

**Identification of Radionuclides
of Concern in Hanford Site
Environmental Cleanup**

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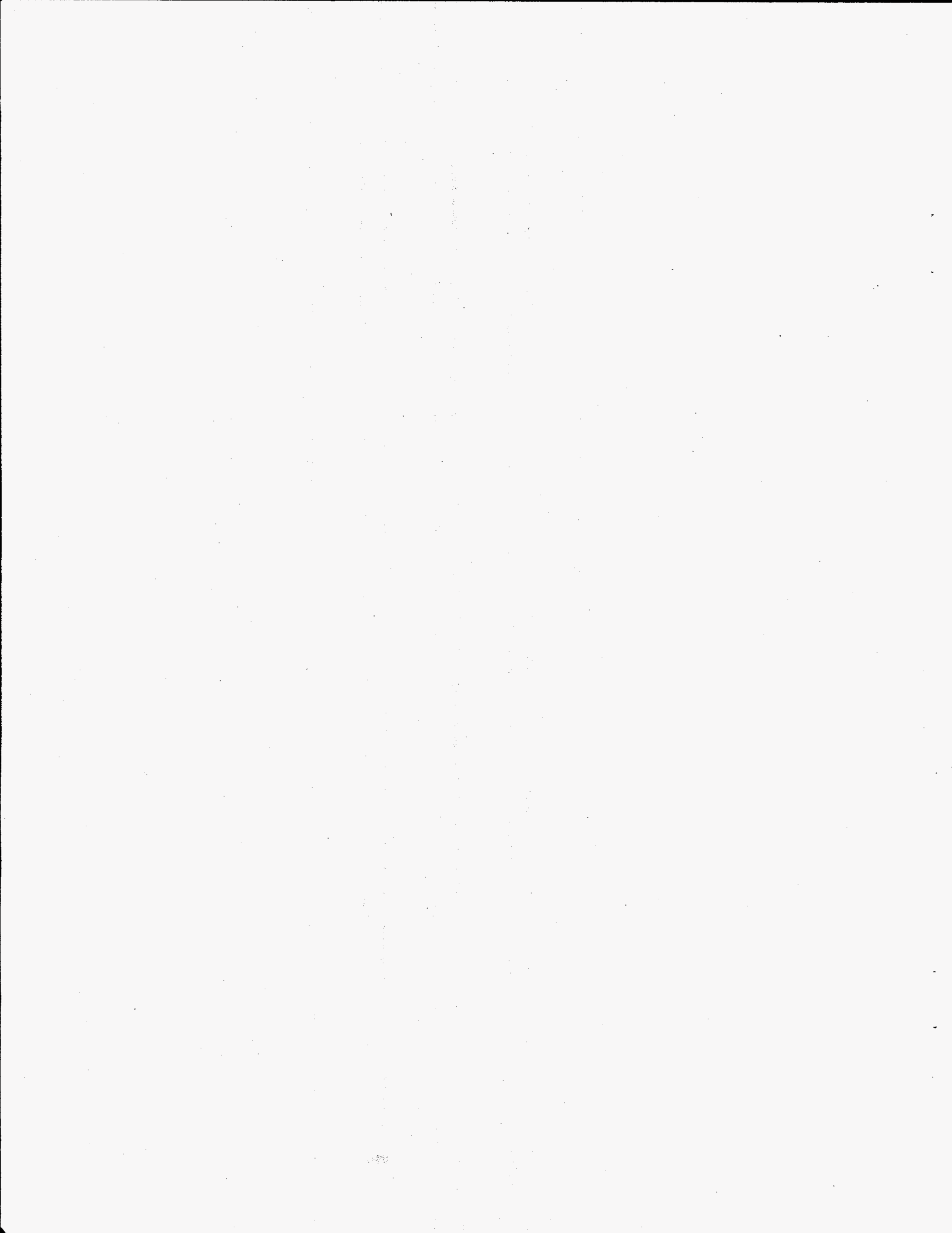
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Executive Summary

The purpose of this document is to consider which radionuclides should be included in conducting environmental surveys relative to site remediation at Hanford. During the operation of the Hanford site, the fission product radionuclides and a large number of activation products including the transuranic radionuclides were formed. The reactor operations and subsequent chemical processing and metallurgical operations resulted in the environmental release of gaseous and liquid effluents containing some radionuclides; however, the majority of the radionuclides were stored in waste tanks or disposed to trenches and cribs. Since some contamination of both soils and subsurface waters occurred, one must decide which radionuclides may remain in sufficient amounts to be of concern at the time when site remediation is to be complete.

Many of the radionuclides which have constituted the principal hazard during site operation have half-lives on the order of a year or less; therefore, they will have decayed to insignificant amounts by the year 2030, a possible date for completion of the remediation process. An example of how decay will take care of decontamination for radionuclides with half-lives of a year or less is illustrated below for a hypothetical radionuclide with a one-year half-life.

<u>Decay Period (years)</u>	<u>Fraction of Original Activity Remaining</u>
10	One-thousandth
20	One-millionth
30	One-billionth
40	One-trillionth

Decay to one-trillionth of the original activity would reduce one curie of a radionuclide [2.22×10^{12} disintegrations per minute (dpm)] to one picocurie (2.22 dpm). If the half-life were two years, then the decay period of 40 years would decrease the content to one-millionth, and 80 years would be required to reduce it to one-trillionth of its original activity.

Since contamination of the environs was usually in quantities ranging from far less than one curie to perhaps thousands of curies, it should be clear that for radionuclides with half-lives of less than a year (unless they are supported by long-lived parents) natural depletion by radioactive decay may have already reduced their concentration to negligible quantities, or it certainly will have by the year 2030.

To estimate the "relative hazard" or concern for those radionuclides which may be present in significant quantities after decay periods of tens, hundreds and thousands of years, their concentrations which would be present in irradiated fuel after various decay periods were calculated by use of the ORIGEN2 Code.^(1,2) These remaining activities were then divided by their "acceptable concentrations" (Derived Concentration Guide values)^(3,4) in drinking water and also in air (as a guide

for inhalation of resuspended soil) to provide an indication of their "relative hazard" after specific decay periods. In addition, calculations were made of the relative hazard from external radiation that would result if these radionuclides were deposited on the surface of Hanford soils. These "relative hazards" (which would only be relative if no fractionation of their initial abundances other than radioactive decay had occurred) provide a reasonable basis for selecting radionuclides which should be included in pre-remediation and subsequent surveys.

Based on this procedure and factoring in other considerations, including special isotope production processes and possible food chain concentration processes, it is concluded that the following radionuclides should probably be included in preremediation site surveys. Most of these are anthropogenic radionuclides of long-term concern. However, certain natural radionuclides are included since they provide a basis for estimating the primary source of these radionuclides which could be natural or man-made. The radionuclides include:

H-3	Eu-152	Pu-238
K-40	Eu-154	U-238
Co-60	Eu-155	Pu-239
Sr-90	Ra-226	Pu-240
Tc-99	Th-232	Am-241
Ru-106	U-232	Pu-241
Sb-125	U-233	Cm-244
I-129	U-234	
Cs-134	U-235	
Cs-137	Np-237	

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1.0 Introduction

The purpose of this work is to provide an estimate of the relative importance of the various radionuclides that were produced during the operation of the Hanford project. Specifically, it is designed to identify those radionuclides which may be present in significant amounts after a decay period comparable to that expected for the site cleanup operation. This information, together with Derived Concentration Guide (DCG) values^(3,4) and external radiation Dose Conversion Factors (DCF)⁽⁵⁾ for each radionuclide, could then provide a basis for selecting the spectrum of radionuclides which should be included in preremediation and subsequent site surveys.

During the production period of the Hanford Site, eight plutonium production reactors, together with the N-reactor which produced both plutonium and electric power, operated and produced fission and activation by-products. Irradiated fuels were processed for recovery of Pu-239 which was the principal product of the operation. In addition, two test reactors, the Plutonium Recycle Test Reactor (PRTR) and the Fast Flux Test Facility (FFTF) were operated and their fuels were reprocessed for material recovery. While literally thousands of fission and activation products were produced, most of these have relatively short half-lives and have decayed to insignificant concentrations since the reprocessing of fuels for plutonium recovery or other product recovery has ceased.

The relative concentrations of radionuclides which would still be present for periods out through 3000 years from now, but with particular emphasis on a period of about 40 years from the present, have been calculated with the ORIGEN2^(1,2) computer code. In carrying out this work, certain assumptions were made as to the irradiation time, the neutron energy spectrum, and the total megawatt days per ton to which this fuel was exposed. This provided a basis for calculating the actual and the relative amounts of the radionuclides that were present in fuel at the end of the irradiation process and for the various decay times of interest following irradiation. The ORIGEN2 code was employed for this purpose. The calculations were made using a cross-section library developed for the N reactor fuel/moderator design. However, analyses indicate that ORIGEN2 would provide a reasonable estimation of the radionuclide spectrum that was produced in the eight Hanford production reactors.⁽⁶⁾ By using results of the ORIGEN2 calculation, together with the DCG^(3,4) and external DCF values⁽⁵⁾ for each of the radionuclides, it was possible to determine the "relative hazards" or concern of each radionuclide as a function of time after production in the nuclear reactors.

2.0 Discussion

In the past, the main effort at the Hanford Site was the production of weapons-grade plutonium. This was accomplished by irradiation of natural and slightly enriched uranium in the eight production reactors and in the N dual-purpose reactor. The chemical separations process that followed fuel irradiation separated the plutonium from the fission, activation, and transuranic radionuclides, as well as the remaining uranium target material. Since plutonium recovery was the object of the process, its presence in the wastes and effluents was minimal, and therefore the amount of plutonium that might be a problem in the site remediation is far less than the amount produced.

In addition to the production of plutonium, some U-233 was produced. This radionuclide is a fissile isotope and was produced as a product for the thorium breeder reactor program. It was produced by irradiation of Th-232 target material. Irradiation of Th-232 produced Th-233 which decayed via Pa-233 to U-233. For this reason, U-233 production, while not specifically included in the tables of "relative hazards," may be of somewhat greater concern than indicated. However, its long half-life of 1.59×10^5 years limits its specific activity and thus its concern from the site cleanup standpoint. U-232, a by-product in U-233 production, is also of concern because of its short half-life (70 years) and associated high specific activity and that of its short-lived progeny. Its production involves the reaction $\text{Th-232}(n,2n)\text{Th-231}$, decay of Th-231 to Pa-231 and a neutron capture to form Pa-232 which, in turn, decays to U-232. The relatively short half-life of U-232 results in a high specific activity of both itself and its short-lived daughters, and thus it is of concern. Several other radionuclides were produced in the Hanford reactors and were separated as by-products and employed for research, heat or power sources, irradiation sources, and other applications. These included Pu-238, Np-237, Cs-137, Sr-90, and Pm-147. However, the amounts that were separated were very small compared with their total production and, therefore, the amounts removed would not need to be considered when estimating the potential hazard associated with these radionuclides in the Hanford environs.

The ORIGEN2 code^(1,2) was employed to estimate the relative concern of each of the fission products, activation products, and transuranic radionuclides which were produced in the operation of the Hanford Site. As indicated in the Introduction, the cross-section library was actually designed for the Hanford N reactor, but provides a reasonably good estimate of the actual and relative production rates of radionuclides in the eight Hanford Plutonium production reactors.⁽⁶⁾ It was assumed that all the fuel from the eight production reactors was irradiated to the average exposure of 728 MWd/MTU (see Appendix A).

In carrying out this work, it was recognized that most of the fission products, activation products, and many of the transuranic isotopes would have decayed to insignificance within a few years after their production.

If one were to assume that the Hanford Site cleanup would be completed in the year 2030, then it would be appropriate to determine what the relative concentrations of Hanford-produced radionuclides would be at that time. Since this is roughly 40 years past cessation of the last Hanford reactor operation, then one can readily illustrate that for radionuclides with half-lives of less than one year, they will have decayed to one-trillionth, or less of their original activities. The example is given of a hypothetical radionuclide with a half-life of one year. After a 10-year decay period, such a radionuclide will have decayed by approximately one-thousandth of its original activity. During each additional 10-year

period, the remaining radionuclides will again decay by the same amount as indicated below; and therefore, at the end of 40 years, they will have decayed to one-trillionth of their original activity.

<u>Decay Period (years)</u>	<u>Residual Activity</u>	<u>Fraction of Original Activity Remaining</u>
0	1 Ci	
10	1 mCi	One-thousandth
20	1 μ Ci	One-millionth
30	1 nCi	One-billionth
40	1 pCi	One-trillionth

Thus, if one curie (2.22×10^{12} dpm) of a radionuclide with a half-life of one year were produced, then 40 years later it will have decayed to one picocurie (2.22 dpm). Obviously, another 40 years of decay would have reduced it to an additional one-trillionth or to 10^{-24} of its original activity. Similarly, a radionuclide with a half-life of two years would decay to one-millionth in 40 years and one-trillionth in 80 years of its original concentration.

Even for a radionuclide with a half-life of five years, such as Co-60, its initial concentration will have been reduced to one-thousandth after 50 years and to one-millionth after 100 years. Keeping these facts in mind, one can better assess the importance of each of the reactor-generated radionuclides in any contemplated waste cleanup program. The approach in this document is to provide a simple, straightforward indication of the relative importance of including each of the radionuclides that was produced at Hanford in preremediation and subsequent site surveys.

It is recognized, of course, that during the release and following the release of radionuclides to the environment, there may be substantial fractionation. Nevertheless, this approach still provides a good indication of what radionuclides should be of concern.

To provide a further basis for selection of the radionuclides of concern, the Derived Concentration Guide, (DCG) value for each of the radionuclides was taken into account (see Appendix B). In order to appropriately employ these guides for each of the specific radionuclides, the relative concentrations of each radionuclide after specific decay periods of interest were divided by their DCG values. This approach was applied for the exposure pathways of inhalation and ingestion. In addition to these pathways of exposure, the relative hazards from direct external radiation exposure ("shine") were calculated,⁽⁵⁾ assuming the radionuclides were deposited on soil surfaces. The basic data for these calculations are given in Appendix C, and the results are included in the tables which are explained below.

Tables 2.1, 1-A through 1-I, Tables 2.2, 2-A through 2-I, and Tables 2.3, 3-A through 3-I summarize the concentrations of fission products, activation products, and the actinide radionuclides, respectively, that would be present in irradiated fuel following decay periods of 1 year, 3 years, 10 years, 30 years, 40 years, 100 years, 300 years, 1000 years, and 3000 years. In each case, only the 70 most abundant radionuclides are considered.

In Tables 2.4, 4-A through 4-I, Tables 2.5, 5-A through 5-I, and Tables 2.6, 6-A through 6-I the relative hazard, or relative concern, of each of these radionuclides is indicated for the inhalation pathway. Similarly, the relative hazard of the ingestion pathway (based on drinking water) is shown in Tables 2.7, 7-A through 7-I, Tables 2.8, 8-A through 8-I, and Tables 2.9, 9-A through 9-I. These tables were developed by dividing the relative abundances of each of the radionuclides by their DCG values in air and water, respectively (see Appendix B and Table 18).

Tables 2.10, 10-A through 10-I, Tables 2.11, 11-A through 11-I, and Tables 2.12, 12-A through 12-I summarize in a similar manner the relative hazard or concern of these radionuclides for the external radiation exposure pathway. These relative hazards were calculated by multiplying the relative concentrations of the radionuclides which would be present after various decay periods by their relative radiation dose per unit of radioactivity (curies) assuming surface deposition. These values are summarized in Appendix C.

The relative hazards, or relative concerns, listed in these tables can serve as a useful guide in determining which radionuclides may be of concern at the present time, at the estimated time of return of the Hanford Site to normal or limited usage, and at times, through 3000 years from the present. Since these values represent only the relative hazard for three possible pathways of exposure, the values for one pathway may only be compared within that pathway, and not with the other two pathways. While this provides a relatively simple method of determining which radionuclides should be measured in a preremediation or subsequent survey, it does not address the problem of food chain transfer which may concentrate some of these radionuclides in foods and, therefore, provide a greater relative hazard than that estimated by employing the DCG values in conjunction with the relative amounts of remaining radionuclides after specific decay periods. Food chain concentration factors should be taken into account where they may produce a significant effect on the potential hazards of any specific radionuclides.

An additional concern which is not addressed in the above tables is the production of U-233 (and inadvertently U-232) by irradiation of Th-232 and the production of tritium by irradiation of Li-6. Therefore, in identifying radio nuclides which should be of concern in site surveys, the radionuclides Th-232, U-232, U-233, and tritium should be included. Tritium is, of course, a ternary fission product, and is therefore already included with the fission products but far greater amounts could have been released during tritium production.

Table 2.1. Radionuclide Content of Fission Products in Hanford Reactor Fuel at Various Decay Times

Table 1-A. Decay Time = 1 Year				Table 1-B. Decay Time = 3 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
PR144	17.28 Min.	29.44	26.44	CE144	284.3 Days	4.958	18.86
CE144	284.3 Days	29.44	26.44	PR144	17.28 Min.	4.958	18.86
NB 95	35.15 Days	11.69	10.50	PM147	2.623 Years	4.322	16.44
PM147	2.623 Years	7.33	6.58	CS137	30 Years	2.271	8.64
RH106	29.9 Sec.	5.92	5.31	BA137m	2.552 Min.	2.149	8.17
RU106	1.008 Years	5.92	5.31	Y 90	2.667 Days	1.945	7.40
ZR 95	63.98 Days	5.43	4.87	SR 90	29.12 Years	1.944	7.39
Y 91	58.51 Days	3.41	3.06	RU106	1.008 Years	1.495	5.69
CS137	30 Years	2.38	2.14	RH106	29.9 Sec.	1.495	5.69
BA137m	2.552 Min.	2.25	2.02	KR 85	10.72 Years	0.226	0.858
Y 90	2.667 Days	2.04	1.83	SB125	2.77 Years	0.197	0.749
SR 90	29.12 Years	2.04	1.83	CS134	2.062 Years	0.104	0.397
SR 89	50.5 Days	1.50	1.35	PR144m	7.2 Min.	0.059	0.226
RU103	39.28 Days	0.375	0.337	TE125m	58 Days	0.048	0.183
PR144m	7.2 Min.	0.353	0.317	SM151	89.99 Years	0.044	0.166
RH103m	56.12 Min.	0.338	0.304	EU155	4.959 Years	0.042	0.161
SB125	2.77 Years	0.325	0.292	EU154	8.6 Years	0.012	0.045
KR 85	10.72 Years	0.257	0.231	H 3	12.35 Years	0.010	0.040
CS134	2.062 Years	0.204	0.183	NB 95	35.15 Days	0.0044	0.017
CE141	32.51 Days	0.158	0.142	ZR 95	63.98 Days	0.0020	7.5E-03
TE127m	109 Days	0.121	0.108	TE127m	109 Days	0.0012	4.4E-03
TE127	9.35 Hours	0.118	0.106	TE127	9.35 Hours	0.0011	4.3E-03
TE125m	58 Days	0.078	0.070	SN123	129.2 Days	0.00096	3.7E-03
EU155	4.959 Years	0.056	0.050	CD113m	14.59 Years	0.00084	3.2E-03
SN123	129.2 Days	0.048	0.043	Y 91	58.51 Days	0.00059	2.3E-03
SM151	89.99 Years	0.044	0.040	SN119m	245 Days	0.00054	2.0E-03
NB 95m	3.609 Days	0.040	0.036	TC 99	213 kY	0.00034	1.3E-03
EU154	8.6 Years	0.014	0.013	AG110m	249.9 Days	0.00025	9.4E-04
H 3	12.35 Years	0.012	0.011	SR 89	50.5 Days	6.6E-05	2.5E-04
TE129m	33.6 Days	0.0045	4.1E-03	EU152	13.6 Years	5.5E-05	2.1E-04
SN119m	245 Days	0.0042	3.8E-03	ZR 93	1.53 MY	4.7E-05	1.8E-04
PM148m	41.3 Days	0.0030	2.7E-03	SN126	100 kY	1.7E-05	6.3E-05
TE129	1.16 Hours	0.0029	2.6E-03	SB126m	19 Min.	1.7E-05	6.3E-05
AG110m	249.9 Days	0.0019	1.7E-03	NB 95m	3.609 Days	1.5E-05	5.6E-05
CD115m	44.59 Days	0.0011	9.7E-04	SE 79	64.96 kY	1.0E-05	3.9E-05
CD113m	14.59 Years	0.00093	8.3E-04	CS135	2.3 MY	8.3E-06	3.2E-05
TC 99	213 kY	0.00034	3.1E-04	NB 93m	13.6 Years	6.6E-06	2.5E-05
PM148	5.37 Days	0.00017	1.5E-04	PM146	5.5 Years	3.9E-06	1.5E-05
SB124	60.2 Days	0.00010	9.3E-05	AG110	24.6 Sec.	3.3E-06	1.3E-05
EU152	13.6 Years	6.1E-05	5.5E-05	SN121m	49.97 Years	2.9E-06	1.1E-05
TB160	72.3 Days	6.0E-05	5.4E-05	SB126	12.4 Days	2.3E-06	8.8E-06
ZR 93	1.53 MY	4.7E-05	4.2E-05	PD107	6.496 MY	1.2E-06	4.6E-06
AG110	24.6 Sec.	2.5E-05	2.2E-05	RU103	39.28 Days	9.5E-07	3.6E-06
SN126	100 kY	1.7E-05	1.5E-05	GD153	242 Days	9.3E-07	3.5E-06
SB126m	19 Min.	1.7E-05	1.5E-05	RH103m	56.12 Min.	8.5E-07	3.2E-06
SE 79	64.96 kY	1.0E-05	9.1E-06	I129	15.7 MY	6.8E-07	2.6E-06
CS135	2.3 MY	8.3E-06	7.5E-06	RH102	2.9 Years	3.2E-07	1.2E-06
GD153	242 Days	7.5E-06	6.7E-06	TB160	72.3 Days	5.4E-08	2.1E-07
PM146	5.5 Years	5.0E-06	4.5E-06	CE141	32.51 Days	2.7E-08	1.0E-07
PR143	13.56 Days	3.9E-06	3.5E-06	SB124	60.2 Days	2.3E-08	8.7E-08
SN121m	49.97 Years	3.0E-06	2.7E-06	PM148m	41.3 Days	1.4E-08	5.5E-08
NB 93m	13.6 Years	2.5E-06	2.2E-06	CD115m	44.59 Days	1.3E-08	4.8E-08
SB126	12.4 Days	2.3E-06	2.1E-06	TE123m	119.7 Days	2.9E-09	1.1E-08
LA140	1.676 Days	1.4E-06	1.3E-06	C 14	5.729 kY	2.7E-09	1.0E-08
BA140	12.79 Days	1.2E-06	1.1E-06	NB 94	20.3 kY	1.6E-09	5.9E-09
PD107	6.496 MY	1.2E-06	1.1E-06	TE129m	33.6 Days	1.3E-09	4.9E-09
I129	15.7 MY	6.8E-07	6.1E-07	HO166m	1.2 kY	1.1E-09	4.0E-09
RH102	2.9 Years	5.1E-07	4.6E-07	TE129	1.16 Hours	8.4E-10	3.2E-09
EU156	15.19 Days	4.0E-07	3.6E-07	PM148	5.37 Days	8.1E-10	3.1E-09
TE123m	119.7 Days	2.0E-07	1.8E-07	CE142	104.9 GY	6.5E-10	2.5E-09
IN115m	4.3 Hours	7.6E-08	6.8E-08	RB 87	46.96 GY	5.9E-10	2.2E-09
RB 86	18.66 Days	3.7E-08	3.3E-08	AG108m	127 Years	2.2E-10	8.5E-10
ND147	11.06 Days	2.1E-08	1.9E-08	SM147	107 GY	1.3E-10	5.0E-10
CS136	13.1 Days	9.7E-09	8.8E-09	BE 10	1.6 MY	6.7E-11	2.6E-10
XE131m	11.9 Days	5.1E-09	4.6E-09	EU150	36 Years	3.9E-11	1.5E-10
IN114m	49.51 Days	4.9E-09	4.4E-09	AG108	2.37 Min.	2.0E-11	7.5E-11
IN114	1.198 Min.	4.7E-09	4.3E-09	CD109	1.27 Years	1.1E-11	4.3E-11
C 14	5.729 kY	2.7E-09	2.4E-09	AG109m	39.6 Sec.	1.1E-11	4.3E-11
BA136m	0.308 Sec.	1.6E-09	1.4E-09	TC 98	4.199 MY	5.9E-12	2.2E-11
NB 94	20.3 kY	1.6E-09	1.4E-09	KR 81	209.9 kY	2.3E-12	8.9E-12

Table 2.1. (contd)

Table 1-C. Decay Time = 10 Years				Table 1-D. Decay Time = 30 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
CS137	30 Years	1.932	24.02	CS137	30 Years	1.217	27.06
BA137m	2.552 Min.	1.828	22.73	BA137m	2.552 Min.	1.151	25.60
Y 90	2.667 Days	1.646	20.46	Y 90	2.667 Days	1.023	22.75
SR 90	29.12 Years	1.646	20.46	SR 90	29.12 Years	1.022	22.73
PM147	2.623 Years	0.680	8.45	KR 85	10.72 Years	0.0394	0.876
KR 85	10.72 Years	0.144	1.78	SM151	89.99 Years	0.0355	0.789
SM151	89.99 Years	0.0414	0.514	PM147	2.623 Years	0.0034	0.077
SB125	2.77 Years	0.0342	0.425	H 3	12.35 Years	0.0023	0.051
EU155	4.959 Years	0.0160	0.198	EU154	8.6 Years	0.0013	0.030
RU106	1.008 Years	0.0121	0.151	EU155	4.959 Years	0.00097	0.022
RH106	29.9 Sec.	0.0121	0.151	TC 99	213 KY	0.00034	7.6E-03
CS134	2.062 Years	0.0099	0.123	CD113m	14.59 Years	0.00023	5.2E-03
PR144	17.28 Min.	0.0097	0.121	SB125	2.77 Years	0.00023	5.1E-03
CE144	284.3 Days	0.0097	0.121	TE125m	58 Days	5.6E-05	1.2E-03
TE125m	58 Days	0.0083	0.104	ZR 93	1.53 MY	4.7E-05	1.0E-03
H 3	12.35 Years	0.0071	0.088	NB 93m	13.6 Years	3.5E-05	7.8E-04
EU154	8.6 Years	0.0067	0.084	SB126m	19 Min.	1.6E-05	3.7E-04
CD113m	14.59 Years	0.00061	7.5E-03	SN126	100 KY	1.6E-05	3.7E-04
TC 99	213 KY	0.00034	4.3E-03	EU152	13.6 Years	1.4E-05	3.1E-04
PR144m	7.2 Min.	0.00012	1.4E-03	CS134	2.062 Years	1.2E-05	2.7E-04
ZR 93	1.53 MY	4.7E-05	5.9E-04	SE 79	64.96 KY	1.0E-05	2.3E-04
EU152	13.6 Years	3.9E-05	4.8E-04	CS135	2.3 MY	8.3E-06	1.9E-04
NB 93m	13.6 Years	1.8E-05	2.2E-04	SB126	12.4 Days	2.3E-06	5.1E-05
SB126m	19 Min.	1.6E-05	2.1E-04	SN121m	49.97 Years	2.0E-06	4.5E-05
SN126	100 KY	1.6E-05	2.1E-04	PD107	6.496 MY	1.2E-06	2.7E-05
SE 79	64.96 KY	1.0E-05	1.3E-04	I129	15.7 MY	6.8E-07	1.5E-05
CS135	2.3 MY	8.3E-06	1.0E-04	PM146	5.5 Years	1.3E-07	2.9E-06
SN121m	49.97 Years	2.7E-06	3.3E-05	RH106	29.9 Sec.	1.3E-08	2.9E-07
SB126	12.4 Days	2.3E-06	2.9E-05	RU106	1.008 Years	1.3E-08	2.9E-07
PM146	5.5 Years	1.6E-06	2.0E-05	C 14	5.729 KY	2.7E-09	6.0E-08
PD107	6.496 MY	1.2E-06	1.5E-05	NB 94	20.3 KY	1.6E-09	3.4E-08
I129	15.7 MY	6.8E-07	8.4E-06	HO166m	1.2 KY	1.0E-09	2.3E-08
SN119m	245 Days	3.9E-07	4.8E-06	CE142	104.9 GY	6.5E-10	1.4E-08
AG110m	249.9 Days	2.1E-07	2.6E-06	RB 87	46.96 GY	5.9E-10	1.3E-08
RH102	2.9 Years	6.0E-08	7.4E-07	RH102	2.9 Years	5.0E-10	1.1E-08
AG110	24.6 Sec.	2.7E-09	3.4E-08	SM147	107 GY	2.4E-10	5.3E-09
C 14	5.729 KY	2.7E-09	3.4E-08	AG108m	127 Years	1.9E-10	4.3E-09
NB 94	20.3 KY	1.6E-09	1.9E-08	PR144	17.28 Min.	1.8E-10	4.0E-09
SN123	129.2 Days	1.1E-09	1.3E-08	CE144	284.3 Days	1.8E-10	4.0E-09
HO166m	1.2 KY	1.0E-09	1.3E-08	BE 10	1.6 MY	6.7E-11	1.5E-09
CE142	104.9 GY	6.5E-10	8.1E-09	EU150	36 Years	2.3E-11	5.1E-10
GD153	242 Days	6.1E-10	7.6E-09	AG108	2.37 Min.	1.7E-11	3.8E-10
RB 87	46.96 GY	5.9E-10	7.3E-09	TC 98	4.199 MY	5.9E-12	1.3E-10
SM147	107 GY	2.2E-10	2.7E-09	KR 81	209.9 KY	2.3E-12	5.2E-11
AG108m	127 Years	2.1E-10	2.7E-09	PR144m	7.2 Min.	2.1E-12	4.8E-11
TE127m	109 Days	1.0E-10	1.3E-09	SM146	70 MY	1.8E-13	4.0E-12
TE127	9.35 Hours	9.9E-11	1.2E-09	ND144	2E+06 GY	3.0E-14	6.6E-13
BE 10	1.6 MY	6.7E-11	8.4E-10	LA138	135 GY	4.2E-15	9.3E-14
EU150	36 Years	3.4E-11	4.2E-10	IN115	5E+05 GY	1.3E-15	2.9E-14
AG108	2.37 Min.	1.9E-11	2.4E-10	SN119m	245 Days	4.1E-16	9.1E-15
TC 98	4.199 MY	5.9E-12	7.3E-11	AG110m	249.9 Days	3.3E-16	7.3E-15
KR 81	209.9 KY	2.3E-12	2.9E-11	SM149	1E+07 GY	1.8E-16	4.1E-15
AG109m	39.6 Sec.	2.5E-13	3.1E-12	SM148	8E+06 GY	1.4E-16	3.2E-15
CD109	1.27 Years	2.5E-13	3.1E-12	TM171	1.92 Years	5.0E-18	1.1E-16
SM146	70 MY	1.4E-13	1.7E-12	AG109m	39.6 Sec.	4.5E-18	1.0E-16
ND144	2E+06 GY	3.0E-14	3.7E-13	CD109	1.27 Years	4.5E-18	1.0E-16
TM171	1.92 Years	6.9E-15	8.5E-14	AG110	24.6 Sec.	4.3E-18	9.7E-17
LA138	135 GY	4.2E-15	5.2E-14	GD152	1E+05 GY	4.2E-18	9.3E-17
NB 95	35.15 Days	4.1E-15	5.1E-14	GD153	242 Days	5.0E-19	1.1E-17
ZR 95	63.98 Days	1.9E-15	2.3E-14	TE123	10001 GY	2.2E-19	5.0E-18
IN115	5E+05 GY	1.3E-15	1.6E-14	SN123	129.2 Days	1.0E-26	2.2E-25
TE123m	119.7 Days	1.1E-15	1.4E-14	TE127m	109 Days	6.7E-31	1.5E-29
SM149	1E+07 GY	1.8E-16	2.3E-15	TE127	9.35 Hours	6.6E-31	1.5E-29
SM148	8E+06 GY	1.4E-16	1.8E-15	TE123m	119.7 Days	4.6E-34	1.0E-32
Y 91	58.51 Days	4.2E-17	5.2E-16	TM170	128.6 Days	7.3E-36	1.6E-34
NB 95m	3.609 Days	1.4E-17	1.7E-16	SB139	0.172 Sec.	0	
GD152	1E+05 GY	3.3E-18	4.1E-17	TE133	12.45 Min.	0	
TB160	72.3 Days	1.2E-18	1.5E-17	TE133m	55.4 Min.	0	
TM170	128.6 Days	9.2E-19	1.1E-17	XE133	5.245 Days	0	
TE123	10001 GY	2.2E-19	2.8E-18	I133	20.8 Hours	0	

Table 2.1. (contd)

Table 1-E. Decay Time = 40 Years				Table 1-F. Decay Time = 100 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
CS137	30 Years	0.9659	27.22	CS137	30 Years	0.2415	27.50
BA137m	2.552 Min.	0.9138	25.75	BA137m	2.552 Min.	0.2284	26.01
Y 90	2.667 Days	0.8061	22.72	Y 90	2.667 Days	0.1933	22.01
SR 90	29.12 Years	0.8059	22.71	SR 90	29.12 Years	0.1932	22.00
SM151	89.99 Years	0.0328	0.926	SM151	89.99 Years	0.0207	2.36
KR 85	10.72 Years	0.0206	0.581	KR 85	10.72 Years	0.00043	0.049
H 3	12.35 Years	0.0013	0.037	TC 99	213 kY	0.00034	0.010
EU154	8.6 Years	0.00060	0.017	ZR 93	1.53 MY	4.7E-05	5.4E-03
TC 99	213 kY	0.00034	0.010	H 3	12.35 Years	4.5E-05	5.1E-03
PM147	2.623 Years	0.00025	6.9E-03	NB 93m	13.6 Years	4.5E-05	5.1E-03
EU155	4.959 Years	0.00024	6.8E-03	SN126	100 kY	1.6E-05	1.9E-03
CD113m	14.59 Years	0.00015	4.1E-03	SB126m	19 Min.	1.6E-05	1.9E-03
ZR 93	1.53 MY	4.7E-05	1.3E-03	SE 79	64.96 kY	1.0E-05	2.9E-04
NB 93m	13.6 Years	3.9E-05	1.1E-03	EU152	13.6 Years	8.4E-06	2.4E-04
SB125	2.77 Years	1.9E-05	5.3E-04	CS135	2.3 MY	8.3E-06	9.5E-04
SB126m	19 Min.	1.6E-05	4.6E-04	EU154	8.6 Years	4.8E-06	5.4E-04
SN126	100 kY	1.6E-05	4.6E-04	SB126	12.4 Days	2.3E-06	2.6E-04
SE 79	64.96 kY	1.0E-05	2.9E-04	PD107	6.496 MY	1.2E-06	1.4E-04
EU152	13.6 Years	8.4E-06	2.4E-04	SN121m	49.97 Years	7.7E-07	8.7E-05
CS135	2.3 MY	8.3E-06	2.3E-04	I129	15.7 MY	6.8E-07	7.7E-05
TE125m	58 Days	4.6E-06	1.3E-04	EU152	13.6 Years	3.9E-07	4.5E-05
SB126	12.4 Days	2.3E-06	6.5E-05	EU155	4.959 Years	5.5E-08	6.3E-06
SN121m	49.97 Years	1.8E-06	5.0E-05	C 14	5.729 kY	2.7E-09	3.1E-07
PD107	6.496 MY	1.2E-06	3.4E-05	NB 94	20.3 kY	1.5E-09	1.8E-07
I129	15.7 MY	6.8E-07	1.9E-05	HO166m	1.2 kY	9.9E-10	1.1E-07
CS134	2.062 Years	4.2E-07	1.2E-05	CE142	104.9 GY	6.5E-10	7.4E-08
PM146	5.5 Years	3.7E-08	1.0E-06	RB 87	46.96 GY	5.9E-10	6.7E-08
C 14	5.729 kY	2.7E-09	7.6E-08	SM147	107 GY	2.4E-10	2.7E-08
NB 94	20.3 kY	1.6E-09	4.4E-08	AG108m	127 Years	1.3E-10	1.5E-08
HO166m	1.2 kY	1.0E-09	2.9E-08	BE 10	1.6 MY	6.7E-11	7.7E-09
CE142	104.9 GY	6.5E-10	1.8E-08	PM147	2.623 Years	3.2E-11	3.6E-09
RB 87	46.96 GY	5.9E-10	1.7E-08	PM146	5.5 Years	1.9E-11	2.2E-09
SM147	107 GY	2.4E-10	6.7E-09	AG108	2.37 Min.	1.2E-11	1.3E-09
AG108m	127 Years	1.8E-10	5.1E-09	EU150	36 Years	6.0E-12	6.8E-10
BE 10	1.6 MY	6.7E-11	1.9E-09	TC 98	4.199 MY	5.9E-12	6.7E-10
RH102	2.9 Years	4.6E-11	1.3E-09	SB125	2.77 Years	5.7E-12	6.4E-10
EU150	36 Years	1.9E-11	5.3E-10	KR 81	209.9 kY	2.3E-12	2.7E-10
AG108	2.37 Min.	1.6E-11	4.6E-10	TE125m	58 Days	1.4E-12	1.6E-10
RH106	29.9 Sec.	1.3E-11	3.8E-10	SM146	70 MY	1.8E-13	2.1E-11
RU106	1.008 Years	1.3E-11	3.8E-10	ND144	2E+06 GY	3.0E-14	3.4E-12
TC 98	4.199 MY	5.9E-12	1.7E-10	LA138	135 GY	4.2E-15	4.8E-13
KR 81	209.9 kY	2.3E-12	6.6E-11	IN115	5E+05 GY	1.3E-15	1.5E-13
SM146	70 MY	1.8E-13	5.2E-12	CS134	2.062 Years	7.2E-16	8.2E-14
ND144	2E+06 GY	3.0E-14	8.4E-13	SM149	1E+07 GY	1.8E-16	2.1E-14
CE144	284.3 Days	2.4E-14	6.8E-13	SM148	8E+06 GY	1.4E-16	1.7E-14
PR144	17.28 Min.	2.4E-14	6.8E-13	RH102	2.9 Years	2.7E-17	3.1E-15
LA138	135 GY	4.2E-15	1.2E-13	GD152	1E+05 GY	4.7E-18	5.3E-16
IN115	5E+05 GY	1.3E-15	3.7E-14	TE123	10001 GY	2.2E-19	2.5E-17
PR144m	7.2 Min.	2.9E-16	8.2E-15	TM171	1.92 Years	5.3E-29	6.0E-27
SM149	1E+07 GY	1.8E-16	5.1E-15	RH106	29.9 Sec.	1.6E-29	1.8E-27
SM148	8E+06 GY	1.4E-16	4.1E-15	RU106	1.008 Years	1.6E-29	1.8E-27
GD152	1E+05 GY	4.4E-18	1.2E-16	CD109	1.27 Years	1.2E-34	1.3E-32
TE123	10001 GY	2.2E-19	6.3E-18	CS133	0 Stable	0	0
TM171	1.92 Years	1.5E-19	4.1E-18	BA133	10.74 Years	0	0
AG109m	39.6 Sec.	1.9E-20	5.5E-19	XE133m	2.19 Days	0	0
SN119m	245 Days	1.3E-20	3.8E-19	IN134	0.078 Sec.	0	0
AG110m	249.9 Days	1.3E-20	3.7E-19	XE133	5.245 Days	0	0
CD109	1.27 Years	9.3E-21	2.6E-19	I133m	9 Sec.	0	0
AG110	24.6 Sec.	1.7E-22	4.9E-21	SB134	11 Sec.	0	0
GD153	242 Days	1.4E-23	4.0E-22	XE131m	11.9 Days	0	0
SN123	129.2 Days	3.1E-35	8.6E-34	I131	8.041 Days	0	0
I127	0 Stable	0	0	IN132	0.12 Sec.	0	0
I128	24.98 Min.	0	0	CD132	0.145 Sec.	0	0
I130	12.36 Hours	0	0	SB132	2.8 Min.	0	0
I130m	9 Min.	0	0	XE131	0 Stable	0	0
I131	8.041 Days	0	0	TE132	3.258 Days	0	0
I132	2.3 Hours	0	0	TE131m	1.25 Days	0	0
I133	20.8 Hours	0	0	TE131	25 Min.	0	0
I133m	9 Sec.	0	0	SN132	40 Sec.	0	0
I134	52.6 Min.	0	0	I133	20.8 Hours	0	0

Table 2.1. (contd)

Table 1-G. Decay Time = 300 Years				Table 1-H. Decay Time = 1000 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
SM151	89.99 Years	0.00443	34.48	TC 99	213 KY	3.42E-04	67.1
CS137	30 Years	0.00238	18.49	ZR 93	1.53 MY	4.72E-05	9.25
BA137m	2.552 Min.	0.00225	17.48	NB 93m	13.6 Years	4.48E-05	8.79
Y 90	2.667 Days	0.00166	12.87	SM151	89.99 Years	2.02E-05	3.96
SR 90	29.12 Years	0.00165	12.86	SN126	100 KY	1.64E-05	3.21
TC 99	213 KY	0.00034	2.67	SB126m	19 Min.	1.64E-05	3.21
ZR 93	1.53 MY	4.7E-05	0.367	SE 79	64.96 KY	1.01E-05	1.97
NB 93m	13.6 Years	4.5E-05	0.349	CS135	2.3 MY	8.3E-06	1.63
SB126m	19 Min.	1.6E-05	0.128	SB126	12.4 Days	2.3E-06	0.450
SN126	100 KY	1.6E-05	0.128	PD107	6.496 MY	1.2E-06	0.237
SE 79	64.96 KY	1.0E-05	0.079	I129	15.7 MY	6.8E-07	0.133
CS135	2.3 MY	8.3E-06	0.065	C 14	5.729 KY	2.4E-09	4.7E-04
SB126	12.4 Days	2.3E-06	0.018	NB 94	20.3 KY	1.5E-09	2.9E-04
PD107	6.496 MY	1.2E-06	9.4E-03	CE142	104.9 GY	6.5E-10	1.3E-04
I129	15.7 MY	6.8E-07	5.3E-03	HO166m	1.2 KY	5.9E-10	1.2E-04
SN121m	49.97 Years	4.8E-08	3.7E-04	RB 87	46.96 GY	5.9E-10	1.2E-04
C 14	5.729 KY	2.6E-09	2.0E-05	SM147	107 GY	2.4E-10	4.7E-05
NB 94	20.3 KY	1.5E-09	1.2E-05	CS137	30 Years	2.2E-10	4.4E-05
KR 85	10.72 Years	1.0E-09	8.0E-06	BA137m	2.552 Min.	2.1E-10	4.2E-05
HO166m	1.2 KY	8.9E-10	6.9E-06	Y 90	2.667 Days	9.6E-11	1.9E-05
CE142	104.9 GY	6.5E-10	5.0E-06	SR 90	29.12 Years	9.6E-11	1.9E-05
CD113m	14.59 Years	6.3E-10	4.9E-06	BE 10	1.6 MY	6.7E-11	1.3E-05
H 3	12.35 Years	6.0E-10	4.7E-06	TC 98	4.199 MY	5.9E-12	1.2E-06
RB 87	46.96 GY	5.9E-10	4.6E-06	SN121m	49.97 Years	2.9E-12	5.7E-07
SM147	107 GY	2.4E-10	1.8E-06	KR 81	209.9 KY	2.3E-12	4.6E-07
BE 10	1.6 MY	6.7E-11	5.2E-07	AG108m	127 Years	9.7E-13	1.9E-07
AG108m	127 Years	4.4E-11	3.4E-07	SM146	70 MY	1.8E-13	3.6E-08
EU152	13.6 Years	1.5E-11	1.1E-07	AG108	2.37 Min.	8.6E-14	1.7E-08
TC 98	4.199 MY	5.9E-12	4.6E-08	ND144	2E+06 GY	3.0E-14	5.8E-09
AG108	2.37 Min.	3.9E-12	3.0E-08	LA138	135 GY	4.2E-15	8.2E-10
KR 81	209.9 KY	2.3E-12	1.8E-08	IN115	5E+05 GY	1.3E-15	2.6E-10
EU154	8.6 Years	4.8E-13	3.7E-09	SM149	1E+07 GY	1.8E-16	3.6E-11
SM146	70 MY	1.8E-13	1.4E-09	SM148	8E+06 GY	1.4E-16	2.8E-11
EU150	36 Years	1.3E-13	9.9E-10	GD152	1E+05 GY	4.7E-18	9.2E-13
ND144	2E+06 GY	3.0E-14	2.3E-10	TE123	10001 GY	2.2E-19	4.4E-14
LA138	135 GY	4.2E-15	3.3E-11	EU150	36 Years	1.8E-19	3.5E-14
IN115	5E+05 GY	1.3E-15	1.0E-11	CD113m	14.59 Years	2.3E-24	4.4E-19
SM149	1E+07 GY	1.8E-16	1.4E-12	H 3	12.35 Years	5.2E-27	1.0E-21
SM148	8E+06 GY	1.4E-16	1.1E-12	EU152	13.6 Years	4.7E-27	9.3E-22
GD152	1E+05 GY	4.7E-18	3.6E-14	KR 85	10.72 Years	2.3E-29	4.5E-24
TE123	10001 GY	2.2E-19	1.7E-15	XE133m	2.19 Days	0	0
EU155	4.959 Years	4.0E-20	3.1E-16	XE133	5.245 Days	0	0
PM146	5.5 Years	2.2E-22	1.7E-18	SN131	1.05 Min.	0	0
RH102	2.9 Years	4.7E-38	3.7E-34	CS133	0 Stable	0	0
SB134	11 Sec.	0	0	SB134	11 Sec.	0	0
IN134	0.078 Sec.	0	0	SB131	23 Min.	0	0
SN134	0.845 Sec.	0	0	SN134	0.845 Sec.	0	0
CS133	0 Stable	0	0	TE134	41.8 Min.	0	0
BA133	10.74 Years	0	0	BA133	10.74 Years	0	0
SB132	2.8 Min.	0	0	SB134m	10.7 Sec.	0	0
SN132	40 Sec.	0	0	IN134	0.078 Sec.	0	0
TE131	25 Min.	0	0	I133m	9 Sec.	0	0
IN132	0.12 Sec.	0	0	TE131m	1.25 Days	0	0
CD132	0.145 Sec.	0	0	SB132m	4.2 Min.	0	0
SB134m	10.7 Sec.	0	0	I132	2.3 Hours	0	0
TE134	41.8 Min.	0	0	I131	8.041 Days	0	0
SB131	23 Min.	0	0	XE131	0 Stable	0	0
XE133m	2.19 Days	0	0	XE131m	11.9 Days	0	0
XE132	0 Stable	0	0	CD132	0.145 Sec.	0	0
IN133	0.114 Sec.	0	0	IN132	0.12 Sec.	0	0
SN133	1.47 Sec.	0	0	SN132	40 Sec.	0	0
TE131m	1.25 Days	0	0	SB132	2.8 Min.	0	0
I132	2.3 Hours	0	0	I133	20.8 Hours	0	0
TE132	3.258 Days	0	0	TE132	3.258 Days	0	0
BA132	0 Stable	0	0	TE133m	55.4 Min.	0	0
XE131m	11.9 Days	0	0	TE131	25 Min.	0	0
I131	8.041 Days	0	0	XE132	0 Stable	0	0
XE133	5.245 Days	0	0	BA132	0 Stable	0	0
I133m	9 Sec.	0	0	IN133	0.114 Sec.	0	0
SB133	2.4 Min.	0	0	SN133	1.47 Sec.	0	0

Table 2.1. (contd)

Table 1-1. Decay Time = 3000 Years

Isotope	Half-Life	Curies/kgU	Per Cent
TC 99	213 KY	3.40E-04	69.9
ZR 93	1.53 MY	4.71E-05	9.68
NB 93m	13.6 Years	4.48E-05	9.20
SN126	100 KY	1.62E-05	3.32
SB126m	19 Min.	1.62E-05	3.32
SE 79	64.96 KY	9.8E-06	2.02
CS135	2.3 MY	8.3E-06	1.71
SB126	12.4 Days	2.3E-06	0.465
PD107	6.496 MY	1.2E-06	0.248
I129	15.7 MY	6.8E-07	0.139
C 14	5.729 KY	1.9E-09	3.9E-04
NB 94	20.3 KY	1.4E-09	2.9E-04
CE142	104.9 GY	6.5E-10	1.3E-04
RB 87	46.96 GY	5.9E-10	1.2E-04
SM147	107 GY	2.4E-10	4.9E-05
HO166m	1.2 KY	1.9E-10	3.8E-05
BE 10	1.6 MY	6.7E-11	1.4E-05
TC 98	4.199 MY	5.9E-12	1.2E-06
SM151	89.99 Years	4.1E-12	8.5E-07
KR 81	209.9 KY	2.3E-12	4.8E-07
SM146	70 MY	1.8E-13	3.8E-08
ND144	2E+06 GY	3.0E-14	6.1E-09
LA138	135 GY	4.2E-15	8.6E-10
IN115	5E+05 GY	1.3E-15	2.7E-10
SM149	1E+07 GY	1.8E-16	3.7E-11
SM148	8E+06 GY	1.4E-16	3.0E-11
AG108m	127 Years	1.8E-17	3.6E-12
GD152	1E+05 GY	4.7E-18	9.6E-13
AG108	2.37 Min.	1.6E-18	3.2E-13
TE123	10001 GY	2.2E-19	4.6E-14
SN121m	49.97 Years	2.6E-24	5.3E-19
CS137	30 Years	1.9E-30	3.9E-25
BA137m	2.552 Min.	1.8E-30	3.7E-25
Y 90	2.667 Days	2.0E-31	4.2E-26
SR 90	29.12 Years	2.0E-31	4.2E-26
EU150	36 Years	3.4E-36	6.9E-31
TE131	25 Min.	0	0
SN134	0.845 Sec.	0	0
BA133	10.74 Years	0	0
CS133	0 Stable	0	0
XE133m	2.19 Days	0	0
IN134	0.078 Sec.	0	0
XE131m	11.9 Days	0	0
SB134	11 Sec.	0	0
SB134m	10.7 Sec.	0	0
TE134	41.8 Min.	0	0
SB131	23 Min.	0	0
CD132	0.145 Sec.	0	0
SN131	1.05 Min.	0	0
IN131	0.3 Sec.	0	0
IN132	0.12 Sec.	0	0
I133	20.8 Hours	0	0
XE133	5.245 Days	0	0
CS132	6.475 Days	0	0
IN133	0.114 Sec.	0	0
I132	2.3 Hours	0	0
XE132	0 Stable	0	0
TE131m	1.25 Days	0	0
SB132m	4.2 Min.	0	0
SB132	2.8 Min.	0	0
SN132	40 Sec.	0	0
I133m	9 Sec.	0	0
BA132	0 Stable	0	0
TE132	3.258 Days	0	0
I131	8.041 Days	0	0
XE131	0 Stable	0	0
SN133	1.47 Sec.	0	0
SB133	2.4 Min.	0	0
TE133	12.45 Min.	0	0
TE133m	55.4 Min.	0	0

**Table 2.2. Radionuclide Content of Activation Products in Hanford
Reactor Fuel and Cladding at Various Decay Times**

Table 2-A. Decay Time = 1 Year				Table 2-B. Decay Time = 3 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
H 3	12.35 Years	0.0739	51.42	H 3	12.35 Years	0.0660	74.36
FE 55	2.6 Years	0.0267	18.57	FE 55	2.6 Years	0.0157	17.63
NB 95	35.15 Days	0.0144	10.03	NI 63	92 Years	0.0022	2.52
ZR 95	63.98 Days	0.0067	4.65	CO 60	5.270 Years	0.0020	2.29
SN119m	245 Days	0.0064	4.47	SB125	2.77 Years	0.0013	1.43
CO 58	70.78 Days	0.0039	2.69	SN119m	245 Days	0.00081	0.916
CO 60	5.270 Years	0.0027	1.85	TE125m	58 Days	0.00031	0.349
NI 63	92 Years	0.0023	1.58	MN 54	312.5 Days	0.00025	0.281
SB125	2.77 Years	0.0021	1.46	C 14	5.729 kY	0.00012	0.140
MN 54	312.5 Days	0.0013	0.877	NI 59	80 kY	1.8E-05	0.021
IN113m	1.658 Hours	0.0011	0.777	IN113m	1.658 Hours	1.4E-05	0.015
SN113	115.1 Days	0.0011	0.776	SN113	115.1 Days	1.4E-05	0.015
TE125m	58 Days	0.00051	0.352	SN123	129.2 Days	7.2E-06	8.1E-03
SN123	129.2 Days	0.00036	0.253	NB 95	35.15 Days	5.4E-06	6.1E-03
C 14	5.729 kY	0.00012	0.087	CO 58	70.78 Days	3.0E-06	3.4E-03
NB 95m	3.609 Days	5.0E-05	0.034	ZR 95	63.98 Days	2.4E-06	2.7E-03
HF181	42.4 Days	3.2E-05	0.022	SN121m	49.97 Years	1.3E-06	1.5E-03
CR 51	27.71 Days	2.6E-05	0.018	AG109m	39.6 Sec.	9.7E-07	1.1E-03
HF175	70 Days	2.4E-05	0.017	CD109	1.27 Years	9.7E-07	1.1E-03
Y 91	58.51 Days	1.9E-05	0.013	ZR 93	1.530 MY	2.2E-07	2.5E-04
NI 59	80 kY	1.8E-05	0.013	ZN 65	243.9 Days	1.5E-07	1.6E-04
FE 59	45 Days	1.7E-05	0.012	TA182	115 Days	4.7E-08	5.3E-05
W185	75.1 Days	1.6E-05	0.011	NB 93m	13.60 Years	3.1E-08	3.5E-05
SR 89	50.50 Days	3.9E-06	2.7E-03	W181	121.2 Days	2.9E-08	3.3E-05
TA182	115 Days	3.8E-06	2.7E-03	W185	75.1 Days	1.9E-08	2.2E-05
CD109	1.27 Years	2.9E-06	2.0E-03	NB 95m	3.609 Days	1.8E-08	2.0E-05
AG109m	39.6 Sec.	2.9E-06	2.0E-03	HF175	70 Days	1.7E-08	2.0E-05
W181	121.2 Days	1.9E-06	1.3E-03	Y 91	58.51 Days	3.2E-09	3.7E-06
SN121m	49.97 Years	1.3E-06	9.2E-04	MO 93	3.498 kY	1.4E-09	1.6E-06
ZN 65	243.9 Days	1.2E-06	8.1E-04	SC 46	83.80 Days	4.3E-10	4.8E-07
CD115m	44.59 Days	1.1E-06	7.5E-04	RE188	16.98 Hours	3.5E-10	3.9E-07
RE188	16.98 Hours	5.1E-07	3.6E-04	W188	69.4 Days	3.5E-10	3.9E-07
W188	69.4 Days	5.1E-07	3.5E-04	BE 10	1.600 MY	2.7E-10	3.1E-07
IN114m	49.51 Days	2.8E-07	1.9E-04	SR 90	29.12 Years	2.3E-10	2.6E-07
IN114	1.198 Min.	2.7E-07	1.9E-04	Y 90	2.667 Days	2.3E-10	2.6E-07
ZR 93	1.530 MY	2.2E-07	1.5E-04	FE 59	45 Days	2.2E-10	2.5E-07
SC 46	83.80 Days	1.8E-07	1.2E-04	HF181	42.4 Days	2.1E-10	2.3E-07
SB124	60.2 Days	3.2E-08	2.2E-05	SR 89	50.50 Days	1.7E-10	2.0E-07
NB 93m	13.60 Years	1.2E-08	8.2E-06	CA 45	163.0 Days	1.7E-10	1.9E-07
TE123m	119.7 Days	4.7E-09	3.3E-06	TE123m	119.7 Days	6.8E-11	7.7E-08
CA 45	163.0 Days	3.7E-09	2.6E-06	TC 99	213 kY	6.5E-11	7.3E-08
SN117m	14 Days	1.5E-09	1.0E-06	AG110m	249.9 Days	2.4E-11	2.7E-08
MO 93	3.498 kY	1.4E-09	9.8E-07	CD115m	44.59 Days	1.3E-11	1.4E-08
BE 10	1.600 MY	2.7E-10	1.9E-07	IN114m	49.51 Days	1.0E-11	1.1E-08
Y 90	2.667 Days	2.4E-10	1.7E-07	IN114	1.198 Min.	9.6E-12	1.1E-08
SR 90	29.12 Years	2.4E-10	1.7E-07	AG108m	127 Years	7.2E-12	8.1E-09
AG110m	249.9 Days	1.8E-10	1.3E-07	SB124	60.2 Days	7.0E-12	7.9E-09
TC 99	213 kY	6.5E-11	4.5E-08	NB 94	20.3 kY	2.3E-12	2.6E-09
LU177m	155 Days	3.5E-11	2.5E-08	LU177m	155 Days	1.4E-12	1.5E-09
TE127m	109 Days	1.3E-11	8.8E-09	AG108	2.37 Min.	6.4E-13	7.2E-10
TE127	9.35 Hours	1.2E-11	8.6E-09	HF182	9 MY	5.3E-13	6.0E-10
LU177	6.709 Days	8.2E-12	5.7E-09	SI 32	650 Years	5.1E-13	5.7E-10
AG108m	127 Years	7.3E-12	5.0E-09	P 32	14.3 Days	5.1E-13	5.7E-10
AG110	24.6 Sec.	2.4E-12	1.7E-09	AG110	24.6 Sec.	3.2E-13	3.6E-10
NB 94	20.3 kY	2.3E-12	1.6E-09	LU177	6.709 Days	3.1E-13	3.5E-10
AG108	2.37 Min.	6.5E-13	4.5E-10	CR 51	27.71 Days	3.0E-13	3.4E-10
HF182	9 MY	5.3E-13	3.7E-10	TE127m	109 Days	1.2E-13	1.4E-10
P 32	14.3 Days	5.1E-13	3.6E-10	TE127	9.35 Hours	1.2E-13	1.3E-10
SI 32	650 Years	5.1E-13	3.5E-10	RE187	50 GY	8.8E-14	9.9E-11
RE187	50 GY	8.8E-14	6.1E-11	PB205	30 MY	8.0E-14	9.1E-11
SN125	9.64 Days	8.2E-14	5.7E-11	PO210	138.4 Days	1.2E-15	1.4E-12
PB205	30 MY	8.0E-14	5.6E-11	LU176	30 GY	1.2E-17	1.3E-14
RU103	39.28 Days	5.7E-14	3.9E-11	TC 98	4.199 MY	1.3E-18	1.5E-15
PO210	138.4 Days	4.7E-14	3.3E-11	IR192	74.02 Days	5.2E-19	5.9E-16
SB126	12.4 Days	3.6E-14	2.5E-11	V 50	4E+07 GY	1.7E-19	1.9E-16
IR192	74.02 Days	5.5E-16	3.8E-13	RU103	39.28 Days	1.4E-19	1.6E-16
NB 92	10.16 Days	4.0E-17	2.8E-14	PB204	1E+08 GY	1.3E-19	1.5E-16
LU176	30 GY	1.2E-17	8.2E-15	IN115	5E+05 GY	1.2E-19	1.4E-16
TC 98	4.199 MY	1.3E-18	9.1E-16	BI208	368 kY	4.7E-20	5.3E-17
XE127	36.41 Days	2.4E-19	1.7E-16	BI210m	3 MY	3.1E-20	3.5E-17

Table 2.2. (contd)

Table 2-C. Decay Time = 10 Years

Isotope	Half-Life	Curies/kgU	Per Cent
H 3	12.35 Years	0.04456	88.53
FE 55	2.6 Years	0.00242	4.81
NI 63	92 Years	0.00212	4.22
CO 60	5.270 Years	0.00081	1.61
SB125	2.77 Years	0.00022	0.437
C 14	5.729 kY	0.00012	0.248
TE125m	58 Days	5.4E-05	0.107
NI 59	80 kY	1.8E-05	0.037
SN121m	49.97 Years	1.2E-06	2.3E-03
MN 54	312.5 Days	8.6E-07	1.7E-03
SN119m	245 Days	5.9E-07	1.2E-03
ZR 93	1.530 MY	2.2E-07	4.3E-04
NB 93m	13.60 Years	8.4E-08	1.7E-04
AG109m	39.6 Sec.	2.1E-08	4.2E-05
CD109	1.27 Years	2.1E-08	4.2E-05
MO 93	3.498 kY	1.4E-09	2.8E-06
BE 10	1.600 MY	2.7E-10	5.4E-07
SR 90	29.12 Years	2.0E-10	3.9E-07
Y 90	2.667 Days	2.0E-10	3.9E-07
ZN 65	243.9 Days	1.0E-10	2.0E-07
TC 99	213 kY	6.5E-11	1.3E-07
SN123	129.2 Days	7.9E-12	1.6E-08
AG108m	127 Years	6.9E-12	1.4E-08
IN113m	1.658 Hours	2.8E-12	5.6E-09
SN113	115.1 Days	2.8E-12	5.6E-09
NB 94	20.3 kY	2.3E-12	4.5E-09
AG108	2.37 Min.	6.1E-13	1.2E-09
TA182	115 Days	5.4E-13	1.1E-09
HF182	9 MY	5.3E-13	1.1E-09
P 32	14.3 Days	5.0E-13	1.0E-09
SI 32	650 Years	5.0E-13	1.0E-09
RE187	50 GY	8.8E-14	1.7E-10
PB205	30 MY	8.0E-14	1.6E-10
AG110m	249.9 Days	2.0E-14	3.9E-11
W181	121.2 Days	1.3E-14	2.6E-11
CA 45	163.0 Days	3.2E-15	6.3E-12
AG110	24.6 Sec.	2.6E-16	5.2E-13
CO 58	70.78 Days	4.0E-17	8.0E-14
TE123m	119.7 Days	2.5E-17	5.0E-14
LU177m	155 Days	1.5E-17	2.9E-14
LU176	30 GY	1.2E-17	2.3E-14
NB 95	35.15 Days	5.1E-18	1.0E-14
LU177	6.709 Days	3.4E-18	6.7E-15
ZR 95	63.98 Days	2.3E-18	4.5E-15
TC 98	4.199 MY	1.3E-18	2.6E-15
W185	75.1 Days	1.1E-18	2.2E-15
SC 46	83.80 Days	2.8E-19	5.5E-16
HF175	70 Days	1.8E-19	3.5E-16
V 50	4E+07 GY	1.7E-19	3.4E-16
PB204	1E+08 GY	1.3E-19	2.6E-16
IN115	5E+05 GY	1.2E-19	2.5E-16
BI208	368 kY	4.7E-20	9.4E-17
BI210m	3 MY	3.1E-20	6.2E-17
TL206	4.19 Min.	3.1E-20	6.2E-17
NB 95m	3.609 Days	1.7E-20	3.4E-17
TE127m	109 Days	1.1E-20	2.1E-17
TE127	9.35 Hours	1.0E-20	2.0E-17
PD107	6.496 MY	7.1E-21	1.4E-17
IR192	74.02 Days	6.7E-21	1.3E-17
IR192m	241 Years	6.7E-21	1.3E-17
TE123	10001 GY	5.3E-21	1.1E-17
PO210	138.4 Days	3.5E-21	6.9E-18
RE188	16.98 Hours	2.8E-21	5.6E-18
W188	69.4 Days	2.8E-21	5.6E-18
RH102	2.9 Years	1.6E-21	3.2E-18
PT193	500 Years	4.0E-22	7.9E-19
Y 91	58.51 Days	2.3E-22	4.5E-19
SB124	60.2 Days	1.1E-24	2.3E-21
I129	15.7 MY	1.2E-25	2.3E-22
SR 89	50.50 Days	9.9E-26	2.0E-22

Table 2-D. Decay Time = 30 Years

Isotope	Half-Life	Curies/kgU	Per Cent
H 3	12.35 Years	0.01450	87.66
NI 63	92 Years	0.00183	11.04
C 14	5.729 kY	0.00012	0.751
CO 60	5.270 Years	5.8E-05	0.353
NI 59	80 kY	1.8E-05	0.111
FE 55	2.6 Years	1.2E-05	0.071
SB125	2.77 Years	1.5E-06	8.9E-03
SN121m	49.97 Years	8.9E-07	5.4E-03
TE125m	58 Days	3.6E-07	2.2E-03
ZR 93	1.530 MY	2.2E-07	1.3E-03
NB 93m	13.60 Years	1.6E-07	9.9E-04
MO 93	3.498 kY	1.4E-09	8.4E-06
BE 10	1.600 MY	2.7E-10	1.6E-06
Y 90	2.667 Days	1.2E-10	7.4E-07
SR 90	29.12 Years	1.2E-10	7.4E-07
TC 99	213 kY	6.5E-11	3.9E-07
AG108m	127 Years	6.2E-12	3.7E-08
NB 94	20.3 kY	2.3E-12	1.4E-08
AG108	2.37 Min.	5.5E-13	3.3E-09
HF182	9 MY	5.3E-13	3.2E-09
TA182	115 Days	5.3E-13	3.2E-09
P 32	14.3 Days	4.9E-13	3.0E-09
SI 32	650 Years	4.9E-13	3.0E-09
AG109m	39.6 Sec.	3.9E-13	2.3E-09
CD109	1.27 Years	3.9E-13	2.3E-09
RE187	50 GY	8.8E-14	5.3E-10
PB205	30 MY	8.0E-14	4.9E-10
MN 54	312.5 Days	7.9E-14	4.8E-10
SN119m	245 Days	6.2E-16	3.8E-12
LU176	30 GY	1.2E-17	7.1E-14
TC 98	4.199 MY	1.3E-18	7.9E-15
V 50	4E+07 GY	1.7E-19	1.0E-15
PB204	1E+08 GY	1.3E-19	7.9E-16
IN115	5E+05 GY	1.2E-19	7.5E-16
ZN 65	243.9 Days	9.6E-20	5.9E-16
BI208	368 kY	4.7E-20	2.9E-16
BI210m	3 MY	3.1E-20	1.9E-16
TL206	4.19 Min.	3.1E-20	1.9E-16
PD107	6.496 MY	7.1E-21	4.3E-17
IR192	74.02 Days	6.3E-21	3.8E-17
IR192m	241 Years	6.3E-21	3.8E-17
TE123	10001 GY	5.3E-21	3.2E-17
RH102	2.9 Years	1.6E-21	9.7E-18
PT193	500 Years	4.0E-22	2.4E-18
PO210	138.4 Days	1.2E-22	7.5E-19
AG110m	249.9 Days	3.1E-23	1.9E-19
AG110	24.6 Sec.	4.2E-25	2.5E-21
I129	15.7 MY	1.2E-25	7.0E-22
K 42	12.36 Hours	6.7E-26	4.1E-22
AR 42	33 Years	6.7E-26	4.1E-22
CA 45	163.0 Days	1.0E-28	6.1E-25
SN123	129.2 Days	7.5E-29	4.5E-25
TM171	1.92 Years	6.5E-31	3.9E-27
IN113m	1.658 Hours	2.2E-31	1.3E-27
SN113	115.1 Days	2.2E-31	1.3E-27
LU177m	155 Days	9.5E-32	5.8E-28
LU177	6.709 Days	2.2E-32	1.3E-28
W181	121.2 Days	9.3E-33	5.6E-29
RH106	29.9 Sec.	5.3E-33	3.2E-29
RU106	1.008 Years	5.3E-33	3.2E-29
TE123m	119.7 Days	1.1E-35	6.4E-32
BA131m	15 Min.	0	0
LA138	135 GY	0	0
BA132	0 Stable	0	0
BA135m	1.196 Days	0	0
BA133	10.74 Years	0	0
BA133m	1.62 Days	0	0
SM146	70 MY	0	0
BA134	0 Stable	0	0
BA135	0 Stable	0	0

Table 2.2. (contd)

Table 2-E. Decay Time = 40 Years				Table 2-F. Decay Time = 100 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
H 3	12.35 Years	0.00827	81.69	NI 63	92 Years	0.001078	71.60
NI 63	92 Years	0.00169	16.73	H 3	12.35 Years	0.000285	18.94
C 14	5.729 kY	0.00012	1.23	C 14	5.729 kY	0.000123	8.19
NI 59	80 kY	1.8E-05	0.182	NI 59	80 kY	1.8E-05	1.22
CO 60	5.270 Years	1.6E-05	0.155	SN121m	49.97 Years	3.4E-07	0.022
FE 55	2.6 Years	8.1E-07	8.0E-03	ZR 93	1.530 MY	2.2E-07	0.015
SN121m	49.97 Years	7.7E-07	7.6E-03	NB 93m	13.60 Years	2.1E-07	0.014
ZR 93	1.530 MY	2.2E-07	2.2E-03	CO 60	5.270 Years	5.9E-09	3.9E-04
NB 93m	13.60 Years	1.8E-07	1.8E-03	MO 93	3.498 kY	1.4E-09	9.1E-05
SB125	2.77 Years	1.2E-07	1.2E-03	BE 10	1.600 MY	2.7E-10	1.8E-05
TE125m	58 Days	2.9E-08	2.9E-04	TC 99	213 kY	6.5E-11	4.3E-06
MO 93	3.498 kY	1.4E-09	1.4E-05	Y 90	2.667 Days	2.3E-11	1.5E-06
BE 10	1.600 MY	2.7E-10	2.7E-06	SR 90	29.12 Years	2.3E-11	1.5E-06
Y 90	2.667 Days	9.6E-11	9.5E-07	AG108m	127 Years	4.2E-12	2.8E-07
SR 90	29.12 Years	9.6E-11	9.5E-07	NB 94	20.3 kY	2.3E-12	1.5E-07
TC 99	213 kY	6.5E-11	6.4E-07	TA182	115 Days	5.3E-13	3.5E-08
AG108m	127 Years	5.9E-12	5.8E-08	HF182	9 MY	5.3E-13	3.5E-08
NB 94	20.3 kY	2.3E-12	2.2E-08	SI 32	650 Years	4.6E-13	3.0E-08
HF182	9 MY	5.3E-13	5.3E-09	P 32	14.3 Days	4.6E-13	3.0E-08
TA182	115 Days	5.3E-13	5.3E-09	AG108	2.37 Min.	3.8E-13	2.5E-08
AG108	2.37 Min.	5.2E-13	5.1E-09	FE 55	2.6 Years	9.2E-14	6.1E-09
P 32	14.3 Days	4.9E-13	4.8E-09	RE187	50 GY	8.8E-14	5.8E-09
SI 32	650 Years	4.9E-13	4.8E-09	PB205	30 MY	8.0E-14	5.3E-09
RE187	50 GY	8.8E-14	8.7E-10	SB125	2.77 Years	3.6E-14	2.4E-09
PB205	30 MY	8.0E-14	7.9E-10	TE125m	58 Days	8.9E-15	5.9E-10
AG109m	39.6 Sec.	1.7E-15	1.6E-11	LU176	30 GY	1.2E-17	7.8E-13
CD109	1.27 Years	1.7E-15	1.6E-11	TC 98	4.199 MY	1.3E-18	8.6E-14
MN 54	312.5 Days	2.4E-17	2.4E-13	V 50	4E+07 GY	1.7E-19	1.1E-14
LU176	30 GY	1.2E-17	1.2E-13	PB204	1E+08 GY	1.3E-19	8.6E-15
TC 98	4.199 MY	1.3E-18	1.3E-14	IN115	5E+05 GY	1.2E-19	8.2E-15
V 50	4E+07 GY	1.7E-19	1.7E-15	BI208	368 kY	4.7E-20	3.1E-15
PB204	1E+08 GY	1.3E-19	1.3E-15	BI210m	3 MY	3.1E-20	2.1E-15
IN115	5E+05 GY	1.2E-19	1.2E-15	TL206	4.19 Min.	3.1E-20	2.1E-15
BI208	368 kY	4.7E-20	4.7E-16	PD107	6.496 MY	7.1E-21	4.7E-16
BI210m	3 MY	3.1E-20	3.1E-16	TE123	10001 GY	5.3E-21	3.6E-16
TL206	4.19 Min.	3.1E-20	3.1E-16	IR192	74.02 Days	5.1E-21	3.4E-16
SN119m	245 Days	2.0E-20	2.0E-16	IR192m	241 Years	5.0E-21	3.3E-16
PD107	6.496 MY	7.1E-21	7.0E-17	PT193	500 Years	4.0E-22	2.6E-17
IR192	74.02 Days	6.1E-21	6.0E-17	PO210	138.4 Days	1.2E-22	8.3E-18
IR192m	241 Years	6.1E-21	6.0E-17	I129	15.7 MY	1.2E-25	7.6E-21
TE123	10001 GY	5.3E-21	5.3E-17	AR 42	33 Years	6.7E-26	4.5E-21
RH102	2.9 Years	1.6E-21	1.6E-17	K 42	12.36 Hours	6.7E-26	4.5E-21
PT193	500 Years	4.0E-22	3.9E-18	RH102	2.9 Years	8.7E-29	5.8E-24
PO210	138.4 Days	1.2E-22	1.2E-18	AG109m	39.6 Sec.	1.0E-29	6.6E-25
ZN 65	243.9 Days	3.0E-24	3.0E-20	CD109	1.27 Years	1.0E-29	6.6E-25
I129	15.7 MY	1.1E-25	1.1E-21	B 10	0 Stable	0	0
K 42	12.36 Hours	6.7E-26	6.6E-22	B 11	0 Stable	0	0
AR 42	33 Years	6.7E-26	6.6E-22	B 12	0.02 Sec.	0	0
AG110m	249.9 Days	1.3E-27	1.2E-23	C 12	0 Stable	0	0
AG110	24.6 Sec.	1.7E-29	1.6E-25	C 13	0 Stable	0	0
TM171	1.92 Years	6.5E-31	6.4E-27	C 15	2.449 Sec.	0	0
RU106	1.008 Years	5.3E-33	5.2E-29	F 19	0 Stable	0	0
CA 45	163.0 Days	1.8E-35	1.8E-31	F 20	11.4 Sec.	0	0
SN123	129.2 Days	2.3E-37	2.3E-33	H 1	0 Stable	0	0
LU177m	155 Days	7.1E-39	7.0E-35	H 2	0 Stable	0	0
B 10	0 Stable	0	0	H 4	0.001 Sec.	0	0
B 11	0 Stable	0	0	I125	59.7 Days	0	0
B 12	0.02 Sec.	0	0	I126	13.02 Days	0	0
C 12	0 Stable	0	0	I127	0 Stable	0	0
C 13	0 Stable	0	0	I128	24.98 Min.	0	0
C 15	2.449 Sec.	0	0	I130	12.36 Hours	0	0
F 19	0 Stable	0	0	I130m	9 Min.	0	0
F 20	11.4 Sec.	0	0	I131	8.041 Days	0	0
H 1	0 Stable	0	0	I132	2.3 Hours	0	0
H 2	0 Stable	0	0	K 39	0 Stable	0	0
H 4	0.001 Sec.	0	0	K 40	1.280 GY	0	0
I125	59.7 Days	0	0	K 41	0 Stable	0	0
I126	13.02 Days	0	0	K 43	22.6 Hours	0	0
I127	0 Stable	0	0	K 44	22 Min.	0	0
I128	24.98 Min.	0	0	N 13	9.97 Min.	0	0

Table 2.2. (contd)

Table 2-G. Decay Time = 300 Years				Table 2-H. Decay Time = 1000 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
Ni 63	92 Years	0.000239	63.19	C 14	5.729 kY	0.000111	84.74
C 14	5.729 kY	0.000120	31.83	Ni 59	80 kY	0.000018	14.00
Ni 59	80 kY	0.000018	4.86	Ni 63	92 Years	1.2E-06	0.939
Zr 93	1.530 MY	2.2E-07	0.058	Zr 93	1.530 MY	2.2E-07	0.168
NB 93m	13.60 Years	2.1E-07	0.055	NB 93m	13.60 Years	2.1E-07	0.159
SN121m	49.97 Years	2.1E-08	5.6E-03	MO 93	3.498 kY	1.2E-09	8.8E-04
H 3	12.35 Years	3.8E-09	1.0E-03	BE 10	1.600 MY	2.7E-10	2.1E-04
MO 93	3.498 kY	1.3E-09	3.5E-04	TC 99	213 kY	6.5E-11	5.0E-05
BE 10	1.600 MY	2.7E-10	7.2E-05	NB 94	20.3 kY	2.2E-12	1.7E-06
TC 99	213 kY	6.5E-11	1.7E-05	SN121m	49.97 Years	1.3E-12	9.8E-07
NB 94	20.3 kY	2.2E-12	5.9E-07	TA182	115 Days	5.3E-13	4.1E-07
AG108m	127 Years	1.4E-12	3.8E-07	HF182	9 MY	5.3E-13	4.1E-07
TA182	115 Days	5.3E-13	1.4E-07	P 32	14.3 Days	1.7E-13	1.3E-07
HF182	9 MY	5.3E-13	1.4E-07	SI 32	650 Years	1.7E-13	1.3E-07
P 32	14.3 Days	3.7E-13	9.8E-08	RE187	50 GY	8.8E-14	6.7E-08
SI 32	650 Years	3.7E-13	9.8E-08	PB205	30 MY	8.0E-14	6.2E-08
Y 90	2.667 Days	2.0E-13	5.2E-08	AG108m	127 Years	3.1E-14	2.4E-08
SR 90	29.12 Years	2.0E-13	5.2E-08	AG108	2.37 Min.	2.8E-15	2.1E-09
AG108	2.37 Min.	1.3E-13	3.3E-08	LU176	30 GY	1.2E-17	9.0E-12
RE187	50 GY	8.8E-14	2.3E-08	TC 98	4.199 MY	1.3E-18	1.0E-12
PB205	30 MY	8.0E-14	2.1E-08	V 50	4E+07 GY	1.7E-19	1.3E-13
LU176	30 GY	1.2E-17	3.1E-12	PB204	1E+08 GY	1.3E-19	1.0E-13
TC 98	4.199 MY	1.3E-18	3.4E-13	IN115	5E+05 GY	1.2E-19	9.5E-14
V 50	4E+07 GY	1.7E-19	4.5E-14	BI208	368 kY	4.7E-20	3.6E-14
PB204	1E+08 GY	1.3E-19	3.4E-14	BI210m	3 MY	3.1E-20	2.4E-14
IN115	5E+05 GY	1.2E-19	3.3E-14	TL206	4.19 Min.	3.1E-20	2.4E-14
BI208	368 kY	4.7E-20	1.3E-14	SR 90	29.12 Years	1.1E-20	8.8E-15
BI210m	3 MY	3.1E-20	8.3E-15	Y 90	2.667 Days	1.1E-20	8.8E-15
TL206	4.19 Min.	3.1E-20	8.2E-15	PD107	6.496 MY	7.1E-21	5.5E-15
CO 60	5.270 Years	2.2E-20	5.8E-15	TE123	10001 GY	5.3E-21	4.1E-15
PD107	6.496 MY	7.1E-21	1.9E-15	IR192	74.02 Days	4.3E-22	3.3E-16
TE123	10001 GY	5.3E-21	1.4E-15	IR192m	241 Years	4.3E-22	3.3E-16
IR192	74.02 Days	2.8E-21	7.5E-16	PT193	500 Years	1.4E-22	1.1E-16
IR192m	241 Years	2.8E-21	7.4E-16	PO210	138.4 Days	1.2E-22	9.6E-17
PT193	500 Years	2.9E-22	7.6E-17	I129	15.7 MY	1.2E-25	8.8E-20
PO210	138.4 Days	1.2E-22	3.3E-17	H 3	12.35 Years	3.3E-26	2.5E-20
I129	15.7 MY	1.2E-25	3.0E-20	AR 42	33 Years	2.8E-32	2.1E-26
K 42	12.36 Hours	6.7E-26	1.8E-20	K 42	12.36 Hours	2.8E-32	2.1E-26
AR 42	33 Years	6.7E-26	1.8E-20	LA141	3.931 Hours	0	0
BA141	18.27 Min.	0	0	LA137	59.99 kY	0	0
LA137	59.99 kY	0	0	CS137	30 Years	0	0
BA137m	2.552 Min.	0	0	BA141	18.27 Min.	0	0
LA139	0 Stable	0	0	BA131	11.81 Days	0	0
LA140	1.676 Days	0	0	CS138	32.2 Min.	0	0
LA138	135 GY	0	0	SM148	8E+06 GY	0	0
BA140	12.79 Days	0	0	LA139	0 Stable	0	0
LA141	3.931 Hours	0	0	LA140	1.676 Days	0	0
SM150	0 Stable	0	0	LA138	135 GY	0	0
BA134	0 Stable	0	0	BA133	10.74 Years	0	0
CS138	32.2 Min.	0	0	BA140	12.79 Days	0	0
BA130	0 Stable	0	0	BA135	0 Stable	0	0
BA131	11.81 Days	0	0	BA136	0 Stable	0	0
BA131m	15 Min.	0	0	SM151	89.99 Years	0	0
BA132	0 Stable	0	0	BA133m	1.62 Days	0	0
BA133	10.74 Years	0	0	SM150	0 Stable	0	0
SM151	89.99 Years	0	0	BA132	0 Stable	0	0
BA139	1.378 Hours	0	0	BA134	0 Stable	0	0
BA133m	1.62 Days	0	0	BA130	0 Stable	0	0
SM148	8E+06 GY	0	0	BA135m	1.196 Days	0	0
SM149	1E+07 GY	0	0	BA139	1.378 Hours	0	0
BA135	0 Stable	0	0	BA131m	15 Min.	0	0
BA135m	1.196 Days	0	0	BA137	0 Stable	0	0
BA136	0 Stable	0	0	BA137m	2.552 Min.	0	0
BA136m	0.308 Sec.	0	0	SM149	1E+07 GY	0	0
BA137	0 Stable	0	0	BA138	0 Stable	0	0
BA138	0 Stable	0	0	BA136m	0.308 Sec.	0	0
SM147	107 GY	0	0	SM145	340 Days	0	0
CE139	137.6 Days	0	0	CE136	0 Stable	0	0
PM145	17.7 Years	0	0	PM147	2.623 Years	0	0
PM147	2.623 Years	0	0	PM148	5.37 Days	0	0

Table 2.2. (contd)

Table 2-1. Decay Time = 3000 Years

Isotope	Half-Life	Curies/kgU	Per Cent
C 14	5.729 kY	0.000087	82.53
NI 59	80 kY	0.000018	17.06
ZR 93	1.530 MY	2.2E-07	0.208
NB 93m	13.60 Years	2.1E-07	0.197
MO 93	3.498 kY	7.7E-10	7.4E-04
BE 10	1.600 MY	2.7E-10	2.6E-04
TC 99	213 kY	6.4E-11	6.1E-05
NB 94	20.3 kY	2.0E-12	1.9E-06
TA182	115 Days	5.3E-13	5.1E-07
HF182	9 MY	5.3E-13	5.1E-07
NI 63	92 Years	3.5E-13	3.3E-07
RE187	50 GY	8.8E-14	8.3E-08
PB205	30 MY	8.0E-14	7.6E-08
P 32	14.3 Days	2.1E-14	2.0E-08
SI 32	650 Years	2.1E-14	2.0E-08
LU176	30 GY	1.2E-17	1.1E-11
TC 98	4.199 MY	1.3E-18	1.2E-12
AG108m	127 Years	5.7E-19	5.4E-13
V 50	4E+07 GY	1.7E-19	1.6E-13
PB204	1E+08 GY	1.3E-19	1.2E-13
IN115	5E+05 GY	1.2E-19	1.2E-13
AG108	2.37 Min.	5.0E-20	4.8E-14
BI208	368 kY	4.7E-20	4.5E-14
BI210m	3 MY	3.1E-20	3.0E-14
TL206	4.19 Min.	3.1E-20	3.0E-14
PD107	6.496 MY	7.1E-21	6.8E-15
TE123	10001 GY	5.3E-21	5.1E-15
PO210	138.4 Days	1.2E-22	1.2E-16
IR192	74.02 Days	6.2E-23	5.9E-17
IR192m	241 Years	6.2E-23	5.9E-17
PT193	500 Years	3.6E-23	3.4E-17
SN121m	49.97 Years	1.1E-24	1.1E-18
I129	15.7 MY	1.2E-25	1.1E-19
SR 90	29.12 Years	1.7E-41	1.6E-35
BA137m	2.552 Min.	0	0
BA139	1.378 Hours	0	0
BA137	0 Stable	0	0
LA139	0 Stable	0	0
BA141	18.27 Min.	0	0
BA138	0 Stable	0	0
LA138	135 GY	0	0
LA137	59.99 kY	0	0
BA140	12.79 Days	0	0
BA136m	0.308 Sec.	0	0
LA140	1.676 Days	0	0
SM150	0 Stable	0	0
CS136	13.1 Days	0	0
BA130	0 Stable	0	0
CS138	32.2 Min.	0	0
SM149	1E+07 GY	0	0
CS137	30 Years	0	0
BA131m	15 Min.	0	0
CS135	2.3 MY	0	0
CS134m	2.9 Hours	0	0
BA131	11.81 Days	0	0
BA136	0 Stable	0	0
BA134	0 Stable	0	0
BA133	10.74 Years	0	0
BA135m	1.196 Days	0	0
BA135	0 Stable	0	0
CE137m	1.433 Days	0	0
BA133m	1.62 Days	0	0
SM148	8E+06 GY	0	0
BA132	0 Stable	0	0
SM147	107 GY	0	0
SM146	70 MY	0	0
PM151	1.183 Days	0	0
ND148	0 Stable	0	0
ND150	0 Stable	0	0
ND142	0 Stable	0	0

Table 2.3. Radionuclide Content of Actinides in Hanford Reactor Fuel for Various Decay Times

Table 3-A. Decay Time = 1 Year				Table 3-B. Decay Time = 3 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
PU241	14.4 Years	0.4798	88.12	PU241	14.4 Years	0.4357	86.89
PU239	24.06 kY	0.0489	8.98	PU239	24.06 kY	0.0489	9.75
PU240	6.537 kY	0.0105	1.92	PU240	6.537 kY	0.0105	2.08
PU238	87.74 Years	0.00270	0.496	PU238	87.74 Years	0.00266	0.530
AM241	432.2 Years	0.00083	0.152	AM241	432.2 Years	0.00229	0.457
CM242	163.2 Days	0.00036	0.067	U234	244.5 kY	0.00035	0.070
U234	244.5 kY	0.00035	0.064	U238	4.468 GY	0.00033	0.067
PA234m	1.17 Min.	0.00033	0.061	TH234	24.1 Days	0.00033	0.067
TH234	24.1 Days	0.00033	0.061	PA234m	1.17 Min.	0.00033	0.067
U238	4.468 GY	0.00033	0.061	CM242	163.2 Days	1.7E-05	3.4E-03
CM244	18.11 Years	1.5E-05	2.8E-03	CM244	18.11 Years	1.4E-05	2.8E-03
TH231	1.063 Days	1.4E-05	2.6E-03	U235	703.8 MY	1.4E-05	2.8E-03
U235	703.8 MY	1.4E-05	2.6E-03	TH231	1.063 Days	1.4E-05	2.8E-03
U237	6.75 Days	1.2E-05	2.2E-03	U237	6.75 Days	1.1E-05	2.1E-03
U236	23.41 MY	8.6E-06	1.6E-03	U236	23.41 MY	8.6E-06	1.7E-03
NP237	2.14 MY	5.2E-06	9.5E-04	NP237	2.14 MY	5.2E-06	1.0E-03
PA233	27 Days	5.2E-06	9.5E-04	PA233	27 Days	5.2E-06	1.0E-03
AM242m	152 Years	6.9E-07	1.3E-04	AM242m	152 Years	6.9E-07	1.4E-04
AM242	16.02 Hours	6.9E-07	1.3E-04	AM242	16.02 Hours	6.8E-07	1.4E-04
PU236	2.851 Years	5.4E-07	9.8E-05	PU242	386.9 kY	4.6E-07	9.3E-05
PU242	386.9 kY	4.6E-07	8.5E-05	PA234	6.7 Hours	4.3E-07	8.6E-05
PA234	6.7 Hours	4.3E-07	8.0E-05	PU236	2.851 Years	3.3E-07	6.6E-05
AM243	7.38 kY	1.6E-07	2.9E-05	AM243	7.38 kY	1.6E-07	3.1E-05
NP239	2.355 Days	1.6E-07	2.9E-05	NP239	2.355 Days	1.6E-07	3.1E-05
CM243	28.5 Years	3.0E-08	5.5E-06	U232	72 Years	3.5E-08	7.0E-06
U232	72 Years	2.7E-08	5.0E-06	CM243	28.5 Years	2.9E-08	5.7E-06
PU237	45.6 Days	1.2E-08	2.2E-06	RN220	55.6 Sec.	2.0E-08	4.1E-06
PO216	0.15 Sec.	8.1E-09	1.5E-06	PB212	10.64 Hours	2.0E-08	4.1E-06
PB212	10.64 Hours	8.1E-09	1.5E-06	RA224	3.66 Days	2.0E-08	4.1E-06
RA224	3.66 Days	8.1E-09	1.5E-06	PO216	0.15 Sec.	2.0E-08	4.1E-06
RN220	55.6 Sec.	8.1E-09	1.5E-06	BI212	1.009 Hours	2.0E-08	4.1E-06
BI212	1.009 Hours	8.1E-09	1.5E-06	TH228	1.913 Years	2.0E-08	4.1E-06
TH228	1.913 Years	8.1E-09	1.5E-06	PO212	3E-07 Sec.	1.3E-08	2.6E-06
NP235	1.084 Years	6.7E-09	1.2E-06	TH230	77 kY	1.0E-08	2.0E-06
PO212	3E-07 Sec.	5.2E-09	9.6E-07	TL208	3.07 Min.	7.3E-09	1.5E-06
TH230	77 kY	3.8E-09	7.0E-07	NP238	2.117 Days	3.4E-09	6.9E-07
NP238	2.117 Days	3.5E-09	6.4E-07	NP235	1.084 Years	1.9E-09	3.7E-07
TL208	3.07 Min.	2.9E-09	5.4E-07	PA231	32.77 kY	9.9E-10	2.0E-07
U233	158.5 kY	3.9E-10	7.2E-08	U233	158.5 kY	4.4E-10	8.8E-08
PA231	32.77 kY	3.9E-10	7.2E-08	CM245	8.499 kY	8.3E-11	1.7E-08
CM245	8.499 kY	8.3E-11	1.5E-08	RN219	3.96 Sec.	5.0E-11	1.0E-08
NP236	115 kY	1.1E-11	2.1E-09	PO215	0.002 Sec.	5.0E-11	1.0E-08
PB211	36.1 Min.	7.8E-12	1.4E-09	PB211	36.1 Min.	5.0E-11	1.0E-08
RN219	3.96 Sec.	7.8E-12	1.4E-09	BI211	2.13 Min.	5.0E-11	1.0E-08
PO215	0.002 Sec.	7.8E-12	1.4E-09	RA223	11.43 Days	5.0E-11	1.0E-08
RA223	11.43 Days	7.8E-12	1.4E-09	AC227	21.77 Years	5.0E-11	1.0E-08
BI211	2.13 Min.	7.8E-12	1.4E-09	TL207	4.77 Min.	5.0E-11	1.0E-08
AC227	21.77 Years	7.8E-12	1.4E-09	TH227	18.72 Days	5.0E-11	9.9E-09
TL207	4.77 Min.	7.8E-12	1.4E-09	NP236	115 kY	1.1E-11	2.3E-09
TH227	18.72 Days	7.7E-12	1.4E-09	RA226	1.6 kY	7.0E-12	1.4E-09
PO218	3.05 Min.	1.0E-12	1.8E-10	RN222	3.824 Days	7.0E-12	1.4E-09
RN222	3.824 Days	1.0E-12	1.8E-10	PO218	3.05 Min.	7.0E-12	1.4E-09
RA226	1.6 kY	1.0E-12	1.8E-10	PB214	26.8 Min.	7.0E-12	1.4E-09
PB214	26.8 Min.	1.0E-12	1.8E-10	BI214	19.9 Min.	7.0E-12	1.4E-09
BI214	19.9 Min.	1.0E-12	1.8E-10	PO214	2E-04 Sec.	7.0E-12	1.4E-09
PO214	2E-04 Sec.	1.0E-12	1.8E-10	FR223	21.8 Min.	6.9E-13	1.4E-10
CM246	4.731 kY	6.9E-13	1.3E-10	CM246	4.731 kY	6.9E-13	1.4E-10
FR223	21.8 Min.	1.1E-13	2.0E-11	BI210	5.012 Days	2.3E-13	4.5E-11
TH229	7.339 kY	6.4E-14	1.2E-11	PB210	22.3 Years	2.3E-13	4.5E-11
RA225	14.8 Days	6.4E-14	1.2E-11	PU237	45.6 Days	1.8E-13	3.6E-11
FR221	4.8 Min.	6.4E-14	1.2E-11	AC225	10 Days	1.4E-13	2.8E-11
AC225	10 Days	6.4E-14	1.2E-11	AT217	0.032 Sec.	1.4E-13	2.8E-11
BI213	45.65 Min.	6.4E-14	1.2E-11	PB209	3.3 Hours	1.4E-13	2.8E-11
AT217	0.032 Sec.	6.4E-14	1.2E-11	RA225	14.8 Days	1.4E-13	2.8E-11
PB209	3.3 Hours	6.4E-14	1.2E-11	TH229	7.339 kY	1.4E-13	2.8E-11
PO213	4E-06 Sec.	6.2E-14	1.1E-11	FR221	4.8 Min.	1.4E-13	2.8E-11
CM241	36 Days	5.9E-14	1.1E-11	BI213	45.65 Min.	1.4E-13	2.8E-11
PO211	0.56 Sec.	2.2E-14	4.0E-12	PO210	138.4 Days	1.4E-13	2.8E-11
PB210	22.3 Years	1.3E-14	2.3E-12	PO211	0.56 Sec.	1.4E-13	2.8E-11
BI210	5.012 Days	1.3E-14	2.3E-12	PO213	4E-06 Sec.	1.4E-13	2.8E-11

Table 2.3. (contd)

Table 3-C. Decay Time = 10 Years				Table 3-D. Decay Time = 30 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
PU241	14.4 Years	0.3111	81.71	PU241	14.4 Years	0.1188	61.20
PU239	24.06 kY	0.0489	12.84	PU239	24.06 kY	0.0489	25.17
PU240	6.537 kY	0.0104	2.74	AM241	432.2 Years	0.0125	6.43
AM241	432.2 Years	0.00639	1.68	PU240	6.537 kY	0.0104	5.37
PU238	87.74 Years	0.00251	0.660	PU238	87.74 Years	0.00215	1.11
U234	244.5 kY	0.00035	0.092	U234	244.5 kY	0.00035	0.180
U238	4.468 GY	0.00033	0.088	PA234m	1.17 Min.	0.00033	0.172
PA234m	1.17 Min.	0.00033	0.088	U238	4.468 GY	0.00033	0.172
TH234	24.1 Days	0.00033	0.088	TH234	24.1 Days	0.00033	0.172
TH231	1.063 Days	1.4E-05	3.7E-03	U235	703.8 MY	1.4E-05	7.3E-03
U235	703.8 MY	1.4E-05	3.7E-03	TH231	1.063 Days	1.4E-05	7.3E-03
CM244	18.11 Years	1.1E-05	2.9E-03	U236	23.41 MY	8.6E-06	4.4E-03
U236	23.41 MY	8.6E-06	2.3E-03	NP237	2.14 MY	5.3E-06	2.7E-03
U237	6.75 Days	7.6E-06	2.0E-03	PA233	27 Days	5.3E-06	2.7E-03
NP237	2.14 MY	5.2E-06	1.4E-03	CM244	18.11 Years	5.1E-06	2.6E-03
PA233	27 Days	5.2E-06	1.4E-03	U237	6.75 Days	2.9E-06	1.5E-03
AM242m	152 Years	6.7E-07	1.8E-04	AM242m	152 Years	6.1E-07	3.1E-04
AM242	16.02 Hours	6.6E-07	1.7E-04	AM242	16.02 Hours	6.1E-07	3.1E-04
CM242	163.2 Days	5.5E-07	1.4E-04	CM242	163.2 Days	5.0E-07	2.6E-04
PU242	386.9 kY	4.6E-07	1.2E-04	PU242	386.9 kY	4.6E-07	2.4E-04
PA234	6.7 Hours	4.3E-07	1.1E-04	PA234	6.7 Hours	4.3E-07	2.2E-04
AM243	7.38 kY	1.6E-07	4.1E-05	NP239	2.355 Days	1.6E-07	8.1E-05
NP239	2.355 Days	1.6E-07	4.1E-05	AM243	7.38 kY	1.6E-07	8.1E-05
PU236	2.851 Years	6.0E-08	1.6E-05	TH230	77 kY	9.5E-08	4.9E-05
U232	72 Years	4.3E-08	1.1E-05	PB212	10.64 Hours	3.8E-08	2.0E-05
RA224	3.66 Days	4.0E-08	1.1E-05	RN220	55.6 Sec.	3.8E-08	2.0E-05
RN220	55.6 Sec.	4.0E-08	1.1E-05	RA224	3.66 Days	3.8E-08	2.0E-05
PB212	10.64 Hours	4.0E-08	1.1E-05	PO216	0.15 Sec.	3.8E-08	2.0E-05
BI212	1.009 Hours	4.0E-08	1.1E-05	BI212	1.009 Hours	3.8E-08	2.0E-05
PO216	0.15 Sec.	4.0E-08	1.1E-05	TH228	1.913 Years	3.8E-08	2.0E-05
TH228	1.913 Years	4.0E-08	1.1E-05	U232	72 Years	3.7E-08	1.9E-05
TH230	77 kY	3.2E-08	8.4E-06	PO212	3E-07 Sec.	2.5E-08	1.3E-05
PO212	3E-07 Sec.	2.6E-08	6.7E-06	CM243	28.5 Years	1.5E-08	7.7E-06
CM243	28.5 Years	2.4E-08	6.4E-06	TL208	3.07 Min.	1.4E-08	7.1E-06
TL208	3.07 Min.	1.4E-08	3.8E-06	PA231	32.77 kY	9.1E-09	4.7E-06
NP238	2.117 Days	3.3E-09	8.8E-07	BI211	2.13 Min.	3.3E-09	1.7E-06
PA231	32.77 kY	3.1E-09	8.2E-07	RA223	11.43 Days	3.3E-09	1.7E-06
U233	158.5 kY	6.0E-10	1.6E-07	RN219	3.96 Sec.	3.3E-09	1.7E-06
RA223	11.43 Days	4.6E-10	1.2E-07	PB211	36.1 Min.	3.3E-09	1.7E-06
PO215	0.002 Sec.	4.6E-10	1.2E-07	PO215	0.002 Sec.	3.3E-09	1.7E-06
RN219	3.96 Sec.	4.6E-10	1.2E-07	AC227	21.77 Years	3.3E-09	1.7E-06
PB211	36.1 Min.	4.6E-10	1.2E-07	AC227	21.77 Years	3.0E-09	1.6E-06
BI211	2.13 Min.	4.6E-10	1.2E-07	TL207	4.77 Min.	1.1E-09	5.4E-07
NP238	2.117 Days	3.3E-09	8.8E-07	TH227	18.72 Days	6.2E-10	3.2E-07
RA223	11.43 Days	4.6E-10	1.2E-07	PO218	3.05 Min.	6.2E-10	3.2E-07
PO215	0.002 Sec.	4.6E-10	1.2E-07	RN222	3.824 Days	6.2E-10	3.2E-07
RN219	3.96 Sec.	4.6E-10	1.2E-07	RA226	1.6 kY	6.2E-10	3.2E-07
PB211	36.1 Min.	4.6E-10	1.2E-07	PO218	3.05 Min.	6.2E-10	3.2E-07
BI211	2.13 Min.	4.6E-10	1.2E-07	PB214	26.8 Min.	6.2E-10	3.2E-07
AC227	21.77 Years	4.6E-10	1.2E-07	BI214	19.9 Min.	6.2E-10	3.2E-07
TL207	4.77 Min.	4.6E-10	1.2E-07	PO214	2E-04 Sec.	6.2E-10	3.2E-07
TH227	18.72 Days	4.5E-10	1.2E-07	PU236	2.851 Years	4.7E-10	2.4E-07
CM245	8.499 kY	8.3E-11	2.2E-08	PB210	22.3 Years	1.6E-10	8.0E-08
RA226	1.6 kY	7.1E-11	1.9E-08	BI210	5.012 Days	1.6E-10	8.0E-08
PO218	3.05 Min.	7.1E-11	1.9E-08	PO210	138.4 Days	1.6E-10	8.0E-08
RN222	3.824 Days	7.1E-11	1.9E-08	CM245	8.499 kY	8.3E-11	4.3E-08
BI214	19.9 Min.	7.1E-11	1.9E-08	FR223	21.8 Min.	4.5E-11	2.3E-08
PB214	26.8 Min.	7.1E-11	1.9E-08	NP236	115 kY	1.1E-11	5.9E-09
PO214	2E-04 Sec.	7.1E-11	1.9E-08	PO211	0.56 Sec.	9.2E-12	4.7E-09
NP235	1.084 Years	2.1E-11	5.5E-09	TH229	7.339 kY	2.1E-12	1.1E-09
NP236	115 kY	1.1E-11	3.0E-09	AC225	10 Days	2.1E-12	1.1E-09
BI210	5.012 Days	6.9E-12	1.8E-09	BI213	45.65 Min.	2.1E-12	1.1E-09
PO210	138.4 Days	6.9E-12	1.8E-09	AT217	0.032 Sec.	2.1E-12	1.1E-09
PB210	22.3 Years	6.9E-12	1.8E-09	PB209	3.3 Hours	2.1E-12	1.1E-09
FR223	21.8 Min.	6.3E-12	1.7E-09	FR221	4.8 Min.	2.1E-12	1.1E-09
PO211	0.56 Sec.	1.3E-12	3.4E-10	RA225	14.8 Days	2.1E-12	1.1E-09
CM246	4.731 kY	6.9E-13	1.8E-10	PO213	4E-06 Sec.	2.0E-12	1.0E-09
BI213	45.65 Min.	4.9E-13	1.3E-10	CM246	4.731 kY	6.9E-13	3.6E-10
AT217	0.032 Sec.	4.9E-13	1.3E-10	TL209	2.2 Min.	4.4E-14	2.3E-11
RA225	14.8 Days	4.9E-13	1.3E-10	TH232	14.05 GY	1.3E-14	6.6E-12
TH229	7.339 kY	4.9E-13	1.3E-10				
PB209	3.3 Hours	4.9E-13	1.3E-10				
AC225	10 Days	4.9E-13	1.3E-10				
FR221	4.8 Min.	4.9E-13	1.3E-10				
PO213	4E-06 Sec.	4.8E-13	1.3E-10				
CM246	4.731 kY	4.8E-13	1.3E-10				
TL209	2.2 Min.	4.8E-13	1.3E-10				
TH232	14.05 GY	1.1E-14	2.8E-12				

Table 2.3. (contd)

Table 3-E. Decay Time = 40 Years				Table 3-F. Decay Time = 100 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
PU241	14.4 Years	0.0734	48.99	PU239	24.06 kY	0.04876	60.58
PU239	24.06 kY	0.0489	32.60	AM241	432.2 Years	0.01467	18.23
AM241	432.2 Years	0.0138	9.20	PU240	6.537 kY	0.01034	12.85
PU240	6.537 kY	0.0104	6.95	PU241	14.4 Years	0.00409	5.08
PU238	87.74 Years	0.00198	1.32	PU238	87.74 Years	0.00124	1.53
U234	244.5 kY	0.00035	0.233	U234	244.5 kY	0.00035	0.434
PA234m	1.17 Min.	0.00033	0.223	TH234	24.1 Days	0.00033	0.414
U238	4.468 GY	0.00033	0.223	PA234m	1.17 Min.	0.00033	0.414
TH234	24.1 Days	0.00033	0.223	U238	4.468 GY	0.00033	0.414
U235	703.8 MY	1.4E-05	9.5E-03	TH231	1.063 Days	1.4E-05	0.018
TH231	1.063 Days	1.4E-05	9.5E-03	U235	703.8 MY	1.4E-05	0.018
U236	23.41 MY	8.6E-06	5.8E-03	U236	23.41 MY	8.6E-06	0.011
NP237	2.14 MY	5.3E-06	3.5E-03	NP237	2.14 MY	5.6E-06	6.9E-03
PA233	27 Days	5.3E-06	3.5E-03	PA233	27 Days	5.6E-06	6.9E-03
CM244	18.11 Years	3.5E-06	2.3E-03	PU242	386.9 kY	4.6E-07	5.8E-04
U237	6.75 Days	1.8E-06	1.2E-03	AM242m	152 Years	4.4E-07	5.5E-04
AM242m	152 Years	5.8E-07	3.9E-04	AM242	16.02 Hours	4.4E-07	5.5E-04
AM242	16.02 Hours	5.8E-07	3.9E-04	PA234	6.7 Hours	4.3E-07	5.4E-04
CM242	163.2 Days	4.8E-07	3.2E-04	CM242	163.2 Days	3.6E-07	4.5E-04
PU242	386.9 kY	4.6E-07	3.1E-04	CM244	18.11 Years	3.5E-07	4.3E-04
PA234	6.7 Hours	4.3E-07	2.9E-04	TH230	77 kY	3.2E-07	3.9E-04
NP239	2.355 Days	1.6E-07	1.0E-04	NP239	2.355 Days	1.6E-07	1.9E-04
AM243	7.38 kY	1.6E-07	1.0E-04	AM243	7.38 kY	1.6E-07	1.9E-04
TH230	77 kY	1.3E-07	8.4E-05	U237	6.75 Days	1.0E-07	1.2E-04
PB212	10.64 Hours	3.5E-08	2.3E-05	PA231	32.77 kY	3.0E-08	3.8E-05
RN220	55.6 Sec.	3.5E-08	2.3E-05	RN219	3.96 Sec.	2.1E-08	2.6E-05
RA224	3.66 Days	3.5E-08	2.3E-05	AC227	21.77 Years	2.1E-08	2.6E-05
PO216	0.15 Sec.	3.5E-08	2.3E-05	RA223	11.43 Days	2.1E-08	2.6E-05
BI212	1.009 Hours	3.5E-08	2.3E-05	PO215	0.002 Sec.	2.1E-08	2.6E-05
TH228	1.913 Years	3.5E-08	2.3E-05	PB211	36.1 Min.	2.1E-08	2.6E-05
U232	72 Years	3.4E-08	2.3E-05	BI211	2.13 Min.	2.1E-08	2.6E-05
PO212	3E-07 Sec.	2.2E-08	1.5E-05	TL207	4.77 Min.	2.1E-08	2.6E-05
TL208	3.07 Min.	1.3E-08	8.4E-06	TH227	18.72 Days	2.1E-08	2.6E-05
PA231	32.77 kY	1.2E-08	8.1E-06	TH228	1.913 Years	2.0E-08	2.4E-05
CM243	28.5 Years	1.2E-08	7.8E-06	RA224	3.66 Days	2.0E-08	2.4E-05
BI211	2.13 Min.	5.3E-09	3.5E-06	PO216	0.15 Sec.	2.0E-08	2.4E-05
RA223	11.43 Days	5.3E-09	3.5E-06	RN220	55.6 Sec.	2.0E-08	2.4E-05
RN219	3.96 Sec.	5.3E-09	3.5E-06	PB212	10.64 Hours	2.0E-08	2.4E-05
PB211	36.1 Min.	5.3E-09	3.5E-06	BI212	1.009 Hours	2.0E-08	2.4E-05
PO215	0.002 Sec.	5.3E-09	3.5E-06	U232	72 Years	1.9E-08	2.4E-05
AC227	21.77 Years	5.3E-09	3.5E-06	PO212	3E-07 Sec.	1.3E-08	1.6E-05
TL207	4.77 Min.	5.3E-09	3.5E-06	TL208	3.07 Min.	7.0E-09	8.7E-06
TH227	18.72 Days	5.2E-09	3.5E-06	PO218	3.05 Min.	6.7E-09	8.4E-06
NP238	2.117 Days	2.9E-09	1.9E-06	RN222	3.824 Days	6.7E-09	8.4E-06
U233	158.5 kY	1.3E-09	8.6E-07	RA226	1.6 kY	6.7E-09	8.4E-06
PO218	3.05 Min.	1.1E-09	7.3E-07	BI214	19.9 Min.	6.7E-09	8.4E-06
RN222	3.824 Days	1.1E-09	7.3E-07	PB214	26.8 Min.	6.7E-09	8.4E-06
PB214	26.8 Min.	1.1E-09	7.3E-07	PO214	2E-04 Sec.	6.7E-09	8.4E-06
PO214	2E-04 Sec.	1.1E-09	7.3E-07	PB210	22.3 Years	3.7E-09	4.7E-06
RA226	1.6 kY	1.1E-09	7.3E-07	PO210	138.4 Days	3.7E-09	4.7E-06
BI214	19.9 Min.	1.1E-09	7.3E-07	BI210	5.012 Days	3.7E-09	4.7E-06
PB210	22.3 Years	3.4E-10	2.3E-07	CM243	28.5 Years	2.7E-09	3.4E-06
BI210	5.012 Days	3.4E-10	2.3E-07	U233	158.5 kY	2.7E-09	3.4E-06
PO210	138.4 Days	3.4E-10	2.3E-07	NP238	2.117 Days	2.2E-09	2.7E-06
CM245	8.499 kY	8.3E-11	5.5E-08	FR223	21.8 Min.	2.9E-10	3.6E-07
FR223	21.8 Min.	7.3E-11	4.9E-08	CM245	8.499 kY	8.3E-11	1.0E-07
PU236	2.851 Years	4.2E-11	2.8E-08	PO211	0.56 Sec.	5.9E-11	7.4E-08
PO211	0.56 Sec.	1.5E-11	9.9E-09	TH229	7.339 kY	1.4E-11	1.8E-08
NP236	115 kY	1.1E-11	7.6E-09	AC225	10 Days	1.4E-11	1.8E-08
TH229	7.339 kY	3.2E-12	2.1E-09	FR221	4.8 Min.	1.4E-11	1.8E-08
AC225	10 Days	3.2E-12	2.1E-09	AT217	0.032 Sec.	1.4E-11	1.8E-08
BI213	45.65 Min.	3.2E-12	2.1E-09	PB209	3.3 Hours	1.4E-11	1.8E-08
AT217	0.032 Sec.	3.2E-12	2.1E-09	BI213	45.65 Min.	1.4E-11	1.8E-08
PB209	3.3 Hours	3.2E-12	2.1E-09	RA225	14.8 Days	1.4E-11	1.8E-08
FR221	4.8 Min.	3.2E-12	2.1E-09	PO213	4E-06 Sec.	1.4E-11	1.8E-08
RA225	14.8 Days	3.2E-12	2.1E-09	NP236	115 kY	1.1E-11	1.4E-08
PO213	4E-06 Sec.	3.1E-12	2.1E-09	PU236	2.851 Years	1.0E-12	1.3E-09
CM246	4.731 kY	6.8E-13	4.6E-10	CM246	4.731 kY	6.8E-13	8.5E-10
TL209	2.2 Min.	6.8E-14	4.5E-11	TL209	2.2 Min.	3.1E-13	3.9E-10
TH232	14.05 GY	1.7E-14	1.1E-11	RA228	6.7 Years	4.3E-14	5.3E-11

Table 2.3. (contd)

Table 3-G. Decay Time = 300 Years				Table 3-H. Decay Time = 1000 Years			
Isotope	Half-Life	Curies/kgU	Per Cent	Isotope	Half-Life	Curies/kgU	Per Cent
PU239	24.06 kY	0.04848	68.27	PU239	24.06 kY	0.04751	76.85
AM241	432.2 Years	0.01075	15.14	PU240	6.537 kY	0.00940	15.20
PU240	6.537 kY	0.01012	14.25	AM241	432.2 Years	0.00350	5.66
U234	244.5 kY	0.00035	0.493	U234	244.5 kY	0.00035	0.566
PA234m	1.17 Min.	0.00033	0.470	PA234m	1.17 Min.	0.00033	0.539
U238	4.468 GY	0.00033	0.470	U238	4.468 GY	0.00033	0.539
TH234	24.1 Days	0.00033	0.470	TH234	24.1 Days	0.00033	0.539
PU238	87.74 Years	0.00025	0.359	U235	703.8 MY	1.4E-05	0.023
TH231	1.063 Days	1.4E-05	0.020	TH231	1.063 Days	1.4E-05	0.023
U235	703.8 MY	1.4E-05	0.020	U236	23.41 MY	8.9E-06	0.014
U236	23.41 MY	8.7E-06	0.012	PA233	27 Days	7.9E-06	0.013
PA233	27 Days	6.4E-06	9.0E-03	NP237	2.14 MY	7.9E-06	0.013
NP237	2.14 MY	6.4E-06	9.0E-03	TH230	77 kY	3.1E-06	5.1E-03
TH230	77 kY	9.4E-07	1.3E-03	PU238	87.74 Years	1.0E-06	1.7E-03
PU242	386.9 kY	4.6E-07	6.5E-04	PO218	3.05 Min.	5.9E-07	9.6E-04
PA234	6.7 Hours	4.3E-07	6.1E-04	RA226	1.6 kY	5.9E-07	9.6E-04
PU241	14.4 Years	2.7E-07	3.8E-04	RN222	3.824 Days	5.9E-07	9.6E-04
AM242m	152 Years	1.8E-07	2.5E-04	BI214	19.9 Min.	5.9E-07	9.6E-04
AM242	16.02 Hours	1.8E-07	2.5E-04	PB214	26.8 Min.	5.9E-07	9.6E-04
NP239	2.355 Days	1.5E-07	2.2E-04	BI210	5.012 Days	5.9E-07	9.6E-04
AM243	7.38 kY	1.5E-07	2.2E-04	PO214	2E-04 Sec.	5.9E-07	9.6E-04
CM242	163.2 Days	1.5E-07	2.1E-04	PB210	22.3 Years	5.9E-07	9.6E-04
PA231	32.77 kY	9.0E-08	1.3E-04	PO210	138.4 Days	5.9E-07	9.6E-04
RN219	3.96 Sec.	8.1E-08	1.1E-04	PU242	386.9 kY	4.6E-07	7.5E-04
BI211	2.13 Min.	8.1E-08	1.1E-04	PA234	6.7 Hours	4.3E-07	7.0E-04
PO215	0.002 Sec.	8.1E-08	1.1E-04	RN219	3.96 Sec.	3.0E-07	4.8E-04
PB211	36.1 Min.	8.1E-08	1.1E-04	AC227	21.77 Years	3.0E-07	4.8E-04
RA223	11.43 Days	8.1E-08	1.1E-04	RA223	11.43 Days	3.0E-07	4.8E-04
AC227	21.77 Years	8.1E-08	1.1E-04	BI211	2.13 Min.	3.0E-07	4.8E-04
TL207	4.77 Min.	8.1E-08	1.1E-04	PB211	36.1 Min.	3.0E-07	4.8E-04
TH227	18.72 Days	8.0E-08	1.1E-04	PO215	0.002 Sec.	3.0E-07	4.8E-04
RN222	3.824 Days	5.9E-08	8.3E-05	PA231	32.77 kY	3.0E-07	4.8E-04
PO218	3.05 Min.	5.9E-08	8.3E-05	TL207	4.77 Min.	3.0E-07	4.8E-04
RA226	1.6 kY	5.9E-08	8.3E-05	TH227	18.72 Days	2.9E-07	4.8E-04
PB214	26.8 Min.	5.9E-08	8.3E-05	NP239	2.355 Days	1.4E-07	2.3E-04
BI214	19.9 Min.	5.9E-08	8.3E-05	AM243	7.38 kY	1.4E-07	2.3E-04
PO214	2E-04 Sec.	5.9E-08	8.3E-05	U233	158.5 kY	3.0E-08	4.9E-05
PB210	22.3 Years	4.8E-08	6.7E-05	AM242m	152 Years	7.3E-09	1.2E-05
PO210	138.4 Days	4.8E-08	6.7E-05	AM242	16.02 Hours	7.3E-09	1.2E-05
BI210	5.012 Days	4.8E-08	6.7E-05	CM242	163.2 Days	6.0E-09	9.7E-06
U233	158.5 kY	8.0E-09	1.1E-05	FR223	21.8 Min.	4.1E-09	6.7E-06
PO216	0.15 Sec.	2.9E-09	4.0E-06	AC225	10 Days	1.3E-09	2.1E-06
RN220	55.6 Sec.	2.9E-09	4.0E-06	TH229	7.339 kY	1.3E-09	2.1E-06
PB212	10.64 Hours	2.9E-09	4.0E-06	FR221	4.8 Min.	1.3E-09	2.1E-06
BI212	1.009 Hours	2.9E-09	4.0E-06	PB209	3.3 Hours	1.3E-09	2.1E-06
RA224	3.66 Days	2.9E-09	4.0E-06	RA225	14.8 Days	1.3E-09	2.1E-06
TH228	1.913 Years	2.9E-09	4.0E-06	BI213	45.65 Min.	1.3E-09	2.1E-06
U232	72 Years	2.8E-09	3.9E-06	AT217	0.032 Sec.	1.3E-09	2.1E-06
PO212	3E-07 Sec.	1.8E-09	2.6E-06	PO213	4E-06 Sec.	1.3E-09	2.1E-06
FR223	21.8 Min.	1.1E-09	1.6E-06	PO211	0.56 Sec.	8.4E-10	1.4E-06
TL208	3.07 Min.	1.0E-09	1.4E-06	PU241	14.4 Years	7.7E-11	1.2E-07
NP238	2.117 Days	8.9E-10	1.3E-06	CM245	8.499 kY	7.7E-11	1.2E-07
PO211	0.56 Sec.	2.3E-10	3.2E-07	NP238	2.117 Days	3.7E-11	5.9E-08
CM244	18.11 Years	1.7E-10	2.3E-07	TL209	2.2 Min.	2.8E-11	4.6E-08
TH229	7.339 kY	1.1E-10	1.6E-07	NP236	115 kY	1.1E-11	1.8E-08
AC225	10 Days	1.1E-10	1.6E-07	RN220	55.6 Sec.	4.9E-12	7.9E-09
RA225	14.8 Days	1.1E-10	1.6E-07	BI212	1.009 Hours	4.9E-12	7.9E-09
AT217	0.032 Sec.	1.1E-10	1.6E-07	RA224	3.66 Days	4.9E-12	7.9E-09
FR221	4.8 Min.	1.1E-10	1.6E-07	TH228	1.913 Years	4.9E-12	7.9E-09
PB209	3.3 Hours	1.1E-10	1.6E-07	PB212	10.64 Hours	4.9E-12	7.9E-09
BI213	45.65 Min.	1.1E-10	1.6E-07	PO216	0.15 Sec.	4.9E-12	7.9E-09
PO213	4E-06 Sec.	1.1E-10	1.6E-07	U232	72 Years	4.3E-12	7.0E-09
CM245	8.499 kY	8.1E-11	1.1E-07	PO212	3E-07 Sec.	3.1E-12	5.0E-09
CM243	28.5 Years	2.1E-11	3.0E-08	TL208	3.07 Min.	1.7E-12	2.8E-09
NP236	115 kY	1.1E-11	1.6E-08	PU236	2.851 Years	1.0E-12	1.6E-09
U237	6.75 Days	6.6E-12	9.3E-09	CM246	4.731 kY	6.0E-13	9.7E-10
TL209	2.2 Min.	2.4E-12	3.4E-09	RA228	6.7 Years	4.3E-13	7.0E-10
PU236	2.851 Years	1.0E-12	1.4E-09	TH232	14.05 GY	4.3E-13	7.0E-10
CM246	4.731 kY	6.6E-13	9.3E-10	AC228	6.131 Hours	4.3E-13	7.0E-10
RA228	6.7 Years	1.3E-13	1.8E-10	PU244	82.61 MY	2.5E-15	4.0E-12

Table 2.3. (contd)

Table 3-I. Decay Time = 3000 Years			
Isotope	Half-Life	Curies/kgU	Per Cent
PU239	24.06 KY	0.04485	82.97
PU240	6.537 KY	0.00760	14.07
U234	244.5 KY	0.00035	0.647
U238	4.468 GY	0.00033	0.617
PA234m	1.17 Min.	0.00033	0.617
TH234	24.1 Days	0.00033	0.617
AM241	432.2 Years	0.00014	0.262
U235	703.8 MY	1.4E-05	0.027
TH231	1.063 Days	1.4E-05	0.027
U236	23.41 MY	9.4E-06	0.017
TH230	77 KY	9.3E-06	0.017
PA233	27 Days	8.5E-06	0.016
NP237	2.14 MY	8.5E-06	0.016
RN222	3.824 Days	4.1E-06	7.6E-03
RA226	1.6 KY	4.1E-06	7.6E-03
PO218	3.05 Min.	4.1E-06	7.6E-03
PB214	26.8 Min.	4.1E-06	7.6E-03
BI214	19.9 Min.	4.1E-06	7.6E-03
PO210	138.4 Days	4.1E-06	7.6E-03
PB210	22.3 Years	4.1E-06	7.6E-03
PO214	2E-04 Sec.	4.1E-06	7.6E-03
BI210	5.012 Days	4.1E-06	7.6E-03
AC227	21.77 Years	8.8E-07	1.6E-03
PO215	0.002 Sec.	8.8E-07	1.6E-03
RN219	3.96 Sec.	8.8E-07	1.6E-03
BI211	2.13 Min.	8.8E-07	1.6E-03
RA223	11.43 Days	8.8E-07	1.6E-03
PB211	36.1 Min.	8.8E-07	1.6E-03
PA231	32.77 KY	8.8E-07	1.6E-03
TL207	4.77 Min.	8.8E-07	1.6E-03
TH227	18.72 Days	8.7E-07	1.6E-03
PU242	386.9 KY	4.6E-07	8.5E-04
PA234	6.7 Hours	4.3E-07	8.0E-04
AM243	7.38 KY	1.2E-07	2.2E-04
NP239	2.355 Days	1.2E-07	2.2E-04
U233	158.5 KY	1.0E-07	1.9E-04
AC225	10 Days	1.3E-08	2.3E-05
RA225	14.8 Days	1.3E-08	2.3E-05
TH229	7.339 KY	1.3E-08	2.3E-05
PB209	3.3 Hours	1.3E-08	2.3E-05
AT217	0.032 Sec.	1.3E-08	2.3E-05
FR221	4.8 Min.	1.3E-08	2.3E-05
BI213	45.65 Min.	1.3E-08	2.3E-05
PO213	4E-06 Sec.	1.2E-08	2.3E-05
FR223	21.8 Min.	1.2E-08	2.2E-05
PO211	0.56 Sec.	2.5E-09	4.6E-06
TL209	2.2 Min.	2.7E-10	5.1E-07
PU241	14.4 Years	6.5E-11	1.2E-07
CM245	8.499 KY	6.5E-11	1.2E-07
NP236	115 KY	1.1E-11	2.1E-08
BI212	1.009 Hours	2.3E-12	4.3E-09
RA224	3.66 Days	2.3E-12	4.3E-09
PB212	10.64 Hours	2.3E-12	4.3E-09
RN220	55.6 Sec.	2.3E-12	4.3E-09
TH228	1.913 Years	2.3E-12	4.3E-09
PO216	0.15 Sec.	2.3E-12	4.3E-09
PU238	87.74 Years	1.7E-12	3.2E-09
PO212	3E-07 Sec.	1.5E-12	2.8E-09
TH232	14.05 GY	1.3E-12	2.5E-09
AC228	6.131 Hours	1.3E-12	2.5E-09
RA228	6.7 Years	1.3E-12	2.5E-09
PU236	2.851 Years	1.0E-12	1.9E-09
U232	72 Years	1.0E-12	1.9E-09
TL208	3.07 Min.	8.4E-13	1.6E-09
AM242m	152 Years	8.0E-13	1.5E-09
AM242	16.02 Hours	8.0E-13	1.5E-09
CM242	163.2 Days	6.6E-13	1.2E-09
CM246	4.731 KY	4.5E-13	8.3E-10
NP238	2.117 Days	4.0E-15	7.4E-12
PU244	82.61 MY	2.5E-15	4.5E-12

Table 2.4. Relative Inhalation Hazard of Fission Products in Hanford Reactor Fuel at Various Decay Times

Table 4-A. Decay Time = 1 Year

Isotope	Half-Life	Air Hazard	Per Cent
CE144	284.3 Days	9.81E+11	77.23
RU106	1.008 Years	1.97E+11	15.52
SR 90	29.12 Years	4.08E+10	3.21
PM147	2.623 Years	1.83E+10	1.44
Y 91	58.51 Days	1.14E+10	0.894
ZR 95	63.98 Days	6.03E+09	0.475
CS137	30 Years	5.95E+09	0.468
NB 95	35.15 Days	3.90E+09	0.307
Y 90	2.667 Days	2.04E+09	0.161
CS134	2.062 Years	1.02E+09	0.080
SR 89	50.5 Days	7.51E+08	0.059
SB125	2.77 Years	3.25E+08	0.026
EU154	8.6 Years	2.78E+08	0.022
TE127m	109 Days	2.01E+08	0.016
RU103	39.28 Days	1.88E+08	0.015
EU155	4.959 Years	1.87E+08	0.015
CE141	32.51 Days	1.58E+08	0.012
SN123	129.2 Days	1.21E+08	0.010
CD113m	14.59 Years	1.16E+08	9.1E-03
SM151	89.99 Years	1.11E+08	8.7E-03
PR144	17.28 Min.	9.81E+07	7.7E-03
TE125m	58 Days	3.92E+07	3.1E-03
NB 95m	3.609 Days	8.05E+06	6.3E-04
TE129m	33.6 Days	7.52E+06	5.9E-04
AG110m	249.9 Days	6.28E+06	4.9E-04
CD115m	44.59 Days	5.38E+06	4.2E-04
PM148m	41.3 Days	4.36E+06	3.4E-04
TE127	9.35 Hours	2.95E+06	2.3E-04
SN119m	245 Days	2.12E+06	1.7E-04
EU152	13.6 Years	1.02E+06	8.0E-05
ZR 93	1.53 MY	4.72E+05	3.7E-05
SB124	60.2 Days	1.73E+05	1.4E-05
PM148	5.37 Days	1.72E+05	1.4E-05
TC 99	213 kY	1.72E+05	1.4E-05
TB160	72.3 Days	1.19E+05	9.4E-06
H 3	12.35 Years	1.17E+05	9.2E-06
RH103m	56.12 Min.	1.13E+05	8.9E-06
SN126	100 kY	8.25E+04	6.5E-06
PM146	5.5 Years	5.02E+04	4.0E-06
TE129	1.16 Hours	1.47E+04	1.2E-06
GD153	242 Days	1.25E+04	9.8E-07
SE 79	64.96 kY	1.02E+04	8.0E-07
I129	15.7 MY	9678	7.6E-07
RH102	2.9 Years	5114	4.0E-07
SN121m	49.97 Years	3027	2.4E-07
CS135	2.3 MY	2775	2.2E-07
SB126	12.4 Days	2310	1.8E-07
PR143	13.56 Days	1956	1.5E-07
PD107	6.496 MY	1340	1.1E-07
NB 93m	13.6 Years	622	4.9E-08
BA140	12.79 Days	412	3.2E-08
EU156	15.19 Days	401	3.2E-08
LA140	1.676 Days	356	2.8E-08
SM147	107 GY	291	2.3E-08
TE123m	119.7 Days	202	1.6E-08
HO166m	1.2 kY	53	4.1E-09
IN114m	49.51 Days	49	3.9E-09
NB 94	20.3 kY	39	3.1E-09
SB126m	19 Min.	33	2.6E-09
RB 86	18.66 Days	19	1.5E-09
ND147	11.06 Days	11	8.3E-10
RH106	29.9 Sec.	5.9	4.7E-10
CS136	13.1 Days	4.9	3.8E-10
BA137m	2.552 Min.	2.3	1.8E-10
BE 10	1.6 MY	2.2	1.8E-10
IN115m	4.3 Hours	0.76	5.9E-11
AG108m	127 Years	0.56	4.4E-11
C 14	5.729 kY	0.45	3.6E-11
SM146	70 MY	0.38	3.0E-11
PR144m	7.2 Min.	0.35	2.8E-11

Table 4-B. Decay Time = 3 Years

Isotope	Half-Life	Air Hazard	Per Cent
CE144	284.3 Days	1.65E+11	60.37
RU106	1.008 Years	4.98E+10	18.20
SR 90	29.12 Years	3.89E+10	14.20
PM147	2.623 Years	1.08E+10	3.94
CS137	30 Years	5.68E+09	2.07
Y 90	2.667 Days	1.95E+09	0.710
CS134	2.062 Years	5.21E+08	0.190
EU154	8.6 Years	2.37E+08	0.087
SB125	2.77 Years	1.97E+08	0.072
EU155	4.959 Years	1.42E+08	0.052
SM151	89.99 Years	1.09E+08	0.040
CD113m	14.59 Years	1.06E+08	0.039
TE125m	58 Days	2.40E+07	8.8E-03
PR144	17.28 Min.	1.65E+07	6.0E-03
SN123	129.2 Days	2.40E+06	8.8E-04
ZR 95	63.98 Days	2.21E+06	8.1E-04
Y 91	58.51 Days	1.98E+06	7.2E-04
TE127m	109 Days	1.93E+06	7.0E-04
NB 95	35.15 Days	1.47E+06	5.4E-04
EU152	13.6 Years	9.23E+05	3.4E-04
AG110m	249.9 Days	8.27E+05	3.0E-04
ZR 93	1.53 MY	4.72E+05	1.7E-04
SN119m	245 Days	2.69E+05	9.8E-05
TC 99	213 kY	1.72E+05	6.3E-05
H 3	12.35 Years	1.05E+05	3.8E-05
SN126	100 kY	8.25E+04	3.0E-05
PM146	5.5 Years	3.90E+04	1.4E-05
SR 89	50.5 Days	3.32E+04	1.2E-05
TE127	9.35 Hours	2.84E+04	1.0E-05
SE 79	64.96 kY	1.02E+04	3.7E-06
I129	15.7 MY	9678	3.5E-06
RH102	2.9 Years	3170	1.2E-06
SN121m	49.97 Years	2945	1.1E-06
NB 95m	3.609 Days	2944	1.1E-06
CS135	2.3 MY	2775	1.0E-06
SB126	12.4 Days	2309	8.4E-07
NB 93m	13.6 Years	1648	6.0E-07
GD153	242 Days	1543	5.6E-07
PD107	6.496 MY	1340	4.9E-07
SM147	107 GY	660	2.4E-07
RU103	39.28 Days	474	1.7E-07
TB160	72.3 Days	109	4.0E-08
CD115m	44.59 Days	63	2.3E-08
HO166m	1.2 kY	53	1.9E-08
NB 94	20.3 kY	39	1.4E-08
SB124	60.2 Days	38	1.4E-08
SB126m	19 Min.	33	1.2E-08
CE141	32.51 Days	27	9.9E-09
PM148m	41.3 Days	21	7.5E-09
TE123m	119.7 Days	2.9	1.1E-09
BE 10	1.6 MY	2.2	8.2E-10
BA137m	2.552 Min.	2.1	7.8E-10
TE129m	33.6 Days	2.1	7.8E-10
RH106	29.9 Sec.	1.5	5.5E-10
PM148	5.37 Days	0.81	3.0E-10
SM146	70 MY	0.71	2.6E-10
AG108m	127 Years	0.56	2.0E-10
C 14	5.729 kY	0.45	1.7E-10
RH103m	56.12 Min.	0.28	1.0E-10
KR 85	10.72 Years	0.23	8.2E-11
RB 87	46.96 GY	0.15	5.4E-11
CD109	1.27 Years	0.11	4.1E-11
PR144m	7.2 Min.	0.059	2.2E-11
TC 98	4.199 MY	8.4E-03	3.1E-12
TE129	1.16 Hours	4.2E-03	1.5E-12
EU150	36 Years	1.9E-03	7.1E-13
IN114m	49.51 Days	1.8E-03	6.5E-13
TM170	128.6 Days	1.8E-03	6.5E-13
LA138	135 GY	5.2E-04	1.9E-13
IN115	5E+05 GY	4.3E-04	1.6E-13

Table 2.4. (contd)

Table 4-C. Decay Time = 10 Years				Table 4-D. Decay Time = 30 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
SR90	29.12 Years	3.29E+10	77.86	SR90	29.12 Years	2.05E+10	82.88
CS137	30 Years	4.83E+09	11.42	CS137	30 Years	3.04E+09	12.33
PM147	2.623 Years	1.70E+09	4.02	Y90	2.667 Days	1.02E+09	4.15
Y90	2.667 Days	1.65E+09	3.89	SM151	89.99 Years	8.87E+07	0.359
RU106	1.008 Years	4.05E+08	0.957	CD113m	14.59 Years	2.93E+07	0.119
CE144	284.3 Days	3.24E+08	0.766	EU154	8.6 Years	2.69E+07	0.109
EU154	8.6 Years	1.35E+08	0.319	PM147	2.623 Years	8.62E+06	0.035
SM151	89.99 Years	1.04E+08	0.245	EU155	4.959 Years	3.25E+06	0.013
CD113m	14.59 Years	7.57E+07	0.179	ZR93	1.53 MY	4.72E+05	1.9E-03
EU155	4.959 Years	5.32E+07	0.126	EU152	13.6 Years	2.33E+05	9.5E-04
CS134	2.062 Years	4.96E+07	0.117	SB125	2.77 Years	2.29E+05	9.3E-04
SB125	2.77 Years	3.42E+07	0.081	TC99	213 KY	1.72E+05	7.0E-04
TE125m	58 Days	4.17E+06	0.010	SN126	100 KY	8.25E+04	3.3E-04
EU152	13.6 Years	6.46E+05	1.5E-03	CS134	2.062 Years	5.97E+04	2.4E-04
ZR93	1.53 MY	4.72E+05	1.1E-03	TE125m	58 Days	2.79E+04	1.1E-04
TC99	213 KY	1.72E+05	4.1E-04	H3	12.35 Years	2.30E+04	9.3E-05
SN126	100 KY	8.25E+04	2.0E-04	SE79	64.96 KY	1.02E+04	4.1E-05
H3	12.35 Years	7.07E+04	1.7E-04	I129	15.7 MY	9678	3.9E-05
PR144	17.28 Min.	3.24E+04	7.7E-05	NB93m	13.6 Years	8794	3.6E-05
PM146	5.5 Years	1.62E+04	3.8E-05	CS135	2.3 MY	2775	1.1E-05
SE79	64.96 KY	1.02E+04	2.4E-05	SB126	12.4 Days	2309	9.4E-06
I129	15.7 MY	9678	2.3E-05	SN121m	49.97 Years	2025	8.2E-06
NB93m	13.6 Years	4517	1.1E-05	PD107	6.496 MY	1340	5.4E-06
CS135	2.3 MY	2775	6.6E-06	PM146	5.5 Years	1299	5.3E-06
SN121m	49.97 Years	2672	6.3E-06	SM147	107 GY	1189	4.8E-06
SB126	12.4 Days	2309	5.5E-06	RU106	1.008 Years	431	1.7E-06
PD107	6.496 MY	1340	3.2E-06	HO166m	1.2 KY	52	2.1E-07
SM147	107 GY	1106	2.6E-06	NB94	20.3 KY	39	1.6E-07
AG110m	249.9 Days	688	1.6E-06	SB126m	19 Min.	33	1.3E-07
RH102	2.9 Years	595	1.4E-06	CE144	284.3 Days	6.0	2.4E-08
SN119m	245 Days	194	4.6E-07	RH102	2.9 Years	5.0	2.0E-08
HO166m	1.2 KY	52	1.2E-07	BE10	1.6 MY	2.2	9.1E-09
NB94	20.3 KY	39	9.2E-08	SM146	70 MY	1.8	7.3E-09
SB126m	19 Min.	33	7.8E-08	BA137m	2.552 Min.	1.2	4.7E-09
SN123	129.2 Days	2.6	6.2E-09	AG108m	127 Years	0.48	1.9E-09
BE10	1.6 MY	2.2	5.3E-09	C14	5.729 KY	0.45	1.8E-09
BA137m	2.552 Min.	1.8	4.3E-09	RB87	46.96 GY	0.15	6.0E-10
SM146	70 MY	1.4	3.2E-09	KR85	10.72 Years	0.039	1.6E-10
GD153	242 Days	1.0	2.4E-09	TC98	4.199 MY	8.4E-03	3.4E-11
AG108m	127 Years	0.54	1.3E-09	EU150	36 Years	1.1E-03	4.7E-12
C14	5.729 KY	0.45	1.1E-09	PR144	17.28 Min.	6.0E-04	2.4E-12
TE127m	109 Days	0.17	4.0E-10	LA138	135 GY	5.2E-04	2.1E-12
RB87	46.96 GY	0.15	3.5E-10	IN115	5E+05 GY	4.3E-04	1.8E-12
KR85	10.72 Years	0.14	3.4E-10	GD152	1E+05 GY	8.4E-05	3.4E-13
RH106	29.9 Sec.	0.012	2.9E-11	AG110m	249.9 Days	1.1E-06	4.4E-15
TC98	4.199 MY	8.4E-03	2.0E-11	SN119m	245 Days	2.1E-07	8.3E-16
CD109	1.27 Years	2.5E-03	5.9E-12	CD109	1.27 Years	4.5E-08	1.8E-16
TE127	9.35 Hours	2.5E-03	5.8E-12	RH106	29.9 Sec.	1.3E-08	5.2E-17
EU150	36 Years	1.7E-03	4.0E-12	TM171	1.92 Years	5.0E-09	2.0E-17
LA138	135 GY	5.2E-04	1.2E-12	GD153	242 Days	8.4E-10	3.4E-18
IN115	5E+05 GY	4.3E-04	1.0E-12	CE142	104.9 GY	6.5E-10	2.6E-18
PR144m	7.2 Min.	1.2E-04	2.8E-13	TE123	10001 GY	7.4E-11	3.0E-19
GD152	1E+05 GY	6.6E-05	1.6E-13	AG108	2.37 Min.	1.7E-11	6.9E-20
TM171	1.92 Years	6.9E-06	1.6E-14	KR81	209.9 KY	2.3E-12	9.5E-21
ZR95	63.98 Days	2.1E-06	4.9E-15	PR144m	7.2 Min.	2.1E-12	8.7E-21
NB95	35.15 Days	1.4E-06	3.2E-15	ND144	2E+06 GY	3.0E-14	1.2E-22
TE123m	119.7 Days	1.1E-06	2.6E-15	SM149	1E+07 GY	1.8E-16	7.4E-25
Y91	58.51 Days	1.4E-07	3.3E-16	SM148	8E+06 GY	1.4E-16	5.9E-25
NB95m	3.609 Days	2.8E-09	6.5E-18	SN123	129.2 Days	2.5E-17	1.0E-25
AG110	24.6 Sec.	2.7E-09	6.5E-18	AG109m	39.6 Sec.	4.5E-18	1.8E-26
TB160	72.3 Days	2.5E-09	5.8E-18	AG110	24.6 Sec.	4.3E-18	1.8E-26
TM170	128.6 Days	1.8E-09	4.4E-18	TE127m	109 Days	1.1E-21	4.6E-30
CE142	104.9 GY	6.5E-10	1.5E-18	TE127	9.35 Hours	1.7E-23	6.7E-32
TE123	10001 GY	7.4E-11	1.8E-19	TE123m	119.7 Days	4.6E-25	1.9E-33
AG108	2.37 Min.	1.9E-11	4.5E-20	TM170	128.6 Days	1.5E-26	5.9E-35
SR89	50.5 Days	1.9E-11	4.5E-20	SN133	1.47 Sec.	0	
SB124	60.2 Days	6.3E-12	1.5E-20	SB133	2.4 Min.	0	
KR81	209.9 KY	2.3E-12	5.5E-21	TE133m	55.4 Min.	0	
AG109m	39.6 Sec.	2.5E-13	5.9E-22	TE133	12.45 Min.	0	
ND144	2E+06 GY	3.0E-14	7.0E-23	I133	20.8 Hours	0	

Table 2.4. (contd)

Table 4--E. Decay Time = 40 Years				Table 4--F. Decay Time = 100 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
SR 90	29.12 Years	1.61E+10	82.85	SR 90	29.12 Years	3.86E+09	81.96
CS137	30 Years	2.42E+09	12.41	CS137	30 Years	6.04E+08	12.80
Y 90	2.667 Days	8.06E+08	4.14	Y 90	2.667 Days	1.93E+08	4.10
SM151	89.99 Years	8.21E+07	0.422	SM151	89.99 Years	5.17E+07	1.10
CD113m	14.59 Years	1.82E+07	0.093	CD113m	14.59 Years	1.05E+06	0.022
EU154	8.6 Years	1.20E+07	0.062	ZR 93	1.53 MY	4.72E+05	0.010
EU155	4.959 Years	8.03E+05	4.1E-03	TC 99	213 KY	1.72E+05	3.6E-03
PM147	2.623 Years	6.14E+05	3.2E-03	EU154	8.6 Years	9.53E+04	2.0E-03
ZR 93	1.53 MY	4.72E+05	2.4E-03	SN126	100 KY	8.24E+04	1.7E-03
TC 99	213 KY	1.72E+05	8.8E-04	NB 93m	13.6 Years	1.11E+04	2.4E-04
EU152	13.6 Years	1.40E+05	7.2E-04	SE 79	64.96 KY	1.01E+04	2.2E-04
SN126	100 KY	8.24E+04	4.2E-04	I129	15.7 MY	9678	2.1E-04
SB125	2.77 Years	1.88E+04	9.6E-05	EU152	13.6 Years	6581	1.4E-04
H 3	12.35 Years	1.31E+04	6.7E-05	CS135	2.3 MY	2775	5.9E-05
SE 79	64.96 KY	1.02E+04	5.2E-05	SB126	12.4 Days	2308	4.9E-05
NB 93m	13.6 Years	9759	5.0E-05	PD107	6.496 MY	1340	2.8E-05
I129	15.7 MY	9677	5.0E-05	SM147	107 GY	1189	2.5E-05
CS135	2.3 MY	2775	1.4E-05	SN121m	49.97 Years	767	1.6E-05
SB126	12.4 Days	2308	1.2E-05	H 3	12.35 Years	452	9.6E-06
TE125m	58 Days	2287	1.2E-05	EU155	4.959 Years	183	3.9E-06
CS134	2.062 Years	2077	1.1E-05	HO166m	1.2 KY	50	1.1E-06
SN121m	49.97 Years	1762	9.1E-06	NB 94	20.3 KY	39	8.2E-07
PD107	6.496 MY	1340	6.9E-06	SB126m	19 Min.	33	7.0E-07
SM147	107 GY	1189	6.1E-06	BE 10	1.6 MY	2.2	4.8E-08
PM146	5.5 Years	368	1.9E-06	SM146	70 MY	1.8	3.9E-08
HO166m	1.2 KY	51	2.6E-07	C 14	5.729 KY	0.45	9.5E-09
NB 94	20.3 KY	39	2.0E-07	AG108m	127 Years	0.33	7.0E-09
SB126m	19 Min.	33	1.7E-07	BA137m	2.552 Min.	0.23	4.8E-09
BE 10	1.6 MY	2.2	1.2E-08	PM146	5.5 Years	0.19	4.1E-09
SM146	70 MY	1.8	9.4E-09	RB 87	46.96 GY	0.15	3.1E-09
BA137m	2.552 Min.	0.91	4.7E-09	PM147	2.623 Years	0.080	1.7E-09
RH102	2.9 Years	0.46	2.4E-09	TC 98	4.199 MY	8.4E-03	1.8E-10
AG108m	127 Years	0.45	2.3E-09	SB125	2.77 Years	5.7E-03	1.2E-10
C 14	5.729 KY	0.45	2.3E-09	TE125m	58 Days	6.9E-04	1.5E-11
RU106	1.008 Years	0.44	2.3E-09	LA138	135 GY	5.2E-04	1.1E-11
RB 87	46.96 GY	0.15	7.6E-10	IN115	5E+05 GY	4.3E-04	9.2E-12
KR 85	10.72 Years	0.021	1.1E-10	KR 85	10.72 Years	4.3E-04	9.0E-12
TC 98	4.199 MY	8.4E-03	4.3E-11	EU150	36 Years	3.0E-04	6.3E-12
EU150	36 Years	9.5E-04	4.9E-12	GD152	1E+05 GY	9.3E-05	2.0E-12
CE144	284.3 Days	8.1E-04	4.1E-12	CS134	2.062 Years	3.6E-06	7.6E-14
LA138	135 GY	5.2E-04	2.7E-12	RH102	2.9 Years	2.7E-07	5.7E-15
IN115	5E+05 GY	4.3E-04	2.2E-12	CE142	104.9 GY	6.5E-10	1.4E-17
GD152	1E+05 GY	8.8E-05	4.5E-13	TE123	10001 GY	7.4E-11	1.6E-18
PR144	17.28 Min.	8.1E-08	4.1E-16	AG108	2.37 Min.	1.2E-11	2.5E-19
CE142	104.9 GY	6.5E-10	3.3E-18	KR 81	209.9 KY	2.3E-12	5.0E-20
TM171	1.92 Years	1.5E-10	7.5E-19	ND144	2E+06 GY	3.0E-14	6.3E-22
CD109	1.27 Years	9.3E-11	4.8E-19	SM149	1E+07 GY	1.8E-16	3.9E-24
TE123	10001 GY	7.4E-11	3.8E-19	SM148	8E+06 GY	1.4E-16	3.1E-24
AG110m	249.9 Days	4.3E-11	2.2E-19	RU106	1.008 Years	5.4E-19	1.1E-26
AG108	2.37 Min.	1.6E-11	8.3E-20	TM171	1.92 Years	5.3E-20	1.1E-27
RH106	29.9 Sec.	1.3E-11	6.9E-20	CD109	1.27 Years	1.2E-24	2.5E-32
SN119m	245 Days	6.7E-12	3.4E-20	RH106	29.9 Sec.	1.6E-29	3.4E-37
KR 81	209.9 KY	2.3E-12	1.2E-20	I127	0 Stable	0	0
ND144	2E+06 GY	3.0E-14	1.5E-22	I128	24.98 Min.	0	0
GD153	242 Days	2.4E-14	1.2E-22	I130	12.36 Hours	0	0
PR144m	7.2 Min.	2.9E-16	1.5E-24	I130m	9 Min.	0	0
SM149	1E+07 GY	1.8E-16	9.4E-25	I131	8.041 Days	0	0
SM148	8E+06 GY	1.4E-16	7.4E-25	I132	2.3 Hours	0	0
AG109m	39.6 Sec.	1.9E-20	1.0E-28	I133	20.8 Hours	0	0
AG110	24.6 Sec.	1.7E-22	8.9E-31	I133m	9 Sec.	0	0
SN123	129.2 Days	7.7E-26	3.9E-34	I134	52.6 Min.	0	0
I127	0 Stable	0	0	I134m	3.7 Min.	0	0
I128	24.98 Min.	0	0	I135	6.611 Hours	0	0
I130	12.36 Hours	0	0	I136	1.383 Min.	0	0
I130m	9 Min.	0	0	I136m	46 Sec.	0	0
I131	8.041 Days	0	0	I137	24.6 Sec.	0	0
I132	2.3 Hours	0	0	I138	6.4 Sec.	0	0
I133	20.8 Hours	0	0	I139	2.4 Sec.	0	0
I133m	9 Sec.	0	0	I140	0.86 Sec.	0	0
I134	52.6 Min.	0	0	I141	0.4 Sec.	0	0

Table 2.4. (contd)

Table 4-G. Decay Time = 300 Years				Table 4-H. Decay Time = 1000 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
SR 90	29.12 Years	3.31E+07	62.98	ZR 93	1.53 MY	4.72E+05	57.96
SM151	89.99 Years	1.11E+07	21.10	TC 99	213 KY	1.71E+05	21.03
CS137	30 Years	5.94E+06	11.31	SN126	100 KY	8.19E+04	10.06
Y 90	2.667 Days	1.66E+06	3.15	SM151	89.99 Years	5.05E+04	6.21
ZR 93	1.53 MY	4.72E+05	0.899	NB 93m	13.6 Years	1.12E+04	1.38
TC 99	213 KY	1.72E+05	0.327	SE 79	64.96 KY	1.01E+04	1.23
SN126	100 KY	8.23E+04	0.157	I129	15.7 MY	9678	1.19
NB 93m	13.6 Years	1.12E+04	0.021	CS135	2.3 MY	2775	0.341
SE 79	64.96 KY	1.01E+04	0.019	SB126	12.4 Days	2293	0.282
I129	15.7 MY	9678	0.018	PD107	6.496 MY	1340	0.165
CS135	2.3 MY	2775	5.3E-03	SM147	107 GY	1189	0.146
SB126	12.4 Days	2305	4.4E-03	NB 94	20.3 KY	38	4.6E-03
PD107	6.496 MY	1340	2.6E-03	SB126m	19 Min.	33	4.0E-03
SM147	107 GY	1189	2.3E-03	HO166m	1.2 KY	30	3.6E-03
CD113m	14.59 Years	79	1.5E-04	BE 10	1.6 MY	2.2	2.2E-04
SN121m	49.97 Years	48	9.1E-05	SR 90	29.12 Years	1.9	2.4E-04
HO166m	1.2 KY	44	8.4E-05	SM146	70 MY	1.8	2.3E-04
NB 94	20.3 KY	38	7.3E-05	CS137	30 Years	0.56	6.9E-05
SB126m	19 Min.	33	6.3E-05	C 14	5.729 KY	0.40	4.9E-05
BE 10	1.6 MY	2.2	4.3E-06	RB 87	46.96 GY	0.15	1.8E-05
SM146	70 MY	1.8	3.5E-06	Y 90	2.667 Days	0.096	1.2E-05
C 14	5.729 KY	0.44	8.3E-07	TC 98	4.199 MY	8.4E-03	1.0E-06
EU152	13.6 Years	0.25	4.7E-07	SN121m	49.97 Years	2.9E-03	3.6E-07
RB 87	46.96 GY	0.15	2.8E-07	AG108m	127 Years	2.4E-03	3.0E-07
AG108m	127 Years	0.11	2.1E-07	LA138	135 GY	5.2E-04	6.4E-08
EU154	8.6 Years	0.010	1.8E-08	IN115	5E+05 GY	4.3E-04	5.3E-08
TC 98	4.199 MY	8.4E-03	1.6E-08	GD152	1E+05 GY	9.3E-05	1.1E-08
H 3	12.35 Years	6.0E-03	1.1E-08	CE142	104.9 GY	6.5E-10	8.0E-14
BA137m	2.552 Min.	2.2E-03	4.3E-09	BA137m	2.552 Min.	2.1E-10	2.6E-14
LA138	135 GY	5.2E-04	1.0E-09	TE123	10001 GY	7.4E-11	9.1E-15
IN115	5E+05 GY	4.3E-04	8.3E-10	EU150	36 Years	8.9E-12	1.1E-15
GD152	1E+05 GY	9.3E-05	1.8E-10	KR 81	209.9 KY	2.3E-12	2.9E-16
EU150	36 Years	6.3E-06	1.2E-11	CD113m	14.59 Years	2.8E-13	3.5E-17
KR 85	10.72 Years	1.0E-09	2.0E-15	AG108	2.37 Min.	8.6E-14	1.1E-17
CE142	104.9 GY	6.5E-10	1.2E-15	ND144	2E+06 GY	3.0E-14	3.7E-18
EU155	4.959 Years	1.3E-10	2.5E-16	SM149	1E+07 GY	1.8E-16	2.2E-20
TE123	10001 GY	7.4E-11	1.4E-16	SM148	8E+06 GY	1.4E-16	1.8E-20
AG108	2.37 Min.	3.9E-12	7.5E-18	EU152	13.6 Years	7.9E-17	9.7E-21
KR 81	209.9 KY	2.3E-12	4.4E-18	H 3	12.35 Years	5.2E-20	6.4E-24
PM146	5.5 Years	2.2E-12	4.1E-18	KR 85	10.72 Years	2.3E-29	2.8E-33
ND144	2E+06 GY	3.0E-14	5.7E-20	SB131	23 Min.	0	0
SM149	1E+07 GY	1.8E-16	3.5E-22	XE133m	2.19 Days	0	0
SM148	8E+06 GY	1.4E-16	2.8E-22	CS133	0 Stable	0	0
RH102	2.9 Years	4.7E-28	9.0E-34	XE133	5.245 Days	0	0
BA133	10.74 Years	0	0	I133m	9 Sec.	0	0
SN134	0.845 Sec.	0	0	BA133	10.74 Years	0	0
IN134	0.078 Sec.	0	0	IN134	0.078 Sec.	0	0
XE133m	2.19 Days	0	0	SN134	0.845 Sec.	0	0
SN132	40 Sec.	0	0	SB134	11 Sec.	0	0
SB134	11 Sec.	0	0	TE134	41.8 Min.	0	0
SB132	2.8 Min.	0	0	SN131	1.05 Min.	0	0
TE131	25 Min.	0	0	SB134m	10.7 Sec.	0	0
IN132	0.12 Sec.	0	0	TE131m	1.25 Days	0	0
SB134m	10.7 Sec.	0	0	SB132	2.8 Min.	0	0
TE134	41.8 Min.	0	0	TE132	3.258 Days	0	0
CD132	0.145 Sec.	0	0	I131	8.041 Days	0	0
SB131	23 Min.	0	0	XE131	0 Stable	0	0
CS133	0 Stable	0	0	XE131m	11.9 Days	0	0
XE132	0 Stable	0	0	CD132	0.145 Sec.	0	0
TE131m	1.25 Days	0	0	TE131	25 Min.	0	0
SB132m	4.2 Min.	0	0	IN132	0.12 Sec.	0	0
XE131m	11.9 Days	0	0	SN132	40 Sec.	0	0
I131	8.041 Days	0	0	I133	20.8 Hours	0	0
CS132	6.475 Days	0	0	SB132m	4.2 Min.	0	0
XE131	0 Stable	0	0	TE133m	55.4 Min.	0	0
TE132	3.258 Days	0	0	I132	2.3 Hours	0	0
BA132	0 Stable	0	0	XE132	0 Stable	0	0
XE133	5.245 Days	0	0	BA132	0 Stable	0	0
IN133	0.114 Sec.	0	0	IN133	0.114 Sec.	0	0
I133m	9 Sec.	0	0	SN133	1.47 Sec.	0	0

Table 2.4. (contd)

Table 4-1. Decay Time = 3000 Years

Isotope	Half-Life	Air Hazard	Per Cent
ZR 93	1.53 MY	4.71E+05	61.97
TC 99	213 kY	1.70E+05	22.37
SN126	100 kY	8.08E+04	10.62
NB 93m	13.6 Years	1.12E+04	1.47
SE 79	64.96 kY	9836	1.29
I129	15.7 MY	9677	1.27
CS135	2.3 MY	2773	0.365
SB126	12.4 Days	2262	0.297
PD107	6.496 MY	1340	0.176
SM147	107 GY	1189	0.156
NB 94	20.3 kY	35	4.6E-03
SB126m	19 Min.	32	4.2E-03
HO166m	1.2 kY	9.3	1.2E-03
BE 10	1.6 MY	2.2	3.0E-04
SM146	70 MY	1.8	2.4E-04
C 14	5.729 kY	0.32	4.1E-05
RB 87	46.96 GY	0.15	1.9E-05
SM151	89.99 Years	0.010	1.4E-06
TC 98	4.199 MY	8.4E-03	1.1E-06
LA138	135 GY	5.2E-04	6.9E-08
IN115	5E+05 GY	4.3E-04	5.7E-08
GD152	1E+05 GY	9.3E-05	1.2E-08
AG108m	127 Years	4.4E-08	5.8E-12
CE142	104.9 GY	6.5E-10	8.5E-14
TE123	10001 GY	7.4E-11	9.8E-15
KR 81	209.9 kY	2.3E-12	3.0E-16
ND144	2E+06 GY	3.0E-14	3.9E-18
SN121m	49.97 Years	2.6E-15	3.4E-19
SM149	1E+07 GY	1.8E-16	2.4E-20
SM148	8E+06 GY	1.4E-16	1.9E-20
AG108	2.37 Min.	1.6E-18	2.1E-22
CS137	30 Years	4.8E-21	6.3E-25
SR 90	29.12 Years	4.1E-21	5.4E-25
Y 90	2.667 Days	2.0E-22	2.7E-26
EU150	36 Years	1.7E-28	2.2E-32
BA137m	2.552 Min.	1.8E-30	2.4E-34
SN131	1.05 Min.	0	0
XE133	5.245 Days	0	0
IN131	0.3 Sec.	0	0
TE134	41.8 Min.	0	0
XE133m	2.19 Days	0	0
CS133	0 Stable	0	0
SB134m	10.7 Sec.	0	0
IN134	0.078 Sec.	0	0
BA133	10.74 Years	0	0
SB134	11 Sec.	0	0
BA132	0 Stable	0	0
SN134	0.845 Sec.	0	0
I133m	9 Sec.	0	0
TE131m	1.25 Days	0	0
SN132	40 Sec.	0	0
CD132	0.145 Sec.	0	0
SB132m	4.2 Min.	0	0
SB132	2.8 Min.	0	0
I132	2.3 Hours	0	0
IN132	0.12 Sec.	0	0
XE132	0 Stable	0	0
XE131m	11.9 Days	0	0
XE131	0 Stable	0	0
TE132	3.258 Days	0	0
I133	20.8 Hours	0	0
SN133	1.47 Sec.	0	0
I131	8.041 Days	0	0
TE133	12.45 Min.	0	0
SB133	2.4 Min.	0	0
TE133m	55.4 Min.	0	0
IN133	0.114 Sec.	0	0
TE131	25 Min.	0	0
CS132	6.475 Days	0	0
SB131	23 Min.	0	0

Table 2.5. Relative Inhalation Hazard of Activation Products in Hanford Reactor Fuel and Cladding at Various Decay Times

Table 5-A. Decay Time = 1 Year				Table 5-B. Decay Time = 3 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
CO 60	5.270 Years	3.31E+07	55.68	CO 60	5.270 Years	2.55E+07	84.62
ZR 95	63.98 Days	7.41E+06	12.46	FE 55	2.6 Years	1.57E+06	5.20
NB 95	35.15 Days	4.80E+06	8.07	SB125	2.77 Years	1.27E+06	4.22
SN119m	245 Days	3.21E+06	5.40	H 3	12.35 Years	6.60E+05	2.19
FE 55	2.6 Years	2.67E+06	4.48	SN119m	245 Days	4.07E+05	1.35
SB125	2.77 Years	2.09E+06	3.52	NI 63	92 Years	3.73E+05	1.24
CO 58	70.78 Days	1.94E+06	3.25	TE125m	58 Days	1.55E+05	0.515
SN113	115.1 Days	1.12E+06	1.87	MN 54	312.5 Days	1.25E+05	0.414
SN123	129.2 Days	9.10E+05	1.53	C 14	5.729 kY	2.08E+04	0.069
H 3	12.35 Years	7.39E+05	1.24	SN123	129.2 Days	1.81E+04	0.060
MN 54	312.5 Days	6.30E+05	1.06	SN113	115.1 Days	1.37E+04	0.046
NI 63	92 Years	3.79E+05	0.637	CD109	1.27 Years	9676	0.032
TE125m	58 Days	2.53E+05	0.425	ZR 95	63.98 Days	2711	9.0E-03
Y 91	58.51 Days	6.20E+04	0.104	ZR 93	1.530 MY	2189	7.3E-03
HF181	42.4 Days	3.55E+04	0.060	NB 95	35.15 Days	1805	6.0E-03
CD109	1.27 Years	2.88E+04	0.048	CO 58	70.78 Days	1512	5.0E-03
C 14	5.729 kY	2.08E+04	0.035	SN121m	49.97 Years	1291	4.3E-03
FE 59	45 Days	1.72E+04	0.029	NI 59	80 kY	921	3.1E-03
TA182	115 Days	1.27E+04	0.021	ZN 65	243.9 Days	243	8.1E-04
HF175	70 Days	1.21E+04	0.020	TA182	115 Days	156	5.2E-04
NB 95m	3.609 Days	9901	0.017	IN113m	1.658 Hours	46	1.5E-04
CD115m	44.59 Days	5348	9.0E-03	Y 91	58.51 Days	11	3.6E-05
IN113m	1.658 Hours	3719	6.3E-03	BE 10	1.600 MY	9.0	3.0E-05
IN114m	49.51 Days	2784	4.7E-03	HF175	70 Days	8.7	2.9E-05
ZR 93	1.530 MY	2189	3.7E-03	NB 93m	13.60 Years	7.7	2.6E-05
SR 89	50.50 Days	1961	3.3E-03	SR 90	29.12 Years	4.6	1.5E-05
ZN 65	243.9 Days	1936	3.3E-03	NB 95m	3.609 Days	3.6	1.2E-05
SN121m	49.97 Years	1328	2.2E-03	W185	75.1 Days	1.0	3.2E-06
NI 59	80 kY	921	1.5E-03	SC 46	83.80 Days	0.71	2.4E-06
W185	75.1 Days	817	1.4E-03	W181	121.2 Days	0.37	1.2E-06
CR 51	27.71 Days	514	8.6E-04	Y 90	2.667 Days	0.23	7.7E-07
SC 46	83.80 Days	299	5.0E-04	HF181	42.4 Days	0.23	7.7E-07
W188	69.4 Days	170	2.9E-04	FE 59	45 Days	0.22	7.4E-07
RE188	16.98 Hours	73	1.2E-04	MO 93	3.498 kY	0.14	4.7E-07
SB124	60.2 Days	53	8.8E-05	HF182	9 MY	0.13	4.4E-07
W181	121.2 Days	24	4.0E-05	W188	69.4 Days	0.12	3.8E-07
BE 10	1.600 MY	9.0	1.5E-05	IN114m	49.51 Days	0.10	3.4E-07
SR 90	29.12 Years	4.9	8.2E-06	SR 89	50.50 Days	0.087	2.9E-07
TE123m	119.7 Days	4.7	7.9E-06	CA 45	163.0 Days	0.083	2.8E-07
NB 93m	13.60 Years	2.9	5.0E-06	AG110m	249.9 Days	0.080	2.6E-07
CA 45	163.0 Days	1.9	3.1E-06	TE123m	119.7 Days	0.068	2.3E-07
AG110m	249.9 Days	0.60	1.0E-06	CD115m	44.59 Days	0.063	2.1E-07
SN117m	14 Days	0.49	8.2E-07	NB 94	20.3 kY	0.057	1.9E-07
Y 90	2.667 Days	0.24	4.1E-07	RE188	16.98 Hours	0.050	1.7E-07
LU177m	155 Days	0.18	3.0E-07	TC 99	213 kY	0.032	1.1E-07
MO 93	3.498 kY	0.14	2.4E-07	AG108m	127 Years	0.018	6.0E-08
HF182	9 MY	0.13	2.2E-07	SB124	60.2 Days	0.012	3.9E-08
NB 94	20.3 kY	0.057	9.5E-08	LU177m	155 Days	0.0068	2.2E-08
PO210	138.4 Days	0.047	7.9E-08	SI 32	650 Years	0.0017	5.6E-09
TC 99	213 kY	0.032	5.4E-08	PO210	138.4 Days	0.0012	4.0E-09
TE127m	109 Days	0.021	3.5E-08	P 32	14.3 Days	0.00025	8.4E-10
AG108m	127 Years	0.018	3.0E-08	TE127m	109 Days	0.00020	6.7E-10
SI 32	650 Years	0.0017	2.8E-09	LU177	6.709 Days	6.2E-05	2.1E-10
LU177	6.709 Days	0.0016	2.7E-09	PB205	30 MY	2.7E-05	8.9E-11
TE127	9.35 Hours	0.00031	5.2E-10	CR 51	27.71 Days	6.0E-06	2.0E-11
P 32	14.3 Days	0.00026	4.3E-10	TE127	9.35 Hours	3.0E-06	9.9E-12
SN125	9.64 Days	0.00010	1.7E-10	AG109m	39.6 Sec.	9.7E-07	3.2E-12
SB126	12.4 Days	3.6E-05	6.1E-11	LU176	30 GY	5.9E-07	2.0E-12
RU103	39.28 Days	2.8E-05	4.8E-11	RE187	50 GY	4.4E-07	1.5E-12
PB205	30 MY	2.7E-05	4.5E-11	IN115	5E+05 GY	4.1E-08	1.4E-13
AG109m	39.6 Sec.	2.9E-06	4.8E-12	BI210m	3 MY	1.6E-08	5.2E-14
IR192	74.02 Days	1.1E-06	1.9E-12	TC 98	4.199 MY	1.9E-09	6.2E-15
LU176	30 GY	5.9E-07	9.9E-13	IR192	74.02 Days	1.0E-09	3.5E-15
RE187	50 GY	4.4E-07	7.4E-13	IR192m	241 Years	1.7E-10	5.5E-16
IN114	1.198 Min.	2.7E-07	4.5E-13	RU103	39.28 Days	7.1E-11	2.4E-16
IN115	5E+05 GY	4.1E-08	6.9E-14	RH102	2.9 Years	1.6E-11	5.4E-17
BI210m	3 MY	1.6E-08	2.6E-14	IN114	1.198 Min.	9.6E-12	3.2E-17
TC 98	4.199 MY	1.9E-09	3.1E-15	PD107	6.496 MY	7.9E-12	2.6E-17
IR192m	241 Years	1.7E-10	2.8E-16	TE123	10001 GY	1.8E-12	5.9E-18
OS191	15.41 Days	4.7E-11	7.9E-17	AG108	2.37 Min.	6.4E-13	2.1E-18

Table 2.5. (contd)

Table 5-C. Decay Time = 10 Years

Isotope	Half-Life	Air Hazard	Per Cent
CO 60	5.270 Years	1.01E+07	88.52
H 3	12.35 Years	4.46E+05	3.89
NI 63	92 Years	3.54E+05	3.09
FE 55	2.6 Years	2.42E+05	2.11
SB125	2.77 Years	2.20E+05	1.92
TE125m	58 Days	2.69E+04	0.234
C 14	5.729 kY	2.08E+04	0.181
ZR 93	1.530 MY	2189	0.019
SN121m	49.97 Years	1172	0.010
NI 59	80 kY	921	8.0E-03
MN 54	312.5 Days	429	3.7E-03
SN119m	245 Days	294	2.6E-03
CD109	1.27 Years	212	1.9E-03
NB 93m	13.60 Years	21	1.8E-04
BE 10	1.600 MY	9.0	7.9E-05
SR 90	29.12 Years	3.9	3.4E-05
Y 90	2.667 Days	0.20	1.7E-06
ZN 65	243.9 Days	0.17	1.5E-06
MO 93	3.498 kY	0.14	1.2E-06
HF182	9 MY	0.13	1.2E-06
NB 94	20.3 kY	0.057	4.9E-07
TC 99	213 kY	0.032	2.8E-07
SN123	129.2 Days	0.020	1.7E-07
AG108m	127 Years	0.017	1.5E-07
SN113	115.1 Days	0.0028	2.5E-08
TA182	115 Days	0.0018	1.6E-08
SI 32	650 Years	0.0017	1.5E-08
P 32	14.3 Days	0.00025	2.2E-09
AG110m	249.9 Days	6.6E-05	5.8E-10
PB205	30 MY	2.7E-05	2.3E-10
IN113m	1.658 Hours	9.4E-06	8.2E-11
CA 45	163.0 Days	1.6E-06	1.4E-11
LU176	30 GY	5.9E-07	5.1E-12
RE187	50 GY	4.4E-07	3.8E-12
W181	121.2 Days	1.6E-07	1.4E-12
LU177m	155 Days	7.3E-08	6.4E-13
IN115	5E+05 GY	4.1E-08	3.6E-13
TE123m	119.7 Days	2.5E-08	2.2E-13
AG109m	39.6 Sec.	2.1E-08	1.9E-13
CO 58	70.78 Days	2.0E-08	1.8E-13
BI210m	3 MY	1.6E-08	1.4E-13
PO210	138.4 Days	3.5E-09	3.0E-14
ZR 95	63.98 Days	2.5E-09	2.2E-14
TC 98	4.199 MY	1.9E-09	1.6E-14
NB 95	35.15 Days	1.7E-09	1.5E-14
LU177	6.709 Days	6.7E-10	5.9E-15
SC 46	83.80 Days	4.6E-10	4.0E-15
IR192m	241 Years	1.7E-10	1.5E-15
HF175	70 Days	8.8E-11	7.7E-16
W185	75.1 Days	5.5E-11	4.8E-16
TE127m	109 Days	1.8E-11	1.5E-16
RH102	2.9 Years	1.6E-11	1.4E-16
IR192	74.02 Days	1.3E-11	1.2E-16
PD107	6.496 MY	7.9E-12	6.9E-17
NB 95m	3.609 Days	3.4E-12	3.0E-17
TE123	10001 GY	1.8E-12	1.6E-17
W188	69.4 Days	9.3E-13	8.2E-18
Y 91	58.51 Days	7.6E-13	6.6E-18
AG108	2.37 Min.	6.1E-13	5.4E-18
RE188	16.98 Hours	4.0E-13	3.5E-18
TE127	9.35 Hours	2.6E-13	2.2E-18
PT193	500 Years	6.6E-15	5.8E-20
SB124	60.2 Days	1.9E-15	1.7E-20
I129	15.7 MY	1.6E-15	1.4E-20
AG110	24.6 Sec.	2.6E-16	2.3E-21
RU106	1.008 Years	1.7E-16	1.4E-21
SR 89	50.50 Days	5.0E-17	4.3E-22
IN114m	49.51 Days	2.9E-17	2.5E-22
K 42	12.36 Hours	6.7E-18	5.9E-23
FE 59	45 Days	1.8E-18	1.5E-23

Table 5-D. Decay Time = 30 Years

Isotope	Half-Life	Air Hazard	Per Cent
CO 60	5.270 Years	7.30E+05	60.49
NI 63	92 Years	3.04E+05	25.21
H 3	12.35 Years	1.45E+05	12.01
C 14	5.729 kY	2.07E+04	1.72
ZR 93	1.530 MY	2188	0.181
SB125	2.77 Years	1476	0.122
FE 55	2.6 Years	1170	0.097
NI 59	80 kY	920	0.076
SN121m	49.97 Years	888	0.074
TE125m	58 Days	180	0.015
NB 93m	13.60 Years	41	3.4E-03
BE 10	1.600 MY	9.0	7.5E-04
SR 90	29.12 Years	2.4	2.0E-04
MO 93	3.498 kY	0.14	1.2E-05
HF182	9 MY	0.13	1.1E-05
Y 90	2.667 Days	0.12	1.0E-05
NB 94	20.3 kY	0.057	4.7E-06
TC 99	213 kY	0.032	2.7E-06
AG108m	127 Years	0.015	1.3E-06
CD109	1.27 Years	0.0039	3.2E-07
TA182	115 Days	0.0018	1.5E-07
SI 32	650 Years	0.0016	1.4E-07
P 32	14.3 Days	0.00025	2.0E-08
MN 54	312.5 Days	3.9E-05	3.3E-09
PB205	30 MY	2.7E-05	2.2E-09
LU176	30 GY	5.9E-07	4.9E-11
RE187	50 GY	4.4E-07	3.6E-11
SN119m	245 Days	3.1E-07	2.6E-11
IN115	5E+05 GY	4.1E-08	3.4E-12
BI210m	3 MY	1.6E-08	1.3E-12
TC 98	4.199 MY	1.9E-09	1.5E-13
ZN 65	243.9 Days	1.6E-10	1.3E-14
IR192m	241 Years	1.6E-10	1.3E-14
PO210	138.4 Days	1.2E-10	1.0E-14
RH102	2.9 Years	1.6E-11	1.3E-15
IR192	74.02 Days	1.3E-11	1.0E-15
PD107	6.496 MY	7.9E-12	6.6E-16
TE123	10001 GY	1.8E-12	1.5E-16
AG108	2.37 Min.	5.5E-13	4.6E-17
AG109m	39.6 Sec.	3.9E-13	3.2E-17
AG110m	249.9 Days	1.0E-13	8.7E-18
PT193	500 Years	6.6E-15	5.5E-19
I129	15.7 MY	1.6E-15	1.4E-19
K 42	12.36 Hours	6.7E-18	5.6E-22
SN123	129.2 Days	1.9E-19	1.6E-23
V 50	4E+07 GY	1.7E-19	1.4E-23
PB204	1E+08 GY	1.3E-19	1.1E-23
CA 45	163.0 Days	5.1E-20	4.2E-24
BI208	368 kY	4.7E-20	3.9E-24
TL206	4.19 Min.	3.1E-20	2.6E-24
TM171	1.92 Years	6.5E-22	5.4E-26
LU177m	155 Days	4.8E-22	3.9E-26
SN113	115.1 Days	2.2E-22	1.8E-26
RU106	1.008 Years	1.8E-22	1.5E-26
LU177	6.709 Days	4.4E-24	3.6E-28
IN113m	1.658 Hours	7.4E-25	6.1E-29
AG110	24.6 Sec.	4.2E-25	3.5E-29
W181	121.2 Days	1.2E-25	9.7E-30
AR 42	33 Years	6.7E-26	5.6E-30
TE123m	119.7 Days	1.1E-26	8.8E-31
RH106	29.9 Sec.	5.3E-33	4.4E-37
BA135	0 Stable	0	0
BA135m	1.196 Days	0	0
BA131m	15 Min.	0	0
LA138	135 GY	0	0
BA132	0 Stable	0	0
BA133	10.74 Years	0	0
BA133m	1.62 Days	0	0
SM146	70 MY	0	0
BA134	0 Stable	0	0

Table 2.5. (contd)

Table 5-E. Decay Time = 40 Years				Table 5-F. Decay Time = 100 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
NI 63	92 Years	2.82E+05	48.19	NI 63	92 Years	1.80E+05	86.94
CO 60	5.270 Years	1.96E+05	33.45	C 14	5.729 KY	2.05E+04	9.94
H 3	12.35 Years	8.27E+04	14.12	H 3	12.35 Years	2851	1.38
C 14	5.729 KY	2.07E+04	3.53	ZR 93	1.530 MY	2188	1.06
ZR 93	1.530 MY	2188	0.373	NI 59	80 KY	920	0.445
NI 59	80 KY	920	0.157	SN121m	49.97 Years	336	0.163
SN121m	49.97 Years	773	0.132	CO 60	5.270 Years	73	0.035
SB125	2.77 Years	121	0.021	NB 93m	13.60 Years	52	0.025
FE 55	2.6 Years	81	0.014	BE 10	1.600 MY	9.0	4.4E-03
NB 93m	13.60 Years	45	7.7E-03	SR 90	29.12 Years	0.46	2.2E-04
TE125m	58 Days	15	2.5E-03	MO 93	3.498 KY	0.14	6.7E-05
BE 10	1.600 MY	9.0	1.5E-03	HF182	9 MY	0.13	6.4E-05
SR 90	29.12 Years	1.9	3.3E-04	NB 94	20.3 KY	0.057	2.7E-05
MO 93	3.498 KY	0.14	2.4E-05	TC 99	213 KY	0.032	1.6E-05
HF182	9 MY	0.13	2.3E-05	Y 90	2.667 Days	0.023	1.1E-05
Y 90	2.667 Days	0.096	1.6E-05	AG108m	127 Years	0.011	5.1E-06
NB 94	20.3 KY	0.057	9.7E-06	TA182	115 Days	0.0018	8.6E-07
TC 99	213 KY	0.032	5.5E-06	SI 32	650 Years	0.0015	7.4E-07
AG108m	127 Years	0.015	2.5E-06	P 32	14.3 Days	0.00023	1.1E-07
TA182	115 Days	0.0018	3.0E-07	SB125	2.77 Years	3.6E-05	1.8E-08
SI 32	650 Years	0.0016	2.8E-07	PB205	30 MY	2.7E-05	1.3E-08
P 32	14.3 Days	0.00024	4.1E-08	FE 55	2.6 Years	9.2E-06	4.5E-09
PB205	30 MY	2.7E-05	4.6E-09	TE125m	58 Days	4.4E-06	2.2E-09
CD109	1.27 Years	1.7E-05	2.8E-09	LU176	30 GY	5.9E-07	2.8E-10
LU176	30 GY	5.9E-07	1.0E-10	RE187	50 GY	4.4E-07	2.1E-10
RE187	50 GY	4.4E-07	7.5E-11	IN115	5E+05 GY	4.1E-08	2.0E-11
IN115	5E+05 GY	4.1E-08	7.1E-12	BI210m	3 MY	1.6E-08	7.5E-12
BI210m	3 MY	1.6E-08	2.7E-12	TC 98	4.199 MY	1.9E-09	9.0E-13
MN 54	312.5 Days	1.2E-08	2.0E-12	IR192m	241 Years	1.3E-10	6.1E-14
TC 98	4.199 MY	1.9E-09	3.2E-13	PO210	138.4 Days	1.2E-10	6.0E-14
IR192m	241 Years	1.5E-10	2.6E-14	IR192	74.02 Days	1.0E-11	5.0E-15
PO210	138.4 Days	1.2E-10	2.1E-14	PD107	6.496 MY	7.9E-12	3.8E-15
RH102	2.9 Years	1.6E-11	2.7E-15	TE123	10001 GY	1.8E-12	8.6E-16
IR192	74.02 Days	1.2E-11	2.1E-15	AG108	2.37 Min.	3.8E-13	1.8E-16
SN119m	245 Days	1.0E-11	1.7E-15	PT193	500 Years	6.6E-15	3.2E-18
PD107	6.496 MY	7.9E-12	1.4E-15	I129	15.7 MY	1.6E-15	7.9E-19
TE123	10001 GY	1.8E-12	3.0E-16	K 42	12.36 Hours	6.7E-18	3.3E-21
AG108	2.37 Min.	5.2E-13	8.9E-17	RH102	2.9 Years	8.7E-19	4.2E-22
PT193	500 Years	6.6E-15	1.1E-18	V 50	4E+07 GY	1.7E-19	8.2E-23
ZN 65	243.9 Days	5.0E-15	8.6E-19	PB204	1E+08 GY	1.3E-19	6.3E-23
AG109m	39.6 Sec.	1.7E-15	2.8E-19	CD109	1.27 Years	1.0E-19	4.8E-23
I129	15.7 MY	1.6E-15	2.8E-19	BI208	368 KY	4.7E-20	2.3E-23
K 42	12.36 Hours	6.7E-18	1.1E-21	TL206	4.19 Min.	3.1E-20	1.5E-23
AG110m	249.9 Days	4.2E-18	7.1E-22	AR 42	33 Years	6.7E-26	3.3E-29
V 50	4E+07 GY	1.7E-19	2.9E-23	AG109m	39.6 Sec.	1.0E-29	4.8E-33
PB204	1E+08 GY	1.3E-19	2.2E-23	B 10	0 Stable	0	0
BI208	368 KY	4.7E-20	8.1E-24	B 11	0 Stable	0	0
TL206	4.19 Min.	3.1E-20	5.3E-24	B 12	0.02 Sec.	0	0
TM171	1.92 Years	6.5E-22	1.1E-25	C 12	0 Stable	0	0
RU106	1.008 Years	1.8E-22	3.0E-26	C 13	0 Stable	0	0
AR 42	33 Years	6.7E-26	1.1E-29	C 15	2.449 Sec.	0	0
CA 45	163.0 Days	9.1E-27	1.5E-30	F 19	0 Stable	0	0
SN123	129.2 Days	5.8E-28	9.9E-32	F 20	11.4 Sec.	0	0
LU177m	155 Days	3.5E-29	6.0E-33	H 1	0 Stable	0	0
AG110	24.6 Sec.	1.7E-29	2.8E-33	H 2	0 Stable	0	0
B 10	0 Stable	0	0	H 4	0.001 Sec.	0	0
B 11	0 Stable	0	0	I125	59.7 Days	0	0
B 12	0.02 Sec.	0	0	I126	13.02 Days	0	0
C 12	0 Stable	0	0	I127	0 Stable	0	0
C 13	0 Stable	0	0	I128	24.98 Min.	0	0
C 15	2.449 Sec.	0	0	I130	12.36 Hours	0	0
F 19	0 Stable	0	0	I130m	9 Min.	0	0
F 20	11.4 Sec.	0	0	I131	8.041 Days	0	0
H 1	0 Stable	0	0	I132	2.3 Hours	0	0
H 2	0 Stable	0	0	K 39	0 Stable	0	0
H 4	0.001 Sec.	0	0	K 40	1.280 GY	0	0
I125	59.7 Days	0	0	K 41	0 Stable	0	0
I126	13.02 Days	0	0	K 43	22.6 Hours	0	0
I127	0 Stable	0	0	K 44	22 Min.	0	0
I128	24.98 Min.	0	0	N 13	9.97 Min.	0	0

Table 2.5. (contd)

Table 5-G. Decay Time = 300 Years				Table 5-H. Decay Time = 1000 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
NI 63	92 Years	39,810	63.14	C 14	5.729 kY	18,420	84.55
C 14	5.729 kY	20,050	31.80	ZR 93	1.530 MY	2188	10.04
ZR 93	1.530 MY	2188	3.47	NI 59	80 kY	913	4.19
NI 59	80 kY	918	1.46	NI 63	92 Years	204	0.936
NB 93m	13.60 Years	52	0.082	NB 93m	13.60 Years	52	0.238
SN121m	49.97 Years	21	0.033	BE 10	1.600 MY	9.0	0.042
BE 10	1.600 MY	9.0	0.014	HF182	9 MY	0.13	6.1E-04
HF182	9 MY	0.13	2.1E-04	MO 93	3.498 kY	0.12	5.3E-04
MO 93	3.498 kY	0.13	2.1E-04	NB 94	20.3 kY	0.055	2.5E-04
NB 94	20.3 kY	0.056	8.9E-05	TC 99	213 kY	0.032	1.5E-04
H 3	12.35 Years	0.038	6.0E-05	TA182	115 Days	0.0018	8.1E-06
TC 99	213 kY	0.032	5.1E-05	SN121m	49.97 Years	0.0013	5.8E-06
SR 90	29.12 Years	0.0040	6.3E-06	SI 32	650 Years	0.00058	2.7E-06
AG108m	127 Years	0.0035	5.6E-06	P 32	14.3 Days	8.7E-05	4.0E-07
TA182	115 Days	0.0018	2.8E-06	AG108m	127 Years	7.8E-05	3.8E-07
SI 32	650 Years	0.0012	1.9E-06	PB205	30 MY	2.7E-05	1.2E-07
Y 90	2.667 Days	0.0002	3.1E-07	LU176	30 GY	5.9E-07	2.7E-09
P 32	14.3 Days	0.00018	2.9E-07	RE187	50 GY	4.4E-07	2.0E-09
PB205	30 MY	2.7E-05	4.3E-08	IN115	5E+05 GY	4.1E-08	1.9E-10
LU176	30 GY	5.9E-07	9.3E-10	BI210m	3 MY	1.6E-08	7.2E-11
RE187	50 GY	4.4E-07	7.0E-10	TC 98	4.199 MY	1.9E-09	8.5E-12
IN115	5E+05 GY	4.1E-08	6.6E-11	SR 90	29.12 Years	2.3E-10	1.1E-12
BI210m	3 MY	1.6E-08	2.5E-11	PO210	138.4 Days	1.2E-10	5.7E-13
TC 98	4.199 MY	1.9E-09	2.9E-12	Y 90	2.667 Days	1.1E-11	5.3E-14
CO 60	5.270 Years	2.8E-10	4.4E-13	IR192m	241 Years	1.1E-11	5.0E-14
PO210	138.4 Days	1.2E-10	2.0E-13	PD107	6.496 MY	7.9E-12	3.6E-14
IR192m	241 Years	7.0E-11	1.1E-13	TE123	10001 GY	1.8E-12	8.2E-15
PD107	6.496 MY	7.9E-12	1.3E-14	IR192	74.02 Days	8.7E-13	4.0E-15
IR192	74.02 Days	5.7E-12	9.0E-15	AG108	2.37 Min.	2.8E-15	1.3E-17
TE123	10001 GY	1.8E-12	2.8E-15	PT193	500 Years	2.4E-15	1.1E-17
AG108	2.37 Min.	1.3E-13	2.0E-16	I129	15.7 MY	1.6E-15	7.5E-18
PT193	500 Years	4.8E-15	7.6E-18	H 3	12.35 Years	3.3E-19	1.5E-21
I129	15.7 MY	1.6E-15	2.6E-18	V 50	4E+07 GY	1.7E-19	7.8E-22
K 42	12.36 Hours	6.7E-18	1.1E-20	PB204	1E+08 GY	1.3E-19	6.0E-22
V 50	4E+07 GY	1.7E-19	2.7E-22	BI208	368 kY	4.7E-20	2.2E-22
PB204	1E+08 GY	1.3E-19	2.1E-22	TL206	4.19 Min.	3.1E-20	1.4E-22
BI208	368 kY	4.7E-20	7.5E-23	K 42	12.36 Hours	2.8E-24	1.3E-26
TL206	4.19 Min.	3.1E-20	4.9E-23	AR 42	33 Years	2.8E-32	1.3E-34
AR 42	33 Years	6.7E-26	1.1E-28	BA141	18.27 Min.	0	0
LA137	59.99 kY	0	0	BA130	0 Stable	0	0
BA141	18.27 Min.	0	0	LA140	1.676 Days	0	0
LA139	0 Stable	0	0	BA140	12.79 Days	0	0
BA137m	2.552 Min.	0	0	LA139	0 Stable	0	0
LA140	1.676 Days	0	0	CS137	30 Years	0	0
LA138	135 GY	0	0	SM146	70 MY	0	0
BA140	12.79 Days	0	0	LA138	135 GY	0	0
LA141	3.931 Hours	0	0	CS138	32.2 Min.	0	0
SM150	0 Stable	0	0	LA137	59.99 kY	0	0
BA134	0 Stable	0	0	SM148	8E+06 GY	0	0
CS138	32.2 Min.	0	0	BA139	1.378 Hours	0	0
BA130	0 Stable	0	0	BA132	0 Stable	0	0
BA131	11.81 Days	0	0	BA138	0 Stable	0	0
BA131m	15 Min.	0	0	SM144	0 Stable	0	0
BA132	0 Stable	0	0	BA135	0 Stable	0	0
BA133	10.74 Years	0	0	BA133	10.74 Years	0	0
SM151	89.99 Years	0	0	SM151	89.99 Years	0	0
BA139	1.378 Hours	0	0	BA131m	15 Min.	0	0
BA133m	1.62 Days	0	0	BA133m	1.62 Days	0	0
SM148	8E+06 GY	0	0	SM150	0 Stable	0	0
SM149	1E+07 GY	0	0	SM149	1E+07 GY	0	0
BA135	0 Stable	0	0	BA134	0 Stable	0	0
BA135m	1.196 Days	0	0	BA131	11.81 Days	0	0
BA136	0 Stable	0	0	BA135m	1.196 Days	0	0
BA136m	0.308 Sec.	0	0	BA136	0 Stable	0	0
BA137	0 Stable	0	0	CE137m	1.433 Days	0	0
BA138	0 Stable	0	0	BA136m	0.308 Sec.	0	0
SM147	107 GY	0	0	BA137	0 Stable	0	0
CE139	137.6 Days	0	0	BA137m	2.552 Min.	0	0
PM145	17.7 Years	0	0	PM150	2.68 Hours	0	0
PM147	2.623 Years	0	0	LA141	3.931 Hours	0	0

Table 2.5. (contd)

Table 5-I. Decay Time = 3000 Years

Isotope	Half-Life	Air Hazard	Per Cent
C 14	5.729 kY	14,460	82.14
ZR 93	1.530 MY	2186	12.42
NI 59	80 kY	897	5.09
NB 93m	13.60 Years	52	0.295
BE 10	1.600 MY	9.0	0.051
HF182	9 MY	0.13	7.6E-04
MO 93	3.498 kY	0.077	4.4E-04
NB 94	20.3 kY	0.051	2.9E-04
TC 99	213 kY	0.032	1.8E-04
TA182	115 Days	0.0018	1.0E-05
SI 32	650 Years	6.9E-05	3.9E-07
NI 63	92 Years	5.8E-05	3.3E-07
PB205	30 MY	2.7E-05	1.5E-07
P 32	14.3 Days	1.0E-05	5.9E-08
LJ176	30 GY	5.9E-07	3.3E-09
RE187	50 GY	4.4E-07	2.5E-09
IN115	5E+05 GY	4.1E-08	2.4E-10
Bi210m	3 MY	1.6E-08	8.9E-11
TC 98	4.199 MY	1.9E-09	1.1E-11
AG108m	127 Years	1.4E-09	8.0E-12
PO210	138.4 Days	1.2E-10	7.1E-13
PD107	6.496 MY	7.9E-12	4.5E-14
TE123	10001 GY	1.8E-12	1.0E-14
IR192m	241 Years	1.6E-12	8.8E-15
IR192	74.02 Days	1.2E-13	7.0E-16
I129	15.7 MY	1.6E-15	9.3E-18
SN121m	49.97 Years	1.1E-15	6.5E-18
PT193	500 Years	5.9E-16	3.4E-18
V 50	4E+07 GY	1.7E-19	9.6E-22
PB204	1E+08 GY	1.3E-19	7.4E-22
AG108	2.37 Min.	5.0E-20	2.9E-22
Bi208	368 kY	4.7E-20	2.7E-22
TL206	4.19 Min.	3.1E-20	1.8E-22
SR 90	29.12 Years	3.4E-31	2.0E-33
BA136m	0.308 Sec.	0	0
BA137	0 Stable	0	0
BA139	1.378 Hours	0	0
SM145	340 Days	0	0
BA136	0 Stable	0	0
BA135	0 Stable	0	0
BA137m	2.552 Min.	0	0
BA138	0 Stable	0	0
SM144	0 Stable	0	0
BA140	12.79 Days	0	0
BA141	18.27 Min.	0	0
LA137	59.99 kY	0	0
LA138	135 GY	0	0
BA135m	1.196 Days	0	0
BA133	10.74 Years	0	0
BA134	0 Stable	0	0
BA130	0 Stable	0	0
SM149	1E+07 GY	0	0
CS134m	2.9 Hours	0	0
CS135	2.3 MY	0	0
CS136	13.1 Days	0	0
CS137	30 Years	0	0
SM150	0 Stable	0	0
CS138	32.2 Min.	0	0
BA133m	1.62 Days	0	0
LA141	3.931 Hours	0	0
BA131	11.81 Days	0	0
SM148	8E+06 GY	0	0
SM147	107 GY	0	0
BA131m	15 Min.	0	0
SM146	70 MY	0	0
BA132	0 Stable	0	0
LA139	0 Stable	0	0
ND149	1.73 Hours	0	0
PR144	17.28 Min.	0	0
PR145	5.981 Hours	0	0

Table 2.6. Relative Inhalation Hazard of Actinides in Hanford Reactor Fuel for Various Decay Times

Table 6-A. Decay Time = 1 Year

Isotope	Half-Life	Air Hazard	Per Cent
PU239	24.06 KY	1.22E+12	66.89
PU240	6.537 KY	2.61E+11	14.30
PU241	14.4 Years	2.40E+11	13.13
PU238	87.74 Years	6.75E+10	3.69
AM241	432.2 Years	2.77E+10	1.51
U234	244.5 KY	3.88E+09	0.212
U238	4,468 GY	3.34E+09	0.183
CM242	163.2 Days	5.19E+08	0.028
CM244	18.11 Years	3.08E+08	0.017
NP237	2.14 MY	2.59E+08	0.014
U235	703.8 MY	1.58E+08	8.7E-03
U236	23.41 MY	9.57E+07	5.2E-03
AM242m	152 Years	2.32E+07	1.3E-03
PU242	386.9 KY	1.16E+07	6.3E-04
PU236	2.851 Years	5.36E+06	2.9E-04
AM243	7.38 KY	5.26E+06	2.9E-04
U232	72 Years	1.37E+06	7.5E-05
TH234	24.1 Days	8.34E+05	4.6E-05
CM243	28.5 Years	7.54E+05	4.1E-05
TH228	1.913 Years	2.03E+05	1.1E-05
TH230	77 KY	7.61E+04	4.2E-06
PA231	32.77 KY	3.90E+04	2.1E-06
PA233	27 Days	5181	2.8E-07
U233	158.5 KY	4370	2.4E-07
AM242	16.02 Hours	3455	1.9E-07
U237	6.75 Days	2942	1.6E-07
CM245	8.499 KY	2774	1.5E-07
RA224	3.66 Days	2030	1.1E-07
TH231	1.063 Days	1425	7.8E-08
AC227	21.77 Years	777	4.3E-08
NP236	115 KY	114	6.2E-09
PB212	10.64 Hours	102	5.6E-09
NP239	2.355 Days	32	1.7E-09
CM246	4.731 KY	23	1.3E-09
PA234	6.7 Hours	22	1.2E-09
BI212	1.009 Hours	12	6.3E-10
TH227	18.72 Days	11	6.0E-10
TH229	7.339 KY	9.1	5.0E-10
NP238	2.117 Days	8.7	4.8E-10
RA223	11.43 Days	3.9	2.1E-10
RN220	55.6 Sec.	2.7	1.5E-10
NP235	1.084 Years	2.2	1.2E-10
PU237	45.6 Days	1.7	9.3E-11
RA226	1.6 KY	1.0	5.5E-11
AC225	10 Days	0.064	3.5E-12
PU244	82.61 MY	0.061	3.4E-12
TH232	14.05 GY	0.047	2.6E-12
RA225	14.8 Days	0.032	1.7E-12
PB210	22.3 Years	0.014	7.7E-13
PO210	138.4 Days	0.0048	2.6E-13
PB211	36.1 Min.	0.0039	2.1E-13
CM241	36 Days	0.00074	4.0E-14
BI214	19.9 Min.	0.00050	2.7E-14
PB214	26.8 Min.	0.00050	2.7E-14
PA234m	1.17 Min.	0.00033	1.8E-14
RN222	3.824 Days	0.00033	1.8E-14
BI210	5.012 Days	0.00021	1.1E-14
BI213	45.65 Min.	8.0E-05	4.4E-15
FR223	21.8 Min.	5.4E-05	2.9E-15
RA228	6.7 Years	8.7E-06	4.8E-16
CM247	15.6 MY	2.9E-06	1.6E-16
CM248	339.1 KY	1.2E-06	6.5E-17
U230	20.8 Days	6.5E-07	3.6E-17
PB209	3.3 Hours	6.4E-07	3.5E-17
U240	14.1 Hours	4.1E-07	2.2E-17
AC228	6.131 Hours	2.6E-07	1.4E-17
CF249	350.5 Years	1.5E-07	7.9E-18
BK249	320 Days	1.1E-07	5.9E-18
CF250	13.08 Years	1.6E-08	8.8E-19
PO216	0.15 Sec.	8.1E-09	4.4E-19

Table 6-B. Decay Time = 3 Years

Isotope	Half-Life	Air Hazard	Per Cent
PU239	24.06 KY	1.22E+12	65.98
PU240	6.537 KY	2.61E+11	14.10
PU241	14.4 Years	2.18E+11	11.77
AM241	432.2 Years	7.64E+10	4.13
PU238	87.74 Years	6.64E+10	3.59
U234	244.5 KY	3.88E+09	0.209
U238	4,468 GY	3.34E+09	0.180
CM244	18.11 Years	2.86E+08	0.015
NP237	2.14 MY	2.59E+08	0.014
U235	703.8 MY	1.58E+08	8.5E-03
U236	23.41 MY	9.57E+07	5.2E-03
CM242	163.2 Days	2.41E+07	1.3E-03
AM242m	152 Years	2.29E+07	1.2E-03
PU242	386.9 KY	1.16E+07	6.3E-04
AM243	7.38 KY	5.26E+06	2.8E-04
PU236	2.851 Years	3.29E+06	1.8E-04
U232	72 Years	1.75E+06	9.4E-05
TH234	24.1 Days	8.34E+05	4.5E-05
CM243	28.5 Years	7.18E+05	3.9E-05
TH228	1.913 Years	5.10E+05	2.8E-05
TH230	77 KY	2.02E+05	1.1E-05
PA231	32.77 KY	9.94E+04	5.4E-06
PA233	27 Days	5182	2.8E-07
RA224	3.66 Days	5101	2.8E-07
AC227	21.77 Years	5024	2.7E-07
U233	158.5 KY	4901	2.6E-07
AM242	16.02 Hours	3423	1.8E-07
CM245	8.499 KY	2774	1.5E-07
U237	6.75 Days	2672	1.4E-07
TH231	1.063 Days	1425	7.7E-08
PB212	10.64 Hours	255	1.4E-08
NP236	115 KY	114	6.2E-09
TH227	18.72 Days	71	3.8E-09
NP239	2.355 Days	32	1.7E-09
BI212	1.009 Hours	29	1.6E-09
RA223	11.43 Days	25	1.4E-09
CM246	4.731 KY	23	1.2E-09
PA234	6.7 Hours	22	1.2E-09
TH229	7.339 KY	20	1.1E-09
NP238	2.117 Days	8.6	4.6E-10
RA226	1.6 KY	7.0	3.8E-10
RN220	55.6 Sec.	6.8	3.7E-10
NP235	1.084 Years	0.62	3.3E-11
PB210	22.3 Years	0.25	1.4E-11
AC225	10 Days	0.14	7.7E-12
PO210	138.4 Days	0.14	7.7E-12
TH232	14.05 GY	0.13	7.1E-12
RA225	14.8 Days	0.071	3.9E-12
PU244	82.61 MY	0.061	3.3E-12
PB211	36.1 Min.	0.025	1.4E-12
BI210	5.012 Days	0.0038	2.0E-13
PB214	26.8 Min.	0.0035	1.9E-13
BI214	19.9 Min.	0.0035	1.9E-13
RN222	3.824 Days	0.0023	1.3E-13
FR223	21.8 Min.	0.00035	1.9E-14
PA234m	1.17 Min.	0.00033	1.8E-14
BI213	45.65 Min.	0.00018	9.6E-15
RA228	6.7 Years	6.4E-05	3.4E-15
PU237	45.6 Days	2.6E-05	1.4E-15
CM247	15.6 MY	2.9E-06	1.5E-16
AC228	6.131 Hours	1.9E-06	1.0E-16
PB209	3.3 Hours	1.4E-06	7.7E-17
CM248	339.1 KY	1.2E-06	6.4E-17
U240	14.1 Hours	4.1E-07	2.2E-17
CF249	350.5 Years	2.4E-07	1.3E-17
PO216	0.15 Sec.	2.0E-08	1.1E-18
BK249	320 Days	2.0E-08	1.1E-18
CF250	13.08 Years	1.6E-08	8.7E-19
PO212	3E-07 Sec.	1.3E-08	7.1E-19
TL208	3.07 Min.	7.3E-09	4.0E-19

Table 2.6. (contd)

Table 6-C. Decay Time = 10 Years				Table 6-D. Decay Time = 30 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
PU239	24.06 kY	1.22E+12	63.56	PU239	24.06 kY	1.22E+12	60.49
PU240	6.537 kY	2.61E+11	13.58	AM241	432.2 Years	4.16E+11	20.61
AM241	432.2 Years	2.13E+11	11.08	PU240	6.537 kY	2.60E+11	12.90
PU241	14.4 Years	1.56E+11	8.09	PU241	14.4 Years	5.94E+10	2.94
PU238	87.74 Years	6.29E+10	3.27	PU238	87.74 Years	5.37E+10	2.66
U234	244.5 kY	3.88E+09	0.202	U234	244.5 kY	3.88E+09	0.192
U238	4.468 GY	3.34E+09	0.173	U238	4.468 GY	3.34E+09	0.165
NP237	2.14 MY	2.60E+08	0.014	NP237	2.14 MY	2.63E+08	0.013
CM244	18.11 Years	2.18E+08	0.011	U235	703.8 MY	1.58E+08	7.8E-03
U235	703.8 MY	1.58E+08	8.2E-03	CM244	18.11 Years	1.02E+08	5.0E-03
U236	23.41 MY	9.58E+07	5.0E-03	U236	23.41 MY	9.58E+07	4.7E-03
AM242m	152 Years	2.22E+07	1.2E-03	AM242m	152 Years	2.03E+07	1.0E-03
PU242	386.9 kY	1.16E+07	6.0E-04	PU242	386.9 kY	1.16E+07	5.7E-04
AM243	7.38 kY	5.25E+06	2.7E-04	AM243	7.38 kY	5.24E+06	2.6E-04
U232	72 Years	2.14E+06	1.1E-04	TH230	77 kY	1.90E+06	9.4E-05
TH228	1.913 Years	1.00E+06	5.2E-05	U232	72 Years	1.87E+06	9.3E-05
TH234	24.1 Days	8.34E+05	4.3E-05	TH228	1.913 Years	9.59E+05	4.8E-05
CM242	163.2 Days	7.84E+05	4.1E-05	PA231	32.77 kY	9.13E+05	4.5E-05
TH230	77 kY	6.42E+05	3.3E-05	TH234	24.1 Days	8.34E+05	4.1E-05
CM243	28.5 Years	6.06E+05	3.2E-05	CM242	163.2 Days	7.15E+05	3.5E-05
PU236	2.851 Years	6.00E+05	3.1E-05	CM243	28.5 Years	3.73E+05	1.8E-05
PA231	32.77 kY	3.11E+05	1.6E-05	AC227	21.77 Years	3.27E+05	1.6E-05
AC227	21.77 Years	4.58E+04	2.4E-06	U233	158.5 kY	1.17E+04	5.8E-07
RA224	3.66 Days	9997	5.2E-07	RA224	3.66 Days	9591	4.8E-07
U233	158.5 kY	6664	3.5E-07	PA233	27 Days	5257	2.6E-07
PA233	27 Days	5192	2.7E-07	PU236	2.851 Years	4652	2.3E-07
AM242	16.02 Hours	3316	1.7E-07	TH227	18.72 Days	4613	2.3E-07
CM245	8.499 kY	2772	1.4E-07	AM242	16.02 Hours	3027	1.5E-07
U237	6.75 Days	1908	9.9E-08	CM245	8.499 kY	2768	1.4E-07
TH231	1.063 Days	1425	7.4E-08	RA223	11.43 Days	1637	8.1E-08
TH227	18.72 Days	645	3.4E-08	TH231	1.063 Days	1425	7.1E-08
PB212	10.64 Hours	500	2.6E-08	U237	6.75 Days	729	3.6E-08
RA223	11.43 Days	229	1.2E-08	RA226	1.6 kY	619	3.1E-08
NP236	115 kY	114	5.9E-09	PB212	10.64 Hours	480	2.4E-08
RA226	1.6 kY	71	3.7E-09	TH229	7.339 kY	293	1.5E-08
TH229	7.339 kY	70	3.6E-09	PB210	22.3 Years	173	8.6E-09
BI212	1.009 Hours	57	3.0E-09	PO210	138.4 Days	156	7.7E-09
NP239	2.355 Days	32	1.6E-09	NP236	115 kY	114	5.6E-09
CM246	4.731 kY	23	1.2E-09	BI212	1.009 Hours	55	2.7E-09
PA234	6.7 Hours	22	1.1E-09	NP239	2.355 Days	31	1.6E-09
RN220	55.6 Sec.	13	6.9E-10	CM246	4.731 kY	23	1.1E-09
NP238	2.117 Days	8.3	4.3E-10	PA234	6.7 Hours	22	1.1E-09
PB210	22.3 Years	7.7	4.0E-10	RN220	55.6 Sec.	13	6.3E-10
PO210	138.4 Days	6.9	3.6E-10	NP238	2.117 Days	7.6	3.8E-10
AC225	10 Days	0.49	2.5E-11	BI210	5.012 Days	2.6	1.3E-10
TH232	14.05 GY	0.43	2.2E-11	AC225	10 Days	2.1	1.0E-10
RA225	14.8 Days	0.24	1.3E-11	PB211	36.1 Min.	1.6	8.1E-11
PB211	36.1 Min.	0.23	1.2E-11	TH232	14.05 GY	1.3	6.3E-11
BI210	5.012 Days	0.12	6.0E-12	RA225	14.8 Days	1.0	5.1E-11
PU244	82.61 MY	0.061	3.2E-12	BI214	19.9 Min.	0.31	1.5E-11
PB214	26.8 Min.	0.035	1.8E-12	PB214	26.8 Min.	0.31	1.5E-11
BI214	19.9 Min.	0.035	1.8E-12	RN222	3.824 Days	0.21	1.0E-11
RN222	3.824 Days	0.024	1.2E-12	PU244	82.61 MY	0.061	3.0E-12
NP235	1.084 Years	0.0070	3.7E-13	FR223	21.8 Min.	0.023	1.1E-12
FR223	21.8 Min.	0.0032	1.6E-13	RA228	6.7 Years	0.0030	1.5E-13
BI213	45.65 Min.	0.00061	3.2E-14	BI213	45.65 Min.	0.0026	1.3E-13
RA228	6.7 Years	0.00054	2.8E-14	PA234m	1.17 Min.	0.00033	1.7E-14
PA234m	1.17 Min.	0.00033	1.7E-14	AC228	6.131 Hours	8.9E-05	4.4E-15
AC228	6.131 Hours	1.6E-05	8.5E-16	PB209	3.3 Hours	2.1E-05	1.0E-15
PB209	3.3 Hours	4.9E-06	2.5E-16	CM247	15.6 MY	2.9E-06	1.4E-16
CM247	15.6 MY	2.9E-06	1.5E-16	CM248	339.1 kY	1.2E-06	5.8E-17
CM248	339.1 kY	1.2E-06	6.1E-17	U240	14.1 Hours	4.1E-07	2.0E-17
U240	14.1 Hours	4.1E-07	2.1E-17	CF249	350.5 Years	2.5E-07	1.2E-17
CF249	350.5 Years	2.6E-07	1.3E-17	PO216	0.15 Sec.	3.8E-08	1.9E-18
PO216	0.15 Sec.	4.0E-08	2.1E-18	PO212	3E-07 Sec.	2.5E-08	1.2E-18
PO212	3E-07 Sec.	2.6E-08	1.3E-18	NP235	1.084 Years	2.0E-08	9.8E-19
CF250	13.08 Years	1.6E-08	8.4E-19	CF250	13.08 Years	1.6E-08	8.0E-19
TL208	3.07 Min.	1.4E-08	7.5E-19	TL208	3.07 Min.	1.4E-08	6.8E-19
BK249	320 Days	1.7E-09	8.8E-20	RN219	3.96 Sec.	3.3E-09	1.6E-19
RN219	3.96 Sec.	4.6E-10	2.4E-20	BI211	2.13 Min.	3.3E-09	1.6E-19

Table 2.6. (contd)

Table 6-E. Decay Time = 40 Years				Table 6-F. Decay Time = 100 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
PU239	24.06 kY	1.22E+12	60.01	PU239	24.06 kY	1.22E+12	60.73
AM241	432.2 Years	4.59E+11	22.58	AM241	432.2 Years	4.89E+11	24.37
PU240	6.537 kY	2.60E+11	12.79	PU240	6.537 kY	2.59E+11	12.88
PU238	87.74 Years	4.96E+10	2.44	PU238	87.74 Years	3.09E+10	1.54
PU241	14.4 Years	3.67E+10	1.80	U234	244.5 kY	3.88E+09	0.193
U234	244.5 kY	3.88E+09	0.191	U238	4.468 GY	3.34E+09	0.166
U238	4.468 GY	3.34E+09	0.164	PU241	14.4 Years	2.04E+09	0.102
NP237	2.14 MY	2.65E+08	0.013	NP237	2.14 MY	2.79E+08	0.014
U235	703.8 MY	1.58E+08	7.8E-03	U235	703.8 MY	1.58E+08	7.9E-03
U236	23.41 MY	9.59E+07	4.7E-03	U236	23.41 MY	9.61E+07	4.8E-03
CM244	18.11 Years	6.93E+07	3.4E-03	AM242m	152 Years	1.47E+07	7.3E-04
AM242m	152 Years	1.94E+07	9.5E-04	PU242	386.9 kY	1.16E+07	5.8E-04
PU242	386.9 kY	1.16E+07	5.7E-04	CM244	18.11 Years	6.97E+06	3.5E-04
AM243	7.38 kY	5.24E+06	2.6E-04	TH230	77 kY	6.30E+06	3.1E-04
TH230	77 kY	2.53E+06	1.2E-04	AM243	7.38 kY	5.21E+06	2.6E-04
U232	72 Years	1.70E+06	8.3E-05	PA231	32.77 kY	3.02E+06	1.5E-04
PA231	32.77 kY	1.22E+06	6.0E-05	AC227	21.77 Years	2.11E+06	1.1E-04
TH228	1.913 Years	8.72E+05	4.3E-05	U232	72 Years	9.53E+05	4.7E-05
TH234	24.1 Days	8.34E+05	4.1E-05	TH234	24.1 Days	8.34E+05	4.2E-05
CM242	163.2 Days	6.83E+05	3.4E-05	CM242	163.2 Days	5.20E+05	2.6E-05
AC227	21.77 Years	5.30E+05	2.6E-05	TH228	1.913 Years	4.90E+05	2.4E-05
CM243	28.5 Years	2.92E+05	1.4E-05	CM243	28.5 Years	6.79E+04	3.4E-06
U233	158.5 kY	1.43E+04	7.0E-07	U233	158.5 kY	3.02E+04	1.5E-06
RA224	3.66 Days	8722	4.3E-07	TH227	18.72 Days	2.98E+04	1.5E-06
TH227	18.72 Days	7480	3.7E-07	RA223	11.43 Days	1.06E+04	5.3E-07
PA233	27 Days	5299	2.6E-07	RA226	1.6 kY	6740	3.4E-07
AM242	16.02 Hours	2892	1.4E-07	PA233	27 Days	5585	2.8E-07
CM245	8.499 kY	2765	1.4E-07	RA224	3.66 Days	4895	2.4E-07
RA223	11.43 Days	2655	1.3E-07	PB210	22.3 Years	4162	2.1E-07
TH231	1.063 Days	1425	7.0E-08	PO210	138.4 Days	3746	1.9E-07
RA226	1.6 kY	1094	5.4E-08	CM245	8.499 kY	2752	1.4E-07
TH229	7.339 kY	451	2.2E-08	AM242	16.02 Hours	2200	1.1E-07
U237	6.75 Days	450	2.2E-08	TH229	7.339 kY	2060	1.0E-07
PB212	10.64 Hours	436	2.1E-08	TH231	1.063 Days	1425	7.1E-08
PU236	2.851 Years	418	2.1E-08	PB212	10.64 Hours	245	1.2E-08
PB210	22.3 Years	381	1.9E-08	NP236	115 kY	114	5.7E-09
PO210	138.4 Days	343	1.7E-08	BI210	5.012 Days	62	3.1E-09
NP236	115 kY	114	5.6E-09	NP239	2.355 Days	31	1.6E-09
BI212	1.009 Hours	50	2.4E-09	BI212	1.009 Hours	28	1.4E-09
NP239	2.355 Days	31	1.5E-09	U237	6.75 Days	25	1.2E-09
CM246	4.731 kY	23	1.1E-09	CM246	4.731 kY	23	1.1E-09
PA234	6.7 Hours	22	1.1E-09	PA234	6.7 Hours	22	1.1E-09
RN220	55.6 Sec.	12	5.7E-10	AC225	10 Days	14	7.2E-10
NP238	2.117 Days	7.3	3.6E-10	PB211	36.1 Min.	11	5.3E-10
BI210	5.012 Days	5.7	2.8E-10	PU236	2.851 Years	10	5.1E-10
AC225	10 Days	3.2	1.6E-10	RA225	14.8 Days	7.2	3.6E-10
PB211	36.1 Min.	2.7	1.3E-10	RN220	55.6 Sec.	6.5	3.3E-10
TH232	14.05 GY	1.7	8.4E-11	NP238	2.117 Days	5.5	2.8E-10
RA225	14.8 Days	1.6	7.8E-11	TH232	14.05 GY	4.3	2.1E-10
PB214	26.8 Min.	0.55	2.7E-11	PB214	26.8 Min.	3.4	1.7E-10
BI214	19.9 Min.	0.55	2.7E-11	BI214	19.9 Min.	3.4	1.7E-10
RN222	3.824 Days	0.36	1.8E-11	RN222	3.824 Days	2.2	1.1E-10
PU244	82.61 MY	0.061	3.0E-12	FR223	21.8 Min.	0.15	7.3E-12
FR223	21.8 Min.	0.037	1.8E-12	PU244	82.61 MY	0.061	3.1E-12
RA228	6.7 Years	0.0043	2.1E-13	BI213	45.65 Min.	0.018	9.0E-13
BI213	45.65 Min.	0.0039	1.9E-13	RA228	6.7 Years	0.014	7.1E-13
PA234m	1.17 Min.	0.00033	1.6E-14	AC228	6.131 Hours	0.00043	2.1E-14
AC228	6.131 Hours	0.00013	6.4E-15	PA234m	1.17 Min.	0.00033	1.7E-14
PB209	3.3 Hours	3.2E-05	1.6E-15	PB209	3.3 Hours	0.00014	7.2E-15
CM247	15.6 MY	2.9E-06	1.4E-16	CM247	15.6 MY	2.9E-06	1.4E-16
CM248	339.1 kY	1.2E-06	5.8E-17	CM248	339.1 kY	1.2E-06	5.9E-17
U240	14.1 Hours	4.1E-07	2.0E-17	U240	14.1 Hours	4.1E-07	2.0E-17
CF249	350.5 Years	2.5E-07	1.2E-17	CF249	350.5 Years	2.2E-07	1.1E-17
PO216	0.15 Sec.	3.5E-08	1.7E-18	CF250	13.08 Years	2.1E-08	1.1E-18
PO212	3E-07 Sec.	2.2E-08	1.1E-18	BI211	2.13 Min.	2.1E-08	1.1E-18
CF250	13.08 Years	1.6E-08	7.9E-19	PO215	0.002 Sec.	2.1E-08	1.1E-18
TL208	3.07 Min.	1.3E-08	6.2E-19	RN219	3.96 Sec.	2.1E-08	1.1E-18
RN219	3.96 Sec.	5.3E-09	2.6E-19	TL207	4.77 Min.	2.1E-08	1.1E-18
PO215	0.002 Sec.	5.3E-09	2.6E-19	PO216	0.15 Sec.	2.0E-08	9.8E-19
BI211	2.13 Min.	5.3E-09	2.6E-19	PO212	3E-07 Sec.	1.3E-08	6.2E-19

Table 2.6. (contd)

Table 6--G. Decay Time = 300 Years				Table 6--H. Decay Time = 1000 Years			
Isotope	Half-Life	Air Hazard	Per Cent	Isotope	Half-Life	Air Hazard	Per Cent
PU239	24.06 KY	1.21E+12	65.95	PU239	24.06 KY	1.19E+12	76.76
AM241	432.2 Years	3.58E+11	19.50	PU240	6.537 KY	2.35E+11	15.18
PU240	6.537 KY	2.53E+11	13.77	AM241	432.2 Years	1.17E+11	7.53
PU238	87.74 Years	6.37E+09	0.346	U234	244.5 KY	3.89E+09	0.251
U234	244.5 KY	3.89E+09	0.212	U238	4.468 GY	3.34E+09	0.215
U238	4.468 GY	3.34E+09	0.181	NP237	2.14 MY	3.94E+08	0.025
NP237	2.14 MY	3.20E+08	0.017	U235	703.8 MY	1.59E+08	0.010
U235	703.8 MY	1.59E+08	8.6E-03	U236	23.41 MY	9.90E+07	6.4E-03
U236	23.41 MY	9.67E+07	5.3E-03	TH230	77 KY	6.27E+07	4.1E-03
TH230	77 KY	1.89E+07	1.0E-03	AC227	21.77 Years	2.99E+07	1.9E-03
PU242	386.9 KY	1.16E+07	6.3E-04	PA231	32.77 KY	2.99E+07	1.9E-03
PA231	32.77 KY	9.03E+06	4.9E-04	PU238	87.74 Years	2.56E+07	1.7E-03
AC227	21.77 Years	8.09E+06	4.4E-04	PU242	386.9 KY	1.16E+07	7.5E-04
AM242m	152 Years	5.92E+06	3.2E-04	AM243	7.38 KY	4.79E+06	3.1E-04
AM243	7.38 KY	5.11E+06	2.8E-04	TH234	24.1 Days	8.34E+05	5.4E-05
TH234	24.1 Days	8.34E+05	4.5E-05	PB210	22.3 Years	6.57E+05	4.2E-05
CM242	163.2 Days	2.09E+05	1.1E-05	RA226	1.6 KY	5.92E+05	3.8E-05
U232	72 Years	1.39E+05	7.6E-06	PO210	138.4 Days	5.92E+05	3.8E-05
PU241	14.4 Years	1.35E+05	7.3E-06	TH227	18.72 Days	4.21E+05	2.7E-05
TH227	18.72 Days	1.14E+05	6.2E-06	U233	158.5 KY	3.35E+05	2.2E-05
U233	158.5 KY	8.86E+04	4.8E-06	AM242m	152 Years	2.43E+05	1.6E-05
TH228	1.913 Years	7.14E+04	3.9E-06	TH229	7.339 KY	1.87E+05	1.2E-05
RA226	1.6 KY	5.88E+04	3.2E-06	RA223	11.43 Days	1.49E+05	9.7E-06
PB210	22.3 Years	5.30E+04	2.9E-06	BI210	5.012 Days	9860	6.4E-07
PO210	138.4 Days	4.77E+04	2.6E-06	CM242	163.2 Days	8580	5.5E-07
RA223	11.43 Days	4.04E+04	2.2E-06	PA233	27 Days	7869	5.1E-07
TH229	7.339 KY	1.62E+04	8.8E-07	CM245	8.499 KY	2557	1.7E-07
PA233	27 Days	6406	3.5E-07	TH231	1.063 Days	1429	9.2E-08
CM244	18.11 Years	3301	1.8E-07	AC225	10 Days	1311	8.5E-08
CM245	8.499 KY	2707	1.5E-07	RA225	14.8 Days	656	4.2E-08
TH231	1.063 Days	1426	7.8E-08	BI214	19.9 Min.	296	1.9E-08
AM242	16.02 Hours	884	4.8E-08	PB214	26.8 Min.	296	1.9E-08
BI210	5.012 Days	795	4.3E-08	U232	72 Years	217	1.4E-08
RA224	3.66 Days	714	3.9E-08	RN222	3.824 Days	197	1.3E-08
CM243	28.5 Years	524	2.9E-08	PB211	36.1 Min.	149	9.7E-09
NP236	115 KY	114	6.2E-09	TH228	1.913 Years	121	7.8E-09
AC225	10 Days	113	6.2E-09	NP236	115 KY	113	7.3E-09
RA225	14.8 Days	57	3.1E-09	TH232	14.05 GY	43	2.8E-09
PB211	36.1 Min.	40	2.2E-09	PU241	14.4 Years	38	2.5E-09
PB212	10.64 Hours	36	1.9E-09	AM242	16.02 Hours	36	2.3E-09
NP239	2.355 Days	31	1.7E-09	NP239	2.355 Days	29	1.9E-09
PB214	26.8 Min.	29	1.6E-09	PA234	6.7 Hours	22	1.4E-09
BI214	19.9 Min.	29	1.6E-09	CM246	4.731 KY	20	1.3E-09
CM246	4.731 KY	22	1.2E-09	PU236	2.851 Years	10	6.6E-10
PA234	6.7 Hours	22	1.2E-09	FR223	21.8 Min.	2.1	1.3E-10
RN222	3.824 Days	20	1.1E-09	BI213	45.65 Min.	1.6	1.1E-10
TH232	14.05 GY	13	7.0E-10	RA224	3.66 Days	1.2	7.8E-11
PU236	2.851 Years	10	5.6E-10	RA228	6.7 Years	0.14	9.3E-12
BI212	1.009 Hours	4.1	2.2E-10	NP238	2.117 Days	0.091	5.9E-12
NP238	2.117 Days	2.2	1.2E-10	PU244	82.61 MY	0.061	4.0E-12
RN220	55.6 Sec.	1.0	5.2E-11	PB212	10.64 Hours	0.061	3.9E-12
FR223	21.8 Min.	0.56	3.0E-11	PB209	3.3 Hours	0.013	8.5E-13
BI213	45.65 Min.	0.14	7.7E-12	BI212	1.009 Hours	0.0069	4.5E-13
PU244	82.61 MY	0.061	3.3E-12	AC228	6.131 Hours	0.0043	2.8E-13
RA228	6.7 Years	0.043	2.3E-12	RN220	55.6 Sec.	0.0016	1.0E-13
U237	6.75 Days	0.0017	9.0E-14	PA234m	1.17 Min.	0.00033	2.2E-14
AC228	6.131 Hours	0.0013	7.0E-14	CM243	28.5 Years	2.1E-05	1.4E-15
PB209	3.3 Hours	0.0011	6.2E-14	CM247	15.6 MY	2.9E-06	1.8E-16
PA234m	1.17 Min.	0.00033	1.8E-14	CM248	339.1 KY	1.2E-06	7.6E-17
CM247	15.6 MY	2.9E-06	1.6E-16	PO218	3.05 Min.	5.9E-07	3.8E-17
CM248	339.1 KY	1.2E-06	6.4E-17	PO214	2E-04 Sec.	5.9E-07	3.8E-17
U240	14.1 Hours	4.1E-07	2.2E-17	U237	6.75 Days	4.7E-07	3.0E-17
CF249	350.5 Years	1.5E-07	8.0E-18	U240	14.1 Hours	4.1E-07	2.6E-17
PO215	0.002 Sec.	8.1E-08	4.4E-18	PO215	0.002 Sec.	3.0E-07	1.9E-17
BI211	2.13 Min.	8.1E-08	4.4E-18	RN219	3.96 Sec.	3.0E-07	1.9E-17
RN219	3.96 Sec.	8.1E-08	4.4E-18	BI211	2.13 Min.	3.0E-07	1.9E-17
TL207	4.77 Min.	8.1E-08	4.4E-18	TL207	4.77 Min.	3.0E-07	1.9E-17
PO218	3.05 Min.	5.9E-08	3.2E-18	CF249	350.5 Years	3.6E-08	2.3E-18
PO214	2E-04 Sec.	5.9E-08	3.2E-18	CM244	18.11 Years	7.6E-09	4.9E-19
PO216	0.15 Sec.	2.9E-09	1.6E-19	FR221	4.8 Min.	1.3E-09	8.5E-20

Table 2.6. (contd)

Table 6-1. Decay Time = 3000 Years

Isotope	Half-Life	Air Hazard	Per Cent
PU239	24.06 kY	1.12E+12	84.66
PU240	6.537 kY	1.90E+11	14.36
AM241	432.2 Years	4.72E+09	0.356
U234	244.5 kY	3.89E+09	0.294
U238	4.468 GY	3.34E+09	0.252
NP237	2.14 MY	4.27E+08	0.032
TH230	77 kY	1.87E+08	0.014
U235	703.8 MY	1.60E+08	0.012
U236	23.41 MY	1.05E+08	7.9E-03
AC227	21.77 Years	8.81E+07	6.7E-03
PA231	32.77 kY	8.81E+07	6.7E-03
PU242	386.9 kY	1.15E+07	8.7E-04
PB210	22.3 Years	4.58E+06	3.5E-04
RA226	1.6 kY	4.12E+06	3.1E-04
PO210	138.4 Days	4.12E+06	3.1E-04
AM243	7.38 kY	3.97E+06	3.0E-04
TH229	7.339 kY	1.81E+06	1.4E-04
TH227	18.72 Days	1.24E+06	9.4E-05
U233	158.5 kY	1.14E+06	8.6E-05
TH234	24.1 Days	6.34E+05	6.3E-05
RA223	11.43 Days	4.40E+05	3.3E-05
BI210	5.012 Days	6.87E+04	5.2E-06
AC225	10 Days	1.27E+04	9.6E-07
PA233	27 Days	8542	6.5E-07
RA225	14.8 Days	6329	4.8E-07
CM245	8.499 kY	2172	1.6E-07
BI214	19.9 Min.	2060	1.6E-07
PB214	26.8 Min.	2060	1.6E-07
TH231	1.063 Days	1439	1.1E-07
RN222	3.824 Days	1374	1.0E-07
PB211	36.1 Min.	440	3.3E-08
TH232	14.05 GY	134	1.0E-08
NP236	115 kY	112	8.5E-09
TH228	1.913 Years	59	4.4E-09
U232	72 Years	50	3.8E-09
PU238	87.74 Years	43	3.2E-09
PU241	14.4 Years	33	2.5E-09
AM242m	152 Years	27	2.0E-09
NP239	2.355 Days	24	1.8E-09
PA234	6.7 Hours	22	1.6E-09
BI213	45.65 Min.	16	1.2E-09
CM246	4.731 kY	15	1.1E-09
PU236	2.851 Years	10	7.6E-10
FR223	21.8 Min.	6.1	4.6E-10
CM242	163.2 Days	0.94	7.1E-11
RA224	3.66 Days	0.59	4.4E-11
RA228	6.7 Years	0.45	3.4E-11
PB209	3.3 Hours	0.13	9.6E-12
PU244	82.61 MY	0.061	4.6E-12
PB212	10.64 Hours	0.029	2.2E-12
AC228	6.131 Hours	0.013	1.0E-12
AM242	16.02 Hours	0.0040	3.0E-13
BI212	1.009 Hours	0.0034	2.5E-13
RN220	55.6 Sec.	0.00078	5.9E-14
PA234m	1.17 Min.	0.00033	2.5E-14
NP238	2.117 Days	1.0E-05	7.5E-16
PO218	3.05 Min.	4.1E-06	3.1E-16
PO214	2E-04 Sec.	4.1E-06	3.1E-16
CM247	15.6 MY	2.9E-06	2.2E-16
CM248	339.1 kY	1.2E-06	8.8E-17
BI211	2.13 Min.	8.8E-07	6.7E-17
RN219	3.96 Sec.	8.8E-07	6.7E-17
PO215	0.002 Sec.	8.8E-07	6.7E-17
TL207	4.77 Min.	8.8E-07	6.6E-17
U240	14.1 Hours	4.1E-07	3.1E-17
U237	6.75 Days	4.0E-07	3.0E-17
FR221	4.8 Min.	1.3E-08	9.6E-19
AT217	0.032 Sec.	1.3E-08	9.6E-19
PO213	4E-06 Sec.	1.2E-08	9.3E-19
CF249	350.5 Years	3.2E-09	2.4E-19

Table 2.7. Relative Ingestion Hazard of Fission Products in Hanford Reactor Fuel at Various Decay Times

Table 7-A. Decay Time = 1 Year				Table 7-B. Decay Time = 3 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
CE144	284.3 Days	4.21E+06	45.65	SR 90	29.12 Years	1.94E+06	49.07
SR 90	29.12 Years	2.04E+06	22.14	CS137	30 Years	7.57E+05	19.11
RU106	1.008 Years	9.86E+05	10.70	CE144	284.3 Days	7.08E+05	17.88
CS137	30 Years	7.93E+05	8.61	RU106	1.008 Years	2.49E+05	6.29
Y 91	58.51 Days	3.41E+05	3.70	Y 90	2.667 Days	1.95E+05	4.91
Y 90	2.667 Days	2.04E+05	2.21	CS134	2.062 Years	5.21E+04	1.32
NB 95	35.15 Days	1.95E+05	2.11	PM147	2.623 Years	4.32E+04	1.09
ZR 95	63.98 Days	1.36E+05	1.47	PR144	17.28 Min.	4958	0.125
CS134	2.062 Years	1.02E+05	1.11	SB125	2.77 Years	3937	0.099
SR 89	50.5 Days	7.51E+04	0.815	TE125m	58 Days	1201	0.030
PM147	2.623 Years	7.33E+04	0.796	EU154	8.6 Years	1185	0.030
PR144	17.28 Min.	2.94E+04	0.320	CD113m	14.59 Years	938	0.024
RU103	39.28 Days	7505	0.081	EU155	4.959 Years	425	0.011
SB125	2.77 Years	6495	0.071	SM151	89.99 Years	109	2.8E-03
TE127m	109 Days	6025	0.065	NB 95	35.15 Days	73	1.9E-03
CE141	32.51 Days	3162	0.034	Y 91	58.51 Days	59	1.5E-03
SN123	129.2 Days	2420	0.026	TE127m	109 Days	58	1.5E-03
TE125m	58 Days	1957	0.021	ZR 95	63.98 Days	50	1.3E-03
EU154	8.6 Years	1392	0.015	SN123	129.2 Days	48	1.2E-03
CD113m	14.59 Years	1031	0.011	AG110m	249.9 Days	25	6.3E-04
TE127	9.35 Hours	590	6.4E-03	TE127	9.35 Hours	5.7	1.4E-04
NB 95m	3.609 Days	575	6.2E-03	SN119m	245 Days	5.4	1.4E-04
EU155	4.959 Years	561	6.1E-03	H 3	12.35 Years	5.2	1.3E-04
TE129m	33.6 Days	451	4.9E-03	TC 99	213 kY	3.4	8.7E-05
AG110m	249.9 Days	188	2.0E-03	SR 89	50.5 Days	3.3	8.4E-05
PM148m	41.3 Days	153	1.7E-03	EU152	13.6 Years	2.8	7.0E-05
CD115m	44.59 Days	119	1.3E-03	BA137m	2.552 Min.	2.1	5.4E-05
SM151	89.99 Years	111	1.2E-03	SN126	100 kY	2.1	5.2E-05
SN119m	245 Days	42	4.6E-04	RH106	29.9 Sec.	1.5	3.8E-05
RH103m	56.12 Min.	34	3.7E-04	I129	15.7 MY	1.4	3.4E-05
PM148	5.37 Days	17	1.9E-04	ZR 93	1.53 MY	0.52	1.3E-05
SB124	60.2 Days	10	1.1E-04	SE 79	64.96 kY	0.51	1.3E-05
RH106	29.9 Sec.	5.9	6.4E-05	CS135	2.3 MY	0.42	1.1E-05
H 3	12.35 Years	5.9	6.4E-05	SB126	12.4 Days	0.23	5.8E-06
TE129	1.16 Hours	4.2	4.6E-05	KR 85	10.72 Years	0.23	5.7E-06
TC 99	213 kY	3.4	3.7E-05	NB 95m	3.609 Days	0.21	5.3E-06
EU152	13.6 Years	3.1	3.3E-05	PM146	5.5 Years	0.098	2.5E-06
TB160	72.3 Days	3.0	3.2E-05	PR144m	7.2 Min.	0.059	1.5E-06
BA137m	2.552 Min.	2.3	2.4E-05	SN121m	49.97 Years	0.029	7.4E-07
SN126	100 kY	2.1	2.2E-05	RU103	39.28 Days	0.019	4.8E-07
I129	15.7 MY	1.4	1.5E-05	RH102	2.9 Years	0.016	4.0E-07
ZR 93	1.53 MY	0.52	5.7E-06	GD153	242 Days	9.3E-03	2.3E-07
SE 79	64.96 kY	0.51	5.5E-06	SB126m	19 Min.	8.2E-03	2.1E-07
CS135	2.3 MY	0.42	4.5E-06	TB160	72.3 Days	2.7E-03	6.8E-08
PR144m	7.2 Min.	0.35	3.8E-06	SB124	60.2 Days	2.3E-03	5.8E-08
KR 85	10.72 Years	0.26	2.8E-06	CD115m	44.59 Days	1.4E-03	3.5E-08
SB126	12.4 Days	0.23	2.5E-06	NB 93m	13.6 Years	1.3E-03	3.3E-08
PR143	13.56 Days	0.13	1.4E-06	PD107	6.496 MY	1.2E-03	3.0E-08
PM146	5.5 Years	0.13	1.4E-06	PM148m	41.3 Days	7.2E-04	1.8E-08
GD153	242 Days	0.075	8.1E-07	CE141	32.51 Days	5.4E-04	1.4E-08
LA140	1.676 Days	0.071	7.7E-07	SM147	107 GY	1.6E-04	4.2E-09
BA140	12.79 Days	0.062	6.7E-07	TE129m	33.6 Days	1.3E-04	3.2E-09
SN121m	49.97 Years	0.030	3.3E-07	TE123m	119.7 Days	9.8E-05	2.5E-09
RH102	2.9 Years	0.026	2.8E-07	RH103m	56.12 Min.	8.5E-05	2.2E-09
EU156	15.19 Days	0.020	2.2E-07	PM148	5.37 Days	8.1E-05	2.1E-09
SB126m	19 Min.	8.2E-03	9.0E-08	HO166m	1.2 kY	5.3E-05	1.3E-09
TE123m	119.7 Days	6.7E-03	7.3E-08	NB 94	20.3 kY	5.2E-05	1.3E-09
RB 86	18.66 Days	3.7E-03	4.0E-08	C 14	5.729 kY	3.9E-05	9.8E-10
PD107	6.496 MY	1.2E-03	1.3E-08	RB 87	46.96 GY	2.0E-05	5.0E-10
CS136	13.1 Days	9.7E-04	1.1E-08	AG108m	127 Years	1.1E-05	2.8E-10
IN114m	49.51 Days	5.5E-04	6.0E-09	AG110	24.6 Sec.	3.3E-06	8.3E-11
ND147	11.06 Days	5.3E-04	5.7E-09	BE 10	1.6 MY	2.2E-06	5.7E-11
NB 93m	13.6 Years	5.0E-04	5.4E-09	TE129	1.16 Hours	1.2E-06	3.0E-11
IN115m	4.3 Hours	1.9E-04	2.1E-09	CD109	1.27 Years	1.1E-06	2.9E-11
SM147	107 GY	7.3E-05	7.9E-10	EU150	36 Years	4.3E-07	1.1E-11
HO166m	1.2 kY	5.3E-05	5.7E-10	TC 98	4.199 MY	2.0E-07	4.9E-12
NB 94	20.3 kY	5.2E-05	5.6E-10	SM146	70 MY	1.0E-07	2.5E-12
C 14	5.729 kY	3.9E-05	4.2E-10	TM170	128.6 Days	3.0E-08	7.5E-13
AG110	24.6 Sec.	2.5E-05	2.7E-10	IN114m	49.51 Days	2.0E-08	5.0E-13
RB 87	46.96 GY	2.0E-05	2.1E-10	IN115m	4.3 Hours	2.2E-09	5.6E-14

Table 2.7. (contd)

Table 7-C. Decay Time = 10 Years				Table 7-D. Decay Time = 30 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
SR 90	29.12 Years	1.65E+06	66.58	SR 90	29.12 Years	1.02E+06	66.77
CS137	30 Years	6.44E+05	26.05	CS137	30 Years	4.06E+05	26.51
Y 90	2.667 Days	1.65E+05	6.66	Y 90	2.667 Days	1.02E+05	6.68
PM147	2.623 Years	6799	0.275	CD113m	14.59 Years	260	0.017
CS134	2.062 Years	4957	0.201	EU154	8.6 Years	135	8.8E-03
RU106	1.008 Years	2023	0.082	SM151	89.99 Years	89	5.8E-03
CE144	284.3 Days	1388	0.056	PM147	2.623 Years	34	2.3E-03
SB125	2.77 Years	683	0.028	EU155	4.959 Years	9.7	6.4E-04
EU154	8.6 Years	674	0.027	CS134	2.062 Years	6.0	3.9E-04
CD113m	14.59 Years	672	0.027	SB125	2.77 Years	4.6	3.0E-04
TE125m	58 Days	208	8.4E-03	TC 99	213 kY	3.4	2.2E-04
EU155	4.959 Years	160	6.5E-03	SN126	100 kY	2.1	1.3E-04
SM151	89.99 Years	104	4.2E-03	TE125m	58 Days	1.4	9.1E-05
PR144	17.28 Min.	9.7	3.9E-04	I129	15.7 MY	1.4	8.9E-05
H 3	12.35 Years	3.5	1.4E-04	BA137m	2.552 Min.	1.2	7.5E-05
TC 99	213 kY	3.4	1.4E-04	H 3	12.35 Years	1.2	7.5E-05
SN126	100 kY	2.1	8.3E-05	EU152	13.6 Years	0.70	4.6E-05
EU152	13.6 Years	1.9	7.8E-05	ZR 93	1.53 MY	0.52	3.4E-05
BA137m	2.552 Min.	1.8	7.4E-05	SE 79	64.96 kY	0.51	3.3E-05
I129	15.7 MY	1.4	5.5E-05	CS135	2.3 MY	0.42	2.7E-05
ZR 93	1.53 MY	0.52	2.1E-05	SB126	12.4 Days	0.23	1.5E-05
SE 79	64.96 kY	0.51	2.1E-05	KR 85	10.72 Years	0.039	2.6E-06
CS135	2.3 MY	0.42	1.7E-05	SN121m	49.97 Years	0.020	1.3E-06
SB126	12.4 Days	0.23	9.3E-06	SB126m	19 Min.	8.2E-03	5.4E-07
KR 85	10.72 Years	0.14	5.8E-06	NB 93m	13.6 Years	7.0E-03	4.6E-07
PM146	5.5 Years	0.040	1.6E-06	PM146	5.5 Years	3.2E-03	2.1E-07
SN121m	49.97 Years	0.027	1.1E-06	RU106	1.008 Years	2.2E-03	1.4E-07
AG110m	249.9 Days	0.021	8.3E-07	PD107	6.496 MY	1.2E-03	7.9E-08
RH106	29.9 Sec.	0.012	4.9E-07	SM147	107 GY	3.0E-04	1.9E-08
SB126m	19 Min.	8.2E-03	3.3E-07	HO166m	1.2 kY	5.2E-05	3.4E-09
SN119m	245 Days	3.9E-03	1.6E-07	NB 94	20.3 kY	5.2E-05	3.4E-09
NB 93m	13.6 Years	3.6E-03	1.5E-07	C 14	5.729 kY	3.9E-05	2.5E-09
RH102	2.9 Years	3.0E-03	1.2E-07	CE144	284.3 Days	2.6E-05	1.7E-09
PD107	6.496 MY	1.2E-03	4.9E-08	RH102	2.9 Years	2.5E-05	1.6E-09
SM147	107 GY	2.8E-04	1.1E-08	RB 87	46.96 GY	2.0E-05	1.3E-09
PR144m	7.2 Min.	1.2E-04	4.7E-09	AG108m	127 Years	9.6E-06	6.3E-10
SN123	129.2 Days	5.3E-05	2.1E-09	BE 10	1.6 MY	2.2E-06	1.5E-10
HO166m	1.2 kY	5.2E-05	2.1E-09	SM146	70 MY	2.6E-07	1.7E-11
NB 94	20.3 kY	5.2E-05	2.1E-09	EU150	36 Years	2.6E-07	1.7E-11
C 14	5.729 kY	3.9E-05	1.6E-09	TC 98	4.199 MY	2.0E-07	1.3E-11
RB 87	46.96 GY	2.0E-05	7.9E-10	PR144	17.28 Min.	1.8E-07	1.2E-11
AG108m	127 Years	1.1E-05	4.3E-10	RH106	29.9 Sec.	1.3E-08	8.4E-13
GD153	242 Days	6.1E-06	2.5E-10	IN115	5E+05 GY	1.3E-09	8.5E-14
TE127m	109 Days	5.0E-06	2.0E-10	CE142	104.9 GY	6.5E-10	4.2E-14
BE 10	1.6 MY	2.2E-06	9.1E-11	LA138	135 GY	2.1E-10	1.4E-14
TE127	9.35 Hours	4.9E-07	2.0E-11	AG110m	249.9 Days	3.3E-11	2.1E-15
EU150	36 Years	3.8E-07	1.5E-11	AG108	2.37 Min.	1.7E-11	1.1E-15
SM146	70 MY	2.0E-07	7.9E-12	GD152	1E+05 GY	4.6E-12	3.0E-16
TC 98	4.199 MY	2.0E-07	7.9E-12	SN119m	245 Days	4.1E-12	2.7E-16
CD109	1.27 Years	2.5E-08	1.0E-12	KR 81	209.9 kY	2.3E-12	1.5E-16
AG110	24.6 Sec.	2.7E-09	1.1E-13	PR144m	7.2 Min.	2.1E-12	1.4E-16
IN115	5E+05 GY	1.3E-09	5.3E-14	CD109	1.27 Years	4.5E-13	3.0E-17
CE142	104.9 GY	6.5E-10	2.6E-14	ND144	2E+06 GY	3.0E-14	1.9E-18
LA138	135 GY	2.1E-10	8.5E-15	TM171	1.92 Years	1.7E-14	1.1E-18
NB 95	35.15 Days	6.9E-11	2.8E-15	TE123	10001 GY	7.4E-15	4.9E-19
ZR 95	63.98 Days	4.6E-11	1.9E-15	GD153	242 Days	5.0E-15	3.3E-19
TE123m	119.7 Days	3.6E-11	1.5E-15	SM149	1E+07 GY	1.8E-16	1.2E-20
TM171	1.92 Years	2.3E-11	9.2E-16	SM148	8E+06 GY	1.4E-16	9.5E-21
AG108	2.37 Min.	1.9E-11	7.7E-16	AG109m	39.6 Sec.	4.5E-18	3.0E-22
Y 91	58.51 Days	4.2E-12	1.7E-16	AG110	24.6 Sec.	4.3E-18	2.8E-22
GD152	1E+05 GY	3.7E-12	1.5E-16	SN123	129.2 Days	5.0E-22	3.3E-26
KR 81	209.9 kY	2.3E-12	9.5E-17	TE127m	109 Days	3.4E-26	2.2E-30
AG109m	39.6 Sec.	2.5E-13	1.0E-17	TE127	9.35 Hours	3.3E-27	2.2E-31
NB 95m	3.609 Days	2.0E-13	7.9E-18	TE123m	119.7 Days	1.5E-29	1.0E-33
TB160	72.3 Days	6.1E-14	2.5E-18	TM170	128.6 Days	2.4E-31	1.6E-35
TM170	128.6 Days	3.1E-14	1.2E-18	I133m	9 Sec.	0	0
ND144	2E+06 GY	3.0E-14	1.2E-18	TE133	12.45 Min.	0	0
TE123	10001 GY	7.4E-15	3.0E-19	TE133m	55.4 Min.	0	0
SR 89	50.5 Days	1.9E-15	7.7E-20	I133	20.8 Hours	0	0
SB124	60.2 Days	3.8E-16	1.5E-20	I139	2.4 Sec.	0	0

Table 2.7. (contd)

Table 7-E. Decay Time = 40 Years				Table 7-F. Decay Time = 100 Years			
isotope	Half-Life	Water Haz.	Per Cent	isotope	Half-Life	Water Haz.	Per Cent
SR 90	29.12 Years	8.06E+05	66.67	SR 90	29.12 Years	193,200	65.92
CS137	30 Years	3.22E+05	26.64	CS137	30 Years	80,500	27.46
Y 90	2.667 Days	8.06E+04	6.67	Y 90	2.667 Days	19,330	6.60
CD113m	14.59 Years	162	0.013	SM151	89.99 Years	52	0.018
SM151	89.99 Years	82	6.8E-03	CD113m	14.59 Years	9.3	3.2E-03
EU154	8.6 Years	60	5.0E-03	TC 99	213 kY	3.4	1.2E-03
TC 99	213 kY	3.4	2.8E-04	SN126	100 kY	2.1	7.0E-04
PM147	2.623 Years	2.5	2.0E-04	I129	15.7 MY	1.4	4.6E-04
EU155	4.959 Years	2.4	2.0E-04	ZR 93	1.53 MY	0.52	1.8E-04
SN126	100 kY	2.1	1.7E-04	SE 79	64.96 kY	0.51	1.7E-04
I129	15.7 MY	1.4	1.1E-04	EU154	8.6 Years	0.48	1.6E-04
BA137m	2.552 Min.	0.91	7.6E-05	CS135	2.3 MY	0.42	1.4E-04
H 3	12.35 Years	0.66	5.4E-05	SB126	12.4 Days	0.23	7.9E-05
ZR 93	1.53 MY	0.52	4.3E-05	BA137m	2.552 Min.	0.23	7.8E-05
SE 79	64.96 kY	0.51	4.2E-05	H 3	12.35 Years	0.023	7.7E-06
EU152	13.6 Years	0.42	3.5E-05	EU152	13.6 Years	0.020	6.7E-06
CS135	2.3 MY	0.42	3.4E-05	NB 93m	13.6 Years	8.9E-03	3.0E-06
SB125	2.77 Years	0.37	3.1E-05	SB126m	19 Min.	8.2E-03	2.8E-06
SB126	12.4 Days	0.23	1.9E-05	SN121m	49.97 Years	7.7E-03	2.6E-06
CS134	2.062 Years	0.21	1.7E-05	PD107	6.496 MY	1.2E-03	4.1E-07
TE125m	58 Days	0.11	9.5E-06	EU155	4.959 Years	5.5E-04	1.9E-07
KR 85	10.72 Years	0.021	1.7E-06	KR 85	10.72 Years	4.3E-04	1.5E-07
SN121m	49.97 Years	0.018	1.5E-06	SM147	107 GY	3.0E-04	1.0E-07
SB126m	19 Min.	8.2E-03	6.8E-07	NB 94	20.3 kY	5.2E-05	1.8E-08
NB 93m	13.6 Years	7.8E-03	6.5E-07	HO166m	1.2 kY	5.0E-05	1.7E-08
PD107	6.496 MY	1.2E-03	1.0E-07	C 14	5.729 kY	3.8E-05	1.3E-08
PM146	5.5 Years	9.2E-04	7.6E-08	RB 87	46.96 GY	2.0E-05	6.7E-09
SM147	107 GY	3.0E-04	2.5E-08	AG108m	127 Years	6.6E-06	2.2E-09
NB 94	20.3 kY	5.2E-05	4.3E-09	BE 10	1.6 MY	2.2E-06	7.7E-10
HO166m	1.2 kY	5.1E-05	4.3E-09	PM146	5.5 Years	4.8E-07	1.6E-10
C 14	5.729 kY	3.9E-05	3.2E-09	PM147	2.623 Years	3.2E-07	1.1E-10
RB 87	46.96 GY	2.0E-05	1.6E-09	SM146	70 MY	2.6E-07	9.0E-11
AG108m	127 Years	9.1E-06	7.5E-10	TC 98	4.199 MY	2.0E-07	6.7E-11
RH102	2.9 Years	2.3E-06	1.9E-10	SB125	2.77 Years	1.1E-07	3.9E-11
BE 10	1.6 MY	2.2E-06	1.9E-10	EU150	36 Years	6.6E-08	2.3E-11
RU106	1.008 Years	2.2E-06	1.8E-10	TE125m	58 Days	3.4E-08	1.2E-11
SM146	70 MY	2.6E-07	2.2E-11	IN115	5E+05 GY	1.3E-09	4.4E-13
EU150	36 Years	2.1E-07	1.7E-11	CE142	104.9 GY	6.5E-10	2.2E-13
TC 98	4.199 MY	2.0E-07	1.6E-11	CS134	2.062 Years	3.6E-10	1.2E-13
CE144	284.3 Days	3.5E-09	2.9E-13	LA138	135 GY	2.1E-10	7.2E-14
IN115	5E+05 GY	1.3E-09	1.1E-13	AG108	2.37 Min.	1.2E-11	4.0E-15
CE142	104.9 GY	6.5E-10	5.4E-14	GD152	1E+05 GY	5.2E-12	1.8E-15
LA138	135 GY	2.1E-10	1.7E-14	KR 81	209.9 kY	2.3E-12	8.0E-16
PR144	17.28 Min.	2.4E-11	2.0E-15	RH102	2.9 Years	1.4E-12	4.6E-16
AG108	2.37 Min.	1.6E-11	1.3E-15	ND144	2E+06 GY	3.0E-14	1.0E-17
RH106	29.9 Sec.	1.3E-11	1.1E-15	TE123	10001 GY	7.4E-15	2.5E-18
GD152	1E+05 GY	4.9E-12	4.0E-16	SM149	1E+07 GY	1.8E-16	6.2E-20
KR 81	209.9 kY	2.3E-12	1.9E-16	SM148	8E+06 GY	1.4E-16	4.9E-20
ND144	2E+06 GY	3.0E-14	2.5E-18	RU106	1.008 Years	2.7E-24	9.1E-28
TE123	10001 GY	7.4E-15	6.2E-19	TM171	1.92 Years	1.8E-25	6.0E-29
AG110m	249.9 Days	1.3E-15	1.1E-19	RH106	29.9 Sec.	1.6E-29	5.5E-33
CD109	1.27 Years	9.3E-16	7.7E-20	CD109	1.27 Years	1.2E-29	4.0E-33
TM171	1.92 Yec.s	4.9E-16	4.0E-20	CS133	0 Stable	0	0
PR144m	7.2 Min.	2.9E-16	2.4E-20	BA133	10.74 Years	0	0
SM149	1E+07 GY	1.8E-16	1.5E-20	XE133m	2.19 Days	0	0
SM148	8E+06 GY	1.4E-16	1.2E-20	IN134	0.078 Sec.	0	0
SN119m	245 Days	1.3E-16	1.1E-20	XE133	5.245 Days	0	0
GD153	242 Days	1.4E-19	1.2E-23	I133m	9 Sec.	0	0
AG109m	39.6 Sec.	1.9E-20	1.6E-24	SB134	11 Sec.	0	0
AG110	24.6 Sec.	1.7E-22	1.4E-26	XE131m	11.9 Days	0	0
SN123	129.2 Days	1.5E-30	1.3E-34	I131	8.041 Days	0	0
I127	0 Stable	0	0	IN132	0.12 Sec.	0	0
I128	24.98 Min.	0	0	CD132	0.145 Sec.	0	0
I130	12.36 Hours	0	0	SB132	2.8 Min.	0	0
I130m	9 Min.	0	0	XE131	0 Stable	0	0
I131	8.041 Days	0	0	TE132	3.258 Days	0	0
I132	2.3 Hours	0	0	TE131m	1.25 Days	0	0
I133	20.8 Hours	0	0	TE131	25 Min.	0	0
I133m	9 Sec.	0	0	SN132	40 Sec.	0	0
I134	52.6 Min.	0	0	I133	20.8 Hours	0	0

Table 2.7. (contd)

Table 7-G. Decay Time = 300 Years				Table 7-H. Decay Time = 1000 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
SR 90	29.12 Years	1654	62.86	TC 99	213 kY	3.423	39.95
CS137	30 Years	792	30.11	SN126	100 kY	2.048	23.90
Y 90	2.667 Days	166	6.29	I129	15.7 MY	1.355	15.82
SM151	89.99 Years	11.1	0.421	ZR 93	1.53 MY	0.524	6.12
TC 99	213 kY	3.4	0.130	SE 79	64.96 kY	0.502	5.86
SN126	100 kY	2.1	0.078	CS135	2.3 MY	0.416	4.86
I129	15.7 MY	1.4	0.051	SB126	12.4 Days	0.229	2.68
ZR 93	1.53 MY	0.52	0.020	SM151	89.99 Years	0.0505	0.590
SE 79	64.96 kY	0.51	0.019	NB 93m	13.6 Years	0.0090	0.105
CS135	2.3 MY	0.42	0.016	SB126m	19 Min.	0.0082	0.096
SB126	12.4 Days	0.23	8.8E-03	PD107	6.496 MY	0.0012	0.014
NB 93m	13.6 Years	9.0E-03	3.4E-04	SM147	107 GY	3.0E-04	3.5E-03
SB126m	19 Min.	8.2E-03	3.1E-04	SR 90	29.12 Years	9.6E-05	1.1E-03
BA137m	2.552 Min.	2.2E-03	8.5E-05	CS137	30 Years	7.5E-05	8.7E-04
PD107	6.496 MY	1.2E-03	4.6E-05	NB 94	20.3 kY	5.0E-05	5.8E-04
CD113m	14.59 Years	7.0E-04	2.7E-05	C 14	5.729 kY	3.4E-05	4.0E-04
SN121m	49.97 Years	4.8E-04	1.8E-05	HO166m	1.2 kY	3.0E-05	3.5E-04
SM147	107 GY	3.0E-04	1.1E-05	RB 87	46.96 GY	2.0E-05	2.3E-04
NB 94	20.3 kY	5.1E-05	1.9E-06	Y 90	2.667 Days	9.6E-06	1.1E-04
HO166m	1.2 kY	4.4E-05	1.7E-06	BE 10	1.6 MY	2.2E-06	2.6E-05
C 14	5.729 kY	3.7E-05	1.4E-06	SM146	70 MY	2.6E-07	3.1E-06
RB 87	46.96 GY	2.0E-05	7.5E-07	TC 98	4.199 MY	2.0E-07	2.3E-06
BE 10	1.6 MY	2.2E-06	8.5E-08	AG108m	127 Years	4.8E-08	5.6E-07
AG108m	127 Years	2.2E-06	8.4E-08	SN121m	49.97 Years	2.9E-08	3.4E-07
EU152	13.6 Years	7.4E-07	2.8E-08	IN115	5E+05 GY	1.3E-09	1.5E-08
H 3	12.35 Years	3.0E-07	1.1E-08	CE142	104.9 GY	6.5E-10	7.6E-09
SM146	70 MY	2.6E-07	1.0E-08	BA137m	2.552 Min.	2.1E-10	2.5E-09
TC 98	4.199 MY	2.0E-07	7.4E-09	LA138	135 GY	2.1E-10	2.4E-09
EU154	8.6 Years	4.8E-08	1.8E-09	GD152	1E+05 GY	5.2E-12	6.1E-11
EU150	36 Years	1.4E-09	5.4E-11	KR 81	209.9 kY	2.3E-12	2.7E-11
IN115	5E+05 GY	1.3E-09	5.0E-11	AG108	2.37 Min.	8.6E-14	1.0E-12
KR 85	10.72 Years	1.0E-09	3.9E-11	ND144	2E+06 GY	3.0E-14	3.5E-13
CE142	104.9 GY	6.5E-10	2.5E-11	TE123	10001 GY	7.4E-15	8.7E-14
LA138	135 GY	2.1E-10	8.0E-12	EU150	36 Years	2.0E-15	2.3E-14
GD152	1E+05 GY	5.2E-12	2.0E-13	SM149	1E+07 GY	1.8E-16	2.1E-15
AG108	2.37 Min.	3.9E-12	1.5E-13	SM148	8E+06 GY	1.4E-16	1.7E-15
KR 81	209.9 kY	2.3E-12	8.9E-14	CD113m	14.59 Years	2.5E-18	2.9E-17
ND144	2E+06 GY	3.0E-14	1.1E-15	EU152	13.6 Years	2.4E-22	2.8E-21
TE123	10001 GY	7.4E-15	2.8E-16	H 3	12.35 Years	2.6E-24	3.0E-23
EU155	4.959 Years	4.0E-16	1.5E-17	KR 85	10.72 Years	2.3E-29	2.7E-28
SM149	1E+07 GY	1.8E-16	6.9E-18	SN131	1.05 Min.	0	0
SM148	8E+06 GY	1.4E-16	5.5E-18	TE134	41.8 Min.	0	0
PM146	5.5 Years	5.4E-18	2.1E-19	XE133	5.245 Days	0	0
RH102	2.9 Years	2.4E-33	8.9E-35	XE133m	2.19 Days	0	0
SB134m	10.7 Sec.	0	0	SB131	23 Min.	0	0
CS133	0 Stable	0	0	IN134	0.078 Sec.	0	0
SB131	23 Min.	0	0	CS133	0 Stable	0	0
TE134	41.8 Min.	0	0	SN134	0.845 Sec.	0	0
CD132	0.145 Sec.	0	0	SB134m	10.7 Sec.	0	0
XE133m	2.19 Days	0	0	BA133	10.74 Years	0	0
I133	20.8 Hours	0	0	SB134	11 Sec.	0	0
SB134	11 Sec.	0	0	I133m	9 Sec.	0	0
TE131	25 Min.	0	0	TE131	25 Min.	0	0
BA133	10.74 Years	0	0	SB132	2.8 Min.	0	0
IN134	0.078 Sec.	0	0	TE132	3.258 Days	0	0
SN134	0.845 Sec.	0	0	TE131m	1.25 Days	0	0
XE133	5.245 Days	0	0	I131	8.041 Days	0	0
SB132m	4.2 Min.	0	0	XE131	0 Stable	0	0
TE131m	1.25 Days	0	0	XE131m	11.9 Days	0	0
BA132	0 Stable	0	0	CD132	0.145 Sec.	0	0
SB132	2.8 Min.	0	0	IN132	0.12 Sec.	0	0
I132	2.3 Hours	0	0	SN132	40 Sec.	0	0
XE132	0 Stable	0	0	I133	20.8 Hours	0	0
SN132	40 Sec.	0	0	SB132m	4.2 Min.	0	0
I131	8.041 Days	0	0	TE133m	55.4 Min.	0	0
CS132	6.475 Days	0	0	I132	2.3 Hours	0	0
I133m	9 Sec.	0	0	CS132	6.475 Days	0	0
IN132	0.12 Sec.	0	0	BA132	0 Stable	0	0
TE132	3.258 Days	0	0	IN133	0.114 Sec.	0	0
XE131m	11.9 Days	0	0	SN133	1.47 Sec.	0	0

Table 2.7. (contd)

Table 7-1. Decay Time = 3000 Years

Isotope	Half-Life	Water Haz.	Per Cent
TC 99	213 KY	3.401	40.24
SN126	100 KY	2.020	23.90
I129	15.7 MY	1.355	16.03
ZR 93	1.53 MY	0.524	6.20
SE 79	64.96 KY	0.492	5.82
CS135	2.3 MY	0.416	4.92
SB126	12.4 Days	0.226	2.68
NB 93m	13.6 Years	0.0090	0.106
SB126m	19 Min.	0.0081	0.096
PD107	6.496 MY	0.0012	0.014
SM147	107 GY	3.0E-04	3.5E-03
NB 94	20.3 KY	4.7E-05	5.5E-04
C 14	5.729 KY	2.7E-05	3.2E-04
RB 87	46.96 GY	2.0E-05	2.3E-04
HO166m	1.2 KY	9.3E-06	1.1E-04
BE 10	1.6 MY	2.2E-06	2.7E-05
SM146	70 MY	2.6E-07	3.1E-06
TC 98	4.199 MY	2.0E-07	2.3E-06
SM151	89.99 Years	1.0E-08	1.2E-07
IN115	5E+05 GY	1.3E-09	1.5E-08
CE142	104.9 GY	6.5E-10	7.7E-09
LA138	135 GY	2.1E-10	2.5E-09
GD152	1E+05 GY	5.2E-12	6.1E-11
KR 81	209.9 KY	2.3E-12	2.7E-11
AG108m	127 Years	8.8E-13	1.0E-11
ND144	2E+06 GY	3.0E-14	3.5E-13
TE123	10001 GY	7.4E-15	8.8E-14
SM149	1E+07 GY	1.8E-16	2.2E-15
SM148	8E+06 GY	1.4E-16	1.7E-15
AG108	2.37 Min.	1.6E-18	1.8E-17
SN121m	49.97 Years	2.6E-20	3.1E-19
CS137	30 Years	6.4E-25	7.6E-24
SR 90	29.12 Years	2.0E-25	2.4E-24
Y 90	2.667 Days	2.0E-26	2.4E-25
BA137m	2.552 Min.	1.8E-30	2.1E-29
EU150	36 Years	3.7E-32	4.4E-31
XE133m	2.19 Days	0	0
IN134	0.078 Sec.	0	0
IN131	0.3 Sec.	0	0
CS133	0 Stable	0	0
SN131	1.05 Min.	0	0
SB134m	10.7 Sec.	0	0
BA133	10.74 Years	0	0
SB131	23 Min.	0	0
SB134	11 Sec.	0	0
BA132	0 Stable	0	0
SN134	0.845 Sec.	0	0
TE134	41.8 Min.	0	0
XE133	5.245 Days	0	0
I131	8.041 Days	0	0
I133m	9 Sec.	0	0
TE132	3.258 Days	0	0
XE132	0 Stable	0	0
XE131m	11.9 Days	0	0
CD132	0.145 Sec.	0	0
TE131m	1.25 Days	0	0
IN132	0.12 Sec.	0	0
SN132	40 Sec.	0	0
SB132	2.8 Min.	0	0
SB132m	4.2 Min.	0	0
I133	20.8 Hours	0	0
I132	2.3 Hours	0	0
TE133m	55.4 Min.	0	0
TE131	25 Min.	0	0
CS132	6.475 Days	0	0
XE131	0 Stable	0	0
IN133	0.114 Sec.	0	0
SN133	1.47 Sec.	0	0
SB133	2.4 Min.	0	0
TE133	12.45 Min.	0	0

Table 2.8. Relative Ingestion Hazard of Activation Products in Hanford Reactor Fuel and Cladding at Various Decay Times

Table 2-A. Decay Time = 1 Year				Table 2-B. Decay Time = 3 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
CO 60	5.270 Years	530	37.73	CO 60	5.270 Years	407	70.83
NB 95	35.15 Days	240	17.09	FE 55	2.6 Years	78.2	13.60
ZR 95	63.98 Days	167	11.87	H 3	12.35 Years	33.0	5.74
FE 55	2.6 Years	133	9.49	SB125	2.77 Years	25.4	4.41
CO 58	70.78 Days	96.7	6.89	SN119m	245 Days	8.14	1.41
SN119m	245 Days	64.2	4.57	TE125m	58 Days	7.74	1.35
SB125	2.77 Years	41.9	2.98	NI 63	92 Years	7.46	1.30
H 3	12.35 Years	36.9	2.63	MN 54	312.5 Days	4.98	0.866
MN 54	312.5 Days	25.2	1.79	C 14	5.729 kY	1.78	0.310
SN113	115.1 Days	22.3	1.59	SN123	129.2 Days	0.361	0.063
SN123	129.2 Days	18.2	1.29	SN113	115.1 Days	0.274	0.048
TE125m	58 Days	12.6	0.899	CD109	1.27 Years	0.0968	0.017
NI 63	92 Years	7.57	0.539	NB 95	35.15 Days	0.0903	0.016
Y 91	58.51 Days	1.86	0.132	CO 58	70.78 Days	0.0756	0.013
C 14	5.729 kY	1.78	0.127	ZR 95	63.98 Days	0.0610	0.011
IN113m	1.658 Hours	1.12	0.079	NI 59	80 kY	0.0263	4.6E-03
HF181	42.4 Days	1.07	0.076	ZN 65	243.9 Days	0.0162	2.8E-03
FE 59	45 Days	0.862	0.061	IN113m	1.658 Hours	0.0137	2.4E-03
NB 95m	3.609 Days	0.707	0.050	SN121m	49.97 Years	0.0129	2.2E-03
HF175	70 Days	0.302	0.021	ZR 93	1.530 MY	0.0024	4.2E-04
CD109	1.27 Years	0.288	0.021	TA182	115 Days	0.0023	4.1E-04
W185	75.1 Days	0.233	0.017	Y 91	58.51 Days	0.00032	5.6E-05
SR 89	50.50 Days	0.196	0.014	W185	75.1 Days	0.00028	4.8E-05
TA182	115 Days	0.191	0.014	NB 95m	3.609 Days	0.00026	4.5E-05
ZN 65	243.9 Days	0.129	9.2E-03	SR 90	29.12 Years	0.00023	4.0E-05
CD115m	44.59 Days	0.119	8.5E-03	HF175	70 Days	0.00022	3.8E-05
W188	69.4 Days	0.0509	3.6E-03	W181	121.2 Days	7.3E-05	1.3E-05
IN114m	49.51 Days	0.0309	2.2E-03	W188	69.4 Days	3.5E-05	6.0E-06
NI 59	60 kY	0.0263	1.9E-03	Y 90	2.667 Days	2.3E-05	4.0E-06
CR 51	27.71 Days	0.0257	1.8E-03	SC 46	83.80 Days	2.1E-05	3.7E-06
SN121m	49.97 Years	0.0133	9.5E-04	MO 93	3.498 kY	1.4E-05	2.4E-06
RE188	16.98 Hours	0.0103	7.3E-04	FE 59	45 Days	1.1E-05	1.9E-06
SC 46	83.80 Days	0.0090	6.4E-04	BE 10	1.600 MY	9.0E-06	1.6E-06
W181	121.2 Days	0.0048	3.4E-04	SR 89	50.50 Days	8.7E-06	1.5E-06
SB124	60.2 Days	0.0032	2.2E-04	RE188	16.98 Hours	7.0E-06	1.2E-06
ZR 93	1.530 MY	0.0024	1.7E-04	HF181	42.4 Days	6.9E-06	1.2E-06
SR 90	29.12 Years	0.00024	1.7E-05	NB 93m	13.60 Years	6.2E-06	1.1E-06
TE123m	119.7 Days	0.00016	1.1E-05	CA 45	163.0 Days	3.3E-06	5.8E-07
CA 45	163.0 Days	7.5E-05	5.3E-06	AG110m	249.9 Days	2.4E-06	4.2E-07
SN117m	14 Days	2.9E-05	2.1E-06	TE123m	119.7 Days	2.3E-06	3.9E-07
Y 90	2.667 Days	2.4E-05	1.7E-06	CD115m	44.59 Days	1.4E-06	2.4E-07
AG110m	249.9 Days	1.8E-05	1.3E-06	IN114m	49.51 Days	1.1E-06	1.9E-07
MO 93	3.498 kY	1.4E-05	1.0E-06	AG109m	39.6 Sec.	9.7E-07	1.7E-07
BE 10	1.600 MY	9.0E-06	6.4E-07	SB124	60.2 Days	7.0E-07	1.2E-07
AG109m	39.6 Sec.	2.9E-06	2.1E-07	TC 99	213 kY	6.5E-07	1.1E-07
NB 93m	13.60 Years	2.4E-06	1.7E-07	AG108m	127 Years	3.6E-07	6.2E-08
LU177m	155 Days	1.8E-06	1.3E-07	NB 94	20.3 kY	7.6E-08	1.3E-08
TC 99	213 kY	6.5E-07	4.6E-08	LU177m	155 Days	6.8E-08	1.2E-08
TE127m	109 Days	6.3E-07	4.5E-08	HF182	9 MY	5.3E-08	9.3E-09
PO210	138.4 Days	5.9E-07	4.2E-08	P 32	14.3 Days	2.5E-08	4.4E-09
AG108m	127 Years	3.6E-07	2.6E-08	PO210	138.4 Days	1.5E-08	2.6E-09
IN114	1.198 Min.	2.7E-07	1.9E-08	SI 32	650 Years	6.3E-09	1.1E-09
LU177	6.709 Days	1.2E-07	8.3E-09	TE127m	109 Days	6.1E-09	1.1E-09
NB 94	20.3 kY	7.6E-08	5.4E-09	LU177	6.709 Days	4.4E-09	7.7E-10
TE127	9.35 Hours	6.2E-08	4.4E-09	PB205	30 MY	8.9E-10	1.6E-10
HF182	9 MY	5.3E-08	3.8E-09	TE127	9.35 Hours	5.9E-10	1.0E-10
P 32	14.3 Days	2.6E-08	1.8E-09	CR 51	27.71 Days	3.0E-10	5.2E-11
SN125	9.64 Days	8.2E-09	5.8E-10	IN114	1.198 Min.	9.6E-12	1.7E-12
SI 32	650 Years	6.3E-09	4.5E-10	RE187	50 GY	4.4E-12	7.6E-13
SB126	12.4 Days	3.6E-09	2.6E-10	AG108	2.37 Min.	6.4E-13	1.1E-13
RU103	39.28 Days	1.1E-09	8.1E-11	LU176	30 GY	5.9E-13	1.0E-13
PB205	30 MY	8.9E-10	6.4E-11	AG110	24.6 Sec.	3.2E-13	5.5E-14
IR192	74.02 Days	1.8E-11	1.3E-12	IN115	5E+05 GY	1.2E-13	2.2E-14
RE187	50 GY	4.4E-12	3.1E-13	TC 98	4.199 MY	4.3E-14	7.5E-15
AG110	24.6 Sec.	2.4E-12	1.7E-13	IR192	74.02 Days	1.7E-14	3.0E-15
AG108	2.37 Min.	6.5E-13	4.6E-14	BI210m	3 MY	1.6E-14	2.7E-15
LU176	30 GY	5.9E-13	4.2E-14	RU103	39.28 Days	2.9E-15	5.0E-16
IN115	5E+05 GY	1.2E-13	8.8E-15	TE123	10001 GY	1.8E-16	3.1E-17
TC 98	4.199 MY	4.3E-14	3.1E-15	RH102	2.9 Years	8.1E-17	1.4E-17
BI210m	3 MY	1.6E-14	1.1E-15	IR192m	241 Years	7.4E-17	1.3E-17

Table 2.8. (contd)

Table 8-C. Decay Time = 10 Years				Table 8-D. Decay Time = 30 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
CO 60	5.270 Years	162.2	76.78	CO 60	5.270 Years	11.69	43.39
H 3	12.35 Years	22.3	10.55	H 3	12.35 Years	7.25	26.92
FE 55	2.6 Years	12.1	5.73	NI 63	92 Years	6.09	22.60
NI 63	92 Years	7.08	3.35	C 14	5.729 kY	1.78	6.59
SB125	2.77 Years	4.40	2.08	FE 55	2.6 Years	0.0585	0.217
C 14	5.729 kY	1.78	0.843	SB125	2.77 Years	0.0295	0.110
TE125m	58 Days	1.34	0.636	NI 59	80 kY	0.0263	0.098
NI 59	80 kY	0.0263	0.012	TE125m	58 Days	0.0090	0.033
MN 54	312.5 Days	0.0172	8.1E-03	SN121m	49.97 Years	0.0089	0.033
SN121m	49.97 Years	0.0117	5.5E-03	ZR 93	1.530 MY	0.0024	9.0E-03
SN119m	245 Days	0.0059	2.8E-03	SR 90	29.12 Years	0.00012	4.5E-04
ZR 93	1.530 MY	0.0024	1.2E-03	NB 93m	13.60 Years	3.3E-05	1.2E-04
CD109	1.27 Years	0.0021	1.0E-03	MO 93	3.498 kY	1.4E-05	5.2E-05
SR 90	29.12 Years	0.00020	9.3E-05	Y 90	2.667 Days	1.2E-05	4.5E-05
Y 90	2.667 Days	2.0E-05	9.3E-06	BE 10	1.600 MY	9.0E-06	3.4E-05
NB 93m	13.60 Years	1.7E-05	7.9E-06	TC 99	213 kY	6.5E-07	2.4E-06
MO 93	3.498 kY	1.4E-05	6.6E-06	AG108m	127 Years	3.1E-07	1.1E-06
ZN 65	243.9 Days	1.1E-05	5.3E-06	NB 94	20.3 kY	7.6E-08	2.8E-07
BE 10	1.600 MY	9.0E-06	4.3E-06	HF182	9 MY	5.3E-08	2.0E-07
TC 99	213 kY	6.5E-07	3.1E-07	CD109	1.27 Years	3.9E-08	1.4E-07
SN123	129.2 Days	4.0E-07	1.9E-07	TA182	115 Days	2.7E-08	9.9E-08
AG108m	127 Years	3.5E-07	1.6E-07	P 32	14.3 Days	2.5E-08	9.1E-08
NB 94	20.3 kY	7.6E-08	3.6E-08	SI 32	650 Years	6.1E-09	2.3E-08
SN113	115.1 Days	5.6E-08	2.7E-08	MN 54	312.5 Days	1.6E-09	5.9E-09
HF182	9 MY	5.3E-08	2.5E-08	PB205	30 MY	8.9E-10	3.3E-09
TA182	115 Days	2.7E-08	1.3E-08	SN119m	245 Days	6.2E-12	2.3E-11
P 32	14.3 Days	2.5E-08	1.2E-08	RE187	50 GY	4.4E-12	1.6E-11
AG109m	39.6 Sec.	2.1E-08	1.0E-08	LU176	30 GY	5.9E-13	2.2E-12
SI 32	650 Years	6.3E-09	3.0E-09	AG108	2.37 Min.	5.5E-13	2.0E-12
IN113m	1.658 Hours	2.8E-09	1.3E-09	AG109m	39.6 Sec.	3.9E-13	1.4E-12
AG110m	249.9 Days	2.0E-09	9.4E-10	IN115	5E+05 GY	1.2E-13	4.6E-13
PB205	30 MY	8.9E-10	4.2E-10	TC 98	4.199 MY	4.3E-14	1.6E-13
CA 45	163.0 Days	6.3E-11	3.0E-11	BI210m	3 MY	1.6E-14	5.8E-14
W181	121.2 Days	3.3E-11	1.5E-11	ZN 65	243.9 Days	1.1E-14	4.0E-14
RE187	50 GY	4.4E-12	2.1E-12	PO210	138.4 Days	1.6E-15	5.8E-15
CO 58	70.78 Days	1.0E-12	4.8E-13	IR192	74.02 Days	2.1E-16	7.8E-16
TE123m	119.7 Days	8.4E-13	4.0E-13	TE123	10001 GY	1.8E-16	6.6E-16
LU177m	155 Days	7.3E-13	3.5E-13	RH102	2.9 Years	8.1E-17	3.0E-16
AG108	2.37 Min.	6.1E-13	2.9E-13	IR192m	241 Years	7.0E-17	2.6E-16
LU176	30 GY	5.9E-13	2.8E-13	PD107	6.496 MY	7.1E-18	2.6E-17
IN115	5E+05 GY	1.2E-13	5.9E-14	AG110m	249.9 Days	3.1E-18	1.2E-17
NB 95	35.15 Days	8.4E-14	4.0E-14	PT193	500 Years	4.0E-19	1.5E-18
ZR 95	63.98 Days	5.7E-14	2.7E-14	I129	15.7 MY	2.3E-19	8.5E-19
LU177	6.709 Days	4.8E-14	2.3E-14	V 50	4E+07 GY	1.7E-19	6.3E-19
TC 98	4.199 MY	4.3E-14	2.1E-14	PB204	1E+08 GY	1.3E-19	4.8E-19
PO210	138.4 Days	4.3E-14	2.1E-14	BI208	368 kY	4.7E-20	1.8E-19
BI210m	3 MY	1.6E-14	7.4E-15	TL206	4.19 Min.	3.1E-20	1.2E-19
W185	75.1 Days	1.6E-14	7.4E-15	K 42	12.36 Hours	6.7E-22	2.5E-21
SC 46	83.80 Days	1.4E-14	6.6E-15	SN123	129.2 Days	3.8E-24	1.4E-23
HF175	70 Days	2.2E-15	1.0E-15	CA 45	163.0 Days	2.0E-24	7.5E-24
TE127m	109 Days	5.3E-16	2.5E-16	AG110	24.6 Sec.	4.2E-25	1.6E-24
W188	69.4 Days	2.8E-16	1.3E-16	AR 42	33 Years	6.7E-26	2.5E-25
AG110	24.6 Sec.	2.6E-16	1.3E-16	LU177m	155 Days	4.8E-27	1.8E-26
NB 95m	3.609 Days	2.4E-16	1.1E-16	SN113	115.1 Days	4.4E-27	1.6E-26
IR192	74.02 Days	2.2E-16	1.1E-16	TM171	1.92 Years	2.2E-27	8.0E-27
TE123	10001 GY	1.8E-16	8.4E-17	RU106	1,008 Years	8.8E-28	3.3E-27
RH102	2.9 Years	8.1E-17	3.8E-17	LU177	6,709 Days	3.1E-28	1.2E-27
IR192m	241 Years	7.4E-17	3.5E-17	IN113m	1.658 Hours	2.2E-28	8.2E-28
RE188	16.98 Hours	5.7E-17	2.7E-17	W181	121.2 Days	2.3E-29	8.7E-29
TE127	9.35 Hours	5.2E-17	2.4E-17	TE123m	119.7 Days	3.5E-31	1.3E-30
Y 91	58.51 Days	2.3E-17	1.1E-17	RH106	29.9 Sec.	5.3E-33	2.0E-32
PD107	6.496 MY	7.1E-18	3.4E-18	BA135	0 Stable	0	0
PT193	500 Years	4.0E-19	1.9E-19	BA135m	1.196 Days	0	0
I129	15.7 MY	2.3E-19	1.1E-19	BA131m	15 Min.	0	0
V 50	4E+07 GY	1.7E-19	8.0E-20	LA138	135 GY	0	0
PB204	1E+08 GY	1.3E-19	6.2E-20	BA132	0 Stable	0	0
SB124	60.2 Days	1.1E-19	5.4E-20	BA133	10.74 Years	0	0
BI208	368 kY	4.7E-20	2.2E-20	BA133m	1.62 Days	0	0
TL206	4.19 Min.	3.1E-20	1.5E-20	SM146	70 MY	0	0
SR 89	50.50 Days	5.0E-21	2.4E-21	BA134	0 Stable	0	0

Table 2.8. (contd)

Table 8-E. Decay Time = 40 Years

Isotope	Half-Life	Water Haz.	Per Cent
NI 63	92 Years	5.645	38.31
H 3	12.35 Years	4.136	28.07
CO 60	5.270 Years	3.136	21.28
C 14	5.729 kY	1.774	12.04
NI 59	80 kY	0.026	0.178
SN121m	49.97 Years	0.0077	0.052
FE 55	2.6 Years	0.0041	0.028
ZR 93	1.530 MY	0.0024	0.016
SB125	2.77 Years	0.0024	0.016
TE125m	58 Days	7.4E-04	5.0E-03
SR 90	29.12 Years	9.6E-05	6.5E-04
NB 93m	13.60 Years	3.6E-05	2.5E-04
MO 93	3.498 kY	1.4E-05	9.4E-05
Y 90	2.667 Days	9.6E-06	6.5E-05
BE 10	1.600 MY	9.0E-06	6.1E-05
TC 99	213 kY	6.5E-07	4.4E-06
AG108m	127 Years	2.9E-07	2.0E-06
NB 94	20.3 kY	7.5E-08	5.1E-07
HF182	9 MY	5.3E-08	3.6E-07
TA182	115 Days	2.7E-08	1.8E-07
P 32	14.3 Days	2.4E-08	1.6E-07
SI 32	650 Years	6.1E-09	4.1E-08
PB205	30 MY	8.9E-10	6.1E-09
CD109	1.27 Years	1.7E-10	1.1E-09
RE187	50 GY	4.4E-12	3.0E-11
LU176	30 GY	5.9E-13	4.0E-12
AG108	2.37 Min.	5.2E-13	3.5E-12
MN 54	312.5 Days	4.8E-13	3.2E-12
IN115	5E+05 GY	1.2E-13	8.4E-13
TC 98	4.199 MY	4.3E-14	2.9E-13
BI210m	3 MY	1.6E-14	1.1E-13
AG109m	39.6 Sec.	1.7E-15	1.1E-14
PO210	138.4 Days	1.6E-15	1.1E-14
IR192	74.02 Days	2.0E-16	1.4E-15
SN119m	245 Days	2.0E-16	1.4E-15
TE123	10001 GY	1.8E-16	1.2E-15
RH102	2.9 Years	8.1E-17	5.5E-16
IR192m	241 Years	6.8E-17	4.6E-16
PD107	6.496 MY	7.1E-18	4.8E-17
PT193	500 Years	4.0E-19	2.7E-18
ZN 65	243.9 Days	3.4E-19	2.3E-18
I129	15.7 MY	2.3E-19	1.6E-18
V 50	4E+07 GY	1.7E-19	1.1E-18
PB204	1E+08 GY	1.3E-19	8.8E-19
BI208	368 kY	4.7E-20	3.2E-19
TL206	4.19 Min.	3.1E-20	2.1E-19
K 42	12.36 Hours	6.7E-22	4.6E-21
AG110m	249.9 Days	1.3E-22	8.5E-22
AR 42	33 Years	6.7E-26	4.6E-25
TM171	1.92 Years	2.2E-27	1.5E-26
RU106	1.008 Years	8.8E-28	6.0E-27
AG110	24.6 Sec.	1.7E-29	1.1E-28
CA 45	163.0 Days	3.6E-31	2.5E-30
SN123	129.2 Days	1.2E-32	7.8E-32
LU177m	155 Days	3.5E-34	2.4E-33
B 10	0 Stable	0	0
B 11	0 Stable	0	0
B 12	0.02 Sec.	0	0
C 12	0 Stable	0	0
C 13	0 Stable	0	0
C 15	2.449 Sec.	0	0
F 19	0 Stable	0	0
F 20	11.4 Sec.	0	0
H 1	0 Stable	0	0
H 2	0 Stable	0	0
H 4	0.001 Sec.	0	0
I125	59.7 Days	0	0
I126	13.02 Days	0	0
I127	0 Stable	0	0
I128	24.98 Min.	0	0

Table 8-F. Decay Time = 100 Years

Isotope	Half-Life	Water Haz.	Per Cent
NI 63	92 Years	3.592	64.97
C 14	5.729 kY	1.761	31.85
H 3	12.35 Years	0.143	2.58
NI 59	80 kY	0.0263	0.475
SN121m	49.97 Years	0.0034	0.061
ZR 93	1.530 MY	0.0024	0.044
CO 60	5.270 Years	0.0012	0.021
NB 93m	13.60 Years	4.1E-05	7.5E-04
SR 90	29.12 Years	2.3E-05	4.2E-04
MO 93	3.498 kY	1.4E-05	2.5E-04
BE 10	1.600 MY	9.0E-06	1.6E-04
Y 90	2.667 Days	2.3E-06	4.2E-05
TC 99	213 kY	6.5E-07	1.2E-05
AG108m	127 Years	2.1E-07	3.8E-06
NB 94	20.3 kY	7.5E-08	1.4E-06
HF182	9 MY	5.3E-08	9.6E-07
TA182	115 Days	2.7E-08	4.8E-07
P 32	14.3 Days	2.3E-08	4.1E-07
SI 32	650 Years	5.7E-09	1.0E-07
PB205	30 MY	8.9E-10	1.6E-08
SB125	2.77 Years	7.3E-10	1.3E-08
FE 55	2.6 Years	4.6E-10	8.3E-09
TE125m	58 Days	2.2E-10	4.0E-09
RE187	50 GY	4.4E-12	7.9E-11
LU176	30 GY	5.9E-13	1.1E-11
AG108	2.37 Min.	3.8E-13	6.8E-12
IN115	5E+05 GY	1.2E-13	2.2E-12
TC 98	4.199 MY	4.3E-14	7.8E-13
BI210m	3 MY	1.6E-14	2.8E-13
PO210	138.4 Days	1.6E-15	2.8E-14
TE123	10001 GY	1.8E-16	3.2E-15
IR192	74.02 Days	1.7E-16	3.1E-15
IR192m	241 Years	5.6E-17	1.0E-15
PD107	6.496 MY	7.1E-18	1.3E-16
PT193	500 Years	4.0E-19	7.2E-18
I129	15.7 MY	2.3E-19	4.2E-18
V 50	4E+07 GY	1.7E-19	3.1E-18
PB204	1E+08 GY	1.3E-19	2.4E-18
BI208	368 kY	4.7E-20	8.6E-19
TL206	4.19 Min.	3.1E-20	5.6E-19
K 42	12.36 Hours	6.7E-22	1.2E-20
RH102	2.9 Years	4.4E-24	7.9E-23
CD109	1.27 Years	1.0E-24	1.8E-23
AR 42	33 Years	6.7E-26	1.2E-24
AG109m	39.6 Sec.	1.0E-29	1.8E-28
B 10	0 Stable	0	0
B 11	0 Stable	0	0
B 12	0.02 Sec.	0	0
C 12	0 Stable	0	0
C 13	0 Stable	0	0
C 15	2.449 Sec.	0	0
F 19	0 Stable	0	0
F 20	11.4 Sec.	0	0
H 1	0 Stable	0	0
H 2	0 Stable	0	0
H 4	0.001 Sec.	0	0
I125	59.7 Days	0	0
I126	13.02 Days	0	0
I127	0 Stable	0	0
I128	24.98 Min.	0	0

Table 2.8. (contd)

Table 8-G. Decay Time = 300 Years				Table 8-H. Decay Time = 1000 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
C 14	5.729 kY	1.719	67.57	C-14	5.729 kY	1.579	97.97
NI 63	92 Years	0.796	31.29	NI 59	80 kY	0.0261	1.62
NI 59	80 kY	0.0262	1.03	NI 63	92 Years	0.0041	0.253
ZR 93	1.530 MY	0.0024	0.096	ZR 93	1.530 MY	0.0024	0.151
SN121m	49.97 Years	0.00021	8.2E-03	NB 93m	13.60 Years	4.2E-05	2.6E-03
NB 93m	13.60 Years	4.2E-05	1.6E-03	MO 93	3.498 kY	1.2E-05	7.1E-04
MO 93	3.498 kY	1.3E-05	5.2E-04	BE 10	1.600 MY	9.0E-06	5.6E-04
BE 10	1.600 MY	9.0E-06	3.6E-04	TC 99	213 kY	6.5E-07	4.0E-05
H 3	12.35 Years	1.9E-06	7.5E-05	NB 94	20.3 kY	7.3E-08	4.5E-06
TC 99	213 kY	6.5E-07	2.5E-05	HF182	9 MY	5.3E-08	3.3E-06
SR 90	29.12 Years	2.0E-07	7.8E-06	TA182	115 Days	2.7E-08	1.7E-06
NB 94	20.3 kY	7.5E-08	2.9E-06	SN121m	49.97 Years	1.3E-08	7.9E-07
AG108m	127 Years	7.1E-08	2.8E-06	P 32	14.3 Days	8.7E-09	5.4E-07
HF182	9 MY	5.3E-08	2.1E-06	SI 32	650 Years	2.2E-09	1.4E-07
TA182	115 Days	2.7E-08	1.0E-06	AG108m	127 Years	1.6E-09	9.6E-08
Y 90	2.667 Days	2.0E-08	7.8E-07	PB205	30 MY	8.9E-10	5.5E-08
P 32	14.3 Days	1.8E-08	7.2E-07	RE187	50 GY	4.4E-12	2.7E-10
SI 32	650 Years	4.6E-09	1.8E-07	LU176	30 GY	5.9E-13	3.6E-11
PB205	30 MY	8.9E-10	3.5E-08	IN115	5E+05 GY	1.2E-13	7.7E-12
RE187	50 GY	4.4E-12	1.7E-10	TC 98	4.199 MY	4.3E-14	2.7E-12
LU176	30 GY	5.9E-13	2.3E-11	BI210m	3 MY	1.6E-14	9.7E-13
AG108	2.37 Min.	1.3E-13	5.0E-12	SR 90	29.12 Years	1.1E-14	7.1E-13
IN115	5E+05 GY	1.2E-13	4.9E-12	AG108	2.37 Min.	2.8E-15	1.7E-13
TC 98	4.199 MY	4.3E-14	1.7E-12	PO210	138.4 Days	1.6E-15	9.7E-14
BI210m	3 MY	1.6E-14	6.1E-13	Y 90	2.667 Days	1.1E-15	7.1E-14
CO 60	5.270 Years	4.4E-15	1.7E-13	TE123	10001 GY	1.8E-16	1.1E-14
PO210	138.4 Days	1.6E-15	6.1E-14	IR192	74.02 Days	1.4E-17	9.0E-16
TE123	10001 GY	1.8E-16	7.0E-15	PD107	6.496 MY	7.1E-18	4.4E-16
IR192	74.02 Days	9.4E-17	3.7E-15	IR192m	241 Years	4.8E-18	3.0E-16
IR192m	241 Years	3.1E-17	1.2E-15	I129	15.7 MY	2.3E-19	1.4E-17
PD107	6.496 MY	7.1E-18	2.8E-16	V 50	4E+07 GY	1.7E-19	1.0E-17
PT193	500 Years	2.9E-19	1.1E-17	PT193	500 Years	1.4E-19	8.9E-18
I129	15.7 MY	2.3E-19	9.0E-18	PB204	1E+08 GY	1.3E-19	8.1E-18
V 50	4E+07 GY	1.7E-19	6.6E-18	BI208	368 kY	4.7E-20	2.9E-18
PB204	1E+08 GY	1.3E-19	5.1E-18	TL206	4.19 Min.	3.1E-20	1.9E-18
BI208	368 kY	4.7E-20	1.9E-18	H 3	12.35 Years	1.6E-23	1.0E-21
TL206	4.19 Min.	3.1E-20	1.2E-18	K 42	12.36 Hours	2.8E-28	1.7E-26
K 42	12.36 Hours	6.7E-22	2.6E-20	AR 42	33 Years	2.8E-32	1.7E-30
AR 42	33 Years	6.7E-26	2.6E-24	BA131	11.81 Days	0	0
LA137	59.99 kY	0	0	LA137	59.99 kY	0	0
LA138	135 GY	0	0	LA138	135 GY	0	0
BA139	1.378 Hours	0	0	SM148	8E+06 GY	0	0
LA139	0 Stable	0	0	LA139	0 Stable	0	0
BA141	18.27 Min.	0	0	BA130	0 Stable	0	0
LA140	1.676 Days	0	0	BA140	12.79 Days	0	0
BA140	12.79 Days	0	0	CS138	32.2 Min.	0	0
SM147	107 GY	0	0	LA140	1.676 Days	0	0
SM150	0 Stable	0	0	CS137	30 Years	0	0
BA134	0 Stable	0	0	LA141	3.931 Hours	0	0
CS138	32.2 Min.	0	0	BA131m	15 Min.	0	0
BA130	0 Stable	0	0	SM150	0 Stable	0	0
BA131	11.81 Days	0	0	BA141	18.27 Min.	0	0
BA131m	15 Min.	0	0	BA137	0 Stable	0	0
BA132	0 Stable	0	0	SM149	1E+07 GY	0	0
BA133	10.74 Years	0	0	BA135	0 Stable	0	0
SM151	89.99 Years	0	0	BA135m	1.196 Days	0	0
SM148	8E+06 GY	0	0	BA136	0 Stable	0	0
BA133m	1.62 Days	0	0	BA133m	1.62 Days	0	0
BA138	0 Stable	0	0	BA134	0 Stable	0	0
SM149	1E+07 GY	0	0	BA137m	2.552 Min.	0	0
BA135	0 Stable	0	0	BA132	0 Stable	0	0
BA135m	1.196 Days	0	0	BA138	0 Stable	0	0
BA136	0 Stable	0	0	SM151	89.99 Years	0	0
BA136m	0.308 Sec.	0	0	BA139	1.378 Hours	0	0
BA137	0 Stable	0	0	BA133	10.74 Years	0	0
CE138	0 Stable	0	0	BA136m	0.308 Sec.	0	0
BA137m	2.552 Min.	0	0	SM145	340 Days	0	0
SM144	0 Stable	0	0	CE136	0 Stable	0	0
LA141	3.931 Hours	0	0	PM147	2.623 Years	0	0
ND151	12.4 Min.	0	0	PM148	5.37 Days	0	0

Table 2.8. (contd)

Table 8-1. Decay Time = 3000 Years

Isotope	Half-Life	Water Haz.	Per Cent
C 14	5.729 KY	1.240	97.78
NI 59	80 KY	0.026	2.02
ZR 93	1.530 MY	2.4E-03	0.191
NB 93m	13.60 Years	4.2E-05	3.3E-03
BE 10	1.600 MY	9.0E-06	7.1E-04
MO 93	3.498 KY	7.7E-06	6.1E-04
TC 99	213 KY	6.4E-07	5.1E-05
NB 94	20.3 KY	6.8E-08	5.4E-06
HF182	9 MY	5.3E-08	4.2E-06
TA182	115 Days	2.7E-08	2.1E-06
NI 63	92 Years	1.2E-09	9.2E-08
P 32	14.3 Days	1.0E-09	8.2E-08
PB205	30 MY	8.9E-10	7.0E-08
SI 32	650 Years	2.6E-10	2.0E-08
RE187	50 GY	4.4E-12	3.5E-10
LU176	30 GY	5.9E-13	4.6E-11
IN115	5E+05 GY	1.2E-13	9.8E-12
TC 98	4.199 MY	4.3E-14	3.4E-12
AG108m	127 Years	2.8E-14	2.2E-12
BI210m	3 MY	1.6E-14	1.2E-12
PO210	138.4 Days	1.6E-15	1.2E-13
TE123	10001 GY	1.8E-16	1.4E-14
PD107	6.496 MY	7.1E-18	5.6E-16
IR192	74.02 Days	2.1E-18	1.6E-16
IR192m	241 Years	6.9E-19	5.4E-17
I129	15.7 MY	2.3E-19	1.8E-17
V 50	4E+07 GY	1.7E-19	1.3E-17
PB204	1E+08 GY	1.3E-19	1.0E-17
AG108	2.37 Min.	5.0E-20	4.0E-18
BI208	368 KY	4.7E-20	3.7E-18
PT193	500 Years	3.6E-20	2.8E-18
TL206	4.19 Min.	3.1E-20	2.4E-18
SN121m	49.97 Years	1.1E-20	9.0E-19
SR 90	29.12 Years	1.7E-35	1.4E-33
BA136	0 Stable	0	0
BA136m	0.308 Sec.	0	0
BA135	0 Stable	0	0
BA135m	1.196 Days	0	0
LA138	135 GY	0	0
SM145	340 Days	0	0
BA141	18.27 Min.	0	0
LA137	59.99 KY	0	0
BA140	12.79 Days	0	0
BA137	0 Stable	0	0
BA137m	2.552 Min.	0	0
BA139	1.378 Hours	0	0
SM144	0 Stable	0	0
BA138	0 Stable	0	0
BA133m	1.62 Days	0	0
BA134	0 Stable	0	0
BA130	0 Stable	0	0
SM149	1E+07 GY	0	0
CS134m	2.9 Hours	0	0
CS135	2.3 MY	0	0
CS136	13.1 Days	0	0
CS137	30 Years	0	0
SM150	0 Stable	0	0
CS138	32.2 Min.	0	0
CE136	0 Stable	0	0
BA133	10.74 Years	0	0
BA131	11.81 Days	0	0
SM148	8E+06 GY	0	0
SM147	107 GY	0	0
BA131m	15 Min.	0	0
SM146	70 MY	0	0
BA132	0 Stable	0	0
LA139	0 Stable	0	0
ND151	12.4 Min.	0	0
ND142	0 Stable	0	0
ND143	0 Stable	0	0

Table 2.9. (contd)

Table 9--E. Decay Time = 40 Years				Table 9--F. Decay Time = 100 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
AM241	432.2 Years	344,500	95.57	AM241	432.2 Years	366,800	95.97
PU239	24.06 kY	12,210	3.39	PU239	24.06 kY	12,190	3.19
PU240	6.537 kY	2602	0.722	PU240	6.537 kY	2585	0.676
PU238	87.74 Years	397	0.110	PU238	87.74 Years	247	0.065
PU241	14.4 Years	367	0.102	NP237	2.14 MY	186	0.049
NP237	2.14 MY	177	4.9E-02	U234	244.5 kY	58	0.015
U234	244.5 kY	58	1.6E-02	U238	4.468 GY	56	0.015
U238	4.468 GY	56	1.5E-02	TH234	24.1 Days	33	8.7E-03
CM244	18.11 Years	49	1.4E-02	PU241	14.4 Years	20	5.3E-03
TH234	24.1 Days	33	9.3E-03	AM242m	152 Years	11	2.9E-03
AM242m	152 Years	15	4.0E-03	RN220	55.6 Sec.	6.5	1.7E-03
RN220	55.6 Sec.	12	3.2E-03	CM244	18.11 Years	5.0	1.3E-03
AM243	7.38 kY	3.9	1.1E-03	AM243	7.38 kY	3.9	1.0E-03
U235	703.8 MY	2.9	7.9E-04	PA231	32.77 kY	3.0	7.9E-04
U236	23.41 MY	1.4	4.0E-04	U235	703.8 MY	2.9	7.5E-04
PA231	32.77 kY	1.2	3.4E-04	RN222	3.824 Days	2.2	5.9E-04
AC227	21.77 Years	0.53	1.5E-04	AC227	21.77 Years	2.1	5.5E-04
CM242	163.2 Days	0.48	1.3E-04	U236	23.41 MY	1.4	3.8E-04
TH230	77 kY	0.42	1.2E-04	TH230	77 kY	1.1	2.7E-04
RN222	3.824 Days	0.36	1.0E-04	CM242	163.2 Days	0.36	9.5E-05
CM243	28.5 Years	0.19	5.4E-05	TH231	1.063 Days	0.14	3.7E-05
TH231	1.063 Days	0.14	4.0E-05	PA233	27 Days	0.14	3.7E-05
PA233	27 Days	0.13	3.7E-05	PB210	22.3 Years	0.12	3.3E-05
PU242	386.9 kY	0.093	2.6E-05	RA223	11.43 Days	0.11	2.8E-05
RA224	3.66 Days	0.087	2.4E-05	PU242	386.9 kY	0.093	2.4E-05
TH228	1.913 Years	0.087	2.4E-05	RA226	1.6 kY	0.067	1.8E-05
U237	6.75 Days	0.036	1.0E-05	TH228	1.913 Years	0.049	1.3E-05
RA223	11.43 Days	0.027	7.4E-06	RA224	3.66 Days	0.049	1.3E-05
U232	72 Years	0.017	4.7E-06	PO210	138.4 Days	0.047	1.2E-05
PB212	10.64 Hours	0.012	3.2E-06	CM243	28.5 Years	0.045	1.2E-05
PB210	22.3 Years	0.011	3.2E-06	U232	72 Years	0.0095	2.5E-06
RA226	1.6 kY	0.011	3.0E-06	PB212	10.64 Hours	0.0065	1.7E-06
PA234	6.7 Hours	0.0062	1.7E-06	PA234	6.7 Hours	0.0062	1.6E-06
AM242	16.02 Hours	0.0058	1.6E-06	TH227	18.72 Days	0.0052	1.4E-06
PO210	138.4 Days	0.0043	1.2E-06	AM242	16.02 Hours	0.0044	1.2E-06
NP239	2.355 Days	0.0031	8.7E-07	NP239	2.355 Days	0.0031	8.2E-07
CM245	8.499 kY	0.0021	5.8E-07	CM245	8.499 kY	0.0021	5.4E-07
TH227	18.72 Days	0.0013	3.6E-07	U237	6.75 Days	0.0020	5.2E-07
BI212	1.009 Hours	0.00035	9.7E-08	U233	158.5 kY	0.00054	1.4E-07
PA234m	1.17 Min.	0.00033	9.3E-08	TH229	7.339 kY	0.00036	9.4E-08
U233	158.5 kY	0.00026	7.1E-08	PA234m	1.17 Min.	0.00033	8.7E-08
TH229	7.339 kY	7.9E-05	2.2E-08	BI212	1.009 Hours	0.00020	5.1E-08
NP238	2.117 Days	7.3E-05	2.0E-08	BI210	5.012 Days	0.00019	4.9E-08
NP236	115 kY	5.7E-05	1.6E-08	PB211	36.1 Min.	7.0E-05	1.8E-08
PB211	36.1 Min.	1.8E-05	4.9E-09	NP236	115 kY	5.7E-05	1.5E-08
CM246	4.731 kY	1.7E-05	4.8E-09	NP238	2.117 Days	5.5E-05	1.4E-08
BI210	5.012 Days	1.7E-05	4.8E-09	RA225	14.8 Days	3.6E-05	9.4E-09
PU236	2.851 Years	8.4E-06	2.3E-09	PB214	26.8 Min.	3.4E-05	8.8E-09
RA225	14.8 Days	7.9E-06	2.2E-09	CM246	4.731 kY	1.7E-05	4.5E-09
PB214	26.8 Min.	5.5E-06	1.5E-09	FR223	21.8 Min.	1.5E-05	3.8E-09
FR223	21.8 Min.	3.7E-06	1.0E-09	AC225	10 Days	1.4E-05	3.8E-09
AC225	10 Days	3.2E-06	8.8E-10	BI214	19.9 Min.	1.1E-05	2.9E-09
BI214	19.9 Min.	1.8E-06	5.1E-10	TH232	14.05 GY	8.5E-07	2.2E-10
TH232	14.05 GY	3.4E-07	9.5E-11	RA228	6.7 Years	4.3E-07	1.1E-10
RA228	6.7 Years	1.3E-07	3.6E-11	PU236	2.851 Years	2.1E-07	5.4E-11
PO216	0.15 Sec.	3.5E-08	9.7E-12	BI213	45.65 Min.	7.2E-08	1.9E-11
PO212	3E-07 Sec.	2.2E-08	6.2E-12	RN219	3.96 Sec.	2.1E-08	5.5E-12
BI213	45.65 Min.	1.6E-08	4.4E-12	BI211	2.13 Min.	2.1E-08	5.5E-12
TL208	3.07 Min.	1.3E-08	3.5E-12	PO215	0.002 Sec.	2.1E-08	5.5E-12
RN219	3.96 Sec.	5.3E-09	1.5E-12	TL207	4.77 Min.	2.1E-08	5.5E-12
PO215	0.002 Sec.	5.3E-09	1.5E-12	PB209	3.3 Hours	2.1E-08	5.4E-12
BI211	2.13 Min.	5.3E-09	1.5E-12	PO216	0.15 Sec.	2.0E-08	5.1E-12
TL207	4.77 Min.	5.3E-09	1.5E-12	PO212	3E-07 Sec.	1.3E-08	3.3E-12
PB209	3.3 Hours	4.5E-09	1.3E-12	TL208	3.07 Min.	7.0E-09	1.8E-12
PO214	2E-04 Sec.	1.1E-09	3.0E-13	PO218	3.05 Min.	6.7E-09	1.8E-12
PO218	3.05 Min.	1.1E-09	3.0E-13	PO214	2E-04 Sec.	6.7E-09	1.8E-12
PU244	82.61 MY	8.2E-10	2.3E-13	PU244	82.61 MY	8.2E-10	2.1E-13
AC228	6.131 Hours	2.2E-10	6.0E-14	AC228	6.131 Hours	7.1E-10	1.9E-13
U240	14.1 Hours	8.2E-11	2.3E-14	U240	14.1 Hours	8.2E-11	2.1E-14
PO211	0.56 Sec.	1.5E-11	4.1E-15	PO211	0.56 Sec.	5.9E-11	1.5E-14

Table 2.9. (contd)

Table 9-G. Decay Time = 300 Years				Table 9-H. Decay Time = 1000 Years			
Isotope	Half-Life	Water Haz.	Per Cent	Isotope	Half-Life	Water Haz.	Per Cent
AM241	432.2 Years	268,700	94.67	AM241	432.2 Years	87,460	85.40
PU239	24.06 kY	12,120	4.27	PU239	24.06 kY	11,880	11.60
PU240	6.537 kY	2531	0.892	PU240	6.537 kY	2350	2.29
NP237	2.14 MY	214	0.075	NP237	2.14 MY	262	0.256
U234	244.5 kY	58	0.021	RN222	3.824 Days	197	0.193
U238	4.468 GY	56	0.020	U234	244.5 kY	58	0.057
PU238	87.74 Years	51	0.018	U238	4.468 GY	56	0.054
TH234	24.1 Days	33	0.012	TH234	24.1 Days	33	0.033
RN222	3.824 Days	20	6.9E-03	AC227	21.77 Years	30	0.029
PA231	32.77 kY	9.0	3.2E-03	PA231	32.77 kY	30	0.029
AC227	21.77 Years	8.1	2.8E-03	PB210	22.3 Years	20	0.019
AM242m	152 Years	4.4	1.6E-03	TH230	77 kY	10	0.010
AM243	7.38 kY	3.8	1.4E-03	PO210	138.4 Days	7.4	7.2E-03
TH230	77 kY	3.1	1.1E-03	RA226	1.6 kY	5.9	5.8E-03
U235	703.8 MY	2.9	1.0E-03	AM243	7.38 kY	3.6	3.5E-03
PB210	22.3 Years	1.6	5.6E-04	U235	703.8 MY	2.9	2.8E-03
U236	23.41 MY	1.5	5.1E-04	RA223	11.43 Days	1.5	1.5E-03
RN220	55.6 Sec.	0.95	3.4E-04	U236	23.41 MY	1.5	1.5E-03
PO210	138.4 Days	0.60	2.1E-04	PU238	87.74 Years	0.20	2.0E-04
RA226	1.6 kY	0.59	2.1E-04	PA233	27 Days	0.20	1.9E-04
RA223	11.43 Days	0.40	1.4E-04	AM242m	152 Years	0.18	1.8E-04
PA233	27 Days	0.16	5.6E-05	TH231	1.063 Days	0.14	1.4E-04
CM242	163.2 Days	0.15	5.2E-05	PU242	386.9 kY	0.093	9.0E-05
TH231	1.063 Days	0.14	5.0E-05	TH227	18.72 Days	0.074	7.2E-05
PU242	386.9 kY	0.093	3.3E-05	TH229	7.339 kY	0.033	3.2E-05
TH227	18.72 Days	0.020	7.0E-06	BI210	5.012 Days	0.030	2.9E-05
TH228	1.913 Years	0.0071	2.5E-06	PA234	6.7 Hours	0.0062	6.0E-06
RA224	3.66 Days	0.0071	2.5E-06	U233	158.5 kY	0.0060	5.9E-06
PA234	6.7 Hours	0.0062	2.2E-06	CM242	163.2 Days	0.0060	5.9E-06
NP239	2.355 Days	0.0031	1.1E-06	RA225	14.8 Days	0.0033	3.2E-06
TH229	7.339 kY	0.0028	1.0E-06	PB214	26.8 Min.	0.0030	2.9E-06
BI210	5.012 Days	0.0024	8.4E-07	NP239	2.355 Days	0.0029	2.8E-06
CM244	18.11 Years	0.0024	8.3E-07	CM245	8.499 kY	0.0019	1.9E-06
CM245	8.499 kY	0.0020	7.2E-07	RN220	55.6 Sec.	0.0016	1.6E-06
AM242	16.02 Hours	0.0018	6.2E-07	AC225	10 Days	0.0013	1.3E-06
U233	158.5 kY	0.0016	5.6E-07	PB211	36.1 Min.	0.0010	9.7E-07
U232	72 Years	0.0014	4.9E-07	BI214	19.9 Min.	0.00099	9.6E-07
PU241	14.4 Years	0.0013	4.7E-07	PA234m	1.17 Min.	0.00033	3.3E-07
PB212	10.64 Hours	0.00095	3.4E-07	FR223	21.8 Min.	0.00021	2.0E-07
CM243	28.5 Years	0.00035	1.2E-07	AM242	16.02 Hours	7.3E-05	7.1E-08
PA234m	1.17 Min.	0.00033	1.2E-07	NP236	115 kY	5.7E-05	5.5E-08
PB214	26.8 Min.	0.00029	1.0E-07	CM246	4.731 kY	1.5E-05	1.5E-08
RA225	14.8 Days	0.00028	1.0E-07	RA224	3.66 Days	1.2E-05	1.2E-08
PB211	36.1 Min.	0.00027	9.5E-08	TH228	1.913 Years	1.2E-05	1.2E-08
AC225	10 Days	0.00011	4.0E-08	TH232	14.05 GY	8.6E-06	8.4E-09
BI214	19.9 Min.	9.8E-05	3.5E-08	BI214	45.65 Min.	6.6E-06	6.4E-09
NP236	115 kY	5.7E-05	2.0E-08	RA228	6.7 Years	4.3E-06	4.2E-09
FR223	21.8 Min.	5.6E-05	2.0E-08	U232	72 Years	2.2E-06	2.1E-09
BI212	1.009 Hours	2.9E-05	1.0E-08	PB209	3.3 Hours	1.9E-06	1.8E-09
NP238	2.117 Days	2.2E-05	7.8E-09	PB212	10.64 Hours	1.6E-06	1.6E-09
CM246	4.731 kY	1.7E-05	5.8E-09	NP238	2.117 Days	9.1E-07	8.9E-10
TH232	14.05 GY	2.6E-06	9.0E-10	PO218	3.05 Min.	5.9E-07	5.8E-10
RA228	6.7 Years	1.3E-06	4.5E-10	PO214	2E-04 Sec.	5.9E-07	5.8E-10
BI213	45.65 Min.	5.7E-07	2.0E-10	PU241	14.4 Years	3.8E-07	3.8E-10
PU236	2.851 Years	2.0E-07	7.2E-11	BI211	2.13 Min.	3.0E-07	2.9E-10
PB209	3.3 Hours	1.6E-07	5.7E-11	RN219	3.96 Sec.	3.0E-07	2.9E-10
U237	6.75 Days	1.3E-07	4.7E-11	PO215	0.002 Sec.	3.0E-07	2.9E-10
RN219	3.96 Sec.	8.1E-08	2.8E-11	TL207	4.77 Min.	3.0E-07	2.9E-10
BI211	2.13 Min.	8.1E-08	2.8E-11	PU236	2.851 Years	2.0E-07	2.0E-10
PO215	0.002 Sec.	8.1E-08	2.8E-11	BI212	1.009 Hours	4.9E-08	4.7E-11
TL207	4.77 Min.	8.1E-08	2.8E-11	AC228	6.131 Hours	7.2E-09	7.0E-12
PO218	3.05 Min.	5.9E-08	2.1E-11	AT217	0.032 Sec.	1.3E-09	1.3E-12
PO214	2E-04 Sec.	5.9E-08	2.1E-11	FR221	4.8 Min.	1.3E-09	1.3E-12
PO216	0.15 Sec.	2.9E-09	1.0E-12	PO213	4E-06 Sec.	1.3E-09	1.3E-12
AC228	6.131 Hours	2.1E-09	7.5E-13	PO211	0.56 Sec.	8.4E-10	8.2E-13
PO212	3E-07 Sec.	1.8E-09	6.4E-13	PU244	82.61 MY	8.2E-10	8.0E-13
TL208	3.07 Min.	1.0E-09	3.6E-13	U240	14.1 Hours	8.2E-11	8.0E-14
PU244	82.61 MY	8.2E-10	2.9E-13	U237	6.75 Days	3.8E-11	3.7E-14
PO211	0.56 Sec.	2.3E-10	8.0E-14	TL209	2.2 Min.	2.8E-11	2.8E-14
FR221	4.8 Min.	1.1E-10	4.0E-14	CM243	28.5 Years	1.4E-11	1.4E-14

Table 2.9. (contd)

Table 9-1. Decay Time = 3000 Years

Isotope	Half-Life	Water Haz.	Per Cent
PU239	24.06 kY	11,210	59.29
AM241	432.2 Years	3539	18.72
PU240	6.537 kY	1901	10.05
RN222	3.824 Days	1374	7.27
NP237	2.14 MY	285	1.51
PB210	22.3 Years	137	0.726
AC227	21.77 Years	88	0.466
PA231	32.77 kY	88	0.466
U234	244.5 kY	58	0.308
U238	4.468 GY	56	0.294
PO210	138.4 Days	51	0.272
RA226	1.6 kY	41	0.218
TH234	24.1 Days	33	0.176
TH230	77 kY	31	0.164
RA223	11.43 Days	4.4	0.023
AM243	7.38 kY	3.0	0.016
U235	703.8 MY	2.9	0.015
U236	23.41 MY	1.6	8.3E-03
TH229	7.339 kY	0.32	1.7E-03
TH227	18.72 Days	0.22	1.1E-03
PA233	27 Days	0.21	1.1E-03
BI210	5.012 Days	0.21	1.1E-03
TH231	1.063 Days	0.14	7.6E-04
PU242	386.9 kY	0.092	4.9E-04
RA225	14.8 Days	0.032	1.7E-04
PB214	26.8 Min.	0.021	1.1E-04
U233	158.5 kY	0.021	1.1E-04
AC225	10 Days	0.013	6.7E-05
BI214	19.9 Min.	0.0069	3.6E-05
PA234	6.7 Hours	0.0062	3.3E-05
PB211	36.1 Min.	0.0029	1.6E-05
NP239	2.355 Days	0.0024	1.3E-05
CM245	8.499 kY	0.0016	8.6E-06
RN220	55.6 Sec.	0.00078	4.1E-06
FR223	21.8 Min.	0.00061	3.2E-06
PA234m	1.17 Min.	0.00033	1.8E-06
BI213	45.65 Min.	6.3E-05	3.3E-07
NP236	115 kY	5.6E-05	3.0E-07
TH232	14.05 GY	2.7E-05	1.4E-07
AM242m	152 Years	2.0E-05	1.1E-07
PB209	3.3 Hours	1.8E-05	9.6E-08
RA228	6.7 Years	1.3E-05	7.1E-08
CM246	4.731 kY	1.1E-05	5.9E-08
RA224	3.66 Days	5.9E-06	3.1E-08
TH228	1.913 Years	5.9E-06	3.1E-08
PO216	3.05 Min.	4.1E-06	2.2E-08
PO214	2E-04 Sec.	4.1E-06	2.2E-08
PO215	0.002 Sec.	8.8E-07	4.7E-09
RN219	3.96 Sec.	8.8E-07	4.7E-09
BI211	2.13 Min.	8.8E-07	4.7E-09
TL207	4.77 Min.	8.8E-07	4.6E-09
PB212	10.64 Hours	7.8E-07	4.1E-09
CM242	163.2 Days	6.6E-07	3.5E-09
U232	72 Years	5.0E-07	2.7E-09
PU238	87.74 Years	3.4E-07	1.8E-09
PU241	14.4 Years	3.3E-07	1.7E-09
PU236	2.851 Years	2.0E-07	1.1E-09
BI212	1.009 Hours	2.3E-08	1.2E-10
AC228	6.131 Hours	2.2E-08	1.2E-10
AT217	0.032 Sec.	1.3E-08	6.7E-11
FR221	4.8 Min.	1.3E-08	6.7E-11
PO213	4E-06 Sec.	1.2E-08	6.5E-11
AM242	16.02 Hours	8.0E-09	4.2E-11
PO211	0.56 Sec.	2.5E-09	1.3E-11
PU244	82.61 MY	8.2E-10	4.3E-12
TL209	2.2 Min.	2.7E-10	1.4E-12
NP238	2.117 Days	1.0E-10	5.3E-13
U240	14.1 Hours	8.2E-11	4.3E-13
U237	6.75 Days	3.2E-11	1.7E-13
PO216	0.15 Sec.	2.3E-12	1.2E-14

Table 2.10. Relative Radiation Hazard of Surface—Deposited Fission Products from Hanford Reactor Fuel for Various Decay Times

Table 10—A. Decay Time = 1 Year				Table 10—B. Decay Time = 3 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
NB 95	35.15 Days	907	32.5	PR144	17.28 Min.	148	35.3
PR144	17.28 Min.	877	31.4	BA137m	2.552 Min.	131	31.4
ZR 95	63.98 Days	405	14.5	RH106	29.9 Sec.	49.6	11.9
RH106	29.9 Sec.	196	7.03	Y 90	2.667 Days	48.6	11.6
BA137m	2.552 Min.	137	4.92	CS134	2.062 Years	16.5	3.94
CE144	284.3 Days	64	2.28	CE144	284.3 Days	10.7	2.56
Y 91	58.51 Days	57	2.02	SB125	2.77 Years	8.7	2.09
Y 90	2.667 Days	51	1.83	EU154	8.6 Years	1.4	0.34
CS134	2.062 Years	32	1.16	CS137	30 Years	1.3	0.31
SR 89	50.5 Days	24	0.86	SR 90	29.12 Years	0.67	0.16
RJ103	39.28 Days	19	0.67	KR 85	10.72 Years	0.44	0.11
SB125	2.77 Years	14	0.51	NB 95	35.15 Days	0.34	8.2E-02
EU154	8.6 Years	1.7	6.0E-02	EU155	4.959 Years	0.30	7.3E-02
CE141	32.51 Days	1.4	5.0E-02	ZR 95	63.98 Days	0.15	3.5E-02
CS137	30 Years	1.3	4.8E-02	TE125m	58 Days	0.10	2.4E-02
SR 90	29.12 Years	0.71	2.5E-02	AG110m	249.9 Days	6.7E-02	1.6E-02
SN123	129.2 Days	0.68	2.4E-02	PR144m	7.2 Min.	6.0E-02	1.4E-02
PM148m	41.3 Days	0.62	2.2E-02	SN123	129.2 Days	1.3E-02	3.2E-03
AG110m	249.9 Days	0.50	1.8E-02	Y 91	58.51 Days	9.9E-03	2.4E-03
KR 85	10.72 Years	0.50	1.8E-02	EU152	13.6 Years	6.1E-03	1.5E-03
EU155	4.959 Years	0.40	1.4E-02	SB126m	19 Min.	2.7E-03	6.4E-04
PR144m	7.2 Min.	0.36	1.3E-02	PM147	2.623 Years	1.8E-03	4.2E-04
NB 95m	3.609 Days	0.28	1.0E-02	TE127	9.35 Hours	1.4E-03	3.4E-04
TE125m	58 Days	0.16	5.9E-03	SR 89	50.5 Days	1.1E-03	2.5E-04
TE127	9.35 Hours	0.15	5.3E-03	TE127m	109 Days	7.8E-04	1.9E-04
TE127m	109 Days	8.1E-02	2.9E-03	SB126	12.4 Days	6.5E-04	1.6E-04
TE129	1.16 Hours	4.0E-02	1.4E-03	SN119m	245 Days	3.2E-04	7.7E-05
RH103m	56.12 Min.	3.9E-02	1.4E-03	CD113m	14.59 Years	3.1E-04	7.4E-05
TE129m	33.6 Days	2.6E-02	9.4E-04	PM146	5.5 Years	3.0E-04	7.2E-05
SB124	60.2 Days	1.8E-02	6.5E-04	SN126	100 kY	1.0E-04	2.4E-05
CD115m	44.59 Days	1.8E-02	6.3E-04	NB 95m	3.609 Days	1.0E-04	2.4E-05
PM148	5.37 Days	9.2E-03	3.3E-04	AG110	24.6 Sec.	9.8E-05	2.3E-05
EU152	13.6 Years	6.8E-03	2.4E-04	RJ103	39.28 Days	4.7E-05	1.1E-05
TB160	72.3 Days	6.3E-03	2.3E-04	SM151	89.99 Years	2.3E-05	5.4E-06
PM147	2.623 Years	3.0E-03	1.1E-04	GD153	242 Days	1.2E-05	2.8E-06
SB126m	19 Min.	2.7E-03	9.6E-05	TB160	72.3 Days	5.8E-06	1.4E-06
SN119m	245 Days	2.5E-03	9.1E-05	SB124	60.2 Days	4.0E-06	9.7E-07
AG110	24.6 Sec.	7.4E-04	2.7E-05	PM148m	41.3 Days	2.9E-06	7.0E-07
SB126	12.4 Days	6.5E-04	2.3E-05	I129	15.7 MY	1.5E-06	3.6E-07
PM146	5.5 Years	3.9E-04	1.4E-05	NB 93m	13.6 Years	6.8E-07	1.6E-07
CD113m	14.59 Years	3.4E-04	1.2E-05	NB 94	20.3 kY	2.5E-07	5.9E-08
LA140	1.676 Days	3.0E-04	1.1E-05	CE141	32.51 Days	2.4E-07	5.7E-08
SN126	100 kY	1.0E-04	3.7E-06	CD115m	44.59 Days	2.1E-07	4.9E-08
GD153	242 Days	9.5E-05	3.4E-06	HO166m	1.2 kY	1.7E-07	4.2E-08
EU156	15.19 Days	5.0E-05	1.8E-06	RH103m	56.12 Min.	9.8E-08	2.3E-08
BA140	12.79 Days	2.4E-05	8.8E-07	TE123m	119.7 Days	4.8E-08	1.1E-08
SM151	89.99 Years	2.3E-05	8.3E-07	PM148	5.37 Days	4.4E-08	1.0E-08
PR143	13.56 Days	1.9E-05	6.6E-07	AG108m	127 Years	3.7E-08	8.8E-09
TE123m	119.7 Days	3.3E-06	1.2E-07	TC 99	213 kY	2.1E-08	5.1E-09
CS136	13.1 Days	2.1E-06	7.5E-08	TE129	1.16 Hours	1.1E-08	2.7E-09
I129	15.7 MY	1.5E-06	5.3E-08	TE129m	33.6 Days	7.5E-09	1.8E-09
IN115m	4.3 Hours	1.3E-06	4.7E-08	TC 98	4.199 MY	8.3E-10	2.0E-10
RB 86	18.66 Days	6.8E-07	2.4E-08	AG108	2.37 Min.	3.3E-10	7.8E-11
ND147	11.06 Days	3.1E-07	1.1E-08	BE 10	1.6 MY	2.0E-11	4.8E-12
NB 93m	13.6 Years	2.6E-07	9.2E-09	IN115m	4.3 Hours	1.5E-11	3.7E-12
NB 94	20.3 kY	2.5E-07	8.8E-09	CD109	1.27 Years	1.1E-11	2.6E-12
HO166m	1.2 kY	1.7E-07	6.2E-09	AG109m	39.6 Sec.	1.0E-11	2.4E-12
IN114	1.198 Min.	1.0E-07	3.6E-09	TM170	128.6 Days	4.3E-12	1.0E-12
IN114m	49.51 Days	4.8E-08	1.7E-09	IN114	1.198 Min.	3.6E-12	8.7E-13
AG108m	127 Years	3.7E-08	1.3E-09	KR 81	209.9 kY	3.2E-12	7.6E-13
TC 99	213 kY	2.1E-08	7.7E-10	IN114m	49.51 Days	1.8E-12	4.2E-13
XE131m	11.9 Days	9.3E-09	3.3E-10	TM171	1.92 Years	6.8E-15	1.6E-15
TC 98	4.199 MY	8.3E-10	3.0E-11	XE127	36.41 Days	2.3E-16	5.5E-17
SN125	9.64 Days	3.7E-10	1.3E-11	IN115	5E+05 GY	6.5E-17	1.6E-17
AG108	2.37 Min.	3.3E-10	1.2E-11	RB 86	18.66 Days	1.1E-18	2.7E-19
XE127	36.41 Days	2.5E-10	9.1E-12	EU156	15.19 Days	1.7E-19	4.0E-20
I131	8.041 Days	2.3E-10	8.1E-12	TE123	10001 GY	1.6E-19	3.8E-20
TM170	128.6 Days	2.2E-10	7.9E-12	LA140	1.676 Days	1.9E-21	4.6E-22
CD109	1.27 Years	3.2E-11	1.1E-12	PR143	13.56 Days	1.1E-21	2.7E-22
AG109m	39.6 Sec.	3.0E-11	1.1E-12	BA140	12.79 Days	1.6E-22	3.7E-23

Table 2.10. (contd)

Table 10-C. Decay Time = 10 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
BA137m	2.552 Min.	112	70.0
Y 90	2.667 Days	41.2	25.8
CS134	2.062 Years	1.57	0.98
SB125	2.77 Years	1.51	0.95
CS137	30 Years	1.09	0.68
EU154	8.6 Years	0.82	0.51
SR 90	29.12 Years	0.57	0.36
RH106	29.9 Sec.	0.40	0.25
PR144	17.28 Min.	0.29	0.18
KR 85	10.72 Years	0.28	0.18
EU155	4.959 Years	0.11	7.2E-02
CE144	284.3 Days	2.1E-02	1.3E-02
TE125m	58 Days	1.7E-02	1.1E-02
EU152	13.6 Years	4.3E-03	2.7E-03
SB126m	19 Min.	2.7E-03	1.7E-03
SB126	12.4 Days	6.5E-04	4.1E-04
PM147	2.623 Years	2.8E-04	1.7E-04
CD113m	14.59 Years	2.2E-04	1.4E-04
PM146	5.5 Years	1.2E-04	7.8E-05
PR144m	7.2 Min.	1.2E-04	7.4E-05
SN126	100 KY	1.0E-04	6.4E-05
AG110m	249.9 Days	5.5E-05	3.5E-05
SM151	89.99 Years	2.2E-05	1.3E-05
NB 93m	13.6 Years	1.9E-06	1.2E-06
I129	15.7 MY	1.5E-06	9.3E-07
NB 94	20.3 KY	2.5E-07	1.5E-07
SN119m	245 Days	2.3E-07	1.5E-07
HO166m	1.2 KY	1.7E-07	1.1E-07
AG110	24.6 Sec.	8.1E-08	5.1E-08
AG108m	127 Years	3.6E-08	2.2E-08
TC 99	213 KY	2.1E-08	1.3E-08
SN123	129.2 Days	1.5E-08	9.3E-09
GD153	242 Days	7.8E-09	4.9E-09
TC 98	4.199 MY	8.3E-10	5.2E-10
AG108	2.37 Min.	3.2E-10	2.0E-10
TE127	9.35 Hours	1.2E-10	7.8E-11
TE127m	109 Days	6.7E-11	4.2E-11
BE 10	1.6 MY	2.0E-11	1.3E-11
KR 81	209.9 KY	3.2E-12	2.0E-12
NB 95	35.15 Days	3.2E-13	2.0E-13
CD109	1.27 Years	2.4E-13	1.5E-13
AG109m	39.6 Sec.	2.2E-13	1.4E-13
ZR 95	63.98 Days	1.4E-13	8.7E-14
TE123m	119.7 Days	1.8E-14	1.1E-14
Y 91	58.51 Days	6.9E-16	4.3E-16
TM171	1.92 Years	5.4E-16	3.4E-16
TB160	72.3 Days	1.3E-16	8.2E-17
NB 95m	3.609 Days	9.5E-17	6.0E-17
IN115	5E+05 GY	6.5E-17	4.1E-17
TM170	128.6 Days	4.4E-18	2.8E-18
SB124	60.2 Days	6.6E-19	4.2E-19
SR 89	50.5 Days	6.1E-19	3.8E-19
TE123	10001 GY	1.6E-19	9.9E-20
RU103	39.28 Days	1.2E-24	7.6E-25
CD115m	44.59 Days	1.1E-24	7.1E-25
PM148m	41.3 Days	6.7E-25	4.2E-25
PM148	5.37 Days	1.0E-26	6.3E-27
RH103m	56.12 Min.	2.5E-27	1.6E-27
IN114	1.198 Min.	1.0E-27	6.5E-28
IN114m	49.51 Days	5.0E-28	3.1E-28
IN115m	4.3 Hours	8.5E-29	5.3E-29
XE127	36.41 Days	1.5E-37	9.4E-38
C 14	5.729 KY	0	0
H 3	12.35 Years	0	0
I127	0 Stable	0	0
I128	24.98 Min.	0	0
I130	12.36 Hours	0	0
I130m	9 Min.	0	0
I131	8.041 Days	0	0
I132	2.3 Hours	0	0
I133	20.8 Hours	0	0
I133m	9 Sec.	0	0
I134	52.6 Min.	0	0
I134m	3.7 Min.	0	0
I135	6.611 Hours	0	0
I136	1.383 Min.	0	0
I136m	46 Sec.	0	0
I137	24.6 Sec.	0	0
I138	6.4 Sec.	0	0
I139	2.4 Sec.	0	0
I140	0.86 Sec.	0	0
I141	0.4 Sec.	0	0
I142	0.196 Sec.	0	0
I143	0.328 Sec.	0	0
I144	0.133 Sec.	0	0
I145	0.187 Sec.	0	0

Table 10-D. Decay Time = 30 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
BA137m	2.552 Min.	70.3	72.3
Y 90	2.667 Days	25.6	26.3
CS137	30 Years	0.68	0.70
SR 90	29.12 Years	0.35	0.36
EU154	8.6 Years	0.16	0.17
KR 85	10.72 Years	7.7E-02	8.0E-02
SB125	2.77 Years	1.0E-02	1.0E-02
EU155	4.959 Years	7.0E-03	7.2E-03
SB126m	19 Min.	2.7E-03	2.7E-03
CS134	2.062 Years	1.9E-03	1.9E-03
EU152	13.6 Years	1.6E-03	1.6E-03
SB126	12.4 Days	6.5E-04	6.7E-04
TE125m	58 Days	1.2E-04	1.2E-04
SN126	100 KY	1.0E-04	1.0E-04
CD113m	14.59 Years	8.6E-05	8.8E-05
SM151	89.99 Years	1.8E-05	1.9E-05
PM146	5.5 Years	1.0E-05	1.0E-05
NB 93m	13.6 Years	3.6E-06	3.7E-06
I129	15.7 MY	1.5E-06	1.5E-06
PM147	2.623 Years	1.4E-06	1.5E-06
RH106	29.9 Sec.	4.3E-07	4.4E-07
NB 94	20.3 KY	2.5E-07	2.5E-07
HO166m	1.2 KY	1.7E-07	1.8E-07
AG108m	127 Years	3.2E-08	3.3E-08
TC 99	213 KY	2.1E-08	2.2E-08
PR144	17.28 Min.	5.3E-09	5.5E-09
TC 98	4.199 MY	8.3E-10	8.6E-10
CE144	284.3 Days	3.9E-10	4.0E-10
AG108	2.37 Min.	2.8E-10	2.9E-10
BE 10	1.6 MY	2.0E-11	2.1E-11
KR 81	209.9 KY	3.2E-12	3.3E-12
PR144m	7.2 Min.	2.2E-12	2.2E-12
AG110m	249.9 Days	8.8E-14	9.0E-14
SN119m	245 Days	2.5E-16	2.5E-16
AG110	24.6 Sec.	1.3E-16	1.3E-16
IN115	5E+05 GY	6.5E-17	6.7E-17
GD153	242 Days	6.4E-18	6.5E-18
CD109	1.27 Years	4.3E-18	4.4E-18
AG109m	39.6 Sec.	4.1E-18	4.2E-18
TM171	1.92 Years	4.0E-19	4.1E-19
TE123	10001 GY	1.6E-19	1.6E-19
SN123	129.2 Days	1.4E-25	1.4E-25
TE127	9.35 Hours	8.4E-31	8.6E-31
TE127m	109 Days	4.5E-31	4.7E-31
TE123m	119.7 Days	7.5E-33	7.7E-33
TM170	128.6 Days	3.5E-35	3.6E-35
C 14	5.729 KY	0	0
H 3	12.35 Years	0	0
I127	0 Stable	0	0
I128	24.98 Min.	0	0
I130	12.36 Hours	0	0
I130m	9 Min.	0	0
I131	8.041 Days	0	0
I132	2.3 Hours	0	0
I133	20.8 Hours	0	0
I133m	9 Sec.	0	0
I134	52.6 Min.	0	0
I134m	3.7 Min.	0	0
I135	6.611 Hours	0	0
I136	1.383 Min.	0	0
I136m	46 Sec.	0	0
I137	24.6 Sec.	0	0
I138	6.4 Sec.	0	0
I139	2.4 Sec.	0	0
I140	0.86 Sec.	0	0
I141	0.4 Sec.	0	0
I142	0.196 Sec.	0	0
I143	0.328 Sec.	0	0
I144	0.133 Sec.	0	0
I145	0.187 Sec.	0	0

Table 2.10. (contd)

Table 10-E. Decay Time = 40 Years				Table 10-F. Decay Time = 100 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
BA137m	2.552 Min.	55.8	72.6	BA137m	2.552 Min.	14.0	73.5
Y 90	2.667 Days	20.2	26.2	Y 90	2.667 Days	4.83	25.4
CS137	30 Years	0.54	0.71	CS137	30 Years	0.14	0.71
SR 90	29.12 Years	0.28	0.36	SR 90	29.12 Years	6.7E-02	0.35
EU154	8.6 Years	7.3E-02	9.4E-02	SB126m	19 Min.	2.7E-03	1.4E-02
KR 85	10.72 Years	4.1E-02	5.3E-02	KR 85	10.72 Years	8.4E-04	4.4E-03
SB126m	19 Min.	2.7E-03	3.5E-03	SB126	12.4 Days	6.5E-04	3.4E-03
EU155	4.959 Years	1.7E-03	2.2E-03	EU154	8.6 Years	5.8E-04	3.0E-03
EU152	13.6 Years	9.3E-04	1.2E-03	SN126	100 KY	1.0E-04	5.4E-04
SB125	2.77 Years	8.3E-04	1.1E-03	EU152	13.6 Years	4.4E-05	2.3E-04
SB126	12.4 Days	6.5E-04	8.4E-04	SM151	89.99 Years	1.1E-05	5.7E-05
SN126	100 KY	1.0E-04	1.3E-04	NB 93m	13.6 Years	4.6E-06	2.4E-05
CS134	2.062 Years	6.6E-05	8.5E-05	CD113m	14.59 Years	3.1E-06	1.6E-05
CD113m	14.59 Years	5.3E-05	6.9E-05	I129	15.7 MY	1.5E-06	7.8E-06
SM151	89.99 Years	1.7E-05	2.2E-05	EU155	4.959 Years	3.9E-07	2.1E-06
TE125m	58 Days	9.6E-06	1.2E-05	NB 94	20.3 KY	2.5E-07	1.3E-06
NB 93m	13.6 Years	4.0E-06	5.2E-06	HO166m	1.2 KY	1.6E-07	8.6E-07
PM146	5.5 Years	2.8E-06	3.7E-06	AG108m	127 Years	2.2E-08	1.1E-07
I129	15.7 MY	1.5E-06	1.9E-06	TC 99	213 KY	2.1E-08	1.1E-07
NB 94	20.3 KY	2.5E-07	3.2E-07	PM146	5.5 Years	1.5E-09	7.8E-09
HO166m	1.2 KY	1.7E-07	2.2E-07	TC 98	4.199 MY	8.3E-10	4.4E-09
PM147	2.623 Years	1.0E-07	1.3E-07	SB125	2.77 Years	2.5E-10	1.3E-09
AG108m	127 Years	3.0E-08	3.9E-08	AG108	2.37 Min.	1.9E-10	1.0E-09
TC 99	213 KY	2.1E-08	2.8E-08	BE 10	1.6 MY	2.0E-11	1.1E-10
TC 98	4.199 MY	8.3E-10	1.1E-09	KR 81	209.9 KY	3.2E-12	1.7E-11
RH106	29.9 Sec.	4.4E-10	5.8E-10	TE125m	58 Days	2.9E-12	1.5E-11
AG108	2.37 Min.	2.7E-10	3.5E-10	CS134	2.062 Years	1.1E-13	6.0E-13
BE 10	1.6 MY	2.0E-11	2.6E-11	PM147	2.623 Years	1.3E-14	6.9E-14
KR 81	209.9 KY	3.2E-12	4.1E-12	IN115	5E+05 GY	6.5E-17	3.4E-16
PR144	17.28 Min.	7.2E-13	9.4E-13	TE123	10001 GY	1.6E-19	8.4E-19
CE144	284.3 Days	5.2E-14	6.8E-14	RH106	29.9 Sec.	5.3E-28	2.8E-27
PR144m	7.2 Min.	2.9E-16	3.8E-16	TM171	1.92 Years	4.2E-30	2.2E-29
IN115	5E+05 GY	6.5E-17	8.5E-17	CD109	1.27 Years	1.1E-34	5.8E-34
AG110m	249.9 Days	3.5E-18	4.5E-18	C 14	5.729 KY	0	0
TE123	10001 GY	1.6E-19	2.1E-19	H 3	12.35 Years	0	0
AG109m	39.6 Sec.	1.7E-20	2.3E-20	I127	0 Stable	0	0
TM171	1.92 Years	1.2E-20	1.5E-20	I128	24.98 Min.	0	0
CD109	1.27 Years	8.8E-21	1.1E-20	I130	12.36 Hours	0	0
SN119m	245 Days	8.0E-21	1.0E-20	I130m	9 Min.	0	0
AG110	24.6 Sec.	5.1E-21	6.7E-21	I131	8.041 Days	0	0
GD153	242 Days	1.8E-22	2.4E-22	I132	2.3 Hours	0	0
SN123	129.2 Days	4.3E-34	5.6E-34	I133	20.8 Hours	0	0
C 14	5.729 KY	0	0	I133m	9 Sec.	0	0
H 3	12.35 Years	0	0	I134	52.6 Min.	0	0
I127	0 Stable	0	0	I134m	3.7 Min.	0	0
I128	24.98 Min.	0	0	I135	6.611 Hours	0	0
I130	12.36 Hours	0	0	I136	1.383 Min.	0	0
I130m	9 Min.	0	0	I136m	46 Sec.	0	0
I131	8.041 Days	0	0	I137	24.6 Sec.	0	0
I132	2.3 Hours	0	0	I138	6.4 Sec.	0	0
I133	20.8 Hours	0	0	I139	2.4 Sec.	0	0
I133m	9 Sec.	0	0	I140	0.86 Sec.	0	0
I134	52.6 Min.	0	0	I141	0.4 Sec.	0	0
I134m	3.7 Min.	0	0	I142	0.196 Sec.	0	0
I135	6.611 Hours	0	0	I143	0.328 Sec.	0	0
I136	1.383 Min.	0	0	I144	0.133 Sec.	0	0
I136m	46 Sec.	0	0	I145	0.187 Sec.	0	0
I137	24.6 Sec.	0	0	Y 89	0 Stable	0	0
I138	6.4 Sec.	0	0	Y 89m	16.06 Sec.	0	0
I139	2.4 Sec.	0	0	Y 90m	3.1 Hours	0	0
I140	0.86 Sec.	0	0	Y 91	58.51 Days	0	0
I141	0.4 Sec.	0	0	Y 91m	49.72 Min.	0	0
I142	0.196 Sec.	0	0	Y 92	3.539 Hours	0	0
I143	0.328 Sec.	0	0	Y 93	10.1 Hours	0	0
I144	0.133 Sec.	0	0	Y 94	19.1 Min.	0	0
I145	0.187 Sec.	0	0	Y 95	10.5 Min.	0	0
Y 89	0 Stable	0	0	Y 96	2.3 Min.	0	0
Y 89m	16.06 Sec.	0	0	Y 97	1.11 Sec.	0	0
Y 90m	3.1 Hours	0	0	Y 98	0.3 Sec.	0	0
Y 91	58.51 Days	0	0	Y 99	0.8 Sec.	0	0

Table 2.10. (contd)

Table 10-G. Decay Time = 300 Years				Table 10-H. Decay Time = 1000 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
BA137m	2.552 Min.	1.4E-01	74.6	SB126m	19 Min.	2.7E-03	77.9
Y 90	2.667 Days	4.1E-02	22.5	SB126	12.4 Days	6.4E-04	18.9
SB126m	19 Min.	2.7E-03	1.45	SN126	100 kY	1.0E-04	2.97
CS137	30 Years	1.3E-03	0.73	NB 93m	13.6 Years	4.6E-06	0.14
SB126	12.4 Days	6.5E-04	0.35	I129	15.7 MY	1.5E-06	4.4E-02
SR 90	29.12 Years	5.7E-04	0.31	NB 94	20.3 kY	2.4E-07	7.0E-03
SN126	100 kY	1.0E-04	5.5E-02	HO166m	1.2 kY	9.8E-08	2.9E-03
NB 93m	13.6 Years	4.6E-06	2.5E-03	TC 99	213 kY	2.1E-08	6.3E-04
SM151	89.99 Years	2.3E-06	1.3E-03	BA137m	2.552 Min.	1.3E-08	3.8E-04
I129	15.7 MY	1.5E-06	8.1E-04	SM151	89.99 Years	1.1E-08	3.1E-04
NB 94	20.3 kY	2.4E-07	1.3E-04	Y 90	2.667 Days	2.4E-09	7.1E-05
HO166m	1.2 kY	1.5E-07	7.9E-05	TC 98	4.199 MY	8.3E-10	2.4E-05
TC 99	213 kY	2.1E-08	1.2E-05	AG108m	127 Years	1.6E-10	4.7E-06
AG108m	127 Years	7.3E-09	4.0E-06	CS137	30 Years	1.3E-10	3.7E-06
KR 85	10.72 Years	2.0E-09	1.1E-06	SR 90	29.12 Years	3.3E-11	9.8E-07
EU152	13.6 Years	1.6E-09	8.9E-07	BE 10	1.6 MY	2.0E-11	5.9E-07
TC 98	4.199 MY	8.3E-10	4.5E-07	KR 81	209.9 kY	3.2E-12	9.3E-08
CD113m	14.59 Years	2.3E-10	1.2E-07	AG108	2.37 Min.	1.4E-12	4.2E-08
AG108	2.37 Min.	6.5E-11	3.5E-08	IN115	5E+05 GY	6.5E-17	1.9E-12
EU154	8.6 Years	5.8E-11	3.1E-08	TE123	10001 GY	1.6E-19	4.7E-15
BE 10	1.6 MY	2.0E-11	1.1E-08	CD113m	14.59 Years	8.3E-25	2.4E-20
KR 81	209.9 kY	3.2E-12	1.7E-09	EU152	13.6 Years	5.3E-25	1.5E-20
IN115	5E+05 GY	6.5E-17	3.6E-14	KR 85	10.72 Years	4.5E-29	1.3E-24
EU155	4.959 Years	2.8E-19	1.5E-16	C 14	5.729 kY	0	0
TE123	10001 GY	1.6E-19	8.6E-17	H 3	12.35 Years	0	0
PM146	5.5 Years	1.7E-20	9.1E-18	I127	0 Stable	0	0
C 14	5.729 kY	0	0	I128	24.98 Min.	0	0
H 3	12.35 Years	0	0	I130	12.36 Hours	0	0
I127	0 Stable	0	0	I130m	9 Min.	0	0
I128	24.98 Min.	0	0	I131	8.041 Days	0	0
I130	12.36 Hours	0	0	I132	2.3 Hours	0	0
I130m	9 Min.	0	0	I133	20.8 Hours	0	0
I131	8.041 Days	0	0	I133m	9 Sec.	0	0
I132	2.3 Hours	0	0	I134	52.6 Min.	0	0
I133	20.8 Hours	0	0	I134m	3.7 Min.	0	0
I133m	9 Sec.	0	0	I135	6.611 Hours	0	0
I134	52.6 Min.	0	0	I136	1.383 Min.	0	0
I134m	3.7 Min.	0	0	I136m	46 Sec.	0	0
I135	6.611 Hours	0	0	I137	24.6 Sec.	0	0
I136	1.383 Min.	0	0	I138	6.4 Sec.	0	0
I136m	46 Sec.	0	0	I139	2.4 Sec.	0	0
I137	24.6 Sec.	0	0	I140	0.86 Sec.	0	0
I138	6.4 Sec.	0	0	I141	0.4 Sec.	0	0
I139	2.4 Sec.	0	0	I142	0.196 Sec.	0	0
I140	0.86 Sec.	0	0	I143	0.328 Sec.	0	0
I141	0.4 Sec.	0	0	I144	0.133 Sec.	0	0
I142	0.196 Sec.	0	0	I145	0.187 Sec.	0	0
I143	0.328 Sec.	0	0	Y 89	0 Stable	0	0
I144	0.133 Sec.	0	0	Y 89m	16.06 Sec.	0	0
I145	0.187 Sec.	0	0	Y 90m	3.1 Hours	0	0
Y 89	0 Stable	0	0	Y 91	58.51 Days	0	0
Y 89m	16.06 Sec.	0	0	Y 91m	49.72 Min.	0	0
Y 90m	3.1 Hours	0	0	Y 92	3.539 Hours	0	0
Y 91	58.51 Days	0	0	Y 93	10.1 Hours	0	0
Y 91m	49.72 Min.	0	0	Y 94	19.1 Min.	0	0
Y 92	3.539 Hours	0	0	Y 95	10.5 Min.	0	0
Y 93	10.1 Hours	0	0	Y 96	2.3 Min.	0	0
Y 94	19.1 Min.	0	0	Y 97	1.11 Sec.	0	0
Y 95	10.5 Min.	0	0	Y 98	0.3 Sec.	0	0
Y 96	2.3 Min.	0	0	Y 99	0.8 Sec.	0	0
Y 97	1.11 Sec.	0	0	Y100	0.756 Sec.	0	0
Y 98	0.3 Sec.	0	0	Y101	0.976 Sec.	0	0
Y 99	0.8 Sec.	0	0	Y102	0.273 Sec.	0	0
Y100	0.756 Sec.	0	0	Y103	0.366 Sec.	0	0
Y101	0.976 Sec.	0	0	Y104	0.144 Sec.	0	0
Y102	0.273 Sec.	0	0	Y105	0.174 Sec.	0	0
Y103	0.366 Sec.	0	0	Y106	0.093 Sec.	0	0
Y104	0.144 Sec.	0	0	Y107	0.105 Sec.	0	0
Y105	0.174 Sec.	0	0	AG106	8.5 Days	0	0
Y106	0.093 Sec.	0	0	AG107	0 Stable	0	0

Table 2.10. (contd)

Table 10-I. Decay Time = 3000 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
SB126m	19 Min.	2.6E-03	77.9
SB126	12.4 Days	6.4E-04	18.9
SN126	100 kY	1.0E-04	2.97
NB 93m	13.6 Years	4.6E-06	0.14
I129	15.7 MY	1.5E-06	4.4E-02
NB 94	20.3 kY	2.2E-07	6.6E-03
HO166m	1.2 kY	3.1E-08	9.1E-04
TC 99	213 kY	2.1E-08	6.3E-04
TC 98	4.199 MY	8.3E-10	2.5E-05
BE 10	1.6 MY	2.0E-11	6.0E-07
KR 81	209.9 kY	3.1E-12	9.4E-08
AG108m	127 Years	2.9E-15	8.7E-11
SM151	89.99 Years	2.1E-15	6.4E-11
IN115	5E+05 GY	6.5E-17	1.9E-12
AG108	2.37 Min.	2.6E-17	7.7E-13
TE123	10001 GY	1.6E-19	4.7E-15
BA137m	2.552 Min.	1.1E-28	3.3E-24
Y 90	2.667 Days	5.1E-30	1.5E-25
CS137	30 Years	1.1E-30	3.2E-26
SR 90	29.12 Years	7.0E-32	2.1E-27
C 14	5.729 kY	0	0
H 3	12.35 Years	0	0
I127	0 Stable	0	0
I128	24.98 Min.	0	0
I130	12.36 Hours	0	0
I130m	9 Min.	0	0
I131	8.041 Days	0	0
I132	2.3 Hours	0	0
I133	20.8 Hours	0	0
I133m	9 Sec.	0	0
I134	52.6 Min.	0	0
I134m	3.7 Min.	0	0
I135	6.611 Hours	0	0
I136	1.383 Min.	0	0
I136m	46 Sec.	0	0
I137	24.6 Sec.	0	0
I138	6.4 Sec.	0	0
I139	2.4 Sec.	0	0
I140	0.86 Sec.	0	0
I141	0.4 Sec.	0	0
I142	0.196 Sec.	0	0
I143	0.328 Sec.	0	0
I144	0.133 Sec.	0	0
I145	0.187 Sec.	0	0
Y 89	0 Stable	0	0
Y 89m	16.06 Sec.	0	0
Y 90m	3.1 Hours	0	0
Y 91	58.51 Days	0	0
Y 91m	49.72 Min.	0	0
Y 92	3.539 Hours	0	0
Y 93	10.1 Hours	0	0
Y 94	19.1 Min.	0	0
Y 95	10.5 Min.	0	0
Y 96	2.3 Min.	0	0
Y 97	1.11 Sec.	0	0
Y 98	0.3 Sec.	0	0
Y 99	0.8 Sec.	0	0
Y100	0.756 Sec.	0	0
Y101	0.976 Sec.	0	0
Y102	0.273 Sec.	0	0
Y103	0.366 Sec.	0	0
Y104	0.144 Sec.	0	0
Y105	0.174 Sec.	0	0
Y106	0.093 Sec.	0	0
Y107	0.105 Sec.	0	0
AG106	8.5 Days	0	0
AG107	0 Stable	0	0
AG109	0 Stable	0	0
AG109m	39.6 Sec.	0	0
AG110	24.6 Sec.	0	0

Table 2.11. Relative Radiation Hazard of Surface—Deposited Activation Products from Hanford Reactor Fuel and Cladding at Various Decay Times

Table 11—A. Decay Time = 1 Year				Table 11—B. Decay Time = 3 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
NB 95	35.15 Days	1.117	39.3	CO 60	5.270 Years	0.462	85.2
CO 60	5.270 Years	0.602	21.1	SB125	2.77 Years	0.056	10.4
ZR 95	63.98 Days	0.498	17.5	MN 54	312.5 Days	0.021	3.86
CO 58	70.78 Days	0.382	13.4	TE125m	58 Days	6.5E-04	0.12
MN 54	312.5 Days	0.106	3.72	SN119m	245 Days	4.9E-04	9.0E-02
SB125	2.77 Years	0.093	3.26	NB 95	35.15 Days	4.2E-04	7.7E-02
IN113m	1.658 Hours	0.030	1.07	IN113m	1.658 Hours	3.7E-04	6.9E-02
SN123	129.2 Days	5.1E-03	0.18	FE 55	2.6 Years	3.5E-04	6.4E-02
SN119m	245 Days	3.8E-03	0.13	CO 58	70.78 Days	3.0E-04	5.5E-02
FE 59	45 Days	1.9E-03	6.7E-02	ZR 95	63.98 Days	1.8E-04	3.4E-02
HF181	42.4 Days	1.8E-03	6.5E-02	SN123	129.2 Days	1.0E-04	1.9E-02
SN113	115.1 Days	1.7E-03	6.0E-02	SN113	115.1 Days	2.1E-05	3.8E-03
TE125m	58 Days	1.1E-03	3.7E-02	ZN 65	243.9 Days	8.0E-06	1.5E-03
FE 55	2.6 Years	5.9E-04	2.1E-02	TA182	115 Days	5.7E-06	1.1E-03
TA182	115 Days	4.7E-04	1.7E-02	CD109	1.27 Years	9.1E-07	1.7E-04
NB 95m	3.609 Days	3.4E-04	1.2E-02	AG109m	39.6 Sec.	8.7E-07	1.6E-04
Y 91	58.51 Days	3.1E-04	1.1E-02	NI 59	80 kY	7.7E-07	1.4E-04
CR 51	27.71 Days	8.8E-05	3.1E-03	W181	121.2 Days	1.4E-07	2.5E-05
ZN 65	243.9 Days	6.4E-05	2.2E-03	NB 95m	3.609 Days	1.3E-07	2.3E-05
SR 89	50.50 Days	6.3E-05	2.2E-03	SC 46	83.80 Days	8.2E-08	1.5E-05
SC 46	83.80 Days	3.5E-05	1.2E-03	Y 91	58.51 Days	5.4E-08	9.9E-06
CD115m	44.59 Days	1.7E-05	6.1E-04	FE 59	45 Days	2.5E-08	4.5E-06
RE188	16.98 Hours	1.1E-05	3.8E-04	HF181	42.4 Days	1.2E-08	2.2E-06
W181	121.2 Days	9.0E-06	3.2E-04	RE188	16.98 Hours	7.3E-09	1.4E-06
IN114	1.198 Min.	5.6E-06	2.0E-04	AG110m	249.9 Days	6.4E-09	1.2E-06
SB124	60.2 Days	5.5E-06	1.9E-04	Y 90	2.667 Days	5.8E-09	1.1E-06
IN114m	49.51 Days	2.7E-06	9.6E-05	NB 93m	13.60 Years	3.2E-09	5.8E-07
CD109	1.27 Years	2.7E-06	9.6E-05	SR 89	50.50 Days	2.8E-09	5.1E-07
AG109m	39.6 Sec.	2.6E-06	9.1E-05	SB124	60.2 Days	1.2E-09	2.3E-07
NI 59	80 kY	7.7E-07	2.7E-05	AG108m	127 Years	1.2E-09	2.2E-07
W188	69.4 Days	9.8E-08	3.5E-06	TE123m	119.7 Days	1.1E-09	2.0E-07
TE123m	119.7 Days	7.6E-08	2.7E-06	MO 93	3.498 kY	8.1E-10	1.5E-07
W185	75.1 Days	5.7E-08	2.0E-06	NB 94	20.3 kY	3.6E-10	6.6E-08
AG110m	249.9 Days	4.9E-08	1.7E-06	CD115m	44.59 Days	2.0E-10	3.8E-08
SN117m	14 Days	2.5E-08	8.8E-07	IN114	1.198 Min.	2.0E-10	3.8E-08
Y 90	2.667 Days	6.1E-09	2.1E-07	LU177m	155 Days	1.5E-10	2.7E-08
LU177m	155 Days	3.9E-09	1.4E-07	IN114m	49.51 Days	9.9E-11	1.8E-08
NB 93m	13.60 Years	1.2E-09	4.3E-08	BE 10	1.600 MY	8.1E-11	1.5E-08
AG108m	127 Years	1.2E-09	4.2E-08	SR 90	29.12 Years	8.0E-11	1.5E-08
MO 93	3.498 kY	8.1E-10	2.8E-08	W185	75.1 Days	6.8E-11	1.3E-08
NB 94	20.3 kY	3.6E-10	1.3E-08	W188	69.4 Days	6.7E-11	1.2E-08
SR 90	29.12 Years	8.4E-11	3.0E-09	AG108	2.37 Min.	1.1E-11	1.9E-09
BE 10	1.600 MY	8.1E-11	2.9E-09	P 32	14.3 Days	9.8E-12	1.8E-09
AG110	24.6 Sec.	7.1E-11	2.5E-09	AG110	24.6 Sec.	9.4E-12	1.7E-09
LU177	6.709 Days	3.2E-11	1.1E-09	LU177	6.709 Days	1.2E-12	2.3E-10
TE127	9.35 Hours	1.6E-11	5.5E-10	CR 51	27.71 Days	1.0E-12	1.9E-10
AG108	2.37 Min.	1.1E-11	3.8E-10	TE127	9.35 Hours	1.5E-13	2.8E-11
SB126	12.4 Days	1.0E-11	3.6E-10	TE127m	109 Days	8.1E-14	1.5E-11
P 32	14.3 Days	9.9E-12	3.5E-10	PB205	30 MY	6.1E-15	1.1E-12
TE127m	109 Days	8.4E-12	3.0E-10	TC 99	213 kY	4.1E-15	7.5E-13
RU103	39.28 Days	2.8E-12	9.9E-11	TC 98	4.199 MY	1.8E-16	3.4E-14
SN125	9.64 Days	2.4E-12	8.4E-11	IR192	74.02 Days	4.5E-17	8.3E-15
IR192	74.02 Days	4.8E-14	1.7E-12	BI208	368 kY	1.1E-17	2.0E-15
PB205	30 MY	6.1E-15	2.1E-13	RU103	39.28 Days	7.1E-18	1.3E-15
TC 99	213 kY	4.1E-15	1.4E-13	CA 45	163.0 Days	3.6E-18	6.6E-16
NB 92	10.16 Days	3.8E-15	1.3E-13	PO210	138.4 Days	1.0E-18	1.9E-16
TC 98	4.199 MY	1.8E-16	6.5E-15	IN115	5E+05 GY	6.2E-21	1.1E-18
CA 45	163.0 Days	8.0E-17	2.8E-15	TE123	10001 GY	3.8E-21	7.0E-19
PO210	138.4 Days	4.0E-17	1.4E-15	PT193	500 Years	2.2E-23	4.1E-21
BI208	368 kY	1.1E-17	3.8E-16	XE127	36.41 Days	6.6E-24	1.2E-21
XE127	36.41 Days	7.3E-18	2.5E-16	SN117m	14 Days	5.0E-24	9.1E-22
OS191	15.41 Days	2.0E-18	7.1E-17	K 42	12.36 Hours	2.2E-24	4.1E-22
TE129	1.16 Hours	8.9E-21	3.1E-19	I129	15.7 MY	2.5E-25	4.7E-23
IN115	5E+05 GY	6.2E-21	2.2E-19	RH106	29.9 Sec.	1.6E-25	3.0E-23
TE123	10001 GY	3.7E-21	1.3E-19	TM171	1.92 Years	7.0E-29	1.3E-26
AG106	8.5 Days	3.6E-22	1.3E-20	SB126	12.4 Days	1.9E-29	3.4E-27
PT193	500 Years	2.2E-23	7.8E-22	OS191	15.41 Days	1.1E-32	2.0E-30
K 42	12.36 Hours	2.2E-24	7.8E-23	NB 92	10.16 Days	1.7E-36	3.2E-34
AG111	7.45 Days	3.2E-25	1.1E-23	B 10	0 Stable	0	0
I129	15.7 MY	2.5E-25	8.9E-24	B 11	0 Stable	0	0

Table 2.11. (contd)

Table 11-C. Decay Time = 10 Years				Table 11-D. Decay Time = 30 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
CO 60	5.270 Years	1.8E-01	94.9	CO 60	5.270 Years	1.3E-02	99.5
SB125	2.77 Years	9.8E-03	5.02	SB125	2.77 Years	6.5E-05	0.49
TE125m	58 Days	1.1E-04	5.8E-02	NI 59	80 kY	7.7E-07	5.7E-03
MN 54	312.5 Days	7.2E-05	3.7E-02	TE125m	58 Days	7.6E-07	5.7E-03
FE 55	2.6 Years	5.4E-05	2.8E-02	FE 55	2.6 Years	2.6E-07	1.9E-03
NI 59	80 kY	7.7E-07	3.9E-04	NB 93m	13.60 Years	1.7E-08	1.3E-04
SN119m	245 Days	3.5E-07	1.8E-04	Y 90	2.667 Days	3.1E-09	2.3E-05
CD109	1.27 Years	2.0E-08	1.0E-05	AG108m	127 Years	1.0E-09	7.7E-06
AG109m	39.6 Sec.	1.9E-08	9.8E-06	MO 93	3.498 kY	8.1E-10	6.0E-06
NB 93m	13.60 Years	8.6E-09	4.5E-06	NB 94	20.3 kY	3.6E-10	2.7E-06
ZN 65	243.9 Days	5.6E-09	2.9E-06	BE 10	1.600 MY	8.1E-11	6.1E-07
Y 90	2.667 Days	4.9E-09	2.5E-06	TA182	115 Days	6.5E-11	4.9E-07
AG108m	127 Years	1.1E-09	5.9E-07	SR 90	29.12 Years	4.2E-11	3.2E-07
MO 93	3.498 kY	8.1E-10	4.2E-07	P 32	14.3 Days	9.5E-12	7.1E-08
NB 94	20.3 kY	3.6E-10	1.9E-07	AG108	2.37 Min.	9.1E-12	6.8E-08
SN123	129.2 Days	1.1E-10	5.7E-08	MN 54	312.5 Days	6.6E-12	5.0E-08
BE 10	1.600 MY	8.1E-11	4.2E-08	CD109	1.27 Years	3.7E-13	2.7E-09
IN113m	1.658 Hours	7.7E-11	4.0E-08	AG109m	39.6 Sec.	3.5E-13	2.6E-09
SR 90	29.12 Years	6.8E-11	3.5E-08	PB205	30 MY	6.1E-15	4.6E-11
TA182	115 Days	6.7E-11	3.4E-08	TC 99	213 kY	4.1E-15	3.0E-11
AG108	2.37 Min.	1.0E-11	5.2E-09	SN119m	245 Days	3.7E-16	2.8E-12
P 32	14.3 Days	9.7E-12	5.0E-09	TC 98	4.199 MY	1.8E-16	1.4E-12
AG110m	249.9 Days	5.3E-12	2.7E-09	BI208	368 kY	1.1E-17	8.1E-14
SN113	115.1 Days	4.3E-12	2.2E-09	ZN 65	243.9 Days	5.4E-18	4.0E-14
W181	121.2 Days	6.1E-14	3.2E-11	IR192	74.02 Days	5.5E-19	4.1E-15
AG110	24.6 Sec.	7.8E-15	4.0E-12	AG110m	249.9 Days	8.4E-21	6.3E-17
PB205	30 MY	6.1E-15	3.1E-12	IN115	5E+05 GY	6.2E-21	4.7E-17
TC 99	213 kY	4.1E-15	2.1E-12	TE123	10001 GY	3.8E-21	2.9E-17
CO 58	70.78 Days	4.0E-15	2.1E-12	PT193	500 Years	2.2E-23	1.7E-19
LU177m	155 Days	1.6E-15	8.2E-13	AG110	24.6 Sec.	1.2E-23	9.3E-20
TE123m	119.7 Days	4.1E-16	2.1E-13	K 42	12.36 Hours	2.2E-24	1.7E-20
NB 95	35.15 Days	3.9E-16	2.0E-13	I129	15.7 MY	2.5E-25	1.9E-21
TC 98	4.199 MY	1.8E-16	9.5E-14	PO210	138.4 Days	1.1E-25	8.1E-22
ZR 95	63.98 Days	1.7E-16	8.8E-14	SN123	129.2 Days	1.1E-27	7.9E-24
SC 46	83.80 Days	5.4E-17	2.8E-14	LU177m	155 Days	1.0E-29	7.8E-26
LU177	6.709 Days	1.3E-17	6.9E-15	IN113m	1.658 Hours	6.1E-30	4.5E-26
BI208	368 kY	1.1E-17	5.6E-15	SN113	115.1 Days	3.4E-31	2.5E-27
IR192	74.02 Days	5.8E-19	3.0E-16	RH106	29.9 Sec.	1.8E-31	1.3E-27
NB 95m	3.609 Days	1.2E-19	6.0E-17	LU177	6.709 Days	8.7E-32	6.5E-28
RE188	16.98 Hours	5.9E-20	3.1E-17	TM171	1.92 Years	5.1E-32	3.9E-28
TE127	9.35 Hours	1.3E-20	6.7E-18	W181	121.2 Days	4.4E-32	3.3E-28
TE127m	109 Days	7.0E-21	3.6E-18	TE123m	119.7 Days	1.7E-34	1.3E-30
IN115	5E+05 GY	6.2E-21	3.2E-18	CA 45	163.0 Days	2.2E-36	1.6E-32
W185	75.1 Days	3.8E-21	2.0E-18	B 10	0 Stable	0	0
TE123	10001 GY	3.8E-21	2.0E-18	B 11	0 Stable	0	0
Y 91	58.51 Days	3.8E-21	1.9E-18	B 12	0.02 Sec.	0	0
W188	69.4 Days	5.4E-22	2.8E-19	C 12	0 Stable	0	0
SB124	60.2 Days	2.0E-22	1.0E-19	C 13	0 Stable	0	0
CA 45	163.0 Days	6.8E-23	3.5E-20	C 14	5.729 kY	0	0
PT193	500 Years	2.2E-23	1.1E-20	C 15	2.449 Sec.	0	0
PO210	138.4 Days	3.0E-24	1.5E-21	F 19	0 Stable	0	0
K 42	12.36 Hours	2.2E-24	1.1E-21	F 20	11.4 Sec.	0	0
SR 89	50.50 Days	1.6E-24	8.2E-22	H 1	0 Stable	0	0
I129	15.7 MY	2.5E-25	1.3E-22	H 2	0 Stable	0	0
FE 59	45 Days	1.9E-25	1.0E-22	H 3	12.35 Years	0	0
RH106	29.9 Sec.	1.6E-25	8.5E-23	H 4	0.001 Sec.	0	0
IN114	1.198 Min.	5.8E-26	3.0E-23	I125	59.7 Days	0	0
IN114m	49.51 Days	2.8E-26	1.5E-23	I126	13.02 Days	0	0
HF181	42.4 Days	8.4E-27	4.3E-24	I127	0 Stable	0	0
CD115m	44.59 Days	1.1E-27	5.8E-25	I128	24.98 Min.	0	0
TM171	1.92 Years	7.0E-29	3.6E-26	I130	12.36 Hours	0	0
RU103	39.28 Days	2.3E-37	1.2E-34	I130m	9 Min.	0	0
B 10	0 Stable	0	0	I131	8.041 Days	0	0
B 11	0 Stable	0	0	I132	2.3 Hours	0	0
B 12	0.02 Sec.	0	0	K 39	0 Stable	0	0
C 12	0 Stable	0	0	K 40	1.280 GY	0	0
C 13	0 Stable	0	0	K 41	0 Stable	0	0
C 14	5.729 kY	0	0	K 43	22.6 Hours	0	0
C 15	2.449 Sec.	0	0	K 44	22 Min.	0	0
F 19	0 Stable	0	0	N 13	9.97 Min.	0	0

Table 2.11. (contd)

Table 11-E. Decay Time = 40 Years				Table 11-F. Decay Time = 100 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
CO 60	5.270 Years	3.6E-03	99.8	CO 60	5.270 Years	1.3E-06	62.8
SB125	2.77 Years	5.4E-06	0.15	NI 59	80 kY	7.7E-07	36.1
NI 59	80 kY	7.7E-07	2.1E-02	NB 93m	13.60 Years	2.1E-08	1.00
TE125m	58 Days	6.2E-08	1.7E-03	MO 93	3.498 kY	7.9E-10	3.7E-02
NB 93m	13.60 Years	1.9E-08	5.2E-04	AG108m	127 Years	7.0E-10	3.3E-02
FE 55	2.6 Years	1.8E-08	5.0E-04	Y 90	2.667 Days	5.8E-10	2.7E-02
Y 90	2.667 Days	2.4E-09	6.8E-05	NB 94	20.3 kY	3.6E-10	1.7E-02
AG108m	127 Years	9.7E-10	2.7E-05	BE 10	1.600 MY	8.1E-11	3.8E-03
MO 93	3.498 kY	8.0E-10	2.3E-05	TA182	115 Days	6.5E-11	3.1E-03
NB 94	20.3 kY	3.6E-10	1.0E-05	P 32	14.3 Days	8.8E-12	4.1E-04
BE 10	1.600 MY	8.1E-11	2.3E-06	SR 90	29.12 Years	8.0E-12	3.8E-04
TA182	115 Days	6.5E-11	1.8E-06	AG108	2.37 Min.	6.2E-12	2.9E-04
SR 90	29.12 Years	3.3E-11	9.3E-07	SB125	2.77 Years	1.6E-12	7.6E-05
P 32	14.3 Days	9.4E-12	2.6E-07	TE125m	58 Days	1.9E-14	8.8E-07
AG108	2.37 Min.	8.6E-12	2.4E-07	PB205	30 MY	6.1E-15	2.9E-07
PB205	30 MY	6.1E-15	1.7E-10	TC 99	213 kY	4.1E-15	1.9E-07
TC 99	213 kY	4.1E-15	1.1E-10	FE 55	2.6 Years	2.0E-15	9.6E-08
MN 54	312.5 Days	2.0E-15	5.6E-11	TC 98	4.199 MY	1.8E-16	8.7E-09
CD109	1.27 Years	1.6E-15	4.4E-11	BI208	368 kY	1.1E-17	5.1E-10
AG109m	39.6 Sec.	1.5E-15	4.2E-11	IR192	74.02 Days	4.5E-19	2.1E-11
TC 98	4.199 MY	1.8E-16	5.2E-12	IN115	5E+05 GY	6.2E-21	2.9E-13
BI208	368 kY	1.1E-17	3.0E-13	TE123	10001 GY	3.8E-21	1.8E-13
IR192	74.02 Days	5.3E-19	1.5E-14	PT193	500 Years	2.2E-23	1.0E-15
SN119m	245 Days	1.2E-20	3.4E-16	K 42	12.36 Hours	2.2E-24	1.0E-16
IN115	5E+05 GY	6.2E-21	1.7E-16	I129	15.7 MY	2.5E-25	1.2E-17
TE123	10001 GY	3.8E-21	1.1E-16	PO210	138.4 Days	1.1E-25	5.1E-18
ZN 65	243.9 Days	1.7E-22	4.7E-18	CD109	1.27 Years	9.5E-30	4.5E-22
PT193	500 Years	2.2E-23	6.2E-19	AG109m	39.6 Sec.	9.0E-30	4.2E-22
K 42	12.36 Hours	2.2E-24	6.2E-20	B 10	0 Stable	0	0
AG110m	249.9 Days	3.4E-25	9.4E-21	B 11	0 Stable	0	0
I129	15.7 MY	2.5E-25	7.1E-21	B 12	0.02 Sec.	0	0
PO210	138.4 Days	1.1E-25	3.0E-21	C 12	0 Stable	0	0
AG110	24.6 Sec.	4.9E-28	1.4E-23	C 13	0 Stable	0	0
TM171	1.92 Years	5.1E-32	1.4E-27	C 14	5.729 kY	0	0
SN123	129.2 Days	3.2E-36	9.1E-32	C 15	2.449 Sec.	0	0
LJ177m	155 Days	7.7E-37	2.2E-32	F 19	0 Stable	0	0
CA 45	163.0 Days	3.9E-43	1.1E-38	F 20	11.4 Sec.	0	0
B 10	0 Stable	0	0	H 1	0 Stable	0	0
B 11	0 Stable	0	0	H 2	0 Stable	0	0
B 12	0.02 Sec.	0	0	H 3	12.35 Years	0	0
C 12	0 Stable	0	0	H 4	0.001 Sec.	0	0
C 13	0 Stable	0	0	I125	59.7 Days	0	0
C 14	5.729 kY	0	0	I126	13.02 Days	0	0
C 15	2.449 Sec.	0	0	I127	0 Stable	0	0
F 19	0 Stable	0	0	I128	24.98 Min.	0	0
F 20	11.4 Sec.	0	0	I130	12.36 Hours	0	0
H 1	0 Stable	0	0	I130m	9 Min.	0	0
H 2	0 Stable	0	0	I131	8.041 Days	0	0
H 3	12.35 Years	0	0	I132	2.3 Hours	0	0
H 4	0.001 Sec.	0	0	K 39	0 Stable	0	0
I125	59.7 Days	0	0	K 40	1.280 GY	0	0
I126	13.02 Days	0	0	K 41	0 Stable	0	0
I127	0 Stable	0	0	K 43	22.6 Hours	0	0
I128	24.98 Min.	0	0	K 44	22 Min.	0	0
I130	12.36 Hours	0	0	N 13	9.97 Min.	0	0
I130m	9 Min.	0	0	N 14	0 Stable	0	0
I131	8.041 Days	0	0	N 15	0 Stable	0	0
I132	2.3 Hours	0	0	N 16	7.12 Sec.	0	0
K 39	0 Stable	0	0	O 16	0 Stable	0	0
K 40	1.280 GY	0	0	O 17	0 Stable	0	0
K 41	0 Stable	0	0	O 18	0 Stable	0	0
K 43	22.6 Hours	0	0	O 19	29 Sec.	0	0
K 44	22 Min.	0	0	P 31	0 Stable	0	0
N 13	9.97 Min.	0	0	P 33	25 Days	0	0
N 14	0 Stable	0	0	P 34	12.4 Sec.	0	0
N 15	0 Stable	0	0	S 32	0 Stable	0	0
N 16	7.12 Sec.	0	0	S 33	0 Stable	0	0
O 16	0 Stable	0	0	S 34	0 Stable	0	0
O 17	0 Stable	0	0	S 35	88 Days	0	0
O 18	0 Stable	0	0	S 36	0 Stable	0	0

Table 2.11. (contd)

Table 11-G. Decay Time = 300 Years				Table 11-H. Decay Time = 1000 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
NI 59	80 KY	7.6E-07	97.1	NI 59	80 KY	7.6E-07	97.1
NB 93m	13.60 Years	2.1E-08	2.72	NB 93m	13.60 Years	2.1E-08	2.74
MO 93	3,498 KY	7.6E-10	9.7E-02	MO 93	3,498 KY	6.6E-10	8.5E-02
NB 94	20.3 KY	3.6E-10	4.5E-02	NB 94	20.3 KY	3.5E-10	4.5E-02
AG108m	127 Years	2.4E-10	3.0E-02	BE 10	1,600 MY	8.1E-11	1.0E-02
BE 10	1,600 MY	8.1E-11	1.0E-02	TA182	115 Days	6.5E-11	8.4E-03
TA182	115 Days	6.5E-11	8.3E-03	AG108m	127 Years	5.2E-12	6.6E-04
P 32	14.3 Days	7.1E-12	9.0E-04	P 32	14.3 Days	3.4E-12	4.3E-04
Y 90	2,667 Days	4.9E-12	6.3E-04	AG108	2.37 Min.	4.6E-14	5.9E-06
AG108	2.37 Min.	2.1E-12	2.7E-04	PB205	30 MY	6.1E-15	7.8E-07
SR 90	29.12 Years	6.8E-14	8.7E-06	TC 99	213 KY	4.0E-15	5.2E-07
PB205	30 MY	6.1E-15	7.7E-07	TC 98	4,199 MY	1.8E-16	2.4E-08
TC 99	213 KY	4.1E-15	5.2E-07	BI208	368 KY	1.1E-17	1.4E-09
TC 98	4,199 MY	1.8E-16	2.3E-08	Y 90	2,667 Days	2.9E-19	3.7E-11
BI208	368 KY	1.1E-17	1.4E-09	IR192	74.02 Days	3.8E-20	4.8E-12
CO 60	5,270 Years	5.0E-18	6.4E-10	IN115	5E+05 GY	6.2E-21	8.0E-13
IR192	74.02 Days	2.5E-19	3.1E-11	SR 90	29.12 Years	4.0E-21	5.1E-13
IN115	5E+05 GY	6.2E-21	7.9E-13	TE123	10001 GY	3.8E-21	4.9E-13
TE123	10001 GY	3.8E-21	4.8E-13	PT193	500 Years	8.0E-24	1.0E-15
PT193	500 Years	1.6E-23	2.0E-15	I129	15.7 MY	2.5E-25	3.2E-17
K 42	12.36 Hours	2.2E-24	2.8E-16	PO210	138.4 Days	1.1E-25	1.4E-17
I129	15.7 MY	2.5E-25	3.2E-17	K 42	12.36 Hours	9.1E-31	1.2E-22
PO210	138.4 Days	1.1E-25	1.4E-17	B 10	0 Stable	0	0
B 10	0 Stable	0	0	B 11	0 Stable	0	0
B 11	0 Stable	0	0	B 12	0.02 Sec.	0	0
B 12	0.02 Sec.	0	0	C 12	0 Stable	0	0
C 12	0 Stable	0	0	C 13	0 Stable	0	0
C 13	0 Stable	0	0	C 14	5,729 KY	0	0
C 14	5,729 KY	0	0	C 15	2,449 Sec.	0	0
C 15	2,449 Sec.	0	0	F 19	0 Stable	0	0
F 19	0 Stable	0	0	F 20	11.4 Sec.	0	0
F 20	11.4 Sec.	0	0	H 1	0 Stable	0	0
H 1	0 Stable	0	0	H 2	0 Stable	0	0
H 2	0 Stable	0	0	H 3	12.35 Years	0	0
H 3	12.35 Years	0	0	H 4	0.001 Sec.	0	0
H 4	0.001 Sec.	0	0	I125	59.7 Days	0	0
I125	59.7 Days	0	0	I126	13.02 Days	0	0
I126	13.02 Days	0	0	I127	0 Stable	0	0
I127	0 Stable	0	0	I128	24.98 Min.	0	0
I128	24.98 Min.	0	0	I130	12.36 Hours	0	0
I130	12.36 Hours	0	0	I130m	9 Min.	0	0
I130m	9 Min.	0	0	I131	8.041 Days	0	0
I131	8.041 Days	0	0	I132	2.3 Hours	0	0
I132	2.3 Hours	0	0	K 39	0 Stable	0	0
K 39	0 Stable	0	0	K 40	1,280 GY	0	0
K 40	1,280 GY	0	0	K 41	0 Stable	0	0
K 41	0 Stable	0	0	K 43	22.6 Hours	0	0
K 43	22.6 Hours	0	0	K 44	22 Min.	0	0
K 44	22 Min.	0	0	N 13	9.97 Min.	0	0
N 13	9.97 Min.	0	0	N 14	0 Stable	0	0
N 14	0 Stable	0	0	N 15	0 Stable	0	0
N 15	0 Stable	0	0	N 16	7.12 Sec.	0	0
N 16	7.12 Sec.	0	0	O 16	0 Stable	0	0
O 16	0 Stable	0	0	O 17	0 Stable	0	0
O 17	0 Stable	0	0	O 18	0 Stable	0	0
O 18	0 Stable	0	0	O 19	29 Sec.	0	0
O 19	29 Sec.	0	0	P 31	0 Stable	0	0
P 31	0 Stable	0	0	P 33	25 Days	0	0
P 33	25 Days	0	0	P 34	12.4 Sec.	0	0
P 34	12.4 Sec.	0	0	S 32	0 Stable	0	0
S 32	0 Stable	0	0	S 33	0 Stable	0	0
S 33	0 Stable	0	0	S 34	0 Stable	0	0
S 34	0 Stable	0	0	S 35	88 Days	0	0
S 35	88 Days	0	0	S 36	0 Stable	0	0
S 36	0 Stable	0	0	S 37	5.06 Min.	0	0
S 37	5.06 Min.	0	0	V 49	330.0 Days	0	0
V 49	330.0 Days	0	0	V 50	4E+07 GY	0	0
V 50	4E+07 GY	0	0	V 51	0 Stable	0	0
V 51	0 Stable	0	0	V 52	3.75 Min.	0	0
V 52	3.75 Min.	0	0	V 53	1.61 Min.	0	0

Table 2.11. (contd)

Table 11-I. Decay Time = 3000 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
NI 59	80 kY	7.5E-07	97.1
NB 93m	13.60 Years	2.1E-08	2.78
MO 93	3.498 kY	4.5E-10	5.8E-02
NB 94	20.3 kY	3.3E-10	4.2E-02
BE 10	1.600 MY	8.1E-11	1.1E-02
TA182	115 Days	6.5E-11	8.5E-03
P 32	14.3 Days	4.0E-13	5.2E-05
PB205	30 MY	6.1E-15	7.9E-07
TC 99	213 kY	4.0E-15	5.2E-07
TC 98	4.199 MY	1.8E-16	2.4E-08
AG108m	127 Years	9.4E-17	1.2E-08
B1208	368 kY	1.1E-17	1.4E-09
AG108	2.37 Min.	8.3E-19	1.1E-10
IN115	5E+05 GY	6.2E-21	8.1E-13
IR192	74.02 Days	5.4E-21	7.0E-13
TE123	10001 GY	3.8E-21	4.9E-13
PT193	500 Years	2.0E-24	2.6E-16
I129	15.7 MY	2.5E-25	3.3E-17
PO210	138.4 Days	1.1E-25	1.4E-17
SR 90	29.12 Years	6.0E-42	7.7E-34
B 10	0 Stable	0	0
B 11	0 Stable	0	0
B 12	0.02 Sec.	0	0
C 12	0 Stable	0	0
C 13	0 Stable	0	0
C 14	5.729 kY	0	0
C 15	2.449 Sec.	0	0
F 19	0 Stable	0	0
F 20	11.4 Sec.	0	0
H 1	0 Stable	0	0
H 2	0 Stable	0	0
H 3	12.35 Years	0	0
H 4	0.001 Sec.	0	0
I125	59.7 Days	0	0
I126	13.02 Days	0	0
I127	0 Stable	0	0
I128	24.98 Min.	0	0
I130	12.36 Hours	0	0
I130m	9 Min.	0	0
I131	8.041 Days	0	0
I132	2.3 Hours	0	0
K 39	0 Stable	0	0
K 40	1.280 GY	0	0
K 41	0 Stable	0	0
K 42	12.36 Hours	0	0
K 43	22.6 Hours	0	0
K 44	22 Min.	0	0
N 13	9.97 Min.	0	0
N 14	0 Stable	0	0
N 15	0 Stable	0	0
N 16	7.12 Sec.	0	0
O 16	0 Stable	0	0
O 17	0 Stable	0	0
O 18	0 Stable	0	0
O 19	29 Sec.	0	0
P 31	0 Stable	0	0
P 33	25 Days	0	0
P 34	12.4 Sec.	0	0
S 32	0 Stable	0	0
S 33	0 Stable	0	0
S 34	0 Stable	0	0
S 35	88 Days	0	0
S 36	0 Stable	0	0
S 37	5.06 Min.	0	0
V 49	330.0 Days	0	0
V 50	4E+07 GY	0	0
V 51	0 Stable	0	0
V 52	3.75 Min.	0	0
V 53	1.61 Min.	0	0
V 54	55 Sec.	0	0

Table 2.12. Relative Radiation Hazard of Surface—Deposited Actinides from Hanford Reactor Fuel for Various Decay Times

Table 12-A. Decay Time = 1 Year				Table 12-B. Decay Time = 3 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
PA234m	1.17 Min.	7.41E-03	53.14	PA234m	1.17 Min.	7.40E-03	40.55
AM241	432.2 Years	2.48E-03	17.80	AM241	432.2 Years	6.85E-03	37.54
PU239	24.06 kY	1.85E-03	13.26	PU239	24.06 kY	1.85E-03	10.12
PU240	6.537 kY	8.57E-04	6.15	PU240	6.537 kY	8.57E-04	4.69
TH234	24.1 Days	3.37E-04	2.42	TH234	24.1 Days	3.37E-04	1.85
U235	703.8 MY	2.44E-04	1.75	U235	703.8 MY	2.44E-04	1.33
PU238	87.74 Years	2.31E-04	1.66	PU238	87.74 Years	2.28E-04	1.25
U237	6.75 Days	1.89E-04	1.36	U237	6.75 Days	1.72E-04	0.943
PA233	27 Days	1.22E-04	0.877	PA233	27 Days	1.22E-04	0.670
PA234	6.7 Hours	8.50E-05	0.610	PA234	6.7 Hours	8.50E-05	0.466
CM242	163.2 Days	3.39E-05	0.243	U234	244.5 kY	2.82E-05	0.154
U234	244.5 kY	2.82E-05	0.202	TH231	1.063 Days	2.72E-05	0.149
TH231	1.063 Days	2.72E-05	0.195	U238	4.468 GY	2.15E-05	0.118
U238	4.468 GY	2.15E-05	0.155	NP237	2.14 MY	1.68E-05	0.092
NP237	2.14 MY	1.68E-05	0.120	NP239	2.355 Days	3.0E-06	0.017
NP239	2.355 Days	3.0E-06	0.022	TL208	3.07 Min.	2.2E-06	0.012
CM244	18.11 Years	1.3E-06	9.2E-03	CM242	163.2 Days	1.6E-06	8.6E-03
AM242	16.02 Hours	1.3E-06	9.0E-03	AM242	16.02 Hours	1.2E-06	6.8E-03
AM243	7.38 kY	1.0E-06	7.5E-03	CM244	18.11 Years	1.2E-06	6.5E-03
TL208	3.07 Min.	8.8E-07	6.3E-03	AM243	7.38 kY	1.0E-06	5.7E-03
U236	23.41 MY	6.3E-07	4.5E-03	U236	23.41 MY	6.3E-07	3.5E-03
CM243	28.5 Years	4.4E-07	3.2E-03	CM243	28.5 Years	4.2E-07	2.3E-03
AM242m	152 Years	1.9E-07	1.4E-03	Bi212	1.009 Hours	3.6E-07	2.0E-03
NP238	2.117 Days	1.9E-07	1.3E-03	PB212	10.64 Hours	3.4E-07	1.8E-03
Bi212	1.009 Hours	1.4E-07	1.0E-03	AM242m	152 Years	1.9E-07	1.0E-03
PB212	10.64 Hours	1.3E-07	9.6E-04	NP238	2.117 Days	1.9E-07	1.0E-03
PU237	45.6 Days	7.1E-08	5.1E-04	PU236	2.851 Years	3.3E-08	1.8E-04
PU236	2.851 Years	5.3E-08	3.8E-04	PU242	386.9 kY	3.2E-08	1.7E-04
PU242	386.9 kY	3.2E-08	2.3E-04	RA224	3.66 Days	2.2E-08	1.2E-04
RA224	3.66 Days	8.9E-09	6.4E-05	TH228	1.913 Years	5.6E-09	3.1E-05
NP235	1.084 Years	3.2E-09	2.3E-05	U232	72 Years	3.6E-09	2.0E-05
U232	72 Years	2.8E-09	2.0E-05	PA231	32.77 kY	3.6E-09	1.9E-05
TH228	1.913 Years	2.2E-09	1.6E-05	RN220	55.6 Sec.	1.1E-09	6.0E-06
PA231	32.77 kY	1.4E-09	1.0E-05	Bi214	19.9 Min.	9.9E-10	5.4E-06
CM245	8.499 kY	7.1E-10	5.1E-06	TH230	77 kY	9.2E-10	5.0E-06
RN220	55.6 Sec.	4.4E-10	3.1E-06	NP235	1.084 Years	8.8E-10	4.8E-06
TH230	77 kY	3.5E-10	2.5E-06	RA223	11.43 Days	7.6E-10	4.2E-06
NP236	115 kY	1.8E-10	1.3E-06	CM245	8.499 kY	7.1E-10	3.9E-06
Bi214	19.9 Min.	1.4E-10	1.0E-06	TL207	4.77 Min.	6.2E-10	3.4E-06
RA223	11.43 Days	1.2E-10	8.5E-07	TH227	18.72 Days	5.8E-10	3.2E-06
TL207	4.77 Min.	9.5E-11	6.8E-07	PB211	36.1 Min.	5.5E-10	3.0E-06
TH227	18.72 Days	9.1E-11	6.5E-07	RN219	3.96 Sec.	3.1E-10	1.7E-06
PB211	36.1 Min.	8.5E-11	6.1E-07	Bi211	2.13 Min.	2.6E-10	1.4E-06
RN219	3.96 Sec.	4.8E-11	3.4E-07	PB214	26.8 Min.	1.9E-10	1.0E-06
Bi211	2.13 Min.	4.0E-11	2.8E-07	NP236	115 kY	1.8E-10	9.9E-07
PB214	26.8 Min.	2.7E-11	1.9E-07	PO216	0.15 Sec.	3.0E-11	1.6E-07
U233	158.5 kY	2.0E-11	1.4E-07	U233	158.5 kY	2.2E-11	1.2E-07
PO216	0.15 Sec.	1.2E-11	8.6E-08	RA226	1.6 kY	5.3E-12	2.9E-08
Bi213	45.65 Min.	9.3E-13	6.7E-09	FR223	21.8 Min.	4.4E-12	2.4E-08
RA226	1.6 kY	7.6E-13	5.4E-09	Bi213	45.65 Min.	2.1E-12	1.1E-08
FR223	21.8 Min.	6.8E-13	4.9E-09	Bi210	5.012 Days	1.8E-12	1.0E-08
TH229	7.339 kY	6.7E-13	4.8E-09	TH229	7.339 kY	1.5E-12	8.2E-09
TL209	2.2 Min.	2.7E-13	1.9E-09	PU237	45.6 Days	1.1E-12	5.9E-09
FR221	4.8 Min.	2.2E-13	1.6E-09	AC227	21.77 Years	1.1E-12	5.8E-09
AC227	21.77 Years	1.6E-13	1.2E-09	PO215	0.002 Sec.	7.8E-13	4.3E-09
PO215	0.002 Sec.	1.2E-13	8.7E-10	TL209	2.2 Min.	6.0E-13	3.3E-09
AC225	10 Days	1.1E-13	7.6E-10	FR221	4.8 Min.	4.9E-13	2.7E-09
Bi210	5.012 Days	1.0E-13	7.3E-10	RN222	3.824 Days	2.8E-13	1.5E-09
RA225	14.8 Days	9.6E-14	6.9E-10	AC225	10 Days	2.4E-13	1.3E-09
NP240m	7.4 Min.	8.2E-14	5.9E-10	RA225	14.8 Days	2.2E-13	1.2E-09
CM246	4.731 kY	5.1E-14	3.6E-10	PO211	0.56 Sec.	1.1E-13	6.0E-10
PB209	3.3 Hours	4.4E-14	3.2E-10	PB209	3.3 Hours	9.9E-14	5.4E-10
RN222	3.824 Days	4.0E-14	2.9E-10	NP240m	7.4 Min.	8.2E-14	4.5E-10
PO211	0.56 Sec.	1.7E-14	1.2E-10	PB210	22.3 Years	6.8E-14	3.7E-10
PO214	2E-04 Sec.	8.4E-15	6.0E-11	PO214	2E-04 Sec.	5.9E-14	3.2E-10
PB210	22.3 Years	3.8E-15	2.7E-11	CM246	4.731 kY	5.1E-14	2.8E-10
AC228	6.131 Hours	2.4E-15	1.7E-11	AC228	6.131 Hours	1.7E-14	9.6E-11
AT217	0.032 Sec.	1.6E-15	1.1E-11	AT217	0.032 Sec.	3.5E-15	1.9E-11
U240	14.1 Hours	9.8E-16	7.0E-12	U240	14.1 Hours	9.8E-16	5.3E-12
PO213	4E-06 Sec.	1.9E-16	1.4E-12	PO213	4E-06 Sec.	4.3E-16	2.4E-12

Table 2.12. (contd)

Table 12-C. Decay Time = 10 Years				Table 12-D. Decay Time = 30 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
AM241	432.2 Years	1.91E-02	62.77	AM241	432.2 Years	3.73E-02	76.86
PA234m	1.17 Min.	7.40E-03	24.31	PA234m	1.17 Min.	7.40E-03	15.25
PU239	24.06 KY	1.85E-03	6.07	PU239	24.06 KY	1.85E-03	3.80
PU240	6.537 KY	8.56E-04	2.81	PU240	6.537 KY	8.54E-04	1.76
TH234	24.1 Days	3.37E-04	1.11	TH234	24.1 Days	3.37E-04	0.694
U235	703.8 MY	2.44E-04	0.800	U235	703.8 MY	2.44E-04	0.502
PU238	87.74 Years	2.16E-04	0.708	PU238	87.74 Years	1.84E-04	0.379
U237	6.75 Days	1.23E-04	0.403	PA233	27 Days	1.24E-04	0.256
PA233	27 Days	1.23E-04	0.402	PA234	6.7 Hours	8.50E-05	0.175
PA234	6.7 Hours	8.50E-05	0.279	U237	6.75 Days	4.69E-05	0.097
U234	244.5 KY	2.82E-05	0.092	U234	244.5 KY	2.82E-05	0.058
TH231	1.063 Days	2.72E-05	0.089	TH231	1.063 Days	2.72E-05	0.056
U238	4.468 GY	2.15E-05	0.071	U238	4.468 GY	2.15E-05	0.044
NP237	2.14 MY	1.68E-05	0.055	NP237	2.14 MY	1.70E-05	0.035
TL208	3.07 Min.	4.4E-06	0.014	TL208	3.07 Min.	4.2E-06	8.6E-03
NP239	2.355 Days	3.0E-06	9.9E-03	NP239	2.355 Days	3.0E-06	6.2E-03
AM242	16.02 Hours	1.2E-06	4.0E-03	AM242	16.02 Hours	1.1E-06	2.3E-03
AM243	7.38 KY	1.0E-06	3.4E-03	AM243	7.38 KY	1.0E-06	2.1E-03
CM244	18.11 Years	9.1E-07	3.0E-03	BI212	1.009 Hours	6.8E-07	1.4E-03
BI212	1.009 Hours	7.1E-07	2.3E-03	PB212	10.64 Hours	6.3E-07	1.3E-03
PB212	10.64 Hours	6.6E-07	2.2E-03	U236	23.41 MY	6.3E-07	1.3E-03
U236	23.41 MY	6.3E-07	2.1E-03	CM244	18.11 Years	4.2E-07	8.7E-04
CM243	28.5 Years	3.5E-07	1.2E-03	CM243	28.5 Years	2.2E-07	4.5E-04
AM242m	152 Years	1.8E-07	6.1E-04	AM242m	152 Years	1.7E-07	3.5E-04
NP238	2.117 Days	1.8E-07	5.9E-04	NP238	2.117 Days	1.6E-07	3.4E-04
CM242	163.2 Days	5.1E-08	1.7E-04	BI214	19.9 Min.	8.7E-08	1.8E-04
RA224	3.66 Days	4.4E-08	1.4E-04	RA223	11.43 Days	5.0E-08	1.0E-04
PU242	386.9 KY	3.2E-08	1.0E-04	CM242	163.2 Days	4.7E-08	9.6E-05
PA231	32.77 KY	1.1E-08	3.6E-05	RA224	3.66 Days	4.2E-08	8.7E-05
TH228	1.913 Years	1.1E-08	3.6E-05	TL207	4.77 Min.	4.0E-08	8.3E-05
BI214	19.9 Min.	1.0E-08	3.3E-05	TH227	18.72 Days	3.8E-08	7.8E-05
RA223	11.43 Days	7.0E-09	2.3E-05	PB211	36.1 Min.	3.6E-08	7.4E-05
PU236	2.851 Years	6.0E-09	2.0E-05	PA231	32.77 KY	3.3E-08	6.7E-05
TL207	4.77 Min.	5.6E-09	1.8E-05	PU242	386.9 KY	3.2E-08	6.5E-05
TH227	18.72 Days	5.3E-09	1.7E-05	RN219	3.96 Sec.	2.0E-08	4.2E-05
PB211	36.1 Min.	5.0E-09	1.6E-05	BI211	2.13 Min.	1.7E-08	3.4E-05
U232	72 Years	4.4E-09	1.4E-05	PB214	26.8 Min.	1.7E-08	3.4E-05
TH230	77 KY	2.9E-09	9.6E-06	TH228	1.913 Years	1.1E-08	2.2E-05
RN219	3.96 Sec.	2.8E-09	9.3E-06	TH230	77 KY	8.6E-09	1.8E-05
BI211	2.13 Min.	2.3E-09	7.7E-06	U232	72 Years	3.8E-09	7.9E-06
RN220	55.6 Sec.	2.2E-09	7.1E-06	RN220	55.6 Sec.	2.1E-09	4.3E-06
PB214	26.8 Min.	1.9E-09	6.3E-06	BI210	5.012 Days	1.3E-09	2.6E-06
CM245	8.499 KY	7.1E-10	2.3E-06	CM245	8.499 KY	7.1E-10	1.5E-06
NP236	115 KY	1.8E-10	5.9E-07	RA226	1.6 KY	4.7E-10	9.7E-07
PO216	0.15 Sec.	5.9E-11	1.9E-07	FR223	21.8 Min.	2.9E-10	5.9E-07
BI210	5.012 Days	5.6E-11	1.8E-07	NP236	115 KY	1.8E-10	3.7E-07
RA226	1.6 KY	5.4E-11	1.8E-07	AC227	21.77 Years	6.9E-11	1.4E-07
FR223	21.8 Min.	4.0E-11	1.3E-07	PO216	0.15 Sec.	5.6E-11	1.2E-07
U233	158.5 KY	3.0E-11	9.8E-08	U233	158.5 KY	5.3E-11	1.1E-07
NP235	1.084 Years	1.0E-11	3.3E-08	PO215	0.002 Sec.	5.1E-11	1.1E-07
AC227	21.77 Years	9.7E-12	3.2E-08	PB210	22.3 Years	4.7E-11	9.6E-08
PO215	0.002 Sec.	7.1E-12	2.3E-08	PU236	2.851 Years	4.6E-11	9.5E-08
BI213	45.65 Min.	7.1E-12	2.3E-08	BI213	45.65 Min.	3.0E-11	6.2E-08
TH229	7.339 KY	5.1E-12	1.7E-08	RN222	3.824 Days	2.5E-11	5.1E-08
RN222	3.824 Days	2.8E-12	9.4E-09	TH229	7.339 KY	2.2E-11	4.4E-08
PB210	22.3 Years	2.1E-12	6.8E-09	TL209	2.2 Min.	8.7E-12	1.8E-08
TL209	2.2 Min.	2.1E-12	6.8E-09	PO211	0.56 Sec.	7.2E-12	1.5E-08
FR221	4.8 Min.	1.7E-12	5.5E-09	FR221	4.8 Min.	7.1E-12	1.5E-08
PO211	0.56 Sec.	1.0E-12	3.3E-09	PO214	2E-04 Sec.	5.2E-12	1.1E-08
AC225	10 Days	8.1E-13	2.7E-09	AC225	10 Days	3.4E-12	7.0E-09
RA225	14.8 Days	7.4E-13	2.4E-09	RA225	14.8 Days	3.1E-12	6.4E-09
PO214	2E-04 Sec.	6.0E-13	2.0E-09	PB209	3.3 Hours	1.4E-12	2.9E-09
PB209	3.3 Hours	3.4E-13	1.1E-09	AC228	6.131 Hours	8.1E-13	1.7E-09
AC228	6.131 Hours	1.5E-13	4.9E-10	PO210	138.4 Days	1.3E-13	2.8E-10
NP240m	7.4 Min.	8.2E-14	2.7E-10	NP240m	7.4 Min.	8.2E-14	1.7E-10
CM246	4.731 KY	5.1E-14	1.7E-10	CM246	4.731 KY	5.1E-14	1.0E-10
AT217	0.032 Sec.	1.2E-14	3.9E-11	AT217	0.032 Sec.	5.0E-14	1.0E-10
PO210	138.4 Days	6.0E-15	2.0E-11	PO213	4E-06 Sec.	6.2E-15	1.3E-11
PO213	4E-06 Sec.	1.5E-15	4.8E-12	U240	14.1 Hours	9.8E-16	2.0E-12
U240	14.1 Hours	9.8E-16	3.2E-12	TH232	14.05 GY	8.5E-16	1.8E-12

Table 2.12. (contd)

Table 12-E. Decay Time = 40 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
AM241	432.2 Years	4.12E-02	78.63
PA234m	1.17 Min.	7.40E-03	14.13
PU239	24.06 kY	1.85E-03	3.52
PU240	6.537 kY	8.54E-04	1.63
TH234	24.1 Days	3.37E-04	0.643
U235	703.8 MY	2.44E-04	0.465
PU238	87.74 Years	1.70E-04	0.325
PA233	27 Days	1.25E-04	0.239
PA234	6.7 Hours	8.50E-05	0.162
U237	6.75 Days	2.90E-05	0.055
U234	244.5 kY	2.82E-05	0.054
TH231	1.063 Days	2.72E-05	0.052
U238	4.468 GY	2.15E-05	0.041
NP237	2.14 MY	1.72E-05	0.033
TL208	3.07 Min.	3.8E-06	7.2E-03
NP239	2.355 Days	3.0E-06	5.8E-03
AM242	16.02 Hours	1.1E-06	2.0E-03
AM243	7.38 kY	1.0E-06	2.0E-03
U236	23.41 MY	6.3E-07	1.2E-03
Bi212	1.009 Hours	6.2E-07	1.2E-03
PB212	10.64 Hours	5.8E-07	1.1E-03
CM244	18.11 Years	2.9E-07	5.5E-04
CM243	28.5 Years	1.7E-07	3.3E-04
AM242m	152 Years	1.6E-07	3.1E-04
NP238	2.117 Days	1.6E-07	3.0E-04
Bi214	19.9 Min.	1.5E-07	2.9E-04
RA223	11.43 Days	8.1E-08	1.5E-04
TL207	4.77 Min.	6.5E-08	1.2E-04
TH227	18.72 Days	6.2E-08	1.2E-04
PB211	36.1 Min.	5.8E-08	1.1E-04
CM242	163.2 Days	4.5E-08	8.5E-05
PA231	32.77 kY	4.3E-08	8.3E-05
RA224	3.66 Days	3.8E-08	7.3E-05
RN219	3.96 Sec.	3.3E-08	6.3E-05
PU242	386.9 kY	3.2E-08	6.0E-05
PB214	26.8 Min.	2.9E-08	5.6E-05
Bi211	2.13 Min.	2.7E-08	5.2E-05
TH230	77 kY	1.1E-08	2.2E-05
TH228	1.913 Years	9.7E-09	1.8E-05
U232	72 Years	3.5E-09	6.7E-06
Bi210	5.012 Days	2.8E-09	5.3E-06
RN220	55.6 Sec.	1.9E-09	3.6E-06
RA226	1.6 kY	8.3E-10	1.6E-06
CM245	8.499 kY	7.1E-10	1.4E-06
FR223	21.8 Min.	4.6E-10	8.8E-07
NP236	115 kY	1.8E-10	3.4E-07
AC227	21.77 Years	1.1E-10	2.1E-07
PB210	22.3 Years	1.0E-10	2.0E-07
PO215	0.002 Sec.	8.3E-11	1.6E-07
U233	158.5 kY	6.4E-11	1.2E-07
PO216	0.15 Sec.	5.1E-11	9.8E-08
Bi213	45.65 Min.	4.6E-11	8.8E-08
RN222	3.824 Days	4.4E-11	8.4E-08
TH229	7.339 kY	3.3E-11	6.3E-08
TL209	2.2 Min.	1.3E-11	2.5E-08
PO211	0.56 Sec.	1.2E-11	2.2E-08
FR221	4.8 Min.	1.1E-11	2.1E-08
PO214	2E-04 Sec.	9.2E-12	1.8E-08
AC225	10 Days	5.2E-12	1.0E-08
RA225	14.8 Days	4.8E-12	9.1E-09
PU236	2.851 Years	4.2E-12	7.9E-09
PB209	3.3 Hours	2.2E-12	4.2E-09
AC228	6.131 Hours	1.2E-12	2.3E-09
PO210	138.4 Days	2.9E-13	5.6E-10
NP240m	7.4 Min.	8.2E-14	1.6E-10
AT217	0.032 Sec.	7.7E-14	1.5E-10
CM246	4.731 kY	5.1E-14	9.6E-11
PO213	4E-06 Sec.	9.5E-15	1.8E-11
TH232	14.05 GY	1.1E-15	2.2E-12
U240	14.1 Hours	9.8E-16	1.9E-12

Table 12-F. Decay Time = 100 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
AM241	432.2 Years	4.39E-02	79.80
PA234m	1.17 Min.	7.40E-03	13.47
PU239	24.06 kY	1.84E-03	3.35
PU240	6.537 kY	8.48E-04	1.54
TH234	24.1 Days	3.37E-04	0.613
U235	703.8 MY	2.44E-04	0.443
PA233	27 Days	1.32E-04	0.240
PU238	87.74 Years	1.06E-04	0.193
PA234	6.7 Hours	8.50E-05	0.155
U234	244.5 kY	2.82E-05	0.051
TH231	1.063 Days	2.72E-05	0.050
U238	4.468 GY	2.15E-05	0.039
NP237	2.14 MY	1.81E-05	0.033
NP239	2.355 Days	3.0E-06	5.5E-03
TL208	3.07 Min.	2.1E-06	3.9E-03
U237	6.75 Days	1.6E-06	2.9E-03
AM243	7.38 kY	1.0E-06	1.9E-03
Bi214	19.9 Min.	9.5E-07	1.7E-03
AM242	16.02 Hours	8.0E-07	1.5E-03
U236	23.41 MY	6.3E-07	1.2E-03
Bi212	1.009 Hours	3.5E-07	6.3E-04
PB212	10.64 Hours	3.2E-07	5.9E-04
RA223	11.43 Days	3.2E-07	5.8E-04
TL207	4.77 Min.	2.6E-07	4.7E-04
TH227	18.72 Days	2.5E-07	4.5E-04
PB211	36.1 Min.	2.3E-07	4.2E-04
PB214	26.8 Min.	1.8E-07	3.3E-04
RN219	3.96 Sec.	1.3E-07	2.4E-04
AM242m	152 Years	1.2E-07	2.2E-04
NP238	2.117 Days	1.2E-07	2.2E-04
PA231	32.77 kY	1.1E-07	2.0E-04
Bi211	2.13 Min.	1.1E-07	2.0E-04
CM243	28.5 Years	4.0E-08	7.2E-05
CM242	163.2 Days	3.4E-08	6.2E-05
PU242	386.9 kY	3.2E-08	5.8E-05
Bi210	5.012 Days	3.0E-08	5.5E-05
CM244	18.11 Years	2.9E-08	5.3E-05
TH230	77 kY	2.9E-08	5.2E-05
RA224	3.66 Days	2.2E-08	3.9E-05
TH228	1.913 Years	5.4E-09	9.9E-06
RA226	1.6 kY	5.1E-09	9.3E-06
U232	72 Years	2.0E-09	3.6E-06
FR223	21.8 Min.	1.8E-09	3.4E-06
PB210	22.3 Years	1.1E-09	2.0E-06
RN220	55.6 Sec.	1.1E-09	1.9E-06
CM245	8.499 kY	7.1E-10	1.3E-06
AC227	21.77 Years	4.5E-10	8.2E-07
PO215	0.002 Sec.	3.3E-10	6.0E-07
RN222	3.824 Days	2.7E-10	4.9E-07
Bi213	45.65 Min.	2.1E-10	3.8E-07
NP236	115 kY	1.8E-10	3.3E-07
TH229	7.339 kY	1.5E-10	2.8E-07
U233	158.5 kY	1.4E-10	2.5E-07
TL209	2.2 Min.	6.1E-11	1.1E-07
PO214	2E-04 Sec.	5.7E-11	1.0E-07
FR221	4.8 Min.	5.0E-11	9.0E-08
PO211	0.56 Sec.	4.6E-11	8.4E-08
PO216	0.15 Sec.	2.9E-11	5.2E-08
AC225	10 Days	2.4E-11	4.4E-08
RA225	14.8 Days	2.2E-11	4.0E-08
PB209	3.3 Hours	1.0E-11	1.8E-08
AC228	6.131 Hours	3.9E-12	7.1E-09
PO210	138.4 Days	3.2E-12	5.9E-09
AT217	0.032 Sec.	3.5E-13	6.4E-10
PU236	2.851 Years	1.0E-13	1.9E-10
NP240m	7.4 Min.	8.2E-14	1.5E-10
CM246	4.731 kY	5.0E-14	9.1E-11
PO213	4E-06 Sec.	4.4E-14	7.9E-11
TH232	14.05 GY	2.8E-15	5.2E-12
U240	14.1 Hours	9.8E-16	1.8E-12

Table 2.12. (contd)

Table 12-G. Decay Time = 300 Years				Table 12-H. Decay Time = 1000 Years			
Isotope	Half-Life	Rad. Haz.	Per Cent	Isotope	Half-Life	Rad. Haz.	Per Cent
AM241	432.2 Years	3.21E-02	74.46	AM241	432.2 Years	1.05E-02	48.62
PA234m	1.17 Min.	7.40E-03	17.15	PA234m	1.17 Min.	7.40E-03	34.42
PU239	24.06 kY	1.83E-03	4.25	PU239	24.06 kY	1.80E-03	8.35
PU240	6.537 kY	8.30E-04	1.92	PU240	6.537 kY	7.71E-04	3.58
TH234	24.1 Days	3.37E-04	0.780	TH234	24.1 Days	3.37E-04	1.57
U235	703.8 MY	2.44E-04	0.565	U235	703.8 MY	2.44E-04	1.14
PA233	27 Days	1.51E-04	0.350	PA233	27 Days	1.86E-04	0.863
PA234	6.7 Hours	8.50E-05	0.197	PA234	6.7 Hours	8.50E-05	0.395
U234	244.5 kY	2.82E-05	0.065	BI214	19.9 Min.	8.34E-05	0.388
TH231	1.063 Days	2.72E-05	0.063	U234	244.5 kY	2.82E-05	0.131
PU238	87.74 Years	2.18E-05	0.051	TH231	1.063 Days	2.73E-05	0.127
U238	4.468 GY	2.15E-05	0.050	NP237	2.14 MY	2.55E-05	0.119
NP237	2.14 MY	2.08E-05	0.048	U238	4.468 GY	2.15E-05	0.100
BI214	19.9 Min.	8.3E-06	0.019	PB214	26.8 Min.	1.59E-05	0.074
NP239	2.355 Days	2.9E-06	6.8E-03	BI210	5.012 Days	4.8E-06	0.022
PB214	26.8 Min.	1.6E-06	3.7E-03	RA223	11.43 Days	4.5E-06	0.021
RA223	11.43 Days	1.2E-06	2.8E-03	TL207	4.77 Min.	3.7E-06	0.017
AM243	7.38 kY	1.0E-06	2.3E-03	TH227	18.72 Days	3.5E-06	0.016
TL207	4.77 Min.	9.9E-07	2.3E-03	PB211	36.1 Min.	3.3E-06	0.015
TH227	18.72 Days	9.4E-07	2.2E-03	NP239	2.355 Days	2.8E-06	0.013
PB211	36.1 Min.	8.8E-07	2.0E-03	RN219	3.96 Sec.	1.8E-06	8.6E-03
U236	23.41 MY	6.4E-07	1.5E-03	BI211	2.13 Min.	1.5E-06	7.1E-03
RN219	3.96 Sec.	5.0E-07	1.2E-03	PA231	32.77 kY	1.1E-06	5.0E-03
BI211	2.13 Min.	4.1E-07	9.6E-04	AM243	7.38 kY	9.5E-07	4.4E-03
BI210	5.012 Days	3.8E-07	8.9E-04	U236	23.41 MY	6.5E-07	3.0E-03
PA231	32.77 kY	3.2E-07	7.5E-04	RA226	1.6 kY	4.5E-07	2.1E-03
AM242	16.02 Hours	3.2E-07	7.5E-04	TH230	77 kY	2.8E-07	1.3E-03
TL208	3.07 Min.	3.1E-07	7.2E-04	PB210	22.3 Years	1.8E-07	8.2E-04
TH230	77 kY	8.6E-08	2.0E-04	PU238	87.74 Years	8.8E-08	4.1E-04
BI212	1.009 Hours	5.1E-08	1.2E-04	PU242	386.9 kY	3.2E-08	1.5E-04
AM242m	152 Years	4.9E-08	1.1E-04	FR223	21.8 Min.	2.6E-08	1.2E-04
NP238	2.117 Days	4.8E-08	1.1E-04	RN222	3.824 Days	2.4E-08	1.1E-04
PB212	10.64 Hours	4.7E-08	1.1E-04	BI213	45.65 Min.	1.9E-08	8.9E-05
RA226	1.6 kY	4.5E-08	1.0E-04	TH229	7.339 kY	1.4E-08	6.4E-05
PU242	386.9 kY	3.2E-08	7.3E-05	AM242	16.02 Hours	1.3E-08	6.1E-05
PB210	22.3 Years	1.4E-08	3.3E-05	AC227	21.77 Years	6.3E-09	2.9E-05
CM242	163.2 Days	1.4E-08	3.2E-05	TL209	2.2 Min.	5.6E-09	2.6E-05
FR223	21.8 Min.	7.1E-09	1.6E-05	PO214	2E-04 Sec.	5.0E-09	2.3E-05
RA224	3.66 Days	3.1E-09	7.3E-06	PO215	0.002 Sec.	4.7E-09	2.2E-05
RN222	3.824 Days	2.4E-09	5.5E-06	FR221	4.8 Min.	4.5E-09	2.1E-05
AC227	21.77 Years	1.7E-09	4.0E-06	AC225	10 Days	2.2E-09	1.0E-05
BI213	45.65 Min.	1.7E-09	3.8E-06	AM242m	152 Years	2.0E-09	9.4E-06
PO215	0.002 Sec.	1.3E-09	2.9E-06	RA225	14.8 Days	2.0E-09	9.2E-06
TH229	7.339 kY	1.2E-09	2.8E-06	NP238	2.117 Days	2.0E-09	9.1E-06
TH228	1.913 Years	7.9E-10	1.8E-06	U233	158.5 kY	1.5E-09	7.0E-06
CM245	8.499 kY	6.9E-10	1.6E-06	PB209	3.3 Hours	9.1E-10	4.2E-06
PO214	2E-04 Sec.	5.0E-10	1.1E-06	PO211	0.56 Sec.	6.6E-10	3.0E-06
TL209	2.2 Min.	4.8E-10	1.1E-06	CM245	8.499 kY	6.6E-10	3.0E-06
U233	158.5 kY	4.0E-10	9.2E-07	CM242	163.2 Days	5.6E-10	2.6E-06
FR221	4.8 Min.	3.9E-10	9.0E-07	TL208	3.07 Min.	5.3E-10	2.5E-06
CM243	28.5 Years	3.1E-10	7.1E-07	PO210	138.4 Days	5.1E-10	2.4E-06
U232	72 Years	2.9E-10	6.6E-07	NP236	115 kY	1.8E-10	8.3E-07
AC225	10 Days	1.9E-10	4.4E-07	BI212	1.009 Hours	8.6E-11	4.0E-07
NP236	115 kY	1.8E-10	4.2E-07	PB212	10.64 Hours	8.0E-11	3.7E-07
PO211	0.56 Sec.	1.8E-10	4.1E-07	AC228	6.131 Hours	3.9E-11	1.8E-07
RA225	14.8 Days	1.7E-10	4.0E-07	AT217	0.032 Sec.	3.2E-11	1.5E-07
RN220	55.6 Sec.	1.5E-10	3.6E-07	RA224	3.66 Days	5.3E-12	2.5E-08
U237	6.75 Days	1.1E-10	2.5E-07	PO213	4E-06 Sec.	4.0E-12	1.8E-08
PB209	3.3 Hours	7.9E-11	1.8E-07	TH228	1.913 Years	1.3E-12	6.3E-09
PO210	138.4 Days	4.1E-11	9.5E-08	U232	72 Years	4.5E-13	2.1E-09
CM244	18.11 Years	1.4E-11	3.2E-08	RN220	55.6 Sec.	2.6E-13	1.2E-09
AC228	6.131 Hours	1.2E-11	2.7E-08	PU236	2.851 Years	1.0E-13	4.7E-10
PO216	0.15 Sec.	4.2E-12	9.7E-09	NP240m	7.4 Min.	8.2E-14	3.8E-10
AT217	0.032 Sec.	2.8E-12	6.4E-09	CM246	4.731 kY	4.4E-14	2.0E-10
PO213	4E-06 Sec.	3.4E-13	7.9E-10	U237	6.75 Days	3.0E-14	1.4E-10
PU236	2.851 Years	1.0E-13	2.4E-10	TH232	14.05 GY	2.9E-14	1.3E-10
NP240m	7.4 Min.	8.2E-14	1.9E-10	PO216	0.15 Sec.	7.1E-15	3.3E-11
CM246	4.731 kY	4.9E-14	1.1E-10	U240	14.1 Hours	9.8E-16	4.5E-12
TH232	14.05 GY	8.5E-15	2.0E-11	PU240m	82.61 MY	1.4E-16	6.6E-13
U240	14.1 Hours	9.8E-16	2.3E-12	CM243	28.5 Years	1.2E-17	5.7E-14

Table 2.12. (contd)

Table 12-1. Decay Time = 3000 Years

Isotope	Half-Life	Rad. Haz.	Per Cent
PA234m	1.17 Min.	7.40E-03	62.15
PU239	24.06 kY	1.70E-03	14.23
PU240	6.537 kY	6.23E-04	5.23
BI214	19.9 Min.	5.81E-04	4.88
AM241	432.2 Years	4.23E-04	3.55
TH234	24.1 Days	3.37E-04	2.83
U235	703.8 MY	2.46E-04	2.07
PA233	27 Days	2.02E-04	1.69
PB214	26.8 Min.	1.11E-04	0.930
PA234	6.7 Hours	8.50E-05	0.713
BI210	5.012 Days	3.32E-05	0.279
U234	244.5 kY	2.82E-05	0.237
NP237	2.14 MY	2.77E-05	0.232
TH231	1.063 Days	2.75E-05	0.231
U238	4.468 GY	2.15E-05	0.181
RA223	11.43 Days	1.34E-05	0.112
TL207	4.77 Min.	1.08E-05	0.091
TH227	18.72 Days	1.02E-05	0.086
PB211	36.1 Min.	9.6E-06	0.081
FN219	3.96 Sec.	5.4E-06	0.046
BI211	2.13 Min.	4.5E-06	0.038
PA231	32.77 kY	3.2E-06	0.026
RA228	1.6 kY	3.1E-06	0.026
NP239	2.355 Days	2.3E-06	0.019
PB210	22.3 Years	1.2E-06	0.010
TH230	77 kY	8.5E-07	7.1E-03
AM243	7.38 kY	7.9E-07	6.6E-03
U236	23.41 MY	6.9E-07	5.8E-03
BI213	45.65 Min.	1.8E-07	1.6E-03
FN222	3.824 Days	1.7E-07	1.4E-03
TH229	7.339 kY	1.3E-07	1.1E-03
FR223	21.8 Min.	7.7E-08	6.4E-04
TL209	2.2 Min.	5.4E-08	4.5E-04
FR221	4.8 Min.	4.4E-08	3.7E-04
PO214	2E-04 Sec.	3.5E-08	2.9E-04
PU242	386.9 kY	3.1E-08	2.6E-04
AC225	10 Days	2.1E-08	1.8E-04
RA225	14.8 Days	1.9E-08	1.6E-04
AC227	21.77 Years	1.9E-08	1.6E-04
PO215	0.002 Sec.	1.4E-08	1.2E-04
PB209	3.3 Hours	8.8E-09	7.4E-05
U233	158.5 kY	5.1E-09	4.3E-05
PO210	138.4 Days	3.5E-09	3.0E-05
PO211	0.56 Sec.	1.9E-09	1.6E-05
CM245	8.499 kY	5.6E-10	4.7E-06
AT217	0.032 Sec.	3.1E-10	2.6E-06
TL208	3.07 Min.	2.6E-10	2.1E-06
NP238	115 kY	1.8E-10	1.5E-06
AC228	6.131 Hours	1.2E-10	1.0E-06
BI212	1.009 Hours	4.2E-11	3.5E-07
PB212	10.64 Hours	3.9E-11	3.2E-07
PO213	4E-06 Sec.	3.8E-11	3.2E-07
RA224	3.66 Days	2.6E-12	2.2E-08
AM242	16.02 Hours	1.4E-12	1.2E-08
TH228	1.913 Years	6.5E-13	5.5E-09
AM242m	152 Years	2.2E-13	1.9E-09
NP238	2.117 Days	2.1E-13	1.8E-09
PU238	87.74 Years	1.5E-13	1.2E-09
FN220	55.6 Sec.	1.3E-13	1.1E-09
U232	72 Years	1.0E-13	8.7E-10
PU236	2.851 Years	1.0E-13	8.4E-10
TH232	14.05 GY	8.9E-14	7.5E-10
NP240m	7.4 Min.	8.2E-14	6.9E-10
CM242	163.2 Days	6.2E-14	5.2E-10
CM246	4.731 kY	3.3E-14	2.8E-10
U237	6.75 Days	2.6E-14	2.2E-10
PO216	0.15 Sec.	3.4E-15	2.9E-11
U240	14.1 Hours	9.8E-16	8.2E-12
PU244	82.61 MY	1.4E-16	1.2E-12
CM247	15.6 MY	2.9E-18	2.4E-14

3.0 Contributions from Fallout Radionuclides

A major source of radionuclide contamination of the earth's surface, including the Hanford Site, is fallout from nuclear weapons testing. Fallout levels were particularly high at mid-latitudes and were also relatively high at our particular longitude. Based on studies conducted by the DOE Health and Safety Laboratory (HASL⁽⁷⁾), currently called the Environmental Measurements Safety Laboratory (EML), we estimate that the cumulative Sr-90 fallout from nuclear weapons testing on the Hanford Site reached about 70 mCi/Km² (1.6×10^5 disintegrations per minute per square meter) in January 1967. Above-ground nuclear testing continued involving megaton devices through 1980. While a precise estimate of the current surface concentration of the resulting Sr-90 on the Hanford Site and that of other long-lived radionuclides will require a considerable effort and is currently underway, it is estimated that the current Sr-90 concentration is approximately 50 mCi/Km² (1.1×10^5 dpm/m²).

Tables 3.1, 13-A, B, and C, and Tables 3.2, 14-A, B, and C show the quantities of each of the long-lived fission products and actinide radionuclides from a 10 kiloton detonation after decay periods of 10, 30, and 40 years as calculated by the ORIGEN2 Code. An estimate of the concentrations of the various long-lived radionuclides in addition to Sr-90 on the Hanford Site can be made by calculating the ratio of each radionuclide of interest to that of Sr-90 from Table 13B or 14B and multiplying this ratio by the above concentration of Sr-90 (1.1×10^5 dpm/m²). A more precise estimate of the fallout source for each radionuclide is currently being made and will be published separately.

One important fact from the above estimate is that fallout from nuclear weapons testing has been substantial and may very well be responsible for the majority of most of the current fission and actinide radionuclides in surface soils on the Hanford Site. A second important fact is that since the ratio of Pu-240 to Pu-239 is 2 to 3 times higher in nuclear weapons fallout than in the weapons plutonium produced at Hanford, measurements of the plutonium isotopic ratio in Hanford soils will allow its origin to be determined—fallout versus Hanford production.

Table 3.1. Radionuclide Content of Fission Products from a 10 KT Burst at Various Decay Times

Table 13-A. Decay Time = 10 Years

Isotope	Half-Life	Curies	Per Cent
CS137	30 Years	988.2	30.6
BA137m	2.552 Min.	934.8	29.0
PM147	2.623 Years	371.7	11.5
Y 90	2.667 Days	337.2	10.4
SR 90	29.12 Years	337.1	10.4
EU155	4.959 Years	64.6	2.00
SM151	89.99 Years	50.0	1.55
KR 85	10.72 Years	38.7	1.20
SB125	2.77 Years	31.7	0.98
RH106	29.9 Sec.	27.3	0.85
RU106	1.008 Years	27.3	0.85
TE125m	58 Days	7.7	0.24
H 3	12.35 Years	4.8	0.15
PR144	17.28 Min.	3.8	0.12
CE144	284.3 Days	3.8	0.12
CD113m	14.59 Years	0.53	0.016
TC 99	213 kY	0.16	5.0E-03
PR144m	7.2 Min.	0.045	1.4E-03
CS134	2.062 Years	0.032	1.0E-03
CS135	2.3 MY	0.019	5.8E-04
SB126m	19 Min.	0.015	4.8E-04
SN126	100 kY	0.015	4.8E-04
ZR 93	1.53 MY	0.015	4.6E-04
SN121m	49.97 Years	0.013	4.1E-04
NB 93m	13.6 Years	0.0057	1.8E-04
SE 79	64.96 kY	0.0040	1.2E-04
PD107	6.496 MY	0.0036	1.1E-04
SB126	12.4 Days	0.0021	6.7E-05
EU154	8.6 Years	0.0018	5.4E-05
I129	15.7 MY	0.00054	1.7E-05
SN119m	245 Days	0.00025	7.7E-06
NB 94	20.3 kY	6.4E-06	2.0E-07
HO166m	1.2 kY	6.3E-06	2.0E-07
EU152	13.6 Years	2.5E-06	7.8E-08
AG108m	127 Years	1.4E-06	4.3E-08
C 14	5.729 kY	1.3E-06	4.1E-08
SN123	129.2 Days	9.3E-07	2.9E-08
AG110m	249.9 Days	4.9E-07	1.5E-08
CE142	104.9 GY	2.7E-07	8.5E-09
RB 87	46.96 GY	1.4E-07	4.2E-09
TE127m	109 Days	1.3E-07	3.9E-09
TE127	9.35 Hours	1.2E-07	3.8E-09
AG108	2.37 Min.	1.2E-07	3.8E-09
SM147	107 GY	1.2E-07	3.6E-09
BE 10	1.6 MY	3.3E-08	1.0E-09
AG110	24.6 Sec.	6.6E-09	2.0E-10
PM146	5.5 Years	5.3E-09	1.6E-10
KR 81	209.9 kY	2.3E-09	7.2E-11
RH102	2.9 Years	1.6E-09	5.0E-11
AG109m	39.6 Sec.	5.9E-11	1.8E-12
CD109	1.27 Years	5.9E-11	1.8E-12
GD153	242 Days	1.0E-11	3.2E-13
ND144	2E+06 GY	1.0E-11	3.2E-13
EU150	36 Years	4.2E-12	1.3E-13
NB 95	35.15 Days	2.4E-12	7.4E-14
ZR 95	63.98 Days	1.1E-12	3.3E-14
IN115	5E+05 GY	8.9E-13	2.8E-14
SM149	1E+07 GY	8.0E-13	2.5E-14
LA138	135 GY	4.2E-13	1.3E-14
TC 98	4.199 MY	2.5E-13	7.9E-15
TE123m	119.7 Days	6.2E-14	1.9E-15
TM171	1.92 Years	3.5E-14	1.1E-15
Y 91	58.51 Days	1.5E-14	4.6E-16
NB 95m	3.609 Days	7.9E-15	2.5E-16
SM146	70 MY	3.9E-16	1.2E-17
TB160	72.3 Days	2.9E-17	8.8E-19
SR 89	50.5 Days	1.5E-17	4.8E-19
TE123	10001 GY	6.1E-18	1.9E-19
SB124	60.2 Days	2.8E-18	8.5E-20
SM148	8E+06 GY	1.3E-18	4.0E-20

Table 13-B. Decay Time = 30 Years

Isotope	Half-Life	Curies	Per Cent
CS137	30 Years	622.5	36.8
BA137m	2.552 Min.	588.9	34.8
Y 90	2.667 Days	209.5	12.4
SR 90	29.12 Years	209.4	12.4
SM151	89.99 Years	42.8	2.53
KR 85	10.72 Years	10.6	0.63
EU155	4.959 Years	3.9	0.23
PM147	2.623 Years	1.9	0.11
H 3	12.35 Years	1.6	0.092
SB125	2.77 Years	0.21	0.013
CD113m	14.59 Years	0.20	0.012
TE 99	213 kY	0.16	0.010
TE125m	58 Days	0.052	3.1E-03
CS135	2.3 MY	0.019	1.1E-03
SB126m	19 Min.	0.015	9.1E-04
SN126	100 kY	0.015	9.1E-04
ZR 93	1.53 MY	0.015	8.7E-04
NB 93m	13.6 Years	0.011	6.5E-04
SN121m	49.97 Years	0.010	5.9E-04
SE 79	64.96 kY	0.0040	2.4E-04
PD107	6.496 MY	0.0036	2.1E-04
SB126	12.4 Days	0.0021	1.3E-04
I129	15.7 MY	0.00054	3.2E-05
EU154	8.6 Years	0.00035	2.1E-05
CS134	2.062 Years	3.9E-05	2.3E-06
RH106	29.9 Sec.	2.9E-05	1.7E-06
RU106	1.008 Years	2.9E-05	1.7E-06
NB 94	20.3 kY	6.4E-06	3.8E-07
HO166m	1.2 kY	6.3E-06	3.7E-07
C 14	5.729 kY	1.3E-06	7.9E-08
AG108m	127 Years	1.2E-06	7.3E-08
EU152	13.6 Years	9.0E-07	5.3E-08
CE142	104.9 GY	2.7E-07	1.6E-08
RB 87	46.96 GY	1.4E-07	8.0E-09
SM147	107 GY	1.3E-07	7.5E-09
AG108	2.37 Min.	1.1E-07	6.5E-09
CE144	284.3 Days	6.9E-08	4.1E-09
PR144	17.28 Min.	6.9E-08	4.1E-09
BE 10	1.6 MY	3.3E-08	2.0E-09
KR 81	209.9 kY	2.3E-09	1.4E-10
PR144m	7.2 Min.	8.3E-10	4.9E-11
PM146	5.5 Years	4.3E-10	2.5E-11
RH102	2.9 Years	1.4E-11	8.0E-13
ND144	2E+06 GY	1.0E-11	6.1E-13
EU150	36 Years	2.9E-12	1.7E-13
IN115	5E+05 GY	8.9E-13	5.3E-14
SM149	1E+07 GY	8.0E-13	4.7E-14
LA138	135 GY	4.2E-13	2.5E-14
SN119m	245 Days	2.6E-13	1.5E-14
TC 98	4.199 MY	2.5E-13	1.5E-14
AG109m	39.6 Sec.	1.1E-15	6.4E-17
CD109	1.27 Years	1.1E-15	6.4E-17
AG110m	249.9 Days	7.8E-16	4.6E-17
SM146	70 MY	5.3E-16	3.1E-17
TM171	1.92 Years	2.5E-17	1.5E-18
AG110	24.6 Sec.	1.0E-17	6.1E-19
TE123	10001 GY	6.1E-18	3.6E-19
SM148	8E+06 GY	1.3E-18	7.7E-20
GD152	1E+05 GY	8.6E-19	5.1E-20
GD153	242 Days	8.5E-21	5.0E-22
SN123	129.2 Days	8.8E-24	5.2E-25
TE127m	109 Days	8.4E-28	5.0E-29
TE127	9.35 Hours	8.3E-28	4.9E-29
TE123m	119.7 Days	2.6E-32	1.5E-33
TM170	128.6 Days	4.0E-36	2.3E-37
I127	0 Stable	0	0
I128	24.98 Min.	0	0
I130	12.36 Hours	0	0
I130m	9 Min.	0	0
I131	8.041 Days	0	0

Table 3.1. (contd)

Table 13-C. Decay Time = 40 Years

isotope	Half-Life	Curies	Per Cent
CS137	30 Years	494.1	36.9
BA137m	2.552 Min.	467.4	34.9
Y 90	2.667 Days	165.1	12.3
SR 90	29.12 Years	165.0	12.3
SM151	89.99 Years	39.7	2.96
KR 85	10.72 Years	5.6	0.42
EU155	4.959 Years	0.98	0.073
H 3	12.35 Years	0.89	0.066
TC 99	213 kY	0.16	0.012
PM147	2.623 Years	0.13	0.010
CD113m	14.59 Years	0.13	9.4E-03
CS135	2.3 MY	0.019	1.4E-03
SB125	2.77 Years	0.017	1.3E-03
SB126m	19 Min.	0.015	1.1E-03
SN126	100 kY	0.015	1.1E-03
ZR 93	1.53 MY	0.015	1.1E-03
NB 93m	13.6 Years	0.012	9.1E-04
SN121m	49.97 Years	0.0088	6.5E-04
TE125m	58 Days	0.0042	3.2E-04
SE 79	64.96 kY	0.0040	3.0E-04
PD107	6.496 MY	0.0036	2.7E-04
SB126	12.4 Days	0.0021	1.6E-04
I129	15.7 MY	0.00054	4.0E-05
EU154	8.6 Years	0.00016	1.2E-05
NB 94	20.3 kY	6.4E-06	4.8E-07
HO166m	1.2 kY	6.2E-06	4.7E-07
CS134	2.062 Years	1.3E-06	1.0E-07
C 14	5.729 kY	1.3E-06	1.0E-07
AG108m	127 Years	1.2E-06	8.7E-08
EU152	13.6 Years	5.4E-07	4.1E-08
CE142	104.9 GY	2.7E-07	2.0E-08
RB 87	46.96 GY	1.4E-07	1.0E-08
SM147	107 GY	1.3E-07	9.4E-09
AG108	2.37 Min.	1.0E-07	7.8E-09
BE 10	1.6 MY	3.3E-08	2.5E-09
RH106	29.9 Sec.	3.0E-08	2.2E-09
RU106	1.008 Years	3.0E-08	2.2E-09
KR 81	209.9 kY	2.3E-09	1.7E-10
PM146	5.5 Years	1.2E-10	9.0E-12
ND144	2E+06 GY	1.0E-11	7.7E-13
CE144	284.3 Days	9.4E-12	7.0E-13
PR144	17.28 Min.	9.4E-12	7.0E-13
EU150	36 Years	2.4E-12	1.8E-13
RH102	2.9 Years	1.2E-12	9.3E-14
IN115	5E+05 GY	8.9E-13	6.7E-14
SM149	1E+07 GY	8.0E-13	6.0E-14
LA138	135 GY	4.2E-13	3.2E-14
TC 98	4.199 MY	2.5E-13	1.9E-14
PR144m	7.2 Min.	1.1E-13	8.4E-15
SM146	70 MY	5.4E-16	4.0E-17
SN119m	245 Days	8.5E-18	6.4E-19
TE123	10001 GY	6.1E-18	4.6E-19
AG109m	39.6 Sec.	4.6E-18	3.4E-19
CD109	1.27 Years	4.6E-18	3.4E-19
SM148	8E+06 GY	1.3E-18	9.8E-20
GD152	1E+05 GY	8.8E-19	6.5E-20
TM171	1.92 Years	6.9E-19	5.1E-20
AG110m	249.9 Days	3.1E-20	2.3E-21
AG110	24.6 Sec.	4.1E-22	3.1E-23
GD153	242 Days	2.4E-25	1.8E-26
SN123	129.2 Days	2.7E-32	2.0E-33
TE127m	109 Days	6.9E-38	5.1E-39
I127	0 Stable	0	
I128	24.98 Min.	0	
I130	12.36 Hours	0	
I130m	9 Min.	0	
I131	8.041 Days	0	
I132	2.3 Hours	0	
I133	20.8 Hours	0	
I133m	9 Sec.	0	

Table 3.2. Radionuclide Content of Actinides from a 10 KT Burst at Various Decay Times

Table 14-A. Decay Time = 10 Years

Isotope	Half-Life	Curies	Per Cent
PU241	14.4 Years	867.7	91.8
PU240	6.537 kY	30.8	3.26
PU239	24.06 kY	27.8	2.94
AM241	432.2 Years	17.7	1.87
PU238	87.74 Years	0.97	0.10
U237	6.75 Days	0.021	2.3E-03
NP239	2.355 Days	0.016	1.7E-03
AM243	7.38 kY	0.016	1.7E-03
PU242	386.9 kY	0.0046	4.9E-04
PA233	27 Days	3.1E-05	3.3E-06
NP237	2.14 MY	3.1E-05	3.3E-06
U234	244.5 kY	2.9E-05	3.0E-06
U236	23.41 MY	9.1E-06	9.7E-07
CM245	8.499 kY	8.0E-06	8.5E-07
PU236	2.851 Years	3.8E-06	4.0E-07
CM244	18.11 Years	3.8E-06	4.0E-07
U232	72 Years	1.5E-06	1.5E-07
RA224	3.66 Days	1.3E-06	1.4E-07
RN220	55.6 Sec.	1.3E-06	1.4E-07
PO216	0.15 Sec.	1.3E-06	1.4E-07
BI212	1.009 Hours	1.3E-06	1.4E-07
PB212	10.64 Hours	1.3E-06	1.4E-07
TH228	1.913 Years	1.3E-06	1.4E-07
PO212	3E-07 Sec.	8.2E-07	8.7E-08
TL208	3.07 Min.	4.6E-07	4.9E-08
CM246	4.731 kY	3.1E-07	3.3E-08
U235	703.8 MY	2.7E-07	2.9E-08
TH231	1.063 Days	2.7E-07	2.9E-08
PU244	82.61 MY	5.1E-08	5.4E-09
U240	14.1 Hours	5.1E-08	5.4E-09
NP240m	7.4 Min.	5.1E-08	5.4E-09
AM242m	152 Years	2.4E-09	2.6E-10
AM242	16.02 Hours	2.4E-09	2.6E-10
CM242	163.2 Days	2.0E-09	2.1E-10
TH230	77 kY	1.3E-09	1.4E-10
U233	158.5 kY	4.9E-10	5.2E-11
PA231	32.77 kY	2.9E-11	3.1E-12
NP238	2.117 Days	1.2E-11	1.3E-12
TH234	24.1 Days	7.1E-12	7.6E-13
PA234m	1.17 Min.	7.1E-12	7.6E-13
U238	4.468 GY	7.1E-12	7.6E-13
RN219	3.96 Sec.	2.8E-12	3.0E-13
PB211	36.1 Min.	2.8E-12	3.0E-13
BI211	2.13 Min.	2.8E-12	3.0E-13
PO215	0.002 Sec.	2.8E-12	3.0E-13
RA223	11.43 Days	2.8E-12	3.0E-13
AC227	21.77 Years	2.8E-12	3.0E-13
TL207	4.77 Min.	2.8E-12	3.0E-13
TH227	18.72 Days	2.8E-12	3.0E-13
RN222	3.824 Days	1.9E-12	2.0E-13
PO218	3.05 Min.	1.9E-12	2.0E-13
RA226	1.6 kY	1.9E-12	2.0E-13
PO214	2E-04 Sec.	1.9E-12	2.0E-13
BI214	19.9 Min.	1.9E-12	2.0E-13
PB214	26.8 Min.	1.9E-12	2.0E-13
PB210	22.3 Years	1.4E-13	1.5E-14
PO210	138.4 Days	1.4E-13	1.5E-14
BI210	5.012 Days	1.4E-13	1.5E-14
PB209	3.3 Hours	1.3E-13	1.4E-14
RA225	14.8 Days	1.3E-13	1.4E-14
BI213	45.65 Min.	1.3E-13	1.4E-14
AT217	0.032 Sec.	1.3E-13	1.4E-14
AC225	10 Days	1.3E-13	1.4E-14
FR221	4.8 Min.	1.3E-13	1.4E-14
TH229	7.339 kY	1.3E-13	1.4E-14
PO213	4E-06 Sec.	1.3E-13	1.4E-14
FR223	21.8 Min.	3.9E-14	4.2E-15
CM243	28.5 Years	9.8E-15	1.0E-15
PA234	6.7 Hours	9.3E-15	9.8E-16
PO211	0.56 Sec.	8.0E-15	8.4E-16

Table 14-B. Decay Time = 30 Years

Isotope	Half-Life	Curies	Per Cent
PU241	14.4 Years	331.3	77.9
AM241	432.2 Years	34.7	8.16
PU240	6.537 kY	30.7	7.23
PU239	24.06 kY	27.8	6.53
PU238	87.74 Years	0.83	0.20
NP239	2.355 Days	0.016	3.8E-03
AM243	7.38 kY	0.016	3.8E-03
U237	6.75 Days	0.0081	1.9E-03
PU242	386.9 kY	0.0046	1.1E-03
NP237	2.14 MY	0.00021	4.9E-05
PA233	27 Days	0.00021	4.9E-05
U234	244.5 kY	8.0E-05	1.9E-05
U236	23.41 MY	2.7E-05	6.4E-06
CM245	8.499 kY	8.0E-06	1.9E-06
CM244	18.11 Years	1.8E-06	4.1E-07
TH228	1.913 Years	1.4E-06	3.2E-07
RN220	55.6 Sec.	1.4E-06	3.2E-07
RA224	3.66 Days	1.4E-06	3.2E-07
PO216	0.15 Sec.	1.4E-06	3.2E-07
BI212	1.009 Hours	1.4E-06	3.2E-07
PB212	10.64 Hours	1.4E-06	3.2E-07
U232	72 Years	1.3E-06	3.1E-07
PO212	3E-07 Sec.	8.8E-07	2.1E-07
U235	703.8 MY	8.2E-07	1.9E-07
TH231	1.063 Days	8.2E-07	1.9E-07
TL208	3.07 Min.	4.9E-07	1.2E-07
CM246	4.731 kY	3.1E-07	7.3E-08
PU244	82.61 MY	5.1E-08	1.2E-08
NP240m	7.4 Min.	5.1E-08	1.2E-08
U240	14.1 Hours	5.1E-08	1.2E-08
PU236	2.851 Years	2.9E-08	6.9E-09
TH230	77 kY	1.1E-08	2.6E-09
U233	158.5 kY	1.0E-08	2.4E-09
AM242m	152 Years	2.2E-09	5.2E-10
AM242	16.02 Hours	2.2E-09	5.2E-10
CM242	163.2 Days	1.8E-09	4.3E-10
PA231	32.77 kY	2.6E-10	6.1E-11
RA223	11.43 Days	6.6E-11	1.6E-11
PB211	36.1 Min.	6.6E-11	1.6E-11
PO215	0.002 Sec.	6.6E-11	1.6E-11
BI211	2.13 Min.	6.6E-11	1.6E-11
RN219	3.96 Sec.	6.6E-11	1.6E-11
AC227	21.77 Years	6.6E-11	1.6E-11
TL207	4.77 Min.	6.6E-11	1.6E-11
TH227	18.72 Days	6.6E-11	1.5E-11
PO218	3.05 Min.	4.9E-11	1.2E-11
RA226	1.6 kY	4.9E-11	1.2E-11
RN222	3.824 Days	4.9E-11	1.2E-11
BI214	19.9 Min.	4.9E-11	1.2E-11
PB214	26.8 Min.	4.9E-11	1.2E-11
PO214	2E-04 Sec.	4.9E-11	1.2E-11
U238	4.468 GY	2.1E-11	5.0E-12
TH234	24.1 Days	2.1E-11	5.0E-12
PA234m	1.17 Min.	2.1E-11	5.0E-12
NP238	2.117 Days	1.1E-11	2.6E-12
BI210	5.012 Days	9.7E-12	2.3E-12
PB210	22.3 Years	9.7E-12	2.3E-12
PO210	138.4 Days	9.7E-12	2.3E-12
TH229	7.339 kY	7.8E-12	1.8E-12
AT217	0.032 Sec.	7.8E-12	1.8E-12
BI213	45.65 Min.	7.8E-12	1.8E-12
FR221	4.8 Min.	7.8E-12	1.8E-12
AC225	10 Days	7.8E-12	1.8E-12
PB209	3.3 Hours	7.8E-12	1.8E-12
RA225	14.8 Days	7.8E-12	1.8E-12
PO213	4E-06 Sec.	7.6E-12	1.8E-12
FR223	21.8 Min.	9.2E-13	2.2E-13
PO211	0.56 Sec.	1.9E-13	4.4E-14
TL209	2.2 Min.	1.7E-13	4.0E-14
PA234	6.7 Hours	2.8E-14	6.5E-15

Table 3.2. (contd)

Table 14-C. Decay Time = 40 Years

Isotope	Half-Life	Curies	Per Cent
PU241	14.4 Years	204.7	67.7
AM241	432.2 Years	38.3	12.7
PU240	6.537 kY	30.7	10.2
PU239	24.06 kY	27.8	9.19
PU238	87.74 Years	0.77	0.25
AM243	7.38 kY	0.016	5.4E-03
NP239	2.355 Days	0.016	5.4E-03
U237	6.75 Days	0.0050	1.7E-03
PU242	386.9 KY	0.0046	1.5E-03
NP237	2.14 MY	0.00033	1.1E-04
PA233	27 Days	0.00033	1.1E-04
U234	244.5 KY	0.00010	3.4E-05
U236	23.41 MY	3.6E-05	1.2E-05
CM245	8.499 KY	8.0E-06	2.7E-06
BI212	1.009 Hours	1.2E-06	4.1E-07
PB212	10.64 Hours	1.2E-06	4.1E-07
PO216	0.15 Sec.	1.2E-06	4.1E-07
RA224	3.66 Days	1.2E-06	4.1E-07
RN220	55.6 Sec.	1.2E-06	4.1E-07
TH228	1,913 Years	1.2E-06	4.1E-07
U232	72 Years	1.2E-06	4.0E-07
CM244	18.11 Years	1.2E-06	4.0E-07
U235	703.8 MY	1.1E-06	3.6E-07
TH231	1.063 Days	1.1E-06	3.6E-07
PO212	3E-07 Sec.	8.0E-07	2.6E-07
TL208	3.07 Min.	4.5E-07	1.5E-07
CM246	4.731 KY	3.1E-07	1.0E-07
PU244	82.61 MY	5.1E-08	1.7E-08
U240	14.1 Hours	5.1E-08	1.7E-08
NP240m	7.4 Min.	5.1E-08	1.7E-08
U233	158.5 kY	2.2E-08	7.3E-09
TH230	77 KY	1.9E-08	6.4E-09
PU236	2.851 Years	2.6E-09	8.6E-10
AM242m	152 Years	2.1E-09	7.0E-10
AM242	16.02 Hours	2.1E-09	7.0E-10
CM242	163.2 Days	1.8E-09	5.8E-10
PA231	32.77 KY	4.6E-10	1.5E-10
BI211	2.13 Min.	1.5E-10	4.9E-11
PB211	36.1 Min.	1.5E-10	4.9E-11
PO215	0.002 Sec.	1.5E-10	4.9E-11
RA223	11.43 Days	1.5E-10	4.9E-11
RN219	3.96 Sec.	1.5E-10	4.9E-11
AC227	21.77 Years	1.5E-10	4.9E-11
TL207	4.77 Min.	1.5E-10	4.9E-11
TH227	18.72 Days	1.5E-10	4.8E-11
BI214	19.9 Min.	1.1E-10	3.8E-11
PB214	26.8 Min.	1.1E-10	3.8E-11
PO214	2E-04 Sec.	1.1E-10	3.8E-11
PO218	3.05 Min.	1.1E-10	3.8E-11
RA226	1.6 kY	1.1E-10	3.8E-11
RN222	3.824 Days	1.1E-10	3.8E-11
BI210	5.012 Days	2.9E-11	9.5E-12
PB210	22.3 Years	2.9E-11	9.5E-12
PO210	138.4 Days	2.9E-11	9.5E-12
U238	4.468 GY	2.9E-11	9.5E-12
PA234m	1.17 Min.	2.9E-11	9.5E-12
TH234	24.1 Days	2.9E-11	9.5E-12
AC225	10 Days	2.3E-11	7.5E-12
AT217	0.032 Sec.	2.3E-11	7.5E-12
BI213	45.65 Min.	2.3E-11	7.5E-12
FR221	4.8 Min.	2.3E-11	7.5E-12
PB209	3.3 Hours	2.3E-11	7.5E-12
RA225	14.8 Days	2.3E-11	7.5E-12
TH229	7.339 KY	2.3E-11	7.5E-12
PO213	4E-06 Sec.	2.2E-11	7.3E-12
NP238	2.117 Days	1.1E-11	3.5E-12
FR223	21.8 Min.	2.0E-12	6.7E-13
TL209	2.2 Min.	4.9E-13	1.6E-13
PO211	0.56 Sec.	4.1E-13	1.4E-13
PA234	6.7 Hours	3.7E-14	1.2E-14

4.0 Recommendations

The tables in this document which present the relative hazard of each radionuclide as a function of time after irradiation can be used as a guide in selecting those radionuclides which may be of concern at the time when site remediation is complete and after longer periods of time. Based on the relative amounts of each radionuclide present after years of decay and factoring in their DCG values to estimate their relative hazard, it is suggested that the radionuclides listed in Table 4.1 be included in preremediation and subsequent site surveys. The basis for this recommendation is that, in most cases, their relative abundance at 40 years after irradiation, together with their relative hazard based on their DCG values, would warrant this.

The radionuclide Sm-151 (90 yr) has not been included in the list of radionuclides for preremediation and subsequent site surveys. Sm-151 would be very difficult and expensive to measure, and since it should follow the environmental chemistry of the rare earth Eu-154 (8.6 yr) which can be measured with comparative ease, its possible presence and amount could be estimated from measurements of Eu-154. Also, the importance of the radionuclide Cd-113m (14.59 yr) is questionable and therefore not included.

Other radionuclides which may not have a particularly high relative hazard have been added. These include I-129 and Tc-99 since they will be the principal radionuclides after very long decay periods, and they form anions which are relatively mobile in groundwater. There are several other very long-lived radionuclides which could be of concern. However, their concentrations and their potential hazard are likely to be extremely low in environmental matrices and therefore it does not seem justifiable to include them in either preremediation or subsequent surveys.

Certain natural radionuclides are included since they are easily measurable and may constitute a substantial portion of the radiation exposure. These include K-40, Ra-226, and Th-232. The radionuclides Ru-106 and Sb-125 should be included since they do form anions which are readily transported in groundwater and thus provide an indication of the transport of other radionuclides. However, their short half-lives will ensure essentially no contribution to human exposure after decay periods of 40 years or longer.

Tritium is also included in Table 4.1 since it exists as tritiated water (HTO) and is thus a precursor of all the radionuclides which are transported in subsurface water.

The selection of radionuclides in Table 4.1 which could be measured in preremediation and subsequent site surveys should only be regarded as a suggestion. The addition or deletion of radionuclides from this list could be made where specific information on concentrations and fractionation processes would warrant it.

Important information which was employed in the various calculations and considerations that went into the preparation of this document are included in Tables A.1, B.1, B.2, and B.3. Table A.1 summarizes the concentrations of major and minor elements in the fuel cladding, as well as the uranium isotopic composition of the single pass and N reactor fuels. Table B.1 provides a listing of the Hanford

Table 4.1. Suggested Radionuclides to be Included in Surveys Relative to Site Remediation

<u>Radionuclide</u>	<u>Half-Life, Years</u>
H-3*	12.35
K-40	1.28×10^9
Co-60	5.270
Sr-90	29.12
Tc-99	2.13×10^5
Ru-106	1.008
Sb-125	2.77
I-129	1.57×10^7
Cs-134	2.062
Cs-137	30
Eu-152	13.6
Eu-154	8.6
Eu-155	4.96
Ra-226	1600
Th-232	1.4×10^{10}
U-232	72
U-233	1.59×10^5
U-234	2.45×10^5
U-235	7.038×10^8
Np-237	2.14×10^6
Pu-238	87.74
U-238	4.468×10^9
Pu-239	2.406×10^4
Pu-240	6537
Am-241	432.2
Pu-241	14.4
Cm-244	18.11

* Tritium should probably be included in ground water measurements since it is an excellent indicator and precursor of other radioactive wastes.

Default Inhalation classes which were used in determining DCG values for Hanford (see Appendix B). Table B.2 summarizes the selected DCG values for Hanford which were used in calculating all of the relative hazards of the radionuclides after specific decay periods. Table B.3 provides the dose conversion factors for external exposure to radionuclides assuming they were deposited on the surface of Hanford soils.

5.0 References

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4. Napier, B. A., R. A. Peloquin, D. L. Streng, and J. V. Ramsdell. 1988. *GENII - The Hanford Environmental Radiation Dosimetry Software System*. Vol. 1: *Conceptual Representation*; Vol. 2: *Users' Manual*; Vol. 3: *Code Maintenance Manual*, PNL-6584, Vol. 1, 2, and 3, Pacific Northwest Laboratory, Richland, Washington.
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6. Heeb, C. M. 1991. *Uncertainties in Source Term Calculations Generated by the ORIGEN2 Computer Code for Hanford Production Reactors*; PNL-7223 HEDR, Pacific Northwest Laboratory, Richland, Washington.
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8. Bergsman, K. K. 1993. *Hanford Irradiated Fuel Inventory Baseline*, WHC-SD-CP-TI-175 Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Appendix A

Basis for ORIGEN2 Calculation

Appendix A

Basis for ORIGEN2 Calculation

ORIGEN2 calculations were made for single-pass reactor irradiations and for N-Reactor irradiations to determine radionuclide concentrations in spent fuel and cladding. Impurities in the fuel and the cladding were included in the model. The quantities are based on data of Bergsman^(a) and are given Table A.1. The brazing was also included in the model. It was assumed that the single-pass reactor fuel was all natural uranium as opposed to the actual situation where 25% of it was slightly enriched uranium. The average burnup of the single-pass reactor fuel was 728 MWD/MTU. It was also assumed that all of the N-Reactor fuel was enriched to 0.947% U-235 when, in fact, some of it was higher enrichment. The average burnup of the N-Reactor fuel was 1045 MWD/MTU. The power density was assumed to be 10 MW/MTU for all of the fuel. For long decay times, the radionuclide concentrations are insensitive to the power density. About 90% of the fuel reprocessed at Hanford was irradiated in the single-pass reactors.

(a) Bergsman, K. K. 1993. *Hanford Irradiated Fuel Inventory Baseline*, WHC-SD-CP-TI-175 Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Table A.1. Composition of Hanford Reactor Fuel and Cladding

N-Reactor Fuel		Single Pass Reactor Fuel	
Isotope	g/KgU	Isotope	g/KgU
U-234	0.077	U-234	0.055
U-235	9.47	U-235	7.11
U-238	990.45	U-238	992.84

N-Reactor Fuel Impurities		Single Pass Reactor Fuel Impurities	
Element	g/KgU	Element	g/KgU
Al	0.900	C	0.750
Be	0.010	Cr	0.065
B	0.00025	Fe	0.150
Cd	0.00025	Mg	0.025
C	0.735	Mn	0.025
Cr	0.065	Ni	0.100
Cu	0.075	N	0.100
H	0.002	Si	0.075
Fe	0.400		
Mg	0.025		
Mn	0.025		
Ni	0.100		
N	0.075		
Si	0.124		
Zr	0.065		

N-Reactor Cladding		Single Pass Reactor Cladding	
Element	g/KgZr	Element	g/KgAl
Al	0.075	B	0.010
Be	0.390	Cd	0.030
B	0.0005	Co	0.010
Cd	0.0005	Cu	1.50
C	0.275	Fe	7.0
Cr	1.5	Li	0.080
Co	0.010	Ni	13.0
Cu	0.050	Si	18.1
Hf	0.200	Al	960.3
H	0.025		
Fe	2.0		
Pb	0.100		
Mg	0.020		
Mn	0.050		
Mo	0.050		
Ni	0.8		
N	0.080		
Ox	0.018		
Si	0.100		
Na	0.020		
Sn	17.0		
Ti	0.050		
W	0.050		
V	0.050		
Zr	977.1		

Appendix B

Selection of the Derived Concentration Guide (DCG) Values

Appendix B

Selection of the Derived Concentration Guide (DCG) Values

The Derived Concentration Guide (DCG) values are given in 10 CFR 834^(a) for two exposure modes: 1) inhalation of air and 2) ingestion of water. DCG values for air are given for inhalation classes, D, W, and Y which indicate retention half-times of days, weeks, and years. Some isotopes have values for two or even three classes, depending on the application. The Hanford default inhalation classes are given by Napier et al.^(b) and are listed in Table B.1. Using the Hanford default inhalation classes, the appropriate DCG values were extracted from 10 CFR 834. The values are given in Table B.2 and were put onto the ORIGEN2 Decay Library. Table 18 contains a number of isotopes which do not appear in an ORIGEN2 calculation, thus the number of isotopes on the ORIGEN2 Decay Library with DCG values is significantly less than the number in Table 18. Short-lived isotopes do not have a DCG value; however, the DCG value of a long-lived parent includes the effect of the short-lived daughter.

(a) 10 CFR 834. *Radiation Protection of the Public and the Environment - Derived Concentration Guides for Air and Water*; March 25, 1993. Federal Register Vol. 58, No. 56 Proposed Rules, pp. 16268-16322.

(b) Napier, B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell. 1988. *GENII - The Hanford Environmental Radiation Dosimetry Software System*. Vol. 1: *Conceptual Representation*; Vol. 2: *Users' Manual*; Vol. 3: *Code Maintenance Manual*, PNL-6584, Vol. 1, 2, and 3, Pacific Northwest Laboratory, Richland, Washington.

Table B.1. Hanford Default Inhalation Classes

<u>Element</u>	<u>Class*</u>	<u>Element</u>	<u>Class*</u>
H	D	SB	W
BE	Y	TE	W
C	D	I	D
N	D	XE	D
F	D	CS	D
NA	D	BA	D
SI	W	LA	D
P	D	CE	Y
S	W	PR	Y
CL	D	ND	Y
K	D	PM	Y
AR	D	SM	W
CA	W	EU	W
SC	Y	GD	D
CR	Y	TB	W
MN	W	DY	W
FE	W	HO	W
CO	Y	ER	W
NI	W	TA	Y
CU	D	W	D
ZN	Y	RE	W
GA	W	OS	D
AS	W	IR	Y
SE	W	HG	D
BR	D	TH	Y
KR	D	RA	W
SR	D	RN	D
RB	D	PB	D
Y	Y	BI	W
MO	D	PO	W
ZR	W	PU	Y
NB	Y	U	Y
TC	W	TH	Y
RU	Y	AC	Y
PD	Y	PA	Y
RH	Y	FR	D
AG	D	NP	W
CD	D	AM	Y
IN	D	CM	W
SN	W	CF	W

* D, W, and Y are lung retention classes with removal half-times of 0.5, 50, and 500 days, respectively.

Table B.2. Derived Concentration Guide Values

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
H-3	1E-07	2E-03	Co-55	6E-09	3E-05
Be-7	4E-08	1E-03	Co-56	5E-10	1E-05
Be-10	3E-11	3E-05	Co-57	2E-09	2E-04
C-11	1E-06	1E-02	Co-58m	2E-07	2E-03
C-14	6E-09	7E-05	Co-58	2E-09	4E-05
F-18	2E-07	1E-03	Co-60m	6E-06	4E-02
Na-22	2E-09	1E-05	Co-60	8E-11	5E-06
Na-24	1E-08	1E-04	Co-61	1E-07	5E-04
Mg-28	3E-09	2E-05	Co-62m	4E-07	1E-03
Al-26	1E-10	1E-05	Ni-56	3E-09	4E-05
Si-31	7E-08	3E-04	Ni-57	7E-09	4E-05
Si-32	3E-10	8E-05	Ni-59	2E-08	7E-04
P-32	2E-09	2E-05	Ni-63	6E-09	3E-04
P-33	2E-08	2E-04	Ni-65	7E-08	2E-04
S-35	5E-09	2E-04	Ni-66	2E-09	1E-05
Cl-36	6E-09	5E-05	Cu-60	2E-07	8E-04
Cl-38	1E-07	7E-04	Cu-61	7E-08	3E-04
Cl-39	1E-07	1E-03	Cu-64	7E-08	3E-04
K-40	9E-10	7E-06	Cu-67	2E-08	1E-04
K-42	1E-08	1E-04	Zn-62	7E-09	4E-05
K-43	2E-08	2E-04	Zn-63	2E-07	7E-04
K-44	2E-07	9E-04	Zn-65	6E-10	9E-06
K-45	3E-07	2E-03	Zn-69m	2E-08	1E-04
Ca-41	9E-09	1E-04	Zn-69	3E-07	2E-03
Ca-45	2E-09	5E-05	Zn-71m	4E-08	2E-04
Ca-47	2E-09	2E-05	Zn-72	3E-09	3E-05
Sc-43	5E-08	2E-04	Ga-65	5E-07	2E-03
Sc-44m	2E-09	1E-05	Ga-66	7E-09	3E-05
Sc-44	3E-08	1E-04	Ga-67	3E-08	2E-04
Sc-46	6E-10	2E-05	Ga-68	1E-07	4E-04
Sc-47	7E-09	7E-05	Ga-70	5E-07	2E-03
Sc-48	3E-09	2E-05	Ga-72	7E-09	3E-05
Sc-49	1E-07	6E-04	Ga-73	4E-08	1E-04
Ti-44	1E-11	7E-06	Ge-66	5E-08	7E-04
Ti-45	6E-08	2E-04	Ge-67	2E-07	1E-03
V-47	2E-07	9E-04	Ge-68	2E-10	1E-04
V-48	2E-09	2E-05	Ge-69	2E-08	4E-04
V-49	4E-08	2E-03	Ge-71	1E-07	1E-02
Cr-48	2E-08	2E-04	Ge-75	2E-07	2E-03
Cr-49	2E-07	8E-04	Ge-77	1E-08	2E-04
Cr-51	5E-08	1E-03	Ge-78	5E-08	7E-04
Mn-51	1E-07	5E-04	As-69	3E-07	1E-03
Mn-52m	2E-07	9E-04	As-70	1E-07	4E-04
Mn-52	2E-09	2E-05	As-71	1E-08	1E-04
Mn-53	3E-08	1E-03	As-72	3E-09	2E-05
Mn-54	2E-09	5E-05	As-73	4E-09	2E-04
Mn-56	5E-08	1E-04	As-74	2E-09	4E-05
Fe-52	6E-09	3E-05	As-76	4E-09	3E-05
Fe-55	1E-08	2E-04	As-77	1E-08	1E-04
Fe-59	1E-09	2E-05	As-78	5E-08	2E-04
Fe-60	4E-11	9E-07			

Table B.2. (contd)

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
Se-70	1E-07	3E-04	Zr-86	6E-09	4E-05
Se-73m	3E-07	9E-04	Zr-88	1E-09	1E-04
Se-73	4E-08	9E-05	Zr-89	6E-09	4E-05
Se-75	1E-09	2E-05	Zr-93	1E-10	9E-05
Se-79	1E-09	2E-05	Zr-95	9E-10	4E-05
Se-81m	2E-07	7E-04	Zr-97	3E-09	2E-05
Se-81	6E-07	2E-03	Nb-88	5E-07	2E-03
Se-83	3E-07	9E-04	Nb-89	9E-08	3E-04
Br-74m	9E-08	6E-04	Nb-89m	4E-08	1E-04
Br-74	2E-07	1E-03	Nb-90	6E-09	3E-05
Br-75	1E-07	1E-03	Nb-93m	4E-09	5E-03
Br-76	1E-08	1E-04	Nb-94	4E-11	3E-05
Br-77	6E-08	4E-04	Nb-95m	5E-09	7E-05
Br-80m	4E-08	6E-04	Nb-95	3E-09	6E-05
Br-80	4E-07	2E-03	Nb-96	6E-09	3E-05
Br-82	1E-08	8E-05	Nb-97	2E-07	6E-04
Br-83	2E-07	2E-03	Nb-98	1E-07	4E-04
Br-84	1E-07	9E-04	Mo-90	2E-08	1E-04
Rb-79	3E-07	2E-03	Mo-93m	4E-08	3E-04
Rb-81m	8E-07	7E-03	Mo-93	1E-08	1E-04
Rb-81	1E-07	1E-03	Mo-99	6E-09	5E-05
Rb-82m	4E-08	3E-04	Mo-101	3E-07	2E-03
Rb-83	2E-09	2E-05	Tc-93m	7E-07	2E-03
Rb-84	2E-09	1E-05	Tc-93	2E-07	9E-04
Rb-86	2E-09	1E-05	Tc-94m	1E-07	5E-04
Rb-87	4E-09	3E-05	Tc-94	6E-08	2E-04
Rb-88	2E-07	8E-04	Tc-95m	5E-09	1E-04
Rb-89	3E-07	2E-03	Tc-95	5E-08	3E-04
Sr-80	3E-08	1E-04	Tc-96m	6E-07	4E-03
Sr-81	2E-07	7E-04	Tc-96	5E-09	5E-05
Sr-82	7E-10	7E-06	Tc-97m	3E-09	1E-04
Sr-83	2E-08	8E-05	Tc-97	1E-08	9E-04
Sr-85m	2E-06	6E-03	Tc-98	7E-10	3E-05
Sr-85	6E-09	7E-05	Tc-99m	6E-07	2E-03
Sr-87m	3E-07	1E-03	Tc-99	2E-09	1E-04
Sr-89	2E-09	2E-05	Tc-101	9E-07	4E-03
Sr-90	5E-11	1E-06	Tc-104	2E-07	8E-04
Sr-91	1E-08	6E-05	Ru-94	1E-07	4E-04
Sr-92	2E-08	9E-05	Ru-97	3E-08	2E-04
Y-86m	1E-07	6E-04	Ru-103	2E-09	5E-05
Y-86	7E-09	3E-05	Ru-105	3E-08	1E-04
Y-87	7E-09	6E-05	Ru-106	3E-11	6E-06
Y-88	6E-10	3E-05	Rh-99m	2E-07	5E-04
Y-90m	3E-08	2E-04	Rh-99	5E-09	7E-05
Y-90	1E-09	1E-05	Rh-100	9E-09	5E-05
Y-91m	4E-07	4E-03	Rh-101m	2E-08	2E-04
Y-91	3E-10	1E-05	Rh-101	4E-10	6E-05
Y-92	2E-08	7E-05	Rh-102m	3E-10	4E-05
Y-93	6E-09	3E-05	Rh-102	1E-10	2E-05
Y-94	2E-07	8E-04	Rh-103m	3E-06	1E-02
Y-95	3E-07	1E-03	Rh-105	1E-08	1E-04
			Rh-106m	8E-08	2E-04
			Rh-107	6E-07	2E-03

Table B.2. (contd)

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
Pd-100	4E-09	4E-05	Sb-115	7E-07	2E-03
Pd-101	7E-08	4E-04	Sb-116m	3E-07	6E-04
Pd-103	8E-09	2E-04	Sb-116	8E-07	2E-03
Pd-107	9E-10	1E-03	Sb-117	7E-07	2E-03
Pd-109	1E-08	6E-05	Sb-118m	5E-08	2E-04
Ag-102	4E-07	2E-03	Sb-119	6E-08	4E-04
Ag-103	2E-07	1E-03	Sb-120	1E-06	5E-03
Ag-104m	2E-07	9E-04	Sb-120m	3E-09	2E-05
Ag-104	2E-07	6E-04	Sb-122	2E-09	2E-05
Ag-105	2E-09	7E-05	Sb-124m	1E-06	7E-03
Ag-106m	2E-09	2E-05	Sb-124	6E-10	1E-05
Ag-106	4E-07	2E-03	Sb-125	1E-09	5E-05
Ag-108m	4E-10	2E-05	Sb-126m	5E-07	2E-03
Ag-110m	3E-10	1E-05	Sb-126	1E-09	1E-05
Ag-111	4E-09	3E-05	Sb-127	2E-09	2E-05
Ag-112	2E-08	9E-05	Sb-128	8E-09	3E-05
Ag-115	2E-07	9E-04	Sb-128m	1E-06	3E-03
Cd-104	2E-07	6E-04	Sb-129	2E-08	8E-05
Cd-107	1E-07	6E-04	Sb-130	2E-07	5E-04
Cd-109	1E-10	1E-05	Sb-131	1E-07	5E-04
Cd-113m	8E-12	9E-07	Te-116	7E-08	2E-04
Cd-113	8E-12	8E-07	Te-121m	1E-09	2E-05
Cd-115m	2E-10	9E-06	Te-121	7E-09	9E-05
Cd-115	3E-09	3E-05	Te-123m	1E-09	3E-05
Cd-117m	3E-08	1E-04	Te-123	3E-09	3E-05
Cd-117	3E-08	1E-04	Te-125m	2E-09	4E-05
In-109	1E-07	5E-04	Te-127m	6E-10	2E-05
In-110	1E-07	4E-04	Te-127	4E-08	2E-04
In-110m	4E-08	1E-04	Te-129m	6E-10	1E-05
In-111	1E-08	1E-04	Te-129	2E-07	7E-04
In-112	2E-06	6E-03	Te-131m	2E-09	2E-05
In-113m	3E-07	1E-03	Te-131	3E-08	2E-04
In-114m	1E-10	9E-06	Te-132	2E-09	2E-05
In-115m	1E-07	4E-04	Te-133m	3E-08	2E-04
In-115	3E-12	1E-06	Te-133	1E-07	9E-04
In-116m	2E-07	7E-04	Te-134	1E-07	7E-04
In-117m	8E-08	3E-04	I-120m	5E-08	3E-04
In-117	4E-07	2E-03	I-120	3E-08	2E-04
In-119m	3E-07	1E-03	I-121	1E-07	8E-04
Sn-110	3E-08	9E-05	I-123	4E-08	3E-04
Sn-111	6E-07	2E-03	I-124	6E-10	4E-06
Sn-113	1E-09	5E-05	I-125	5E-10	4E-06
Sn-117m	3E-09	5E-05	I-126	3E-10	2E-06
Sn-119m	2E-09	1E-04	I-128	3E-07	2E-03
Sn-121m	1E-09	1E-04	I-129	7E-11	5E-07
Sn-121	3E-08	2E-04	I-130	5E-09	3E-05
Sn-123m	3E-07	1E-03	I-131	4E-10	3E-06
Sn-123	4E-10	2E-05	I-132m	5E-08	3E-04
Sn-125	8E-10	1E-05	I-132	4E-08	2E-04
Sn-126	2E-10	8E-06	I-133	2E-09	1E-05
Sn-127	4E-08	2E-04	I-134	1E-07	7E-04
Sn-128	9E-08	3E-04	I-135	1E-08	7E-05

Table B.2. (contd)

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
Cs-125	3E-07	2E-03	Nd-136	1E-07	4E-04
Cs-127	2E-07	2E-03	Nd-138	1E-08	5E-05
Cs-129	8E-08	6E-04	Nd-139m	3E-08	1E-04
Cs-130	4E-07	3E-03	Nd-139	7E-07	2E-03
Cs-131	7E-08	6E-04	Nd-141	1E-06	4E-03
Cs-132	9E-09	7E-05	Nd-147	2E-09	4E-05
Cs-134m	3E-07	3E-03	Nd-149	6E-08	3E-04
Cs-134	2E-10	2E-06	Nd-151	4E-07	2E-03
Cs-135m	5E-07	3E-03	Pm-141	4E-07	2E-03
Cs-135	3E-09	2E-05	Pm-143	2E-09	1E-04
Cs-136	2E-09	1E-05	Pm-144	3E-10	4E-05
Cs-137	4E-10	3E-06	Pm-145	4E-10	3E-04
Cs-138	1E-07	9E-04	Pm-146	1E-10	4E-05
Ba-126	4E-08	2E-04	Pm-147	4E-10	1E-04
Ba-128	4E-09	1E-05	Pm-148m	7E-10	2E-05
Ba-131m	3E-06	1E-02	Pm-148	1E-09	1E-05
Ba-131	2E-08	8E-05	Pm-149	4E-09	4E-05
Ba-133m	2E-08	7E-05	Pm-150	4E-08	1E-04
Ba-133	2E-09	4E-05	Pm-151	7E-09	5E-05
Ba-135m	3E-08	9E-05	Sm-141m	2E-07	8E-04
Ba-139	7E-08	3E-04	Sm-141	4E-07	2E-03
Ba-140	3E-09	2E-05	Sm-142	6E-08	2E-04
Ba-141	2E-07	7E-04	Sm-145	1E-09	2E-04
Ba-142	3E-07	1E-03	Sm-146	1E-13	7E-07
La-131	3E-07	1E-03	Sm-147	2E-13	8E-07
La-132	2E-08	9E-05	Sm-151	4E-10	4E-04
La-135	2E-07	1E-03	Sm-153	7E-09	5E-05
La-137	2E-10	3E-04	Sm-155	5E-07	2E-03
La-138	8E-12	2E-05	Sm-156	2E-08	1E-04
La-140	4E-09	2E-05	Eu-145	5E-09	4E-05
La-141	2E-08	1E-04	Eu-146	3E-09	3E-05
La-142	5E-08	2E-04	Eu-147	4E-09	8E-05
La-143	2E-07	1E-03	Eu-148	8E-10	3E-05
Ce-134	2E-09	1E-05	Eu-149	7E-09	3E-04
Ce-135	8E-09	4E-05	Eu-150	2E-08	9E-05
Ce-137m	9E-09	7E-05	Eu-150m	4E-11	2E-05
Ce-137	3E-07	1E-03	Eu-152m	2E-08	7E-05
Ce-139	2E-09	1E-04	Eu-152	6E-11	2E-05
Ce-141	1E-09	5E-05	Eu-154	5E-11	1E-05
Ce-143	4E-09	3E-05	Eu-155	3E-10	1E-04
Ce-144	3E-11	7E-06	Eu-156	1E-09	2E-05
Pr-136	5E-07	2E-03	Eu-157	1E-08	6E-05
Pr-137	3E-07	1E-03	Eu-158	1E-07	5E-04
Pr-138m	1E-07	3E-04	Gd-145	4E-07	1E-03
Pr-139	2E-07	1E-03	Gd-146	3E-10	4E-05
Pr-142m	3E-07	2E-03	Gd-147	1E-08	5E-05
Pr-142	4E-09	3E-05	Gd-148	4E-14	7E-07
Pr-143	2E-09	3E-05	Gd-149	5E-09	8E-05
Pr-144	3E-07	1E-03	Gd-151	2E-09	2E-04
Pr-145	2E-08	9E-05	Gd-152	5E-14	9E-07
Pr-147	4E-07	2E-03	Gd-153	6E-10	1E-04
			Gd-159	2E-08	7E-05

Table B.2. (contd)

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
Tb-147	8E-08	2E-04	Lu-169	1E-08	7E-05
Tb-149	2E-09	1E-04	Lu-170	5E-09	3E-05
Tb-150	5E-08	1E-04	Lu-171	4E-09	5E-05
Tb-151	2E-08	1E-04	Lu-172	3E-09	3E-05
Tb-153	2E-08	1E-04	Lu-173	6E-10	1E-04
Tb-154	1E-08	5E-05	Lu-174m	5E-10	8E-05
Tb-155	2E-08	2E-04	Lu-174	4E-10	1E-04
Tb-156m	2E-08	2E-04	Lu-176m	5E-08	2E-04
Tb-156	3E-09	3E-05	Lu-176	2E-11	2E-05
Tb-157	1E-09	1E-03	Lu-177m	2E-10	2E-05
Tb-158	5E-11	3E-05	Lu-177	5E-09	7E-05
Tb-160	5E-10	2E-05	Lu-178m	4E-07	2E-03
Tb-161	4E-09	5E-05	Lu-178	3E-07	1E-03
Dy-155	6E-08	2E-04	Lu-179	4E-08	2E-04
Dy-157	2E-07	5E-04	Hf-170	1E-08	7E-05
Dy-159	6E-09	3E-04	Hf-172	4E-11	3E-05
Dy-165	1E-07	4E-04	Hf-173	3E-08	1E-04
Dy-166	2E-09	2E-05	Hf-175	2E-09	8E-05
Ho-155	4E-07	1E-03	Hf-177m	1E-07	5E-04
Ho-157	3E-06	7E-03	Hf-178m	6E-12	7E-06
Ho-159	2E-06	6E-03	Hf-179m	1E-09	3E-05
Ho-161	1E-06	3E-03	Hf-180m	5E-08	2E-04
Ho-162m	6E-07	2E-03	Hf-181	9E-10	3E-05
Ho-162	6E-06	2E-02	Hf-182m	2E-07	1E-03
Ho-164m	7E-07	3E-03	Hf-182	4E-12	1E-05
Ho-164	2E-06	6E-03	Hf-183	1E-07	5E-04
Ho-166m	2E-11	2E-05	Hf-184	2E-08	7E-05
Ho-166	4E-09	2E-05	Ta-172	2E-07	1E-03
Ho-167	1E-07	4E-04	Ta-173	4E-08	2E-04
Er-161	2E-07	4E-04	Ta-174	2E-07	7E-04
Er-165	4E-07	2E-03	Ta-175	3E-08	2E-04
Er-169	6E-09	1E-04	Ta-176	3E-08	1E-04
Er-171	2E-08	1E-04	Ta-177	4E-08	3E-04
Er-172	3E-09	4E-05	Ta-178	2E-07	5E-04
Tm-162	7E-07	2E-03	Ta-179	2E-09	6E-04
Tm-166	3E-08	1E-04	Ta-180m	1E-07	6E-04
Tm-167	5E-09	7E-05	Ta-180	6E-11	4E-05
Tm-170	5E-10	3E-05	Ta-182m	1E-06	6E-03
Tm-171	1E-09	3E-04	Ta-182	3E-10	2E-05
Tm-172	3E-09	2E-05	Ta-183	2E-09	3E-05
Tm-173	3E-08	1E-04	Ta-184	1E-08	5E-05
Tm-175	6E-07	2E-03	Ta-185	2E-07	7E-04
Yb-162	7E-07	2E-03	Ta-186	5E-07	2E-03
Yb-166	4E-09	4E-05	W-176	1E-07	3E-04
Yb-167	2E-06	8E-03	W-177	2E-07	6E-04
Yb-169	2E-09	5E-05	W-178	5E-08	2E-04
Yb-175	8E-09	9E-05	W-179	4E-06	1E-02
Yb-177	1E-07	4E-04	W-181	8E-08	4E-04
Yb-178	9E-08	3E-04	W-185	2E-08	7E-05
			W-187	2E-08	5E-05
			W-188	3E-09	1E-05

Table B.2. (contd)

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
Re-177	8E-07	3E-03	Au-198m	3E-09	3E-05
Re-178	7E-07	3E-03	Au-198	4E-09	3E-05
Re-181	2E-08	1E-04	Au-199	9E-09	9E-05
Re-182	5E-09	4E-05	Au-200m	6E-09	3E-05
Re-182m	4E-08	2E-04	Au-200	2E-07	7E-04
Re-184m	1E-09	6E-05	Au-201	5E-07	2E-03
Re-184	3E-09	6E-05	Hg-193m	2E-08	9E-05
Re-186m	4E-10	4E-05	Hg-193	1E-07	4E-04
Re-186	4E-09	5E-05	Hg-194	1E-10	2E-05
Re-187	2E-07	2E-02	Hg-195m	1E-08	6E-05
Re-188m	3E-07	2E-03	Hg-195	8E-08	4E-04
Re-188	7E-09	5E-05	Hg-197m	2E-08	8E-05
Re-189	1E-08	9E-05	Hg-197	3E-08	2E-04
Os-180	9E-07	3E-03	Hg-199m	3E-07	2E-03
Os-181	1E-07	4E-04	Hg-203	3E-09	7E-05
Os-182	1E-08	6E-05	Tl-194m	4E-07	2E-03
Os-185	1E-09	7E-05	Tl-194	1E-06	7E-03
Os-189m	5E-07	2E-03	Tl-195	3E-07	2E-03
Os-191m	7E-08	4E-04	Tl-197	3E-07	2E-03
Os-191	5E-09	7E-05	Tl-198m	1E-07	8E-04
Os-193	1E-08	4E-05	Tl-198	7E-08	5E-04
Os-194	1E-10	1E-05	Tl-199	2E-07	2E-03
Ir-182	3E-07	1E-03	Tl-200	3E-08	2E-04
Ir-184	6E-08	2E-04	Tl-201	5E-08	5E-04
Ir-185	2E-08	1E-04	Tl-202	1E-08	9E-05
Ir-186	1E-08	7E-05	Tl-204	5E-09	4E-05
Ir-187	6E-08	3E-04	Pb-195m	5E-07	2E-03
Ir-188	8E-09	5E-05	Pb-198	2E-07	9E-04
Ir-189	9E-09	2E-04	Pb-199	2E-07	6E-04
Ir-190m	4E-07	5E-03	Pb-200	1E-08	9E-05
Ir-190	2E-09	3E-05	Pb-201	5E-08	2E-04
Ir-192m	4E-11	9E-05	Pb-202m	7E-08	3E-04
Ir-192	5E-10	3E-05	Pb-202	1E-10	4E-06
Ir-194m	2E-10	2E-05	Pb-203	2E-08	1E-04
Ir-194	4E-09	3E-05	Pb-205	3E-09	9E-05
Ir-195m	5E-08	2E-04	Pb-209	1E-07	7E-04
Ir-195	1E-07	4E-04	Pb-210	9E-13	3E-08
Pt-186	9E-08	4E-04	Pb-211	2E-09	3E-04
Pt-188	4E-09	5E-05	Pb-212	8E-11	3E-06
Pt-189	7E-08	3E-04	Pb-214	2E-09	2E-04
Pt-191	2E-08	1E-04	Bi-200	2E-07	8E-04
Pt-193m	1E-08	8E-05	Bi-201	9E-08	3E-04
Pt-193	6E-08	1E-03	Bi-202	2E-07	4E-04
Pt-195m	1E-08	6E-05	Bi-203	1E-08	7E-05
Pt-197m	1E-07	4E-04	Bi-205	3E-09	4E-05
Pt-197	2E-08	9E-05	Bi-206	2E-09	2E-05
Pt-199	3E-07	1E-03	Bi-207	8E-10	3E-05
Pt-200	8E-09	3E-05	Bi-210m	2E-12	2E-06
Au-193	4E-08	3E-04	Bi-210	6E-11	2E-05
Au-194	1E-08	8E-05	Bi-212	7E-10	1E-04
Au-195	1E-09	1E-04	Bi-213	8E-10	2E-04
			Bi-214	2E-09	6E-04

Table B.2. (contd)

Isotope	DCG (Ci/m ³)		Isotope	DCG (Ci/m ³)	
	Air	Water		Air	Water
Po-203	2E-07	7E-04	Np-232	1E-08	4E-03
Po-205	2E-07	6E-04	Np-233	7E-06	2E-02
Po-207	7E-08	2E-04	Np-234	6E-09	6E-05
Po-210	1E-12	8E-08	Np-235	3E-09	7E-04
At-207	5E-09	2E-04	Np-236	1E-13	2E-07
At-211	1E-10	3E-06	Np-236m	2E-10	1E-04
Rn-220	3E-09	3E-09	Np-237	2E-14	3E-08
Rn-222	3E-09	3E-09	Np-238	4E-10	4E-05
Fr-222	1E-09	6E-05	Np-239	5E-09	5E-05
Fr-223	2E-09	2E-05	Np-240	2E-07	6E-04
Ra-223	2E-12	2E-07	Pu-234	4E-10	3E-04
Ra-224	4E-12	4E-07	Pu-235	6E-06	2E-02
Ra-225	2E-12	4E-07	Pu-236	1E-13	5E-06
Ra-226	1E-12	1E-07	Pu-237	7E-09	3E-04
Ra-227	4E-08	6E-04	Pu-238	4E-14	5E-06
Ra-228	3E-12	1E-07	Pu-239	4E-14	4E-06
Ac-224	1E-10	5E-05	Pu-240	4E-14	4E-06
Ac-225	1E-12	1E-06	Pu-241	2E-12	2E-04
Ac-226	1E-11	4E-06	Pu-242	4E-14	5E-06
Ac-227	1E-14	1E-08	Pu-243	9E-08	4E-04
Ac-228	1E-10	6E-05	Pu-244	4E-14	3E-06
Th-226	3E-10	2E-04	Pu-245	1E-08	6E-05
Th-227	7E-13	4E-06	Pu-246	6E-10	1E-05
Th-228	4E-14	4E-07	Am-237	7E-07	2E-03
Th-229	7E-15	4E-08	Am-238	1E-08	1E-03
Th-230	5E-14	3E-07	Am-239	3E-08	1E-04
Th-231	1E-08	1E-04	Am-240	7E-09	6E-05
Th-232	1E-14	5E-08	Am-241	3E-14	4E-08
Th-234	4E-10	1E-05	Am-242m	3E-14	4E-08
Pa-227	2E-10	1E-04	Am-242	2E-10	1E-04
Pa-228	3E-11	3E-05	Am-243	3E-14	4E-08
Pa-230	8E-12	2E-05	Am-244m	2E-08	2E-03
Pa-231	1E-14	1E-08	Am-244	7E-10	7E-05
Pa-232	2E-10	4E-05	Am-245	2E-07	8E-04
Pa-233	1E-09	4E-05	Am-246m	5E-07	2E-03
Pa-234	2E-08	7E-05	Am-246	2E-07	9E-04
U-230	6E-13	1E-06	Cm-238	3E-09	4E-04
U-231	1E-08	1E-04	Cm-240	1E-12	2E-06
U-232	2E-14	2E-06	Cm-241	8E-11	3E-05
U-233	9E-14	5E-06	Cm-242	7E-13	1E-06
U-234	9E-14	6E-06	Cm-243	4E-14	6E-08
U-235	9E-14	5E-06	Cm-244	5E-14	7E-08
U-236	9E-14	6E-06	Cm-245	3E-14	4E-08
U-237	4E-09	5E-05	Cm-246	3E-14	4E-08
U-238	1E-13	6E-06	Cm-247	3E-14	4E-08
U-239	4E-07	2E-03	Cm-248	7E-15	1E-08
U-240	6E-09	3E-05	Cm-249	6E-08	1E-03
			Cm-250	1E-15	2E-09

Table B.2. (contd)

<u>Isotope</u>	<u>DCG (Ci/m³)</u>	
	<u>Air</u>	<u>Water</u>
Bk-245	3E-09	6E-05
Bk-246	7E-09	7E-05
Bk-247	2E-14	3E-08
Bk-249	9E-12	1E-05
Bk-250	2E-09	2E-04
Cf-244	1E-09	8E-04
Cf-246	2E-11	1E-05
Cf-248	3E-13	5E-07
Cf-249	2E-14	3E-08
Cf-250	5E-14	7E-08
Cf-251	2E-14	3E-08
Cf-252	9E-14	1E-07
Cf-253	5E-12	1E-05
Cf-254	5E-14	6E-08
Es-250	3E-09	1E-03
Es-251	3E-09	2E-04
Es-253	3E-12	4E-06
Es-254m	2E-11	9E-06
Es-254	3E-13	5E-07
Fm-252	3E-11	1E-05
Fm-253	2E-11	3E-05
Fm-254	2E-10	8E-05
Fm-255	5E-11	1E-05
Fm-257	5E-13	1E-06

Table B.3. Dose—Rate Factors for Skin for Exposure 1 m Above Contaminated Ground Surface, mrem/yr/ μ Ci/m²

Isotope	Half-Life	Photon	Electron	Total
H 3	12.28 Y	0	0	0
BE 7	53.44 D	6.88	0	6.88
BE 10	1.6E+06 Y	0	15	15
C 11	20.48 M	141	349	490
C 14	5730 Y	0	0	0
N 13	9.97 M	141	596	737
N 16	7.13 S	394	2110	2500
O 15	122.24 S	141	1040	1180
F 18	109.74 M	136	51.7	188
NA 22	2.602 Y	281	14.3	295
NA 24	15 H	462	724	1190
MG 27	9.458 M	120	974	1090
MG 28	20.91 H	174	1.3	175
AL 26	7.2E+05 Y	332	480	812
AL 28	2.24 M	209	1550	1760
SI 31	157.3 M	0.107	801	801
SI 32	330 Y	0	0	0
P 32	14.29 D	0	964	964
P 33	25.4 D	0	0	0
S 35	87.44 D	0	0	0
CL 36	3.01E+05 Y	5.60E-05	85.5	85.5
CL 38	37.21 M	174	1460	1630
AR 37	35.02 D	0.00946	0	0.00946
AR 39	269 Y	0	27.1	27.1
AR 41	1.827 H	155	542	696
K 40	1.28E+09 Y	18.2	569	588
K 42	12.36 H	32.2	1620	1650
K 43	22.6 H	134	197	332
CA 41	1.03E+05 Y	0.0248	0	0.0248
CA 45	162.7 D	2.06E-07	0	2.06E-07
CA 47	4.536 D	129	263	392
CA 49	8.719 M	328	1180	1510
SC 44	3.927 H	279	828	1110
SC 46	83.8 D	262	0.0279	262
SC 46m	18.72 S	12.7	0	12.7
SC 47	3.422 D	15.3	8.73	24
SC 48	43.67 H	425	47.1	472
SC 49	57.4 M	0.122	1140	1140
TI 44	47.3 Y	21.6	0	21.6
TI 45	3.08 H	120	396	516
TI 51	5.752 M	51.1	1180	1230
V 48	15.971 D	372	54.5	426
V 49	330 D	0.0905	0	0.0905
V 52	3.75 M	170	1400	1560
CR 49	42.09 M	145	825	970
CR 51	27.704 D	4.53	0	4.53
MN 52	5.591 D	441	8.39	450
MN 52m	21.4 M	303	1470	1770
MN 53	3.7E+06 Y	0.19	0	0.19
MN 54	312.7 D	114	0	114
MN 56	2.5785 H	214	972	1190
MN 57	1.47 M	10.6	1420	1430
FE 52	8.275 H	102	120	222

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
FE 55	2.7 Y	0.266	0	0.266
FE 59	44.63 D	148	2.07	150
CO 56	78.76 D	440	164	604
CO 57	270.9 D	18.5	0	18.5
CO 58	70.8 D	133	0.409	134
CO 58m	9.15 H	0.426	0	0.426
CO 60	5.271 Y	305	0	305
CO 60m	10.47 M	1.04	1.89	2.93
CO 61	1.65 H	13.6	549	562
NI 56	6.1 D	232	0	232
NI 57	36.08 H	236	93.4	329
NI 59	75,000 Y	0.5	0	0.5
NI 63	100.1 Y	0	0	0
NI 65	2.52 H	66.1	775	841
CU 61	3.408 H	113	373	486
CU 62	9.74 M	139	1590	1730
CU 64	12.701 H	26.3	20.4	46.7
CU 67	61.88 D	16.4	3.81	20.2
ZN 62	9.26 H	64	3.46	67.5
ZN 65	244.4 D	74.5	0	74.5
ZN 69	55.6 M	8.34E-04	236	236
ZN 69m	13.76 H	57.8	8.12	65.9
GA 66	9.4 H	293	974	1270
GA 67	3.261 D	22	0	22
GA 68	68 M	131	1040	1170
GA 72	14.1 H	337	504	842
GE 68	288 D	1.38	0	1.38
GE 71	11.8 D	1.4	0	1.4
GE 77	11.3 H	143	819	962
AS 72	26 H	242	1330	1570
AS 73	80.3 D	4.72	0	4.72
AS 74	17.77 D	106	277	383
AS 76	26.32 H	57.3	1330	1390
AS 77	38.8 H	1.2	64.9	66.1
SE 73	7.15 H	153	490	644
SE 75	119.78 D	56.5	0	56.5
SE 79	65,000 Y	0	0	0
BR 77	57.04 H	46	0	46
BR 80	17.4 M	10.4	991	1000
BR 80m	4.42 H	6.54	0	6.54
BR 82	35.3 H	350	0.395	350
BR 83	2.39 H	1.03	240	241
BR 84	31.8 M	208	1300	1510
BR 85	172 S	8.79	1320	1330
KR 79	35.04 H	37.4	3.47	40.9
KR 81	2.1E+05 Y	4.08	0	4.08
KR 83m	1.83 H	1.08	0	1.08
KR 85	10.72 Y	0.308	97.9	98.2
KR 85m	4.48 H	22.5	138	160
KR 87	76.3 M	96.9	1480	1580
KR 88	2.84 H	231	287	519
KR 89	3.16 M	220	1480	1700
KR 90	32.32 S	160	1520	1680

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
RB 81	4.58 H	86.9	159	246
RB 82	1.25 M	151	1640	1800
RB 83	86.2 D	72	0	72
RB 84	32.9 D	124	186	310
RB 86	18.66 D	12.1	905	917
RB 87	4.73E+10 Y	0	0	0
RB 88	17.8 M	76.1	1890	1960
RB 89	15.44 M	253	1170	1420
RB 90	157 S	224	1760	1980
RB 90m	258 S	380	1490	1870
SR 82	25 D	3.53	0	3.53
SR 85	64.84 D	74	3.43	77.5
SR 85m	67.66 M	30.6	0	30.6
SR 87m	2.805 H	45.1	1.92	47
SR 89	50.55 D	0.0184	797	797
SR 90	28.6 Y	0	17.3	17.3
SR 91	9.5 H	91.4	789	880
SR 92	2.71 H	160	53.7	213
SR 93	7.3 M	288	1150	1430
Y 86	14.74 H	462	290	751
Y 87	80.3 H	66.9	0.881	67.8
Y 88	106.6 D	334	0.523	334
Y 90	64.1 H	0	1250	1250
Y 90m	3.19 H	88.4	30.6	119
Y 91	58.51 D	0.445	829	829
Y 91m	49.71 M	73.4	37.8	111
Y 92	3.54 H	32.6	1610	1640
Y 93	10.1 H	11.3	1440	1460
ZR 86	16.5 H	46.1	0	46.1
ZR 88	83.4 D	57.2	0.325	57.5
ZR 89	78.43 H	159	90.3	249
ZR 93	1.53E+06 Y	0	0	0
ZR 95	64.02 D	101	2.6	104
ZR 97	16.9 H	23.2	939	962
NB 90	14.6 H	509	495	1000
NB 91	10,000 Y	4.12	0	4.12
NB 91m	61 D	8.3	0	8.3
NB 92m	3.6E+07 Y	206	2.01	208
NB 92	10.15 D	132	0	132
NB 93m	14.6 Y	0.66	0	0.66
NB 94	20,300 Y	215	3.12	218
NB 94m	6.26 M	3.07	2.4	5.47
NB 95	35.06 D	105	1.76	107
NB 95m	86.6 H	10.7	29	39.6
NB 96	23.35 H	330	103	433
NB 97	72.1 M	91.6	558	650
NB 97m	60 S	100	25.3	125
MO 91	15.49 M	135	1660	1800
MO 93	3500 Y	3.69	0	3.69
MO 99	66.02 H	21.5	422	444
MO101	14.61 M	190	568	758
TC 95	20 H	111	1.58	113
TC 95m	61 D	94.8	0.579	95.4

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
TC 96	4.28 D	343	1.65	344
TC 96m	51.5 M	7.45	0	7.45
TC 97	2.6E+06 Y	3.76	0	3.76
TC 97m	89 D	2.86	0	2.86
TC 98	4.2E+06 Y	192	4.41	196
TC 99	2.13E+05 Y	7.73E-05	0	7.73E-05
TC 99m	6.02 H	18.2	0	18.2
TC101	14.2 M	47.8	561	609
RU 97	2.9 D	35.7	0	35.7
RU103	39.35 D	66.8	4.56	71.4
RU105	4.44 H	108	422	530
RU106	368.2 D	0	0	0
RH103m	56.119 M	0.532	0	0.532
RH105	35.36 H	10.9	10.2	21.1
RH105m	45 S	6.58	0	6.58
RH106	29.92 S	28.2	1630	1660
PD103	16.961 D	4.73	0	4.73
PD107	6.5E+06 Y	0	0	0
PD109	13.453 H	0.095	332	332
AG106	8.46 D	372	2.07	374
AG108	2.37 M	2.5	824	827
AG108m	127 Y	226	5.18	231
AG109m	39.6 S	2.52	0	2.52
AG110	24.57 S	4.22	1480	1480
AG110m	249.85 D	361	4.77	366
AG111	7.46 D	3.68	310	314
CD109	464 D	3.82	0	3.82
CD111m	48.7 M	40.9	0	40.9
CD113	9.3E+15 Y	0	0	0
CD113m	13.7 Y	0	18.3	18.3
CD115	53.46 H	28.3	253	282
CD115m	44.6 D	2.84	814	817
CD117	2.49 H	137	454	591
CD117m	3.36 H	251	69.5	320
IN111	2.83 D	58.2	0	58.2
IN113m	1.658 H	36.5	1.4	37.9
IN114	71.9 S	4.38	1060	1060
IN114m	49.51 D	13.9	0	13.9
IN115	4.6E+15 Y	0	2.51	2.51
IN115m	4.36 H	23.5	6.58	30.1
IN116m	54.15 M	303	224	527
IN117	43.8 M	95.7	98.2	194
IN117m	116.5 M	13.1	472	485
SN113	115.1 D	4.09	0	4.09
SN117m	13.6 D	22.7	0	22.7
SN119m	293 D	2.03	0	2.03
SN123	129.2 D	0.882	700	700
SN125	9.64 D	39	1060	1090
SN126	1.0E+05 Y	8.79	0	8.79
SB117	2.8 H	26.5	0.508	27
SB122	2.7 D	61	730	791
SB124	60.2 D	235	364	599
SB125	2.77 Y	60.2	6.89	67.1

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
SB126	12.4 D	379	269	647
SB126m	19 M	217	796	1010
SB127	3.85 D	91.2	238	329
SB129	4.4 H	189	337	525
TE121	16.8 D	80.2	3.36	83.6
TE121m	154 D	30.3	0	30.3
TE123	1.0E+13 Y	2.1	0	2.1
TE123m	119.7 D	21.2	0	21.2
TE125m	58 D	5.6	0	5.6
TE127	9.35 H	0.673	62.6	63.3
TE127m	109 D	1.79	2.21	4
TE129	69.6 M	7.94	667	675
TE129m	33.6 D	5.6	286	291
TE131	25 M	57.3	921	979
TE131m	30 H	190	58.1	248
TE132	78.2 H	33.1	0	33.1
TE133	12.45 M	122	1070	1190
TE133m	55.4 M	295	900	1190
TE134	41.8 M	121	1.3	122
I122	3.62 M	134	1260	1400
I123	13.13 H	24.8	0	24.8
I124	4.18 D	140	274	413
I125	60.14 D	6.66	0	6.66
I126	12.93 D	64.5	109	174
I128	24.99 M	10.5	1030	1040
I129	1.57E+07 Y	5.28	0	5.28
I130	12.36 H	293	193	486
I131	8.04 D	53.2	22.4	75.6
I132	2.3 H	308	566	874
I133	20.8 H	82.7	448	531
I134	52.6 M	348	786	1130
I135	6.61 H	193	369	562
I136	83 S	293	1930	2230
XE122	20.1 H	11.5	0	11.5
XE123	2.14 H	84.4	210	295
XE125	16.8 H	38.4	0.064	38.5
XE127	36.406 D	39.9	0	39.9
XE129m	8.89 D	10.4	0	10.4
XE131m	11.84 D	4.11	0	4.11
XE133	5.245 D	7.97	0	7.97
XE133m	2.19 D	7.13	0	7.13
XE135	9.11 H	34.6	212	246
XE135m	15.36 M	59.8	103	163
XE137	3.83 M	25.1	1830	1850
XE138	14.13 M	138	712	851
CS126	1.64 M	155	1480	1640
CS129	32.06 H	42	0.0331	42.1
CS131	9.688 D	4.97	0	4.97
CS132	6.475 D	100	6.07	106
CS134	2.062 Y	213	39.4	252
CS134m	2.9 H	4.66	0	4.66
CS135	2.3E+06 Y	0	0	0
CS136	13.16 D	288	6.34	295

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
CS137	30.17 Y	0	28.1	28.1
CS138	32.2 M	285	1490	1780
CS139	9.4 M	36.2	1740	1780
BA131	11.8 D	68.1	1.65	69.8
BA133	10.5 Y	58.2	0	58.2
BA133m	38.9 H	10.6	0	10.6
BA135m	28.7 H	9.6	0	9.6
BA137m	2.552 M	82.6	108	191
BA139	83.1 M	4.9	1210	1210
BA140	12.789 D	27	202	229
BA141	18.27 M	118	1090	1210
BA142	10.7 M	118	493	611
LA140	40.22 H	284	665	949
LA141	3.94 H	5.06	1250	1260
LA142	95.4 M	320	1040	1360
CE139	137.66 D	23.9	0	23.9
CE141	32.5 D	11.1	4.88	16
CE143	33 H	38.8	439	478
CE144	284.3 D	2.86	0	2.86
PR142	19.13 H	6.81	1100	1110
PR143	13.56 D	1.22E-06	237	237
PR144	17.28 M	3.94	1490	1490
PR144m	7.2 M	2.01	0	2.01
ND147	10.98 D	20.4	108	129
ND149	1.73 H	53.6	523	576
PM143	265 D	44.1	1.74	45.8
PM144	363 D	215	10.7	226
PM145	17.7 Y	5.36	0	5.36
PM146	2020 D	104	45.3	150
PM147	2.6234 Y	4.96E-04	0	4.96E-04
PM148	5.37 D	72	907	979
PM148m	41.3 D	273	29.1	302
PM149	53.08 H	1.62	345	346
PM151	28.4 H	47.4	194	241
SM147	1.07E+11 Y	0	0	0
SM151	90 Y	0.00287	0	0.00287
SM153	46.7 H	10.2	68	78.2
EU152	13.6 Y	150	70.5	221
EU152m	9.32 H	42.9	660	702
EU154	8.8 Y	162	149	312
EU155	4.96 Y	9.39	0	9.39
EU156	15.19 D	167	412	579
GD152	1.1E+14 Y	0	0	0
GD153	241.6 D	18.6	0	18.6
GD159	18.56 H	5.94	235	241
GD162	9.7 M	59	253	312
TB157	150 Y	0.896	0	0.896
TB160	72.3 D	142	104	246
TB162	7.76 M	150	600	750
DY157	8.06 H	50.6	0	50.6
DY165	2.334 H	3.75	510	514
DY166	81.6 H	6.58	0.141	6.72
HO166	26.8 H	3.97	923	927

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
HO166m	1200 Y	220	27.5	248
ER169	9.4 D	0.00394	0	0.00394
ER171	7.52 H	53.1	337	390
TM170	128.6 D	0.902	240	241
TM171	1.92 Y	0.119	0	0.119
YB169	31.97 D	48.3	0	48.3
YB175	4.19 D	5.58	0.814	6.4
LU177	6.71 D	5.05	1.93	6.99
LU177m	160.1 D	141	0.105	142
HF181	42.39 D	76.2	3.21	79.4
TA182	114.74 D	165	4.32	169
W181	120.95 D	6.89	0	6.89
W185	75.1 D	0.00376	0.172	0.176
W187	23.83 H	66.4	172	238
W188	69.4 D	0.249	0	0.249
RE182	64 H	230	0	230
RE182m	12.7 H	154	20.7	175
RE183	70 D	24.7	0	24.7
RE184	38 D	123	5.33	128
RE184m	169 D	55.3	0	55.3
RE186	90.64 H	3.14	293	296
RE187	4.7E+10 Y	0	0	0
RE188	16.98 H	8.08	1040	1050
OS185	93.6 D	98.9	8.53	107
OS186	2.0E+15 Y	0	0	0
OS190m	9.9 M	221	16	237
OS191	15.4 D	11.9	0	11.9
OS191m	13.03 H	1.37	0	1.37
OS193	30 H	9.79	313	323
IR190	11.78 D	195	7.23	202
IR190m	1.2 H	0.688	0	0.688
IR190m	3.2 H	8.26	0	8.26
IR192	74.02 D	114	28.5	143
IR193m	11.9 D	0.724	0	0.724
IR194	19.15 H	12.3	1080	1100
IR194m	171 D	324	21.9	346
PT191	2.71 D	43.2	2.03	45.2
PT193	50 Y	0.671	0	0.671
PT193m	4.33 D	2.47	0	2.47
PT195m	4.02 D	13	0	13
PT197	18.3 H	4.1	35.5	39.6
PT197m	94.4 M	13.3	2.15	15.4
AU194	39.5 H	139	14.4	153
AU195	183 D	14.4	0	14.4
AU195m	30.6 S	29	0	29
AU196	6.183 D	67.6	0	67.6
AU198	2.696 D	56.3	239	296
AU199	3.139 D	13	0.0612	13.1
HG197	64.14 H	11.9	0	11.9
HG197m	23.8 H	14.7	0	14.7
HG203	46.6 D	32.2	0	32.2
TL200	26.1 H	173	10.6	183
TL201	73.06 H	15.1	0	15.1

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
TL202	12.23 D	66.5	1.54	68.1
TL204	3.779 Y	0.191	135	135
TL207	4.77 M	0.293	613	614
TL208	3.053 M	394	739	1130
TL209	2.2 M	260	902	1160
TL210	1.3 M	351	884	1230
PB203	52.02 H	44.3	0	44.3
PB204m	66.9 M	283	136	419
PB205	1.51E+07 Y	0.882	0	0.882
PB209	3.253 H	0	34.7	34.7
PB210	22.26 Y	1.37	0	1.37
PB211	36.1 M	7.01	538	545
PB212	10.643 H	21.4	1.28	22.7
PB214	26.8 M	35.3	72.3	108
BI206	6.243 D	435	52	487
BI207	33.4 Y	204	162	366
BI208	3.68E+05 Y	295	3.63	299
BI210	5.013 D	0	403	403
BI211	2.13 M	6.67	0.039	6.71
BI212	60.55 M	24.2	603	627
BI213	45.65 M	19.4	475	494
BI214	19.9 M	188	787	974
PO209	102 Y	0.48	0	0.48
PO210	138.378 D	0.00116	0	0.00116
PO211	0.516 S	1.06	0	1.06
PO212	2.98E-07 S	0	0	0
PO213	4.2E-06 S	0.00418	0	0.00418
PO214	1.637E-04 S	0.0114	0	0.0114
PO215	1.778E-03 S	0.0207	0	0.0207
PO216	0.146 S	0.00198	0	0.00198
PO218	3.05 M	0	0	0
AT211	7.214 H	6.49	0	6.49
AT217	0.0323 S	0.0328	0	0.0328
RN218	0.035 S	0.104	0	0.104
RN219	3.96 S	8.03	0.0161	8.05
RN220	55.61 S	0.0721	0	0.0721
RN222	3.8235 D	0.0537	0	0.0537
FR221	4.8 M	4.42	0	4.42
FR223	21.8 M	9.69	307	316
RA222	38 S	1.29	0	1.29
RA223	11.434 D	20.3	0	20.3
RA224	3.62 D	1.41	0	1.41
RA225	14.8 D	3.42	0	3.42
RA226	1600 Y	0.977	0	0.977
RA228	5.75 Y	8.02E-07	0	8.02E-07
AC225	10 D	3.03	0	3.03
AC227	21.773 Y	0.0862	0	0.0862
AC228	6.13 H	124	379	503
TH226	30.9 M	1.5	0	1.5
TH227	18.718 D	17.1	0	17.1
TH228	1.9132 Y	0.8	0	0.8
TH229	7340 Y	17	0	17
TH230	77,000 Y	0.516	0	0.516

Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
TH231	25.52 H	6.42	0	6.42
TH232	1.4E+10 Y	0.485	0	0.485
TH233	22.3 M	5.37	428	433
TH234	24.1 D	1.77	0	1.77
PA230	17.4 D	92.5	2.56	95.1
PA231	32,760 Y	6.94	0	6.94
PA233	27 D	32.8	0	32.8
PA234	6.7 H	268	136	404
PA234m	1.17 M	1.55	1110	1110
U230	20.8 D	0.872	0	0.872
U231	4.2 D	16.2	0	16.2
U232	72 Y	0.742	0	0.742
U233	1.59E+05 Y	0.261	0	0.261
U234	2.45E+05 Y	0.636	0	0.636
U235	7.04E+08 Y	22.7	0	22.7
U236	2.34E+07 Y	0.599	0	0.599
U237	6.75 D	24.2	0	24.2
U238	4.47E+09 Y	0.53	0	0.53
U239	23.4 M	8.04	423	431
U240	14.1 H	2.83	0.195	3.02
NP235	396.1 D	2.57	0	2.57
NP236	1.15E+05 Y	26.8	0	26.8
NP236m	22.5 H	8.98	3.64	12.6
NP237	2.14E+06 Y	7.54	0	7.54
NP238	2.117 D	74.7	211	285
NP239	2.355 D	27.2	2.63	29.8
NP240	65 M	162	117	279
NP240m	7.4 M	46.4	770	816
PU236	2.851 Y	0.811	0	0.811
PU237	45.3 D	10.1	0	10.1
PU238	87.75 Y	0.717	0	0.717
PU239	24,131 Y	0.28	0	0.28
PU240	6537 Y	0.683	0	0.683
PU241	14.4 Y	0	0	0
PU242	3.76E+05 Y	0.567	0	0.567
PU243	4.956 H	4.24	9.56	13.8
PU244	8.26E+07 Y	0.491	0	0.491
PU245	10.57 H	58.3	166	225
PU246	10.85 D	14.6	0	14.6
AM241	432.2 Y	6.39	0	6.39
AM242	16.02 H	3.96	26.2	30.1
AM242m	152 Y	1.97	0	1.97
AM243	7380 Y	10.6	0	10.6
AM244	10.1 H	116	66.2	183
AM245	122.4 M	5.03	144	149
AM246	25 M	130	476	606
CM242	163.2 D	0.736	0	0.736
CM243	28.5 Y	21.5	0	21.5
CM244	18.11 Y	0.656	0	0.656
CM245	8500 Y	13.9	0	13.9
CM246	4750 Y	0.584	0	0.584
CM247	1.56E+07 Y	44.4	0.0276	44.5
CM248	3.39E+05 Y	0.463	0	0.463

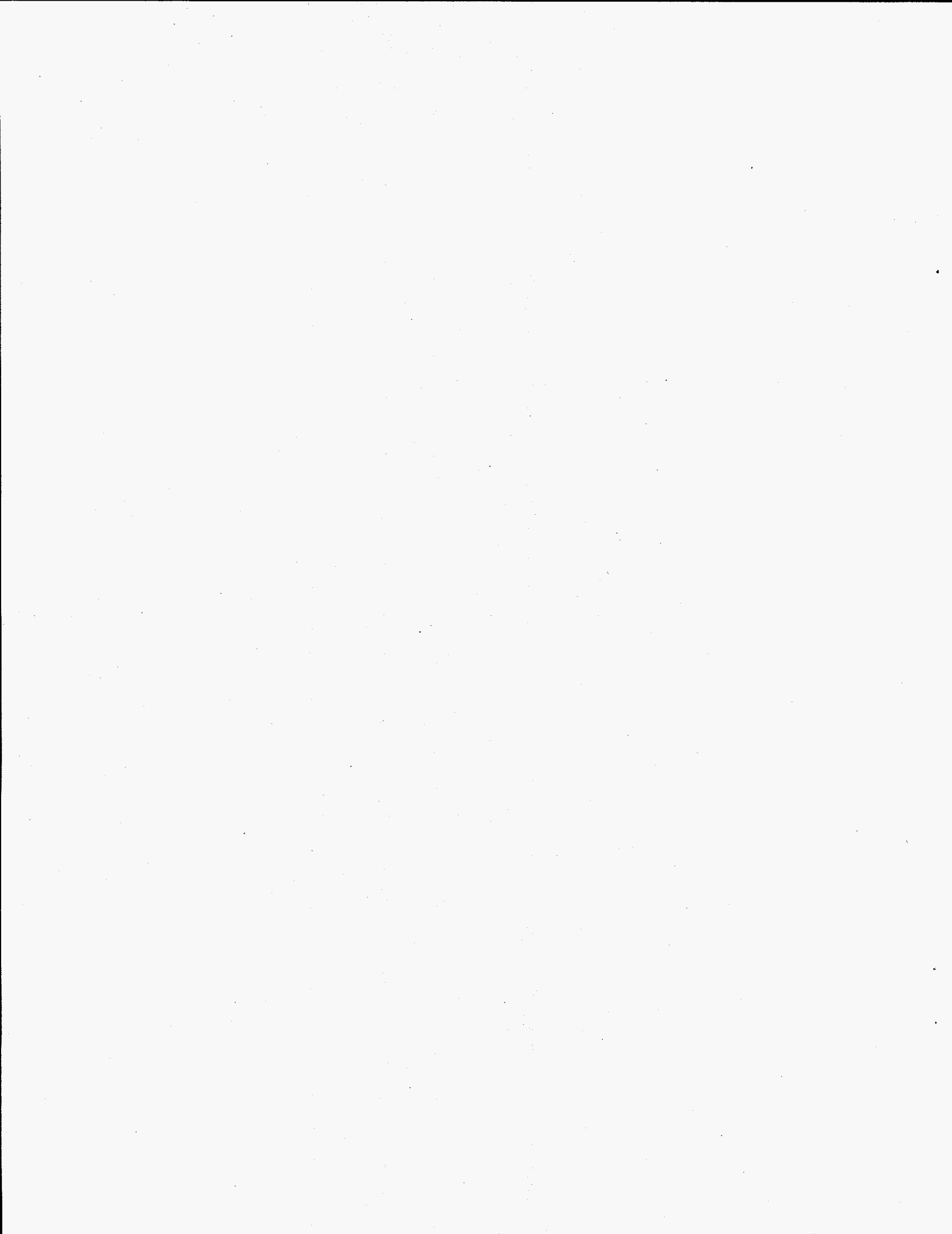
Table B.3. (contd)

Isotope	Half-Life	Photon	Electron	Total
CM249	64.15 M	2.62	167	170
CM250	6900 Y	0	0	0
BK249	320 D	0	0	0
BK250	3.222 H	118	177	295
BK251	57 M	0	347	347
CF248	333.5 D	0.505	0	0.505
CF249	350.6 Y	47.6	0	47.6
CF250	13.08 Y	0.501	0	0.501
CF251	900 Y	19.9	0	19.9
CF252	2.639 Y	0.466	0	0.466
CF253	17.81 D	0.00854	0	0.00854
CF254	60.5 D	3.95E-06	0	3.95E-06
ES253	20.467 D	0.33	0	0.33
ES254	275.7 D	6.68	0	6.68
ES254m	39.3 H	79.4	71.2	151
ES255	39.8 D	0.0361	0	0.0361
FM254	3.24 H	0.493	0	0.493
FM255	20.07 H	4.04	0	4.04
FM256	157.6 M	0	0	0

Spaces were inserted between the element name and 1 & 2 digit mass numbers so they would be the same as ORIGEN2 nuclide names.

The name of AG106m was changed to AG106 so it would be the same as the ORIGEN2 name.

The names NB 92 and NB 92m were interchanged so nuclide NB 92 would be consistent with the ORIGEN2 name.



Appendix C

External Dose-Rate Conversion Factors

Appendix C

External Dose-Rate Conversion Factors

Dose-rate conversion factors for external exposure to photons and electrons emitted by radionuclides deposited on the ground surface are given by Kocher and Eckerman.^(a) Dose-rate factors are given for a number of internal organs as well as the skin. Effective dose-rate factors were calculated by Kocher and Eckerman by using weighing factors for specific internal body organs. The larger of the effective dose-rate factor and the total skin dose-rate factor for each radionuclide was multiplied by the Hanford total radionuclide activity in curies to give a radiation hazard value. Comparison amongst nuclides gives a relative radiation hazard.

(a) Kocher, D. C., and K. F. Eckerman. 1988. *External Dose-Rate Conversion Factors for Calculation of Dose to the Public*; DOE/EH-0070, U.S. Department of Energy, Washington, D.C., and 1989 Erratum Sheet.

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