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ESTIMATES OF EXTERNAL DOSE-RATE CONVERSION FACTORS AND INTERNAL DOSE CONVERSION FACTORS FOR SELECTED RADIONUCLIDES RELEASED FROM FUSION FACILITIES

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Estimates of External Dose-rate Conversion Factors and Internal Dose Conversion Factors for Selected Radionuclides Released from Fusion Facilities

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This report provides a tabulation of both external dose-rate conversion factors and internal dose conversion factors using radioactive decay data in the updated Evaluated Nuclear Structure Data File (ENSDF) for selected 26 radionuclides and all their daughter radionuclides of potential importance in safety assessments of fusion facilities. The external dose-rate conversion factors for 21 target organs are tabulated for three exposure modes that are immersion in contaminated air, irradiation at a height of 1 m above a contaminated ground surface and immersion contaminated water. For internal exposure, committed dose equivalents, based on the methodology of ICRP Publication 30, in the same target organs per intake of unit activity are given for the inhalation and ingestion exposure pathways. The data presented here is intended to be generally used for safety assessments of fusion reactors.

Comparisons of external effective dose-rate conversion factors and committed effective dose equivalents are made with the previous data from the independent data bases to provide quality assurance on our calculated results. There is generally good agreement among data from the independent data bases. The differences in the values of both effective dose-rate and dose conversion factors appeared are primarily due to differences in calculational methodology, the use of different radioactive decay data, and compilation errors.

Keywords: Committed Dose Equivalents, Dose and Dose-rate Conversion Factors, External Exposure, Fusion Facilities, ICRP Publication 30, Internal Exposure

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核融合施設から放出が予想される放射性核種に対する外部被曝線量率換算係数と内部被曝線量換算係数の算定

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（1996年10月14日受理）

この報告書では、核融合施設の安全評価に重要と考えられる26の放射性核種とその娘核種に対して、最新の評価済み核構造データファイル（ＥＮＳＤＦ）の崩壊データを使用して計算した外部被曝線量率換算係数と内部被曝線量換算係数を表にまとめた。21の標的器官に対する外部被曝線量率換算係数は、汚染空気中、地表汚染上１ｍの高さ及び汚染水中の３つの被曝形態に対して与えた。内部被曝線量換算係数については、吸入と経口摂取の経路について単位摂取量あたりの上記標的器官に対する預託線量当量として与えてある。ここに提示したデータは、今後、核融合炉の安全評価に一般的に使用することができる。

計算された結果の品質を確認するため、実効線量率換算係数と預託実効線量当量に関して、これまでに計算された独立のデータベースの値と比較を行った。比較の結果、各データベース間で概ねよい一致を見たが、いくつかの放射性核種について実効線量率換算係数及び預託実効線量当量の値に相違が見いだされた。これらの相違の主たる原因は、算定方法の相違、使用した崩壊データの相違、及び単なるデータ編集上の誤り等に大別できた。

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1. Introduction

Prediction of resultant doses to individuals is essential to a radiological assessment of any release of radioactive material from nuclear facilities into the environment. The major exposure pathways following a release to either the atmosphere or the aquatic environment are considered to be external irradiation from contaminated air, contaminated ground surface and contaminated water, and internal irradiation from radioactive material taken by inhalation of contaminated air and by ingestion of contaminated foods.

In estimating external exposure, the concept of the external dose-rate conversion factor is often used where idealized conditions are assumed that the source region is regarded as effectively infinite or semi-infinite in extent and that the radionuclide concentration is uniformly distributed throughout the source region. On the other hand, the committed dose equivalents are useful in internal dose estimates per unit intake of radionuclide by inhalation and ingestion. In JAERI a computer code system DOSDAC (DOSimetric DAta Calculation) has been developed to systematically compute the dose-rate and dose conversion factors described above for use in the assessment of the radiological consequences to the public due to the releases of activity to the environment (Yamaguchi, 1982; Yamaguchi et al., 1988; Togawa, 1993).

The primary purpose of this report is to present a set of both external dose-rate and internal dose conversion factors to 21 target organs for selected 26 radionuclides of potential importance in safety assessments of fusion facilities, calculated with the DOSDAC system. Those critical fusion radionuclides in Rood and Abbott (1991) were identified for the International Thermonuclear Experimental Reactor (ITER) and the Burning Plasma Experiment (BPX). In order to verify the quality of our calculated results, comparisons are made both for effective dose-rate conversion factors and for committed effective dose equivalents from independent data bases developed by several organizations for radiological assessment purposes. The sources of data for this comparison study are the US comparison study by Rood and Abbott (1991), the Supplements to International Committee on Radiological Protection (ICRP) Publication 30 (ICRP, 1979b, 1981, 1982a and 1982b) and the work by Kocher (1982). The US comparison study by Rood and Abbott (1991) includes four data bases: the United Kingdom (UK), Soviet Union, U.S. Department Energy (DOE) (DOE, 1988a and 1988b), and Idaho National Engineering Laboratory Fusion Safety Program (INEL-FSP) (Fetter, 1988).

The next section of this report gives a very brief description of the DOSDAC system. The third section compares the DOSDAC results of the effective dose-rate conversion factors and committed effective dose equivalents with those from the other data bases.

2. Description of DOSDAC

DOSDAC considers both external and internal exposure pathways. It systematically calculates dose-rate conversion factors for external exposure to photons and electrons and dose conversion factors for internal exposure using a number of basic data such as radioactive decay data, atomic, anatomical and metabolic data. Calculations of the internal dose conversion factors are based upon the methodology described in International Committee on Radiological Protection (ICRP) Publication 30 (ICRP, 1979a). DOSDAC computes committed dose equivalents in various organs per intake of unit activity and the secondary and derived limits on occupational exposure for both inhalation and ingestion modes. For external exposure the method of Kocher (1980) at Oak Ridge National Laboratory (ORNL) is used to compute dose-rate conversion factors. The three exposure modes considered are immersion in contaminated air, immersion in contaminated water, and exposure to a contaminated ground surface. The calculations assume that the contaminated air, water, and ground surface are infinite in extent and that the radionuclide concentration is uniform.

Figure 1 shows the overall structure of the DOSDAC system. As shown in Figure 1, it consists of two main executive routines, DOSDAC and REVENS, twelve functional modules controlled by these two main routines, two other computational routines, OUTDF and VADMAP, and several input libraries. A list of functional description of each routine and module is given in Table 1. Users can implement DOSDAC as a stand-alone code by preparing all the data required for each functional module as a part of input data for the TDGEM module in Figure 1. Since default values are prepared for most of the required data in each module, users can also simply run DOSDAC by only preparing a few input data for TDGEN. The default values except for radioactive decay data and a part of metabolic data are mainly taken from ICRP Publication 30, Parts 1-4 (ICRP, 1979a, 1980, 1981b, 1988). The metabolic data for actinide elements are taken from the data given in ICRP Publication 48 (ICRP, 1986). The three main functional modules, ICRP-TIMED, ICRP-SEE and ICRP-DOSE, are introduced from the ICRP code package (Watson and Ford, 1980) originally developed at ORNL. The extended version of ICRP-TIMED, which is indicated as TIMED/J in Figure 1, is also available in DOSDAC to allow for recycling of iodine to the thyroid gland and/or for different assumptions of daughter products behaviour than the parent. The DOSEFACTER developed by Kocher (1980) is also introduced to compute the external dose equivalent rate per unit concentration of a radionuclide in the environment.

The radiation data required for the calculation of internal and external dose factors are obtained from basic radioactive decay information in the Evaluated Nuclear Structure Data File (ENSDF). In DOSDAC, the RADCAL module which is equivalent to the EDISTR code (Dillman, 1980) developed at ORNL is designed to use ENSDF as input and to produce

those radiation data including the mean energies and absolute intensities of all the radiations emitted in the radioactive decay process. The radioactive decay data used for this calculation are based upon the 1987 version of ENSDF (ENSDF, 1987). The values of photon specific absorbed fractions (SAFs) used in the calculation of SEE values are obtained from Snyder et. al. (1974) as default values. In order to prepare the specific SEE values for exposure population to be assessed, the VADMAP routine (Yamaguchi et. al., 1987) can be used to calculate the SAF values for another phantom of the human body than the standard phantom of ICRP Reference Man (ICRP, 1975).

As described above, DOSDAC has a modular structure which systematically provides the calculation of dose-rate and dose conversion factors from a number of basic data. Therefore, it can readily revise the values of dose-rate and dose conversion factors using updated basic data such as radioactive decay data and metabolic data.

3. Result and discussions

As described in the introduction section, the dose-rate and dose conversion factors are calculated for the 26 critical fusion radionuclides plus those 7 daughter radionuclides. The values of dose-rate conversion factors for immersion in contaminated air are given first in Table A.1, followed by the values for a height of 1 m above a contaminated ground surface and immersion in contaminated water in Tables A.2 and A.3, respectively. For a given exposure mode the dose-rate conversion factors for photons are given for each of 21 target organs. The effective dose-rate conversion factors are also obtained from the photon dose-rate conversion factors for separate body organs based on the definition of the effective dose equivalent given in ICRP Publication 26 (ICRP, 1977).

Appendix B gives tabulations of calculated dose conversion factors for inhalation and ingestion for the above radionuclides but C-14. At present, DOSDAC does not calculate the conversion factors for C-14. Table B.1 provides committed dose equivalents for each of 21 target organs and committed effective dose equivalents by inhalation. The inhalation tables correspond to particle activity median aerodynamic diameter (AMAD) of 1.0 μm, where the lung clearance class of each parent radionuclide is shown in the column labeled "LCC", and the GI tract absorption fraction "f1" is listed. Table 2 shows the lung clearance class and GI tract absorption fraction for each radionuclide used in this calculation. The values in Table B.1 are given for both the oxide chemical form and the form which makes the value highest. Committed dose equivalents for each of 21 target organs and committed effective dose equivalents by ingestion are given in Table B.2, where only the GI tract absorption fraction of each parent radionuclide is shown. The chemical form of each radionuclide, and corre-

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sponding lung clearance class and GI tract absorption fraction are based on the metabolic data in ICRP publication 30 and its supplements.

In the following sections comparisons are made of the effective dose-rate conversion factors for air immersion and ground surface exposure from DOSDAC, DOE, INEL-FSP, Soviet and Kocher's data bases. Since most of the data bases does not contain the dose-rate conversion factors for water immersion, comparisons are not made for this pathway. For internal exposure the values of committed effective dose equivalents are compared among DOSDAC, DOE, INEL-FSP, Soviet, UK and also ICRP data bases because many of the DOE, Soviet and UK values are taken directly from the ICRP Publication 30.

3.1 Air immersion

The effective dose-rate conversion factors for air immersion from DOSDAC, DOE, INEL-FSP, Soviet and Kocher's data bases are given in Table 3. In Figure 2 comparisons are made of the effective dose-rate conversion factors relative to Kocher's values. Logarithmic values of the ratio of the corresponding conversion factor to the Kocher's value are shown in Figure 2 for the selected 26 radionuclides except V-53 and Cu-66 because the values of both V-53 and Cu-66 are lacking from the Kocher's data base.

Table 3 and Figure 2 show that the Soviet values are consistently higher than those of all the other data bases. As indicated in Rood and Abbott (1991), this is mainly due to the combination of decay data used and differences in the methodology used to calculate the external dose-rate conversion factors. The Soviet methodology uses a constant value (1.09 Sv/Gy) for all energies to convert absorbed energy in air to equivalent dose in tissue. The other methodologies, however, use the energy-specific ratio G(k) of absorbed energy in tissue k to absorbed energy in air. This is because the Soviet values are systematically higher than the values of the other data bases. For the Nb-94m and Mo-93 cases, the Soviet values are much higher than that of all the other data bases. This big difference may be due to the radioactive decay data used in the Soviet data base.

The INEL-FSP methodology uses the estimates by Poston and Snyder (1974) of the absorbed dose-rates in the body organs to the absorbed dose-rate in air in a semi-infinite atmospheric cloud. The DOE and Kocher's revised methodology (Kocher, 1982), on the other hand, are based on an improved set of dose-rate factors developed by Eckerman et al. (1980). Eckerman et al. (1980) calculated the conversion factors by combining the results of Dillman (1974) on the energy spectra of scattered photons for an infinite cloud source and the organ dose data of O'Brien and Sanna (1976, 1980) from isotropic monoenergetic sources. Since the results of Eckerman et al. (1980) are less than those of Poston and Snyder (1974) for all organs except for thyroid, the INEL-FSP values in Table 3 are higher than those of DOE and

Kocher. In Figure 2, however, the INEL-FSP values for V-49 and Fe-55 are much lower than the values of Kocher. These differences may be attributed primarily to the radioactive decay data used in the different data bases. For C-14, there are big differences in the value among the data bases. As described in Rood and Abbott (1991), this is because INEL includes very low energy "internal bremsstrahlung (IB)" photons that accompany β^-, β^+, and electron-capture decay but DOSDAC, DOE and Kocher do not include IB. Therefore, DOSDAC and DOE values are zero. Kocher, however, includes the weighting factor for skin in the calculation of the effective dose-rate conversion factor. Another big difference in the value for W-185 is likely due to the fact that Kocher includes the weighting factor for skin in the calculation of the effective dose-rate conversion factor. In fact, the electron dose-rate of W-185 at body surface is five thousands times higher than the photon dose-rate (Kocher, 1979).

3.2 Ground surface exposure

The effective dose-rate conversion factors for ground surface exposure from DOSDAC, DOE, INEL-FSP, Soviet and Kocher's data bases are given in Table 4. Logarithmic values of the ratio of the corresponding conversion factor to the Kocher's value are also shown for the selected 26 radionuclides except V-53 and Cu-66 in Figure 3. In contrast to Figure 2, the Soviet values except Nb-94m and Mo-93 are systematically lower than those of all the other data bases as shown in Figure 3. As described by Rood and Abbott (1991), the Soviet methodology uses a constant conversion factor from energy deposited in air to that in tissue, like air immersion dose-rate conversion factors and also applies a 2π geometry correction factor. Since the other methodologies use the same ratios of absorbed energy in tissue to absorbed energy in air for ground surface exposure as those for air immersion exposure, these differences are mainly considered to be due to the geometry factor used in the Soviet methodology. The differences in the Soviet Mo-93 and Nb-94m values are attributed to the radioactive decay data used, like air immersion dose-rate factors.

Figure 3 shows another significant differences in the values of INEL-FSP for V-49 and Fe-55. These differences are considered to be attributed primarily to radioactive decay data used in the different data bases. Other minor differences in the Re-186 value are also considered to be attributed to radioactive decay data.

3.3 Inhalation exposure

The committed effective dose equivalents per unit intake by inhalation from the DOSDAC, DOE, INEL-FSP, Soviet, UK and ICRP data bases are given in Table 5 for the corresponding respiratory clearance class and GI tract absorption fraction depending on the

chemical form of each radionuclide considered appropriate. Figure 4 shows the logarithmic values of ratio of the corresponding conversion factor to the ICRP value for the oxide form of the selected 26 radionuclides except V-52, V-53, Cu-62, Cu-66, Nb-92m and Nb-94m because those values are lacking from the ICRP data base.

In Figure 4, there is generally good agreement among data bases. This is happened because, as noted by Rood and Abbott (1991), all of the DOE and Soviet values and many of the UK values are reportedly taken from the Supplements of ICRP Publication 30. In the UK data base, only the value is selected from the highest committed effective dose equivalent in the ICRP Supplements. Figure 4 shows that the UK values of Mn-56, Fe-55 and Mo-101 are slightly different from those of the ICRP data base. These differences are likely due to compilation errors. Those are probably not the values for the oxide form but the highest values for the corresponding respiratory clearance class and GI tract absorption fraction.

On the other hand, DOSDAC and INEL-FSP values in Figure 4 are slightly higher than the ICRP values. This is considered to be mainly due to differences in the methodology of internal dose calculations. The main purpose of the ICRP methodology is to calculate the Annual limit on Intake (ALI) values according to the principles recommended in ICRP Publication 26. There are, therefore, two rules to calculate (weighted) committed dose equivalents in the tables of the Supplements. The 10% rule is performed to eliminate target organs, whose weighted committed dose equivalent is not 10% of the maximum weighted dose equivalent. The 1% rule is also performed to eliminate source organs that contribute less than 1% to the committed dose equivalent in a target organ not eliminated by the 10% rule. These rules are not applied in both the DOSDAC and INEL-FSP methodologies. Then, there is generally good agreement between the DOSDAC and INEL-FSP data bases.

Using Table 5, comparisons are made of the committed effective dose equivalents for the radionuclides not appeared in the ICRP data base. The values for those radionuclides, V-52, V-53, Cu-62, Cu-66, Nb-92m and Nb-94m are reported from the DOSDAC, INEL-FSP, Soviet and UK data bases. In the Soviet data base, however, the V-49 values are also used in V-52 and V-53. The same compilation errors are also found in Cu-62, Cu-66, Nb-92m and Nb-94m of the Soviet data base. The Ni-66 values are used in Cu-62, the Cu-64 values are used in Cu-66, the Nb-90 values are used in Nb-92m and the Nb-94 values are also used in Nb-94m. Therefore, the values of these six radionuclides for the oxide form are compared in Figure 5 among the DOSDAC, INEL-FSP and UK data bases. The V-52 and V-53 are different by a factor of about ten and eight, respectively among the different data bases. The Nb-92m value is good agreement and the INEL-FSP values for Cu-62, Cu-64 and Nb-94m are somewhat higher than the DOSDAC and UK values . Those differences may be primarily attributed to the radioactive decay data.

3.4 Ingestion exposure

The committed effective dose equivalents per unit intake by ingestion from the DOSDAC, DOE, INEL-FSP, Soviet, UK and ICRP data bases are given in Table 6 for the corresponding GI tract absorption fraction depending on the chemical form of each radionuclide considered appropriate. Figure 5 shows the logarithmic values of ratio of the corresponding conversion factor to the ICRP value for the selected 26 radionuclides except V-52, V-53, Cu-62, Cu-66, Nb-92m and Nb-94m whose values are lacking from the ICRP data base.

As shown in Figure 6, there is generally good agreement among data bases except a few radionuclides. This is due to the fact that, as is the case of inhalation exposure, all of the DOE and Soviet values and many of the UK values are taken directly from the Supplements of ICRP Publication 30. The UK values of Co-57/58/60 (f1=0.05), Mo-93 (f1=0.05) and W-181/185/187 (f1=0.3) are different from those of the ICRP data base. These differences are likely due to compilation errors. Those UK values assume worst-case f1 values but are listed with wrong f1 values. The Soviet values of Mo-99 are slightly different from those of the ICRP data base. Those values listed in Table 6 are probably assigned with wrong f1 values each other due to also compilation errors.

As is the case of inhalation exposure, most of the DOSDAC and INEL-FSP values in Figure 6 are slightly higher than the ICRP values. This is considered to be mainly due to differences in the methodology of internal dose calculations. The 10% rule for exclusion of target organs and the 1% rule for exclusion of source organs used in the ICRP methodology are not applied in both the DOSDAC and INEL-FSP methodologies. The INEL-FSP values for W-181 and Re-186, however, show lower values than those from the other data bases. These differences may be attributed to radioactive decay data used in the different data bases. Figure 6 also shows the much smaller INEL-FSP value of C-14. As indicated in Rood and Abbott (1991), INEL-FSP uses the CO_2 inhalation retention function for the ingestion calculation while ICRP recommends that dietary carbon will be in the organic form with a biological half-life of approximately 40 days.

In Figure 7 comparisons are made of the committed effective dose equivalents for the radionuclides not appeared in the ICRP data base. The values for those radionuclides, V-52, V-53, Cu-62, Cu-66, Nb-92m and Nb-94m are reported from the DOSDAC, INEL-FSP and UK data bases. The difference in the values among the different data bases are within a factor of about five. The Nb-92m value is good agreement, as is the case of inhalation pathway. Those differences may be primarily attributed to the radioactive decay data, but further work to check these data with other sources is necessary.

4. Summary

As described above, the main purpose of this report is to provide a tabulation of both external and internal dose conversion factors using the DOSDAC code system and updated ENSDF for the selected radionuclides of potential importance in safety assessments of fusion facilities. The external dose-rate conversion factors for three exposure modes are tabulated for each of 21 target organs. For internal exposure, committed dose equivalents in the same target organs per intake of unit activity are given for the inhalation and ingestion exposure pathways. The data presented here is intended to be generally used for safety assessments of fusion reactors.

Comparisons of effective dose-rate conversion factors and committed effective dose equivalents are made with the previous data from the independent data bases. Even from the limited materials comparison study finds some inconsistent values for some radionuclides. Probable reasons for differences in those values are differences in calculational methodology, use of different radioactive decay data, and some compilation errors. In particular, further work is necessary on the comparison of radioactive decay data used between data bases.

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Table 1. Description of DOSDAC program modules

Module	Description
Executive module	
DOSDAC	Main program module of the DOSDAC system
Function module	
TDGEN	generates input data for each module under the DOSDAC system
FETCH44	finds data associated with a given radionuclide in terms of its name from radioactive decay data in ENSDF
SEARCH	searches data in terms of its half life from radioactive decay data selected by FETCH44
RADCAL	calculates radiation data including the mean energies and absolute intensities of all the radiations emitted in the radioactive decay process
MERGE	prepares data calculated with RADCAL for both ICRP-SEE and DOSFACTER/J
TIMED/J	calculates the cumulative activity at a specified time after intake (extended version of ICRP-TIMED)
ICRP-TIMED	calculates the cumulative activity at a specified time after intake
ICRP-SEE	calculates the specific effective energy absorbed in the target organ
ICRP-DOSE	combines the output of the SEE and TIMED program modules to compute dose equivalent and the secondary and derived limits for the control of internal dose
DOSEFACTER/J	computes the external dose equivalent rate per unit concentration of a radionuclide in the environment
Executive module	
REVENS	revises decay data in ENSDF
Function module	
SAVE44	saves revised or modifed radioactive decay data of ENSDF in the form of the DOSDAC data file
GENCHA	finds data for producing decay chain in ENSDF and writes them in the data file
Calculation module	
OUTDF	generates a data file of dose-rate and dose conversion factors for environmental radiological assessments
VADMAP	calculates the specific absorbed fraction of photon for human phantom of arbitary geometry

Table 2. Lung clearance class and GI tract absorption fraction
for the radionuclides considered in the calculation of inhalation dose factors

Nuclide	Clearance class		f1	Nuclide	Clearance class		f1
	Oxide	Max.			Oxide	Max.	
V-49	W	W	0.01	Nb-94m	Y	Y	0.01
V-52	W	D	0.01	Nb-94	Y	Y	0.01
V-53	W	D	0.01	Mo-93	Y	Y	0.05
Cr-51	Y	Y	0.1	Mo-99	Y	Y	0.05
Mn-54	W	W	0.1	Mo-101	Y	Y	0.05
Mn-56	W	D	0.1	Tc-99m	W	D	0.8
Fe-55	W	D	0.1	Tc-99	W	W	0.8
Co-57	Y	Y	0.05	Tc-101	W	D	0.8
Co-58	Y	Y	0.05	Ta-182	Y	Y	0.01
Co-60	Y	Y	0.05	W-181	D	D	0.3
Ni-57	W	W	0.05	W-185	D	D	0.3
Cu-62	Y	D	0.5	W-187	D	D	0.3
Cu-64	Y	Y	0.5	Re-186	W	W	0.8
Cu-66	Y	D	0.5	Re-187	W	W	0.8
Nb-92m	Y	Y	0.01	Os-186	Y	Y	0.01
Nb-93m	Y	Y	0.01	Po-210	W	D	0.1

Max.: this clearance class is selected from the highest committed effective dose equivalent

Table 3. Comparison of effective dose-rate conversion factors for immersion in contaminated air from DOSDAC, DOE, INEL-FSP, Soviet and Kocher's data bases for critical fusion radionuclides (pSv/sec per Bq/m^3)

NUCLIDE	HALF-LIFE	DOSDAC	DOE	INEL-FSP	Soviet	Kocher
C-14	5.730E3 Y	0.00E+00	0.00E+00	1.04E-07	-	1.86E-06
V-49	338. D	3.96E-07	4.04E-07	8.14E-08	-	4.53E-07
V-52	3.75 M	6.31E-02	6.39E-02	7.22E-02	9.76E-02	6.59E-02
V-53	1.61 M	4.66E-02	-	4.78E-02	7.05E-02	-
Cr-51	27.704 D	1.37E-03	1.35E-03	1.69E-03	2.20E-03	1.37E-03
Mn-54	312.12 D	3.68E-02	3.73E-02	3.84E-02	5.65E-02	3.80E-02
Mn-56	2.5785 H	7.86E-02	7.94E-02	7.81E-02	1.14E-01	8.14E-02
Fe-55	2.73 Y	9.70E-07	9.86E-07	1.91E-07	-	1.10E-06
Co-57	271.79 D	5.13E-03	5.41E-03	6.27E-03	8.47E-03	5.51E-03
Co-58	70.916 D	4.28E-02	4.32E-02	4.54E-02	8.20E-02	4.37E-02
Co-60	5.2714 Y	1.10E-01	1.11E-01	1.18E-01	1.69E-01	1.12E-01
Ni-57	35.60 H	8.59E-02	8.57E-02	9.03E-02	1.32E-01	8.75E-02
Cu-62	9.74 M	4.25E-02	4.32E-02	5.00E-02	6.82E-02	4.47E-02
Cu-64	12.700 H	8.05E-03	8.12E-03	1.02E-02	1.33E-02	8.27E-03
Cu-66	5.088 M	3.52E-03	-	4.41E-03	6.37E-03	-
Nb-92m	10.15 D	4.28E-02	4.31E-02	4.38E-02	6.54E-02	4.40E-02
Nb-94m	6.26 M	2.15E-04	2.07E-04	2.08E-04	5.88E-04	2.13E-04
Mo-93	3.500E3 Y	3.20E-05	3.24E-05	2.39E-05	5.47E-04	3.45E-05
Mo-99	65.94 H	6.46E-03	6.83E-03	7.62E-03	1.87E-02	7.16E-03
Mo-101	14.61 M	6.62E-02	6.78E-02	7.73E-02	1.35E-01	6.94E-02
Ta-182	114.43 D	5.67E-02	5.70E-02	6.14E-02	8.72E-02	5.80E-02
W-181	121.2 D	1.26E-03	1.39E-03	1.60E-03	2.59E-03	1.43E-03
W-185	75.1 D	1.86E-06	1.18E-06	1.37E-06	-	4.37E-05
W-187	23.72 H	1.83E-02	2.07E-02	2.28E-02	2.92E-02	2.11E-02
Re-186	90.64 H	7.22E-04	8.66E-04	1.14E-03	1.35E-03	1.07E-03
Po-210	138.376 D	4.28E-07	3.79E-07	3.95E-07	6.51E-07	3.83E-07

Table 4. Comparison of effective dose-rate conversion factors for a height of 1 m above contaminated ground surface from DOSDAC, DOE, INEL-FSP, Soviet and Kocher's data bases for critical fusion radionuclides (pSv/sec per Bq/m^2)

NUCLIDE	HALF-LIFE	DOSDAC	DOE	INEL-FSP	Soviet	Kocher
C-14	5.730E3 Y	0.00E+00	0.00E+00	4.86E-09	-	0.00E+00
V-49	338. D	8.14E-08	6.46E-08	9.70E-11	-	7.26E-08
V-52	3.75 M	1.19E-03	1.08E-03	1.22E-03	6.48E-04	1.22E-03
V-53	1.61 M	9.51E-04	-	8.76E-04	5.03E-04	-
Cr-51	27.704 D	3.26E-05	2.91E-05	3.62E-05	1.59E-05	2.96E-05
Mn-54	312.12 D	7.80E-04	7.18E-04	7.41E-04	4.16E-04	7.32E-04
Mn-56	2.5785 H	1.49E-03	1.37E-03	1.34E-03	7.64E-04	1.47E-03
Fe-55	2.73 Y	2.46E-07	1.89E-07	8.16E-09	-	2.12E-07
Co-57	271.79 D	1.27E-04	1.22E-04	1.40E-04	9.04E-05	1.24E-04
Co-58	70.916 D	9.19E-04	8.42E-04	8.89E-04	6.06E-04	8.56E-04
CO-60	5.2714 Y	2.15E-03	1.94E-03	2.08E-03	1.16E-03	1.97E-03
Ni-57	35.60 H	1.68E-03	1.51E-03	1.60E-03	9.85E-04	1.54E-03
Cu-62	9.74 M	9.70E-04	8.91E-04	1.03E-03	5.24E-04	1.04E-03
Cu-64	12.700 H	1.83E-04	1.66E-04	2.08E-04	1.02E-04	1.70E-04
Cu-66	5.088 M	7.13E-05	-	8.05E-05	4.54E-05	-
Nb-92m	10.15 D	8.90E-04	8.12E-04	8.24E-04	6.63E-04	8.27E-04
Nb-94m	6.26 M	7.38E-06	6.88E-06	6.86E-06	1.11E-04	7.35E-06
Mo-93	3.500E3 Y	5.01E-06	4.95E-06	3.84E-06	1.29E-04	5.26E-06
Mo-99	65.94 H	1.42E-04	1.36E-04	1.53E-04	1.51E-04	1.74E-04
Mo-101	14.61 M	1.31E-03	1.22E-03	1.38E-03	9.53E-04	1.28E-03
Ta-182	114.43 D	1.16E-03	1.05E-03	1.11E-03	6.04E-04	1.07E-03
W-181	121.2 D	3.99E-05	3.94E-05	4.62E-05	1.94E-05	4.06E-05
W-185	75.1 D	5.07E-08	2.65E-08	3.11E-08	-	3.71E-08
W-187	23.72 H	4.15E-04	4.23E-04	4.68E-04	2.20E-04	4.44E-04
Re-186	90.64 H	1.83E-05	2.04E-05	2.84E-05	8.86E-06	4.56E-05
Po-210	138.376 D	9.16E-09	7.34E-09	7.65E-09	4.82E-09	7.48E-09

Table 5. Comparison of committed effective dose equivalents per unit intake by inhalation from DOSDAC, DOE, INEL-FSP, Soviet, UK and ICRP data bases for critical fusion radionuclides (pSv/Bq)

NUCLIDE	HALF-LIFE	f1	LCC	DOSDAC	DOE	INEL-FSP	Soviet	UK	ICRP
C-14(ORG)	5.730E3 Y		N*	-	5.68E+02		5.60E+02	5.60E+02	5.60E+02
(CO2)			N*	-	6.49E+00	7.92E+00	-	-	6.30E+00
V-49	338. D	0.01	D	-	4.05E+01	-	4.00E+01	-	4.10E+01
		0.01	W	9.27E+01	7.57E+01	9.19E+01	7.60E+01	7.60E+01	7.60E+01
V-52	3.75 M	0.01	D	2.59E+00	-	-	4.00E+01	-	-
		0.01	W	2.39E+00	-	4.43E+00	7.60E+01	2.30E+01	-
V-53	1.61 M	0.01	D	9.70E-01	-	-	4.00E+01	-	-
		0.01	W	9.58E-01	-	1.91E+00	7.60E+01	7.80E+00	-
Cr-51	27.704 D	0.1	D	-	2.97E+01	-	2.90E+01	-	2.90E+01
		0.1	W	-	5.68E+01	-	5.80E+01	-	5.70E+01
		0.1	Y	8.90E+01	7.03E+01	9.11E+01	7.10E+01	7.30E+01	7.10E+01
Mn-54	312.12 D	0.1	D	-	1.46E+03	-	1.46E+03	-	1.50E+03
		0.1	W	1.82E+03	1.73E+03	1.85E+03	1.72E+03	1.70E+03	1.70E+03
Mn-56	2.5785 H	0.1	D	1.03E+02	8.92E+01	-	8.80E+01	-	8.80E+01
		0.1	W	8.97E+01	6.49E+01	1.43E+02	6.50E+01	8.80E+01	6.40E+01
Fe-55	2.73 Y	0.1	D	7.25E+02	7.03E+02	-	6.96E+02	-	6.90E+02
		0.1	W	3.60E+02	3.24E+02	3.49E+02	3.33E+02	7.10E+02	3.30E+02
Co-57	271.79 D	0.05	W	-	4.86E+02	-	4.92E+02	-	4.90E+02
		0.05	Y	2.45E+03	2.03E+03	2.41E+03	2.04E+03	2.00E+03	2.00E+03
Co-58	70.916 D	0.05	W	-	1.24E+03	-	1.23E+03	-	1.20E+03
		0.05	Y	2.95E+03	1.92E+03	2.97E+03	1.92E+03	1.90E+03	1.90E+03
Co-60	5.2714 Y	0.05	W	-	8.11E+03	-	7.98E+03	-	7.90E+03
		0.05	Y	5.91E+04	4.05E+04	5.81E+04	4.10E+04	4.10E+04	4.10E+04
Ni-57	35.60 H	0.05	D	-	2.70E+02	-	2.82E+02	-	2.80E+02
		0.05	W	5.27E+02	4.59E+02	5.46E+02	4.48E+02	4.50E+02	4.50E+02
Cu-62	9.74 M	0.5	D	8.20E+00	-	-	8.39E+02	-	-
		0.5	W	-	-	-	2.16E+03	-	-
		0.5	Y	7.39E+00	-	1.49E+01	8.50E+00	7.60E+00	-
Cu-64	12.700 H	0.5	D	-	4.32E+01	-	4.40E+01	-	4.40E+01
		0.5	W	-	5.95E+01	-	5.80E+01	-	5.70E+01
		0.5	Y	7.57E+01	6.22E+01	1.04E+02	6.20E+01	6.30E+01	6.20E+01
Cu-66	5.088 M	0.5	D	3.26E+00	-	-	4.40E+01	-	-
		0.5	W	-	-	-	5.80E+01	-	-
		0.5	Y	3.05E+00	-	5.76E+00	6.20E+01	2.00E+00	-

Table 5. (continued)

NUCLIDE	HALF-LIFE	f1	LCC	DOSDAC	DOE	INEL-FSP	USSR	UK	ICRP
Nb-92m	10.15 D	0.01	W	-	-	-	5.09E+02	-	-
		0.01	Y	5.83E+02	-	5.92E+02	5.72E+02	5.50E+02	
Nb-94m	6.26 M	0.01	W	-	-	-	7.00E+03	-	-
		0.01	Y	1.37E-01	-	3.38E-01	9.00E+04	1.30E-01	-
Mo-93	3.500E3 Y	0.8	D	-	2.49E+02	-	2.50E+02	-	2.50E+02
		0.05	Y	7.71E+03	7.57E+03	9.43E+03	7.56E+03	7.50E+03	7.60E+03
Mo-99	65.94 H	0.8	D	-	5.41E+02	-	5.27E+02	-	5.20E+02
		0.05	Y	1.12E+03	9.73E+02	1.13E+03	9.84E+02	9.90E+02	9.90E+02
Mo-101	14.61 M	0.8	D	9.58E+00	9.73E+00	-	9.70E+00	-	9.70E+00
		0.05	Y	8.32E+00	8.92E+00	1.67E+01	9.00E+00	9.70E+00	9.00E+00
Ta-182	114.43 D	0.001	W	-	4.32E+03	-	4.28E+03	-	4.20E+03
		0.001	Y	1.19E+04	1.00E+04	1.16E+04	9.96E+03	9.90E+03	9.90E+03
W-181	121.2 D	0.3	D	4.08E+01	4.05E+01	3.08E+01	4.10E+01	4.10E+01	4.10E+01
W-185	75.1 D	0.3	D	2.06E+02	2.03E+02	2.27E+02	2.02E+02	2.10E+02	2.00E+02
W-187	23.72 H	0.3	D	1.79E+02	1.43E+02	1.69E+02	1.42E+02	1.70E+02	1.40E+02
Re-186	90.64 H	0.8	D	-	4.59E+02	-	4.64E+02	-	4.70E+02
		0.8	W	8.70E+02	8.11E+02	8.43E+02	7.98E+02	8.10E+02	8.10E+02
Po-210	138.376 D	0.1	D	2.57E+06	2.16E+06	-	2.20E+06	-	2.20E+06
		0.1	W	2.33E+06	2.19E+06	2.36E+06	2.20E+06	2.20E+06	2.10E+06

* not available

Table 6. Comparison of committed effective dose equivalents per unit intake by ingestion from DOSDAC, DOE, INEL-FSP, Soviet, UK and ICRP data bases for critical fusion radionuclides (pSv/Bq)

NUCLIDE	HALF-LIFE	f1	DOSDAC	DOE	INEL-FSP	Soviet	UK	ICRP
C-14	5.730E3 Y	ORG*	-	5.68E+02	8.14E+00	5.60E+02	5.60E+02	5.60E+02
V-49	338. D	0.01	1.64E+01	1.46E+01	1.41E+01	1.40E+01	1.50E+01	1.50E+01
V-52	3.75 M	0.01	7.78E+00	-	1.13E+01	-	1.00E+01	-
V-53	1.61 M	0.01	3.10E+00	-	4.95E+00	-	3.60E+00	-
Cr-51	27.704 D	0.01	3.94E+01	3.51E+01	-	3.60E+01	-	3.50E+01
		0.1	3.75E+01	3.51E+01	3.65E+01	3.60E+01	3.90E+01	3.60E+01
Mn-54	312.12 D	0.1	7.48E+02	7.30E+02	7.41E+02	7.31E+02	7.20E+02	7.30E+02
Mn-56	2.5785 H	0.1	2.64E+02	2.57E+02	2.69E+02	2.58E+02	2.50E+02	2.50E+02
Fe-55	2.73 Y	0.1	1.62E+02	1.57E+02	1.48E+02	1.57E+02	1.60E+02	1.60E+02
Co-57	271.79 D	0.05	2.00E+02	1.78E+02	1.78E+02	1.79E+02	3.10E+02	1.80E+02
		0.3	3.20E+02	2.97E+02	-	3.11E+02	-	3.10E+02
Co-58	70.916 D	0.05	8.09E+02	7.57E+02	7.84E+02	7.58E+02	9.40E+02	7.70E+02
		0.3	9.70E+02	9.46E+02	-	9.53E+02	-	9.40E+02
Co-60	5.2714 Y	0.05	2.77E+03	2.70E+03	2.73E+03	2.71E+03	7.00E+03	2.70E+03
		0.3	7.28E+03	7.03E+03	-	7.04E+03	-	7.00E+03
Ni-57	35.60 H	0.05	1.05E+03	8.92E+02	9.49E+02	8.98E+02	9.00E+02	9.00E+02
Cu-62	9.74 M	0.5	2.20E+01	-	3.41E+01	-	1.20E+01	-
Cu-64	12.700 H	0.5	1.27E+02	1.16E+02	1.28E+02	1.16E+02	1.20E+02	1.20E+02
Cu-66	5.088 M	0.5	8.85E+00	-	1.38E+01	-	3.10E+00	-
Nb-92m	10.15 D	0.01	6.03E+02	-	5.81E+02	-	5.60E+02	-
Nb-94m	6.26 M	0.01	3.86E-01	-	7.30E-01	-	2.50E-01	-
Mo-93	3.500E3 Y	0.05	6.65E+01	5.95E+01	7.97E+01	5.80E+01	3.00E+02	5.80E+01
		0.8	3.73E+02	3.51E+02	-	3.42E+02	-	3.50E+02
Mo-99	65.94 H	0.05	1.39E+03	1.19E+03	1.23E+03	8.14E+02	1.20E+03	1.20E+03
		0.8	8.48E+02	7.84E+02	-	1.18E+03	-	8.20E+02
Mo-101	14.61 M	0.05	2.56E+01	2.49E+01	3.49E+01	-	2.50E+01	2.50E+01
		0.8	2.41E+01	2.32E+01	-	-	-	2.30E+01
Ta-182	114.43 D	0.001	1.74E+03	1.62E+03	1.60E+03	1.61E+03	1.60E+03	1.60E+03
W-181	121.2 D	0.01	9.06E+01	8.38E+01	-	8.40E+01	-	8.40E+01
		0.3	-	7.30E+01	5.49E+01	7.40E+01	8.30E+01	7.40E+01
W-185	75.1 D	0.01	5.38E+02	5.14E+02	-	5.04E+02	-	5.10E+02
		0.3	-	3.51E+02	4.43E+02	3.60E+02	5.10E+02	3.60E+02
W-187	23.72 H	0.01	7.78E+02	7.03E+02	-	7.01E+02	-	7.00E+02
		0.3	-	5.14E+02	5.19E+02	5.12E+02	7.40E+02	5.10E+02
Re-186	90.64 H	0.8	7.93E+02	7.03E+02	5.92E+02	7.08E+02	7.10E+02	7.00E+02
Po-210	138.376 D	0.1	5.14E+05	4.32E+05	5.08E+05	4.40E+05	4.30E+05	4.40E+05

* Organic compounds

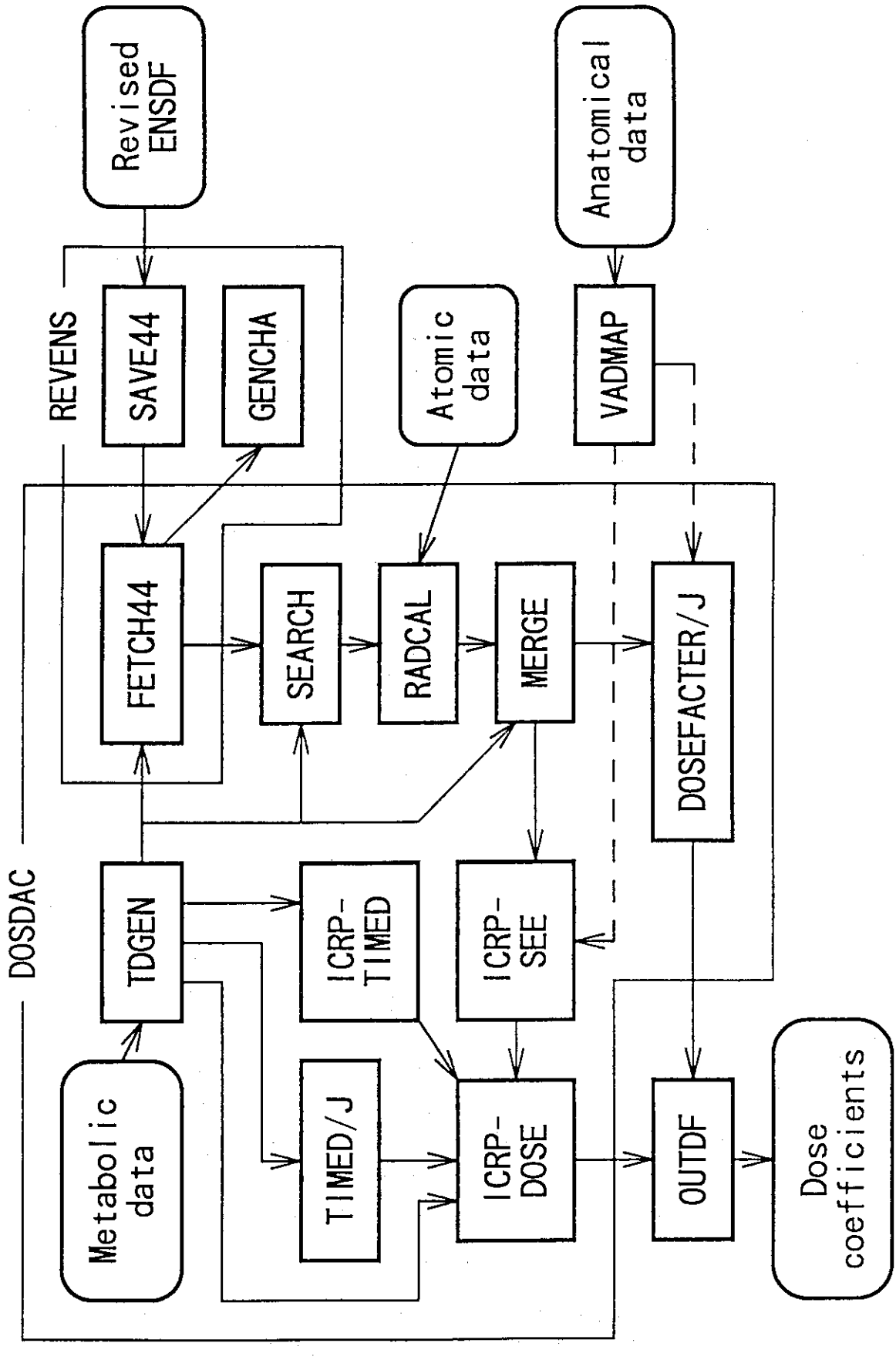

Figure 1. Schematic representation of the DOSDAC computer code system

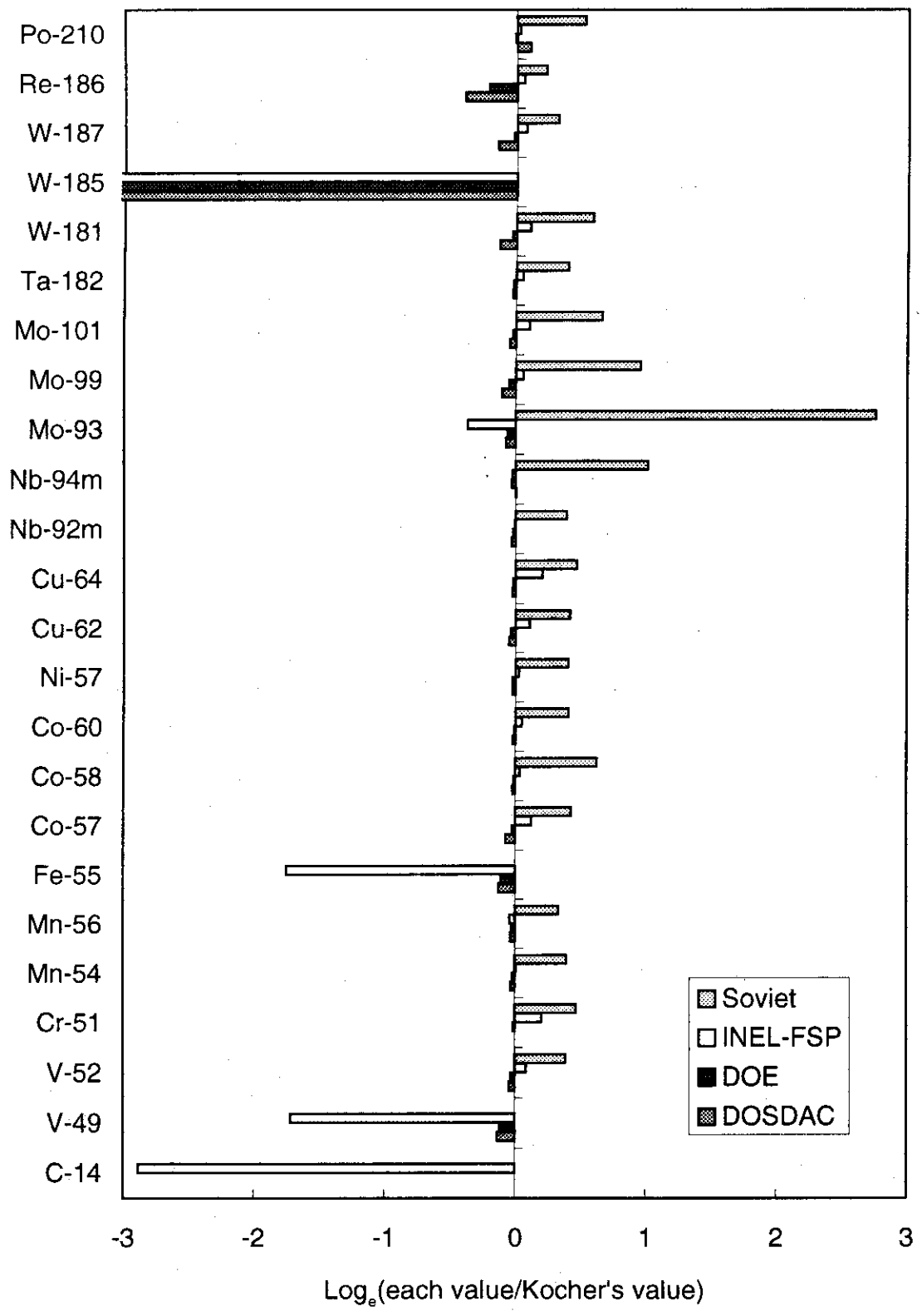

Figure 2. Comparison of effective dose-rate conversion factors for air immersion from independent data bases

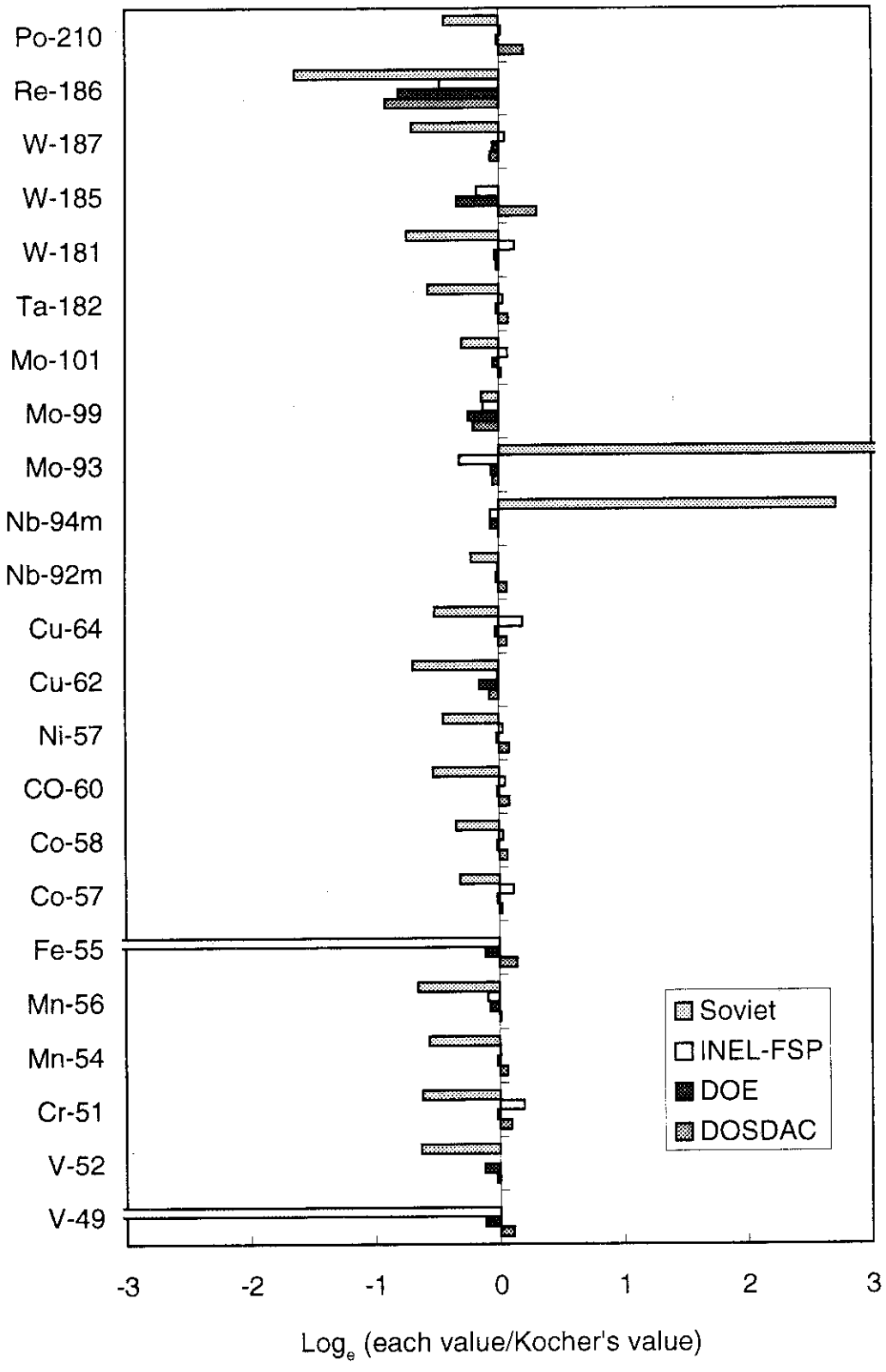

Figure 3. Comparison of effective dose-rate conversion factors for ground surface from independent data bases

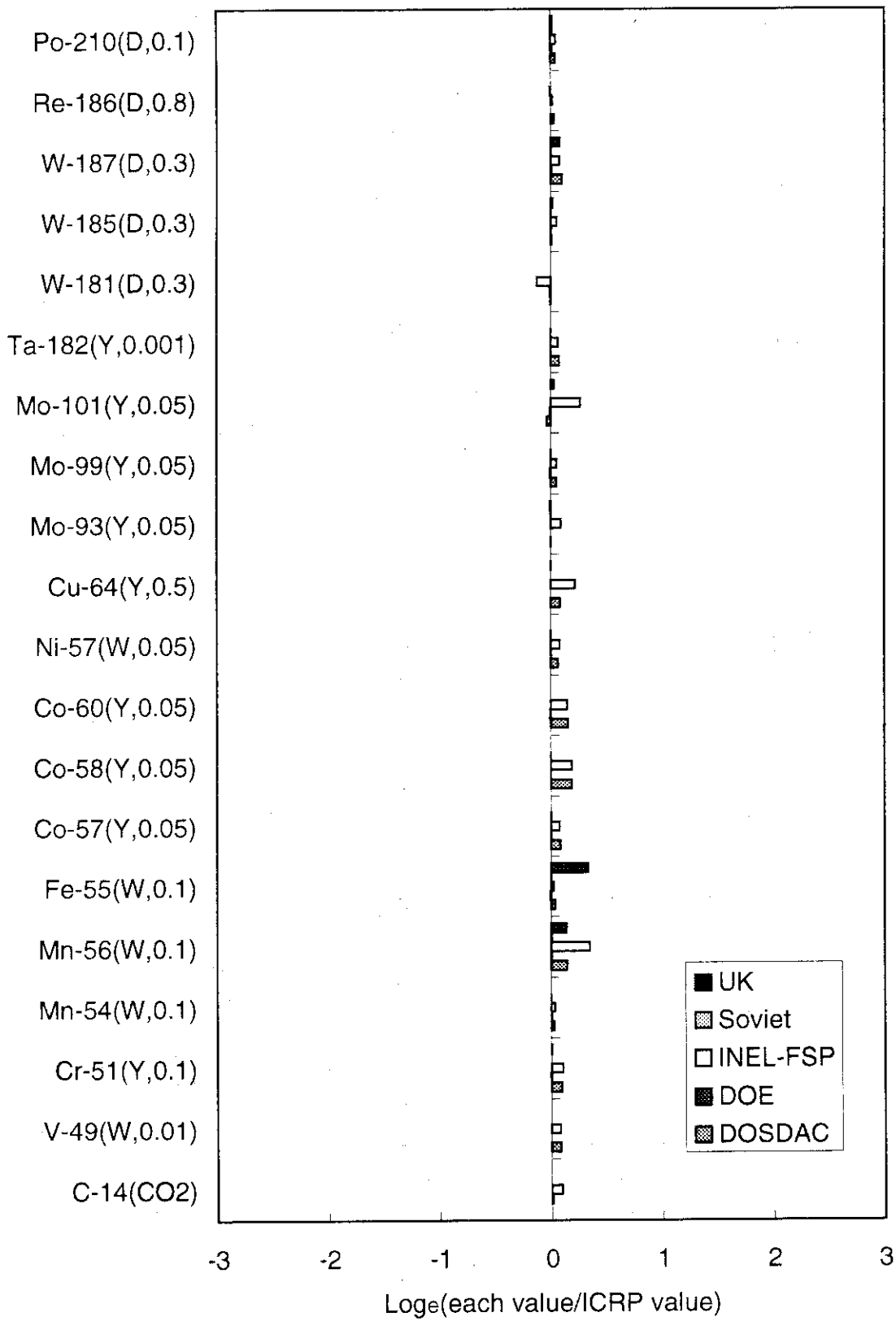

Figure 4. Comparison of committed effective dose equivalents per unit intake by inhalation from independent data bases

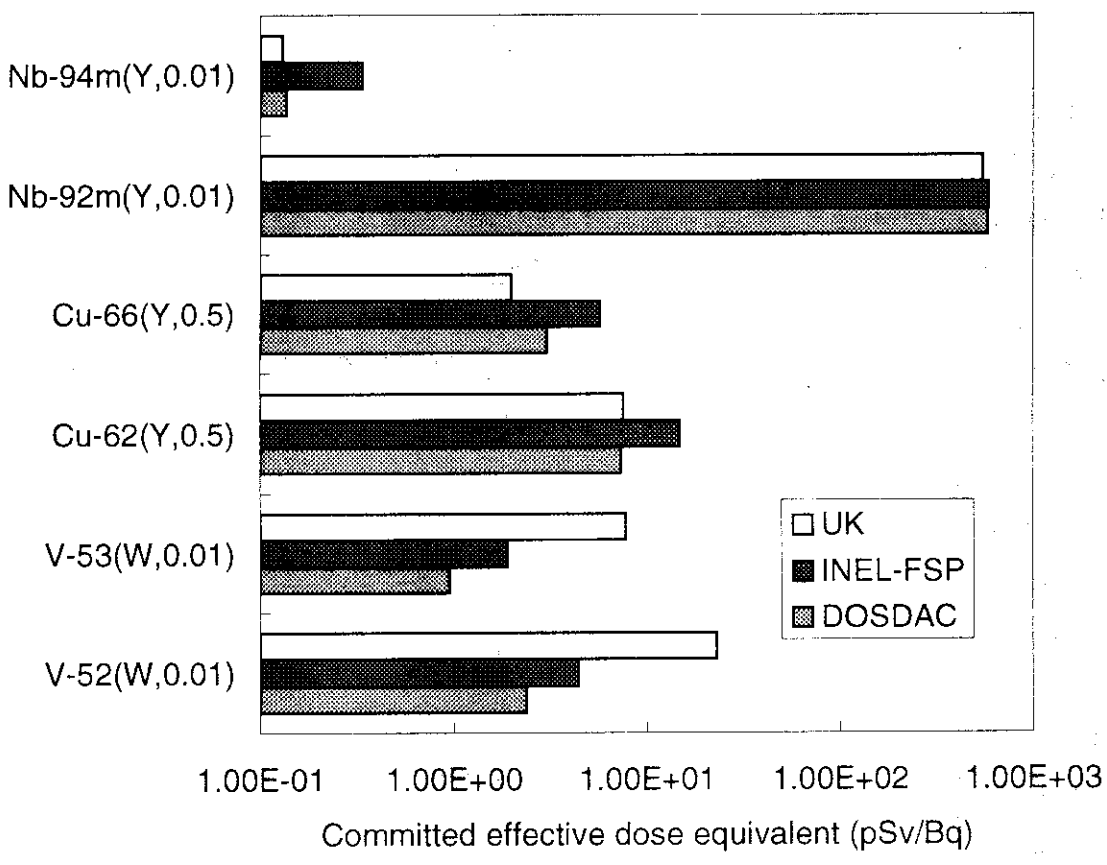

Figure 5. Comparison of DOSDAC, INEL-FSP and UK inhalation values for radionuclides not included in the ICRP data bases

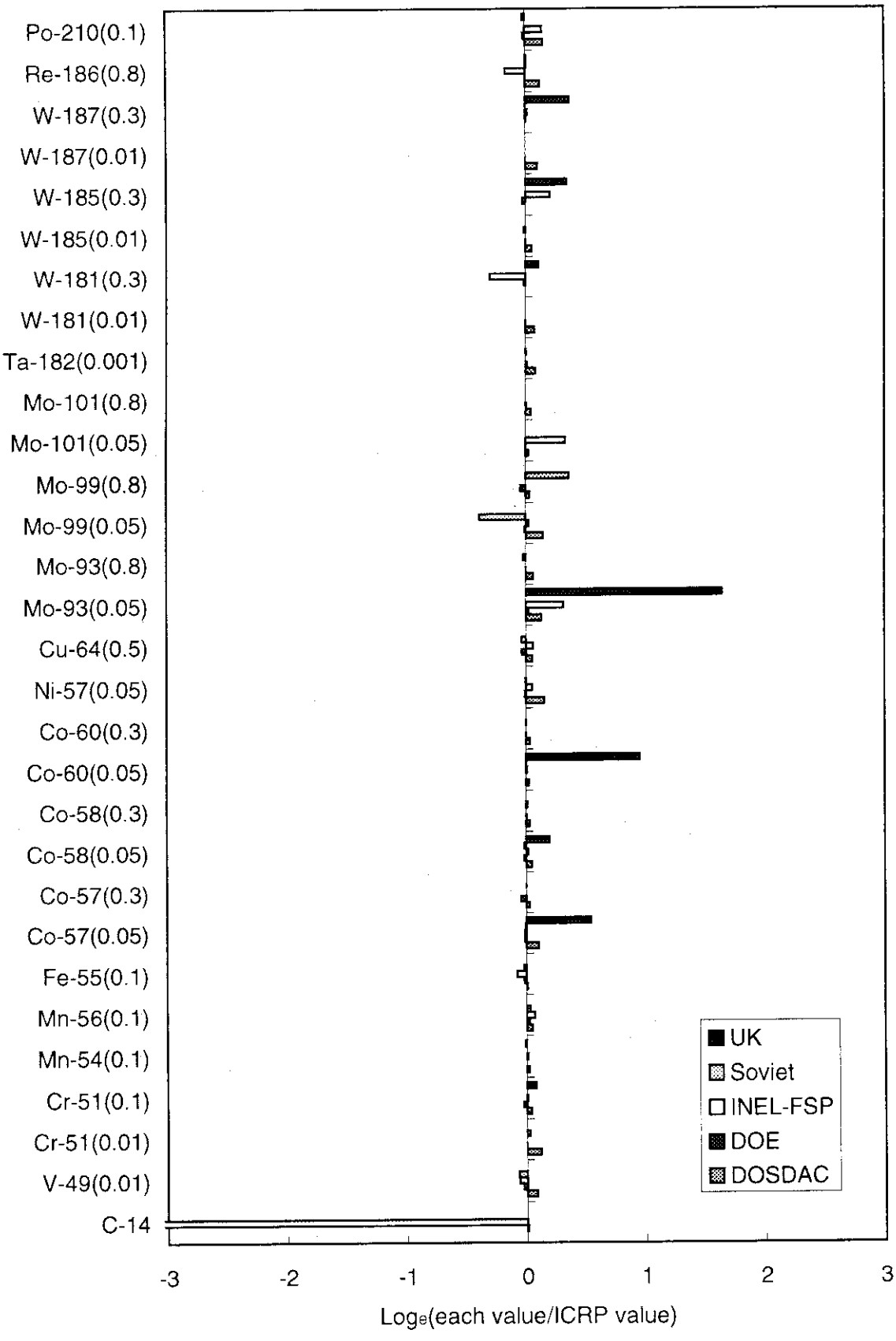

Figure 6. Comparison of committed effective dose equivalents per unit intake by ingestion from independent data bases

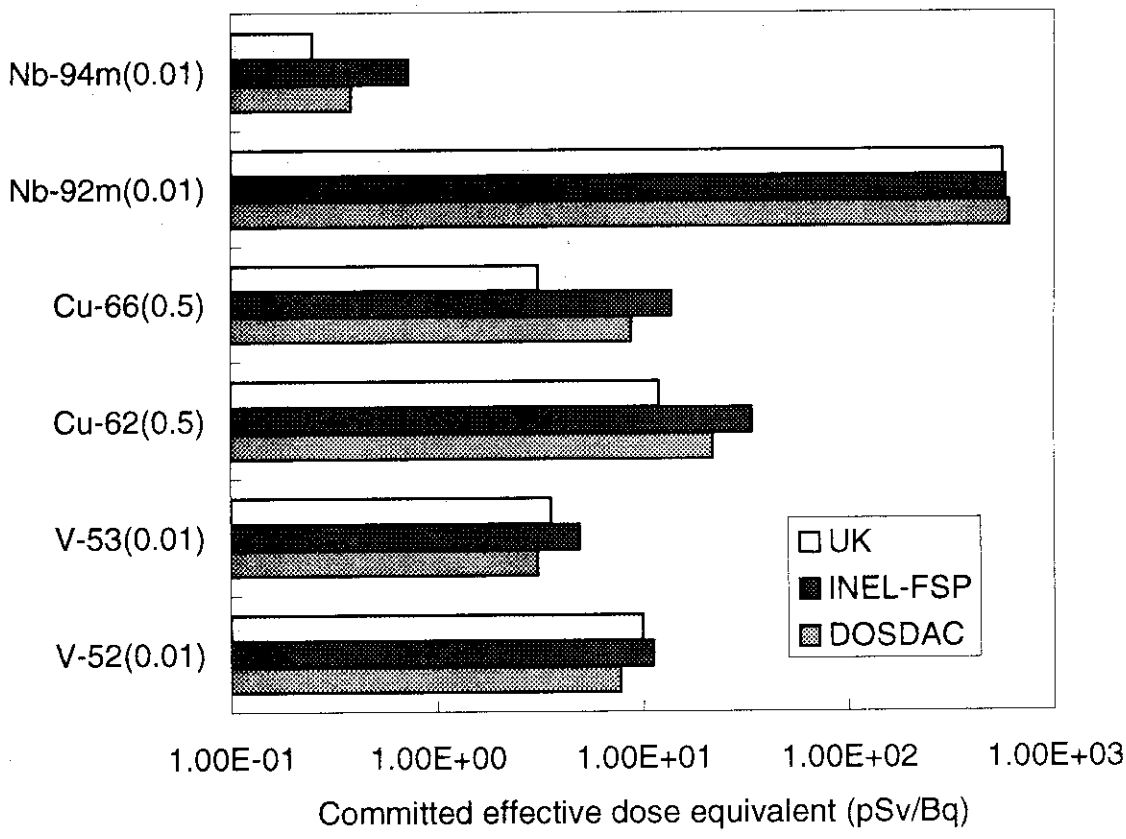

Figure 7. Comparison of DOSDAC, INEL-FSP and UK ingestion values for radionuclides not included in the ICRP data bases

APPENDIX A

Tables of dose-rate conversion factors for external exposure

Table A.1

Dose rate conversion factors for various organs for immersion in contaminated air (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
C-14	5.730E3 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-49	338. D	1.64E-13	1.85E-07	1.53E-09	2.26E-09	3.76E-07	1.10E-09	8.92E-09	7.24E-43	7.16E-05	3.57E-07	5.35E-07
V-52	3.75 M	1.72E+00	1.68E+00	1.58E+00	1.81E+00	1.68E+00	1.81E+00	1.72E+00	1.81E+00	2.14E+00	1.62E+00	1.50E+00
V-53	1.61 M	1.25E+00	1.22E+00	1.12E+00	1.31E+00	1.20E+00	1.31E+00	1.24E+00	1.31E+00	1.55E+00	1.19E+00	1.07E+00
Cr-51	27.704 D	3.49E-02	3.41E-02	3.03E-02	3.59E-02	3.35E-02	3.59E-02	3.46E-02	3.73E-02	5.05E-02	3.19E-02	2.97E-02
Mn-54	312.12 D	9.76E-01	9.59E-01	8.73E-01	1.02E+00	9.41E-01	1.02E+00	9.70E-01	1.03E+00	1.24E+00	9.32E-01	8.38E-01
Mn-56	2.5785 H	2.11E+00	2.07E+00	1.92E+00	2.22E+00	2.05E+00	2.23E+00	2.10E+00	2.22E+00	2.64E+00	1.97E+00	1.83E+00
Fe-55	2.73 Y	4.00E-13	4.51E-07	3.73E-09	5.51E-09	9.14E-07	2.68E-09	2.18E-08	1.77E-42	1.75E-04	8.70E-07	1.30E-06
Co-57	271.79 D	1.22E-01	1.20E-01	1.03E-01	1.27E-01	1.15E-01	1.25E-01	1.22E-01	1.35E-01	2.19E-01	1.05E-01	9.78E-02
Co-58	70.916 D	1.13E+00	1.11E+00	1.00E+00	1.18E+00	1.09E+00	1.18E+00	1.12E+00	1.19E+00	1.44E+00	1.08E+00	9.65E-01
Co-60	5.2714 Y	2.97E+00	2.92E+00	2.73E+00	3.14E+00	2.89E+00	3.14E+00	2.97E+00	3.16E+00	3.73E+00	2.81E+00	2.58E+00
Ni-57	35.60 H	2.31E+00	2.26E+00	2.11E+00	2.44E+00	2.25E+00	2.44E+00	2.31E+00	2.45E+00	2.92E+00	2.17E+00	2.01E+00
Cu-62	9.74 M	1.11E+00	1.09E+00	9.76E-01	1.15E+00	1.06E+00	1.15E+00	1.11E+00	1.18E+00	1.47E+00	1.06E+00	9.46E-01
Cu-64	12.700 H	2.09E-01	2.06E-01	1.85E-01	2.19E-01	2.02E-01	2.19E-01	2.09E-01	2.23E-01	2.78E-01	2.00E-01	1.79E-01
Cu-66	5.088 M	9.35E-02	9.19E-02	8.43E-02	9.81E-02	9.03E-02	9.81E-02	9.30E-02	9.86E-02	1.17E-01	8.92E-02	8.03E-02
Nb-92m	10.15 D	1.14E+00	1.12E+00	1.02E+00	1.19E+00	1.10E+00	1.19E+00	1.13E+00	1.20E+00	1.43E+00	1.09E+00	9.76E-01
Nb-93m	15.8 Y	1.66E-06	1.74E-05	2.76E-06	2.76E-06	2.08E-05	1.01E-05	6.11E-06	1.65E-25	7.41E-04	2.11E-05	2.03E-05

Table A.1 (continued)

Dose rate conversion factors for various organs for immersion in contaminated air (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
C-14	5.730E3 Y	0.00E+00	5.62E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-49	338. D	2.37E-07	1.52E-04	2.06E-07	6.62E-06	1.52E-10	4.54E-07	6.68E-11	9.16E-34	1.18E-06	7.16E-08	1.25E-05
V-52	3.75 M	1.84E+00	4.95E+00	1.65E+00	2.21E+00	1.89E+00	2.24E+00	1.54E+00	1.73E+00	1.93E+00	1.94E+00	1.99E+00
V-53	1.61 M	1.33E+00	4.08E+00	1.19E+00	1.72E+00	1.39E+00	1.66E+00	1.08E+00	1.27E+00	1.43E+00	1.41E+00	1.47E+00
Cr-51	27.704 D	3.78E-02	5.70E-02	3.41E-02	5.08E-02	3.86E-02	4.78E-02	3.05E-02	3.73E-02	4.81E-02	3.78E-02	4.33E-02
Fe-55	312.12 D	5.78E-07	3.70E-04	5.03E-07	1.62E-05	3.70E-10	1.11E-06	1.63E-10	2.23E-33	2.86E-06	1.75E-07	3.06E-05
Mn-54	2.5785 H	1.05E+00	1.58E+00	9.38E-01	1.37E+00	1.08E+00	1.30E+00	8.49E-01	1.00E+00	1.15E+00	1.10E+00	1.16E+00
Mn-56	2.73 Y	2.26E+00	5.03E+00	2.02E+00	2.89E+00	2.30E+00	2.73E+00	1.87E+00	2.11E+00	2.39E+00	2.36E+00	2.48E+00
Co-57	271.79 D	1.14E-01	2.10E-01	1.20E-01	1.92E-01	1.48E-01	1.89E-01	1.05E-01	1.29E-01	2.17E-01	1.29E-01	1.62E-01
Co-58	70.916 D	1.21E+00	1.87E+00	1.08E+00	1.59E+00	1.25E+00	1.50E+00	9.78E-01	1.16E+00	1.34E+00	1.26E+00	1.35E+00
Co-60	5.2714 Y	3.19E+00	4.84E+00	2.86E+00	3.95E+00	3.30E+00	3.92E+00	2.64E+00	3.03E+00	3.38E+00	3.38E+00	3.48E+00
Ni-57	35.60 H	2.48E+00	3.95E+00	2.23E+00	3.08E+00	2.53E+00	3.03E+00	2.06E+00	2.34E+00	2.67E+00	2.60E+00	2.71E+00
Cu-62	9.74 M	1.21E+00	4.51E+00	1.08E+00	1.58E+00	1.20E+00	1.47E+00	9.68E-01	1.16E+00	1.38E+00	1.24E+00	1.34E+00
Cu-64	12.700 H	2.29E-01	5.22E-01	2.04E-01	3.00E-01	2.28E-01	2.78E-01	1.83E-01	2.20E-01	2.61E-01	2.34E-01	2.54E-01
Cu-66	5.088 M	9.97E-02	2.39E+00	8.95E-02	1.29E-01	1.05E-01	1.25E-01	8.14E-02	9.51E-02	1.07E-01	1.06E-01	1.11E-01
Nb-92m	10.15 D	1.22E+00	1.84E+00	1.09E+00	1.59E+00	1.27E+00	1.52E+00	9.86E-01	1.16E+00	1.32E+00	1.28E+00	1.35E+00
Nb-93m	15.8 Y	1.21E-05	1.15E-03	1.60E-05	2.08E-04	3.27E-06	5.59E-05	2.01E-07	3.32E-05	5.84E-05	6.51E-06	1.74E-04

Table A.1 (continued)

Dose rate conversion factors for various organs for immersion in contaminated air (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
Nb-94m	6.26 M	5.57E-03	1.69E-02	5.00E-03	8.03E-03	5.76E-03	7.11E-03	4.49E-03	5.43E-03	6.27E-03	5.84E-03	6.80E-03
Nb-94	2.03E4 Y	1.95E+00	3.14E+00	1.74E+00	2.55E+00	2.01E+00	2.42E+00	1.57E+00	1.87E+00	2.14E+00	2.04E+00	2.16E+00
Mo-93	3.500E3 Y	6.97E-05	6.65E-03	9.27E-05	1.21E-03	1.87E-05	3.24E-04	1.11E-06	1.92E-04	3.38E-04	3.76E-05	1.01E-03
Mo-99	65.94 H	1.81E-01	9.92E-01	1.63E-01	2.41E-01	1.88E-01	2.28E-01	1.47E-01	1.76E-01	2.10E-01	1.88E-01	2.04E-01
Mo-101	14.61 M	1.91E+00	3.78E+00	1.71E+00	2.42E+00	1.95E+00	2.32E+00	1.57E+00	1.80E+00	2.05E+00	1.99E+00	2.09E+00
Tc-99m	6.01 H	1.25E-01	2.22E-01	1.26E-01	1.99E-01	1.52E-01	1.95E-01	1.11E-01	1.37E-01	2.20E-01	1.36E-01	1.69E-01
Tc-99	2.111E5 Y	4.35E-07	7.81E-02	5.16E-07	9.22E-07	6.84E-07	8.92E-07	4.38E-07	5.49E-07	1.04E-06	5.49E-07	7.54E-07
Tc-101	14.2 M	3.95E-01	1.50E+00	3.57E-01	5.30E-01	4.03E-01	5.00E-01	3.19E-01	3.89E-01	5.00E-01	3.97E-01	4.51E-01
Ta-182	114.43 D	1.59E+00	2.61E+00	1.45E+00	2.07E+00	1.69E+00	2.03E+00	1.32E+00	1.54E+00	1.79E+00	1.69E+00	1.79E+00
W-181	121.2 D	1.61E-02	6.05E-02	2.34E-02	5.14E-02	3.68E-02	4.81E-02	1.92E-02	2.43E-02	5.43E-02	2.42E-02	3.98E-02
W-185	75.1 D	3.38E-05	1.33E-01	3.97E-05	7.22E-05	5.38E-05	6.97E-05	3.38E-05	4.22E-05	7.95E-05	4.22E-05	5.86E-05
W-187	23.72 H	5.08E-01	1.25E+00	4.59E-01	6.84E-01	5.27E-01	6.43E-01	4.14E-01	4.95E-01	6.00E-01	5.27E-01	5.79E-01
Re-186	90.64 H	1.57E-02	6.24E-01	1.66E-02	2.73E-02	2.07E-02	2.66E-02	1.44E-02	1.79E-02	3.00E-02	1.78E-02	2.28E-02
Re-187	4.35E10 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-186	2.0E15 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-210	138.376 D	1.22E-05	1.85E-05	1.09E-05	1.59E-05	1.25E-05	1.51E-05	9.84E-06	1.16E-05	1.34E-05	1.27E-05	1.35E-05

Table A.1 (continued)

Dose rate conversion factors for various organs for immersion in contaminated air (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
Nb-94m	6.26 M	5.16E-03	5.14E-03	4.62E-03	5.41E-03	5.05E-03	5.43E-03	5.14E-03	5.43E-03	9.38E-03	5.00E-03	4.49E-03
Nb-94	2.03E4 Y	1.81E+00	1.78E+00	1.62E+00	1.89E+00	1.75E+00	1.89E+00	1.80E+00	1.92E+00	2.31E+00	1.73E+00	1.55E+00
Mo-93	3.500E3 Y	9.43E-06	1.01E-04	1.58E-05	1.59E-05	1.20E-04	5.84E-05	3.51E-05	4.22E-25	4.27E-03	1.22E-04	1.18E-04
Mo-99	65.94 H	1.69E-01	1.66E-01	1.50E-01	1.76E-01	1.63E-01	1.76E-01	1.68E-01	1.79E-01	2.25E-01	1.59E-01	1.44E-01
Mo-101	14.61 M	1.78E+00	1.74E+00	1.61E+00	1.87E+00	1.72E+00	1.87E+00	1.77E+00	1.88E+00	2.25E+00	1.67E+00	1.54E+00
Tc-99m	6.01 H	1.29E-01	1.26E-01	1.09E-01	1.34E-01	1.22E-01	1.31E-01	1.28E-01	1.41E-01	2.23E-01	1.11E-01	1.04E-01
Tc-99	2.111E5 Y	5.46E-07	5.22E-07	4.38E-07	5.51E-07	4.89E-07	5.68E-07	5.38E-07	6.00E-07	1.12E-06	4.57E-07	4.03E-07
Tc-101	14.2 M	3.62E-01	3.57E-01	3.19E-01	3.78E-01	3.51E-01	3.76E-01	3.62E-01	3.89E-01	5.24E-01	3.32E-01	3.11E-01
Ta-182	114.43 D	1.52E+00	1.48E+00	1.36E+00	1.58E+00	1.46E+00	1.59E+00	1.51E+00	1.60E+00	1.96E+00	1.42E+00	1.30E+00
W-181	121.2 D	2.78E-02	2.45E-02	2.03E-02	2.49E-02	2.16E-02	3.08E-02	2.66E-02	3.00E-02	6.41E-02	2.19E-02	1.68E-02
W-185	75.1 D	4.30E-05	4.03E-05	3.43E-05	4.22E-05	3.76E-05	4.54E-05	4.22E-05	4.70E-05	8.57E-05	3.57E-05	3.08E-05
W-187	23.72 H	4.76E-01	4.68E-01	4.19E-01	4.95E-01	4.57E-01	4.97E-01	4.73E-01	5.08E-01	6.46E-01	4.51E-01	4.03E-01
Re-186	90.64 H	1.72E-02	1.66E-02	1.43E-02	1.76E-02	1.59E-02	1.78E-02	1.70E-02	1.88E-02	3.11E-02	1.46E-02	1.35E-02
Re-187	4.35E10 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-186	2.0E15 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-210	138.376 D	1.13E-05	1.11E-05	1.01E-05	1.18E-05	1.09E-05	1.18E-05	1.12E-05	1.20E-05	1.44E-05	1.08E-05	9.70E-06

Table A.2

Dose rate conversion factors for various organs for exposure 1 m above contaminated ground surface (Sv/yr per Bq/cm^2)

NUCLIDE	HALF-LIFE	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
C-14	5.730E3 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-49	338. D	3.35E-16	3.78E-10	3.14E-12	4.62E-12	7.68E-10	2.25E-12	1.83E-11	1.49E-45	1.47E-07	7.30E-10	1.09E-09
V-52	3.75 M	3.24E-04	3.16E-04	2.97E-04	3.41E-04	3.16E-04	3.41E-04	3.24E-04	3.41E-04	4.03E-04	3.05E-04	2.81E-04
V-53	1.61 M	2.54E-04	2.49E-04	2.28E-04	2.65E-04	2.45E-04	2.65E-04	2.51E-04	2.67E-04	3.16E-04	2.42E-04	2.18E-04
Cr-51	27.704 D	8.24E-06	8.11E-06	7.22E-06	8.57E-06	7.97E-06	8.54E-06	8.24E-06	8.86E-06	1.22E-05	7.54E-06	7.05E-06
Mn-54	312.12 D	2.07E-04	2.04E-04	1.85E-04	2.16E-04	1.99E-04	2.16E-04	2.06E-04	2.19E-04	2.63E-04	1.98E-04	1.77E-04
Mn-56	2.5785 H	4.00E-04	3.92E-04	3.65E-04	4.22E-04	3.89E-04	4.22E-04	4.00E-04	4.22E-04	5.03E-04	3.76E-04	3.46E-04
Fe-55	2.73 Y	1.02E-15	1.15E-09	9.49E-12	1.40E-11	2.32E-09	6.81E-12	5.54E-11	4.49E-45	4.43E-07	2.21E-09	3.30E-09
Co-57	271.79 D	3.00E-05	2.95E-05	2.53E-05	3.14E-05	2.84E-05	3.08E-05	3.00E-05	3.30E-05	5.57E-05	2.58E-05	2.40E-05
Co-58	70.916 D	2.42E-04	2.38E-04	2.16E-04	2.53E-04	2.34E-04	2.53E-04	2.41E-04	2.57E-04	3.11E-04	2.31E-04	2.08E-04
Co-60	5.2714 Y	5.81E-04	5.70E-04	5.30E-04	6.11E-04	5.65E-04	6.11E-04	5.78E-04	6.14E-04	7.24E-04	5.51E-04	5.03E-04
Ni-57	35.60 H	4.51E-04	4.43E-04	4.11E-04	4.76E-04	4.38E-04	4.76E-04	4.51E-04	4.78E-04	5.76E-04	4.24E-04	3.92E-04
Cu-62	9.74 M	2.52E-04	2.48E-04	2.22E-04	2.63E-04	2.43E-04	2.63E-04	2.52E-04	2.69E-04	3.35E-04	2.41E-04	2.16E-04
Cu-64	12.700 H	4.76E-05	4.68E-05	4.19E-05	4.97E-05	4.57E-05	4.95E-05	4.76E-05	5.05E-05	6.38E-05	4.54E-05	4.05E-05
Cu-66	5.088 M	1.91E-05	1.87E-05	1.71E-05	1.99E-05	1.84E-05	1.99E-05	1.89E-05	2.01E-05	2.37E-05	1.82E-05	1.64E-05
Nb-92m	10.15 D	2.36E-04	2.32E-04	2.11E-04	2.47E-04	2.28E-04	2.47E-04	2.34E-04	2.49E-04	3.03E-04	2.25E-04	2.02E-04
Nb-93m	15.8 Y	2.29E-09	2.68E-08	4.08E-09	3.81E-09	3.22E-08	1.48E-08	9.16E-09	1.51E-28	1.17E-06	3.24E-08	3.16E-08

Table A.2 (continued)

Dose rate conversion factors for various organs for exposure 1 m above contaminated ground surface (Sv/yr per Bq/cm^2)

NUCLIDE	HALF-LIFE	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
C-14	5.730E3 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-49	338. D	4.86E-10	3.11E-07	4.22E-10	1.36E-08	3.11E-13	9.32E-10	1.37E-13	1.88E-36	2.41E-09	1.47E-10	2.57E-08
V-52	3.75 M	3.46E-04	4.22E-03	3.11E-04	4.16E-04	3.57E-04	4.22E-04	2.89E-04	3.27E-04	3.65E-04	3.65E-04	3.74E-04
V-53	1.61 M	2.70E-04	3.95E-03	2.42E-04	3.51E-04	2.84E-04	3.38E-04	2.20E-04	2.58E-04	2.89E-04	2.86E-04	3.00E-04
Cr-51	27.704 D	8.97E-06	1.39E-05	8.11E-06	1.21E-05	9.16E-06	1.14E-05	7.24E-06	8.89E-06	1.15E-05	9.03E-06	1.03E-05
Mn-54	312.12 D	2.22E-04	3.35E-04	1.99E-04	2.89E-04	2.30E-04	2.76E-04	1.80E-04	2.13E-04	2.43E-04	2.33E-04	2.46E-04
Mn-56	2.5785 H	4.30E-04	3.22E-03	3.84E-04	5.49E-04	4.38E-04	5.19E-04	3.54E-04	4.00E-04	4.54E-04	4.49E-04	4.71E-04
Fe-55	2.73 Y	1.47E-09	9.41E-07	1.28E-09	4.11E-08	9.41E-13	2.81E-09	4.14E-13	5.68E-36	7.30E-09	4.43E-10	7.77E-08
Co-57	271.79 D	2.81E-05	5.46E-05	2.95E-05	4.76E-05	3.62E-05	4.65E-05	2.57E-05	3.19E-05	5.32E-05	3.16E-05	4.02E-05
Co-58	70.916 D	2.61E-04	3.97E-04	2.33E-04	3.41E-04	2.68E-04	3.24E-04	2.11E-04	2.50E-04	2.89E-04	2.73E-04	2.90E-04
Co-60	5.2714 Y	6.19E-04	9.30E-04	5.59E-04	7.70E-04	6.43E-04	7.65E-04	5.14E-04	5.89E-04	6.59E-04	6.57E-04	6.78E-04
Ni-57	35.60 H	4.84E-04	9.95E-04	4.35E-04	6.05E-04	4.95E-04	5.89E-04	4.03E-04	4.57E-04	5.24E-04	5.08E-04	5.31E-04
Cu-62	9.74 M	2.76E-04	4.59E-03	2.45E-04	3.62E-04	2.73E-04	3.35E-04	2.21E-04	2.66E-04	3.16E-04	2.81E-04	3.06E-04
Cu-64	12.700 H	5.22E-05	1.27E-04	4.62E-05	6.78E-05	5.16E-05	6.32E-05	4.16E-05	5.00E-05	5.92E-05	5.30E-05	5.77E-05
Cu-66	5.088 M	2.03E-05	3.70E-03	1.82E-05	2.63E-05	2.13E-05	2.54E-05	1.65E-05	1.94E-05	2.18E-05	2.15E-05	2.25E-05
Nb-92m	10.15 D	2.52E-04	3.95E-04	2.26E-04	3.30E-04	2.63E-04	3.16E-04	2.04E-04	2.41E-04	2.73E-04	2.66E-04	2.81E-04
Nb-93m	15.8 Y	1.86E-08	1.82E-06	2.47E-08	3.24E-07	4.73E-09	8.59E-08	2.76E-10	5.16E-08	9.05E-08	9.97E-09	2.73E-07

Table A.2 (continued)

Dose rate conversion factors for various organs for exposure 1 m above contaminated ground surface (Sv/yr per Bq/cm^2)

NUCLIDE	HALF-LIFE	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
Nb-94m	6.26 M	1.10E-06	1.17E-06	9.89E-07	1.15E-06	1.17E-06	1.20E-06	1.12E-06	1.15E-06	5.86E-06	1.16E-06	1.05E-06
Nb-94	2.03E4 Y	3.86E-04	3.81E-04	3.46E-04	4.05E-04	3.73E-04	4.05E-04	3.84E-04	4.08E-04	4.92E-04	3.70E-04	3.32E-04
Mo-93	3.500E3 Y	1.31E-08	1.55E-07	2.36E-08	2.20E-08	1.86E-07	8.54E-08	5.30E-08	5.24E-28	6.76E-06	1.88E-07	1.83E-07
Mo-99	65.94 H	3.70E-05	3.62E-05	3.27E-05	3.86E-05	3.57E-05	3.86E-05	3.68E-05	3.92E-05	4.97E-05	3.49E-05	3.16E-05
Mo-101	14.61 M	3.51E-04	3.43E-04	3.16E-04	3.68E-04	3.41E-04	3.68E-04	3.49E-04	3.70E-04	4.46E-04	3.30E-04	3.03E-04
Tc-99m	6.01 H	3.14E-05	3.08E-05	2.66E-05	3.24E-05	2.97E-05	3.22E-05	3.11E-05	3.43E-05	5.51E-05	2.70E-05	2.55E-05
Tc-99	2.111E5 Y	1.41E-10	1.36E-10	1.14E-10	1.43E-10	1.29E-10	1.49E-10	1.39E-10	1.54E-10	3.46E-10	1.20E-10	1.06E-10
Tc-101	14.2 M	8.57E-05	8.41E-05	7.49E-05	8.89E-05	8.27E-05	8.86E-05	8.54E-05	9.19E-05	1.24E-04	7.84E-05	7.30E-05
Ta-182	114.43 D	3.08E-04	3.00E-04	2.76E-04	3.22E-04	2.95E-04	3.22E-04	3.05E-04	3.24E-04	4.05E-04	2.89E-04	2.62E-04
W-181	121.2 D	8.43E-06	7.41E-06	6.14E-06	7.54E-06	6.57E-06	9.35E-06	8.05E-06	9.08E-06	2.25E-05	6.65E-06	5.11E-06
W-185	75.1 D	1.15E-08	1.08E-08	9.14E-09	1.12E-08	1.00E-08	1.22E-08	1.13E-08	1.26E-08	2.46E-08	9.54E-09	8.22E-09
W-187	23.72 H	1.07E-04	1.05E-04	9.38E-05	1.11E-04	1.02E-04	1.12E-04	1.06E-04	1.14E-04	1.50E-04	1.01E-04	9.03E-05
Re-186	90.64 H	4.30E-06	4.16E-06	3.57E-06	4.38E-06	3.97E-06	4.46E-06	4.27E-06	4.70E-06	8.08E-06	3.68E-06	3.35E-06
Re-187	4.35E10 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-186	2.0E15 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-210	138.376 D	2.42E-09	2.38E-09	2.15E-09	2.52E-09	2.33E-09	2.53E-09	2.40E-09	2.56E-09	3.08E-09	2.31E-09	2.07E-09

Table A.2 (continued)

Dose rate conversion factors for various organs for exposure 1 m above contaminated ground surface (Sv/yr per Bq/cm^2)

NUCLIDE	HALF-LIFE	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
Nb-94m	6.26 M	1.24E-06	1.54E-05	1.14E-06	2.78E-06	1.23E-06	1.79E-06	9.43E-07	1.31E-06	1.62E-06	1.26E-06	2.33E-06
Nb-94	2.03E4 Y	4.16E-04	6.41E-04	3.70E-04	5.43E-04	4.27E-04	5.16E-04	3.35E-04	3.97E-04	4.57E-04	4.35E-04	4.61E-04
Mo-93	3.500E3 Y	1.08E-07	1.05E-05	1.43E-07	1.88E-06	2.73E-08	5.00E-07	1.55E-09	3.00E-07	5.24E-07	5.76E-08	1.58E-06
Mo-99	65.94 H	3.95E-05	1.16E-03	3.57E-05	5.30E-05	4.11E-05	5.00E-05	3.22E-05	3.84E-05	4.62E-05	4.11E-05	4.49E-05
Mo-101	14.61 M	3.76E-04	1.99E-03	3.38E-04	4.78E-04	3.84E-04	4.59E-04	3.11E-04	3.54E-04	4.05E-04	3.92E-04	4.13E-04
Tc-99m	6.01 H	3.03E-05	5.35E-05	3.08E-05	4.89E-05	3.73E-05	4.76E-05	2.70E-05	3.35E-05	5.38E-05	3.32E-05	4.14E-05
Tc-99	2.111E5 Y	1.14E-10	3.54E-10	1.35E-10	2.58E-10	1.77E-10	2.37E-10	1.13E-10	1.45E-10	2.76E-10	1.42E-10	2.09E-10
Tc-101	14.2 M	9.30E-05	1.62E-03	8.41E-05	1.25E-04	9.51E-05	1.18E-04	7.51E-05	9.19E-05	1.18E-04	9.38E-05	1.07E-04
Ta-182	114.43 D	3.22E-04	5.41E-04	2.95E-04	4.22E-04	3.43E-04	4.14E-04	2.68E-04	3.11E-04	3.68E-04	3.43E-04	3.65E-04
W-181	121.2 D	4.89E-06	2.49E-05	7.08E-06	1.58E-05	1.11E-05	1.46E-05	5.81E-06	7.35E-06	1.65E-05	7.32E-06	1.26E-05
W-185	75.1 D	8.92E-09	2.70E-07	1.06E-08	1.96E-08	1.45E-08	1.88E-08	9.00E-09	1.12E-08	2.15E-08	1.12E-08	1.60E-08
W-187	23.72 H	1.14E-04	6.78E-04	1.03E-04	1.55E-04	1.19E-04	1.45E-04	9.24E-05	1.11E-04	1.36E-04	1.18E-04	1.31E-04
Re-186	90.64 H	3.89E-06	7.73E-04	4.14E-06	6.89E-06	5.22E-06	6.68E-06	3.59E-06	4.46E-06	7.57E-06	4.43E-06	5.76E-06
Re-187	4.35E10 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-186	2.0E15 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-210	138.376 D	2.59E-09	4.32E-09	2.32E-09	3.41E-09	2.68E-09	3.22E-09	2.10E-09	2.49E-09	2.84E-09	2.70E-09	2.89E-09

Table A.3

Dose rate conversion factors for various organs for immersion in contaminated water (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
C-14	5.730E3 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-49	338. D	3.54E-16	4.00E-10	3.30E-12	4.86E-12	8.08E-10	2.38E-12	1.93E-11	1.56E-45	1.55E-07	7.70E-10	1.15E-09
V-52	3.75 M	3.68E-03	3.59E-03	3.38E-03	3.89E-03	3.59E-03	3.89E-03	3.68E-03	3.89E-03	4.59E-03	3.46E-03	3.22E-03
V-53	1.61 M	2.67E-03	2.62E-03	2.43E-03	2.78E-03	2.58E-03	2.78E-03	2.65E-03	2.81E-03	3.32E-03	2.55E-03	2.29E-03
Cr-51	27.704 D	7.43E-05	7.32E-05	6.51E-05	7.73E-05	7.19E-05	7.70E-05	7.43E-05	8.00E-05	1.08E-04	6.81E-05	6.35E-05
Mn-54	312.12 D	2.09E-03	2.06E-03	1.87E-03	2.19E-03	2.02E-03	2.19E-03	2.08E-03	2.22E-03	2.66E-03	2.00E-03	1.79E-03
Mn-56	2.5785 H	4.51E-03	4.43E-03	4.14E-03	4.76E-03	4.41E-03	4.78E-03	4.51E-03	4.78E-03	5.68E-03	4.22E-03	3.92E-03
Fe-55	2.73 Y	8.78E-16	9.92E-10	8.22E-12	1.21E-11	2.01E-09	5.89E-12	4.78E-11	3.89E-45	3.84E-07	1.91E-09	2.86E-09
Co-57	271.79 D	2.64E-04	2.58E-04	2.22E-04	2.76E-04	2.49E-04	2.69E-04	2.62E-04	2.89E-04	4.73E-04	2.26E-04	2.11E-04
Co-58	70.916 D	2.42E-03	2.38E-03	2.15E-03	2.52E-03	2.33E-03	2.52E-03	2.40E-03	2.56E-03	3.08E-03	2.31E-03	2.07E-03
Co-60	5.2714 Y	6.41E-03	6.27E-03	5.84E-03	6.73E-03	6.22E-03	6.73E-03	6.38E-03	6.76E-03	7.97E-03	6.05E-03	5.54E-03
Ni-57	35.60 H	4.95E-03	4.86E-03	4.51E-03	5.22E-03	4.81E-03	5.22E-03	4.95E-03	5.24E-03	6.27E-03	4.65E-03	4.30E-03
Cu-62	9.74 M	2.36E-03	2.33E-03	2.08E-03	2.47E-03	2.28E-03	2.47E-03	2.36E-03	2.52E-03	3.16E-03	2.26E-03	2.02E-03
Cu-64	12.700 H	4.46E-04	4.41E-04	3.95E-04	4.68E-04	4.30E-04	4.68E-04	4.46E-04	4.76E-04	5.95E-04	4.27E-04	3.84E-04
Cu-66	5.088 M	2.01E-04	1.97E-04	1.81E-04	2.10E-04	1.94E-04	2.10E-04	1.99E-04	2.12E-04	2.50E-04	1.91E-04	1.72E-04
Nb-92m	10.15 D	2.44E-03	2.40E-03	2.19E-03	2.55E-03	2.36E-03	2.55E-03	2.42E-03	2.58E-03	3.08E-03	2.33E-03	2.09E-03
Nb-93m	15.8 Y	3.95E-09	4.14E-08	6.54E-09	6.57E-09	4.92E-08	2.41E-08	1.45E-08	3.92E-28	1.76E-06	5.00E-08	4.84E-08

Table A.3 (continued)

Dose rate conversion factors for various organs for immersion in contaminated water (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
C-14	5.730E3 Y	0.00E+00	5.95E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
V-49	338. D	5.11E-10	3.27E-07	4.46E-10	1.43E-08	3.27E-13	9.84E-10	1.44E-13	1.98E-36	2.54E-09	1.55E-10	2.71E-08
V-52	3.75 M	3.95E-03	8.24E-03	3.54E-03	4.76E-03	4.05E-03	4.81E-03	3.30E-03	3.70E-03	4.14E-03	4.16E-03	4.27E-03
V-53	1.61 M	2.84E-03	6.54E-03	2.55E-03	3.68E-03	2.97E-03	3.57E-03	2.32E-03	2.73E-03	3.05E-03	3.00E-03	3.15E-03
Cr-51	27.704 D	8.11E-05	1.22E-04	7.30E-05	1.09E-04	8.27E-05	1.03E-04	6.54E-05	8.00E-05	1.03E-04	8.14E-05	9.28E-05
Mn-54	312.12 D	2.25E-03	3.38E-03	2.01E-03	2.95E-03	2.32E-03	2.78E-03	1.82E-03	2.15E-03	2.46E-03	2.36E-03	2.50E-03
Mn-56	2.5785 H	4.84E-03	8.95E-03	4.35E-03	6.19E-03	4.95E-03	5.86E-03	4.03E-03	4.51E-03	5.14E-03	5.05E-03	5.32E-03
Fe-55	2.73 Y	1.27E-09	8.14E-07	1.11E-09	3.54E-08	8.14E-13	2.44E-09	3.57E-13	4.89E-36	6.30E-09	3.84E-10	6.72E-08
Co-57	271.79 D	2.46E-04	4.49E-04	2.59E-04	4.14E-04	3.19E-04	4.08E-04	2.26E-04	2.78E-04	4.68E-04	2.78E-04	3.50E-04
Co-58	70.916 D	2.60E-03	3.97E-03	2.32E-03	3.41E-03	2.67E-03	3.22E-03	2.10E-03	2.49E-03	2.86E-03	2.70E-03	2.89E-03
Co-60	5.2714 Y	6.81E-03	1.03E-02	6.14E-03	8.49E-03	7.08E-03	8.41E-03	5.65E-03	6.46E-03	7.24E-03	7.22E-03	7.46E-03
Ni-57	35.60 H	5.32E-03	8.16E-03	4.78E-03	6.62E-03	5.43E-03	6.46E-03	4.41E-03	5.03E-03	5.73E-03	5.57E-03	5.81E-03
Cu-62	9.74 M	2.59E-03	6.78E-03	2.30E-03	3.38E-03	2.57E-03	3.14E-03	2.07E-03	2.49E-03	2.95E-03	2.64E-03	2.87E-03
Cu-64	12.700 H	4.89E-04	9.24E-04	4.35E-04	6.41E-04	4.86E-04	5.95E-04	3.92E-04	4.70E-04	5.57E-04	5.00E-04	5.43E-04
Cu-66	5.088 M	2.14E-04	2.73E-03	1.92E-04	2.76E-04	2.24E-04	2.68E-04	1.74E-04	2.04E-04	2.29E-04	2.26E-04	2.37E-04
Nb-92m	10.15 D	2.61E-03	3.95E-03	2.34E-03	3.41E-03	2.73E-03	3.27E-03	2.12E-03	2.49E-03	2.81E-03	2.76E-03	2.90E-03
Nb-93m	15.8 Y	2.86E-08	2.73E-06	3.81E-08	4.95E-07	7.76E-09	1.33E-07	4.78E-10	7.89E-08	1.39E-07	1.55E-08	4.14E-07

Table A.3 (continued)

Dose rate conversion factors for various organs for immersion in contaminated water (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
Nb-94m	6.26 M	1.11E-05	1.11E-05	9.92E-06	1.16E-05	1.09E-05	1.17E-05	1.11E-05	1.17E-05	2.08E-05	1.08E-05	9.68E-06
Nb-94	2.03E4 Y	3.89E-03	3.81E-03	3.46E-03	4.05E-03	3.73E-03	4.05E-03	3.86E-03	4.11E-03	4.95E-03	3.70E-03	3.32E-03
Mo-93	3.500E3 Y	2.24E-08	2.40E-07	3.76E-08	3.78E-08	2.86E-07	1.39E-07	8.38E-08	1.00E-27	1.02E-05	2.89E-07	2.78E-07
Mo-99	65.94 H	3.62E-04	3.57E-04	3.22E-04	3.78E-04	3.49E-04	3.78E-04	3.59E-04	3.84E-04	4.81E-04	3.41E-04	3.08E-04
Mo-101	14.61 M	3.81E-03	3.73E-03	3.46E-03	4.00E-03	3.70E-03	4.00E-03	3.81E-03	4.03E-03	4.81E-03	3.57E-03	3.30E-03
Tc-99m	6.01 H	2.76E-04	2.70E-04	2.34E-04	2.86E-04	2.62E-04	2.84E-04	2.76E-04	3.03E-04	4.78E-04	2.38E-04	2.24E-04
Tc-99	2.111E5 Y	1.19E-09	1.14E-09	9.62E-10	1.21E-09	1.07E-09	1.24E-09	1.18E-09	1.31E-09	2.47E-09	1.00E-09	8.81E-10
Tc-101	14.2 M	7.78E-04	7.65E-04	6.81E-04	8.08E-04	7.51E-04	8.05E-04	7.76E-04	8.35E-04	1.12E-03	7.14E-04	6.65E-04
Ta-182	114.43 D	3.24E-03	3.19E-03	2.92E-03	3.41E-03	3.14E-03	3.41E-03	3.24E-03	3.43E-03	4.22E-03	3.05E-03	2.78E-03
W-181	121.2 D	6.35E-05	5.57E-05	4.62E-05	5.68E-05	4.92E-05	7.03E-05	6.05E-05	6.84E-05	1.46E-04	4.97E-05	3.81E-05
W-185	75.1 D	9.49E-08	8.86E-08	7.51E-08	9.30E-08	8.27E-08	1.00E-07	9.27E-08	1.04E-07	1.89E-07	7.84E-08	6.78E-08
W-187	23.72 H	1.02E-03	1.00E-03	8.97E-04	1.06E-03	9.76E-04	1.07E-03	1.02E-03	1.09E-03	1.38E-03	9.65E-04	8.62E-04
Re-186	90.64 H	3.73E-05	3.59E-05	3.08E-05	3.81E-05	3.46E-05	3.84E-05	3.68E-05	4.08E-05	6.73E-05	3.16E-05	2.92E-05
Re-187	4.35E10 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-186	2.0E15 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-210	138.376 D	2.43E-08	2.39E-08	2.16E-08	2.54E-08	2.34E-08	2.54E-08	2.41E-08	2.57E-08	3.08E-08	2.32E-08	2.08E-08

Table A.3 (continued)

Dose rate conversion factors for various organs for immersion in contaminated water (Sv/yr per Bq/cm^3)

NUCLIDE	HALF-LIFE	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
Nb-94m	6.26 M	1.19E-05	3.30E-05	1.08E-05	1.74E-05	1.24E-05	1.53E-05	9.59E-06	1.16E-05	1.35E-05	1.25E-05	1.47E-05
Nb-94	2.03E4 Y	4.16E-03	6.51E-03	3.73E-03	5.46E-03	4.30E-03	5.19E-03	3.38E-03	4.00E-03	4.59E-03	4.35E-03	4.63E-03
Mo-93	3.500E3 Y	1.66E-07	1.58E-05	2.20E-07	2.86E-06	4.43E-08	7.70E-07	2.63E-09	4.57E-07	8.05E-07	8.95E-08	2.39E-06
Mo-99	65.94 H	3.86E-04	1.36E-03	3.49E-04	5.16E-04	4.03E-04	4.89E-04	3.14E-04	3.76E-04	4.49E-04	4.03E-04	4.38E-04
Mo-101	14.61 M	4.08E-03	7.11E-03	3.65E-03	5.19E-03	4.19E-03	4.97E-03	3.38E-03	3.84E-03	4.41E-03	4.27E-03	4.49E-03
Tc-99m	6.01 H	2.68E-04	4.70E-04	2.70E-04	4.30E-04	3.27E-04	4.19E-04	2.38E-04	2.95E-04	4.73E-04	2.92E-04	3.63E-04
Tc-99	2.111E5 Y	9.57E-10	8.32E-05	1.13E-09	2.02E-09	1.50E-09	1.95E-09	9.62E-10	1.20E-09	2.28E-09	1.20E-09	1.65E-09
Tc-101	14.2 M	8.46E-04	2.24E-03	7.62E-04	1.14E-03	8.65E-04	1.07E-03	6.84E-04	8.35E-04	1.07E-03	8.51E-04	9.67E-04
Ta-182	114.43 D	3.41E-03	5.43E-03	3.11E-03	4.43E-03	3.65E-03	4.35E-03	2.84E-03	3.30E-03	3.86E-03	3.65E-03	3.85E-03
W-181	121.2 D	3.68E-05	1.38E-04	5.32E-05	1.16E-04	8.32E-05	1.09E-04	4.38E-05	5.51E-05	1.24E-04	5.51E-05	9.06E-05
W-185	75.1 D	7.43E-08	1.42E-04	8.73E-08	1.59E-07	1.19E-07	1.54E-07	7.46E-08	9.30E-08	1.75E-07	9.24E-08	1.29E-07
W-187	23.72 H	1.09E-03	2.18E-03	9.84E-04	1.47E-03	1.13E-03	1.38E-03	8.84E-04	1.06E-03	1.29E-03	1.13E-03	1.24E-03
Re-186	90.64 H	3.38E-05	6.97E-04	3.59E-05	5.92E-05	4.49E-05	5.76E-05	3.11E-05	3.86E-05	6.51E-05	3.84E-05	4.94E-05
Re-187	4.35E10 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Os-186	2.0E15 Y	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-210	138.376 D	2.61E-08	3.95E-08	2.33E-08	3.41E-08	2.69E-08	3.24E-08	2.11E-08	2.50E-08	2.86E-08	2.73E-08	2.90E-08

APPENDIX B

Tables of dose conversion factors for internal exposure

Table B.1

Committed dose equivalent in various organs or tissues per intake of unit activity by inhalation (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	LCC	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
V-49	338. D	0.01	W	2.59E-12	4.72E-12	7.99E-12	3.29E-11	9.27E-11	2.65E-12	2.65E-12	6.23E-10	2.89E-12	2.82E-12	2.67E-12
V-52	3.75 M	0.01	W	2.61E-14	4.26E-13	5.87E-14	5.55E-14	2.45E-14	1.05E-13	1.93E-13	1.89E-11	1.16E-13	3.33E-14	2.06E-13
		0.01	D	7.23E-14	3.80E-12	2.99E-13	1.38E-13	7.93E-14	1.64E-13	2.43E-13	1.85E-11	1.61E-13	8.69E-14	3.46E-13
V-53	1.61 M	0.01	W	5.78E-15	9.81E-14	1.28E-14	1.41E-14	5.82E-15	2.81E-14	6.16E-14	7.68E-12	3.57E-14	7.50E-15	5.85E-14
		0.01	D	1.42E-14	7.92E-13	3.94E-14	2.59E-14	1.53E-14	3.89E-14	7.06E-14	7.59E-12	4.40E-14	1.64E-14	8.24E-14
Cr-51	27.704 D	0.1	Y	6.37E-12	2.46E-11	2.32E-11	5.18E-11	1.17E-10	1.17E-11	2.49E-11	5.30E-10	1.50E-11	1.93E-11	2.74E-11
Mn-54	312.12 D	0.1	W	3.80E-10	1.16E-09	8.45E-10	1.09E-09	1.34E-09	8.96E-10	2.48E-09	6.65E-09	8.63E-10	7.19E-10	1.44E-09
Mn-56	2.5785 H	0.1	W	4.84E-12	7.78E-11	8.43E-11	1.09E-10	4.44E-11	8.10E-12	1.76E-11	5.37E-10	7.86E-12	9.65E-12	1.43E-11
		0.1	D	1.37E-11	1.44E-10	1.62E-10	2.08E-10	8.81E-11	1.72E-11	4.13E-11	4.41E-10	1.50E-11	2.24E-11	2.49E-11
Fe-55	2.73 Y	0.1	W	1.68E-10	1.75E-10	1.80E-10	2.09E-10	2.76E-10	1.73E-10	5.77E-10	1.05E-09	1.75E-10	1.79E-10	1.75E-10
		0.1	D	4.93E-10	5.07E-10	5.12E-10	5.23E-10	5.43E-10	5.08E-10	1.69E-09	5.20E-10	5.10E-10	5.24E-10	5.14E-10
Co-57	271.79 D	0.05	Y	5.65E-11	5.52E-10	1.77E-10	3.41E-10	6.75E-10	2.60E-10	7.24E-10	1.69E-08	3.77E-10	1.26E-10	7.44E-10
Co-58	70.916 D	0.05	Y	2.43E-10	1.40E-09	7.62E-10	1.23E-09	2.03E-09	7.58E-10	1.64E-09	1.60E-08	9.41E-10	6.28E-10	1.68E-09
Co-60	5.2714 Y	0.05	Y	2.97E-09	2.73E-08	7.09E-09	9.76E-09	8.03E-09	1.56E-08	3.35E-08	3.45E-07	1.84E-08	4.79E-09	3.18E-08
Ni-57	35.60 H	0.05	W	1.22E-10	2.56E-10	5.12E-10	1.12E-09	1.82E-09	1.07E-10	1.37E-10	1.47E-09	1.02E-10	3.34E-10	1.56E-10
Cu-62	9.74 M	0.5	Y	2.03E-14	2.60E-12	3.58E-13	1.19E-13	2.63E-14	1.76E-13	3.74E-13	5.87E-11	2.14E-13	3.60E-14	4.81E-13
		0.5	D	3.57E-13	1.94E-11	2.88E-12	8.21E-13	4.08E-13	5.55E-13	7.22E-13	5.36E-11	5.28E-13	3.93E-13	1.14E-12
Cu-64	12.700 H	0.5	Y	5.87E-12	5.15E-11	5.55E-11	1.57E-10	1.93E-10	7.04E-12	1.39E-11	3.49E-10	6.52E-12	1.27E-11	1.67E-11
Cu-66	5.088 M	0.5	Y	1.77E-15	5.68E-13	4.34E-14	6.24E-15	1.90E-15	7.30E-15	1.53E-14	2.50E-11	9.05E-15	2.36E-15	1.53E-14
		0.5	D	7.04E-14	5.61E-12	4.72E-13	9.71E-14	7.15E-14	7.70E-14	8.65E-14	2.36E-11	7.71E-14	7.13E-14	9.49E-14
Nb-92m	10.15 D	0.01	Y	1.33E-10	3.25E-10	4.72E-10	7.11E-10	1.16E-09	1.71E-10	2.87E-10	1.86E-09	1.93E-10	4.40E-10	2.91E-10

Table B.1 (continued)

Committed dose equivalent in various organs or tissues per intake of unit activity by inhalation (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	LCC	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
V-49	338. D	0.01	W	4.08E-11	2.62E-12	2.77E-12	2.65E-12	2.66E-12	2.73E-12	2.66E-12	2.77E-12	1.03E-10	7.45E-12	9.27E-11
V-52	3.75 M	0.01	W	1.08E-13	6.96E-14	1.55E-13	2.05E-14	3.44E-13	8.86E-14	3.90E-14	1.72E-13	8.72E-14	7.53E-14	2.39E-12
		0.01	D	1.53E-13	1.07E-13	2.50E-13	6.14E-14	3.83E-13	1.25E-13	9.01E-14	2.42E-13	1.28E-13	8.89E-14	2.59E-12
V-53	1.61 M	0.01	W	3.35E-14	2.02E-14	5.71E-14	4.16E-15	1.07E-13	3.72E-14	7.05E-15	6.09E-14	2.70E-14	2.47E-14	9.58E-13
		0.01	D	4.16E-14	2.72E-14	7.39E-14	1.18E-14	1.13E-13	4.42E-14	1.67E-14	7.03E-14	3.45E-14	2.69E-14	9.97E-13
Cr-51	27.704 D	0.1	Y	1.79E-11	6.98E-12	2.31E-11	2.35E-12	3.70E-11	9.89E-12	8.59E-12	2.48E-11	1.32E-11	1.24E-11	8.90E-11
Mn-54	312.12 D	0.1	W	1.11E-09	4.93E-10	1.19E-09	2.76E-10	1.82E-09	7.43E-10	4.99E-10	1.55E-09	1.25E-09	9.31E-10	1.82E-09
Mn-56	2.5785 H	0.1	W	1.03E-11	4.89E-12	1.18E-11	3.20E-12	1.54E-11	6.22E-12	7.76E-12	1.02E-11	8.31E-12	4.88E-12	8.97E-11
		0.1	D	2.40E-11	1.08E-11	1.98E-11	1.07E-11	2.01E-11	1.22E-11	1.93E-11	1.87E-11	2.09E-11	8.11E-12	1.03E-10
Fe-55	2.73 Y	0.1	W	1.77E-10	1.68E-10	9.47E-10	1.76E-10	1.73E-10	1.85E-10	1.77E-10	1.79E-10	1.47E-10	2.33E-11	3.60E-10
		0.1	D	5.18E-10	4.92E-10	2.78E-09	5.17E-10	5.06E-10	5.43E-10	5.19E-10	5.24E-10	4.32E-10	6.82E-11	7.25E-10
Co-57	271.79 D	0.05	Y	5.90E-10	1.54E-10	6.53E-10	2.36E-11	1.22E-09	2.72E-10	8.20E-11	7.64E-10	4.53E-10	4.48E-10	2.45E-09
Co-58	70.916 D	0.05	Y	9.27E-10	4.87E-10	1.47E-09	1.08E-10	2.54E-09	8.74E-10	3.18E-10	1.61E-09	6.95E-10	6.92E-10	2.95E-09
Co-60	5.2714 Y	0.05	Y	1.72E-08	1.02E-08	2.70E-08	1.71E-09	5.75E-08	1.62E-08	4.64E-09	3.00E-08	1.35E-08	1.34E-08	5.91E-08
Ni-57	35.60 H	0.05	W	1.25E-10	5.16E-11	1.27E-10	4.32E-11	1.69E-10	5.20E-11	1.69E-10	1.18E-10	7.09E-11	6.84E-11	5.27E-10
Cu-62	9.74 M	0.5	Y	2.02E-13	1.11E-13	3.57E-13	9.60E-15	5.63E-13	1.90E-13	2.82E-14	3.83E-13	1.60E-13	1.56E-13	7.39E-12
		0.5	D	5.23E-13	3.88E-13	8.43E-13	3.27E-13	8.16E-13	4.72E-13	3.94E-13	7.33E-13	4.61E-13	2.49E-13	8.20E-12
Cu-64	12.700 H	0.5	Y	7.18E-12	4.16E-12	8.92E-12	3.95E-12	9.31E-12	4.96E-12	7.60E-12	8.73E-12	5.30E-12	9.08E-12	7.57E-11
Cu-66	5.088 M	0.5	Y	8.49E-15	5.36E-15	1.46E-14	1.39E-15	2.61E-14	9.35E-15	2.10E-15	1.51E-14	6.92E-15	5.86E-15	3.05E-12
		0.5	D	7.65E-14	7.25E-14	8.72E-14	6.94E-14	9.25E-14	7.67E-14	7.18E-14	8.37E-14	7.45E-14	1.12E-14	3.26E-12
Nb-92m	10.15 D	0.01	Y	2.20E-10	9.45E-11	2.79E-10	4.64E-11	4.28E-10	1.46E-10	1.92E-10	2.77E-10	1.48E-10	1.39E-10	5.83E-10

Table B.1 (continued)

Committed dose equivalent in various organs or tissues per intake of unit activity by inhalation (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	LCC	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
Nb-93m	15.8 Y	0.01	Y	1.13E-11	3.78E-11	5.97E-11	2.90E-10	8.42E-10	1.57E-10	2.85E-11	6.31E-08	4.36E-11	1.34E-11	1.25E-11
Nb-94m	6.26 M	0.01	Y	1.08E-16	2.99E-14	2.85E-15	6.25E-16	1.46E-16	5.19E-16	1.96E-15	1.12E-12	2.26E-15	1.68E-16	1.30E-15
Nb-94	2.03E4 Y	0.01	Y	2.30E-09	3.15E-08	6.95E-09	1.02E-08	9.42E-09	1.90E-08	3.88E-08	7.37E-07	2.22E-08	4.39E-09	4.01E-08
Mo-93	3.500E3 Y	0.05	Y	1.27E-11	8.44E-11	3.74E-11	1.15E-10	2.82E-10	2.09E-10	3.75E-10	6.32E-08	2.89E-10	2.53E-11	2.21E-11
Mo-99	65.94 H	0.05	Y	3.38E-11	2.42E-10	5.43E-10	2.47E-09	5.83E-09	9.78E-11	1.13E-10	4.43E-09	2.80E-11	9.74E-11	4.25E-11
Mo-101	14.61 M	0.05	Y	6.03E-14	5.16E-12	1.27E-12	4.89E-13	9.43E-14	4.30E-13	9.11E-13	6.27E-11	5.18E-13	1.22E-13	1.08E-12
	14.61 M	0.5	D	7.79E-13	2.73E-11	5.85E-12	2.36E-12	9.82E-13	1.49E-12	1.84E-12	5.46E-11	1.15E-12	9.53E-13	2.62E-12
Tc-99m	6.01 H	0.8	W	1.06E-12	2.36E-11	4.65E-12	8.01E-12	5.78E-12	1.69E-12	2.67E-12	4.87E-11	1.66E-12	1.86E-12	3.75E-12
		0.8	D	2.21E-12	4.69E-11	6.23E-12	9.84E-12	7.30E-12	2.80E-12	3.64E-12	3.58E-11	2.48E-12	3.14E-12	5.38E-12
Tc-99	2.111E5 Y	0.8	W	4.05E-11	2.26E-09	7.08E-11	2.19E-10	5.79E-10	4.05E-11	5.52E-11	1.68E-08	4.05E-11	4.05E-11	4.05E-11
Tc-101	14.2 M	0.8	W	6.57E-14	2.22E-12	2.75E-13	1.25E-13	7.28E-14	1.35E-13	2.42E-13	3.00E-11	1.54E-13	7.41E-14	2.80E-13
		0.8	D	2.24E-13	1.44E-11	1.98E-12	6.06E-13	2.65E-13	3.27E-13	4.19E-13	2.82E-11	3.09E-13	2.56E-13	6.44E-13
Ta-182	114.43 D	0.001	Y	3.65E-10	2.81E-09	1.40E-09	3.27E-09	7.08E-09	1.66E-09	3.12E-09	8.13E-08	1.80E-09	9.18E-10	3.06E-09
W-181	121.2 D	0.3	D	3.69E-12	1.10E-11	1.58E-11	3.48E-11	8.03E-11	1.19E-10	3.17E-11	5.08E-11	6.01E-12	1.14E-11	1.38E-11
W-185	75.1 D	0.3	D	4.08E-15	2.32E-11	4.06E-11	2.39E-10	7.11E-10	6.96E-10	1.24E-10	3.80E-10	5.51E-15	1.13E-14	1.27E-14
W-187	23.72 H	0.3	D	8.08E-12	7.45E-11	1.24E-10	4.33E-10	7.33E-10	8.49E-11	3.29E-11	6.50E-10	8.02E-12	2.79E-11	1.54E-11
Re-186	90.64 H	0.8	W	4.46E-11	2.47E-09	1.19E-10	4.39E-10	1.04E-09	4.52E-11	6.21E-11	4.42E-09	4.52E-11	4.57E-11	4.82E-11
Re-187	4.35E10 Y	0.8	W	2.64E-13	1.47E-11	4.62E-13	1.43E-12	3.77E-12	2.64E-13	3.60E-13	1.09E-10	2.64E-13	2.64E-13	2.64E-13
Os-186	2.0E15 Y	0.01	Y	8.13E-08	8.17E-08	8.22E-08	8.66E-08	9.77E-08	1.31E-06	1.13E-06	1.74E-04	8.13E-08	8.13E-08	8.13E-08
Po-210	138.376 D	0.1	W	1.27E-07	1.28E-07	1.29E-07	1.35E-07	1.51E-07	3.94E-06	6.79E-07	1.30E-05	1.27E-07	1.27E-07	1.27E-07
		0.1	D	4.09E-07	4.09E-07	4.10E-07	4.12E-07	4.17E-07	1.27E-05	2.18E-06	7.35E-07	4.09E-07	4.09E-07	4.09E-07

Table B.1 (continued)

Committed dose equivalent in various organs or tissues per intake of unit activity by inhalation (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	LCC	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
Nb-93m	15.8 Y	0.01	Y	1.13E-10	1.22E-11	1.60E-10	1.52E-10	1.77E-11	1.12E-11	1.12E-11	2.02E-11	2.79E-10	1.89E-11	7.73E-09
Nb-94m	6.26 M	0.01	Y	1.03E-15	4.20E-16	1.56E-15	8.15E-17	2.11E-15	6.44E-16	1.29E-16	1.52E-15	9.68E-16	8.20E-16	1.37E-13
Nb-94	2.03E4 Y	0.01	Y	2.24E-08	1.18E-08	3.73E-08	2.65E-09	6.42E-08	2.20E-08	2.98E-09	3.98E-08	1.95E-08	1.75E-08	1.10E-07
Mo-93	3.500E3 Y	0.05	Y	1.08E-10	1.98E-11	9.80E-11	1.05E-11	6.77E-11	1.20E-11	1.19E-11	8.97E-11	2.38E-10	8.03E-11	7.71E-09
Mo-99	65.94 H	0.05	Y	5.38E-11	1.40E-11	3.57E-11	1.26E-11	4.42E-11	1.54E-11	4.60E-11	3.57E-11	4.53E-11	2.08E-11	1.12E-09
Mo-101	14.61 M	0.05	Y	4.99E-13	2.74E-13	8.84E-13	2.65E-14	1.51E-12	4.31E-13	1.14E-13	8.24E-13	3.88E-13	3.82E-13	8.32E-12
	14.61 M	0.5	D	1.19E-12	8.03E-13	1.98E-12	6.62E-13	1.98E-12	9.78E-13	9.67E-13	1.61E-12	1.02E-12	6.08E-13	9.58E-12
Tc-99m	6.01 H	0.8	W	2.54E-12	8.80E-13	2.93E-12	6.55E-13	3.51E-12	3.51E-11	1.52E-12	2.69E-12	1.92E-12	1.66E-12	1.07E-11
		0.8	D	3.71E-12	1.53E-12	4.09E-12	1.53E-12	3.97E-12	8.47E-11	2.86E-12	3.55E-12	2.97E-12	2.31E-12	1.31E-11
Tc-99	2.111E5 Y	0.8	W	4.05E-11	4.05E-11	4.05E-11	4.05E-11	4.05E-11	1.08E-09	4.05E-11	4.05E-11	4.05E-11	1.05E-15	2.26E-09
Tc-101	14.2 M	0.8	W	1.61E-13	9.84E-14	2.36E-13	5.84E-14	3.38E-13	2.34E-12	7.30E-14	2.42E-13	1.37E-13	9.17E-14	3.94E-12
		0.8	D	3.25E-13	2.31E-13	4.98E-13	1.99E-13	4.75E-13	7.87E-12	2.59E-13	4.15E-13	2.85E-13	1.28E-13	4.86E-12
Ta-182	114.43 D	0.001	Y	1.93E-09	9.34E-10	2.74E-09	1.38E-10	5.44E-09	1.54E-09	5.52E-10	2.96E-09	1.52E-09	1.44E-09	1.19E-08
W-181	121.2 D	0.3	D	5.04E-11	2.87E-12	1.06E-10	2.10E-12	4.20E-12	2.74E-12	5.21E-12	1.40E-11	6.97E-11	3.81E-11	4.08E-11
W-185	75.1 D	0.3	D	8.38E-11	2.64E-15	6.00E-10	2.18E-15	4.44E-15	2.54E-15	5.65E-15	1.23E-14	2.57E-10	2.36E-14	2.06E-10
W-187	23.72 H	0.3	D	2.05E-11	3.61E-12	7.81E-11	2.54E-12	1.18E-11	3.91E-12	1.25E-11	1.18E-11	9.37E-11	6.95E-12	1.79E-10
Re-186	90.64 H	0.8	W	4.71E-11	4.40E-11	4.70E-11	4.38E-11	4.79E-11	2.23E-09	4.51E-11	4.66E-11	4.60E-11	3.03E-12	8.70E-10
Re-187	4.35E10 Y	0.8	W	2.64E-13	2.64E-13	2.64E-13	2.64E-13	2.64E-13	7.07E-12	2.64E-13	2.64E-13	2.64E-13	0.00E+00	1.47E-11
Os-186	2.0E15 Y	0.01	Y	8.13E-08	8.13E-08	1.13E-06	8.13E-08	8.13E-08	8.13E-08	8.13E-08	8.13E-08	8.13E-08	0.00E+00	2.11E-05
Po-210	138.376 D	0.1	W	1.27E-07	1.27E-07	6.78E-06	1.27E-07	1.27E-07	1.27E-07	1.27E-07	1.27E-07	1.27E-07	8.87E-15	2.33E-06
		0.1	D	4.09E-07	4.09E-07	2.18E-05	4.09E-07	4.09E-07	4.09E-07	4.09E-07	4.09E-07	4.09E-07	1.54E-14	2.57E-06

Table B.2

Committed dose equivalent in various organs or tissues per intake of unit activity by ingestion (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
V-49	338. D	0.01	2.22E-13	4.37E-12	1.10E-11	6.11E-11	1.82E-10	2.26E-13	2.26E-13	2.24E-13	2.28E-13	5.29E-13	2.30E-13
V-52	3.75 M	0.01	1.66E-13	1.12E-10	6.69E-12	1.44E-12	4.39E-13	7.39E-13	4.61E-13	3.88E-13	3.33E-13	3.79E-13	3.53E-12
V-53	1.61 M	0.01	4.29E-14	4.70E-11	1.30E-12	3.00E-13	1.20E-13	2.44E-13	1.47E-13	1.29E-13	1.07E-13	1.38E-13	1.18E-12
Cr-51	27.704 D	0.1	1.22E-11	1.54E-11	4.45E-11	1.04E-10	2.45E-10	5.86E-12	4.41E-12	2.01E-12	5.30E-12	3.81E-11	6.05E-12
		0.01	1.18E-11	1.46E-11	4.71E-11	1.12E-10	2.68E-10	4.80E-12	3.32E-12	7.22E-13	4.36E-12	4.03E-11	4.74E-12
Mn-54	312.12 D	0.1	3.72E-10	4.11E-10	9.84E-10	1.35E-09	2.20E-09	3.82E-10	1.00E-09	2.29E-10	2.77E-10	9.48E-10	3.81E-10
Mn-56	2.5785 H	0.1	2.56E-11	9.02E-10	1.05E-09	1.37E-09	5.40E-10	3.20E-11	2.63E-11	8.80E-12	1.76E-11	8.53E-11	5.62E-11
Fe-55	2.73 Y	0.1	9.93E-11	1.07E-10	1.15E-10	1.70E-10	3.00E-10	1.02E-10	3.40E-10	1.01E-10	1.03E-10	1.06E-10	1.03E-10
Co-57	271.79 D	0.05	8.01E-11	9.04E-11	2.30E-10	5.26E-10	1.25E-09	4.92E-11	8.81E-11	2.89E-11	4.10E-11	1.83E-10	5.27E-11
		0.3	2.05E-10	2.25E-10	3.41E-10	5.60E-10	1.07E-09	1.97E-10	4.64E-10	1.63E-10	1.58E-10	2.95E-10	2.17E-10
Co-58	70.916 D	0.05	3.66E-10	3.85E-10	1.13E-09	1.95E-09	3.97E-09	2.10E-10	2.46E-10	8.53E-11	1.79E-10	1.04E-09	2.00E-10
		0.3	6.68E-10	7.01E-10	1.25E-09	1.86E-09	3.33E-09	5.75E-10	1.01E-09	4.06E-10	4.50E-10	1.09E-09	5.66E-10
Co-60	5.2714 Y	0.05	1.77E-09	1.61E-09	3.59E-09	5.74E-09	1.11E-08	1.35E-09	2.33E-09	8.77E-10	1.10E-09	3.19E-09	1.29E-09
		0.3	6.64E-09	5.85E-09	8.17E-09	9.57E-09	1.35E-08	6.40E-09	1.28E-08	4.96E-09	5.08E-09	7.23E-09	6.22E-09
Ni-57	35.60 H	0.05	3.48E-10	5.69E-10	1.60E-09	3.61E-09	5.94E-09	1.82E-10	1.33E-10	3.70E-11	1.45E-10	1.04E-09	1.82E-10
Cu-62	9.74 M	0.5	4.82E-13	3.00E-10	4.02E-11	7.10E-12	1.17E-12	1.53E-12	9.56E-13	7.60E-13	6.90E-13	9.77E-13	6.78E-12
Cu-64	12.700 H	0.5	2.19E-11	1.87E-10	2.13E-10	6.07E-10	7.50E-10	2.00E-11	3.73E-11	1.31E-11	1.61E-11	4.79E-11	4.55E-11
Cu-66	5.088 M	0.5	1.58E-14	1.36E-10	9.87E-12	6.35E-13	4.67E-14	6.14E-14	3.85E-14	3.23E-14	2.90E-14	4.69E-14	2.65E-13
Nb-92m	10.15 D	0.01	2.63E-10	2.72E-10	9.40E-10	1.43E-09	2.47E-09	1.39E-10	9.15E-11	2.59E-11	1.16E-10	9.06E-10	1.24E-10

Table B.2 (continued)

Committed dose equivalent in various organs or tissues per intake of unit activity by ingestion (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
V-49	338. D	0.01	3.48E-12	2.24E-13	2.33E-13	2.26E-13	2.26E-13	2.33E-13	2.28E-13	2.30E-13	8.83E-12	6.36E-13	1.64E-11
V-52	3.75 M	0.01	2.46E-13	1.48E-13	1.98E-12	5.23E-14	1.65E-13	4.22E-14	3.77E-13	7.73E-13	1.39E-13	1.39E-13	7.78E-12
V-53	1.61 M	0.01	7.75E-14	4.78E-14	6.81E-13	1.43E-14	6.32E-14	1.32E-14	9.53E-14	1.69E-13	4.43E-14	4.43E-14	3.10E-12
Cr-51	27.704 D	0.1	1.02E-11	2.32E-12	4.74E-12	4.50E-12	1.92E-12	1.46E-12	1.61E-11	3.78E-12	6.03E-12	4.49E-12	3.75E-11
		0.01	8.48E-12	1.50E-12	3.55E-12	3.61E-12	3.98E-13	2.03E-13	1.60E-11	2.22E-12	3.06E-12	2.91E-12	3.94E-11
Mn-54	312.12 D	0.1	4.88E-10	1.60E-10	2.65E-10	2.11E-10	1.60E-10	1.33E-10	5.03E-10	4.13E-10	5.67E-10	3.72E-10	7.48E-10
Mn-56	2.5785 H	0.1	2.42E-11	7.84E-12	3.54E-11	7.69E-12	4.44E-12	2.40E-12	5.87E-11	1.75E-11	1.05E-11	8.53E-12	2.64E-10
Fe-55	2.73 Y	0.1	1.04E-10	9.90E-11	5.59E-10	1.04E-10	1.02E-10	1.09E-10	1.04E-10	1.05E-10	8.69E-11	1.37E-11	1.62E-10
Co-57	271.79 D	0.05	8.85E-11	2.15E-11	4.22E-11	3.29E-11	2.82E-11	1.93E-11	1.04E-10	3.90E-11	4.83E-11	4.17E-11	2.00E-10
		0.3	2.67E-10	1.04E-10	1.80E-10	1.37E-10	1.66E-10	1.15E-10	2.48E-10	1.99E-10	2.07E-10	1.66E-10	3.20E-10
Co-58	70.916 D	0.05	2.60E-10	8.43E-11	1.73E-10	1.62E-10	6.68E-11	6.32E-11	4.82E-10	1.51E-10	1.25E-10	1.20E-10	8.09E-10
		0.3	5.40E-10	2.76E-10	5.10E-10	4.91E-10	3.55E-10	3.64E-10	7.85E-10	5.93E-10	4.07E-10	3.75E-10	9.70E-10
Co-60	5.2714 Y	0.05	1.32E-09	6.93E-10	1.16E-09	1.08E-09	9.00E-10	7.88E-10	2.07E-09	1.59E-09	9.39E-10	8.57E-10	2.77E-09
		0.3	5.48E-09	3.54E-09	5.58E-09	5.42E-09	5.27E-09	4.68E-09	7.13E-09	8.74E-09	4.81E-09	4.31E-09	7.28E-09
Ni-57	35.60 H	0.05	2.24E-10	5.99E-11	1.44E-10	1.00E-10	2.06E-11	1.08E-11	4.91E-10	9.14E-11	8.13E-11	8.00E-11	1.05E-09
Cu-62	9.74 M	0.5	6.33E-13	2.97E-13	3.73E-12	7.49E-14	1.35E-13	9.23E-14	1.08E-12	9.36E-13	3.24E-13	3.02E-13	2.20E-11
Cu-64	12.700 H	0.5	1.92E-11	1.13E-11	2.03E-11	1.48E-11	1.16E-11	1.09E-11	2.85E-11	1.75E-11	1.37E-11	2.78E-11	1.27E-10
Cu-66	5.088 M	0.5	2.36E-14	1.48E-14	1.55E-13	7.39E-15	1.77E-14	6.49E-15	3.50E-14	4.21E-14	1.43E-14	1.10E-14	8.85E-12
Nb-92m	10.15 D	0.01	1.91E-10	4.57E-11	1.10E-10	8.50E-11	1.35E-11	6.80E-12	3.81E-10	6.77E-11	8.34E-11	7.28E-11	6.03E-10

Table B.2 (continued)

Committed dose equivalent in various organs or tissues per intake of unit activity by ingestion (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	BLADDER	STOMACH	SMALL INTESTINE	UPPER LARGE INTESTINE	LOWER LARGE INTESTINE	KIDNEYS	LIVER	LUNGS	BREASTS	OVARIES	PANCREAS
Nb-93m	15.8 Y	0.01	2.47E-12	3.54E-11	8.65E-11	4.85E-10	1.44E-09	3.37E-11	2.42E-12	2.40E-12	2.52E-12	5.75E-12	2.49E-12
Nb-94m	6.26 M	0.01	9.51E-16	5.73E-12	5.31E-13	7.71E-14	7.90E-15	4.22E-15	2.74E-15	2.67E-15	3.27E-15	5.52E-15	3.75E-14
Nb-94	2.03E4 Y	0.01	5.99E-10	7.62E-10	2.21E-09	5.12E-09	1.23E-08	6.87E-10	2.79E-10	1.70E-10	3.44E-10	1.78E-09	3.69E-10
Mo-93	3.500E3 Y	0.05	6.90E-12	1.85E-11	4.83E-11	1.75E-10	4.45E-10	1.05E-10	1.15E-10	6.78E-12	6.93E-12	2.61E-11	7.02E-12
		0.8	1.05E-10	1.11E-10	1.08E-10	1.36E-10	1.85E-10	1.68E-09	1.84E-09	1.08E-10	1.02E-10	1.30E-10	1.09E-10
Mo-99	65.94 H	0.05	7.50E-11	5.18E-10	1.26E-09	5.90E-09	1.41E-08	1.82E-10	1.85E-10	1.54E-11	3.46E-11	2.18E-10	3.87E-11
		0.8	1.94E-10	6.75E-10	4.68E-10	1.48E-09	3.24E-09	2.57E-09	2.75E-09	1.97E-10	1.88E-10	2.26E-10	2.39E-10
Mo-101	14.61 M	0.05	1.28E-12	2.76E-10	7.81E-11	2.40E-11	3.97E-12	3.61E-12	2.25E-12	1.55E-12	1.64E-12	3.77E-12	1.39E-11
		0.8	1.44E-12	2.77E-10	5.65E-11	1.85E-11	3.62E-12	3.88E-12	2.63E-12	1.88E-12	1.88E-12	3.37E-12	1.42E-11
Tc-99m	6.01 H	0.8	5.03E-12	1.11E-10	2.93E-11	5.30E-11	3.82E-11	5.70E-12	5.39E-12	3.64E-12	4.07E-12	1.02E-11	1.12E-11
Tc-99	2.111E5 Y	0.8	6.04E-11	3.39E-09	1.19E-10	4.05E-10	1.10E-09	6.04E-11	8.23E-11	6.04E-11	6.04E-11	6.04E-11	6.04E-11
Tc-101	14.2 M	0.8	2.87E-13	1.50E-10	2.28E-11	4.95E-12	7.60E-13	8.32E-13	5.40E-13	4.15E-13	4.08E-13	6.33E-13	3.26E-12
Ta-182	114.43 D	0.001	4.25E-10	6.08E-10	1.92E-09	5.40E-09	1.38E-08	2.19E-10	1.31E-10	3.48E-11	1.69E-10	1.33E-09	1.73E-10
W-181	121.2 D	0.01	2.01E-11	3.01E-11	1.02E-10	2.71E-10	6.81E-10	8.64E-12	4.97E-12	6.24E-13	7.02E-12	7.34E-11	6.61E-12
W-185	75.1 D	0.01	2.37E-14	1.46E-10	3.61E-10	2.12E-09	6.32E-09	1.32E-11	2.35E-12	8.35E-16	7.96E-15	7.76E-14	8.25E-15
W-187	23.72 H	0.01	6.59E-11	4.46E-10	1.07E-09	3.77E-09	6.40E-09	3.93E-11	2.74E-11	5.76E-12	2.90E-11	2.35E-10	3.95E-11
Re-186	90.64 H	0.8	9.60E-11	5.38E-09	2.96E-10	1.15E-09	2.78E-09	9.57E-11	1.29E-10	9.48E-11	9.49E-11	9.90E-11	9.89E-11
Re-187	4.35E10 Y	0.8	3.94E-13	2.21E-11	7.74E-13	2.64E-12	7.16E-12	3.94E-13	5.37E-13	3.94E-13	3.94E-13	3.94E-13	3.94E-13
Os-186	2.0E15 Y	0.01	1.45E-08	1.52E-08	1.61E-08	2.36E-08	4.24E-08	2.34E-07	2.02E-07	1.45E-08	1.45E-08	1.45E-08	1.45E-08
Po-210	138.376 D	0.1	8.25E-08	8.37E-08	8.52E-08	9.83E-08	1.31E-07	2.55E-06	4.40E-07	8.25E-08	8.25E-08	8.25E-08	8.25E-08

Table B.2 (continued)

Committed dose equivalent in various organs or tissues per intake of unit activity by ingestion (Sv/Bq)

NUCLIDE	HALF-LIFE	f1	RED MARROW	SKIN	SPLEENN	TESTES	THYMUS	THYROID	UTERUS	ADRENALS	BONE SURFACE	BRAIN	EFFECTIVE
Nb-93m	15.8 Y	0.01	2.28E-11	2.38E-12	3.23E-11	3.27E-11	2.46E-12	2.39E-12	2.46E-12	2.47E-12	5.85E-11	2.54E-12	1.38E-10
Nb-94m	6.26 M	0.01	2.05E-15	8.74E-16	1.29E-14	2.32E-16	7.99E-16	1.99E-16	3.14E-15	2.58E-15	1.03E-15	1.03E-15	3.86E-13
Nb-94	2.03E4 Y	0.01	7.31E-10	1.83E-10	6.19E-10	5.18E-10	1.32E-10	1.21E-10	8.13E-10	3.37E-10	7.55E-10	4.10E-10	1.91E-09
Mo-93	3.500E3 Y	0.05	2.01E-11	4.70E-12	6.19E-12	5.31E-12	7.70E-12	6.02E-12	6.41E-12	8.41E-12	7.33E-11	1.02E-11	6.65E-11
		0.8	2.88E-10	7.43E-11	9.86E-11	8.48E-11	1.23E-10	9.63E-11	9.64E-11	1.35E-10	1.16E-09	1.54E-10	3.73E-10
Mo-99	65.94 H	0.05	8.43E-11	1.77E-11	3.13E-11	2.75E-11	1.25E-11	1.06E-11	9.98E-11	2.57E-11	6.99E-11	2.06E-11	1.39E-09
		0.8	5.48E-10	1.66E-10	2.05E-10	1.75E-10	1.83E-10	1.68E-10	2.07E-10	2.47E-10	8.76E-10	6.55E-11	8.48E-10
Mo-101	14.61 M	0.05	1.64E-12	6.93E-13	7.97E-12	2.82E-13	5.24E-13	1.64E-13	3.40E-12	2.50E-12	7.55E-13	7.50E-13	2.56E-11
		0.8	1.83E-12	9.67E-13	8.22E-12	6.20E-13	9.00E-13	5.23E-13	3.12E-12	2.83E-12	1.07E-12	8.09E-13	2.41E-11
Tc-99m	6.01 H	0.8	6.79E-12	2.41E-12	7.53E-12	2.79E-12	3.58E-12	1.41E-10	7.67E-12	4.84E-12	4.56E-12	3.46E-12	2.33E-11
Tc-99	2.111E5 Y	0.8	6.04E-11	6.04E-11	6.04E-11	6.04E-11	6.04E-11	1.62E-09	6.04E-11	6.04E-11	6.04E-11	3.75E-16	3.95E-10
Tc-101	14.2 M	0.8	4.38E-13	2.02E-13	1.86E-12	1.23E-13	1.56E-13	3.88E-12	6.42E-13	5.63E-13	2.56E-13	1.79E-13	1.14E-11
Ta-182	114.43 D	0.001	3.07E-10	6.61E-11	1.50E-10	1.17E-10	1.79E-11	9.09E-12	5.84E-10	9.21E-11	1.15E-10	1.05E-10	1.74E-09
W-181	121.2 D	0.01	3.27E-11	1.66E-12	7.07E-12	4.52E-12	1.19E-13	5.41E-14	3.08E-11	2.08E-12	1.03E-11	9.71E-12	9.06E-11
W-185	75.1 D	0.01	1.62E-12	2.05E-15	1.14E-11	5.24E-15	2.15E-16	6.73E-17	3.43E-14	2.77E-15	4.88E-12	9.39E-15	5.38E-10
W-187	23.72 H	0.01	5.31E-11	1.03E-11	3.02E-11	1.92E-11	2.21E-12	6.93E-13	1.03E-10	1.63E-11	1.92E-11	1.74E-11	7.78E-10
Re-186	90.64 H	0.8	9.76E-11	9.36E-11	9.68E-11	9.42E-11	9.49E-11	4.79E-09	9.71E-11	9.54E-11	9.59E-11	3.51E-12	7.93E-10
Re-187	4.35E10 Y	0.8	3.94E-13	3.94E-13	3.94E-13	3.94E-13	3.94E-13	1.05E-11	3.94E-13	3.94E-13	3.94E-13	0.00E+00	2.57E-12
Os-186	2.0E15 Y	0.01	1.45E-08	1.45E-08	2.02E-07	1.45E-08	1.45E-08	1.45E-08	1.45E-08	1.45E-08	1.45E-08	0.00E+00	5.24E-08
Po-210	138.376 D	0.1	8.25E-08	8.25E-08	4.39E-06	8.25E-08	8.25E-08	8.25E-08	8.25E-08	8.25E-08	8.25E-08	3.69E-15	5.14E-07