1.00				
	Ac-226	29.37 h	B-ECA	0.0003	0.2914	0.1327	0.4245
		Th-226	8.3000E-01				
		Ra-226	1.7000E-01				
		Fr-222	6.0000E-05				
	Ac-227	21.772 y	B-A	0.0693	0.0150	0.0011	0.0853
		Th-227	9.8620E-01				
		Fr-223	1.3800E-02				
	Ac-228	6.15 h	B-	–	0.4495	0.8671	1.3166
	Th-228	1.00					
Ac-230	122 s	B-	–	0.9229	0.5440	1.4668	
	Th-230	1.00					
Ac-231	7.5 m	B-	–	0.6361	0.4190	1.0550	
	Th-231	1.00					
Ac-232	119 s	B-	–	0.9707	1.1528	2.1235	
	Th-232	1.00					
Ac-233	145 s	B-	–	0.8355	0.4993	1.3348	
	Th-233	1.00					
Thorium	Th-223	0.60 s	A	7.4134	0.0575	0.0754	7.5463
	Ra-219	1.00					
Th-224	1.05 s	A	7.2635	0.0129	0.0232	7.2996	
	Ra-220	1.00					
Th-226	30.57 m	A	6.4219	0.0211	0.0089	6.4519	
	Ra-222	1.00					
Th-227	18.68 d	A	5.9883	0.0755	0.1317	6.1955	
	Ra-223	1.00					
Th-228	1.9116 y	A	5.4956	0.0210	0.0036	5.5202	
	Ra-224	1.00					
Th-229	7.34E+3 y	A	4.9584	0.1217	0.0971	5.1772	
	Ra-225	1.00					
Th-230	7.538E+4 y	A	4.7538	0.0146	0.0018	4.7702	
	Ra-226	1.00					
Th-231	25.52 h	B-	–	0.1622	0.0269	0.1891	
	Pa-231	1.00					
Th-232	1.405E10 y	A	4.0688	0.0126	0.0015	4.0829	
	Ra-228	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Protactinium	Th-233	22.3 m	B-	–	0.4140	0.0375	0.4515
		Pa-233	1.00				
	Th-234	24.10 d	B-	–	0.0622	0.0105	0.0728
		Pa-234m	1.00				
	Th-235	7.1 m	B-	–	0.6713	0.0537	0.7251
		Pa-235	1.00				
	Th-236	37.5 m	B-	–	0.3671	0.0346	0.4017
		Pa-236	1.00				
	Pa-227	38.3 m	AEC	5.5650	0.0226	0.0234	5.6110
		Ac-223	8.5000E-01				
		Th-227	1.5000E-01				
	Pa-228	22 h	ECB+A	0.1217	0.1320	1.3694	1.6230
		Th-228	9.8000E-01				
		Ac-224	2.0000E-02				
	Pa-229	1.50 d	ECA	0.0274	0.0131	0.0666	0.1071
		Th-229	9.9520E-01				
		Ac-225	4.8000E-03				
	Pa-230	17.4 d	ECB-A	0.0002	0.0668	0.6708	0.7377
		Th-230	9.1600E-01				
		U-230	8.4000E-02				
		Ac-226	3.2000E-05				
	Pa-231	3.276E+4 y	A	5.0592	0.0538	0.0450	5.1580
		Ac-227	1.00				
	Pa-232	1.31 d	B-EC	–	0.1738	0.9393	1.1131
		U-232	1.00				
		Th-232	3.0000E-05				
	Pa-233	26.967 d	B-	–	0.2151	0.2229	0.4380
		U-233	1.00				
Pa-234	6.70 h	B-	–	0.4037	1.4718	1.8755	
	U-234	1.00					
Pa-234m	1.17 m	B-IT	–	0.8171	0.0162	0.8334	
	U-234	9.9840E-01					
	Pa-234	1.6000E-03					
Pa-235	24.5 m	B-	–	0.4886	0.0008	0.4894	
	U-235m	9.9990E-01					
	U-235	1.0109E-04					
Pa-236	9.1 m	B-	–	0.8049	0.9148	1.7197	
	U-236	1.00					
Pa-237	8.7 m	B-	–	0.5780	0.6095	1.1875	
	U-237	1.00					
Uranium	U-227	1.1 m	A	6.9984	0.0960	0.1199	7.2143
		Th-223	1.00				
	U-228	9.1 m	A	6.6046	0.0231	0.0056	6.6333
		Th-224	9.7500E-01				
	U-230	20.8 d	A	5.9681	0.0216	0.0032	5.9929
	Th-226	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Neptunium	U-231	4.2 d	ECA	0.0002	0.0847	0.0896	0.1745
		Pa-231	1.00				
		Th-227	4.0000E-05				
	U-232	68.9 y	A	5.3948	0.0164	0.0023	5.4135
		Th-228	1.00				
	U-233	1.592E+5 y	A	4.9013	0.0059	0.0013	4.9085
		Th-229	1.00				
	U-234	2.455E+5 y	A	4.8430	0.0137	0.0020	4.8587
		Th-230	1.00				
	U-235	7.04E+8 y	A	4.4693	0.0530	0.1669	4.6891
		Th-231	1.00				
	U-235m	26 m	IT	–	<E-04	<E-04	<E-04
		U-235	1.00				
	U-236	2.342E+7 y	A	4.5592	0.0114	0.0018	4.5723
		Th-232	1.00				
	U-237	6.75 d	B-	–	0.1991	0.1442	0.3433
		Np-237	1.00				
	U-238	4.468E+9 y	ASF	4.2584	0.0092	0.0014	4.2691
		Th-234	1.00				
		SF	5.4500E-07				
	U-239	23.45 m	B-	–	0.4108	0.0519	0.4626
		Np-239	1.00				
	U-240	14.1 h	B-	–	0.1276	0.0099	0.1374
		Np-240m	1.00				
	U-242	16.8 m	B-	–	0.3859	0.0413	0.4272
		Np-242	1.00				
	Np-232	14.7 m	ECB+	–	0.1073	1.1969	1.3042
		U-232	1.00				
	Np-233	36.2 m	ECA	<E-04	0.0144	0.0911	0.1055
		U-233	1.00				
	Pa-229	1.0000E-05					
Np-234	4.4 d	ECB+	–	0.0574	1.1086	1.1660	
	U-234	1.00					
Np-235	396.1 d	ECA	0.0001	0.0105	0.0071	0.0178	
	U-235	9.9598E-01					
	U-235m	3.9933E-03					
	Pa-231	2.6000E-05					
Np-236	1.54E+5 y	ECB-A	0.0074	0.2372	0.1594	0.4039	
	U-236	8.7300E-01					
	Pu-236	1.2500E-01					
	Pa-232	1.6000E-03					
Np-236m	22.5 h	ECB-	–	0.0880	0.0507	0.1387	
	U-236	5.2000E-01					
	Pu-236	4.8000E-01					
Np-237	2.144E+6 y	A	4.8499	0.0681	0.0350	4.9529	
	Pa-233	1.00					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Plutonium	Np-238	2.117 d	B-	–	0.2519	0.5879	0.8398	
		Pu-238	1.00					
	Np-239	2.3565 d	B-	–	0.2623	0.1846	0.4469	
		Pu-239	1.00					
	Np-240	61.9 m	B-	–	0.5095	1.0538	1.5632	
		Pu-240	1.00					
	Np-240m	7.22 m	B-IT	–	0.6779	0.3225	1.0004	
		Pu-240	9.9890E-01					
		Np-240	1.1000E-03					
	Np-241	13.9 m	B-	–	0.4341	0.0395	0.4736	
		Pu-241	1.00					
	Np-242	2.2 m	B-	–	0.9027	0.2654	1.1681	
		Pu-242	1.00					
	Np-242m	5.5 m	B-	–	0.7551	0.9194	1.6744	
		Pu-242	1.00					
		Pu-232	33.7 m	ECA	1.5402	0.0087	0.0633	1.6122
		Np-232	7.7000E-01					
		U-228	2.3000E-01					
		Pu-234	8.8 h	ECA	0.3776	0.0114	0.0693	0.4583
		Np-234	9.4000E-01					
		U-230	6.0000E-02					
		Pu-235	25.3 m	ECA	0.0002	0.0228	0.0957	0.1187
		Np-235	9.9997E-01					
		U-231	2.7000E-05					
		Pu-236	2.858 y	ASF	5.8524	0.0128	0.0022	5.8674
		U-232	1.00					
		SF	1.3700E-09					
		Pu-237	45.2 d	ECA	0.0002	0.0171	0.0537	0.0710
		Np-237	1.00					
		U-233	4.2000E-05					
	Pu-238	87.7 y	ASF	5.5803	0.0107	0.0021	5.5930	
	U-234	1.00						
	SF	1.8500E-09						
	Pu-239	2.411E+4 y	A	5.2357	0.0075	0.0011	5.2442	
	U-235m	9.9940E-01						
	U-235	6.0000E-04						
	Pu-240	6564 y	ASF	5.2434	0.0105	0.0019	5.2559	
	U-236	1.00						
	SF	5.7500E-08						
	Pu-241	14.35 y	B-A	0.0001	0.0052	<E-04	0.0054	
	Am-241	9.9998E-01						
	U-237	2.4500E-05						
	Pu-242	3.75E+5 y	ASF	4.9738	0.0090	0.0017	4.9855	
	U-238	1.00						
	SF	5.5400E-06						
	Pu-243	4.956 h	B-	–	0.1729	0.0259	0.1988	

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Americium		Am-243	1.00				
	Pu-244	8.00E+7 y	ASF	4.6513	0.0197	0.0211	4.9094
		U-240	9.9879E-01				
		SF	1.2100E-03				
	Pu-245	10.5 h	B-	–	0.3190	0.4027	0.7217
		Am-245	1.00				
	Pu-246	10.84 d	B-	–	0.1159	0.1431	0.2590
		Am-246m	1.00				
	Am-237	73.0 m	ECA	0.0015	0.0802	0.3714	0.4531
		Pu-237	9.9975E-01				
		Np-233	2.5000E-04				
	Am-238	98 m	ECB+A	<E-04	0.0485	0.9023	0.9509
		Pu-238	1.00				
		Np-234	1.0000E-06				
	Am-239	11.9 h	ECA	0.0006	0.1709	0.2436	0.4150
		Pu-239	9.9990E-01				
		Np-235	1.0000E-04				
	Am-240	50.8 h	ECA	<E-04	0.0758	1.0355	1.1112
		Pu-240	1.00				
		Np-236	1.9000E-06				
	Am-241	432.2 y	A	5.5712	0.0373	0.0293	5.6379
		Np-237	1.00				
	Am-242	16.02 h	B-EC	–	0.1806	0.0188	0.1994
		Cm-242	8.2700E-01				
		Pu-242	1.7300E-01				
	Am-242m	141 y	ITA	0.0238	0.0439	0.0056	0.0734
		Am-242	9.9550E-01				
		Np-238	4.5000E-03				
	Am-243	7.37E+3 y	A	5.3583	0.0234	0.0585	5.4402
		Np-239	1.00				
	Am-244	10.1 h	B-	–	0.3330	0.8052	1.1382
		Cm-244	1.00				
Am-244m	26 m	B-	–	0.5187	0.0172	0.5359	
	Cm-244	9.9960E-01					
Am-245	2.05 h	B-	–	0.2874	0.0324	0.3198	
	Cm-245	1.00					
Am-246	39 m	B-	–	0.7241	0.7498	1.4739	
	Cm-246	1.00					
Am-246m	25.0 m	B-	–	0.5033	0.9799	1.4832	
	Cm-246	1.00					
Am-247	23.0 m	B-	–	0.5683	0.1348	0.7031	
	Cm-247	1.00					
Curium	Am-238	2.4 h	ECA	0.2537	0.0117	0.0829	0.3482
		Am-238	9.6160E-01				
		Pu-234	3.8400E-02				
	Cm-239	2.9 h	ECB+	–	0.0291	0.2593	0.2883

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)			
				Alpha	Electron	Photon	Total
Berkelium	Cm-240	Am-239	1.00				
		27 d	ASF	6.3650	0.0108	0.0022	6.3781
	Cm-241	Pu-236	9.9700E-01				
		SF	3.9000E-08				
	Cm-242	32.8 d	ECA	0.0603	0.1342	0.5034	0.6979
		Am-241	9.9000E-01				
	Cm-243	Pu-237	1.0000E-02				
		162.8 d	ASF	6.2041	0.0096	0.0020	6.2156
	Cm-244	Pu-238	1.00				
		SF	6.3700E-08				
	Cm-245	29.1 y	AEC	5.8929	0.1342	0.1353	6.1624
		Pu-239	9.9760E-01				
	Cm-246	Am-243	2.4000E-03				
		18.10 y	ASF	5.8915	0.0079	0.0017	5.9014
	Cm-247	Pu-240	1.00				
		SF	1.3710E-06				
	Cm-248	8.5E+3 y	ASF	5.4474	0.0824	0.1084	5.6382
		Pu-241	1.00				
	Cm-249	SF	6.1000E-09				
		4.76E+3 y	ASF	5.4654	0.0085	0.0050	5.5285
	Cm-250	Pu-242	9.9974E-01				
		SF	2.6300E-04				
	Cm-251	1.56E+7 y	A	5.0292	0.0114	0.3138	5.3544
		Pu-243	1.00				
	Cm-252	3.48E+5 y	ASF	4.7212	0.7716	1.3127	22.5608
		Pu-244	9.1610E-01				
	Cm-253	SF	8.3900E-02				
		64.15 m	B-	–	0.2835	0.0200	0.3035
	Cm-254	Bk-249	1.00				
		8300 y	AB-SF	0.9283	8.4270	13.3167	161.287
	Cm-255	Pu-246	1.8000E-01				
		Bk-250	8.0000E-02				
Cm-256	SF	7.4000E-01					
	16.8 m	B-	–	0.4545	0.1112	0.5657	
Cm-257	Bk-251	1.00					
	Bk-245	4.94 d	ECA	0.0075	0.1326	0.2352	0.3752
Cm-258	Cm-245	9.9880E-01					
	Am-241	1.2000E-03					
Cm-259	1.80 d	EC	–	0.0554	0.8546	0.9101	
	Cm-246	1.00					
Cm-260	1.38E+3 y	A	5.7031	0.0691	0.1468	5.9190	
	Am-243	1.00					
Cm-261	Bk-248m	23.7 h	B-EC	–	0.1910	0.0559	0.2470
	Cf-248	7.0000E-01					
Cm-262	Cm-248	3.0000E-01					
	Bk-249	330 d	B-A	<E-04	0.0324	<E-04	0.0325



**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Californium		Cf-249	1.00					
		Am-245	1.4500E-05					
		Bk-250	3.212 h	B-	–	0.2949	0.8983	1.1932
			Cf-250	1.00				
		Bk-251	55.6 m	B-	–	0.3693	0.0915	0.4608
			Cf-251	1.00				
		Cf-244	19.4 m	A	7.3196	0.0075	0.0020	7.3291
			Cm-240	1.00				
		Cf-246	35.7 h	ASF	6.8527	0.0060	0.0014	6.8606
			Cm-242	1.00				
			SF	2.5000E-06				
		Cf-247	3.11 h	ECA	0.0022	0.0463	0.1050	0.1536
			Bk-247	9.9965E-01				
			Cm-243	3.5000E-04				
		Cf-248	334 d	ASF	6.3518	0.0075	0.0020	6.3670
			Cm-244	9.9997E-01				
			SF	2.9000E-05				
		Cf-249	351 y	ASF	5.9262	0.0399	0.3282	6.2944
			Cm-245	1.00				
			SF	5.0200E-09				
		Cf-250	13.08 y	ASF	6.1168	0.0103	0.0111	6.2897
			Cm-246	9.9923E-01				
			SF	7.7000E-04				
	Cf-251	900 y	A	5.8803	0.1705	0.1245	6.1754	
		Cm-247	1.00					
	Cf-252	2.645 y	ASF	6.0177	0.2516	0.4572	12.8107	
		Cm-248	9.6908E-01					
		SF	3.0920E-02					
	Cf-253	17.81 d	B-A	0.0188	0.0908	0.0048	0.1144	
		Es-253	9.9690E-01					
		Cm-249	3.1000E-03					
	Cf-254	60.5 d	ASF	0.0183	10.0442	16.8399	222.890	
		Cm-250	3.1000E-03					
		SF	9.9690E-01					
	Cf-255	85 m	B-	–	0.2178	–	0.2178	
		Es-255	1.00					
Einsteinium	Es-249	102.2 m	ECB+A	0.0392	0.0437	0.4129	0.4958	
		Cf-249	9.9430E-01					
		Bk-245	5.7000E-03					
	Es-250	8.6 h	EC	–	0.3281	1.2235	1.5516	
		Cf-250	9.8500E-01					
	Es-250m	2.22 h	ECB+	–	0.0343	0.5549	0.5892	
		Cf-250	1.00					
	Es-251	33 h	ECA	0.0329	0.0522	0.1016	0.1868	
		Cf-251	9.9500E-01					
		Bk-247	5.0000E-03					

**Table A-1. Nuclides of ICRP Publication 107 ordered by atomic number. (continued)**

Element	Nuclide	Half-life & Decay products	Decay mode & Fractional yield	Emitted energy (MeV/nt)				
				Alpha	Electron	Photon	Total	
Fermium	Es-253	20.47 d	ASF	6.7335	0.0022	0.0008	6.7366	
		Bk-249	1.00					
	Es-254	275.7 d	SF	8.9000E-08	6.5244	0.0727	0.0208	6.6179
			Bk-250	1.00				
			Fm-254	1.7400E-06				
	Es-254m	39.3 h	SF	3.0000E-08	0.0208	0.2408	0.4757	0.8269
			B-AECSF					
			Fm-254	9.8000E-01				
			Bk-250	3.2000E-03				
			Cf-254	7.6000E-04				
	Es-255	39.8 d	SF	4.5000E-04	0.5117	0.0737	0.0007	0.5950
			B-ASF					
			Fm-255	9.2000E-01				
			Bk-251	8.0000E-02				
	Es-256	25.4 m	SF	4.5000E-05	—	0.5822	0.0032	0.5854
			B-					
	Fm-251	5.30 h	Fm-256	1.00	0.1252	0.0337	0.1588	0.3176
			ECB+A					
			Es-251	9.8200E-01				
	Fm-252	25.39 h	Cf-247	1.8000E-02	7.1449	0.0064	0.0018	7.1578
			ASF					
			Cf-248	9.9998E-01				
	Fm-253	3.00 d	SF	2.3000E-05	0.8352	0.1084	0.0713	1.0150
			ECA					
			Es-253	8.8000E-01				
	Fm-254	3.240 h	Cf-249	1.2000E-01	7.2956	0.0095	0.0086	7.4339
			ASF					
			Cf-250	9.9941E-01				
Fm-255	20.07 h	SF	5.9200E-04	7.1292	0.0954	0.0170	7.2417	
		ASF						
		Cf-251	1.00					
Fm-256	157.6 m	SF	2.3000E-07	0.5686	6.3116	12.4371	205.496	
		ASF						
		Cf-252	8.1000E-02					
Fm-257	100.5 d	SF	9.1900E-01	6.6154	0.1471	0.1521	7.3388	
		ASF						
		Cf-253	9.9790E-01					
		SF	2.1000E-03					

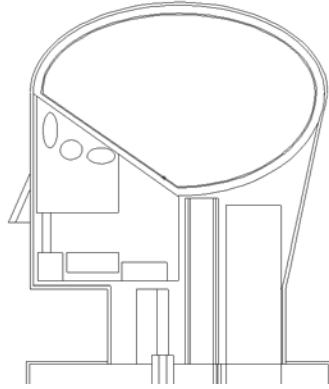
## APPENDIX B. MODIFICATIONS TO THE HUMAN PHANTOM

This appendix focuses on the differences in the mathematical phantoms used in this report and the phantom used in Federal Guidance Report No. 12 (EPA, 1993). In Federal Guidance Report No. 12, dose rate coefficients were computed for 25 tissues of an adult; the printed tables provided values for the gonad, breast, lung, red marrow, bone surface, thyroid, remainder, skin and for effective dose. The effective dose coefficients were based on an adult hermaphrodite phantom and the tissue weighting factors of ICRP Publication 26 (1977); thus the skin dose coefficient was not part of the effective dose coefficient. In this report, tissue dose rate coefficients were computed for 28 tissues in each of the phantoms as described below. Effective dose rate coefficients in this report are based on an average of the male and female tissue coefficients, as recommended in ICRP Publication 103 (2007).

The series of stylized (or mathematical) computational phantoms used in this report are modifications (Han et al., 2006) of the computational phantoms developed at ORNL in the 1980s (Cristy and Eckerman, 1987). The original ORNL age-specific phantoms have been used extensively (e.g., EPA, 1993; Eckerman et al., 1999; ICRP, 1990, 1992, 1994, 1995a, 1995b, 2001). The ORNL series of phantoms utilize three-dimensional surface equations to represent both internal organ structure and external body shape. The ORNL series are hermaphrodites (inclusive of both male and female reproductive organs) and include mathematical representations of a newborn, children at ages 1, 5, 10 and 15 years, and an adult. In their original design, adult organ volumes (defined by mathematical equations) were set so that their product with reference tissue densities provided reasonable agreement with reference organ masses given in ICRP Publication 23 (1975). Because reference organ masses for pre-adult ages were not given in ICRP Publication 23, other literature sources were consulted during model construction (Cristy, 1980). For all phantoms except the newborn, three tissue compositions were assumed: soft tissue ( $1.04 \text{ g cm}^{-3}$ ), homogeneous skeleton (bone and marrow at  $1.4 \text{ g cm}^{-3}$ ) and homogeneous lung (soft tissue and air at  $0.296 \text{ g cm}^{-3}$ ). The elemental compositions adopted for the newborn soft tissues and the newborn skeleton were  $1.04 \text{ g cm}^{-3}$  and  $1.22 \text{ g cm}^{-3}$ , respectively.

The changes to the original ORNL phantoms are summarized below. The reader is referred to Han et al. (2006) for a detailed description of these changes.

The age-dependent model of the head and brain described in Pamphlet No. 15 of the Committee on Medical Internal Radiation Dose (MIRD) and its subsequent monograph (Bouchet et al., 1999a, 1999b) was adopted. In the original ORNL series, the brain is represented by an ellipsoid. In the modified ORNL phantoms, the brain is an ellipsoid sliced by a plane, as shown Figure B-1. Revisions were made to the shape of the spine (cervical, thoracic, lumbar/sacrum sections); the ORNL spine was more elliptical in cross section.



**Figure B-1. Shape of the brain in the dosimetric phantoms applied in this report.**

The age-dependent multi-region kidney models of MIRD Pamphlet No. 19 were adopted (Bouchet et al., 2003). These models include separate sub-organ models for the renal cortex, medulla and pelvis within the original boundaries of the ORNL kidney series.

Revisions suggested by Mardirossian et al. (1999) for the rectosigmoid colon and associated repositioning of the prostate gland and urinary bladder were adopted. The stylized representations of the extrathoracic airways, trachea and extrapulmonary bronchi given by Farfán et al. (2004) for the adult model were adopted and rescaled for inclusion in the revised ORNL pediatric phantoms.

Mathematical models of the salivary glands were created for insertion within the oral cavity of the revised phantoms. The three pairs of ellipsoidal salivary glands were designed with volumes selected to match their age-dependent tissue masses given in ICRP Publication 89 (2002) and with shapes guided by histological photographs and anatomic drawings (Marieb, 2001; Netter and Hansen, 2003).

The parotid glands are modeled as two elliptical cylinders parallel to the  $z$ -axis and located in the soft-tissue region medial to the lateral sides of the mandible. The defining equations for the parotid glands are

$$\left(\frac{x \pm x_{PG}}{a_{PG}}\right)^2 + \left(\frac{y - y_{PG}}{b_{PG}}\right)^2 \leq 1 \quad (\text{B-1})$$

and

$$z_{PG1} \leq z \leq z_{PG2} \quad (\text{B-2})$$

The sublingual glands are modeled as two right circular cylinders parallel to the  $y$ -axis and located in the soft-tissue region medial to the anterior portion of the mandible. The defining equations for the sublingual glands are given as

$$\left(\frac{x \pm x_{LG}}{r_{LG}}\right)^2 + \left(\frac{z - z_{LG}}{r_{LG}}\right)^2 \leq 1 \quad (\text{B-3})$$

and

$$y_{LG1} \leq y \leq y_{LG2} \quad (\text{B-4})$$

The submandibular glands are modeled as two right circular cylinders parallel to the  $z$ -axis and located in the soft-tissue region medial to the posterior portion of the mandible. The defining equations for the submandibular glands are

$$\left(\frac{x \pm x_{MG}}{r_{MG}}\right)^2 + \left(\frac{y - y_{MG}}{r_{MG}}\right)^2 \leq 1 \quad (\text{B-5})$$

and

$$z_{MG1} \leq z \leq z_{MG2} \quad (\text{B-6})$$

Ellipsoidal parameters used to define the age-dependent salivary gland volumes were given by Han et al. (2006).

### Update of Organ Volume

During the quality assurance review of the modified ORNL phantoms, several organ volumes were found to be imprecisely declared when compared to ICRP Publication 89 (2002). These discrepancies were found by comparing the track-length estimated volume with the declared volume. Corrections were made whenever the disparity was greater than 3 percent.

Selected revisions to other organ volumes in the original ORNL series were made for consistency with organ masses given in ICRP Publication 89 (2002). In those cases where a mass difference was found between the ORNL organ mass and the ICRP Publication 89 organ mass, a change in organ volume was attempted, noting slight changes as well in ICRU tissue densities (ICRU, 1992) from the three-tissue composition in the original ORNL series. Volume decreases were easily accommodated within the mathematical phantom series, while volume increases were constrained by the need to avoid organ boundary overlap within the rigid structure of the phantoms. For newly introduced organs, such as the larynx and pharynx walls, a decision was made to preserve the reference wall thickness (for electron transport simulations), and then match reference organ masses as closely as feasible using only the length of the organ in the  $+z$  and  $-z$  directions. For sections of the large colon, wall thicknesses in the original ORNL series were set artificially high in order to match ICRP Publication 23 (1975) reference wall masses, because reference colon lengths could not be accommodated within the stylized abdomen. For similar reasons, these wall thicknesses and sectional lengths were retained in the revised phantom series.

The tissue density of the lungs given in both ICRU Report 46 (1992) and ICRP Publication 89 (2002) is  $0.26 \text{ g cm}^{-3}$  and represents an effective density for the homogenized lung (tissue parenchyma, pulmonary blood, and airway contents). This value is lower than the value of  $0.296 \text{ g cm}^{-3}$  adopted in the original ORNL phantom series and was found to yield inconsistencies between original ORNL phantom lung volumes and ICRP Publication 89 (2002) reference lung masses (inclusive of their blood content). Attempts were made to adjust lung volumes in the ORNL series using this lower recommended effective density, but this effort proved difficult because many of the lung volumes had to be expanded beyond the dimensions permitted by the fixed geometries of the rib cage and heart. Consequently, one of two options was available: (1) assign a unique effective lung density to each phantom to force agreement with ICRP Publication 89 (2002) reference masses, or (2) optimize the assignment of a single effective lung density across the entire age-range of ORNL phantoms. Physiologically, it can be argued that under option 1, effective lung densities in the phantoms should systematically decrease with increasing phantom age as the lung tree more fully develops, resulting in a larger fraction of total lung volume occupied by the pulmonary airways. Option 1, however, yielded effective lung densities that varied erratically with phantom age; thus, option 2 was deemed the more appropriate choice. The final value on the effective lung density adopted in this study was  $0.352 \text{ g cm}^{-3}$ .

## APPENDIX C. EXTERNAL BREMSSTRAHLUNG

When electrons decelerate in a medium, a fraction of their kinetic energy is converted into energy in the form of photons. In this context, the photons are called bremsstrahlung, from the German word for “braking radiation.” This type of radiation is further specified as external bremsstrahlung. Bremsstrahlung emitted when an electron is ejected from the nucleus in the beta decay process is called internal bremsstrahlung. Generation of bremsstrahlung is a stochastically governed process and the bremsstrahlung can range in energy from 0 up to the initial kinetic energy of the electron. Hence, for a large collection of monoenergetic electrons, a continuous bremsstrahlung energy spectrum is generated.

Calculations of bremsstrahlung spectral shapes are tedious because of the complexity of the bremsstrahlung cross section formulas. Pratt et al. (1977) tabulated bremsstrahlung cross section data for electrons of kinetic energy between 1 keV and 2 MeV incident on neutral atoms of atomic number between 2 and 92. Seltzer and Berger (1986) used the results of Pratt and colleagues to address neutral atoms with atomic number  $Z = 1$  to 100 and extended the electron energy range to 10 GeV. The cross section values are believed to be accurate within 10 percent.

Tables of scaled bremsstrahlung spectral shape data from electrons of kinetic energy between 1 keV and 10 MeV incident on neutral atoms of atomic number between 1 and 100 were prepared. These tables provide values of bremsstrahlung spectra, multiplied by a scaling factor of  $100 k/T$ , as a function of  $k/T$  where  $k$  is the bremsstrahlung energy and  $T$  is the kinetic energy of the electron. These tables are based on the cross section values of Seltzer and Berger (1986) for electrons from 1 keV to 10 MeV.

Tables C-1 through C-3 provide scaled values of  $S(k, T)$ , the bremsstrahlung spectra produced at photon energy  $k$  for initial electron kinetic energy  $T$  in units of keV for air, water and soil, respectively. The tabulated quantity is  $S(k, T)$  in units of photons  $\text{MeV}^{-1}$ , multiplied by a dimensionless scaling factor of  $100 k/T$ . The scaled quantity, designated as  $S'(k, T)$ , is tabulated for a grid of 27 electron kinetic energy values ranging from 1 keV to 10 MeV; for each electron energy, there are entries for 12 values of  $k/T$  ranging from 0.0 to 0.95. The tabulated quantity approaches 0 as  $k/T$  approaches 1.0, so a table entry at  $k/T = 1.0$  is not necessary. The fraction of the initial kinetic energy of an electron that is converted to bremsstrahlung, that is, the radiation yield  $Y$ , is given by

$$Y = \int_0^T \frac{k}{T} S(k, T) dk = \frac{1}{100} \int_0^T S'(k, T) dk \quad (\text{C-1})$$

The radiation yield  $Y$  must, of course, be less than 1. The values of  $S'(k, T)$  for the slowing-down medium are folded with the beta spectrum to obtain the bremsstrahlung spectrum associated with beta decay. Defining  $S_\beta(k, T_0)$  as the bremsstrahlung spectrum (photons  $\text{MeV}^{-1}$  per Bq s) at energy  $k$  for a beta spectrum with endpoint kinetic energy  $T_0$ , we have

$$S_\beta(k, T_0) = \int_k^{T_0} Y_\beta(T) S(k, T) dT = \int_k^{T_0} Y_\beta(T) \frac{S'(k, T)}{100 k/T} dT \quad (\text{C-2})$$

where  $Y_{\beta}(T)$  is the probability per unit energy of beta emission with kinetic energy  $T$ .

The beta spectrum  $Y_{\beta}$  of ICRP Publication 107 (2008) is used in this work. Figure C-1 shows the external bremsstrahlung spectrum of  $^{85}\text{Kr}$  in air computed using these data. External bremsstrahlung spectra were calculated in this work only for beta particles slowing down in air, water and soil. We applied the above to positron emissions, even though important differences exist in the slowing-down process between electrons and positrons. For positron emitters, the annihilation photons, not bremsstrahlung, are the major penetrating radiations.

For exposure to contaminated soil, it has been assumed that all emitted beta particles slow down in the soil. This assumption slightly overestimates the bremsstrahlung contribution for beta emitters on the soil surface at an effective depth of 3 mm.



**Table C-1. Scaled external bremsstrahlung spectra from electrons for air.**  
*Tabulated quantities are in units of photons per MeV.*

k/T	0.00	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
T (keV)												
1.0	6.71	5.19	4.29	3.31	2.69	2.20	1.76	1.37	0.997	0.649	0.318	0.157
2.5	4.04	3.45	3.07	2.58	2.16	1.79	1.43	1.11	0.809	0.525	0.256	0.126
5.0	3.34	3.06	2.82	2.37	1.96	1.60	1.26	0.965	0.693	0.444	0.215	0.105
10.0	3.14	2.89	2.64	2.15	1.72	1.36	1.06	0.794	0.563	0.356	0.170	0.0834
25.0	3.08	2.72	2.38	1.82	1.40	1.08	0.809	0.590	0.405	0.249	0.116	0.0557
50.0	3.02	2.53	2.14	1.57	1.17	0.871	0.638	0.453	0.303	0.180	0.0802	0.0380
75.0	2.96	2.42	2.00	1.43	1.05	0.766	0.553	0.386	0.253	0.147	0.0635	0.0295
100.0	2.90	2.32	1.90	1.33	0.960	0.697	0.497	0.342	0.220	0.126	0.0531	0.0243
200.0	2.72	2.08	1.64	1.10	0.772	0.543	0.375	0.250	0.155	0.0844	0.0334	0.0146
300.0	2.60	1.93	1.50	0.983	0.675	0.466	0.317	0.207	0.126	0.0668	0.0254	0.0108
400.0	2.51	1.83	1.41	0.909	0.616	0.420	0.282	0.182	0.109	0.0570	0.0212	0.0088
500.0	2.44	1.76	1.34	0.858	0.577	0.391	0.260	0.166	0.0992	0.0512	0.0187	0.0075
600.0	2.38	1.71	1.29	0.821	0.550	0.370	0.245	0.156	0.0925	0.0475	0.0171	0.0068
800.0	2.30	1.63	1.22	0.775	0.515	0.346	0.228	0.145	0.0855	0.0435	0.0154	0.0060
1000.0	2.24	1.58	1.18	0.747	0.497	0.332	0.220	0.140	0.0825	0.0418	0.0146	0.0056
1200.0	2.20	1.55	1.16	0.730	0.485	0.327	0.217	0.138	0.0814	0.0413	0.0144	0.0054
1400.0	2.15	1.52	1.14	0.718	0.478	0.323	0.216	0.138	0.0815	0.0414	0.0143	0.0054
1600.0	2.12	1.49	1.13	0.712	0.477	0.323	0.216	0.139	0.0823	0.0417	0.0144	0.0053
1800.0	2.09	1.48	1.12	0.707	0.476	0.323	0.217	0.140	0.0834	0.0423	0.0145	0.0054
2000.0	2.07	1.46	1.11	0.705	0.475	0.325	0.218	0.142	0.0845	0.0430	0.0148	0.0054
2500.0	2.02	1.44	1.09	0.705	0.479	0.330	0.224	0.147	0.0882	0.0452	0.0154	0.0057
3000.0	1.99	1.43	1.09	0.708	0.484	0.337	0.231	0.152	0.0919	0.0471	0.0161	0.0060
4000.0	1.94	1.42	1.09	0.716	0.498	0.350	0.243	0.161	0.0987	0.0508	0.0172	0.0064
5000.0	1.90	1.40	1.09	0.725	0.510	0.362	0.253	0.170	0.105	0.0541	0.0185	0.0068
6000.0	1.88	1.39	1.09	0.733	0.520	0.372	0.261	0.177	0.110	0.0571	0.0195	0.0072
8000.0	1.84	1.38	1.08	0.741	0.533	0.385	0.274	0.188	0.118	0.0620	0.0213	0.0079
10000.0	1.80	1.36	1.07	0.744	0.539	0.394	0.283	0.196	0.124	0.0659	0.0229	0.0086

**Table C-2. Scaled external bremsstrahlung spectra from electrons for water.**  
*Tabulated quantities are in units of photons per MeV.*

k/T	0.00	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
T (keV)												
1.0	5.8851	4.5348	3.7312	2.8741	2.3237	1.8935	1.5196	1.1743	0.8543	0.5551	0.2718	0.1340
2.5	3.5500	3.0241	2.6859	2.2375	1.8684	1.5386	1.2289	0.9472	0.6899	0.4460	0.2164	0.1067
5.0	2.9481	2.6837	2.4542	2.0525	1.6849	1.3652	1.0741	0.8191	0.5867	0.3746	0.1802	0.0884
10.0	2.7706	2.5242	2.2868	1.8513	1.4761	1.1574	0.8957	0.6699	0.4726	0.2974	0.1417	0.0693
25.0	2.7092	2.3644	2.0567	1.5611	1.1961	0.9141	0.6825	0.4947	0.3380	0.2060	0.0951	0.0457
50.0	2.6501	2.1986	1.8472	1.3263	0.9978	0.7386	0.5387	0.3807	0.2529	0.1487	0.0658	0.0310
75.0	2.5847	2.0978	1.7289	1.2265	0.8905	0.6503	0.4676	0.3250	0.2116	0.1218	0.0521	0.0240
100.0	2.5295	2.0069	1.6381	1.1362	0.8201	0.5926	0.4207	0.2881	0.1846	0.1048	0.0436	0.0198
200.0	2.3740	1.7977	1.4117	0.9463	0.6602	0.4626	0.3188	0.2114	0.1305	0.0706	0.0276	0.0119
300.0	2.2649	1.6708	1.2939	0.8450	0.5788	0.3984	0.2700	0.1753	0.1062	0.0561	0.0211	0.0088
400.0	2.1655	1.5802	1.2124	0.7817	0.5290	0.3595	0.2410	0.1545	0.0926	0.0481	0.0176	0.0072
500.0	2.1287	1.5256	1.1580	0.7382	0.4954	0.3350	0.2220	0.1419	0.0842	0.0433	0.0156	0.0062
600.0	2.0741	1.4803	1.1128	0.7074	0.4728	0.3178	0.2103	0.1337	0.0788	0.0402	0.0143	0.0056
800.0	2.0103	1.4168	1.0585	0.6684	0.4439	0.2970	0.1958	0.1247	0.0730	0.0370	0.0130	0.0050
1000.0	1.9671	1.3717	1.0223	0.6450	0.4285	0.2862	0.1895	0.1202	0.0706	0.0356	0.0123	0.0047
1200.0	1.9194	1.3443	1.0042	0.6315	0.4186	0.2817	0.1868	0.1184	0.0698	0.0353	0.0122	0.0045
1400.0	1.8827	1.3174	0.9862	0.6215	0.4132	0.2790	0.1859	0.1185	0.0700	0.0354	0.0122	0.0045
1600.0	1.8553	1.2993	0.9771	0.6161	0.4124	0.2791	0.1860	0.1194	0.0708	0.0358	0.0123	0.0044
1800.0	1.8279	1.2902	0.9682	0.6126	0.4115	0.2791	0.1869	0.1203	0.0718	0.0363	0.0124	0.0045
2000.0	1.8095	1.2722	0.9592	0.6108	0.4116	0.2810	0.1888	0.1222	0.0728	0.0370	0.0126	0.0045
2500.0	1.7711	1.2538	0.9505	0.6119	0.4153	0.2857	0.1943	0.1268	0.0761	0.0389	0.0132	0.0048
3000.0	1.7395	1.2441	0.9506	0.6148	0.4201	0.2921	0.1999	0.1314	0.0794	0.0407	0.0138	0.0051
4000.0	1.6886	1.2343	0.9513	0.6234	0.4330	0.3042	0.2109	0.1397	0.0855	0.0440	0.0149	0.0055
5000.0	1.6586	1.2249	0.9517	0.6319	0.4443	0.3153	0.2202	0.1480	0.0909	0.0469	0.0160	0.0058
6000.0	1.6392	1.2159	0.9522	0.6395	0.4536	0.3245	0.2274	0.1544	0.0959	0.0496	0.0169	0.0062
8000.0	1.6019	1.2068	0.9437	0.6481	0.4658	0.3366	0.2396	0.1637	0.1033	0.0540	0.0185	0.0069
10000.0	1.5742	1.1889	0.9441	0.6521	0.4725	0.3451	0.2480	0.1711	0.1089	0.0576	0.0200	0.0075

**Table C-3. Scaled external bremsstrahlung spectra from electrons for soil.**  
*Tabulated quantities are in units of photons per MeV.*

k/T	0.00	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
T (keV)												
1.0	7.60	5.92	4.91	3.80	3.09	2.54	2.04	1.59	1.17	0.764	0.375	0.186
2.5	4.58	3.91	3.48	2.94	2.48	2.06	1.67	1.31	0.957	0.626	0.307	0.152
5.0	3.80	3.48	3.21	2.73	2.29	1.88	1.51	1.16	0.842	0.544	0.264	0.130
10.0	3.58	3.33	3.06	2.53	2.06	1.66	1.30	0.990	0.709	0.453	0.218	0.107
25.0	3.54	3.17	2.82	2.21	1.74	1.36	1.04	0.771	0.537	0.335	0.157	0.0764
50.0	3.50	3.00	2.58	1.93	1.47	1.11	0.831	0.601	0.410	0.249	0.114	0.0545
75.0	3.46	2.88	2.42	1.76	1.32	0.982	0.723	0.514	0.344	0.205	0.0914	0.0433
100.0	3.40	2.77	2.30	1.65	1.21	0.893	0.649	0.455	0.300	0.176	0.0770	0.0360
200.0	3.21	2.50	2.00	1.37	0.973	0.694	0.487	0.329	0.209	0.117	0.0485	0.0219
300.0	3.09	2.33	1.83	1.22	0.849	0.592	0.407	0.270	0.167	0.0913	0.0365	0.0160
400.0	3.00	2.22	1.72	1.13	0.772	0.532	0.361	0.236	0.144	0.0772	0.0300	0.0130
500.0	2.91	2.13	1.64	1.06	0.720	0.492	0.331	0.214	0.130	0.0686	0.0262	0.0111
600.0	2.85	2.07	1.58	1.01	0.685	0.465	0.311	0.200	0.120	0.0632	0.0238	0.0099
800.0	2.76	1.97	1.50	0.955	0.639	0.432	0.287	0.184	0.110	0.0571	0.0211	0.0087
1000.0	2.69	1.91	1.45	0.919	0.613	0.414	0.276	0.177	0.105	0.0545	0.0198	0.0080
1200.0	2.63	1.87	1.41	0.896	0.598	0.405	0.270	0.173	0.104	0.0534	0.0193	0.0076
1400.0	2.59	1.84	1.38	0.881	0.589	0.401	0.268	0.173	0.103	0.0532	0.0190	0.0075
1600.0	2.54	1.81	1.37	0.871	0.586	0.399	0.268	0.173	0.104	0.0534	0.0191	0.0074
1800.0	2.51	1.79	1.36	0.864	0.584	0.398	0.269	0.174	0.105	0.0539	0.0191	0.0074
2000.0	2.48	1.78	1.34	0.860	0.582	0.400	0.270	0.176	0.106	0.0547	0.0194	0.0073
2500.0	2.42	1.74	1.33	0.859	0.586	0.404	0.276	0.181	0.110	0.0571	0.0199	0.0075
3000.0	2.39	1.72	1.32	0.861	0.592	0.412	0.283	0.187	0.114	0.0590	0.0205	0.0078
4000.0	2.31	1.70	1.31	0.868	0.605	0.427	0.297	0.198	0.122	0.0631	0.0218	0.0082
5000.0	2.25	1.68	1.31	0.876	0.618	0.440	0.308	0.207	0.128	0.0668	0.0231	0.0087
6000.0	2.22	1.66	1.30	0.883	0.627	0.450	0.317	0.215	0.134	0.0701	0.0242	0.0091
8000.0	2.15	1.63	1.29	0.889	0.640	0.464	0.331	0.227	0.143	0.0756	0.0263	0.0099
10000.0	2.10	1.60	1.28	0.883	0.645	0.472	0.340	0.236	0.150	0.0799	0.0280	0.0106

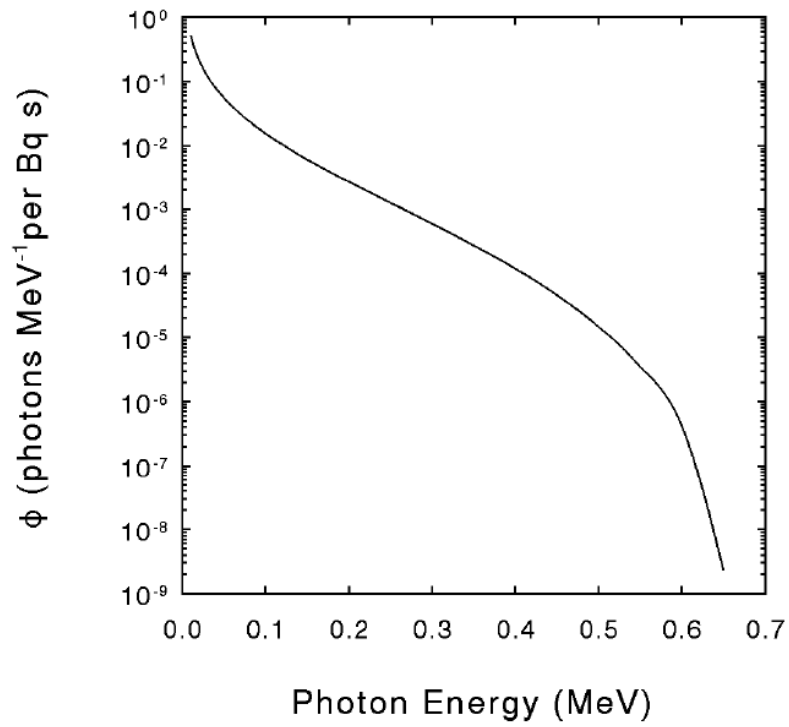


Figure C-1. External bremsstrahlung spectrum of  $^{85}\text{Kr}$  in air.

## APPENDIX D. EXAMPLE CALCULATIONS

This appendix illustrates applications of the external dose rate coefficients tabulated in this report. It is not the purpose of this appendix to suggest or endorse formulations regarding the behavior of radionuclides in the environment. Thus, the examples are of an instructional nature.

**Example 1. The concentration of  $^{85}\text{Kr}$  in the atmosphere,  $C_{Kr}$ , at a location in the environs of a fuel reprocessing plant is estimated to be  $1,000 \text{ Bq m}^{-3}$ . Compute the annual effective dose to an adult at that location. Assume the exposure is continuous and without benefit of any shielding by structures.**

From Table 4-6, the effective dose rate coefficient,  $e_E$ , for air submersion for  $^{85}\text{Kr}$  is  $6.67 \times 10^{-16} \text{ Sv m}^3 \text{ Bq}^{-1} \text{ s}^{-1}$ . The annual effective dose,  $E$ , can be estimated as the product of the dose rate and the exposure duration of  $3.15 \times 10^7 \text{ s}$  (1 year) as

$$\begin{aligned} E &= e_E C_{Kr} t \\ &= 6.67 \times 10^{-16} \frac{\text{Sv m}^3}{\text{Bq s}} \times 10^3 \frac{\text{Bq}}{\text{m}^3} \times 3.15 \times 10^7 \text{ s} \\ &= 2 \times 10^{-5} \text{ Sv} . \end{aligned}$$

**Example 2. In the planning phase of a construction project, it was determined that 30 hours of underwater welding are needed. The average concentrations of  $^{60}\text{Co}$  and  $^{137}\text{Cs}$  in the water during the planned welding period are  $1,000 \text{ Bq m}^{-3}$  and  $7,000 \text{ Bq m}^{-3}$ , respectively. Assuming no radionuclide ingestion, what is the estimated effective dose to the worker if only one welder is used to complete the job?**

From Table A-1, assume that  $^{137\text{m}}\text{Ba}$  is in secular equilibrium with  $^{137}\text{Cs}$ . First, calculate the concentration of  $^{137\text{m}}\text{Ba}$ . The secular equilibrium concentration of  $^{137\text{m}}\text{Ba}$  is the  $^{137}\text{Cs}$  concentration  $\times$   $^{137\text{m}}\text{Ba}$  fractional yield:

$$C_{Ba137m} = 7,000 \frac{\text{Bq}}{\text{m}^3} \times 0.944 = 6,608 \frac{\text{Bq}}{\text{m}^3} .$$

Next, calculate the dose rate contributions of individual radionuclides. The dose rate is average concentration  $\times$  dose rate coefficient. Because the welder is being exposed to contaminated water, the water immersion dose rate coefficients are most appropriate. From Table 4-7, the effective dose rate coefficients for  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$  and  $^{137\text{m}}\text{Ba}$  are  $2.53 \times 10^{-16}$ ,  $1.03 \times 10^{-19}$  and  $5.54 \times 10^{-17} \text{ Sv s}^{-1} \text{ Bq}^{-1} \text{ m}^3$ , respectively.

$$\begin{aligned} ^{60}\text{Co dose rate} &= 1,000 \frac{\text{Bq}}{\text{m}^3} \times 2.53 \times 10^{-16} \frac{\text{Sv m}^3}{\text{Bq s}} = 2.53 \times 10^{-13} \frac{\text{Sv}}{\text{s}} \\ ^{137}\text{Cs dose rate} &= 7,000 \frac{\text{Bq}}{\text{m}^3} \times 1.03 \times 10^{-19} \frac{\text{Sv m}^3}{\text{Bq s}} = 7.21 \times 10^{-16} \frac{\text{Sv}}{\text{s}} \\ ^{137\text{m}}\text{Ba dose rate} &= 6,608 \frac{\text{Bq}}{\text{m}^3} \times 5.54 \times 10^{-17} \frac{\text{Sv m}^3}{\text{Bq s}} = 3.66 \times 10^{-13} \frac{\text{Sv}}{\text{s}} . \end{aligned}$$

Next, determine the total dose rate for the radionuclide mixture. The total average dose rate is the sum of the individual radionuclide dose rates, or  $^{60}\text{Co}$  dose rate +  $^{137}\text{Cs}$  dose rate +  $^{137\text{m}}\text{Ba}$  dose rate:

$$\begin{aligned} \text{Total dose rate} &= 2.53 \times 10^{-13} \frac{\text{Sv}}{\text{s}} + 7.21 \times 10^{-16} \frac{\text{Sv}}{\text{s}} + 3.66 \times 10^{-13} \frac{\text{Sv}}{\text{s}} \\ &= 6.20 \times 10^{-13} \frac{\text{Sv}}{\text{s}} . \end{aligned}$$

Finally, calculate the total dose to the worker. The duration of exposure in seconds is 30 hours  $\times$  3,600 seconds per hour = 108,000 seconds. The total dose to the welder is dose rate  $\times$  exposure duration.

$$\begin{aligned} \text{Total dose} &= 6.20 \times 10^{-13} \frac{\text{Sv}}{\text{s}} \times 108,000 \text{ s} \\ &= 7 \times 10^{-8} \text{ Sv} . \end{aligned}$$

**Example 3. A pilot is given an assignment to fly an aircraft through a large radioactive plume for forensic sample collection. The estimated radionuclide concentrations are 1 MBq m<sup>-3</sup> of <sup>131</sup>I and 2 GBq m<sup>-3</sup> of <sup>192</sup>Ir. Assuming no shielding from the airplane and clothing, how long can the pilot stay inside the cloud before the external effective dose exceeds 50 mSv?**

First, calculate the dose rate contribution of the individual radionuclides. The dose rate is estimated concentration  $\times$  dose rate coefficient. From Table 4-6, the effective dose rate coefficients for air submersion for <sup>131</sup>I and <sup>192</sup>Ir are  $1.69 \times 10^{-14}$  and  $3.56 \times 10^{-14}$  Sv s<sup>-1</sup> m<sup>3</sup> Bq<sup>-1</sup>, respectively.

$$\begin{aligned} ^{131}\text{I dose rate} &= 1 \frac{\text{MBq}}{\text{m}^3} \times \frac{10^6 \text{ Bq}}{\text{MBq}} \times 1.69 \times 10^{-14} \frac{\text{Sv m}^3}{\text{Bq s}} = 1.7 \times 10^{-8} \frac{\text{Sv}}{\text{s}} \\ ^{192}\text{Ir dose rate} &= 2 \frac{\text{GBq}}{\text{m}^3} \times \frac{10^9 \text{ Bq}}{\text{GBq}} \times 3.56 \times 10^{-14} \frac{\text{Sv m}^3}{\text{Bq s}} = 7.1 \times 10^{-5} \frac{\text{Sv}}{\text{s}} . \end{aligned}$$

Next, determine the total dose rate for the radionuclide mixture. The total dose rate is the sum of the individual radionuclide dose rates, or <sup>131</sup>I dose rate + <sup>192</sup>Ir dose rate:

$$\text{Total dose rate} = 1.7 \times 10^{-8} \frac{\text{Sv}}{\text{s}} + 7.1 \times 10^{-5} \frac{\text{Sv}}{\text{s}} = 7.1 \times 10^{-5} \frac{\text{Sv}}{\text{s}} .$$

Finally, to calculate the duration of exposure before exceeding 50 mSv, divide the dose by the dose rate:

$$\begin{aligned} \frac{\text{Dose}}{\text{Dose rate}} &= \frac{0.05 \text{ Sv}}{7.1 \times 10^{-5} \frac{\text{Sv}}{\text{s}}} \\ &= 700 \text{ seconds} . \end{aligned}$$

**Example 4. Consider that at time 0 the ground surface was uniformly contaminated with pure  $^{137}\text{Cs}$  at a surface concentration of  $2 \text{ Bq m}^{-2}$ . Calculate the effective dose rate,  $\dot{E}$ , for an adult at time 0 and at 10 years. Also compute the annual effective dose in the year following the initial deposition. Assume that radioactive decay is the only mechanism by which the radioactivity is removed from the ground surface.**

The radiological properties of the radionuclides are summarized in Table A-1 of Appendix A. From that table, it is seen that  $^{137}\text{Cs}$  has a physical half-life of  $\sim 30.2$  years, undergoes beta decay, and emits, as electrons, a total energy of  $0.1884 \text{ MeV}$  per nuclear transformation ( $nt$ ). No alpha radiation is emitted and energy associated with photon emissions is less than  $10^{-7} \text{ MeV nt}^{-1}$ . In 94.4 percent of the  $^{137}\text{Cs}$  transformations, the radioactive decay product  $^{137\text{m}}\text{Ba}$  is formed. Table A-1 indicates that  $^{137\text{m}}\text{Ba}$  has a half-life of 2.552 minutes, forms no radioactive decay products, and emits electrons and photons with total energies of  $0.0653$  and  $0.5963 \text{ MeV nt}^{-1}$ , respectively. The energies listed in Table A-1, and quoted above, represent the energy of all radiations of that type emitted per nuclear transformation. A nuclide emitting a single photon of energy  $1 \text{ MeV}$  in 1 percent of its transformations releases the same energy in photon radiation as another nuclide emitting photons of  $0.01 \text{ MeV}$  in 100 percent of its transformations. The dosimetric significance of these photons, however, can be quite different. Barium-137m emits a gamma ray of  $0.6617 \text{ MeV}$  in 89.74 percent of its nuclear transformations; the total energy emitted is  $0.6617 \times 0.8974$  or  $0.594 \text{ MeV nt}^{-1}$ . The tabulated value of  $0.5963 \text{ MeV}$  includes the contribution from K x-rays emitted following the internal conversion of the  $0.6617 \text{ MeV}$  photon. Note that the sum of the emitted energies ( $0.0653 + 0.5963$ ) is  $0.6616 \text{ MeV}$ , essentially the same as the energy of the metastable state.

At time  $t = 0$ , the ground surface is uniformly contaminated with pure  $^{137}\text{Cs}$ ; the decay product,  $^{137\text{m}}\text{Ba}$  is not present. From Table 4-1, the effective dose rate coefficient,  $e_{\text{Cs}-137}$ , for  $^{137}\text{Cs}$  distributed on the ground surface is  $7.85 \times 10^{-18} \text{ Sv Bq}^{-1} \text{ s}^{-1} \text{ m}^2$ . Note that the dose rate coefficient is stated here as an instantaneous dose rate per activity concentration. The dose rate at time 0 is

$$\begin{aligned}\dot{E} &= 7.85 \times 10^{-18} \frac{\text{Sv m}^2}{\text{Bq s}} \times 2.0 \frac{\text{Bq}}{\text{m}^2} \\ &= 1.57 \times 10^{-17} \frac{\text{Sv}}{\text{s}}.\end{aligned}$$

This dose is due to bremsstrahlung arising as the beta particles emitted by  $^{137}\text{Cs}$  slow down in the ground. Recall that Table A-1 indicates virtually no emission of photons by  $^{137}\text{Cs}$ .

To compute the effective dose rate after 10 years, we first compute the activities of  $^{137}\text{Cs}$  and  $^{137\text{m}}\text{Ba}$  on the ground surface at that time. For  $^{137}\text{Cs}$  the activity is calculated as

$$A_{\text{Cs}137}(t) = A_{\text{Cs}137}(0)e^{-\lambda_{\text{Cs}137}t}$$

where  $A_{\text{Cs}137}(0)$  is the activity of  $^{137}\text{Cs}$  on the ground surface at  $t = 0$ .

The decay constant for  $^{137}\text{Cs}$ ,  $\lambda_{\text{Cs}137}$ , is

$$\lambda_{\text{Cs}137} = \frac{\ln(2)}{T_{1/2}} = \frac{0.693}{30.2 \text{ y} \times 3.15 \times 10^7 \frac{\text{s}}{\text{y}}} = 7.28 \times 10^{-10} \text{ s}^{-1}$$

and for  $^{137\text{m}}\text{Ba}$ , with  $T_{1/2}$  of 2.552 minutes, the decay constant is  $4.53 \times 10^{-3} \text{ s}^{-1}$ . The activity of  $^{137}\text{Cs}$  on the ground surface at 10 years ( $3.15 \times 10^8 \text{ s}$ ) is

$$A_{\text{Cs}137}(10 \text{ y}) = 2.0 e^{-7.28 \times 10^{-10} \text{ s}^{-1} \times 3.15 \times 10^8 \text{ s}} = 1.59 \frac{\text{Bq}}{\text{m}^2}$$

and that of  $^{137}\text{Ba}$  is 0.944 times that of  $^{137}\text{Cs}$  because  $^{137\text{m}}\text{Ba}$  is in secular equilibrium with its parent  $^{137}\text{Cs}$ . A decay product is said to be in secular equilibrium when the ratio of its activity to that of the parent no longer changes with time; in the case of  $^{137\text{m}}\text{Ba}$ , this ratio is simply the fraction of  $^{137}\text{Cs}$  transformations forming  $^{137\text{m}}\text{Ba}$  (0.944). Using the dose rate coefficient from Table 4-1, we obtain

$$\begin{aligned} \dot{E}(10 \text{ y}) &= e_{\text{Cs}137} A_{\text{Cs}137}(10 \text{ y}) + e_{\text{Ba}137\text{m}} A_{\text{Ba}137\text{m}}(10 \text{ y}) \\ &= 7.85 \times 10^{-18} \frac{\text{Sv m}^2}{\text{Bq s}} \times 1.59 \frac{\text{Bq}}{\text{m}^2} + 3.90 \times 10^{-16} \frac{\text{Sv m}^2}{\text{Bq s}} \times 1.50 \frac{\text{Bq}}{\text{m}^2} \\ &= 5.97 \times 10^{-16} \frac{\text{Sv}}{\text{s}} . \end{aligned}$$

The annual effective dose after 1 year of exposure is just the integral of the dose rate, or

$$E(1 \text{ y}) = \int_0^1 \dot{E}(t) dt = e_{\text{Cs}137} \int_0^1 A_{\text{Cs}137}(t) dt + e_{\text{Ba}137\text{m}} \int_0^1 A_{\text{Ba}137\text{m}}(t) dt .$$

Activity, by definition, is the rate at which nuclear transformations are occurring and thus, its time integral is the number of nuclear transformations during the time period. Equation (A-3) provides the necessary formulations to compute the number of nuclear transformations. The number of nuclear transformations of  $^{137}\text{Cs}$  in the first year ( $3.15 \times 10^7 \text{ s}$ ) is

$$\int_0^T A_{\text{Cs}137}(t) dt = A_{\text{Cs}137}(0) \frac{[1 - e^{-\lambda_{\text{Cs}137} T}]}{\lambda_{\text{Cs}137}} = 6.23 \times 10^7 \frac{\text{Bq} \cdot \text{s}}{\text{m}^2}$$

and that of  $^{137\text{m}}\text{Ba}$  is



$$\begin{aligned}
& \int_0^T A_{Ba137m}(t) dt \\
&= \int_0^T A_{Cs137}(0) \frac{f_{Cs137,Ba137m} \lambda_{Ba137m}}{\lambda_{Ba137m} - \lambda_{Cs137}} [e^{-\lambda_{Cs137}t} - e^{-\lambda_{Ba137m}t}] dt \\
&= A_{Cs137}(0) \frac{f_{Cs137,Ba137m} \lambda_{Ba137m}}{\lambda_{Ba137m} - \lambda_{Cs137}} \left[ \frac{(1 - e^{-\lambda_{Cs137}T})}{\lambda_{Cs137}} - \frac{(1 - e^{-\lambda_{Ba137m}T})}{\lambda_{Ba137m}} \right] \\
&= 5.88 \times 10^7 \frac{Bq s}{m^2} .
\end{aligned}$$

The annual effective dose,  $E$ , is

$$\begin{aligned}
E &= 7.85 \times 10^{-18} \frac{Sv m^2}{Bq s} \times 6.23 \times 10^7 \frac{Bq s}{m^2} + 3.90 \times 10^{-16} \frac{Sv m^2}{Bq s} \times 5.88 \times 10^7 \frac{Bq s}{m^2} \\
&= 2 \times 10^{-8} Sv .
\end{aligned}$$

## APPENDIX E. LIST OF ACRONYMS

Bq	becquerel (unit)
CT	computed tomography
DOE	U.S. Department of Energy
DOSFACTER	Dose Rate Conversion Factors for Photon and Electron Exposure
EC	electron capture
ENDF	Evaluated Nuclear Data File
EPA	U.S. Environmental Protection Agency
Gy	gray (unit)
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
IT	isomeric transition
JAERI	Japan Atomic Energy Research Institute
keV	kilo-electronvolt (unit)
LET	linear energy transfer
MCNP	Monte Carlo N-Particle Transport Code
MIRD	Committee on Medical Internal Radiation Dose
μCi	microcurie (unit)
mrem	millirem (unit)
NAS-NRC	National Academy of Sciences–National Research Council
NCRP	National Council on Radiation Protection and Measurements
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
RBE	relative biological effectiveness
SF	spontaneous fission
SI	International System of Units
Sv	sievert (unit)
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation

## ERRATA

After the initial publication of Federal Guidance Report No. 15 in June 2018, errors were discovered in the tables of dose coefficients for soil. The cause of the errors was two-fold: (1) a coding error caused an omission of bremsstrahlung emissions for low-energy beta emitting radionuclides in soil; and (2) an interim set of monoenergetic dose coefficients was used to generate radionuclide-specific dose coefficients for soil.

Although no errors were found in dose coefficients for air submersion and water immersion, an in-depth methodology review prompted the authors to adopt a uniform method of data-smoothing and extrapolation of monoenergetic organ doses at low energies across all exposure pathways; the originally published dose coefficients utilized different methods for each media type. As a result, the dose coefficients for all external exposure pathways in this report have been updated.

The dose coefficients in this report—as well as the methods used to generate them—went through a rigorous and comprehensive review. For information on the technical details of this review, or for further explanation of text changes, please contact [radiation.questions@epa.gov](mailto:radiation.questions@epa.gov).

Changes from the June 2018 Federal Guidance Report No. 15 include:

- Preface and Chapter 1: the following footnote, referring to the passage “...radionuclides distributed in air,\* water and soil,” was removed: “This also includes cosmic rays that are low linear energy transfer (LET).”
- Figure 1-1: caption text was slightly modified to indicate the comparison between ICRP Publications 60 and 103.
- Chapter 1, page 5: the following sentence was removed: “The effective dose coefficients tabulated in this report are sex-averaged per the definition of this quantity in ICRP Publication 103 (2007).”
- Table 2-1 and Section 3.2.2.4: removal of text indicating that radionuclide-specific dose coefficients for a smooth (0 mm) infinite plane would be available online.
- Chapter 3, Section 3.2.2.3: section header was changed from, “Ground plane depths” to “Soil depths considered.”
- Table 4-1: revised dose coefficients for ground surface.
- Table 4-2: revised dose coefficients for soil to 1 cm.
- Table 4-3: revised dose coefficients for soil to 5 cm.
- Table 4-4: revised dose coefficients for soil to 15 cm.
- Table 4-5: revised dose coefficients for soil to infinite depth.
- Table 4-6: revised dose coefficients for air submersion.
- Table 4-7: revised dose coefficients for water immersion.
- Chapter 5, Section 5.5: the following sentence was added: “However, bremsstrahlung generated as the emitted electrons stop within the soil does contribute to the dose to skin and other tissues.”

- Appendix A: equation (A-4) erroneously duplicated equation (A-3). Equation (A-4) now reads as follows:

$$E = A_1^0 \frac{1 - e^{-\lambda_1 T}}{\lambda_1} \sum_{i=1}^n e_{E,i}^{gs} \prod_{j=1}^{i-1} f_{j,j+1}$$

- Appendix A: removal of text indicating that characteristic gamma emissions for 1,252 radionuclides would be available online.
- Appendix D: example calculations have been revised with the new dose coefficients provided in this report.

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## REFERENCES

- Beck, H. L. (1980). *Exposure Rate Conversion Factors for Radionuclides Deposited on the Ground* (No. EML-378). Department of Energy. Environmental Measurements Laboratory, New York.
- Beck, H. & de Planque, G. (1968). *The Radiation Field in Air due to Distributed Gamma-Ray Sources in the Ground* (No. HASL-195). New York Operations Office (AEC), Health and Safety Laboratory.
- Berger, M. J. (1974). Beta-Ray Dose in Tissue-Equivalent Material Immersed in a Radioactive Cloud. *Health Physics*, 26(1), 1-12.
- Berger, M. J., Hubbell, J. H., Seltzer, S. M., Chang, J., Coursey, J. S., Sukumar, R., Zucker, D. S., & Olson, K. (1998). *XCOM: Photon Cross Sections Database* (No. NBSIR 87-3597). National Institute of Standards and Technology, Washington, DC.
- Bouchet, L. G., Bolch, W. E., Weber, D. A., Atkins, H. L. & Poston Sr., J.W. (1999a). MIRD Pamphlet No. 15: Radionuclide S Values in a Revised Dosimetric Model of the Adult Head and Brain. *Journal of Nuclear Medicine*, 40(3), S62.
- Bouchet, L. G., Bolch, W. E. & Wessels, B. A. (1999b). *Head and Brain Dosimetry: Absorbed Fractions of Energy and Absorbed Dose per Unit; Cumulated Activity Within Pediatric and Adult Head and Brain; Models for Use in Nuclear Medicine Internal Dosimetry*. Society of Nuclear Medicine, Reston, VA.
- Bouchet, L. G., Bolch, W. E., Blanco, H. P., Wessels, B. W., Siegle, J. A., Rajon, D. A., Clairand, I., & Sgouros, G. (2003). MIRD Pamphlet No. 19: Absorbed Fractions and Radionuclide S Values for Six Age-dependent Multi-region Models of the Kidney. *Journal of Nuclear Medicine*, 44(7), 1113-1147.
- Burson, Z. G., & Profio, A. E. (1977). Structure shielding in reactor accidents. *Health Physics*, 33(4), 287-299.
- Chen, S. Y. (1991). Calculation of Effective Dose-equivalent Responses for External Exposure From Residual Photon Emitters in Soil. *Health Physics*, 60(3), 411-426.
- Chilton, A. B., Shultis, J. K., & Faw, R. E. (1984). *Principles of Radiation Shielding*. Prentice-Hall, Englewood Cliffs, NJ.
- Cristy, M. (1980). *Mathematical Phantoms Representing Children of Various Ages for Use in Estimates of Internal Dose* (No. NUREG/TM-367). Oak Ridge National Laboratory, Oak Ridge, TN.
- Cristy, M. & Eckerman, K. F. (1987). *Specific Absorbed Fractions of Energy at Various Ages From Internal Photon Sources Parts I-VII* (No. ORNL/TM 8381/V1-V7). Oak Ridge National Laboratory, Oak Ridge, TN.

- Dickson, E. D. & Hamby, D. M. (2016). Building protection- and building shielding-factors for environmental exposure to radionuclides and monoenergetic photon emissions. *Journal of Radiological Protection*, 36(3), 579.
- Dickson, E. D. & Hamby, D. M. (2014). Cloud Immersion Building Shielding Factors for U.S. Residential Structures. *Journal of Radiological Protection*, 34(4), 853.
- Dickson, E. D., Hamby, D. M. & Eckerman, K. F. (2015). Contaminant Deposition Building Shielding Factors for U.S. Residential Structures. *Journal of Radiological Protection*, 35(2), 317.
- Dillman, L. T. (1974). Absorbed Gamma Dose Rate for Immersion in a Semi-infinite Radioactive Cloud. *Health Physics*, 27(6), 571-580.
- Dillman, L. T. (1980). *EDISTR - A Computer Program to Obtain a Nuclear Decay Data Base for Radiation Dosimetry* (No. ORNL/TM-6689). Oak Ridge National Laboratory, Oak Ridge, TN.
- Dillman, L. T. & Jones, T. D. (1975). Internal Dosimetry of Spontaneously Fissioning Nuclides. *Health Physics* 29(1), 111-123.
- DOE (1988). *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (No. DOE/EH-0070). U.S. Department of Energy, Washington, DC.
- DOE (2011a). Radiation Protection of the Public and the Environment. *DOE Order 458.1*. U.S. Department of Energy, Washington, DC.
- DOE (2011b). Derived Concentration Technical Standard. *DOE-STD-1196-2011*. U.S. Department of Energy, Washington, DC.
- Eckerman, K. F. (1984). Aspects of the Dosimetry of Radionuclides Within the Skeleton with Particular Emphasis on the Active Marrow. In Schlafke-Stelson, A. T. & Watson, E. E. (Eds.), *Proceedings of the Fourth International Radiopharmaceutical Dosimetry Symposium* (No. CONF-851113 [DE86010102]) (pp. 514-534). Oak Ridge Associated Universities, Oak Ridge, TN.
- Eckerman, K. F., & Cristy, M. (1984). Computational Method for Realistic Estimates of the Dose to Active Marrow. In Kaul, A., Neider, R., Pensko, J., Stieve, F.-E., & Brunner, H., (Eds.), *Radiation Risk Protection, Proceedings of the Sixth International Congress, International Radiation Protection Association, Vol. III* (pp. 984). International Radiation Protection Association, Berlin, FRG.
- Eckerman, K. F., Kerr, G. D., & Raridon, R. (1980). Organ Doses from Isotropic Cloud Sources of Gamma Rays. *Health Physics*, 39(6), 1054.
- Endo, A., Yamaguchi, Y., & Eckerman, K. F. (2005). *Nuclear Decay Data for Dosimetry Calculation: Revised Data of ICRP Publication 38* (No. JAERI-1347). Japan Atomic Energy Research Institute.

- EPA (1987). Radiation Protection Guidance to Federal Agencies for Occupational Exposure. *52 Fed. Reg.* 2822 (January 27, 1987).
- EPA (1993). *External Exposure to Radionuclides in Air, Water, and Soil, Federal Guidance Report No. 12* (No. EPA-402-R-93-081). U.S. Environmental Protection Agency, Washington, DC.
- EPA (1999). *Cancer Risk Coefficients for Environmental Exposures to Radionuclides, Federal Guidance Report No. 13* (No. EPA-402-R-99-001). U.S. Environmental Protection Agency, Washington, DC.
- EPA (2011). *Exposure Factors Handbook 2011 Edition (Final Report)* (No. EPA-600-R-09-052F). U.S. Environmental Protection Agency, Washington, DC.
- Farfán, E. B., Han, E. Y., Bolch, W. E., Huh, C., Huston, T. E., & Bolch Jr., W. E. (2004). Revised Stylized Model of the Extrathoracic and Thoracic Airways for Use with the ICRP-66 Respiratory Tract Model. *Health Physics*, 86(4), 337-352.
- Fritsch, F. N. & Carlson, R. E. (1980). Monotone Piecewise Cubic Interpolation. *SIAM Journal on Numerical Analysis*, 17(2), 238-246.
- Goorley, T., James, M., Booth, T., Brown, F., Bull, J., Cox, L. J., Durkee, J., Elson, J., Fensin, M., Forster, R. A., Hendricks, J., Hughes, H. G., Johns, R., Kiedrowski, B., Martz, R., Mashnik, S., McKinney, G., Pelowitz, D., Prael, R., Sweezy, J., Waters, L., Wilcox, T., & Zukaitis, T. (2012). Initial MCNP6 Release Overview. *Nuclear Technology*, 180(3), 298-315.
- Han, E. Y., Bolch, W. E., & Eckerman, K. F. (2006). Revisions to the ORNL Series of Adult and Pediatric Computational Phantoms for Use with the MIRD Schema. *Health Physics*, 90(4), 337-356.
- Helmke, P. A. (1999). The chemical composition of soils. In M. E. Summer (Ed.), *Handbook of Soil Science* (pp. B3-B24). Boca Raton, FL: CRC Press.
- Herman, M., & Trkov, A. (2005). *ENDF-6 formats manual*. National Nuclear Data Centre, BNL, Upton, New York.
- Hiller, M. M., Veinot, K., Easterly, C. E., Hertel, N. E., Eckerman, K. F., & Bellamy, M. B. (2016). Reducing statistical uncertainties in simulated organ doses of phantoms immersed in water. *Radiation Protection Dosimetry*, 174(4), 439-448.
- ICRP (1959). *Report of Committee II on Permissible Dose for Internal Radiation* (ICRP Publication 2). International Commission on Radiological Protection. Pergamon Press, New York.
- ICRP (1975). *Report of the Task Group on Reference Man* (ICRP Publication 23). International Commission on Radiological Protection. Pergamon Press, New York.



- ICRP (1977). Recommendations of the International Commission on Radiological Protection (ICRP Publication 26). *Annals of the ICRP* 1(3).
- ICRP (1983). Radionuclide Transformations: Energy and Intensity of Emissions (ICRP Publication 38). *Annals of the ICRP* 11–13.
- ICRP (1987). Data for Use in Protection Against External Radiation (ICRP Publication 51). *Annals of the ICRP* 17(2-3).
- ICRP (1990). Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 1 (ICRP Publication 56). *Annals of the ICRP* 20(2).
- ICRP (1991). 1990 Recommendations of the International Commission on Radiological Protection (ICRP Publication 60). *Annals of the ICRP* 21(1–3).
- ICRP (1992). Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 2 – Ingestion Dose Coefficients (ICRP Publication 67). *Annals of the ICRP* 22(3–4).
- ICRP (1994). Dose Coefficients for Intakes of Radionuclides by Workers (ICRP Publication 68). *Annals of the ICRP* 24(4).
- ICRP (1995a). Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 3 – Ingestion Dose Coefficients (ICRP Publication 69). *Annals of the ICRP* 25(1).
- ICRP (1995b). Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 4 – Inhalation Dose Coefficients (ICRP Publication 71). *Annals of the ICRP* 25(3-4).
- ICRP (1996). Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 5 – Compilation of Ingestion and Inhalation Dose Coefficients (ICRP Publication 72). *Annals of the ICRP* 26(1).
- ICRP (2001). Doses to the Embryo and Fetus from Intakes of Radionuclides by the Mother (ICRP Publication 88). *Annals of the ICRP* 31(1-3).
- ICRP (2002). Basic Anatomical and Physiological Data for Use in Radiological Protection Reference Values (ICRP Publication 89). *Annals of the ICRP*, 32(3–4).
- ICRP (2007). The 2007 Recommendations of the International Commission on Radiological Protection (ICRP Publication 103). *Annals of the ICRP*, 37(2–4).
- ICRP (2008). Nuclear Decay Data for Dosimetric Calculations (ICRP Publication 107). *Annals of the ICRP*, 38(3).

- ICRU (1992). *Photon, Electron, Proton and Neutron Interaction Data for Body Tissues* (ICRU Report 46). International Commission on Radiation Units and Measurements, Bethesda, MD.
- ICRU (1994). *Gamma-Ray Spectrometry in the Environment* (ICRU Report 53). International Commission on Radiation Units and Measurements, Bethesda, MD.
- Jacob, P., & Meckbach, R. (1991). External Exposure from Deposited Radionuclides. In Kelly, G. N., & Luykx, F. (Eds.), *Proc. Seminar on Methods and Codes for Assessing the Off-Site Consequences of Nuclear Accidents* (No. EUR 13013/1) (pp. 40). Commission of the European Communities, Luxembourg.
- Jacob, P., Paretzke, H. G., Rosenbaum, H., & Zankl, M. (1986). Effective Dose Equivalents for Photon Exposures from Plane Sources on the Ground. *Radiation Protection Dosimetry*, 14(4), 299-310.
- Jacob, P., Paretzke, H. G., Rosenbaum, H., & Zankl, M. (1988a). Organ Doses from Radionuclides on the Ground. Part I. Simple Time Dependencies. *Health Physics*, 54(6), 617-633.
- Jacob, P., Paretzke, H. G., & Rosenbaum, H. (1988b). Organ Doses from Radionuclides on the Ground. Part II. Non-trivial Time Dependencies. *Health Physics*, 55(1), 37-49.
- Jacob, P., Rosenbaum, H., Petoussi, N., and Zankl, M. (1990). *Calculation of Organ Doses from Environmental Gamma Rays Using Human Phantoms and Monte Carlo Methods. Part II: Radionuclides Distributed in the Air or Deposited on the Ground* (Report 12/90). GSF-National Research Center for Environment and Health, Neuherberg.
- Jacquez, J. A. (1972). *Compartmental Analysis in Biology and Medicine*. Elsevier, Amsterdam.
- Koblinger, L. & Nagy, G. Y. (1985). Calculations on the Relationship Between Gamma Source Distributions in the Soil and External Doses. *Science of the Total Environment*, 45, 357-364.
- Kocher, D. C. (1980). Effects of Indoor Residence on Radiation Doses from Routine Releases of Radionuclides to the Atmosphere. *Nuclear Technology*, 48(2), 171-179.
- Kocher, D. C. (1981). *Dose-Rate Conversion Factors for External Exposure to Photons and Electrons* (No. NUREG/CR-1918, ORNL/NUREG-79). Oak Ridge National Laboratory, Oak Ridge, TN.
- Kocher, D. C. (1983). Dose-Rate Conversion Factors for External Exposure to Photons and Electrons. *Health Physics*, 45(3), 665-686.
- Kocher, D. C., & Sjoreen, A. L. (1985). Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil. *Health Physics*, 48(2), 193-205.
- LeGrand, J., Roux, Y., Meckbach, R., Jacob, P., Hedomon Jenson, P., & Thykier-Nelson, S. (1991). External Exposure from Airborne Radionuclides. In G. N. Kelly and F. Luykx (Eds.), *Proc. Seminar*

- on Methods and Codes for Assessing the Off-Site Consequences of Nuclear Accidents* (No. EUR 13013/1) (pp. 3854). Commission of the European Communities, Luxembourg.
- Mardirossian, G., Tagesson, M., Blanco, P., Bouchet, L.G., Stabin, M., Yoriyaz, H., Baza, S., Ljungberg, M., Strand, S. E., & Brill, A. B. (1999). A New Rectal Model for Dosimetry Applications. *Journal of Nuclear Medicine*, 40(9), 1524.
- Marieb, E. N. (2001). *Human Anatomy and Physiology*. Benjamin-Cummings Science Publishing, Menlo Park, CA.
- NAS–NRC (1964). *Studies in Penetration of Charged Particles in Matter* (NAS–NRC Publication 1133). National Academy of Sciences–National Research Council. National Academies Press, Washington, DC.
- NAS–NRC (2006). *Health Risk From Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase II*. National Academy of Sciences–National Research Council. National Academies Press, Washington, DC.
- NCRP (1975). *Natural Background Radiation in the United States* (NCRP Report No. 45). National Council on Radiation Protection and Measurements, Washington, DC.
- NCRP (2007). *Uncertainties in the Measurement and Dosimetry of External Radiation* (NCRP Report No. 158). National Council on Radiation Protection and Measurements, Washington, DC.
- Netter, F. H., & Hansen, J. T. (2003). *Atlas of Human Anatomy*. Icon Learning Systems, Teterboro, NJ.
- NRC (1977). *Regulatory Guide 1.109. Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*. Nuclear Regulatory Commission, Washington, DC.
- Oakley, D. T. (1972). *Natural Radiation Exposure in the United States* (No. ORP/SID 72-1). U. S. Environmental Protection Agency, Washington, DC.
- O’Brien, K., & Sanna, R. (1978). The Effect of the Male-Female Body-Size Difference on Absorbed Dose-Rate Distributions in Humans from Natural Gamma Rays. *Health Physics*, 34(1), 107-112.
- Petoussi, N., Jacob, P., Zankl M., & Saito K. (1991). Organ Doses for Foetuses, Babies, Children and Adults From Environmental Gamma Rays. *Radiation Protect Dosimetry*, 37(1), 31-41.
- Petoussi-Hens, N., Schlattl, H., Zankl, M., Endo A., & Saito K. (2012). Organ Doses From Environmental Exposures Calculated Using Voxel Phantoms of Adults and Children. *Phys Med Biol* 57(18), 5679.
- Poston J. W., & Snyder, W. S. (1974). A Model for Exposure to a Semi-infinite Cloud of a Photon Emitter. *Health Physics*, 26(4), 287-293.

- Pratt, R. H., Tseng, H. K., Lee, C. M., Kissel, L., MacCallum C., & Riley, M. (1977). Bremsstrahlung Energy Spectra from Electrons of Kinetic Energy  $1 \text{ keV} \leq T_1 \leq 2000 \text{ keV}$  Incident on Neutral Atoms  $2 \leq Z \leq 92$ . *Atomic Data and Nuclear Data Tables*, 20(2), 175-209.
- Ryman, J. C., Faw, R. E., & Shultis, K. (1981). Air-ground Interface Effect on  $\gamma$ -ray Submersion Dose. *Health Physics*, 41(5), 759-768.
- Saito, K., Petoussi, N., Zankl, M., Veit, R., Jacob, P., & Drexler, G. (1990). *Calculation of Organ Doses from Environmental Gamma Rays Using Human Phantoms and Monte Carlo Methods. Part I: Monoenergetic Sources and Natural Radionuclides in the Ground* (GSF-Bericht 2/90). Gesellschaft für Strahlen- und Umweltforschung, München, FRG.
- Seltzer S. M., & M. J. Berger (1986). Bremsstrahlung Energy Spectra from Electrons with Kinetic Energy  $1 \text{ keV} - 10 \text{ GeV}$  Incident on Screened Nuclide and Orbital Electrons of Neutral Atoms with  $Z = 1-100$ . *Atomic Data and Nuclear Data Tables*, 35(3), 345-418.
- Sjoreen, A. L., Kocher, D. C., Killough G. G., & Miller, C. W. (1984). *MLSOIL and DFSOIL -Computer Codes to Estimate Effective Ground Surface Contaminations for Dose Computations* (No. ORNL-5974) Oak Ridge National Laboratory, Oak Ridge, TN.
- Skrafle, K., French, C., Chabot, G., & Major, A. (1974). A General Equation for the Kinetics of Linear First Order Phenomena and Suggested Applications. *Health Physics*, 27(1), 155-157.
- United Nations Scientific Committee on the Effects of Atomic Radiation (2000). *Sources and Effects of Ionizing Radiation: UNSCEAR 2000 Report to the General Assembly, with Scientific Annexes*. United Nations Publications, New York, NY.
- United Nations Scientific Committee on the Effects of Atomic Radiation (2008). *Effects of Ionizing Radiation: UNSCEAR 2006 Report to the General Assembly with Scientific Annexes*. United Nations Publications, New York, NY.
- Williams, G., Zankl, M., Eckerl, H., & Drexler, G. (1985). *The Calculation of Dose from External Photon Exposures Using Reference Human Phantoms and Monte Carlo Methods. Part II: Organ Doses from Occupational Exposures* (GSF-Bericht S-1079). Gesellschaft für Strahlen- und Umweltforschung, München, FRG.
- Yu, C., Kamboj, S., Wang, C., & Cheng, J.-J. (2015). *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil and Building Structures* (No. ANL/EVS/TM-14/4). Argonne National Laboratory, Chicago, IL.

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