Sludge Source Term (U) (PUREX Process Radionuclide Dose Impact)

by

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SLUDGE SOURCE TERM (U)
(PUREX Process Radionuclide Dose Impact)

BY

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SUMMARY

This report analyzes the radionuclide dose impact of the PUREX process waste stream. The radionuclide ingestion and inhalation pathways are analyzed. Two spent fuel assemblies processed in the Separation facilities are analyzed, the Mark 31A and Mark 31B.

The individual radionuclide significance to dose is evaluated in terms of dose percentage. Comparing the radionuclide individual dose value allows the determination of those radionuclides whose dose impact is significant.

The results of this analysis demonstrate that a limited number of radionuclides contribute 1% or more to the total dose and that the major contributor to the sludge source dose is strontium.

The results obtained permit reducing the list of radionuclides to be considered in the development of source terms to support the High Level Waste Safety Analysis Report.

INTRODUCTION

The PUREX process has been used in the Separation facilities in F & H-Area. It has been used in the F-Canyon since building start up in November 1954 to separate plutonium from uranium. In the H-Canyon building it was used between August 1955 and March 1959 to separate weapons grade plutonium from uranium.

This report analyzes both the inhalation and ingestion radionuclide dose impact of the PUREX Process waste stream. The spent fuel assemblies analyzed are the Mark 31A and Mark 31B.

The results from this report will be used to establish source terms for High Level Waste. This report summarizes the approach used to determine those radionuclides whose dose impact is significant for establishing the sludge source terms.

DISCUSSION

Isotopic Dose Calculations

The data for the Mark 31A and Mark 31B and the ICRP-30 (Ref. 1) Dose Conversion Factors were used to determine the isotopic source dose contribution in terms of rem.

Only those radionuclides with a half life exceeding a day were considered. The isotopic dose contribution was evaluated at 5 and 15 years for each spent fuel assembly (Mark 31A and Mark 31B).

The data was normalized in terms of Pu-239. The spent fuel isotopic content was adjusted using the data from Ref. 3. From this data the fraction insoluble was calculated as (1.0 - soluble fraction) and used to account for the amount of each radionuclide in the sludge. In order to determine those radionuclides whose dose impact is important, the radionuclide source values were converted to dose values. To obtain the dose contribution for each isotope in terms of rem, the normalized isotopic content for each isotope was multiplied by the ICRP-30 (Ref. 1) Inhalation and Ingestion Dose Conversion factors. For both the ingestion and the inhalation pathways, the calculated dose values were added together to determine the total dose (rem). The individual isotope inhalation and ingestion dose contribution was calculated in terms of dose percentage.

The isotopic dose contribution for the inhalation pathway was also evaluated considering evaporative conditions. Table 1 contains the Release Fractions values used to adjust the Dose Conversion factors (for evaporative conditions) as specified by DOE (Ref. 1). No Release Fractions values are applied to volatile conditions.

TABLE 1
DOE Release Fractions Values

1. <u>Gases</u> - (such as tritium, krypton, xenon, argon, radon, chlorine, etc.).	1.0
2. <u>Highly volatile/combustible</u> (phosphorus, sulfur, potassium, iodine, sodium, bromine)	0.5
3. <u>Semi-volatile</u> (selenium, mercury, cesium, polonium, tellurium ruthenium, carbon)	1E-2
4. <u>Solid/Powder/Liquid</u> (All materials not listed above.)	1E-3

The results of the calculations are tabulated in Appendix A and Appendix B for the inhalation and the ingestion pathway, respectively. A radionuclide contributing at least one percent of the total dose is considered significant to the source dose. Those isotopes contributing one percent or more to the total dose are indicated in bold-underlined face type. Tables 2 and 3 in the **Analysis** section summarize the dose contribution (dose percentage) for those radionuclides contributing one percent or more of the total dose for the inhalation and ingestion pathways.

SAMPLE CALCULATION

For the Mark 31A spent fuel assembly at 5 years (radionuclide inhalation pathway):

<u>Isotope</u>	<u>Isotopic Content</u> (g/assembly)
H-3	3.64E-05
:	:
Sr-90	2.16E+00
:	:
Cs-134	6.39E-03
Cs-135	5.91E-01
Cs-136	6.85E-45
Cs-137	4.59E+00
:	:
Pu-239	7.96E-01
:	:

For each isotope the isotopic content was normalized in terms of Pu-239:

<u>Isotope</u>	<u>Normalized</u> <u>Sludge Content</u>
H-3	0.00E+00
:	:
Sr-90	2.72E+00
:	:
Cs-134	4.01E-04
Cs-135	3.71E-02
Cs-136	4.30E-46
Cs-137	2.88E-01
:	:
Pu-239	1.00E+00
:	:

Note:

- The isotopic content was adjusted by solubility fraction values to account for the amount of each radionuclide present in the sludge, Ref. 3.

To express the source dose in terms of rem, the normalized isotopic content were multiplied by the ICRP-30 Inhalation Dose Conversion Factors. The dose values obtained are:

<u>Isotope</u>	<u>Dose</u> (rem/g Pu-239)	<u>Percent</u> <u>Dose</u>
H-3	0.00E+00	0%
:	:	:
Sr-90	4.92E+08	57%
:	:	:
Cs-134	2.44E+04	0%
Cs-135	1.92E-01	0%
Cs-136	2.35E-37	0%
Cs-137	3.36E+05	0%
:	:	:
Pu-239	3.16E+07	4%
:	:	:
Total 8.25E+08		

The individual isotope dose value was then divided by the total dose to determine the isotopic dose contribution.

To determine the radionuclide contribution considering evaporative conditions (for the inhalation pathway only) the ICRP-30 Dose Conversion Factors were adjusted by the DOE release fraction values.

<u>Isotope</u>	<u>Evaporative Conditions</u> <u>Dose</u> (rem/g Pu-239)	<u>Percent</u> <u>Dose</u>
H-3	0.00E+00*(1)	0%
:	:	:
Sr-90	4.92E+08*(0.001)	34%
:	:	:
Cs-134	2.44E+04*(0.01)	0%
Cs-135	1.92E-01*(0.01)	0%
Cs-136	2.35E-37*(0.01)	0%
Cs-137	7.99E+05*(0.01)	1%
:	:	:
Pu-239	3.16E+07*(0.001)	2%
:	:	:
Total 1.43 E+06		

Note:

- The same above calculations were performed for the ingestion pathway.

ANALYSIS

Tables 2 & 3 summarize the dose percentage of those radionuclides contributing one percent or more to the total dose for the inhalation and ingestion pathways. The results included in Appendix A, Appendix B, and Tables 2 & 3 demonstrate that only a limited number of radionuclides have a significant impact to the total dose.

TABLE 2
RADIONUCLIDE INHALATION DOSE CONTRIBUTION
 (Dose Percentage)

	Volatile Conditions				Evaporative Conditions			
	5 years		15 years		5 years		15 years	
	31A	31B	31A	31B	31A	31B	31A	31B
Sr-90	60	62	64	68	44	46	63	67
Ru-106	4	4	0	0	28	28	0	0
Cs-137	0	0	0	0	1	1	1	1
Ce-144	8	8	0	0	6	6	0	0
Pm-147	2	2	0	0	2	2	0	0
Pu-239	4	4	5	5	3	3	5	5
Pu-240	1	1	1	1	0	1	1	1
Pu-241	1	1	1	1	1	1	1	1
Am-241	20	17	28	24	15	13	27	24

TABLE 3
RADIONUCLIDE DOSE
CONTRIBUTION
(Dose Percentage)

	<u>INGESTION</u>			
	<u>5 years</u>		<u>15 years</u>	
	<u>31A</u>	<u>31B</u>	<u>31A</u>	<u>31B</u>
Sr-90	79	80	87	87
Y-90	6	6	7	7
Ru-106	2	2	0	0
Cs-137	2	2	2	2
Ce-144	6	6	0	0
Pm-147	1	1	0	0
Pu-239	0	0	1	1
Am-241	2	2	3	3

The major contributor to the total dose from the PUREX process sludge waste stream is Sr-90, under both the inhalation and ingestion pathway. Due to their short half-life as compared to the other radionuclides shown in Tables 2 & 3, Ru-106, Ce-144 and Pm-147 are significant to the dose only during a short time period. For the plutonium isotope, Pu-239, it is shown that its contribution to the ingestion dose becomes significant after a long period of time.

Appendix C presents the dose contribution for the inhalation and ingestion pathways in a comparative manner. From the Inh/Ing ratio column, it can be demonstrated that the cesium major dose impact occurs when evaluating the ingestion pathway. For the alpha emitters the major dose impact occurs through the inhalation pathway.

CONCLUSION

Source terms can be established based on those radionuclides whose dose impact is significant. The individual radionuclide significance to dose can be readily determined if the source dose is evaluated in terms of rem.

The data analyzed demonstrate that a limited number of radionuclides is significant in determining source terms. Strontium-90 is the major contributor to the PUREX process sludge dose through both, the inhalation and the ingestion pathway.

REFERENCES:

1. DOE STANDARD, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports", DOE-STD-1027-92, December 1992
2. DPSTD-80-39, "Preliminary Technical Data Summary - Defense Waste Processing Facility - Stage 2", December 1980
3. J. R. Fowler, "Update of Chemical and Radiochemical Composition of Decontaminated Soluble Waste from the Precipitation Process", DPST-82-759, August 6, 1982
4. M. C. Chandler, "Dose Contribution from High Level Waste Uranium and Plutonium (U)", WSRC-TR-93-604, November 9, 1993

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized		Volatile Conditions		Release Fraction	Evaporative Conditions	
		Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
H-3	3.64E-05	0.00E+00	9.22E+05	0.00E+00	0%	1	0.00E+00	0%
Cr-51	3.03E-23	3.61E-23	2.40E+07	8.66E-16	0%	0.001	8.66E-19	0%
Co-60	4.50E-03	5.65E-03	1.70E+08	9.61E+05	0%	0.001	9.61E+02	0%
Se-79	2.51E-02	2.84E-02	6.20E+02	1.76E+01	0%	0.01	1.76E-01	0%
Rb-87	1.04E+00	6.54E-02	2.87E-04	1.88E-05	0%	0.001	1.88E-08	0%
Sr-89	3.87E-11	4.86E-11	1.07E+09	5.20E-02	0%	0.001	5.20E-05	0%
Sr-90	2.16E+00	2.72E+00	1.81E+08	4.92E+08	60%	0.001	4.92E+05	44%
Y-90	5.63E-04	7.07E-04	4.46E+09	3.15E+06	0%	0.001	3.15E+03	0%
Y-91	8.07E-10	1.01E-09	1.08E+09	1.09E+00	0%	0.001	1.09E-03	0%
Zr-93	3.05E+00	3.83E+00	8.04E+02	3.08E+03	0%	0.001	3.08E+00	0%
Zr-95	1.06E-08	1.33E-08	3.86E+08	5.12E+00	0%	0.001	5.12E-03	0%
Nb-95	1.22E-08	1.53E-08	1.76E+08	2.70E+00	0%	0.001	2.70E-03	0%
Nb-95m	7.39E-12	9.28E-12	8.08E+08	7.50E-03	0%	0.001	7.50E-06	0%
Tc-99	3.59E+00	0.00E+00	1.27E+02	0.00E+00	0%	0.001	0.00E+00	0%
Ru-103	2.50E-14	1.57E-14	2.51E+08	3.94E-06	0%	0.01	3.94E-08	0%
Ru-106	3.38E-02	2.12E-02	1.47E+09	3.12E+07	4%	0.01	3.12E+05	28%
Pd-107	7.27E-01	9.13E-01	6.68E+00	6.10E+00	0%	0.001	6.10E-03	0%
Cd-115m	2.14E-15	2.55E-15	1.65E+09	4.21E-06	0%	0.001	4.21E-09	0%
In-115	4.24E-02	5.06E-02	1.77E-05	8.96E-07	0%	0.001	8.96E-10	0%
Sn-121m	1.17E-05	1.41E-05	3.48E+05	4.91E+00	0%	0.001	4.91E-03	0%
Sn-123	1.25E-06	1.51E-06	2.47E+08	3.74E+02	0%	0.001	3.74E-01	0%
Sn-125	1.10E-59	1.32E-59	1.52E+09	2.01E-50	0%	0.001	2.01E-53	0%
Sn-126	1.20E-01	1.45E-01	2.44E+03	3.53E+02	0%	0.001	3.53E-01	0%
Sb-124	6.08E-14	7.59E-14	3.67E+08	2.79E-05	0%	0.001	2.79E-08	0%
Sb-125	2.39E-02	2.98E-02	1.01E+07	3.01E+05	0%	0.001	3.01E+02	0%
Sb-126	5.70E-10	6.87E-10	8.36E+08	5.75E-01	0%	0.001	5.75E-04	0%
Te-127m	3.16E-07	3.96E-07	1.79E+08	7.09E+01	0%	0.01	7.09E-01	0%
Te-129m	4.41E-18	5.54E-18	6.03E+08	3.34E-09	0%	0.01	3.34E-11	0%
I-129	7.85E-01	0.00E+00	3.18E+01	0.00E+00	0%	0.5	0.00E+00	0%
I-131	2.81E-69	0.00E+00	3.97E+09	0.00E+00	0%	0.5	0.00E+00	0%
Cs-134	6.39E-03	4.01E-04	6.08E+07	2.44E+04	0%	0.01	2.44E+02	0%
Cs-135	5.91E-01	3.71E-02	5.18E+00	1.92E-01	0%	0.01	1.92E-03	0%
Cs-136	6.85E-45	4.30E-46	5.47E+08	2.35E-37	0%	0.01	2.35E-39	0%
Cs-137	4.59E+00	2.88E-01	2.77E+06	7.99E+05	0%	0.01	7.99E+03	1%
Ba-140	1.86E-43	2.33E-43	2.63E+08	6.14E-35	0%	0.001	6.14E-38	0%
La-140	2.80E-44	3.52E-44	2.45E+09	8.62E-35	0%	0.001	8.62E-38	0%
Ce-141	3.72E-17	4.67E-17	2.42E+08	1.13E-08	0%	0.001	1.13E-11	0%
Ce-144	4.60E-02	5.78E-02	1.12E+09	6.47E+07	8%	0.001	6.47E+04	6%
Pr-143	6.19E-41	7.77E-41	4.92E+08	3.82E-32	0%	0.001	3.82E-35	0%
Nd-144	4.25E+00	5.34E+00	0.00E+00	0.00E+00	0%	0.001	0.00E+00	0%
Nd-147	5.90E-51	7.41E-51	5.02E+08	3.72E-42	0%	0.001	3.72E-45	0%
Pm-147	4.82E-01	6.05E-01	3.15E+07	1.91E+07	2%	0.001	1.91E+04	2%
Pm-148	6.65E-18	8.35E-18	1.64E+09	1.37E-08	0%	0.001	1.37E-11	0%
Pm-148m	7.41E-16	9.31E-16	2.14E+08	1.99E-07	0%	0.001	1.99E-10	0%
Sm-147	1.33E+00	1.68E+00	1.65E+00	2.76E+00	0%	0.001	2.76E-03	0%
Sm-151	2.59E-01	3.25E-01	7.63E+05	2.48E+05	0%	0.001	2.48E+02	0%
Eu-152	4.85E-04	6.09E-04	3.81E+07	2.32E+04	0%	0.001	2.32E+01	0%
Eu-154	1.03E-02	1.30E-02	6.86E+07	8.89E+05	0%	0.001	8.89E+02	0%
Eu-155	2.76E-02	3.46E-02	1.81E+07	6.26E+05	0%	0.001	6.26E+02	0%
Eu-156	4.00E-38	5.02E-38	6.06E+08	3.04E-29	0%	0.001	3.04E-32	0%
Gd-152	1.75E-05	2.20E-05	5.15E-03	1.13E-07	0%	0.001	1.13E-10	0%
Tb-160	2.12E-12	2.66E-12	2.48E+08	6.61E-04	0%	0.001	6.61E-07	0%
Ra-224	4.31E-15	5.42E-15	4.67E+11	2.53E-03	0%	0.001	2.53E-06	0%
Th-228	8.36E-13	1.05E-12	2.54E+11	2.67E-01	0%	0.001	2.67E-04	0%

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
				Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
U-232	1.56E-11	1.95E-11	1.48E+10	2.89E-01	0%	0.001	2.89E-04	0%
U-234	1.42E-17	1.79E-17	8.08E+05	1.45E-11	0%	0.001	1.45E-14	0%
U-235	1.20E-01	1.51E-01	2.59E+02	3.90E+01	0%	0.001	3.90E-02	0%
U-236	3.74E-03	4.69E-03	7.76E+03	3.64E+01	0%	0.001	3.64E-02	0%
U-238	7.03E+01	8.82E+01	4.03E+01	3.56E+03	0%	0.001	3.56E+00	0%
Np-237	1.21E-02	1.52E-02	3.45E+05	5.25E+03	0%	0.001	5.25E+00	0%
Pu-236	8.01E-12	1.01E-11	8.53E+10	8.58E-01	0%	0.001	8.58E-04	0%
Pu-238	1.26E-04	1.58E-04	7.88E+09	1.25E+06	0%	0.001	1.25E+03	0%
<u>Pu-239</u>	7.96E-01	1.00E+00	3.16E+07	3.16E+07	<u>4%</u>	0.001	3.16E+04	<u>3%</u>
<u>Pu-240</u>	4.59E-02	5.76E-02	1.16E+08	6.68E+06	<u>1%</u>	0.001	6.68E+03	0%
<u>Pu-241</u>	5.12E-03	6.43E-03	1.03E+09	6.62E+06	<u>1%</u>	0.001	6.62E+03	<u>1%</u>
Pu-242	2.13E-04	2.68E-04	1.89E+06	5.06E+02	0%	0.001	5.06E-01	0%
<u>Am-241</u>	7.34E-02	9.21E-02	1.79E+09	1.65E+08	<u>20%</u>	0.001	1.65E+05	<u>15%</u>
Am-242m	4.00E-05	5.03E-05	4.96E+09	2.49E+05	0%	0.001	2.49E+02	0%
Am-243	4.05E-06	5.08E-06	1.04E+08	5.29E+02	0%	0.001	5.29E-01	0%
Cm-242	2.09E-07	2.63E-07	5.62E+10	1.48E+04	0%	0.001	1.48E+01	0%
Cm-243	4.89E-07	6.14E-07	1.81E+10	1.11E+04	0%	0.001	1.11E+01	0%
Cm-244	6.53E-08	8.20E-08	2.18E+10	1.79E+03	0%	0.001	1.79E+00	0%
Cm-245	3.72E-10	4.67E-10	9.27E+07	4.33E-02	0%	0.001	4.33E-05	0%
Cm-246	3.51E-12	4.41E-12	1.65E+08	7.28E-04	0%	0.001	7.28E-07	0%
Cm-247	3.66E-15	4.60E-15	4.55E+04	2.09E-10	0%	0.001	2.09E-13	0%
Cm-248	1.93E-17	2.42E-17	8.08E+06	1.95E-10	0%	0.001	1.95E-13	0%
Bk-249	1.06E-23	1.33E-23	2.17E+09	2.88E-14	0%	0.001	2.88E-17	0%
Cf-249	5.80E-22	7.28E-22	2.20E+09	1.60E-12	0%	0.001	1.60E-15	0%
				<u>8.25E+08</u>			<u>1.11E+06</u>	

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
				Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
H-3	2.09E-05	0.00E+00	9.22E+05	0.00E+00	0%	1	0.00E+00	0%
Cr-51	8.51E-63	1.02E-62	2.40E+07	2.44E-55	0%	0.001	2.44E-58	0%
Co-60	1.20E-03	1.51E-03	1.70E+08	2.57E+05	0%	0.001	2.57E+02	0%
Se-79	2.51E-02	2.84E-02	6.20E+02	1.76E+01	0%	0.01	1.76E-01	0%
Rb-87	1.04E+00	6.54E-02	2.87E-04	1.88E-05	0%	0.001	1.88E-08	0%
Sr-89	2.78E-32	3.49E-32	1.07E+09	3.73E-23	0%	0.001	3.73E-26	0%
Sr-90	1.69E+00	2.12E+00	1.81E+08	3.85E+08	64%	0.001	3.85E+05	63%
Y-90	4.40E-04	5.53E-04	4.46E+09	2.46E+06	0%	0.001	2.46E+03	0%
Y-91	1.39E-28	1.75E-28	1.08E+09	1.89E-19	0%	0.001	1.89E-22	0%
Zr-93	3.04E+00	3.82E+00	8.04E+02	3.07E+03	0%	0.001	3.07E+00	0%
Zr-95	1.73E-25	2.17E-25	3.86E+08	8.37E-17	0%	0.001	8.37E-20	0%
Nb-95	1.99E-25	2.51E-25	1.76E+08	4.41E-17	0%	0.001	4.41E-20	0%
Nb-95m	1.21E-28	1.52E-28	8.08E+08	1.23E-19	0%	0.001	1.23E-22	0%
Tc-99	3.59E+00	0.00E+00	1.27E+02	0.00E+00	0%	0.001	0.00E+00	0%
Ru-103	4.29E-42	2.69E-42	2.51E+08	6.76E-34	0%	0.01	6.76E-36	0%
Ru-106	3.54E-05	2.23E-05	1.47E+09	3.27E+04	0%	0.01	3.27E+02	0%
Pd-107	7.27E-01	9.13E-01	6.68E+00	6.10E+00	0%	0.001	6.10E-03	0%
Cd-115m	4.76E-40	5.68E-40	1.65E+09	9.37E-31	0%	0.001	9.37E-34	0%
In-115	4.24E-02	5.07E-02	1.77E-05	8.97E-07	0%	0.001	8.97E-10	0%
Sn-121m	1.02E-05	1.23E-05	3.48E+05	4.28E+00	0%	0.001	4.28E-03	0%
Sn-123	3.76E-15	4.54E-15	2.47E+08	1.12E-06	0%	0.001	1.12E-09	0%
Sn-126	1.20E-01	1.45E-01	2.44E+03	3.53E+02	0%	0.001	3.53E-01	0%
Sb-124	3.31E-32	4.13E-32	3.67E+08	1.52E-23	0%	0.001	1.52E-26	0%
Sb-125	1.89E-03	2.36E-03	1.01E+07	2.38E+04	0%	0.001	2.38E+01	0%
Sb-126	5.70E-10	6.87E-10	8.36E+08	5.75E-01	0%	0.001	5.75E-04	0%
Te-127m	2.58E-17	3.24E-17	1.79E+08	5.80E-09	0%	0.01	5.80E-11	0%
Te-129m	5.31E-51	6.67E-51	6.03E+08	4.02E-42	0%	0.01	4.02E-44	0%
I-129	7.85E-01	0.00E+00	3.18E+01	0.00E+00	0%	0.5	0.00E+00	0%
Cs-134	2.90E-04	1.82E-05	6.08E+07	1.11E+03	0%	0.01	1.11E+01	0%
Cs-135	5.91E-01	3.71E-02	5.18E+00	1.92E-01	0%	0.01	1.92E-03	0%
Cs-137	3.65E+00	2.29E-01	2.77E+06	6.35E+05	0%	0.01	6.35E+03	1%
Ce-141	5.90E-51	7.41E-51	2.42E+08	1.79E-42	0%	0.001	1.79E-45	0%
Ce-144	6.26E-06	7.87E-06	1.12E+09	8.81E+03	0%	0.001	8.81E+00	0%
Nd-144	4.30E+00	5.40E+00	0.00E+00	0.00E+00	0%	0.001	0.00E+00	0%
Pm-147	3.43E-02	4.31E-02	3.15E+07	1.36E+06	0%	0.001	1.36E+03	0%
Pm-148	1.59E-44	1.99E-44	1.64E+09	3.27E-35	0%	0.001	3.27E-38	0%
Pm-148m	1.77E-42	2.22E-42	2.14E+08	4.75E-34	0%	0.001	4.75E-37	0%
Sm-147	1.78E+00	2.24E+00	1.65E+00	3.69E+00	0%	0.001	3.69E-03	0%
Sm-151	2.40E-01	3.02E-01	7.63E+05	2.30E+05	0%	0.001	2.30E+02	0%
Eu-152	2.84E-04	3.57E-04	3.81E+07	1.36E+04	0%	0.001	1.36E+01	0%
Eu-154	4.61E-03	5.79E-03	6.86E+07	3.97E+05	0%	0.001	3.97E+02	0%
Eu-155	6.50E-03	8.16E-03	1.81E+07	1.48E+05	0%	0.001	1.48E+02	0%
Gd-152	1.75E-05	2.20E-05	5.15E-03	1.13E-07	0%	0.001	1.13E-10	0%
Tb-160	1.32E-27	1.65E-27	2.48E+08	4.10E-19	0%	0.001	4.10E-22	0%
Ra-224	2.81E-15	3.53E-15	4.67E+11	1.65E-03	0%	0.001	1.65E-06	0%
Th-228	5.46E-13	6.86E-13	2.54E+11	1.74E-01	0%	0.001	1.74E-04	0%
U-232	2.08E-11	2.62E-11	1.48E+10	3.87E-01	0%	0.001	3.87E-04	0%
U-234	1.42E-17	1.79E-17	8.08E+05	1.45E-11	0%	0.001	1.45E-14	0%
U-235	1.20E-01	1.51E-01	2.59E+02	3.90E+01	0%	0.001	3.90E-02	0%
U-236	3.74E-03	4.69E-03	7.76E+03	3.64E+01	0%	0.001	3.64E-02	0%
U-238	7.03E+01	8.82E+01	4.03E+01	3.56E+03	0%	0.001	3.56E+00	0%
Np-237	1.21E-02	1.52E-02	3.45E+05	5.25E+03	0%	0.001	5.25E+00	0%
Pu-236	7.05E-13	8.85E-13	8.53E+10	7.55E-02	0%	0.001	7.55E-05	0%
Pu-238	1.18E-04	1.48E-04	7.88E+09	1.17E+06	0%	0.001	1.17E+03	0%
Pu-239	7.96E-01	1.00E+00	3.16E+07	3.16E+07	5%	0.001	3.16E+04	5%

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
				Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
Pu-240	4.58E-02	5.75E-02	1.16E+08	6.67E+06	1%	0.001	6.67E+03	1%
Pu-241	3.20E-03	4.01E-03	1.03E+09	4.13E+06	1%	0.001	4.13E+03	1%
Pu-242	2.14E-04	2.68E-04	1.89E+06	5.07E+02	0%	0.001	5.07E-01	0%
Am-241	7.41E-02	9.31E-02	1.79E+09	1.67E+08	28%	0.001	1.67E+05	27%
Am-242m	3.82E-05	4.80E-05	4.96E+09	2.38E+05	0%	0.001	2.38E+02	0%
Am-243	4.04E-06	5.08E-06	1.04E+08	5.28E+02	0%	0.001	5.28E-01	0%
Cm-242	9.26E-08	1.16E-07	5.62E+10	6.54E+03	0%	0.001	6.54E+00	0%
Cm-243	3.84E-07	4.82E-07	1.81E+10	8.72E+03	0%	0.001	8.72E+00	0%
Cm-244	4.45E-08	5.59E-08	2.18E+10	1.22E+03	0%	0.001	1.22E+00	0%
Cm-245	3.72E-10	4.67E-10	9.27E+07	4.33E-02	0%	0.001	4.33E-05	0%
Cm-246	3.51E-12	4.41E-12	1.65E+08	7.27E-04	0%	0.001	7.27E-07	0%
Cm-247	3.66E-15	4.60E-15	4.55E+04	2.09E-10	0%	0.001	2.09E-13	0%
Cm-248	1.93E-17	2.42E-17	8.08E+06	1.95E-10	0%	0.001	1.95E-13	0%
Bk-249	3.33E-27	4.18E-27	2.17E+09	9.07E-18	0%	0.001	9.07E-21	0%
Cf-249	5.79E-22	7.27E-22	2.20E+09	1.60E-12	0%	0.001	1.60E-15	0%
				<u>6.01E+08</u>			<u>6.07E+05</u>	

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly

5 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
				Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
H-3	3.10E-05	0.00E+00	9.22E+05	0.00E+00	0%	1	0.00E+00	0%
Cr-51	1.03E-23	1.74E-23	2.40E+07	4.19E-16	0%	0.001	4.19E-19	0%
Co-60	1.53E-03	2.73E-03	1.70E+08	4.64E+05	0%	0.001	4.64E+02	0%
Se-79	1.84E-02	2.96E-02	6.20E+02	1.83E+01	0%	0.01	1.83E-01	0%
Rb-87	7.83E-01	7.01E-02	2.87E-04	2.01E-05	0%	0.001	2.01E-08	0%
Sr-89	3.11E-11	5.57E-11	1.07E+09	5.96E-02	0%	0.001	5.96E-05	0%
<u>Sr-90</u>	1.63E+00	2.92E+00	1.81E+08	5.29E+08	<u>62%</u>	0.001	5.29E+05	<u>46%</u>
Y-90	4.25E-04	7.60E-04	4.46E+09	3.39E+06	0%	0.001	3.39E+03	0%
Y-91	6.43E-10	1.15E-09	1.08E+09	1.24E+00	0%	0.001	1.24E-03	0%
Zr-93	2.28E+00	4.07E+00	8.04E+02	3.28E+03	0%	0.001	3.28E+00	0%
Zr-95	8.27E-09	1.48E-08	3.86E+08	5.71E+00	0%	0.001	5.71E-03	0%
Nb-95	9.56E-09	1.71E-08	1.76E+08	3.01E+00	0%	0.001	3.01E-03	0%
Nb-95m	5.79E-12	1.04E-11	8.08E+08	8.37E-03	0%	0.001	8.37E-06	0%
Tc-99	2.65E+00	0.00E+00	1.27E+02	0.00E+00	0%	0.001	0.00E+00	0%
Ru-103	1.95E-14	1.75E-14	2.51E+08	4.38E-06	0%	0.01	4.38E-08	0%
<u>Ru-106</u>	2.39E-02	2.14E-02	1.47E+09	3.14E+07	<u>4%</u>	0.01	3.14E+05	<u>28%</u>
Pd-107	5.12E-01	9.16E-01	6.68E+00	6.12E+00	0%	0.001	6.12E-03	0%
Cd-115m	1.40E-15	2.37E-15	1.65E+09	3.92E-06	0%	0.001	3.92E-09	0%
In-115	2.60E-02	4.41E-02	1.77E-05	7.81E-07	0%	0.001	7.81E-10	0%
Sn-121m	8.45E-06	1.45E-05	3.48E+05	5.05E+00	0%	0.001	5.05E-03	0%
Sn-123	8.05E-07	1.38E-06	2.47E+08	3.42E+02	0%	0.001	3.42E-01	0%
Sn-125	8.85E-60	1.52E-59	1.52E+09	2.31E-50	0%	0.001	2.31E-53	0%
Sn-126	7.99E-02	1.37E-01	2.44E+03	3.35E+02	0%	0.001	3.35E-01	0%
Sb-124	3.56E-14	6.33E-14	3.67E+08	2.32E-05	0%	0.001	2.32E-08	0%
Sb-125	1.55E-02	2.76E-02	1.01E+07	2.78E+05	0%	0.001	2.78E+02	0%
Sb-126	3.80E-10	6.53E-10	8.36E+08	5.46E-01	0%	0.001	5.46E-04	0%
Te-127m	2.24E-07	4.01E-07	1.79E+08	7.18E+01	0%	0.01	7.18E-01	0%
Te-129m	3.45E-18	6.18E-18	6.03E+08	3.73E-09	0%	0.01	3.73E-11	0%
I-129	5.60E-01	0.00E+00	3.18E+01	0.00E+00	0%	0.5	0.00E+00	0%
I-131	2.56E-69	0.00E+00	3.97E+09	0.00E+00	0%	0.5	0.00E+00	0%
Cs-134	5.01E-03	4.48E-04	6.08E+07	2.73E+04	0%	0.01	2.73E+02	0%
Cs-135	3.19E-01	2.86E-02	5.18E+00	1.48E-01	0%	0.01	1.48E-03	0%
Cs-136	5.78E-45	5.17E-46	5.47E+08	2.83E-37	0%	0.01	2.83E-39	0%
<u>Cs-137</u>	3.40E+00	3.04E-01	2.77E+06	8.42E+05	0%	0.01	8.42E+03	<u>1%</u>
Ba-140	1.65E-43	2.96E-43	2.63E+08	7.78E-35	0%	0.001	7.78E-38	0%
La-140	2.49E-44	4.46E-44	2.45E+09	1.09E-34	0%	0.001	1.09E-37	0%
Ce-141	3.04E-17	5.44E-17	2.42E+08	1.32E-08	0%	0.001	1.32E-11	0%
<u>Ce-144</u>	3.47E-02	6.21E-02	1.12E+09	6.96E+07	<u>8%</u>	0.001	6.96E+04	<u>6%</u>
Pr-143	5.50E-41	9.83E-41	4.92E+08	4.83E-32	0%	0.001	4.83E-35	0%
Nd-144	3.17E+00	5.67E+00	0.00E+00	0.00E+00	0%	0.001	0.00E+00	0%
Nd-147	5.28E-51	9.44E-51	5.02E+08	4.74E-42	0%	0.001	4.74E-45	0%
<u>Pm-147</u>	3.63E-01	6.49E-01	3.15E+07	2.04E+07	<u>2%</u>	0.001	2.04E+04	<u>2%</u>
Pm-148	3.66E-18	6.54E-18	1.64E+09	1.07E-08	0%	0.001	1.07E-11	0%
Pm-148m	4.08E-16	7.29E-16	2.14E+08	1.56E-07	0%	0.001	1.56E-10	0%
Sm-147	1.00E+00	1.79E+00	1.65E+00	2.95E+00	0%	0.001	2.95E-03	0%
Sm-151	1.76E-01	3.15E-01	7.63E+05	2.40E+05	0%	0.001	2.40E+02	0%
Eu-152	3.77E-04	6.75E-04	3.81E+07	2.57E+04	0%	0.001	2.57E+01	0%
Eu-154	6.84E-03	1.22E-02	6.86E+07	8.39E+05	0%	0.001	8.39E+02	0%
Eu-155	1.86E-02	3.34E-02	1.81E+07	6.04E+05	0%	0.001	6.04E+02	0%
Eu-156	3.32E-38	5.94E-38	6.06E+08	3.60E-29	0%	0.001	3.60E-32	0%
Gd-152	1.06E-05	1.89E-05	5.15E-03	9.73E-08	0%	0.001	9.73E-11	0%
Tb-160	1.21E-12	2.17E-12	2.48E+08	5.38E-04	0%	0.001	5.38E-07	0%
Ra-224	5.05E-11	9.04E-11	4.67E+11	4.22E+01	0%	0.001	4.22E-02	0%
Th-228	9.79E-09	1.75E-08	2.54E+11	4.45E+03	0%	0.001	4.45E+00	0%
U-232	1.82E-07	3.26E-07	1.48E+10	4.82E+03	0%	0.001	4.82E+00	0%

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized		Volatile Conditions		Release Fraction Values	Evaporative Conditions	
		Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
U-234	9.71E-18	1.74E-17	8.08E+05	1.40E-11	0%	0.001	1.40E-14	0%
U-235	7.95E-02	1.42E-01	2.59E+02	3.68E+01	0%	0.001	3.68E-02	0%
U-236	2.75E-03	4.93E-03	7.76E+03	3.82E+01	0%	0.001	3.82E-02	0%
U-238	4.77E+01	8.53E+01	4.03E+01	3.44E+03	0%	0.001	3.44E+00	0%
Np-237	7.47E-03	1.34E-02	3.45E+05	4.61E+03	0%	0.001	4.61E+00	0%
Pu-236	9.38E-08	1.68E-07	8.53E+10	1.43E+04	0%	0.001	1.43E+01	0%
Pu-238	6.68E-05	1.20E-04	7.88E+09	9.42E+05	0%	0.001	9.42E+02	0%
<u>Pu-239</u>	5.59E-01	1.00E+00	3.16E+07	3.16E+07	<u>4%</u>	0.001	3.16E+04	<u>3%</u>
<u>Pu-240</u>	3.41E-02	6.11E-02	1.16E+08	7.08E+06	<u>1%</u>	0.001	7.08E+03	<u>1%</u>
<u>Pu-241</u>	3.24E-03	5.79E-03	1.03E+09	5.97E+06	<u>1%</u>	0.001	5.97E+03	<u>1%</u>
Pu-242	1.49E-04	2.67E-04	1.89E+06	5.05E+02	0%	0.001	5.05E-01	0%
<u>Am-241</u>	4.56E-02	8.16E-02	1.79E+09	1.46E+08	<u>17%</u>	0.001	1.46E+05	<u>13%</u>
Am-242m	2.02E-05	3.62E-05	4.96E+09	1.80E+05	0%	0.001	1.80E+02	0%
Am-243	2.29E-06	4.10E-06	1.04E+08	4.27E+02	0%	0.001	4.27E-01	0%
Cm-242	1.09E-07	1.94E-07	5.62E+10	1.09E+04	0%	0.001	1.09E+01	0%
Cm-243	2.20E-07	3.94E-07	1.81E+10	7.13E+03	0%	0.001	7.13E+00	0%
Cm-244	3.06E-06	5.47E-06	2.18E+10	1.19E+05	0%	0.001	1.19E+02	0%
Cm-245	1.37E-10	2.45E-10	9.27E+07	2.27E-02	0%	0.001	2.27E-05	0%
Cm-246	1.41E-12	2.53E-12	1.65E+08	4.18E-04	0%	0.001	4.18E-07	0%
Cm-247	1.14E-15	2.04E-15	4.55E+04	9.28E-11	0%	0.001	9.28E-14	0%
Cm-248	5.02E-18	8.98E-18	8.08E+06	7.26E-11	0%	0.001	7.26E-14	0%
Bk-249	2.84E-24	5.07E-24	2.17E+09	1.10E-14	0%	0.001	1.10E-17	0%
Cf-249	1.56E-22	2.78E-22	2.20E+09	6.13E-13	0%	0.001	6.13E-16	0%
				<u>8.49E+08</u>			<u>1.14E+06</u>	

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction	Evaporative Conditions	
				Dose (rem/g Pu-239)	Percent Dose	Values	Dose (rem/g Pu-239)	Percent Dose
H-3	1.76E-06	0.00E+00	9.22E+05	0.00E+00	0%	1	0.00E+00	0%
Cr-51	2.89E-63	4.91E-63	2.40E+07	1.18E-55	0%	0.001	1.18E-58	0%
Co-60	4.08E-04	7.30E-04	1.70E+08	1.24E+05	0%	0.001	1.24E+02	0%
Se-79	1.84E-02	2.96E-02	6.20E+02	1.83E+01	0%	0.01	1.83E-01	0%
Rb-87	7.83E-01	7.01E-02	2.87E-04	2.01E-05	0%	0.001	2.01E-08	0%
Sr-89	2.23E-32	4.00E-32	1.07E+09	4.28E-23	0%	0.001	4.28E-26	0%
Sr-90	1.28E+00	2.28E+00	1.81E+08	4.13E+08	68%	0.001	4.13E+05	67%
Y-90	3.32E-04	5.94E-04	4.46E+09	2.65E+06	0%	0.001	2.65E+03	0%
Y-91	1.11E-28	1.99E-28	1.08E+09	2.15E-19	0%	0.001	2.15E-22	0%
Zr-93	2.28E+00	4.07E+00	8.04E+02	3.28E+03	0%	0.001	3.28E+00	0%
Zr-95	1.35E-25	2.42E-25	3.86E+08	9.34E-17	0%	0.001	9.34E-20	0%
Nb-95	1.56E-25	2.80E-25	1.76E+08	4.92E-17	0%	0.001	4.92E-20	0%
Nb-95m	9.47E-29	1.69E-28	8.08E+08	1.37E-19	0%	0.001	1.37E-22	0%
Tc-99	2.65E+00	0.00E+00	1.27E+02	0.00E+00	0%	0.001	0.00E+00	0%
Ru-103	3.35E-42	3.00E-42	2.51E+08	7.52E-34	0%	0.01	7.52E-36	0%
Ru-106	2.51E-05	2.24E-05	1.47E+09	3.30E+04	0%	0.01	3.30E+02	0%
Pd-107	5.12E-01	9.16E-01	6.68E+00	6.12E+00	0%	0.001	6.12E-03	0%
Cd-115m	3.10E-40	5.28E-40	1.65E+09	8.71E-31	0%	0.001	8.71E-34	0%
In-115	2.60E-02	4.42E-02	1.77E-05	7.82E-07	0%	0.001	7.82E-10	0%
Sn-121m	7.36E-06	1.26E-05	3.48E+05	4.40E+00	0%	0.001	4.40E-03	0%
Sn-123	2.41E-15	4.15E-15	2.47E+08	1.02E-06	0%	0.001	1.02E-09	0%
Sn-126	7.99E-02	1.37E-01	2.44E+03	3.35E+02	0%	0.001	3.35E-01	0%
Sb-124	1.94E-32	3.45E-32	3.67E+08	1.27E-23	0%	0.001	1.27E-26	0%
Sb-125	1.22E-03	2.18E-03	1.01E+07	2.20E+04	0%	0.001	2.20E+01	0%
Sb-126	3.80E-10	6.53E-10	8.36E+08	5.46E-01	0%	0.001	5.46E-04	0%
Te-127m	1.83E-17	3.28E-17	1.79E+08	5.87E-09	0%	0.01	5.87E-11	0%
Te-129m	4.16E-51	7.44E-51	6.03E+08	4.49E-42	0%	0.01	4.49E-44	0%
I-129	5.60E-01	0.00E+00	3.18E+01	0.00E+00	0%	0.5	0.00E+00	0%
Cs-134	1.73E-04	1.55E-05	6.08E+07	9.43E+02	0%	0.01	9.43E+00	0%
Cs-135	3.19E-01	2.86E-02	5.18E+00	1.48E-01	0%	0.01	1.48E-03	0%
Cs-137	2.70E+00	2.42E-01	2.77E+06	6.69E+05	0%	0.01	6.69E+03	1%
Ce-141	4.82E-51	8.62E-51	2.42E+08	2.09E-42	0%	0.001	2.09E-45	0%
Ce-144	4.73E-06	8.46E-06	1.12E+09	9.47E+03	0%	0.001	9.47E+00	0%
Nd-144	3.20E+00	5.73E+00	0.00E+00	0.00E+00	0%	0.001	0.00E+00	0%
Pm-147	2.58E-02	4.62E-02	3.15E+07	1.46E+06	0%	0.001	1.46E+03	0%
Pm-148	8.72E-45	1.56E-44	1.64E+09	2.56E-35	0%	0.001	2.56E-38	0%
Pm-148m	9.72E-43	1.74E-42	2.14E+08	3.72E-34	0%	0.001	3.72E-37	0%
Sm-147	1.34E+00	2.39E+00	1.65E+00	3.95E+00	0%	0.001	3.95E-03	0%
Sm-151	1.63E-01	2.92E-01	7.63E+05	2.23E+05	0%	0.001	2.23E+02	0%
Eu-152	2.21E-04	3.96E-04	3.81E+07	1.51E+04	0%	0.001	1.51E+01	0%
Eu-154	3.05E-03	5.46E-03	6.86E+07	3.75E+05	0%	0.001	3.75E+02	0%
Eu-155	4.40E-03	7.87E-03	1.81E+07	1.42E+05	0%	0.001	1.42E+02	0%
Gd-152	1.06E-05	1.89E-05	5.15E-03	9.73E-08	0%	0.001	9.73E-11	0%
Tb-160	7.52E-28	1.34E-27	2.48E+08	3.34E-19	0%	0.001	3.34E-22	0%
Ra-224	3.29E-11	5.89E-11	4.67E+11	2.75E+01	0%	0.001	2.75E-02	0%
Th-228	6.40E-09	1.14E-08	2.54E+11	2.91E+03	0%	0.001	2.91E+00	0%
U-232	2.44E-07	4.37E-07	1.48E+10	6.46E+03	0%	0.001	6.46E+00	0%
U-234	9.70E-18	1.74E-17	8.08E+05	1.40E-11	0%	0.001	1.40E-14	0%
U-235	7.95E-02	1.42E-01	2.59E+02	3.68E+01	0%	0.001	3.68E-02	0%
U-236	2.75E-03	4.93E-03	7.76E+03	3.82E+01	0%	0.001	3.82E-02	0%
U-238	4.77E+01	8.54E+01	4.03E+01	3.44E+03	0%	0.001	3.44E+00	0%
Np-237	7.47E-03	1.34E-02	3.45E+05	4.61E+03	0%	0.001	4.61E+00	0%
Pu-236	8.25E-09	1.48E-08	8.53E+10	1.26E+03	0%	0.001	1.26E+00	0%
Pu-238	6.25E-05	1.12E-04	7.88E+09	8.81E+05	0%	0.001	8.81E+02	0%
<u>Pu-239</u>	5.59E-01	1.00E+00	3.16E+07	3.16E+07	<u>5%</u>	0.001	3.16E+04	<u>5%</u>

PUREX RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
				Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose
<u>Pu-240</u>	3.41E-02	6.10E-02	1.16E+08	7.08E+06	<u>1%</u>	0.001	7.08E+03	<u>1%</u>
<u>Pu-241</u>	2.02E-03	3.62E-03	1.03E+09	3.72E+06	<u>1%</u>	0.001	3.72E+03	<u>1%</u>
Pu-242	1.49E-04	2.67E-04	1.89E+06	5.05E+02	0%	0.001	5.05E-01	0%
<u>Am-241</u>	4.61E-02	8.25E-02	1.79E+09	1.48E+08	<u>24%</u>	0.001	1.48E+05	<u>24%</u>
Am-242m	1.93E-05	3.46E-05	4.96E+09	1.72E+05	0%	0.001	1.72E+02	0%
Am-243	2.29E-06	4.10E-06	1.04E+08	4.26E+02	0%	0.001	4.26E-01	0%
Cm-242	4.68E-08	8.38E-08	5.62E+10	4.71E+03	0%	0.001	4.71E+00	0%
Cm-243	1.73E-07	3.09E-07	1.81E+10	5.59E+03	0%	0.001	5.59E+00	0%
Cm-244	2.09E-08	3.73E-08	2.18E+10	8.14E+02	0%	0.001	8.14E-01	0%
Cm-245	1.37E-10	2.45E-10	9.27E+07	2.27E-02	0%	0.001	2.27E-05	0%
Cm-246	1.41E-12	2.53E-12	1.65E+08	4.17E-04	0%	0.001	4.17E-07	0%
Cm-247	1.14E-15	2.04E-15	4.55E+04	9.28E-11	0%	0.001	9.28E-14	0%
Cm-248	5.02E-18	8.99E-18	8.08E+06	7.26E-11	0%	0.001	7.26E-14	0%
Bk-249	8.93E-28	1.60E-27	2.17E+09	3.47E-18	0%	0.001	3.47E-21	0%
Cf-249	1.55E-22	2.78E-22	2.20E+09	6.12E-13	0%	0.001	6.12E-16	0%
				<u>6.10E+08</u>			<u>6.17E+05</u>	

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
H-3	3.64E-05	0.00E+00	6.11E+05	0.00E+00	0%
Cr-51	3.03E-23	3.61E-23	1.20E+07	4.33E-16	0%
Co-60	4.50E-03	5.65E-03	2.94E+07	1.66E+05	0%
Se-79	2.51E-02	2.84E-02	5.56E+02	1.58E+01	0%
Rb-87	1.04E+00	6.54E-02	4.17E-04	2.73E-05	0%
Sr-89	3.87E-11	4.86E-11	2.53E+08	1.23E-02	0%
Sr-90	2.16E+00	2.72E+00	1.81E+07	4.92E+07	79%
Y-90	5.63E-04	7.07E-04	5.43E+09	3.84E+06	6%
Y-91	8.07E-10	1.01E-09	2.18E+08	2.21E-01	0%
Zr-93	3.05E+00	3.83E+00	4.02E+00	1.54E+01	0%
Zr-95	1.06E-08	1.33E-08	7.30E+07	9.68E-01	0%
Nb-95	1.22E-08	1.53E-08	8.63E+07	1.32E+00	0%
Nb-95m	7.39E-12	9.28E-12	7.35E+08	6.82E-03	0%
Tc-99	3.59E+00	0.00E+00	2.20E+01	0.00E+00	0%
Ru-103	2.50E-14	1.57E-14	8.70E+07	1.37E-06	0%
Ru-106	3.38E-02	2.12E-02	7.03E+07	1.49E+06	2%
Pd-107	7.27E-01	9.13E-01	7.20E-02	6.57E-02	0%
Cd-115m	2.14E-15	2.55E-15	3.81E+08	9.73E-07	0%
In-115	4.24E-02	5.06E-02	7.28E-07	3.69E-08	0%
Sn-121m	1.17E-05	1.41E-05	5.08E+04	7.17E-01	0%
Sn-123	1.25E-06	1.51E-06	6.33E+07	9.57E+01	0%
Sn-125	1.10E-59	1.32E-59	1.14E+07	1.51E-52	0%
Sn-126	1.20E-01	1.45E-01	4.82E+02	6.97E+01	0%
Sb-124	6.08E-14	7.59E-14	1.63E+08	1.24E-05	0%
Sb-125	2.39E-02	2.98E-02	2.69E+06	8.03E+04	0%
Sb-126	5.70E-10	6.87E-10	6.10E+06	4.19E-03	0%
Te-127m	3.16E-07	3.96E-07	7.45E+07	2.95E+01	0%
Te-129m	4.41E-18	5.54E-18	2.98E+08	1.65E-09	0%
I-129	7.85E-01	0.00E+00	4.94E+01	0.00E+00	0%
I-131	2.81E-69	0.00E+00	6.57E+09	0.00E+00	0%
Cs-134	6.39E-03	4.01E-04	9.58E+07	3.84E+04	0%
Cs-135	5.91E-01	3.71E-02	8.17E+00	3.03E-01	0%
Cs-136	6.85E-45	4.30E-46	8.03E+08	3.45E-37	0%
Cs-137	4.59E+00	2.88E-01	4.33E+06	1.25E+06	2%
Ba-140	1.86E-43	2.33E-43	6.13E+08	1.43E-34	0%
La-140	2.80E-44	3.52E-44	4.29E+09	1.51E-34	0%
Ce-141	3.72E-17	4.67E-17	7.41E+07	3.46E-09	0%
Ce-144	4.60E-02	5.78E-02	6.38E+07	3.69E+06	6%
Pr-143	6.19E-41	7.77E-41	3.03E+08	2.35E-32	0%
Nd-144	4.25E+00	5.34E+00	0.00E+00	0.00E+00	0%
Nd-147	5.90E-51	7.41E-51	3.16E+08	2.34E-42	0%
Pm-147	4.82E-01	6.05E-01	8.81E+05	5.33E+05	1%
Pm-148	6.65E-18	8.35E-18	1.56E+09	1.30E-08	0%
Pm-148m	7.41E-16	9.31E-16	1.50E+08	1.40E-07	0%
Sm-147	1.33E+00	1.68E+00	4.19E-03	7.02E-03	0%
Sm-151	2.59E-01	3.25E-01	8.95E+03	2.91E+03	0%
Eu-152	4.85E-04	6.09E-04	1.04E+06	6.33E+02	0%
Eu-154	1.03E-02	1.30E-02	2.40E+06	3.11E+04	0%
Eu-155	2.76E-02	3.46E-02	6.05E+05	2.09E+04	0%
Eu-156	4.00E-38	5.02E-38	4.79E+08	2.41E-29	0%
Gd-152	1.75E-05	2.20E-05	3.22E-06	7.08E-11	0%
Tb-160	2.12E-12	2.66E-12	7.23E+07	1.93E-04	0%
Ra-224	4.31E-15	5.42E-15	5.31E+10	2.88E-04	0%
Th-228	8.36E-13	1.05E-12	3.11E+08	3.27E-04	0%

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
U-232	1.56E-11	1.95E-11	2.86E+07	5.59E-04	0%
U-234	1.42E-17	1.79E-17	1.62E+03	2.90E-14	0%
U-235	1.20E-01	1.51E-01	5.41E-01	8.15E-02	0%
U-236	3.74E-03	4.69E-03	1.62E+01	7.60E-02	0%
U-238	7.03E+01	8.82E+01	7.73E-02	6.82E+00	0%
Np-237	1.21E-02	1.52E-02	2.75E+03	4.19E+01	0%
Pu-236	8.01E-12	1.01E-11	6.93E+08	6.97E-03	0%
Pu-238	1.26E-04	1.58E-04	6.51E+07	1.03E+04	0%
Pu-239	7.96E-01	1.00E+00	2.67E+05	2.67E+05	0%
Pu-240	4.59E-02	5.76E-02	9.75E+05	5.61E+04	0%
Pu-241	5.12E-03	6.43E-03	8.86E+06	5.70E+04	0%
Pu-242	2.13E-04	2.68E-04	1.61E+04	4.31E+00	0%
Am-241	7.34E-02	9.21E-02	1.54E+07	1.42E+06	2%
Am-242m	4.00E-05	5.03E-05	4.08E+07	2.05E+03	0%
Am-243	4.05E-06	5.08E-06	8.97E+05	4.56E+00	0%
Cm-242	2.09E-07	2.63E-07	3.64E+08	9.56E+01	0%
Cm-243	4.89E-07	6.14E-07	1.50E+08	9.21E+01	0%
Cm-244	6.53E-08	8.20E-08	1.86E+08	1.52E+01	0%
Cm-245	3.72E-10	4.67E-10	7.73E+05	3.61E-04	0%
Cm-246	3.51E-12	4.41E-12	1.38E+06	6.09E-06	0%
Cm-247	3.66E-15	4.60E-15	3.80E+02	1.75E-12	0%
Cm-248	1.93E-17	2.42E-17	6.80E+04	1.64E-12	0%
Bk-249	1.06E-23	1.33E-23	1.00E+07	1.33E-16	0%
Cf-249	5.80E-22	7.28E-22	1.84E+07	1.34E-14	0%
				<u>6.22E+07</u>	

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
H-3	2.09E-05	0.00E+00	6.11E+05	0.00E+00	0%
Cr-51	8.51E-63	1.02E-62	1.20E+07	1.22E-55	0%
Co-60	1.20E-03	1.51E-03	2.94E+07	4.45E+04	0%
Se-79	2.51E-02	2.84E-02	5.56E+02	1.58E+01	0%
Rb-87	1.04E+00	6.54E-02	4.17E-04	2.73E-05	0%
Sr-89	2.78E-32	3.49E-32	2.53E+08	8.82E-24	0%
Sr-90	1.69E+00	2.12E+00	1.81E+07	3.85E+07	87%
Y-90	4.40E-04	5.53E-04	5.43E+09	3.00E+06	7%
Y-91	1.39E-28	1.75E-28	2.18E+08	3.81E-20	0%
Zr-93	3.04E+00	3.82E+00	4.02E+00	1.54E+01	0%
Zr-95	1.73E-25	2.17E-25	7.30E+07	1.58E-17	0%
Nb-95	1.99E-25	2.51E-25	8.63E+07	2.16E-17	0%
Nb-95m	1.21E-28	1.52E-28	7.35E+08	1.12E-19	0%
Tc-99	3.59E+00	0.00E+00	2.20E+01	0.00E+00	0%
Ru-103	4.29E-42	2.69E-42	8.70E+07	2.34E-34	0%
Ru-106	3.54E-05	2.23E-05	7.03E+07	1.57E+03	0%
Pd-107	7.27E-01	9.13E-01	7.20E-02	6.58E-02	0%
Cd-115m	4.76E-40	5.68E-40	3.81E+08	2.16E-31	0%
In-115	4.24E-02	5.07E-02	7.28E-07	3.69E-08	0%
Sn-121m	1.02E-05	1.23E-05	5.08E+04	6.24E-01	0%
Sn-123	3.76E-15	4.54E-15	6.33E+07	2.87E-07	0%
Sn-126	1.20E-01	1.45E-01	4.82E+02	6.97E+01	0%
Sb-124	3.31E-32	4.13E-32	1.63E+08	6.74E-24	0%
Sb-125	1.89E-03	2.36E-03	2.69E+06	6.34E+03	0%
Sb-126	5.70E-10	6.87E-10	6.10E+06	4.19E-03	0%
Te-127m	2.58E-17	3.24E-17	7.45E+07	2.41E-09	0%
Te-129m	5.31E-51	6.67E-51	2.98E+08	1.99E-42	0%
I-129	7.85E-01	0.00E+00	4.94E+01	0.00E+00	0%
Cs-134	2.90E-04	1.82E-05	9.58E+07	1.74E+03	0%
Cs-135	5.91E-01	3.71E-02	8.17E+00	3.03E-01	0%
Cs-137	3.65E+00	2.29E-01	4.33E+06	9.92E+05	2%
Ce-141	5.90E-51	7.41E-51	7.41E+07	5.49E-43	0%
Ce-144	6.26E-06	7.87E-06	6.38E+07	5.02E+02	0%
Nd-144	4.30E+00	5.40E+00	0.00E+00	0.00E+00	0%
Pm-147	3.43E-02	4.31E-02	8.81E+05	3.79E+04	0%
Pm-148	1.59E-44	1.99E-44	1.56E+09	3.11E-35	0%
Pm-148m	1.77E-42	2.22E-42	1.50E+08	3.33E-34	0%
Sm-147	1.78E+00	2.24E+00	4.19E-03	9.37E-03	0%
Sm-151	2.40E-01	3.02E-01	8.95E+03	2.70E+03	0%
Eu-152	2.84E-04	3.57E-04	1.04E+06	3.71E+02	0%
Eu-154	4.61E-03	5.79E-03	2.40E+06	1.39E+04	0%
Eu-155	6.50E-03	8.16E-03	6.05E+05	4.94E+03	0%
Gd-152	1.75E-05	2.20E-05	3.22E-06	7.08E-11	0%
Tb-160	1.32E-27	1.65E-27	7.23E+07	1.19E-19	0%
Ra-224	2.81E-15	3.53E-15	5.31E+10	1.87E-04	0%
Th-228	5.46E-13	6.86E-13	3.11E+08	2.13E-04	0%
U-232	2.08E-11	2.62E-11	2.86E+07	7.49E-04	0%
U-234	1.42E-17	1.79E-17	1.62E+03	2.90E-14	0%
U-235	1.20E-01	1.51E-01	5.41E-01	8.16E-02	0%
U-236	3.74E-03	4.68E-03	1.62E+01	7.61E-02	0%
U-238	7.03E+01	8.82E+01	7.73E-02	6.82E+00	0%
Np-237	1.21E-02	1.52E-02	2.75E+03	4.19E+01	0%
Pu-236	7.05E-13	8.85E-13	6.93E+08	6.13E-04	0%
Pu-238	1.18E-04	1.48E-04	6.51E+07	9.65E+03	0%
<u>Pu-239</u>	7.96E-01	1.00E+00	2.67E+05	2.67E+05	<u>1%</u>

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
Pu-240	4.59E-02	5.75E-02	9.75E+05	5.61E+04	0%
Pu-241	3.20E-03	4.01E-03	8.86E+06	3.56E+04	0%
Pu-242	2.14E-04	2.68E-04	1.61E+04	4.32E+00	0%
Am-241	7.41E-02	9.31E-02	1.54E+07	1.43E+06	3%
Am-242m	3.82E-05	4.80E-05	4.08E+07	1.96E+03	0%
Am-243	4.04E-06	5.08E-06	8.97E+05	4.56E+00	0%
Cm-242	9.26E-08	1.16E-07	3.64E+08	4.23E+01	0%
Cm-243	3.84E-07	4.82E-07	1.50E+08	7.23E+01	0%
Cm-244	4.45E-08	5.59E-08	1.86E+08	1.04E+01	0%
Cm-245	3.72E-10	4.67E-10	7.73E+05	3.61E-04	0%
Cm-246	3.51E-12	4.41E-12	1.38E+06	6.08E-06	0%
Cm-247	3.66E-15	4.60E-15	3.80E+02	1.75E-12	0%
Cm-248	1.93E-17	2.42E-17	6.80E+04	1.64E-12	0%
Bk-249	3.33E-27	4.18E-27	1.00E+07	4.18E-20	0%
Cf-249	5.79E-22	7.27E-22	1.84E+07	1.34E-14	0%
				<u>4.44E+07</u>	

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/gPu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
H-3	3.10E-05	0.00E+00	6.11E+05	0.00E+00	0%
Cr-51	1.03E-23	1.74E-23	1.20E+07	2.09E-16	0%
Co-60	1.53E-03	2.73E-03	2.94E+07	8.03E+04	0%
Se-79	1.84E-02	2.96E-02	5.56E+02	1.64E+01	0%
Rb-87	7.83E-01	7.01E-02	4.17E-04	2.92E-05	0%
Sr-89	3.11E-11	5.57E-11	2.53E+08	1.41E-02	0%
Sr-90	1.63E+00	2.92E+00	1.81E+07	5.29E+07	80%
Y-90	4.25E-04	7.60E-04	5.43E+09	4.13E+06	6%
Y-91	6.43E-10	1.15E-09	2.18E+08	2.51E-01	0%
Zr-93	2.28E+00	4.07E+00	4.02E+00	1.64E+01	0%
Zr-95	8.27E-09	1.48E-08	7.30E+07	1.08E+00	0%
Nb-95	9.56E-09	1.71E-08	8.63E+07	1.48E+00	0%
Nb-95m	5.79E-12	1.04E-11	7.35E+08	7.61E-03	0%
Tc-99	2.65E+00	0.00E+00	2.20E+01	0.00E+00	0%
Ru-103	1.95E-14	1.75E-14	8.70E+07	1.52E-06	0%
Ru-106	2.39E-02	2.14E-02	7.03E+07	1.50E+06	2%
Pd-107	5.12E-01	9.16E-01	7.20E-02	6.59E-02	0%
Cd-115m	1.40E-15	2.37E-15	3.81E+08	9.04E-07	0%
In-115	2.60E-02	4.41E-02	7.28E-07	3.21E-08	0%
Sn-121m	8.45E-06	1.45E-05	5.08E+04	7.38E-01	0%
Sn-123	8.05E-07	1.38E-06	6.33E+07	8.75E+01	0%
Sn-125	8.85E-60	1.52E-59	1.14E+07	1.73E-52	0%
Sn-126	7.99E-02	1.37E-01	4.82E+02	6.62E+01	0%
Sb-124	3.56E-14	6.33E-14	1.63E+08	1.03E-05	0%
Sb-125	1.55E-02	2.76E-02	2.69E+06	7.41E+04	0%
Sb-126	3.80E-10	6.53E-10	6.10E+06	3.98E-03	0%
Te-127m	2.24E-07	4.01E-07	7.45E+07	2.99E+01	0%
Te-129m	3.45E-18	6.18E-18	2.98E+08	1.84E-09	0%
I-129	5.60E-01	0.00E+00	4.94E+01	0.00E+00	0%
I-131	2.56E-69	0.00E+00	6.57E+09	0.00E+00	0%
Cs-134	5.01E-03	4.48E-04	9.58E+07	4.30E+04	0%
Cs-135	3.19E-01	2.86E-02	8.17E+00	2.33E-01	0%
Cs-136	5.78E-45	5.17E-46	8.03E+08	4.15E-37	0%
Cs-137	3.40E+00	3.04E-01	4.33E+06	1.32E+06	2%
Ba-140	1.65E-43	2.96E-43	6.13E+08	1.81E-34	0%
La-140	2.49E-44	4.46E-44	4.29E+09	1.91E-34	0%
Ce-141	3.04E-17	5.44E-17	7.41E+07	4.03E-09	0%
Ce-144	3.47E-02	6.21E-02	6.38E+07	3.96E+06	6%
Pr-143	5.50E-41	9.83E-41	3.03E+08	2.98E-32	0%
Nd-144	3.17E+00	5.67E+00	0.00E+00	0.00E+00	0%
Nd-147	5.28E-51	9.44E-51	3.16E+08	2.98E-42	0%
Pm-147	3.63E-01	6.49E-01	8.81E+05	5.72E+05	1%
Pm-148	3.66E-18	6.54E-18	1.56E+09	1.02E-08	0%
Pm-148m	4.08E-16	7.29E-16	1.50E+08	1.09E-07	0%
Sm-147	1.00E+00	1.79E+00	4.19E-03	7.49E-03	0%
Sm-151	1.76E-01	3.15E-01	8.95E+03	2.82E+03	0%
Eu-152	3.77E-04	6.75E-04	1.04E+06	7.02E+02	0%
Eu-154	6.84E-03	1.22E-02	2.40E+06	2.94E+04	0%
Eu-155	1.86E-02	3.34E-02	6.05E+05	2.02E+04	0%
Eu-156	3.32E-38	5.94E-38	4.79E+08	2.85E-29	0%
Gd-152	1.06E-05	1.89E-05	3.22E-06	6.08E-11	0%
Tb-160	1.21E-12	2.17E-12	7.23E+07	1.57E-04	0%
Ra-224	5.05E-11	9.04E-11	5.31E+10	4.80E+00	0%
Th-228	9.79E-09	1.75E-08	3.11E+08	5.45E+00	0%
U-232	1.82E-07	3.26E-07	2.86E+07	9.32E+00	0%

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
5 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/gPu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
U-234	9.71E-18	1.74E-17	1.62E+03	2.81E-14	0%
U-235	7.95E-02	1.42E-01	5.41E-01	7.69E-02	0%
U-236	2.75E-03	4.93E-03	1.62E+01	7.98E-02	0%
U-238	4.77E+01	8.53E+01	7.73E-02	6.60E+00	0%
Np-237	7.47E-03	1.34E-02	2.75E+03	3.67E+01	0%
Pu-236	9.38E-08	1.68E-07	6.93E+08	1.16E+02	0%
Pu-238	6.68E-05	1.20E-04	6.51E+07	7.78E+03	0%
Pu-239	5.59E-01	1.00E+00	2.67E+05	2.67E+05	0%
Pu-240	3.41E-02	6.11E-02	9.75E+05	5.95E+04	0%
Pu-241	3.24E-03	5.79E-03	8.86E+06	5.13E+04	0%
Pu-242	1.49E-04	2.67E-04	1.61E+04	4.30E+00	0%
Am-241	4.56E-02	8.16E-02	1.54E+07	1.26E+06	2%
Am-242m	2.02E-05	3.62E-05	4.08E+07	1.48E+03	0%
Am-243	2.29E-06	4.10E-06	8.97E+05	3.68E+00	0%
Cm-242	1.09E-07	1.94E-07	3.64E+08	7.06E+01	0%
Cm-243	2.20E-07	3.94E-07	1.50E+08	5.91E+01	0%
Cm-244	3.06E-06	5.47E-06	1.86E+08	1.02E+03	0%
Cm-245	1.37E-10	2.45E-10	7.73E+05	1.89E-04	0%
Cm-246	1.41E-12	2.53E-12	1.38E+06	3.49E-06	0%
Cm-247	1.14E-15	2.04E-15	3.80E+02	7.75E-13	0%
Cm-248	5.02E-18	8.98E-18	6.80E+04	6.11E-13	0%
Bk-249	2.84E-24	5.07E-24	1.00E+07	5.07E-17	0%
Cf-249	1.56E-22	2.78E-22	1.84E+07	5.12E-15	0%
				<u>6.63E+07</u>	

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
H-3	1.76E-06	0.00E+00	6.11E+05	0.00E+00	0%
Cr-51	2.89E-63	4.91E-63	1.20E+07	5.89E-56	0%
Co-60	4.08E-04	7.30E-04	2.94E+07	2.15E+04	0%
Se-79	1.84E-02	2.96E-02	5.56E+02	1.64E+01	0%
Rb-87	7.83E-01	7.01E-02	4.17E-04	2.92E-05	0%
Sr-89	2.23E-32	4.00E-32	2.53E+08	1.01E-23	0%
Sr-90	1.28E+00	2.28E+00	1.81E+07	4.13E+07	87%
<u>Y-90</u>	3.32E-04	5.94E-04	5.43E+09	3.23E+06	<u>7%</u>
Y-91	1.11E-28	1.99E-28	2.18E+08	4.33E-20	0%
Zr-93	2.28E+00	4.07E+00	4.02E+00	1.64E+01	0%
Zr-95	1.35E-25	2.42E-25	7.30E+07	1.77E-17	0%
Nb-95	1.56E-25	2.80E-25	8.63E+07	2.41E-17	0%
Nb-95m	9.47E-29	1.69E-28	7.35E+08	1.25E-19	0%
Tc-99	2.65E+00	0.00E+00	2.20E+01	0.00E+00	0%
Ru-103	3.35E-42	3.00E-42	8.70E+07	2.61E-34	0%
Ru-106	2.51E-05	2.24E-05	7.03E+07	1.58E+03	0%
Pd-107	5.12E-01	9.16E-01	7.20E-02	6.60E-02	0%
Cd-115m	3.10E-40	5.28E-40	3.81E+08	2.01E-31	0%
In-115	2.60E-02	4.42E-02	7.28E-07	3.21E-08	0%
Sn-121m	7.36E-06	1.26E-05	5.08E+04	6.42E-01	0%
Sn-123	2.41E-15	4.15E-15	6.33E+07	2.63E-07	0%
Sn-126	7.99E-02	1.37E-01	4.82E+02	6.62E+01	0%
Sb-124	1.94E-32	3.45E-32	1.63E+08	5.63E-24	0%
Sb-125	1.22E-03	2.18E-03	2.69E+06	5.85E+03	0%
Sb-126	3.80E-10	6.53E-10	6.10E+06	3.98E-03	0%
Te-127m	1.83E-17	3.28E-17	7.45E+07	2.44E-09	0%
Te-129m	4.16E-51	7.44E-51	2.98E+08	2.22E-42	0%
I-129	5.60E-01	0.00E+00	4.94E+01	0.00E+00	0%
Cs-134	1.73E-04	1.55E-05	9.58E+07	1.49E+03	0%
Cs-135	3.19E-01	2.86E-02	8.17E+00	2.34E-01	0%
Cs-137	2.70E+00	2.42E-01	4.33E+06	1.05E+06	2%
Ce-141	4.82E-51	8.62E-51	7.41E+07	6.39E-43	0%
Ce-144	4.73E-06	8.46E-06	6.38E+07	5.40E+02	0%
Nd-144	3.20E+00	5.73E+00	0.00E+00	0.00E+00	0%
Pm-147	2.58E-02	4.62E-02	8.81E+05	4.07E+04	0%
Pm-148	8.72E-45	1.56E-44	1.56E+09	2.43E-35	0%
Pm-148m	9.72E-43	1.74E-42	1.50E+08	2.61E-34	0%
Sm-147	1.34E+00	2.39E+00	4.19E-03	1.00E-02	0%
Sm-151	1.63E-01	2.92E-01	8.95E+03	2.61E+03	0%
Eu-152	2.21E-04	3.96E-04	1.04E+06	4.12E+02	0%
Eu-154	3.05E-03	5.46E-03	2.40E+06	1.31E+04	0%
Eu-155	4.40E-03	7.87E-03	6.05E+05	4.76E+03	0%
Gd-152	1.06E-05	1.89E-05	3.22E-06	6.08E-11	0%
Tb-160	7.52E-28	1.34E-27	7.23E+07	9.72E-20	0%
Ra-224	3.29E-11	5.89E-11	5.31E+10	3.13E+00	0%
Th-228	6.40E-09	1.14E-08	3.11E+08	3.56E+00	0%
U-232	2.44E-07	4.37E-07	2.86E+07	1.25E+01	0%
U-234	9.70E-18	1.74E-17	1.62E+03	2.81E-14	0%
U-235	7.95E-02	1.42E-01	5.41E-01	7.69E-02	0%
U-236	2.75E-03	4.93E-03	1.62E+01	7.98E-02	0%
U-238	4.77E+01	8.54E+01	7.73E-02	6.60E+00	0%
Np-237	7.47E-03	1.34E-02	2.75E+03	3.67E+01	0%
Pu-236	8.25E-09	1.48E-08	6.93E+08	1.02E+01	0%
Pu-238	6.25E-05	1.12E-04	6.51E+07	7.28E+03	0%
<u>Pu-239</u>	5.59E-01	1.00E+00	2.67E+05	2.67E+05	<u>1%</u>

PUREX RADIONUCLIDE INGESTION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Isotopic Content (g/assembly)	Normalized Sludge Content (g/g Pu-239)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Pu-239)	Percent Dose
Pu-240	3.41E-02	6.10E-02	9.75E+05	5.95E+04	0%
Pu-241	2.02E-03	3.62E-03	8.86E+06	3.20E+04	0%
Pu-242	1.49E-04	2.67E-04	1.61E+04	4.30E+00	0%
Am-241	4.61E-02	8.25E-02	1.54E+07	1.27E+06	3%
Am-242m	1.93E-05	3.46E-05	4.08E+07	1.41E+03	0%
Am-243	2.29E-06	4.10E-06	8.97E+05	3.68E+00	0%
Cm-242	4.68E-08	8.38E-08	3.64E+08	3.05E+01	0%
Cm-243	1.73E-07	3.09E-07	1.50E+08	4.64E+01	0%
Cm-244	2.09E-08	3.73E-08	1.86E+08	6.94E+00	0%
Cm-245	1.37E-10	2.45E-10	7.73E+05	1.89E-04	0%
Cm-246	1.41E-12	2.53E-12	1.38E+06	3.49E-06	0%
Cm-247	1.14E-15	2.04E-15	3.80E+02	7.75E-13	0%
Cm-248	5.02E-18	8.99E-18	6.80E+04	6.11E-13	0%
Bk-249	8.93E-28	1.60E-27	1.00E+07	1.60E-20	0%
Cf-249	1.55E-22	2.78E-22	1.84E+07	5.12E-15	0%
				<u>4.73E+07</u>	

RADIONUCLIDE DOSE CONTRIBUTION COMPARISON

Mark 31A

Isotope	5 YEARS							15 YEARS						
	INHALATION				INGESTION			INHALATION				INGESTION		
	Volatile Conditions		Evaporative Conditions		Volatile Conditions		Volatile Inh/Ing ratio	Volatile Conditions		Evaporative Conditions		Volatile Conditions		Volatile Inh/Ing ratio
	Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	
H-3	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Cr-51	8.66E-16	0%	8.66E-19	0%	4.33E-16	0%	2	2.44E-55	0%	2.44E-58	0%	1.22E-55	0%	2
Co-60	9.61E+05	0%	9.61E+02	0%	1.66E+05	0%	6	2.57E+05	0%	2.57E+02	0%	4.45E+04	0%	6
Se-79	1.76E+01	0%	1.76E-01	0%	1.58E+01	0%	1	1.76E+01	0%	1.76E-01	0%	1.58E+01	0%	1
Rb-87	1.88E-04	0%	1.88E-04	0%	2.73E-05	0%	7	3.76E-04	0%	3.76E-07	0%	2.73E-05	0%	14
Sr-89	5.20E-02	0%	5.20E-05	0%	1.23E-02	0%	4	3.73E-23	0%	3.73E-26	0%	8.82E-24	0%	4
Sr-90	4.92E+08	80%	4.92E+05	44%	4.92E+07	79%	10	3.85E+08	64%	3.85E+05	63%	3.85E+07	87%	10
Y-90	3.15E+06	0%	3.15E+03	0%	3.84E+06	6%	1	2.47E+06	0%	2.47E+03	0%	3.00E+06	7%	1
Y-91	1.09E+00	0%	1.09E-03	0%	2.21E-01	0%	5	1.89E-19	0%	1.89E-22	0%	3.81E-20	0%	5
Zr-93	3.08E+03	0%	3.08E+00	0%	1.54E+01	0%	200	3.07E+03	0%	3.07E+00	0%	1.54E+01	0%	200
Zr-95	5.12E+00	0%	5.12E-03	0%	9.68E-01	0%	5	8.37E-17	0%	8.37E-20	0%	1.58E-17	0%	5
Nb-95	2.70E+00	0%	2.70E-03	0%	1.32E+00	0%	2	4.41E-17	0%	4.41E-20	0%	2.16E-17	0%	2
Nb-95m	7.50E-03	0%	7.50E-06	0%	6.82E-03	0%	1	1.23E-19	0%	1.23E-22	0%	1.12E-19	0%	1
Tc-99	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Ru-103	3.94E-06	0%	3.94E-08	0%	1.37E-06	0%	3	6.76E-34	0%	6.76E-36	0%	2.34E-34	0%	3
Ru-106	3.12E+07	4%	3.12E+05	28%	1.49E+06	2%	21	3.27E+04	0%	3.27E+02	0%	1.57E+03	0%	21
Pd-107	6.10E+00	0%	6.10E-03	0%	6.57E-02	0%	93	6.10E+00	0%	6.10E-03	0%	6.58E-02	0%	93
Cd-115m	4.21E-06	0%	4.21E-09	0%	9.73E-07	0%	4	9.37E-31	0%	9.37E-34	0%	2.16E-31	0%	4
In-115	8.96E-07	0%	8.96E-10	0%	3.69E-08	0%	24	8.97E-07	0%	8.97E-10	0%	3.66E-08	0%	25
Sn-121m	4.91E+00	0%	4.91E-03	0%	7.17E-01	0%	7	4.28E+00	0%	4.28E-03	0%	6.24E-01	0%	7
Sn-123	3.74E+02	0%	3.74E-01	0%	9.57E+01	0%	4	1.12E-06	0%	1.12E-09	0%	2.87E-07	0%	4
Sn-125	2.01E-50	0%	2.01E-53	0%	1.51E-52	0%	133	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Sn-126	3.53E+02	0%	3.53E-01	0%	6.97E+01	0%	5	3.53E+02	0%	3.53E-01	0%	6.97E+01	0%	5
Sb-124	2.79E-05	0%	2.79E-08	0%	1.24E-05	0%	2	1.52E-23	0%	1.52E-26	0%	6.74E-24	0%	2
Sb-125	3.01E+05	0%	3.01E+02	0%	8.03E+04	0%	4	2.38E+04	0%	2.38E+01	0%	6.34E+03	0%	4
Sb-126	5.75E-01	0%	5.75E-04	0%	4.19E-03	0%	137	5.75E-01	0%	5.75E-04	0%	4.19E-03	0%	137
Te-127m	7.09E+01	0%	7.09E-01	0%	2.95E+01	0%	2	5.80E-09	0%	5.80E-11	0%	2.41E-09	0%	2
Te-129m	3.34E-09	0%	3.34E-11	0%	1.65E-09	0%	2	4.02E-42	0%	4.02E-44	0%	1.99E-42	0%	2
I-129	0.00E+00	0%	1.57E+01	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
I-131	0.00E+00	0%	2.97E+02	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Cs-134	2.44E+04	0%	2.44E+02	0%	3.84E+04	0%	1	1.11E+03	0%	1.11E+01	0%	1.74E+03	0%	1
Cs-135	1.92E-01	0%	1.92E-03	0%	3.03E-01	0%	1	1.92E-01	0%	1.92E-03	0%	3.03E-01	0%	1
Cs-136	2.35E-37	0%	2.35E-39	0%	3.45E-37	0%	1	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Cs-137	7.99E+05	0%	7.99E+03	1%	1.25E+06	2%	1	6.35E+05	0%	6.35E+03	1%	9.92E+05	2%	1
Ba-140	6.14E-35	0%	6.14E-38	0%	1.43E-34	0%	0	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
La-140	8.62E-35	0%	8.63E-38	0%	1.51E-34	0%	1	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Ce-141	1.13E-08	0%	1.13E-11	0%	3.46E-09	0%	3	1.79E-42	0%	1.79E-45	0%	5.49E-43	0%	3
Ce-144	6.47E+07	8%	6.47E+04	6%	3.69E+06	6%	18	8.81E+03	0%	8.81E+00	0%	5.02E+02	0%	18
Pr-143	3.82E-32	0%	3.82E-35	0%	2.35E-32	0%	2	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Nd-144	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Nd-147	3.72E-42	0%	3.72E-45	0%	2.34E-42	0%	2	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Pm-147	1.91E+07	2%	1.91E+04	2%	5.33E+05	1%	36	1.36E+06	0%	1.36E+03	0%	3.79E+04	0%	36

RADIONUCLIDE DOSE CONTRIBUTION COMPARISON

Mark 31A

Isotope	5 YEARS							15 YEARS						
	INHALATION				INGESTION			INHALATION				INGESTION		
	Volatile Conditions		Evaporative Conditions		Volatile Conditions		Volatile Inh/Ing ratio	Volatile Conditions		Evaporative Conditions		Volatile Conditions		Volatile Inh/Ing ratio
	Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose		Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	
Pm-148	1.37E-08	0%	1.37E-11	0%	1.30E-08	0%	1	3.27E-35	0%	3.27E-38	0%	3.11E-35	0%	1
Pm-148m	1.99E-07	0%	1.99E-10	0%	1.40E-07	0%	1	4.75E-34	0%	4.75E-37	0%	3.33E-34	0%	1
Sm-147	2.76E+00	0%	2.76E-03	0%	7.02E-03	0%	394	3.69E+00	0%	3.69E-03	0%	9.37E-03	0%	394
Sm-151	2.48E+05	0%	2.48E+02	0%	2.91E+03	0%	85	2.30E+05	0%	2.30E+02	0%	2.70E+03	0%	85
Eu-152	2.32E+04	0%	2.32E+01	0%	6.33E+02	0%	37	1.36E+04	0%	1.36E+01	0%	3.71E+02	0%	37
Eu-154	8.89E+05	0%	8.89E+02	0%	3.11E+04	0%	29	3.97E+05	0%	3.97E+02	0%	1.39E+04	0%	29
Eu-155	6.26E+05	0%	6.26E+02	0%	2.09E+04	0%	30	1.48E+05	0%	1.48E+02	0%	4.94E+03	0%	30
Eu-156	3.04E-29	0%	3.05E-32	0%	2.41E-29	0%	1	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Gd-152	1.13E-07	0%	1.13E-10	0%	7.08E-11	0%	1599	1.13E-07	0%	1.13E-10	0%	7.08E-11	0%	1599
Tb-160	6.61E-04	0%	6.61E-07	0%	1.93E-04	0%	3	4.10E-19	0%	4.10E-22	0%	1.19E-19	0%	3
Ra-224	2.53E-03	0%	2.53E-06	0%	2.88E-04	0%	9	1.65E-03	0%	1.65E-06	0%	1.87E-04	0%	9
Th-228	2.67E-01	0%	2.67E-04	0%	3.27E-04	0%	817	1.74E-01	0%	1.74E-04	0%	2.13E-04	0%	817
U-232	2.89E-01	0%	2.89E-04	0%	5.59E-04	0%	517	3.87E-01	0%	3.87E-04	0%	7.49E-04	0%	517
U-234	1.45E-11	0%	1.45E-14	0%	2.90E-14	0%	499	1.45E-11	0%	1.45E-14	0%	7.49E-14	0%	499
U-235	3.90E+01	0%	3.90E-02	0%	8.15E-02	0%	479	3.90E+01	0%	3.90E+01	0%	8.16E-02	0%	478
U-236	3.64E+01	0%	3.64E-02	0%	7.60E-02	0%	479	3.64E+01	0%	3.64E-02	0%	7.61E-02	0%	479
U-238	3.56E+03	0%	3.56E+00	0%	6.82E+00	0%	521	3.56E+03	0%	3.56E+00	0%	6.82E+00	0%	521
Np-237	5.25E+03	0%	5.25E+00	0%	4.19E+01	0%	125	5.25E+03	0%	5.25E+00	0%	4.19E+01	0%	125
Pu-236	8.58E-01	0%	8.59E-04	0%	6.97E-03	0%	123	7.55E-02	0%	7.55E-05	0%	6.13E-04	0%	123
Pu-238	1.25E+06	0%	1.25E+03	0%	1.03E+04	0%	121	1.17E+06	0%	1.17E+03	0%	9.65E+03	0%	121
Pu-239*	3.16E+07	4%	3.16E+04	3%	2.67E+05	0%	118	3.16E+07	5%	3.16E+04	5%	2.67E+05	1%	118
Pu-240	6.68E+06	1%	6.68E+03	0%	5.61E+04	0%	119	6.67E+06	1%	6.67E+03	1%	5.61E+04	0%	119
Pu-241	6.62E+06	1%	6.62E+03	1%	5.70E+04	0%	116	4.13E+06	1%	4.13E+03	1%	3.56E+04	0%	116
Pu-242	5.06E+02	0%	5.07E-01	0%	4.31E+00	0%	117	5.07E+02	0%	5.07E-01	0%	4.32E+00	0%	117
Am-241	1.65E+08	20%	1.65E+05	15%	1.42E+06	2%	116	1.67E+08	28%	1.67E+05	27%	1.43E+06	3%	116
Am-242m	2.49E+05	0%	2.49E+02	0%	2.05E+03	0%	122	2.38E+05	0%	2.38E+02	0%	1.96E+03	0%	122
Am-243	5.29E+02	0%	5.29E-01	0%	4.56E+00	0%	116	5.28E+02	0%	5.28E-01	0%	4.56E+00	0%	116
Cm-242	1.48E+04	0%	1.48E+01	0%	9.56E+01	0%	155	6.54E+03	0%	6.54E+00	0%	4.23E+01	0%	155
Cm-243	1.11E+04	0%	1.11E+01	0%	9.21E+01	0%	121	8.72E+03	0%	8.72E+00	0%	7.23E+01	0%	121
Cm-244	1.79E+03	0%	1.79E+00	0%	1.52E+01	0%	118	1.22E+03	0%	1.22E+00	0%	1.04E+01	0%	117
Cm-245	4.33E-02	0%	4.33E-05	0%	3.61E-04	0%	120	4.33E-02	0%	4.33E-05	0%	3.61E-04	0%	120
Cm-246	7.28E-04	0%	7.28E-07	0%	6.09E-06	0%	120	7.27E-04	0%	7.27E-07	0%	6.08E-06	0%	120
Cm-247	2.09E-10	0%	2.09E-13	0%	1.75E-12	0%	120	2.09E-10	0%	2.09E-13	0%	1.75E-12	0%	120
Cm-248	1.95E-10	0%	1.95E-13	0%	1.64E-12	0%	119	1.95E-10	0%	1.95E-13	0%	1.64E-12	0%	119
Bk-249	2.88E-14	0%	2.88E-17	0%	1.33E-16	0%	217	9.07E-18	0%	9.07E-21	0%	4.18E-20	0%	217
Cf-249	1.60E-12	0%	1.60E-15	0%	1.34E-14	0%	120	1.60E-12	0%	1.60E-15	0%	1.34E-14	0%	120
Total	8.26E+06		1.11E+06		6.22E+07			6.01E+06		6.07E+05		4.44E+07		

RADIONUCLIDE DOSE CONTRIBUTION COMPARISON

Mark 31B

Isotope	5 YEARS						15 YEARS							
	INHALATION				INGESTION		Volatile Inh/Lng ratio	INHALATION				INGESTION		Volatile Inh/Lng ratio
	Volatile Conditions		Evaporative Conditions		Volatile Conditions			Volatile Conditions		Evaporative Conditions		Volatile Conditions		
	Dose	Percent	Dose	Percent	Dose	Percent		Dose	Percent	Dose	Percent	Dose	Percent	
	(rem/g Pu-239)	Dose	(rem/g Pu-239)	Dose	(rem/g Pu-239)	Dose		(rem/g Pu-239)	Dose	(rem/g Pu-239)	Dose	(rem/g Pu-239)	Dose	
H-3	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Cr-51	4.19E-16	0%	4.19E-19	0%	2.09E-16	0%	2	1.18E-55	0%	1.18E-58	0%	5.89E-56	0%	2
Co-60	4.64E+05	0%	4.64E+02	0%	8.03E+04	0%	6	1.24E+05	0%	1.24E+02	0%	2.15E+04	0%	6
Se-79	1.83E+01	0%	1.83E-01	0%	1.64E+01	0%	1	1.83E+01	0%	1.83E-01	0%	1.64E+01	0%	1
Rb-87	2.01E-05	0%	2.01E-05	0%	2.92E-05	0%	1	2.01E-05	0%	2.01E-08	0%	2.92E-05	0%	1
Sr-89	5.96E-02	0%	5.96E-05	0%	1.41E-02	0%	4	4.28E-23	0%	4.28E-26	0%	1.01E-23	0%	4
Sr-90	5.29E+08	82%	5.29E+05	46%	5.29E+07	80%	10	4.13E+08	88%	4.13E+05	87%	4.13E+07	87%	10
Y-90	3.39E+06	0%	3.39E+03	0%	4.13E+06	6%	1	2.65E+06	0%	2.65E+03	0%	3.23E+06	7%	1
Y-91	1.24E+00	0%	1.24E-03	0%	2.51E-01	0%	5	2.15E-19	0%	2.15E-22	0%	4.33E-20	0%	5
Zr-93	3.28E+03	0%	3.28E+00	0%	1.64E-01	0%	200	3.28E+03	0%	3.28E+00	0%	1.64E+01	0%	200
Zr-95	5.71E+00	0%	5.71E-03	0%	1.08E+00	0%	5	9.34E-17	0%	9.34E-20	0%	1.77E-17	0%	5
Nb-95	3.01E+00	0%	3.01E-03	0%	1.48E+00	0%	2	4.92E-17	0%	4.92E-20	0%	2.41E-17	0%	2
Nb-95m	8.37E-03	0%	8.37E-06	0%	7.61E-03	0%	1	1.37E-19	0%	1.37E-22	0%	1.25E-19	0%	1
Tc-99	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Ru-103	4.38E-06	0%	4.38E-08	0%	1.52E-06	0%	3	7.52E-34	0%	7.52E-36	0%	2.61E-34	0%	3
Ru-106	3.14E+07	4%	3.14E+05	28%	1.50E+06	2%	21	3.30E+04	0%	3.30E+02	0%	1.58E+03	0%	21
Pd-107	6.12E+00	0%	6.12E-03	0%	6.59E-02	0%	93	6.12E+00	0%	6.12E-03	0%	6.60E-02	0%	93
Cd-115m	3.92E-06	0%	3.92E-09	0%	9.04E-07	0%	4	8.71E-31	0%	8.71E-34	0%	2.01E-31	0%	4
In-115	7.81E-07	0%	7.81E-10	0%	3.21E-08	0%	24	7.82E-07	0%	7.82E-10	0%	3.21E-08	0%	24
Sn-121m	5.05E+00	0%	5.05E-03	0%	7.38E-01	0%	7	4.40E+00	0%	4.40E-03	0%	6.42E-01	0%	7
Sn-123	3.42E+02	0%	3.42E-01	0%	8.75E+01	0%	4	1.02E-06	0%	1.02E-09	0%	2.63E-07	0%	4
Sn-125	2.31E-50	0%	2.31E-50	0%	1.73E-52	0%	134	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Sn-126	3.35E+02	0%	3.35E-01	0%	6.62E+01	0%	5	3.35E+02	0%	3.35E-01	0%	6.62E+01	0%	5
Sb-124	2.32E-05	0%	2.32E-08	0%	1.03E-05	0%	2	1.27E-23	0%	1.27E-26	0%	5.63E-24	0%	2
Sb-125	2.78E+05	0%	2.78E+02	0%	7.41E+04	0%	4	2.20E+04	0%	2.20E+01	0%	5.85E+03	0%	4
Sb-126	5.46E-01	0%	5.46E-04	0%	3.98E-03	0%	137	5.46E-01	0%	5.46E-04	0%	3.98E-03	0%	137
Te-127m	7.18E+01	0%	7.18E-01	0%	2.99E+01	0%	2	5.87E-09	0%	5.87E-11	0%	2.44E-09	0%	2
Te-129m	3.73E-09	0%	3.73E-11	0%	1.84E-09	0%	2	4.49E-42	0%	4.49E-44	0%	2.22E-42	0%	2
I-129	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
I-131	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Cs-134	2.73E+04	0%	2.73E+02	0%	4.30E+04	0%	1	9.43E+02	0%	9.43E+00	0%	1.49E+03	0%	1
Cs-135	1.48E-01	0%	1.48E-03	0%	2.33E-01	0%	1	1.48E-01	0%	1.48E-03	0%	2.34E-01	0%	1
Cs-136	2.83E-37	0%	2.83E-39	0%	4.15E-37	0%	1	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Cs-137	8.42E+05	0%	8.42E+03	1%	1.32E+06	2%	1	6.69E+05	0%	6.69E+03	1%	1.05E+06	2%	1
Ba-140	7.78E-35	0%	7.78E-38	0%	1.81E-34	0%	0	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
La-140	1.09E-34	0%	1.09E-37	0%	1.91E-34	0%	1	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Ce-141	1.32E-08	0%	1.32E-11	0%	4.03E-09	0%	3	2.09E-42	0%	2.09E-45	0%	6.39E-43	0%	3
Ce-144	6.96E+07	8%	6.96E+04	8%	3.96E+06	8%	18	9.47E+03	0%	9.47E+00	0%	5.40E+02	0%	18
Pr-143	4.83E-32	0%	4.83E-35	0%	2.98E-32	0%	2	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Nd-144	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Nd-147	4.74E-42	0%	4.74E-45	0%	2.88E-42	0%	2	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Pm-147	2.04E+07	2%	2.04E+04	2%	5.72E+05	1%	36	1.46E+06	0%	1.46E+03	0%	4.07E+04	0%	36

RADIONUCLIDE DOSE CONTRIBUTION COMPARISON

Mark 31B

Isotope	5 YEARS							15 YEARS						
	INHALATION		Evaporative Conditions		INGESTION		Volatile Inh/Ing ratio	INHALATION		Evaporative Conditions		INGESTION		Volatile Inh/Ing ratio
	Volatile Conditions Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	Volatile Conditions Dose (rem/g Pu-239)	Percent Dose		Volatile Conditions Dose (rem/g Pu-239)	Percent Dose	Dose (rem/g Pu-239)	Percent Dose	Volatile Conditions Dose (rem/g Pu-239)	Percent Dose	
Pm-148	1.07E-08	0%	1.07E-11	0%	1.02E-08	0%	1	2.56E-35	0%	2.56E-38	0%	2.43E-35	0%	1
Pm-148m	1.56E-07	0%	1.56E-10	0%	1.09E-07	0%	1	3.72E-34	0%	3.72E-37	0%	2.61E-34	0%	1
Sm-147	2.95E+00	0%	2.95E-03	0%	7.49E-03	0%	394	3.95E+00	0%	3.95E-03	0%	1.00E-02	0%	394
Sm-151	2.40E+05	0%	2.40E+02	0%	2.82E+03	0%	85	2.23E+05	0%	2.23E+02	0%	2.61E+03	0%	85
Eu-152	2.57E+04	0%	2.57E+01	0%	7.02E+02	0%	37	1.51E+04	0%	1.51E+01	0%	4.12E+02	0%	37
Eu-154	8.39E+05	0%	8.39E+02	0%	2.94E+04	0%	29	3.75E+05	0%	3.75E+02	0%	1.31E+04	0%	29
Eu-155	6.04E+05	0%	6.04E+02	0%	2.02E+04	0%	30	1.42E+05	0%	1.42E+02	0%	4.76E+03	0%	30
Eu-156	3.60E-29	0%	3.60E-32	0%	2.85E-29	0%	1	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%	-
Gd-152	9.73E-08	0%	9.73E-11	0%	6.08E-11	0%	1599	9.73E-08	0%	9.73E-11	0%	6.08E-11	0%	1599
Tb-160	5.38E-04	0%	5.38E-07	0%	1.57E-04	0%	3	3.34E-19	0%	3.34E-22	0%	9.72E-20	0%	3
Ra-224	4.22E+01	0%	4.22E-02	0%	4.80E+00	0%	9	2.75E+01	0%	2.75E-02	0%	3.13E+00	0%	9
Th-228	4.45E+03	0%	4.45E+00	0%	5.45E+00	0%	817	2.91E+03	0%	2.91E+00	0%	3.56E+00	0%	817
U-232	4.82E+03	0%	4.82E+00	0%	9.32E+00	0%	517	6.46E+03	0%	6.46E+00	0%	1.25E+01	0%	517
U-234	1.40E-11	0%	1.40E-14	0%	2.81E-14	0%	499	1.40E-11	0%	1.40E-14	0%	1.81E-14	0%	499
U-235	3.68E+01	0%	3.68E-02	0%	7.69E-02	0%	479	3.68E+01	0%	3.68E-02	0%	7.69E-02	0%	479
U-236	3.82E+01	0%	3.82E-02	0%	7.98E-02	0%	479	3.82E+01	0%	3.82E-02	0%	7.98E-02	0%	479
U-238	3.44E+03	0%	3.44E+00	0%	6.60E+00	0%	521	3.44E+03	0%	3.44E+00	0%	6.60E+00	0%	521
Np-237	4.61E+03	0%	4.61E+00	0%	3.67E+01	0%	125	4.61E+03	0%	4.61E+00	0%	3.67E+01	0%	125
Pu-236	1.43E+04	0%	1.43E+01	0%	1.16E+02	0%	123	1.26E+03	0%	1.26E+00	0%	1.02E+01	0%	123
Pu-238	9.42E+05	0%	9.42E+02	0%	7.78E+03	0%	121	8.81E+05	0%	8.81E+02	0%	7.28E+03	0%	121
Pu-239*	3.16E+07	4%	3.16E+04	3%	2.67E+05	0%	118	3.16E+07	5%	3.16E+04	5%	2.67E+05	1%	118
Pu-240	7.08E+06	1%	7.08E+03	1%	5.95E+04	0%	119	7.08E+06	1%	7.08E+03	1%	5.95E+04	0%	119
Pu-241	5.97E+06	1%	5.97E+03	1%	5.13E+04	0%	116	3.72E+06	1%	3.72E+06	1%	3.20E+04	0%	116
Pu-242	5.05E+02	0%	5.05E-01	0%	4.30E+00	0%	117	5.05E+02	0%	5.05E-01	0%	4.30E+00	0%	117
Am-241	1.46E+08	17%	1.46E+05	13%	1.26E+06	2%	116	1.48E+08	24%	1.48E+05	24%	1.27E+06	3%	116
Am-242m	1.80E+05	0%	1.80E+02	0%	1.48E+03	0%	122	1.72E+05	0%	1.72E+02	0%	1.41E+03	0%	122
Am-243	4.27E+02	0%	4.27E-01	0%	3.68E+00	0%	116	4.26E+02	0%	4.26E-01	0%	3.68E+00	0%	116
Cm-242	1.09E+04	0%	1.09E+01	0%	7.06E+01	0%	155	4.71E+03	0%	4.71E+00	0%	3.05E+01	0%	154
Cm-243	7.13E+03	0%	7.13E+00	0%	5.91E+01	0%	121	5.59E+03	0%	5.59E+00	0%	4.64E+01	0%	121
Cm-244	1.19E+05	0%	1.19E+02	0%	1.02E+03	0%	117	8.14E+02	0%	8.14E-01	0%	6.94E+00	0%	117
Cm-245	2.27E-02	0%	2.27E-05	0%	1.89E-04	0%	120	2.27E-02	0%	2.27E-05	0%	1.89E-04	0%	120
Cm-246	4.18E-04	0%	4.18E-07	0%	3.49E-06	0%	120	4.17E-04	0%	4.17E-07	0%	3.49E-06	0%	120
Cm-247	9.28E-11	0%	9.28E-14	0%	7.75E-13	0%	120	9.28E-11	0%	9.28E-14	0%	7.75E-13	0%	120
Cm-248	7.26E-11	0%	7.26E-14	0%	6.11E-13	0%	119	7.26E-11	0%	7.26E-14	0%	6.11E-13	0%	119
Bk-249	1.10E-14	0%	1.10E-17	0%	5.07E-17	0%	217	3.47E-18	0%	3.47E-21	0%	1.60E-20	0%	217
Cf-249	6.13E-13	0%	6.13E-16	0%	5.13E-15	0%	120	6.12E-13	0%	6.12E-16	0%	5.12E-15	0%	120
Total	8.49E+08		1.14E+06		6.63E+07			6.10E+08		4.33E+06		4.73E+07		

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