Supernate Source Term Analysis (U)

by

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SUMMARY OF REVISIONS

Revision 1

October 13, 1994

Discussion Section

Revised "Example" to reflect numbers as they appear in Appendix A.

Appendix A

Revised at request of HLW Safety Analysis Group. A Normalized isotopic content column added to all the tables included as Appendix A.

Appendix A, B, C and D

Page number added.

SUMMARY

This report analyzes the supernate radionuclide dose impact in High Level Waste. The radionuclide ingestion and inhalation pathways are analyzed. This report analyzes spent fuel assemblies processed in the Separation facilities during the HM and PUREX campaigns and the current Safety Analysis Report (SAR) supernate radionuclide distribution.

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 to the source term.

Analysis of fission yield data and SAR source term values demonstrates that a limited number of radionuclides contribute 1% or more to the total dose and that cesium and plutonium isotopes are the radionuclides with major impact in the supernate source term. This report analyses both volatile and evaporative impact as recommended by DOE guidance. In reality, the only radionuclide volatilized during evaporative conditions is tritium. No evidence of selective volatility occurs during forced evaporation in HLW.

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 HM Process has been used in the H-Canyon since 1959 to recover uranium and byproduct neptunium. 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 depleted uranium.

This report analyzes both the inhalation and ingestion radionuclide dose impact of the HM and PUREX process soluble portion of their waste streams. The spent fuel assemblies analyzed are the Mark 16B, Mark 22 for the HM process, and the Mark 31A, Mark 31B for the PUREX process. The results from this analysis are combined with an analysis of the current SAR source term to evaluate source terms for HLW supernate.

DISCUSSION

Isotopic Dose Calculations

The isotopic content data for the Mark 16B, Mark 22, Mark 31A and Mark 31B spent fuel assemblies processed in the HM and PUREX process was taken from Ref. 4. This data and the ICRP-30 [1] Dose Conversion Factors were used to determine the individual isotopic source dose contribution in terms of rem.

Because most radionuclides decay during cooling or storage in the waste tanks, only those isotopes with a half-life exceeding a day were considered. The individual isotopic dose contribution was evaluated at 5 and 15 years for each spent fuel assembly.

The fission yield data contained in Ref. 4 was normalized in terms of Cs-137. During cooling, the waste separates into two layers, supernate and sludge. Using the solubility data contained in Ref. 2 (Table III) and Ref. 3, the isotopic content of each spent fuel assembly was adjusted to account for the supernate radionuclide content. The fraction soluble data is also contained in Appendix A calculation result tables. Because of differences in the reported solubility data for Tc-99 in the reference documents, its fraction soluble in the supernate was assumed to be 1.

To determine those radionuclides whose dose impact is significant, 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 Inhalation and Ingestion ICRP-30 Dose Conversion factors [1]. For each pathway (inhalation and ingestion), the calculated dose values were added together to determine the total dose (rem). The individual isotope dose contribution was then calculated in terms of dose percentage.

An example of the above mentioned calculation follows.

Example:

For the HM Process

- Mark 16B Inhalation Pathway (5 years)

For the inhalation pathway, the isotopic dose contribution was evaluated considering volatile and evaporative conditions.

<u>Isotope</u>	<u>Volatile Conditions</u>	
	<u>Dose</u> (rem/g Cs-137)	<u>Percent Dose</u>
H-3	8.79E+00	0%
:	:	:
Sr-90	2.88E+04	1%
:	:	:
Cs-134	5.86E+05	11%
Cs-135	6.72E-01	0%
Cs-136	1.08E-37	0%
Cs-137	2.77E+06	53%
:	:	:
Pu-238	4.60E+05	9%
:	:	:
Total 5.21E+06		

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 same release fraction value (1.0) is assumed for each radionuclide under volatile conditions, as could occur in internally initiated events (e. g., fires, explosions), process initiated events (e. g., spills, improper transfer of materials), and externally initiated events (e. g., floods, earthquakes). The evaporative conditions assume normal release values as defined in the ICRP-30 by DOE guidance. [1]

Evaporative Conditions		
Isotope	Dose (rem/g Cs-137)	Percent Dose
H-3	8.79E+00*(1)	0%
:	:	:
Sr-90	2.88E+04*(0.001)	0%
:	:	:
Cs-134	5.86E+05*(0.01)	12%
Cs-135	6.72E-01(0.01)	0%
Cs-136	1.08E-37*(0.01)	0%
Cs-137	2.77E+06*(0.01)	58%
:	:	:
Pu-238	4.60E+05*(0.001)	1%
:	:	:
Total 4.75E+04		

The results of the calculations are tabulated in Appendix A. A radionuclide contributing at least 1% to the total dose is considered important or significant to the source dose. Those isotopes contributing 1% (rounded-off) or more to the total dose are indicated in bold-underlined face type.

ANALYSIS

Appendix A results demonstrate that only a limited number of radionuclides have a significant impact in the supernate total dose.

HM Process

Inhalation Pathway

Table 1 summarizes the results for the radionuclide inhalation dose contribution from the Mark 16B and Mark 22 spent fuel assemblies processed in the HM Process. Under both conditions, volatile and evaporative, Cs-137 is the major contributor to the total dose. Ruthenium-106 also has a significant contribution to the total dose under both conditions. Ruthenium-106 only contributes during the 5 years time period because it is a relatively short-lived isotope. Additionally, Ru-106 inhalation dose conversion factor is also relatively high compared to other radionuclides and to cesium isotopes. After Ru-106 has decayed, Cs-137 dominates the supernate source dose value. Pu-238 also has a significant contribution in the long term to the total dose under volatile conditions.

TABLE 1
HM RADIONUCLIDE DOSE CONTRIBUTION
(Dose Percentage) *
INHALATION

	Volatile Conditions				Evaporative Conditions			
	5 years	15 years	16B	22	5 years	15 years	16B	22
Sr-90	1	1	1	1	0	0	0	0
Ru-106	26	26	0	0	28	28	0	0
Cs-134	11	12	1	1	12	13	1	1
Cs-137	53	53	82	83	58	58	97	97
Pu-238	9	8	16	14	1	1	2	2

*Radionuclides contributing at least 1% to the total dose.

Ingestion Pathway

Table 2 shows that the major contributors to the dose due to ingestion are the cesium isotopes, Cs-134 and Cs-137, with Cs-137 dominating the total dose.

TABLE 2
HM RADIONUCLIDE DOSE CONTRIBUTION
(Dose Percentage)*
(INGESTION)

	<u>5 YEARS</u>		<u>15 YEARS</u>	
	16B	22	16B	22
Ru-106	1	1	0	0
Cs-134	17	19	1	1
Cs-137	81	80	99	99

*Radionuclides contributing at least 1% to the total dose.

PUREX Process

Inhalation

Table 3 contains the results summarized for the inhalation pathway, under both volatile and evaporative conditions. For the 5 years time period, Ru-106 is the major contributor to the total dose, with a contribution of approximately 66%. There is no plutonium isotopes contribution from the PUREX Process since this process was used to separate plutonium from uranium. Cs-137 dominates the total dose for the 15 years time period.

TABLE 3
PUREX RADIONUCLIDE DOSE CONTRIBUTION
(Dose Percentage)*
INHALATION

	<u>Volatile Conditions</u>				<u>Evaporative Conditions</u>			
	<u>5 years</u>		<u>15 years</u>		<u>5 years</u>		<u>15 years</u>	
	31A	31B	31A	31B	31A	31B	31A	31B
Sr-90	0	0	1	1	0	0	0	0
Ru-106	66	65	0	0	67	66	0	0
Cs-134	1	1	0	0	1	1	0	0
Cs-137	32	33	98	98	32	33	99	99

*Radionuclides contributing at least 1% to the total dose.

Ingestion

Table 4 shows that Cs-137 is the major contributor to the ingestion total dose, with a contribution exceeding 90%. Due to the relatively short half-life of Cs-134 and Ru-106 as compared to Cs-137, no contribution follows from them at the 15 years time period.

TABLE 4
PUREX RADIONUCLIDE DOSE CONTRIBUTION
(Dose Percentage)
(INGESTION)

	<u>5 years</u>		<u>15 years</u>	
	31A	31B	31A	31B
Ru-106	6	5	0	0
Cs-134	3	3	0	0
Cs-137	91	91	100	100

*Radionuclides contributing at least 1% to the total dose.

As shown in the tables above, the major contributors to the supernate source dose are the cesium isotopes with Ru-106 impacting the dose during the 5 years decay period.

Impact of Solubility Fraction Values on Dose Calculations

The spent fuel assembly isotopic content (Ref. 4) was adjusted by the solubility fraction values given in Ref. 2 & 3. To determine any possible impacts to the dose due to the use of the aforementioned values, the individual isotope dose contribution (dose percentage) was evaluated.

For the purpose of this report a radionuclide contributing 1% or more to the total dose is considered significant. Tables 5 and 6 below include the results obtained for the Mark 16B assembly (Inhalation Pathway) showing those radionuclides contributing from at least 0.001% to more than 1% of the total dose.

TABLE 5
HM SUPERNATE RADIONUCLIDE DOSE CONTRIBUTION
INHALATION

MARK 16B (5 YEARS)

Isotope	<u>Volatile Conditions</u>				<u>Evaporative Conditions</u>
	>1%	(0.1 - 1)%	(0.01 - 0.1)%	<0.01%	>1%
Sr-90		0.55			
Y-90				0.004	
Tc-99				0.002	
Ru-106	25.76				28.26
Sb-125				0.002	
Cs-134	11.25				12.34
Cs-137	53.14				58.3
Ce-144			0.02		
Pm-147				0.004	
Eu-154				0.001	
Pu-238	8.82				0.97
Pu-239			0.08		
Pu-240			0.06		
Pu-241		0.21			
Am-241		0.1			
Cm-244				0.002	

TABLE 6
HM SUPERNATE RADIONUCLIDE DOSE CONTRIBUTION
INHALATION

MARK 16B (15 YEARS)

Isotope	<u>Volatile Conditions</u>				<u>Evaporative Conditions</u>
	>1%	(0.1 - 1)%	(0.01 - 0.1)%	<0.01%	>1%
Sr-90		0.84			
Y-90				0.005	
Tc-99				0.004	
Ru-106			0.05		
Sb-125					
Cs-134		0.75			0.89
Cs-137	81.6				96.92
Ce-144					
Pm-147				0.001	
Eu-154				0.001	
Pu-238	15.77				1.87
Pu-239		0.15			
Pu-240		0.11			
Pu-241		0.26			
Am-241		0.46			
Cm-244				0.003	

The use of Ref. 2 & 3 solubility fraction values does not have an impact on the total dose. A few radionuclides (Tc-99, Sb-125, Cs-134, Eu-154) contribute less than 0.01% to the total dose. Also they only contribute under volatile conditions. These radionuclides do not appear in the SAR radionuclide list for the Evaporator Concentrate (ECC) and High Heat Supernate (HHS) source term. When comparing their dose contribution in the 15 years decay period to that of the 5 years decay period, an impact to the total dose is not observed from these radionuclides. The SAR does not provide data for all cesium isotopes. From the tables above, Cs-134 contribution to the total dose for the 5 years period and volatile conditions is approximately 11% and 12% under evaporative conditions. Due to its relatively short half-life, its dose contribution is reduced to approximately 1% for a larger period of time (15 years). The Am-241 contribution to the total dose is due mainly to its ingrowth from Pu-241.

TABLE 7
HM SUPERNATE RADIONUCLIDE DOSE CONTRIBUTION
INGESTION

MARK 16B (5 YEARS)

Isotope	>1%	(0.1 - 1)%	(0.01 - 0.1)%	<0.01%
Sr-90			0.05	
Y-90				0.004
Ru-106	1.21			
Sb-125				0.001
Cs-134	17.35			
Cs-137	81.81			
Ce-144				0.001
Pu-238			0.07	
Pu-239				0.001
Pu-241				0.002
Am-241				0.001

From Table 7 and Table 8 it can also be demonstrated that cesium isotopes are the major contributors to the total dose when considering the ingestion pathway. Evaluating the dose contribution at 5 and 15 years demonstrates that the long-lived isotopes contribution is negligible for the decay period considered.

Alpha emitters (i.e., Pu, Am) are contained in the insoluble portion (sludge) of the high level waste. Using the solubility fraction values accounts for the material contained in the sludge, permitting dose evaluation of those radionuclides known to be preferably contained in the supernate. The analysis above indicates the solubility fraction values used would have to be grossly in error to effect the radionuclide contribution to the total dose.

TABLE 8
HM SUPERNATE RADIONUCLIDE DOSE CONTRIBUTION
INGESTION

MARK 16B (15 YEARS)

Isotope	>1%	(0.1 - 1)%	(0.01 - 0.1)%	<0.01%
Sr-90			0.07	
Y-90				0.005
Tc-99				0.001
Ru-106				0.002
Cs-134		0.92		
Cs-137	98.90			
Pu-238		0.10		
Pu-239				0.001
Pu-240				0.001
Am-241				0.003

Comparison to SAR and Bounding Data

Reference 5 illustrates the source term for representative radionuclide content of wastes (i.e., ECC and HHS)*. For both waste tank farms (F and H) the tables list the composite, high and low radionuclide concentration. The calculated dose impact and dose contribution for these radionuclides are included in Appendix B. Under both volatile and evaporative conditions the dose contribution was calculated for the ECC and HHS. The "High" radionuclide content from Ref. 5 data was used in the calculations. The ICRP-30 Dose Conversion Factors were used to express the data in terms of dose (rem). For the evaporative conditions, the Release Fractions values from Ref. 1 were used.

Inhalation Pathway

For H-Area, the major contributor to the total dose is Pu-238, see Table 9. Cesium-137 highest contribution to the ECC and HHS occurs under evaporative conditions. Cerium-144 is the second highest contributor to the HHS dose (volatile conditions). The HHS cerium-144 content from Ref. 5 is very high as compared to the values given for the other radionuclides listed in the table.

* Evaporator Concentrate (ECC) - Represents concentrated aged waste.
High Heat Supernate (HHS) - Represents typical fresh waste.

Additionally, its high contribution to the dose is due to its relatively high dose conversion factor.

In F-Area the highest contributor to the ECC and HHS total dose (under both volatile and evaporative conditions) is Cs-137.

The radionuclides included in Tables 8 & 9 contribute at least 1% (rounded-off) to the ECC or HHS inhalation total dose either under volatile or evaporative conditions.

TABLE 9
SAR ECC AND HHS RADIONUCLIDE DOSE CONTRIBUTION (Percentage)

Isotope	<u>H-Area</u>		<u>HHS</u>		<u>F-Area</u>		<u>HHS</u>	
	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>
	Volatile	Evaporative	Volatile	Evaporative	Volatile	Evaporative	Volatile	Evaporative
	Conditions	Conditions	Conditions	Conditions	Conditions	Conditions	Conditions	Conditions
Am-241	0	0	0	0	2.70	0	1.04	0
Ce-144	0	0	18.17	9.23	0	0	32.94	7.40
Cs-137	3.63	27.30	4.19	21.27	50.86	91.15	26.84	60.27
Nb-95	0	0	0	0	0	0	0.95	0
Pm-147	0	0	0.93	0	0	0	1.83	0
Pu-238	91.83	69.08	62.14	31.57	0	0	0	0
Pu-239	0.70	0.53	0	0	1.82	0	1.02	0
Pu-241	0.61	0	0	0	8.74	1.57	3.38	0.76
Ru-106	0	0	6.57	33.40	0	0	11.53	25.88
Sr-90	2.92	2.20	6.56	3.33	34.86	6.25	17.92	4.02
Zr-95	0	0	0	0	0	0	1.71	0

Appendix B also contains the results for the above calculations using a fixed radionuclide content value for Pu and Cs isotopes. The plutonium isotopic concentration was fixed at 1 mg/liter and the cesium isotopic content to 30 Ci/gal. These values were adjusted to evaluate upper range concentration values for Pu and Cs in waste supernate. Using these values, the following results were obtained.

TABLE 10
ECC AND HHS RADIONUCLIDE DOSE CONTRIBUTION* (Percentage)

Isotope	<u>H-Area</u>		<u>HHS</u>		<u>F-Area</u>		<u>HHS</u>	
	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>	<u>ECC</u>
	Volatile	Evaporative	Volatile	Evaporative	Volatile	Evaporative	Volatile	Evaporative
	Conditions	Conditions	Conditions	Conditions	Conditions	Conditions	Conditions	Conditions
Am-241	0	0	0	0	1.06	0	0	0
Ce-144	0	0	4.01	2.89	0	0	14.94	2.34
Cs-137	3.05	23.92	2.89	20.78	67.28	95.35	54.52	85.49
Nb-95	0	0	0	0	0	0	0	0
Pm-147	0	0	0.93	0	0	0	0.83	0
Pu	96.13	75.38	89.86	64.61	17.78	2.52	14.41	2.26
Ru-106	0	0	1.45	10.44	0	0	5.23	8.20
Sr-90	0.74	0.58	1.45	1.04	13.68	1.94	8.13	1.27
Zr-95	0	0	0	0	0	0	0.77	0

* Pu fixed at 1 mg/liter; Cs fixed at 30 Ci/gal.

The above results show that the H-Area total dose is dominated by the plutonium isotopes contribution. The F-Area total dose is dominated by Cs-137. For the F-Area HHS and under both volatile and evaporative conditions, Ce-144 dose contribution is as significant as that from plutonium isotopes. Evaluation of the SAR source term data for the HHS and ECC demonstrate that the following radionuclides are very significant to the supernate source dose: Sr-90, Ru-106, Cs-137, Ce-144 and Pu-238.

Appendix D summarizes the dose contribution for the SAR H-Area ECC and HHS and the Mark 16B (5 years) radionuclide inhalation dose contribution under volatile conditions.

Mark 16B results shows that Cs-137 dose contribution to the H-Area supernate source dose due to the processing of this assembly dominates. Ruthenium-106 contribution seems very high when compared with that calculated using the SAR values. Tables 9, 10 and Appendix D show that plutonium isotopes dominate the source dose when calculated using the SAR radionuclide concentration values. Cesium-137 dominates the F-Area total dose. In general, the results indicate that cesium and plutonium isotopes are the major contributors to the supernate total inhalation dose.

Ingestion Pathway

Table 11 below summarizes the results for the SAR ECC and HHS source term dose contribution for the ingestion pathway. All radionuclides contributing 1% or more (rounded-off) of the total dose are included. These results indicate that Cs-137 is the major contributor to the supernate source dose to both F and H-Area.

TABLE 11
SAR ECC AND HHS RADIONUCLIDE
DOSE CONTRIBUTION (Percentage)

Isotope	<u>H-Area</u> Volatile Conditions		<u>F-Area</u> Volatile Conditions	
	ECC	HHS	ECC	HHS
Ce-144	0	11.17	0	3.97
Cs-137	83.88	70.62	95.35	88.67
Nb-95	0	0	0	0.99
Pu-238	11.22	5.54	0	0
Rh-106	0	3.39	0	1.17
Sr-90	4.32	7.08	4.18	3.79
Y-90	0	0.54	0	0
Zr-95	0	0.60	0	0.68

Source Term

During waste evaporation to recover tank space, the supernate is concentrated and the plutonium solubility increases. From previous studies [7] it is proposed that the Pu solubility in high salt-NaOH solutions increases. It has also been demonstrated that the Pu solubility can vary for any given hydroxide composition. Limits have been established for Pu solubility in a wide range of salt solutions, ranging from 1 to 1.7 mg/liter. [8]

The differences in radionuclide contribution to the dose as calculated for the SAR ECC and HHS values and the Mark 16B are due to differences in the OH level in high level wastes. Evaluation of the radionuclide total dose contribution (Appendix B, rem/gal) indicates an increase of four times the total dose when fixing the plutonium and cesium source term value to 1 mg/liter and 30 Ci/gal, respectively.

Actual sample analysis data [6] was used to verify the conservatism of the SAR values for the ECC and HHS radionuclide content. According to the data contained in Ref. 6, the H-Area HHS source term values given for plutonium

isotopes (i. e. , Pu-239) has been exceeded in different tanks containing HHS (32H, 35H, 39H) as indicated by the results of samples taken in 1992. The H-Area ECC cesium-137 source term has also been exceeded for tank 30H as indicated by samples analyzed in 1993. For plutonium and cesium isotopes it is recommended to use the proposed solubility value of 1-1.7 mg/l for Pu isotopes and 30 Ci/gal for Cs isotopes, since these isotopes impose the major impact on the supernate dose.

Other radionuclide sample analysis results exceeded the SAR source term value given (i. e., Nb-95, Ru-106), but due to their relatively short half-life they have decayed. Although Ref. 6 provides radionuclide analysis results for all waste tanks, not all possible radionuclides contained in the supernate were analyzed; and the document does not contain the results for the total alpha, beta-gamma or gross alpha of all samples analyzed. Since not enough analytical data have been developed to characterize the waste tanks content, the SAR source term values given are recommended to be used. Analysis of fission yield data permitted to narrow the list of radionuclides to be considered when developing source term. The radionuclides considered to be significant for the supernate source term as a result of dose contribution in the short and long term period are Sr-90, Cs-137, Pu-238 and Ru-106. Analysis of the SAR source term values also shows that these radionuclides are very significant to the source dose. Therefore the SAR source term "High" values should bound the current conditions of the waste tanks. These "High" values are recommended to be used as the supernate source term values for F and H-Area.

CONCLUSION

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

The spent fuel assembly data analyzed demonstrate that a limited number of radionuclides are significant in determining source terms. Based on the spent fuel assembly data (Ref. 4) calculation results, the supernate source term is mainly dominated by Cs-137. Ruthenium-106 has a significant contribution to the source dose, but only through the inhalation pathway and the 5 years time period. Of the plutonium isotopes only Pu-238 contributes to the total dose, but only through the inhalation pathway and its impact to the source dose is due to the HM Process. Dose calculations performed using SAR data show that plutonium isotopes dominate the source dose for H-Area and that Cs-137

dominates the F-Area dose. In general, cesium and plutonium isotopes are the major contributors to the supernate source dose.

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3. J. R. Fowler/R. E. Eibling, "Revision of Distribution of Radionuclides Between the Soluble and Insoluble Fractions of In-Tank Waste, DPST-81-899, November 25, 1981
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HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 16B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	9.06E-06	1.00E+00	9.53E-06	9.22E+05	8.79E+00	0.00%	1	8.79E+00	0.02%
Cr-51	3.22E-24	5.00E-02	1.69E-25	2.40E+07	4.07E-18	0.00%	0.001	4.07E-21	0.00%
Co-60	4.79E-04	1.90E-04	9.58E-08	1.70E+08	1.63E+01	0.00%	0.001	1.63E-02	0.00%
Se-79	5.54E-03	1.00E-01	5.83E-04	6.20E+02	3.62E-01	0.00%	0.01	3.62E-03	0.00%
Rb-87	2.88E-01	9.50E-01	2.88E-01	2.87E-04	9.26E-05	0.00%	0.001	8.26E-08	0.00%
Sr-90	5.38E-12	2.50E-04	1.42E-15	1.07E+09	1.52E-06	0.00%	0.001	1.52E-09	0.00%
Sr-90	6.06E-01	2.50E-04	1.59E-04	1.81E+08	2.88E+04	<u>0.55%</u>	0.001	2.88E+01	0.06%
Y-90	1.58E-04	2.50E-04	4.15E-08	4.46E+09	1.85E+02	0.00%	0.001	1.85E-01	0.00%
Y-91	1.15E-10	1.00E-04	1.21E-14	1.08E+09	1.31E-05	0.00%	0.001	1.31E-08	0.00%
Zr-93	9.89E-01	9.60E-06	9.99E-06	8.04E+02	8.03E-03	0.00%	0.001	8.03E-06	0.00%
Zr-95	1.39E-09	1.00E-05	1.46E-14	3.86E+08	5.64E-06	0.00%	0.001	5.64E-09	0.00%
Nb-95	1.60E-09	1.00E-05	1.69E-14	1.76E+08	2.97E-06	0.00%	0.001	2.97E-09	0.00%
Nb-95m	9.72E-13	1.00E-05	1.02E-17	8.08E+08	8.27E-09	0.00%	0.001	8.27E-12	0.00%
Tc-99	7.81E-01	1.00E+00	8.22E-01	1.27E+02	1.04E+02	0.00%	0.001	1.04E-01	0.00%
Ru-103	1.63E-15	5.00E-01	8.56E-16	2.51E+08	2.15E-07	0.00%	0.01	2.15E-09	0.00%
Ru-103	1.74E-03	5.00E-01	9.13E-04	1.47E+09	1.34E+06	<u>25.75%</u>	0.01	1.34E+04	<u>28.28%</u>
Pd-107	3.13E-02	1.00E-04	3.29E-06	6.68E+00	2.20E-05	0.00%	0.001	2.20E-08	0.00%
Cd-115m	4.81E-17	5.00E-02	2.53E-18	1.65E+09	4.18E-09	0.00%	0.001	4.18E-12	0.00%
In-115	1.61E-03	5.00E-02	8.46E-05	1.77E-05	1.50E-09	0.00%	0.001	1.50E-12	0.00%
Sn-121m	1.31E-06	4.00E-02	5.53E-06	3.48E+05	1.92E-02	0.00%	0.001	1.92E-05	0.00%
Sn-123	6.87E-08	4.00E-02	2.89E-09	2.47E+08	7.15E-01	0.00%	0.001	7.15E-04	0.00%
Sn-125	2.00E-61	4.00E-02	8.44E-63	1.52E+09	1.28E-53	0.00%	0.001	1.28E-56	0.00%
Sn-126	1.23E-02	4.00E-02	5.19E-04	2.44E+03	1.27E+00	0.00%	0.001	1.27E-03	0.00%
Sb-124	1.30E-14	6.00E-03	8.22E-17	3.67E+08	3.02E-08	0.00%	0.001	3.02E-11	0.00%
Sb-125	1.76E-03	6.00E-03	1.11E-05	1.01E+07	1.13E+02	0.00%	0.001	1.13E-01	0.00%
Sb-126	5.87E-11	4.00E-02	2.47E-12	8.36E+08	2.07E-03	0.00%	0.001	2.07E-06	0.00%
Te-127m	2.38E-08	5.00E-04	1.25E-11	1.79E+08	2.24E-03	0.00%	0.01	2.24E-05	0.00%
Te-129m	2.61E-19	5.00E-04	1.38E-22	6.03E+08	8.30E-14	0.00%	0.01	8.30E-16	0.00%
I-129	1.21E-01	1.00E+00	1.28E-01	3.18E+01	4.06E+00	0.00%	0.5	2.03E+00	0.00%
I-131	1.32E-70	1.00E+00	1.39E-70	3.97E+09	5.53E-61	0.00%	0.5	2.76E-61	0.00%
Cs-134	9.64E-03	9.50E-01	9.64E-03	6.08E+07	5.86E+05	<u>11.25%</u>	0.01	5.86E+03	<u>12.34%</u>
Cs-135	1.30E-01	9.50E-01	1.30E-01	5.18E+00	6.72E-01	0.00%	0.01	6.72E-03	0.00%
Cs-136	1.97E-46	9.50E-01	1.97E-46	5.47E+08	1.08E-37	0.00%	0.01	1.08E-39	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	<u>53.13%</u>	0.01	2.77E+04	<u>58.30%</u>
Ba-140	1.15E-44	5.00E-04	6.05E-48	2.63E+08	1.59E-39	0.00%	0.001	1.59E-42	0.00%
La-140	1.73E-45	1.00E-03	1.82E-48	2.45E+09	4.47E-39	0.00%	0.001	4.47E-42	0.00%
Ce-141	3.28E-18	1.00E-04	3.45E-22	2.42E+08	8.36E-14	0.00%	0.001	8.36E-17	0.00%
Ca-144	9.56E-03	1.00E-04	1.01E-06	1.12E+09	1.13E+03	0.02%	0.001	1.13E+00	0.00%
Pr-143	4.09E-42	1.00E-03	4.31E-45	4.92E+08	2.12E-36	0.00%	0.001	2.12E-39	0.00%
Nd-144	1.18E+00	1.00E-04	1.24E-04	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Nd-147	3.37E-52	1.00E-04	3.55E-56	5.02E+08	1.78E-47	0.00%	0.001	1.78E-50	0.00%
Pm-147	6.46E-02	1.00E-04	6.80E-06	3.15E+07	2.14E+02	0.00%	0.001	2.14E-01	0.00%
Pm-148	1.37E-18	1.00E-04	1.44E-22	1.64E+09	2.36E-13	0.00%	0.001	2.36E-16	0.00%
Pm-148m	1.53E-16	1.00E-04	1.61E-20	2.14E+08	3.44E-12	0.00%	0.001	3.44E-15	0.00%
Sm-147	1.92E-01	3.50E-04	7.09E-05	1.65E+00	1.17E-04	0.00%	0.001	1.17E-07	0.00%
Sm-151	1.33E-02	3.50E-04	4.91E-06	7.63E+05	3.74E+00	0.00%	0.001	3.74E-03	0.00%
Eu-152	4.30E-05	1.30E-04	5.88E-09	3.81E+07	2.24E-01	0.00%	0.001	2.24E-04	0.00%
Eu-154	8.22E-03	1.30E-04	1.12E-06	6.86E+07	7.71E+01	0.00%	0.001	7.71E-02	0.00%
Eu-155	2.13E-03	1.30E-04	2.91E-07	1.81E+07	5.27E+00	0.00%	0.001	5.27E-03	0.00%
Eu-156	1.84E-39	1.30E-04	2.52E-43	6.06E+08	1.53E-34	0.00%	0.001	1.53E-37	0.00%
Gd-152	1.13E-05	1.00E-04	1.19E-09	5.15E-03	6.11E-12	0.00%	0.001	6.11E-15	0.00%
Tb-160	2.86E-13	1.00E-04	3.01E-17	2.48E+08	7.46E-09	0.00%	0.001	7.46E-12	0.00%
Ra-224	8.48E-11	3.00E-04	2.68E-14	4.67E+11	1.25E-02	0.00%	0.001	1.25E-05	0.00%
Th-228	1.65E-08	1.00E-05	1.74E-13	2.54E+11	4.42E-02	0.00%	0.001	4.42E-05	0.00%
U-232	1.08E-06	3.00E-04	3.42E-10	1.48E+10	5.06E+00	0.00%	0.001	5.06E-03	0.00%
U-234	2.76E-03	3.00E-04	8.72E-07	8.08E+05	7.05E-01	0.00%	0.001	7.05E-04	0.00%
U-235	7.38E-02	3.00E-04	2.33E-05	2.59E+02	6.03E-03	0.00%	0.001	6.03E-06	0.00%
U-236	7.34E-02	3.00E-04	2.32E-05	7.76E+03	1.80E-01	0.00%	0.001	1.80E-04	0.00%
U-238	2.88E-02	3.00E-04	9.10E-06	4.03E+01	3.67E-04	0.00%	0.001	3.67E-07	0.00%
Np-237	5.06E-02	3.00E-04	1.60E-05	3.45E+05	5.51E+00	0.00%	0.001	5.51E-03	0.00%

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 168 Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	<u>Volatile Conditions</u>		Release Fraction Values	<u>Evaporative Conditions</u>	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Pu-236	5.68E-07	3.00E-04	1.79E-10	8.53E+10	1.53E+01	0.00%	0.001	1.53E-02	0.00%
Pu-238	1.85E-01	3.00E-04	5.84E-05	7.88E+09	4.60E+05	8.82%	0.001	4.60E+02	0.97%
Pu-239	4.12E-01	3.00E-04	1.30E-04	3.16E+07	4.12E+03	0.08%	0.001	4.12E+00	0.01%
Pu-240	8.29E-02	3.00E-04	2.62E-05	1.16E+08	3.04E+03	0.06%	0.001	3.04E+00	0.01%
Pu-241	3.40E-02	3.00E-04	1.07E-05	1.03E+09	1.11E+04	0.21%	0.001	1.11E+01	0.02%
Pu-242	6.66E-03	3.00E-04	2.10E-06	1.89E+06	3.97E+00	0.00%	0.001	3.97E-03	0.00%
Am-241	9.23E-03	3.00E-04	2.91E-06	1.79E+09	5.22E+03	0.10%	0.001	5.22E+00	0.01%
Am-242m	4.02E-06	3.00E-04	1.27E-09	4.96E+09	6.30E+00	0.00%	0.001	6.30E-03	0.00%
Am-243	2.20E-04	3.00E-04	6.94E-08	1.04E+08	7.22E+00	0.00%	0.001	7.22E-03	0.00%
Cm-242	3.34E-08	3.00E-04	1.05E-11	5.62E+10	5.93E-01	0.00%	0.001	5.93E-04	0.00%
Cm-243	4.08E-07	3.00E-04	1.29E-10	1.81E+10	2.33E+00	0.00%	0.001	2.33E-03	0.00%
Cm-244	1.53E-05	3.00E-04	4.84E-09	2.18E+10	1.05E+02	0.00%	0.001	1.05E-01	0.00%
Cm-245	2.93E-07	3.00E-04	9.26E-11	9.27E+07	8.58E-03	0.00%	0.001	8.58E-06	0.00%
Cm-246	1.31E-08	3.00E-04	4.14E-12	1.65E+08	6.84E-04	0.00%	0.001	6.84E-07	0.00%
Cm-247	5.33E-11	3.00E-04	1.68E-14	4.55E+04	7.66E-10	0.00%	0.001	7.66E-13	0.00%
Cm-248	1.21E-12	3.00E-04	3.83E-16	8.08E+06	3.10E-09	0.00%	0.001	3.10E-12	0.00%
Bk-249	1.32E-16	3.00E-04	4.17E-20	2.17E+09	9.06E-11	0.00%	0.001	9.06E-14	0.00%
Cf-249	7.45E-15	3.00E-04	2.35E-18	2.20E+09	5.17E-09	0.00%	0.001	5.17E-12	0.00%
Cf-250	1.10E-15	3.00E-04	3.47E-19	2.43E+10	8.43E-09	0.00%	0.001	8.43E-12	0.00%
Cf-251	3.20E-16	3.00E-04	1.01E-19	1.00E+09	1.01E-10	0.00%	0.001	1.01E-13	0.00%
Cf-252	2.39E-17	3.00E-04	7.55E-21	6.99E+10	5.28E-10	0.00%	0.001	5.28E-13	0.00%
Cf-253	2.23E-50	3.00E-04	7.04E-54	8.81E+10	6.20E-43	0.00%	0.001	6.20E-46	0.00%
					<u>5.21E+08</u>			<u>4.75E+04</u>	

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 16B Fuel Assembly
15 Years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Contribution	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	6.48E-06	1.00E+00	6.82E-06	9.22E+05	6.29E+00	0.00%	1	6.29E+00	0.02%
Cr-51	1.14E-63	5.00E-02	6.00E-65	2.40E+07	1.44E-57	0.00%	0.001	1.44E-60	0.00%
Co-60	1.61E-04	1.90E-04	3.23E-08	1.70E+08	5.48E+00	0.00%	0.001	5.48E-03	0.00%
Se-79	6.98E-03	1.00E-01	7.34E-04	6.20E+02	4.55E-01	0.00%	0.01	4.55E-03	0.00%
Rb-87	3.62E-01	9.50E-01	3.62E-01	2.87E-04	1.04E-04	0.00%	0.001	1.04E-07	0.00%
Sr-89	4.86E-33	2.50E-04	1.28E-36	1.07E+09	1.37E-27	0.00%	0.001	1.37E-30	0.00%
Sr-90	5.96E-01	2.50E-04	1.57E-04	1.81E+08	2.84E+04	<u>0.84%</u>	0.001	2.84E+01	0.10%
Y-90	1.55E-04	2.50E-04	4.08E-08	4.46E+09	1.82E+02	0.01%	0.001	1.82E-01	0.00%
Y-91	2.50E-29	1.00E-04	2.64E-33	1.08E+09	2.85E-24	0.00%	0.001	2.85E-27	0.00%
Zr-93	1.25E+00	9.60E-06	1.26E-05	8.04E+02	1.01E-02	0.00%	0.001	1.01E-05	0.00%
Zr-95	2.86E-26	1.00E-05	3.01E-31	3.86E+08	1.16E-22	0.00%	0.001	1.16E-25	0.00%
Nb-95	3.30E-26	1.00E-05	3.48E-31	1.76E+08	6.12E-23	0.00%	0.001	6.12E-26	0.00%
Nb-95m	2.00E-29	1.00E-05	2.11E-34	8.08E+08	1.70E-25	0.00%	0.001	1.70E-28	0.00%
Tc-99	9.85E-01	1.00E+00	1.04E+00	1.27E+02	1.32E+02	0.00%	0.001	1.32E-01	0.00%
Ru-103	3.52E-43	5.00E-01	1.85E-43	2.51E+08	4.64E-35	0.00%	0.01	4.64E-37	0.00%
Ru-106	2.29E-06	5.00E-01	1.20E-06	1.47E+09	1.77E+03	0.05%	0.01	1.77E+01	0.06%
Pd-107	3.94E-02	1.00E-04	4.14E-06	6.68E+00	2.77E-05	0.00%	0.001	2.77E-08	0.00%
Cd-115m	1.35E-41	5.00E-02	7.09E-43	1.65E+09	1.17E-33	0.00%	0.001	1.17E-36	0.00%
In-115	2.02E-03	5.00E-02	1.07E-04	1.77E-05	1.89E-09	0.00%	0.001	1.89E-12	0.00%
Sn-121m	1.44E-06	4.00E-02	6.05E-08	3.48E+05	2.11E-02	0.00%	0.001	2.11E-05	0.00%
Sn-123	2.60E-16	4.00E-02	1.09E-17	2.47E+08	2.70E-09	0.00%	0.001	2.70E-12	0.00%
Sn-126	1.55E-02	4.00E-02	6.54E-04	2.44E+03	1.60E+00	0.00%	0.001	1.60E-03	0.00%
Sb-124	8.90E-33	6.00E-03	5.62E-35	3.67E+08	2.06E-26	0.00%	0.001	2.06E-29	0.00%
Sb-125	1.75E-04	6.00E-03	1.11E-06	1.01E+07	1.12E+01	0.00%	0.001	1.12E-02	0.00%
Sb-126	7.39E-11	4.00E-02	3.11E-12	8.36E+08	2.60E-03	0.00%	0.001	2.60E-06	0.00%
Te-127m	2.45E-18	5.00E-04	1.29E-21	1.79E+08	2.31E-13	0.00%	0.01	2.31E-15	0.00%
Te-129m	3.96E-52	5.00E-04	2.08E-55	6.03E+08	1.26E-46	0.00%	0.01	1.26E-48	0.00%
I-129	1.53E-01	1.00E+00	1.61E-01	3.18E+01	5.12E+00	0.00%	0.5	2.56E+00	0.01%
Cs-134	4.20E-04	9.50E-01	4.20E-04	6.08E+07	2.55E+04	<u>0.75%</u>	0.01	2.55E+02	<u>0.89%</u>
Cs-135	1.63E-01	9.50E-01	1.63E-01	5.18E+00	8.46E-01	0.00%	0.01	8.46E-03	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	<u>81.80%</u>	0.01	2.77E+04	<u>96.92%</u>
Ce-141	6.55E-52	1.00E-04	6.89E-56	2.42E+08	1.67E-47	0.00%	0.001	1.67E-50	0.00%
Ce-144	1.64E-06	1.00E-04	1.72E-10	1.12E+09	1.93E-01	0.00%	0.001	1.93E-04	0.00%
Nd-144	1.49E+00	1.00E-04	1.57E-04	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Pm-147	5.79E-03	1.00E-04	6.09E-07	3.15E+07	1.92E+01	0.00%	0.001	1.92E-02	0.00%
Pm-148	4.11E-45	1.00E-04	4.32E-49	1.84E+09	7.09E-40	0.00%	0.001	7.09E-43	0.00%
Pm-148m	4.58E-43	1.00E-04	4.82E-47	2.14E+08	1.03E-38	0.00%	0.001	1.03E-41	0.00%
Sm-147	3.18E-01	3.50E-04	1.17E-04	1.65E+00	1.93E-04	0.00%	0.001	1.93E-07	0.00%
Sm-151	1.56E-02	3.50E-04	5.73E-06	7.63E+05	4.37E+00	0.00%	0.001	4.37E-03	0.00%
Eu-152	3.18E-05	1.30E-04	4.34E-09	3.81E+07	1.66E-01	0.00%	0.001	1.66E-04	0.00%
Eu-154	4.62E-03	1.30E-04	6.32E-07	6.86E+07	4.33E+01	0.00%	0.001	4.33E-02	0.00%
Eu-155	6.31E-04	1.30E-04	8.64E-08	1.81E+07	1.56E+00	0.00%	0.001	1.56E-03	0.00%
Gd-152	1.42E-06	1.00E-04	1.49E-09	5.15E-03	7.69E-12	0.00%	0.001	7.69E-15	0.00%
Tb-160	2.23E-28	1.00E-04	2.35E-32	2.48E+08	5.82E-24	0.00%	0.001	5.82E-27	0.00%
Ra-224	2.40E-10	3.00E-04	7.59E-14	4.67E+11	3.55E-02	0.00%	0.001	3.55E-05	0.00%
Th-228	4.67E-08	1.00E-05	4.92E-13	2.54E+11	1.25E-01	0.00%	0.001	1.25E-04	0.00%
U-232	1.84E-06	3.00E-04	5.81E-10	1.48E+10	8.59E+00	0.00%	0.001	8.59E-03	0.00%
U-234	3.48E-03	3.00E-04	1.10E-06	8.08E+05	8.87E-01	0.00%	0.001	8.87E-04	0.00%
U-235	9.29E-02	3.00E-04	2.93E-05	2.59E+02	7.60E-03	0.00%	0.001	7.60E-06	0.00%
U-236	9.24E-02	3.00E-04	2.92E-05	7.76E+03	2.26E-01	0.00%	0.001	2.26E-04	0.00%
U-238	3.63E-02	3.00E-04	1.15E-05	4.03E+01	4.62E-04	0.00%	0.001	4.62E-07	0.00%
Np-237	6.37E-02	3.00E-04	2.01E-05	3.45E+05	6.94E+00	0.00%	0.001	6.94E-03	0.00%
Pu-236	6.28E-08	3.00E-04	1.98E-11	8.53E+10	1.69E+00	0.00%	0.001	1.69E-03	0.00%
Pu-238	2.15E-01	3.00E-04	6.79E-05	7.88E+09	5.35E+05	<u>15.77%</u>	0.001	5.35E+02	<u>1.87%</u>
Pu-239	5.19E-01	3.00E-04	1.64E-04	3.16E+07	5.18E+03	0.15%	0.001	5.18E+00	0.02%
Pu-240	1.04E-01	3.00E-04	3.29E-05	1.16E+08	3.82E+03	0.11%	0.001	3.82E+00	0.01%
Pu-241	2.67E-02	3.00E-04	8.43E-06	1.03E+09	8.68E+03	0.26%	0.001	8.68E+00	0.03%
Pu-242	8.38E-03	3.00E-04	2.65E-06	1.89E+06	5.00E+00	0.00%	0.001	5.00E-03	0.00%
Am-241	2.74E-02	3.00E-04	8.65E-06	1.79E+09	1.55E+04	0.46%	0.001	1.55E+01	0.05%
Am-242m	4.84E-06	3.00E-04	1.53E-09	4.96E+09	7.58E+00	0.00%	0.001	7.58E-03	0.00%

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 16B Fuel Assembly
15 Years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Contribution	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Am-243	2.76E-04	3.00E-04	8.73E-08	1.04E+08	9.08E+00	0.00%	0.001	9.08E-03	0.00%
Cm-242	1.17E-08	3.00E-04	3.70E-12	5.62E+10	2.08E-01	0.00%	0.001	2.08E-04	0.00%
Cm-243	4.03E-07	3.00E-04	1.27E-10	1.81E+10	2.30E+00	0.00%	0.001	2.30E-03	0.00%
Cm-244	1.32E-05	3.00E-04	4.15E-09	2.18E+10	9.05E+01	0.00%	0.001	9.05E-02	0.00%
Cm-245	3.69E-07	3.00E-04	1.16E-10	9.27E+07	1.08E-02	0.00%	0.001	1.08E-05	0.00%
Cm-246	1.65E-08	3.00E-04	5.21E-12	1.65E+08	8.59E-04	0.00%	0.001	8.59E-07	0.00%
Cm-247	6.71E-11	3.00E-04	2.12E-14	4.55E+04	9.64E-10	0.00%	0.001	9.64E-13	0.00%
Cm-248	1.53E-12	3.00E-04	4.83E-16	8.08E+08	3.90E-09	0.00%	0.001	3.90E-12	0.00%
Bk-249	5.24E-20	3.00E-04	1.66E-23	2.17E+09	3.59E-14	0.00%	0.001	3.59E-17	0.00%
Cf-249	9.36E-15	3.00E-04	2.95E-18	2.20E+09	6.50E-09	0.00%	0.001	6.50E-12	0.00%
Cf-250	8.14E-16	3.00E-04	2.57E-19	2.43E+10	6.25E-09	0.00%	0.001	6.25E-12	0.00%
Cf-251	3.99E-16	3.00E-04	1.26E-19	1.00E+09	1.26E-10	0.00%	0.001	1.26E-13	0.00%
Cf-252	2.18E-18	3.00E-04	6.87E-22	6.99E+10	4.80E-11	0.00%	0.001	4.80E-14	0.00%
					3.39E+06			2.86E+04	

HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 16B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
H-3	9.06E-08	1.00E+00	9.53E-08	6.11E+05	5.83E+00	0.00%
Cr-51	3.22E-24	5.00E-02	1.69E-25	1.20E+07	2.03E-18	0.00%
Co-60	4.79E-04	1.90E-04	9.58E-08	2.94E+07	2.82E+00	0.00%
Se-79	5.54E-03	1.00E-01	5.83E-04	5.56E+02	3.24E-01	0.00%
Rb-87	2.88E-01	9.50E-01	2.88E-01	4.17E-04	1.20E-04	0.00%
Sr-89	5.38E-12	2.50E-04	1.42E-15	2.53E+08	3.58E-07	0.00%
Sr-90	6.06E-01	2.50E-04	1.59E-04	1.81E+07	2.88E+03	0.05%
Y-90	1.58E-04	2.50E-04	4.15E-08	5.43E+09	2.25E+02	0.00%
Y-91	1.15E-10	1.00E-04	1.21E-14	2.18E+08	2.64E-06	0.00%
Zr-93	9.89E-01	9.80E-06	9.99E-06	4.02E+00	4.02E-05	0.00%
Zr-95	1.39E-09	1.00E-05	1.46E-14	7.30E+07	1.07E-06	0.00%
Nb-95	1.60E-09	1.00E-05	1.69E-14	8.63E+07	1.46E-06	0.00%
Nb-95m	9.72E-13	1.00E-05	1.02E-17	7.35E+08	7.52E-09	0.00%
Tc-99	7.81E-01	1.00E+00	8.22E-01	2.20E+01	1.81E+01	0.00%
Ru-103	1.83E-15	5.00E-01	8.56E-16	8.70E+07	7.45E-08	0.00%
Ru-106	1.74E-03	5.00E-01	9.13E-04	7.03E+07	6.42E+04	1.21%
Pd-107	3.13E-02	1.00E-04	3.29E-06	7.20E-02	2.37E-07	0.00%
Cd-115m	4.81E-17	5.00E-02	2.53E-18	3.81E+08	9.65E-10	0.00%
In-115	1.61E-03	5.00E-02	8.46E-05	7.28E-07	6.16E-11	0.00%
Sn-121m	1.31E-06	4.00E-02	5.53E-08	5.08E+04	2.81E-03	0.00%
Sn-123	6.87E-06	4.00E-02	2.89E-09	6.33E+07	1.83E-01	0.00%
Sn-125	2.00E-61	4.00E-02	8.44E-63	1.14E+07	9.62E-56	0.00%
Sn-126	1.23E-02	4.00E-02	5.19E-04	4.82E+02	2.50E-01	0.00%
Sb-124	1.30E-14	6.00E-03	8.22E-17	1.63E+08	1.34E-08	0.00%
Sb-125	1.76E-03	6.00E-03	1.11E-05	2.69E+08	3.00E+01	0.00%
Sb-126	5.87E-11	4.00E-02	2.47E-12	6.10E+06	1.51E-05	0.00%
Te-127m	2.38E-08	5.00E-04	1.25E-11	7.45E+07	9.32E-04	0.00%
Te-129m	2.61E-19	5.00E-04	1.38E-22	2.98E+08	4.10E-14	0.00%
I-129	1.21E-01	1.00E+00	1.28E-01	4.94E+01	6.31E+00	0.00%
I-131	1.32E-70	1.00E+00	1.39E-70	6.57E+09	9.15E-61	0.00%
Ce-134	9.64E-03	9.50E-01	9.64E-03	9.58E+07	9.24E+06	17.35%
Ce-135	1.30E-01	9.50E-01	1.30E-01	8.17E+00	1.06E+00	0.00%
Ce-136	1.97E-46	9.50E-01	1.97E-46	8.03E+08	1.58E-37	0.00%
Ce-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	81.31%
Ba-140	1.15E-44	5.00E-04	6.05E-48	6.13E+08	3.71E-39	0.00%
La-140	1.73E-46	1.00E-03	1.82E-48	4.29E+09	7.83E-39	0.00%
Ce-141	3.28E-18	1.00E-04	3.45E-22	7.41E+07	2.56E-14	0.00%
Ce-144	9.56E-03	1.00E-04	1.01E-06	6.38E+07	6.42E+01	0.00%
Pr-143	4.09E-42	1.00E-03	4.31E-45	3.03E+08	1.31E-36	0.00%
Nd-144	1.18E+00	1.00E-04	1.24E-04	0.00E+00	0.00E+00	0.00%
Nd-147	3.37E-52	1.00E-04	3.55E-56	3.16E+08	1.12E-47	0.00%
Pm-147	6.46E-02	1.00E-04	6.80E-06	8.81E+05	5.99E+00	0.00%
Pm-148	1.37E-18	1.00E-04	1.44E-22	1.56E+09	2.25E-13	0.00%
Pm-148m	1.53E-16	1.00E-04	1.61E-20	1.50E+08	2.41E-12	0.00%
Sm-147	1.92E-01	3.50E-04	7.09E-05	4.19E-03	2.97E-07	0.00%
Sm-151	1.33E-02	3.50E-04	4.91E-06	8.95E+03	4.39E-02	0.00%
Eu-152	4.30E-05	1.30E-04	5.88E-09	1.04E+06	6.12E-03	0.00%
Eu-154	8.22E-03	1.30E-04	1.12E-06	2.40E+06	2.70E+00	0.00%
Eu-155	2.13E-03	1.30E-04	2.91E-07	6.05E+05	1.76E-01	0.00%
Eu-156	1.84E-39	1.30E-04	2.52E-43	4.79E+08	1.21E-34	0.00%
Gd-152	1.13E-05	1.00E-04	1.19E-09	3.22E-06	3.82E-15	0.00%
Tb-160	2.86E-13	1.00E-04	3.01E-17	7.23E+07	2.17E-09	0.00%
Ra-224	8.48E-11	3.00E-04	2.68E-14	5.31E+10	1.42E-03	0.00%
Th-228	1.65E-08	1.00E-05	1.74E-13	3.11E+08	5.41E-05	0.00%

HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 16B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Ca-137)	Solubility Fraction	Normalized Supernate Content (g/g Ca-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ca-137)	Percent Dose
U-232	1.08E-06	3.00E-04	3.42E-10	2.86E+07	9.79E-03	0.00%
U-234	2.78E-03	3.00E-04	8.72E-07	1.62E+03	1.41E-03	0.00%
U-235	7.38E-02	3.00E-04	2.33E-05	5.41E-01	1.28E-05	0.00%
U-236	7.34E-02	3.00E-04	2.32E-05	1.62E+01	3.75E-04	0.00%
U-238	2.88E-02	3.00E-04	9.10E-06	7.73E-02	7.03E-07	0.00%
Np-237	5.06E-02	3.00E-04	1.60E-05	2.75E+03	4.39E-02	0.00%
Pu-238	5.68E-07	3.00E-04	1.79E-10	6.93E+08	1.24E-01	0.00%
Pu-239	1.85E-01	3.00E-04	5.84E-05	6.51E+07	3.80E+03	0.07%
Pu-239	4.12E-01	3.00E-04	1.30E-04	2.67E+05	3.48E+01	0.00%
Pu-240	8.29E-02	3.00E-04	2.62E-05	9.75E+05	2.55E+01	0.00%
Pu-241	3.40E-02	3.00E-04	1.07E-05	8.86E+06	9.51E+01	0.00%
Pu-242	6.66E-03	3.00E-04	2.10E-06	1.61E+04	3.38E-02	0.00%
Am-241	9.23E-03	3.00E-04	2.91E-06	1.54E+07	4.49E+01	0.00%
Am-242m	4.02E-06	3.00E-04	1.27E-09	4.06E+07	5.18E-02	0.00%
Am-243	2.20E-04	3.00E-04	6.94E-08	8.97E+05	6.22E-02	0.00%
Cm-242	3.34E-08	3.00E-04	1.05E-11	3.64E+08	3.84E-03	0.00%
Cm-243	4.08E-07	3.00E-04	1.29E-10	1.50E+08	1.93E-02	0.00%
Cm-244	1.53E-05	3.00E-04	4.84E-09	1.88E+06	9.00E-01	0.00%
Cm-245	2.93E-07	3.00E-04	9.26E-11	7.73E+05	7.15E-05	0.00%
Cm-246	1.31E-06	3.00E-04	4.14E-12	1.38E+06	5.72E-06	0.00%
Cm-247	5.33E-11	3.00E-04	1.68E-14	3.80E+02	6.39E-12	0.00%
Cm-248	1.21E-12	3.00E-04	3.83E-16	6.80E+04	2.61E-11	0.00%
Bk-249	1.32E-16	3.00E-04	4.17E-20	1.00E+07	4.17E-13	0.00%
Cf-249	7.45E-15	3.00E-04	2.35E-18	1.84E+07	4.33E-11	0.00%
Cf-250	1.10E-15	3.00E-04	3.47E-19	2.10E+08	7.28E-11	0.00%
Cf-251	3.20E-16	3.00E-04	1.01E-19	8.22E+06	8.30E-13	0.00%
Cf-252	2.39E-17	3.00E-04	7.55E-21	5.05E+08	3.81E-12	0.00%
Cf-253	2.23E-50	3.00E-04	7.04E-54	2.70E+08	1.90E-45	0.00%
					5.33E+06	

**HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTION**

**Mark 16B Fuel Assembly
15 Years**

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
H-3	6.48E-08	1.00E+00	6.92E-08	6.11E+05	4.17E+00	0.00%
Cr-51	1.14E-63	5.00E-02	6.00E-65	1.20E+07	7.20E-58	0.00%
Co-60	1.61E-04	1.90E-04	3.23E-08	2.94E+07	9.48E-01	0.00%
Se-79	6.98E-03	1.00E-01	7.34E-04	5.56E+02	4.08E-01	0.00%
Rb-87	3.62E-01	9.50E-01	3.62E-01	4.17E-04	1.51E-04	0.00%
Sr-89	4.86E-33	2.50E-04	1.28E-36	2.53E+08	3.23E-28	0.00%
Sr-90	5.96E-01	2.50E-04	1.57E-04	1.81E+07	2.84E+03	0.06%
Y-90	1.55E-04	2.50E-04	4.08E-08	5.43E+09	2.21E+02	0.01%
Y-91	2.50E-29	1.00E-04	2.64E-33	2.18E+08	5.75E-25	0.00%
Zr-93	1.25E+00	9.60E-06	1.26E-05	4.02E+00	5.06E-05	0.00%
Zr-95	2.86E-26	1.00E-05	3.01E-31	7.30E+07	2.20E-23	0.00%
Nb-95	3.30E-26	1.00E-05	3.48E-31	8.63E+07	3.00E-23	0.00%
Nb-95m	2.00E-29	1.00E-05	2.11E-34	7.35E+08	1.55E-25	0.00%
Tc-99	9.85E-01	1.00E+00	1.04E+00	2.20E+01	2.28E+01	0.00%
Ru-103	3.52E-43	5.00E-01	1.85E-43	8.70E+07	1.61E-35	0.00%
Ru-106	2.29E-06	5.00E-01	1.20E-06	7.03E+07	8.47E+01	0.00%
Pd-107	3.94E-02	1.00E-04	4.14E-06	7.20E-02	2.98E-07	0.00%
Cd-115m	1.35E-41	5.00E-02	7.09E-43	3.81E+08	2.70E-34	0.00%
In-115	2.02E-03	5.00E-02	1.07E-04	7.28E-07	7.76E-11	0.00%
Sn-121m	1.44E-06	4.00E-02	6.05E-08	5.08E+04	3.08E-03	0.00%
Sn-123	2.60E-16	4.00E-02	1.09E-17	6.33E+07	6.92E-10	0.00%
Sn-126	1.55E-02	4.00E-02	6.54E-04	4.82E+02	3.15E-01	0.00%
Sb-124	8.90E-33	6.00E-03	5.62E-35	1.63E+08	9.16E-27	0.00%
Sb-125	1.75E-04	6.00E-03	1.11E-06	2.69E+06	2.98E+00	0.00%
Sb-126	7.39E-11	4.00E-02	3.11E-12	6.10E+08	1.90E-05	0.00%
Te-127m	2.45E-18	5.00E-04	1.29E-21	7.45E+07	9.60E-14	0.00%
Te-129m	3.96E-52	5.00E-04	2.08E-55	2.98E+08	6.21E-47	0.00%
I-129	1.53E-01	1.00E+00	1.61E-01	4.94E+01	7.95E+00	0.00%
Ce-134	4.20E-04	9.50E-01	4.20E-04	9.58E+07	4.02E+04	0.92%
Ce-135	1.63E-01	9.50E-01	1.63E-01	8.17E+00	1.34E+00	0.00%
Ce-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	99.90%
Ce-141	6.55E-52	1.00E-04	6.89E-56	7.41E+07	5.11E-48	0.00%
Ce-144	1.64E-06	1.00E-04	1.72E-10	6.38E+07	1.10E-02	0.00%
Nd-144	1.49E+00	1.00E-04	1.57E-04	0.00E+00	0.00E+00	0.00%
Pm-147	5.79E-03	1.00E-04	6.09E-07	8.81E+05	5.37E-01	0.00%
Pm-148	4.11E-45	1.00E-04	4.32E-49	1.56E+09	6.74E-40	0.00%
Pm-148m	4.58E-43	1.00E-04	4.82E-47	1.50E+08	7.23E-39	0.00%
Sm-147	3.18E-01	3.50E-04	1.17E-04	4.19E-03	4.91E-07	0.00%
Sm-151	1.56E-02	3.50E-04	5.73E-06	8.95E+03	5.13E-02	0.00%
Eu-152	3.18E-05	1.30E-04	4.34E-09	1.04E+08	4.52E-03	0.00%
Eu-154	4.62E-03	1.30E-04	6.32E-07	2.40E+08	1.52E+00	0.00%
Eu-155	6.31E-04	1.30E-04	8.64E-08	6.05E+05	5.23E-02	0.00%
Gd-152	1.42E-05	1.00E-04	1.49E-09	3.22E-08	4.81E-15	0.00%
Tb-160	2.23E-28	1.00E-04	2.35E-32	7.23E+07	1.70E-24	0.00%
Ra-224	2.40E-10	3.00E-04	7.59E-14	5.31E+10	4.03E-03	0.00%
Th-228	4.67E-08	1.00E-05	4.92E-13	3.11E+08	1.53E-04	0.00%
U-232	1.84E-06	3.00E-04	5.81E-10	2.86E+07	1.66E-02	0.00%
U-234	3.48E-03	3.00E-04	1.10E-06	1.62E+03	1.78E-03	0.00%
U-235	9.29E-02	3.00E-04	2.93E-05	5.41E-01	1.59E-05	0.00%
U-236	9.24E-02	3.00E-04	2.92E-05	1.62E+01	4.73E-04	0.00%
U-238	3.63E-02	3.00E-04	1.15E-05	7.73E-02	8.86E-07	0.00%
Np-237	6.37E-02	3.00E-04	2.01E-05	2.75E+03	5.53E-02	0.00%
Pu-236	6.28E-08	3.00E-04	1.98E-11	6.93E+08	1.38E-02	0.00%
Pu-238	2.15E-01	3.00E-04	6.79E-05	6.51E+07	4.42E+03	0.10%

HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 16B Fuel Assembly
15 Years

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
Pu-239	5.19E-01	3.00E-04	1.64E-04	2.67E+05	4.38E+01	0.00%
Pu-240	1.04E-01	3.00E-04	3.29E-05	9.75E+05	3.21E+01	0.00%
Pu-241	2.67E-02	3.00E-04	8.43E-06	8.86E+06	7.47E+01	0.00%
Pu-242	6.38E-03	3.00E-04	2.65E-06	1.61E+04	4.26E-02	0.00%
Pu-241	2.74E-02	3.00E-04	8.65E-06	1.54E+07	1.33E+02	0.00%
Am-242m	4.84E-06	3.00E-04	1.53E-09	4.08E+07	6.23E-02	0.00%
Am-243	2.76E-04	3.00E-04	8.73E-08	8.97E+05	7.83E-02	0.00%
Cm-242	1.17E-06	3.00E-04	3.70E-12	3.64E+08	1.35E-03	0.00%
Cm-243	4.03E-07	3.00E-04	1.27E-10	1.50E+08	1.91E-02	0.00%
Cm-244	1.32E-05	3.00E-04	4.15E-09	1.86E+08	7.72E-01	0.00%
Cm-245	3.69E-07	3.00E-04	1.16E-10	7.73E+05	9.00E-06	0.00%
Cm-246	1.65E-08	3.00E-04	5.21E-12	1.38E+06	7.19E-06	0.00%
Cm-247	6.71E-11	3.00E-04	2.12E-14	3.80E+02	8.05E-12	0.00%
Cm-248	1.53E-12	3.00E-04	4.83E-16	6.80E+04	3.28E-11	0.00%
Bk-249	5.24E-20	3.00E-04	1.66E-23	1.00E+07	1.66E-16	0.00%
Cf-249	9.36E-15	3.00E-04	2.95E-18	1.84E+07	5.44E-11	0.00%
Cf-250	8.14E-16	3.00E-04	2.57E-19	2.10E+08	5.40E-11	0.00%
Cf-251	3.99E-18	3.00E-04	1.26E-19	8.22E+06	1.04E-12	0.00%
Cf-252	2.18E-18	3.00E-04	6.87E-22	5.05E+08	3.47E-13	0.00%
					<u>4.38E+06</u>	

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 22 Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized		Volatile Conditions		Release Fraction Values	Evaporative Conditions	
			Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	8.70E-06	1.00E+00	9.16E-06	9.22E+05	8.44E+00	0.00%	1	8.44E+00	0.02%
Cr-51	2.21E-24	5.00E-02	1.17E-25	2.40E+07	2.80E-18	0.00%	0.001	2.80E-21	0.00%
Co-60	3.29E-04	1.90E-04	6.59E-08	1.70E+08	1.12E+01	0.00%	0.001	1.12E-02	0.00%
Se-79	5.57E-03	1.00E-01	5.87E-04	6.20E+02	3.64E-01	0.00%	0.01	3.64E-03	0.00%
Rb-87	2.88E-01	9.50E-01	2.88E-01	2.87E-04	8.27E-05	0.00%	0.001	8.27E-08	0.00%
Sr-89	5.26E-12	2.50E-04	1.38E-15	1.07E+09	1.48E-06	0.00%	0.001	1.48E-09	0.00%
Sr-90	6.06E-01	2.50E-04	1.59E-04	1.81E+08	2.88E+04	<u>0.55%</u>	0.001	2.88E+01	0.06%
Y-90	1.58E-04	2.50E-04	4.15E-08	4.46E+09	1.85E+02	0.00%	0.001	1.85E-01	0.00%
Y-91	1.13E-10	1.00E-04	1.19E-14	1.08E+09	1.28E-05	0.00%	0.001	1.28E-08	0.00%
Zr-93	1.54E+00	9.60E-06	1.55E-05	8.04E+02	1.25E-02	0.00%	0.001	1.25E-05	0.00%
Zr-95	1.36E-09	1.00E-05	1.43E-14	3.86E+08	5.53E-06	0.00%	0.001	5.53E-09	0.00%
Nb-95	1.57E-09	1.00E-05	1.65E-14	1.76E+08	2.91E-06	0.00%	0.001	2.91E-09	0.00%
Nb-95m	9.52E-13	1.00E-05	1.00E-17	8.08E+08	8.10E-09	0.00%	0.001	8.10E-12	0.00%
To-99	7.82E-01	1.00E+00	8.23E-01	1.27E+02	1.05E+02	0.00%	0.001	1.05E-01	0.00%
Ru-103	1.58E-15	5.00E-01	8.32E-16	2.51E+08	2.09E-07	0.00%	0.01	2.09E-09	0.00%
Ru-106	1.72E-03	5.00E-01	9.05E-04	1.47E+09	1.33E+06	<u>25.54%</u>	0.01	1.33E+04	<u>27.77%</u>
Pd-107	3.12E-02	1.00E-04	3.29E-06	6.68E+00	2.19E-05	0.00%	0.001	2.19E-08	0.00%
Cd-115m	4.80E-17	5.00E-02	2.52E-18	1.65E+09	4.16E-09	0.00%	0.001	4.16E-12	0.00%
In-115	1.59E-03	5.00E-02	8.39E-05	1.77E-05	1.49E-09	0.00%	0.001	1.49E-12	0.00%
Sn-121m	1.34E-06	4.00E-02	5.65E-08	3.48E+05	1.97E-02	0.00%	0.001	1.97E-05	0.00%
Sn-123	6.94E-08	4.00E-02	2.92E-09	2.47E+08	7.22E-01	0.00%	0.001	7.22E-04	0.00%
Sn-125	1.94E-61	4.00E-02	8.18E-63	1.52E+09	1.24E-63	0.00%	0.001	1.24E-66	0.00%
Sn-126	1.26E-02	4.00E-02	5.30E-04	2.44E+03	1.29E+00	0.00%	0.001	1.29E-03	0.00%
Sb-124	1.47E-14	6.00E-03	9.26E-17	3.67E+08	3.40E-08	0.00%	0.001	3.40E-11	0.00%
Sb-125	1.80E-03	6.00E-03	1.14E-05	1.01E+07	1.15E+02	0.00%	0.001	1.15E-01	0.00%
Sb-126	5.98E-11	4.00E-02	2.52E-12	8.36E+08	2.11E-03	0.00%	0.001	2.11E-06	0.00%
Te-127m	2.38E-08	5.00E-04	1.25E-11	1.79E+08	2.24E-03	0.00%	0.01	2.24E-05	0.00%
Te-129m	2.55E-19	5.00E-04	1.34E-22	6.03E+08	8.10E-14	0.00%	0.01	8.10E-16	0.00%
I-129	1.23E-01	1.00E+00	1.29E-01	3.18E+01	4.10E+00	0.00%	0.5	2.05E+00	0.00%
I-131	1.28E-70	1.00E+00	1.35E-70	3.97E+09	5.34E-61	0.00%	0.5	2.67E-61	0.00%
Cs-134	1.05E-02	9.50E-01	1.05E-02	6.08E+07	6.41E+05	<u>12.31%</u>	0.01	6.41E+03	<u>13.39%</u>
Cs-135	1.51E-01	9.50E-01	1.51E-01	5.18E+00	7.80E-01	0.00%	0.01	7.80E-03	0.00%
Cs-136	2.11E-46	9.50E-01	2.11E-46	5.47E+08	1.16E-37	0.00%	0.01	1.16E-39	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	<u>53.20%</u>	0.01	2.77E+04	<u>57.84%</u>
Ba-140	1.11E-44	5.00E-04	5.85E-48	2.63E+08	1.54E-39	0.00%	0.001	1.54E-42	0.00%
La-140	1.68E-45	1.00E-03	1.76E-48	2.45E+09	4.32E-39	0.00%	0.001	4.32E-42	0.00%
Ce-141	3.19E-18	1.00E-04	3.36E-22	2.42E+08	8.13E-14	0.00%	0.001	8.13E-17	0.00%
Ce-144	9.50E-03	1.00E-04	1.00E-06	1.12E+09	1.12E+03	0.02%	0.001	1.12E+00	0.00%
Pr-143	3.96E-42	1.00E-03	4.17E-45	4.92E+08	2.05E-36	0.00%	0.001	2.05E-39	0.00%
Nd-144	1.15E+00	1.00E-04	1.21E-04	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Nd-147	3.26E-52	1.00E-04	3.43E-56	5.02E+08	1.72E-47	0.00%	0.001	1.72E-50	0.00%
Pm-147	6.22E-02	1.00E-04	6.54E-06	3.15E+07	2.06E+02	0.00%	0.001	2.06E-01	0.00%
Pm-148	1.46E-18	1.00E-04	1.54E-22	1.64E+09	2.53E-13	0.00%	0.001	2.53E-16	0.00%
Pm-148m	1.63E-16	1.00E-04	1.72E-20	2.14E+08	3.68E-12	0.00%	0.001	3.68E-15	0.00%
Sm-147	1.86E-01	3.50E-04	6.84E-05	1.65E+00	1.13E-04	0.00%	0.001	1.13E-07	0.00%
Sm-151	1.48E-02	3.50E-04	5.44E-06	7.63E+05	4.15E+00	0.00%	0.001	4.15E-03	0.00%
Eu-152	4.39E-05	1.30E-04	6.01E-09	3.81E+07	2.29E-01	0.00%	0.001	2.29E-04	0.00%
Eu-154	8.64E-03	1.30E-04	1.18E-06	6.86E+07	8.11E+01	0.00%	0.001	8.11E-02	0.00%
Eu-155	2.36E-03	1.30E-04	3.23E-07	1.81E+07	5.85E+00	0.00%	0.001	5.85E-03	0.00%
Eu-156	1.76E-39	1.30E-04	2.40E-43	6.06E+08	1.46E-34	0.00%	0.001	1.46E-37	0.00%
Gd-152	1.17E-05	1.00E-04	1.23E-09	5.15E-03	6.34E-12	0.00%	0.001	6.34E-15	0.00%
Tb-160	3.19E-13	1.00E-04	3.36E-17	2.48E+08	8.33E-09	0.00%	0.001	8.33E-12	0.00%
Ra-224	4.76E-11	3.00E-04	1.50E-14	4.67E+11	7.03E-03	0.00%	0.001	7.03E-06	0.00%
Th-228	9.29E-09	1.00E-05	9.78E-14	2.54E+11	2.48E-02	0.00%	0.001	2.48E-05	0.00%
U-232	6.08E-11	3.00E-04	1.92E-14	1.48E+10	2.84E-04	0.00%	0.001	2.84E-07	0.00%
U-234	2.28E-03	3.00E-04	7.21E-07	8.08E+05	5.83E-01	0.00%	0.001	5.83E-04	0.00%
U-235	8.39E-02	3.00E-04	2.65E-05	2.59E+02	6.86E-03	0.00%	0.001	6.86E-06	0.00%
U-236	5.12E-02	3.00E-04	1.62E-05	7.76E+03	1.26E-01	0.00%	0.001	1.26E-04	0.00%
U-238	2.02E-02	3.00E-04	6.39E-06	4.03E+01	2.58E-04	0.00%	0.001	2.58E-07	0.00%
Np-237	4.30E-02	3.00E-04	1.36E-05	3.45E+05	4.68E+00	0.00%	0.001	4.68E-03	0.00%

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 22 Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Pu-236	3.18E-07	3.00E-04	1.01E-10	8.53E+10	8.58E+00	0.00%	0.001	8.58E-03	0.00%
Pu-237	3.28E-18	3.00E-04	1.03E-21	1.94E+07	2.00E-14	0.00%	0.001	2.00E-17	0.00%
Pu-238	1.66E-01	3.00E-04	5.25E-06	7.88E+09	4.13E+06	7.94%	0.001	4.13E+02	0.86%
Pu-239	3.79E-01	3.00E-04	1.20E-04	3.16E+07	3.78E+03	0.07%	0.001	3.78E+00	0.01%
Pu-240	6.85E-02	3.00E-04	2.16E-05	1.16E+08	2.51E+03	0.05%	0.001	2.51E+00	0.01%
Pu-241	3.27E-02	3.00E-04	1.03E-05	1.03E+09	1.06E+04	0.20%	0.001	1.06E+01	0.02%
Pu-242	5.93E-03	3.00E-04	1.87E-06	1.89E+06	3.54E+00	0.00%	0.001	3.54E-03	0.00%
Am-241	8.91E-03	3.00E-04	2.81E-06	1.79E+09	5.04E+03	0.10%	0.001	5.04E+00	0.01%
Am-242m	4.19E-06	3.00E-04	1.32E-09	4.96E+09	6.56E+00	0.00%	0.001	6.56E-03	0.00%
Am-243	2.22E-06	3.00E-04	7.01E-10	1.04E+08	7.29E-02	0.00%	0.001	7.29E-05	0.00%
Cm-242	3.27E-10	3.00E-04	1.03E-13	5.62E+10	5.79E-03	0.00%	0.001	5.79E-06	0.00%
Cm-243	4.22E-11	3.00E-04	1.33E-10	1.81E+10	2.41E+00	0.00%	0.001	2.41E-03	0.00%
Cm-244	1.74E-11	3.00E-04	5.50E-11	2.18E+10	1.20E+00	0.00%	0.001	1.20E-03	0.00%
Cm-245	4.05E-12	3.00E-04	1.28E-12	9.27E+07	1.19E-04	0.00%	0.001	1.19E-07	0.00%
Cm-246	1.73E-12	3.00E-04	5.45E-14	1.65E+08	9.00E-06	0.00%	0.001	9.00E-09	0.00%
Cm-247	8.40E-13	3.00E-04	2.65E-16	4.55E+04	1.21E-11	0.00%	0.001	1.21E-14	0.00%
Cm-248	2.18E-14	3.00E-04	6.87E-18	8.08E+06	5.55E-11	0.00%	0.001	5.55E-14	0.00%
Bk-249	1.48E-20	3.00E-04	4.67E-24	2.17E+09	1.01E-14	0.00%	0.001	1.01E-17	0.00%
Cf-249	8.13E-21	3.00E-04	2.57E-24	2.20E+09	5.65E-15	0.00%	0.001	5.65E-18	0.00%
					<u>5.21E+06</u>			<u>4.79E+04</u>	

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 22 Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	6.22E-06	1.00E+00	6.55E-06	9.22E+05	6.04E+00	0.00%	1	6.04E+00	0.02%
Cr-51	7.84E-64	5.00E-02	4.13E-65	2.40E+07	9.91E-58	0.00%	0.001	9.91E-61	0.00%
Co-60	1.11E-04	1.90E-04	2.22E-08	1.70E+08	3.77E+00	0.00%	0.001	3.77E-03	0.00%
Se-79	7.01E-03	1.00E-01	7.38E-04	6.20E+02	4.58E-01	0.00%	0.01	4.58E-03	0.00%
Rb-87	3.63E-01	9.50E-01	3.63E-01	2.87E-04	1.04E-04	0.00%	0.001	1.04E-07	0.00%
Sr-89	4.75E-33	2.50E-04	1.25E-36	1.07E+09	1.34E-27	0.00%	0.001	1.34E-30	0.00%
Sr-90	5.96E-01	2.50E-04	1.57E-04	1.81E+08	2.84E+04	0.85%	0.001	2.84E+01	0.10%
Y-90	1.55E-04	2.50E-04	4.08E-08	4.46E+09	1.82E+02	0.01%	0.001	1.82E-01	0.00%
Y-91	2.45E-29	1.00E-04	2.58E-33	1.08E+09	2.78E-24	0.00%	0.001	2.78E-27	0.00%
Zr-93	1.93E+00	9.60E-08	1.95E-05	8.04E+02	1.57E-02	0.00%	0.001	1.57E-05	0.00%
Zr-95	2.80E-26	1.00E-05	2.95E-31	3.86E+08	1.14E-22	0.00%	0.001	1.14E-25	0.00%
Nb-95	3.24E-26	1.00E-05	3.41E-31	1.76E+08	5.99E-23	0.00%	0.001	5.99E-26	0.00%
Nb-95m	1.96E-29	1.00E-05	2.06E-34	8.08E+08	1.67E-25	0.00%	0.001	1.67E-28	0.00%
Tc-99	9.85E-01	1.00E+00	1.04E+00	1.27E+02	1.32E+02	0.00%	0.001	1.32E-01	0.00%
Ru-103	3.42E-43	5.00E-01	1.80E-43	2.51E+08	4.51E-35	0.00%	0.01	4.51E-37	0.00%
Ru-106	2.27E-06	5.00E-01	1.19E-06	1.47E+09	1.75E+03	0.05%	0.01	1.75E+01	0.06%
Pd-107	3.93E-02	1.00E-04	4.14E-06	6.68E+00	2.76E-05	0.00%	0.001	2.76E-08	0.00%
Cd-115m	1.34E-41	5.00E-02	7.06E-43	1.65E+09	1.17E-33	0.00%	0.001	1.17E-36	0.00%
In-115	2.01E-03	5.00E-02	1.06E-04	1.77E-05	1.87E-09	0.00%	0.001	1.87E-12	0.00%
Sn-121m	1.47E-06	4.00E-02	6.19E-08	3.48E+05	2.16E-02	0.00%	0.001	2.16E-05	0.00%
Sn-123	2.62E-16	4.00E-02	1.10E-17	2.47E+08	2.72E-09	0.00%	0.001	2.72E-12	0.00%
Sn-126	1.58E-02	4.00E-02	6.67E-04	2.44E+03	1.63E+00	0.00%	0.001	1.63E-03	0.00%
Sb-124	1.00E-32	6.00E-03	6.33E-35	3.67E+08	2.32E-26	0.00%	0.001	2.32E-29	0.00%
Sb-125	1.79E-04	6.00E-03	1.13E-06	1.01E+07	1.14E+01	0.00%	0.001	1.14E-02	0.00%
Sb-126	7.53E-11	4.00E-02	3.17E-12	8.36E+08	2.65E-03	0.00%	0.001	2.65E-06	0.00%
Te-127m	2.45E-18	5.00E-04	1.29E-21	1.79E+08	2.31E-13	0.00%	0.01	2.31E-15	0.00%
Te-129m	3.87E-52	5.00E-04	2.04E-55	6.03E+08	1.23E-46	0.00%	0.01	1.23E-48	0.00%
I-129	1.54E-01	1.00E+00	1.62E-01	3.18E+01	5.16E+00	0.00%	0.5	2.58E+00	0.01%
Cs-134	4.59E-04	9.50E-01	4.59E-04	6.08E+07	2.79E+04	0.84%	0.01	2.79E+02	0.98%
Cs-135	1.90E-01	9.50E-01	1.90E-01	5.18E+00	9.82E-01	0.00%	0.01	9.82E-03	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	82.92%	0.01	2.77E+04	97.04%
Cs-141	6.37E-52	1.00E-04	6.71E-56	2.42E+08	1.62E-47	0.00%	0.001	1.62E-50	0.00%
Cs-144	1.63E-06	1.00E-04	1.71E-10	1.12E+09	1.92E-01	0.00%	0.001	1.92E-04	0.00%
Nd-144	1.46E+00	1.00E-04	1.53E-04	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Pm-147	5.57E-03	1.00E-04	5.86E-07	3.15E+07	1.85E+01	0.00%	0.001	1.85E-02	0.00%
Pm-148	4.40E-45	1.00E-04	4.63E-49	1.64E+09	7.59E-40	0.00%	0.001	7.59E-43	0.00%
Pm-148m	4.90E-43	1.00E-04	5.16E-47	2.14E+08	1.10E-38	0.00%	0.001	1.10E-41	0.00%
Sm-147	3.06E-01	3.50E-04	1.13E-04	1.65E+00	1.86E-04	0.00%	0.001	1.86E-07	0.00%
Sm-151	1.73E-02	3.50E-04	6.36E-06	7.63E+05	4.85E+00	0.00%	0.001	4.85E-03	0.00%
Eu-152	3.24E-05	1.30E-04	4.44E-09	3.81E+07	1.69E-01	0.00%	0.001	1.69E-04	0.00%
Eu-154	4.86E-03	1.30E-04	6.84E-07	6.86E+07	4.56E+01	0.00%	0.001	4.56E-02	0.00%
Eu-155	7.01E-04	1.30E-04	9.59E-08	1.81E+07	1.74E+00	0.00%	0.001	1.74E-03	0.00%
Gd-152	1.47E-05	1.00E-04	1.55E-09	5.15E-03	7.99E-12	0.00%	0.001	7.99E-15	0.00%
Tb-160	2.49E-28	1.00E-04	2.62E-32	2.48E+08	6.50E-24	0.00%	0.001	6.50E-27	0.00%
Ra-224	1.35E-10	3.00E-04	4.26E-14	4.67E+11	1.99E-02	0.00%	0.001	1.99E-05	0.00%
Th-228	2.62E-08	1.00E-05	2.76E-13	2.54E+11	7.01E-02	0.00%	0.001	7.01E-05	0.00%
U-232	1.03E-06	3.00E-04	3.26E-10	1.48E+10	4.82E+00	0.00%	0.001	4.82E-03	0.00%
U-234	2.87E-03	3.00E-04	9.08E-07	8.08E+05	7.33E-01	0.00%	0.001	7.33E-04	0.00%
U-235	1.06E-01	3.00E-04	3.34E-05	2.59E+02	8.64E-03	0.00%	0.001	8.64E-06	0.00%
U-236	6.45E-02	3.00E-04	2.04E-05	7.76E+03	1.58E-01	0.00%	0.001	1.58E-04	0.00%
U-238	2.55E-02	3.00E-04	8.05E-06	4.03E+01	3.24E-04	0.00%	0.001	3.24E-07	0.00%
Np-237	5.41E-02	3.00E-04	1.71E-05	3.45E+05	5.89E+00	0.00%	0.001	5.89E-03	0.00%
Pu-236	3.53E-08	3.00E-04	1.11E-11	8.53E+10	9.50E-01	0.00%	0.001	9.50E-04	0.00%
Pu-237	3.29E-42	3.00E-04	1.04E-45	1.94E+07	2.01E-38	0.00%	0.001	2.01E-41	0.00%
Pu-238	1.93E-01	3.00E-04	6.10E-05	7.88E+09	4.81E+05	14.40%	0.001	4.81E+02	1.68%
Pu-239	4.77E-01	3.00E-04	1.50E-04	3.16E+07	4.76E+03	0.14%	0.001	4.76E+00	0.02%
Pu-240	8.61E-02	3.00E-04	2.72E-05	1.16E+08	3.16E+03	0.09%	0.001	3.16E+00	0.01%
Pu-241	2.57E-02	3.00E-04	8.12E-06	1.03E+09	8.37E+03	0.25%	0.001	8.37E+00	0.03%
Pu-242	7.46E-03	3.00E-04	2.36E-06	1.89E+06	4.45E+00	0.00%	0.001	4.45E-03	0.00%
Am-241	2.64E-02	3.00E-04	8.34E-06	1.79E+09	1.49E+04	0.45%	0.001	1.49E+01	0.05%

HM SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 22 Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	<u>Volatle Conditions</u>		Release Fraction Values	<u>Evaporative Conditions</u>	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Am-242m	5.04E-06	3.00E-04	1.59E-09	4.96E+09	7.90E+00	0.00%	0.001	7.90E-03	0.00%
Am-243	2.79E-06	3.00E-04	8.82E-10	1.04E+08	9.17E-02	0.00%	0.001	9.17E-05	0.00%
Cm-242	1.22E-08	3.00E-04	3.85E-12	5.62E+10	2.17E-01	0.00%	0.001	2.17E-04	0.00%
Cm-243	4.16E-07	3.00E-04	1.31E-10	1.81E+10	2.33E+00	0.00%	0.001	2.33E-03	0.00%
Cm-244	1.50E-07	3.00E-04	4.72E-11	2.18E+10	1.03E+00	0.00%	0.001	1.03E-03	0.00%
Cm-245	5.10E-09	3.00E-04	1.61E-12	9.27E+07	1.49E-04	0.00%	0.001	1.49E-07	0.00%
Cm-246	2.17E-10	3.00E-04	6.85E-14	1.65E+08	1.13E-05	0.00%	0.001	1.13E-08	0.00%
Cm-247	1.06E-12	3.00E-04	3.34E-16	4.55E+04	1.52E-11	0.00%	0.001	1.52E-14	0.00%
Cm-248	2.74E-14	3.00E-04	8.65E-18	8.08E+06	6.99E-11	0.00%	0.001	6.99E-14	0.00%
Bk-249	5.87E-24	3.00E-04	1.85E-27	2.17E+09	4.02E-18	0.00%	0.001	4.02E-21	0.00%
Cf-249	1.02E-18	3.00E-04	3.23E-22	2.20E+09	7.10E-13	0.00%	0.001	7.10E-16	0.00%
					<u>3.34E+06</u>			<u>2.85E+04</u>	

HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 22 Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
H-3	8.70E-06	1.00E+00	9.16E-06	6.11E+05	5.60E+00	0.00%
Cr-51	2.21E-24	5.00E-02	1.17E-25	1.20E+07	1.40E-18	0.00%
Co-60	3.29E-04	1.90E-04	6.59E-08	2.94E+07	1.94E+00	0.00%
Se-79	5.57E-03	1.00E-01	5.87E-04	5.56E+02	3.26E-01	0.00%
Rb-87	2.88E-01	9.50E-01	2.88E-01	4.17E-04	1.20E-04	0.00%
Sr-90	5.26E-12	2.50E-04	1.38E-15	2.53E+08	3.50E-07	0.00%
Sr-90	6.08E-01	2.50E-04	1.59E-04	1.81E+07	2.88E+03	0.05%
Y-90	1.58E-04	2.50E-04	4.15E-08	5.43E+09	2.25E+02	0.00%
Y-91	1.13E-10	1.00E-04	1.19E-14	2.18E+08	2.59E-06	0.00%
Zr-93	1.54E+00	9.60E-06	1.55E-05	4.02E+00	6.24E-05	0.00%
Zr-96	1.36E-09	1.00E-05	1.43E-14	7.30E+07	1.05E-06	0.00%
Nb-95	1.57E-09	1.00E-05	1.65E-14	8.63E+07	1.43E-06	0.00%
Nb-95m	9.52E-13	1.00E-05	1.00E-17	7.35E+08	7.37E-09	0.00%
Tc-99	7.82E-01	1.00E+00	8.23E-01	2.20E+01	1.81E+01	0.00%
Ru-103	1.58E-15	5.00E-01	8.32E-16	8.70E+07	7.24E-08	0.00%
Ru-106	1.72E-03	5.00E-01	9.05E-04	7.03E+07	6.36E+04	1.18%
Pd-107	3.12E-02	1.00E-04	3.29E-06	7.20E-02	2.37E-07	0.00%
Cd-115m	4.80E-17	5.00E-02	2.52E-18	3.81E+08	9.82E-10	0.00%
In-115	1.59E-03	5.00E-02	8.39E-05	7.28E-07	6.11E-11	0.00%
Sn-121m	1.34E-06	4.00E-02	5.65E-08	5.08E+04	2.87E-03	0.00%
Sn-123	6.94E-08	4.00E-02	2.92E-09	6.33E+07	1.85E-01	0.00%
Sn-125	1.94E-61	4.00E-02	8.18E-63	1.14E+07	9.32E-56	0.00%
Sn-126	1.26E-02	4.00E-02	5.30E-04	4.82E+02	2.55E-01	0.00%
Sb-124	1.47E-14	6.00E-03	9.26E-17	1.63E+08	1.51E-08	0.00%
Sb-125	1.80E-03	6.00E-03	1.14E-05	2.69E+06	3.05E+01	0.00%
Sb-126	5.98E-11	4.00E-02	2.52E-12	6.10E+06	1.54E-05	0.00%
Te-127m	2.38E-08	5.00E-04	1.25E-11	7.45E+07	9.33E-04	0.00%
Te-129m	2.55E-19	5.00E-04	1.34E-22	2.98E+08	4.01E-14	0.00%
I-129	1.23E-01	1.00E+00	1.29E-01	4.94E+01	6.37E+00	0.00%
I-131	1.28E-70	1.00E+00	1.35E-70	6.57E+09	8.85E-61	0.00%
Cs-134	1.05E-02	9.50E-01	1.05E-02	9.58E+07	1.01E+06	18.67%
Cs-135	1.51E-01	9.50E-01	1.51E-01	8.17E+00	1.23E+00	0.00%
Cs-136	2.11E-46	9.50E-01	2.11E-46	8.03E+06	1.70E-37	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	90.03%
Ba-140	1.11E-44	5.00E-04	5.85E-48	6.13E+08	3.59E-39	0.00%
La-140	1.68E-45	1.00E-03	1.76E-48	4.29E+09	7.57E-39	0.00%
Ce-141	3.19E-18	1.00E-04	3.36E-22	7.41E+07	2.49E-14	0.00%
Ce-144	9.50E-03	1.00E-04	1.00E-06	6.38E+07	6.38E+01	0.00%
Pr-143	3.96E-42	1.00E-03	4.17E-45	3.03E+08	1.26E-36	0.00%
Nd-144	1.15E+00	1.00E-04	1.21E-04	0.00E+00	0.00E+00	0.00%
Nd-147	3.26E-52	1.00E-04	3.43E-56	3.16E+08	1.08E-47	0.00%
Pm-147	6.22E-02	1.00E-04	6.54E-06	8.81E+05	5.76E+00	0.00%
Pm-148	1.46E-18	1.00E-04	1.54E-22	1.56E+09	2.40E-13	0.00%
Pm-148m	1.63E-16	1.00E-04	1.72E-20	1.50E+08	2.58E-12	0.00%
Sm-147	1.86E-01	3.50E-04	6.84E-05	4.19E-03	2.86E-07	0.00%
Sm-151	1.48E-02	3.50E-04	5.44E-06	8.95E+03	4.87E-02	0.00%
Eu-152	4.39E-05	1.30E-04	6.01E-09	1.04E+06	6.25E-03	0.00%
Eu-154	8.64E-03	1.30E-04	1.18E-06	2.40E+06	2.84E+00	0.00%
Eu-155	2.36E-03	1.30E-04	3.23E-07	6.05E+05	1.95E-01	0.00%
Eu-156	1.76E-39	1.30E-04	2.40E-43	4.79E+08	1.15E-34	0.00%
Gd-152	1.17E-05	1.00E-04	1.23E-09	3.22E-06	3.97E-15	0.00%
Tb-160	3.19E-13	1.00E-04	3.36E-17	7.23E+07	2.43E-09	0.00%
Ra-224	4.76E-11	3.00E-04	1.50E-14	5.31E+10	7.99E-04	0.00%
Th-228	9.29E-09	1.00E-05	9.78E-14	3.11E+08	3.04E-05	0.00%

APPENDIX A

HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 22 Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
U-232	6.08E-11	3.00E-04	1.92E-14	2.86E+07	5.49E-07	0.00%
U-234	2.28E-03	3.00E-04	7.21E-07	1.62E+03	1.17E-03	0.00%
U-235	8.39E-02	3.00E-04	2.65E-05	5.41E-01	1.43E-05	0.00%
U-238	5.12E-02	3.00E-04	1.62E-05	1.82E+01	2.62E-04	0.00%
U-238	2.02E-02	3.00E-04	6.39E-06	7.73E-02	4.94E-07	0.00%
Np-237	4.30E-02	3.00E-04	1.36E-05	2.75E+03	3.73E-02	0.00%
Pu-238	3.18E-07	3.00E-04	1.01E-10	6.93E+08	6.97E-02	0.00%
Pu-237	3.26E-18	3.00E-04	1.03E-21	1.21E+07	1.25E-14	0.00%
Pu-238	1.66E-01	3.00E-04	5.25E-05	6.51E+03	3.42E+03	0.06%
Pu-239	3.79E-01	3.00E-04	1.20E-04	2.67E+03	3.19E+01	0.00%
Pu-240	6.85E-02	3.00E-04	2.16E-05	9.75E+03	2.11E+01	0.00%
Pu-241	3.27E-02	3.00E-04	1.03E-05	8.88E+08	9.16E+01	0.00%
Pu-242	5.93E-03	3.00E-04	1.87E-06	1.61E+04	3.01E-02	0.00%
Am-241	8.91E-03	3.00E-04	2.91E-06	1.54E+07	4.33E+01	0.00%
Am-242m	4.19E-06	3.00E-04	1.32E-09	4.08E+07	5.40E-02	0.00%
Am-243	2.22E-06	3.00E-04	7.01E-10	8.97E+06	6.29E-04	0.00%
Cm-242	3.27E-10	3.00E-04	1.03E-13	3.64E+08	3.75E-05	0.00%
Cm-243	4.22E-07	3.00E-04	1.33E-10	1.50E+08	2.00E-02	0.00%
Cm-244	1.74E-07	3.00E-04	5.50E-11	1.86E+08	1.02E-02	0.00%
Cm-245	4.05E-09	3.00E-04	1.28E-12	7.73E+06	9.89E-07	0.00%
Cm-246	1.73E-10	3.00E-04	5.45E-14	1.38E+08	7.52E-08	0.00%
Cm-247	8.40E-13	3.00E-04	2.65E-16	3.80E+02	1.01E-13	0.00%
Cm-248	2.18E-14	3.00E-04	6.87E-18	6.80E+04	4.67E-13	0.00%
Bk-249	1.48E-20	3.00E-04	4.67E-24	1.00E+07	4.67E-17	0.00%
Cf-249	8.13E-21	3.00E-04	2.57E-24	1.84E+07	4.72E-17	0.00%
					<u>5.41E+06</u>	

HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 22 Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
H-3	6.22E-06	1.00E+00	6.55E-06	6.11E+05	4.00E+00	0.00%
Cr-51	7.84E-64	5.00E-02	4.13E-65	1.20E+07	4.96E-58	0.00%
Co-60	1.11E-04	1.90E-04	2.22E-08	2.94E+07	6.52E-01	0.00%
Se-79	7.01E-03	1.00E-01	7.38E-04	5.56E+02	4.11E-01	0.00%
Rb-87	3.63E-01	9.50E-01	3.63E-01	4.17E-04	1.51E-04	0.00%
Sr-89	4.75E-33	2.50E-04	1.25E-36	2.53E+08	3.16E-28	0.00%
Sr-90	5.96E-01	2.50E-04	1.57E-04	1.81E+07	2.84E+03	0.06%
Y-90	1.55E-04	2.50E-04	4.08E-08	5.43E+09	2.21E+02	0.01%
Y-91	2.45E-29	1.00E-04	2.58E-33	2.18E+08	5.62E-25	0.00%
Zr-93	1.93E+00	9.60E-06	1.95E-05	4.02E+00	7.86E-05	0.00%
Zr-95	2.80E-26	1.00E-05	2.95E-31	7.30E+07	2.15E-23	0.00%
Nb-95	3.24E-26	1.00E-05	3.41E-31	8.63E+07	2.94E-23	0.00%
Nb-95m	1.96E-29	1.00E-05	2.06E-34	7.35E+08	1.52E-25	0.00%
Tc-99	9.85E-01	1.00E+00	1.04E+00	2.20E+01	2.28E+01	0.00%
Ru-103	3.42E-43	5.00E-01	1.80E-43	8.70E+07	1.56E-35	0.00%
Ru-106	2.27E-06	5.00E-01	1.19E-06	7.03E+07	8.36E+01	0.00%
Pd-107	3.93E-02	1.00E-04	4.14E-06	7.20E-02	2.98E-07	0.00%
Cd-115m	1.34E-41	5.00E-02	7.06E-43	3.81E+08	2.69E-34	0.00%
In-115	2.01E-03	5.00E-02	1.06E-04	7.28E-07	7.69E-11	0.00%
Sn-121m	1.47E-06	4.00E-02	6.19E-08	5.08E+04	3.15E-03	0.00%
Sn-123	2.62E-16	4.00E-02	1.10E-17	6.33E+07	6.98E-10	0.00%
Sn-126	1.58E-02	4.00E-02	6.67E-04	4.82E+02	3.22E-01	0.00%
Sb-124	1.00E-32	6.00E-03	6.33E-35	1.63E+08	1.03E-26	0.00%
Sb-125	1.79E-04	6.00E-03	1.13E-06	2.69E+06	3.04E+00	0.00%
Sb-126	7.53E-11	4.00E-02	3.17E-12	6.10E+06	1.93E-05	0.00%
Te-127m	2.45E-18	5.00E-04	1.29E-21	7.45E+07	9.61E-14	0.00%
Te-129m	3.87E-52	5.00E-04	2.04E-55	2.98E+08	6.07E-47	0.00%
I-129	1.54E-01	1.00E+00	1.62E-01	4.94E+01	8.02E+00	0.00%
Ce-134	4.59E-04	9.50E-01	4.59E-04	9.58E+07	4.40E+04	1.00%
Ce-135	1.90E-01	9.50E-01	1.90E-01	8.17E+00	1.55E+00	0.00%
Ce-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	98.83%
Ce-141	6.37E-52	1.00E-04	6.71E-56	7.41E+07	4.97E-48	0.00%
Ce-144	1.63E-06	1.00E-04	1.71E-10	6.38E+07	1.09E-02	0.00%
Nd-144	1.46E+00	1.00E-04	1.53E-04	0.00E+00	0.00E+00	0.00%
Pm-147	5.57E-03	1.00E-04	5.86E-07	8.81E+05	5.17E-01	0.00%
Pm-148	4.40E-45	1.00E-04	4.63E-49	1.56E+09	7.22E-40	0.00%
Pm-148m	4.90E-43	1.00E-04	5.16E-47	1.50E+08	7.74E-39	0.00%
Sm-147	3.06E-01	3.50E-04	1.13E-04	4.19E-03	4.73E-07	0.00%
Sm-151	1.73E-02	3.50E-04	6.36E-06	8.95E+03	5.69E-02	0.00%
Eu-152	3.24E-05	1.30E-04	4.44E-09	1.04E+06	4.61E-03	0.00%
Eu-154	4.86E-03	1.30E-04	6.64E-07	2.40E+06	1.59E+00	0.00%
Eu-155	7.01E-04	1.30E-04	9.59E-08	6.05E+05	5.80E-02	0.00%
Gd-152	1.47E-05	1.00E-04	1.55E-09	3.22E-06	4.99E-15	0.00%
Tb-160	2.49E-28	1.00E-04	2.62E-32	7.23E+07	1.89E-24	0.00%
Ra-224	1.35E-10	3.00E-04	4.26E-14	5.31E+10	2.26E-03	0.00%
Th-228	2.62E-08	1.00E-05	2.76E-13	3.11E+08	8.58E-05	0.00%
U-232	1.03E-06	3.00E-04	3.26E-10	2.86E+07	9.32E-03	0.00%
U-234	2.87E-03	3.00E-04	9.08E-07	1.62E+03	1.47E-03	0.00%
U-235	1.06E-01	3.00E-04	3.34E-05	5.41E-01	1.80E-05	0.00%
U-236	6.45E-02	3.00E-04	2.04E-05	1.62E+01	3.30E-04	0.00%
U-238	2.55E-02	3.00E-04	8.05E-06	7.73E-02	6.22E-07	0.00%
Np-237	5.41E-02	3.00E-04	1.71E-05	2.75E+03	4.70E-02	0.00%
Pu-236	3.53E-08	3.00E-04	1.11E-11	6.93E+08	7.72E-03	0.00%
Pu-237	3.29E-42	3.00E-04	1.04E-45	1.21E+07	1.26E-38	0.00%

APPENDIX A

WSRC-TR-94-0276
Revision 1
Page 35 of 58HM SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 22 Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
Pu-238	1.93E-01	3.00E-04	6.10E-05	6.51E+07	3.97E+03	0.09%
Pu-239	4.77E-01	3.00E-04	1.50E-04	2.67E+05	4.02E+01	0.00%
Pu-240	8.61E-02	3.00E-04	2.72E-05	9.75E+05	2.65E+01	0.00%
Pu-241	2.57E-02	3.00E-04	8.12E-06	8.86E+06	7.20E+01	0.00%
Pu-242	7.46E-03	3.00E-04	2.36E-06	1.61E+04	3.79E-02	0.00%
Am-241	2.64E-02	3.00E-04	8.34E-06	1.54E+07	1.28E+02	0.00%
Am-242m	5.04E-06	3.00E-04	1.59E-09	4.08E+07	6.49E-02	0.00%
Am-243	2.79E-06	3.00E-04	8.82E-10	8.97E+05	7.91E-04	0.00%
Cm-242	1.22E-08	3.00E-04	3.85E-12	3.64E+08	1.40E-03	0.00%
Cm-243	4.16E-07	3.00E-04	1.31E-10	1.50E+08	1.97E-02	0.00%
Cm-244	1.50E-07	3.00E-04	4.72E-11	1.86E+08	8.78E-03	0.00%
Cm-245	5.10E-09	3.00E-04	1.61E-12	7.73E+05	1.24E-06	0.00%
Cm-246	2.17E-10	3.00E-04	6.85E-14	1.38E+06	9.46E-08	0.00%
Cm-247	1.06E-12	3.00E-04	3.34E-16	3.80E+02	1.27E-13	0.00%
Cm-248	2.74E-14	3.00E-04	8.65E-18	6.80E+04	5.89E-13	0.00%
Bk-249	5.87E-24	3.00E-04	1.85E-27	1.00E+07	1.85E-20	0.00%
Cf-249	1.02E-18	3.00E-04	3.23E-22	1.84E+07	5.94E-15	0.00%
					<u>4.38E+06</u>	

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fractions	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	7.93E-06	1.00E+00	8.35E-06	9.22E+05	7.70E+00	0.00%	1	7.70E+00	0.01%
Cr-51	6.59E-24	5.00E-02	3.47E-25	2.40E+07	8.32E-18	0.00%	0.001	8.32E-21	0.00%
Co-60	9.80E-04	1.90E-04	1.96E-07	1.70E+08	3.33E+01	0.00%	0.001	3.33E-02	0.00%
Se-79	5.47E-03	1.00E-01	5.76E-04	6.20E+02	3.57E-01	0.00%	0.01	3.57E-03	0.00%
Rb-87	2.27E-01	9.50E-01	2.27E-01	2.87E-04	6.51E-05	0.00%	0.001	6.51E-08	0.00%
Sr-89	8.43E-12	2.50E-04	2.22E-15	1.07E+09	2.37E-06	0.00%	0.001	2.37E-09	0.00%
Sr-90	4.71E-01	2.50E-04	1.24E-04	1.81E+08	2.25E+04	0.26%	0.001	2.25E+01	0.03%
Y-90	1.23E-04	2.50E-04	3.23E-08	4.46E+09	1.44E+02	0.00%	0.001	1.44E-01	0.00%
Y-91	1.76E-10	1.00E-04	1.85E-14	1.08E+09	2.00E-05	0.00%	0.001	2.00E-08	0.00%
Zr-93	6.64E-01	9.60E-06	6.71E-06	8.04E+02	5.39E-03	0.00%	0.001	5.39E-06	0.00%
Zr-95	2.30E-09	1.00E-05	2.42E-14	3.86E+08	9.34E-06	0.00%	0.001	9.34E-09	0.00%
Nb-95	2.66E-09	1.00E-05	2.79E-14	1.76E+08	4.92E-06	0.00%	0.001	4.92E-09	0.00%
Nb-95m	1.61E-12	1.00E-05	1.69E-17	8.08E+08	1.37E-08	0.00%	0.001	1.37E-11	0.00%
Tc-99	7.83E-01	1.00E+00	8.24E-01	1.27E+02	1.05E+02	0.00%	0.001	1.05E-01	0.00%
Ru-103	5.44E-15	5.00E-01	2.86E-15	2.51E+08	7.19E-07	0.00%	0.01	7.19E-09	0.00%
<u>Ru-106</u>	7.37E-03	5.00E-01	3.88E-03	1.47E+09	5.70E+06	<u>66.35%</u>	0.01	5.70E+04	<u>66.59%</u>
Pd-107	1.58E-01	1.00E-04	1.67E-05	6.68E+00	1.11E-04	0.00%	0.001	1.11E-07	0.00%
Cd-115m	4.66E-16	5.00E-02	2.45E-17	1.65E+09	4.05E-08	0.00%	0.001	4.05E-11	0.00%
In-115	9.24E-03	5.00E-02	4.86E-04	1.77E-05	8.61E-09	0.00%	0.001	8.61E-12	0.00%
Sn-121m	2.55E-06	4.00E-02	1.07E-07	3.48E+05	3.73E-02	0.00%	0.001	3.73E-05	0.00%
Sn-123	2.73E-07	4.00E-02	1.15E-08	2.47E+08	2.84E+00	0.00%	0.001	2.84E-03	0.00%
Sn-125	2.39E-60	4.00E-02	1.00E-61	1.52E+09	1.53E-52	0.00%	0.001	1.53E-55	0.00%
Sn-126	2.61E-02	4.00E-02	1.10E-03	2.44E+03	2.68E+00	0.00%	0.001	2.68E-03	0.00%
Sb-124	1.32E-14	6.00E-03	8.36E-17	3.67E+08	3.07E-08	0.00%	0.001	3.07E-11	0.00%
Sb-125	5.20E-03	6.00E-03	3.29E-05	1.01E+07	3.32E+02	0.00%	0.001	3.32E-01	0.00%
Sb-126	1.24E-10	4.00E-02	5.23E-12	8.36E+08	4.37E-03	0.00%	0.001	4.37E-06	0.00%
Te-127m	6.87E-08	5.00E-04	3.62E-11	1.79E+08	6.47E-03	0.00%	0.01	6.47E-05	0.00%
Te-129m	9.60E-19	5.00E-04	5.05E-22	6.03E+08	3.05E-13	0.00%	0.01	3.05E-15	0.00%
I-129	1.71E-01	1.00E+00	1.80E-01	3.18E+01	5.72E+00	0.00%	0.5	2.86E+00	0.00%
I-131	6.12E-70	1.00E+00	6.44E-70	3.97E+09	2.56E-60	0.00%	0.5	1.28E-60	0.00%
Cs-134	1.39E-03	9.50E-01	1.39E-03	6.08E+07	8.45E+04	<u>0.99%</u>	0.01	8.45E+02	<u>0.99%</u>
Cs-135	1.29E-01	9.50E-01	1.29E-01	5.18E+00	6.66E-01	0.00%	0.01	6.66E-03	0.00%
Cs-136	1.49E-45	9.50E-01	1.49E-45	5.47E+08	8.16E-37	0.00%	0.01	8.16E-39	0.00%
<u>Cs-137</u>	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	<u>32.25%</u>	0.01	2.77E+04	<u>32.37%</u>
Ba-140	4.05E-44	5.00E-04	2.13E-47	2.63E+08	5.60E-39	0.00%	0.001	5.60E-42	0.00%
La-140	6.11E-45	1.00E-03	6.43E-48	2.45E+09	1.57E-38	0.00%	0.001	1.57E-41	0.00%
Ce-141	8.10E-18	1.00E-04	8.53E-22	2.42E+08	2.06E-13	0.00%	0.001	2.06E-16	0.00%
Ce-144	1.00E-02	1.00E-04	1.05E-06	1.12E+09	1.18E+03	0.01%	0.001	1.18E+00	0.00%
Pr-143	1.35E-41	1.00E-03	1.42E-44	4.92E+08	6.98E-36	0.00%	0.001	6.98E-39	0.00%
Nd-144	9.26E-01	1.00E-04	9.75E-05	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Nd-147	1.28E-51	1.00E-04	1.35E-55	5.02E+08	6.79E-47	0.00%	0.001	6.79E-50	0.00%
Pm-147	1.05E-01	1.00E-04	1.10E-05	3.15E+07	3.48E+02	0.00%	0.001	3.48E-01	0.00%
Pm-148	1.45E-18	1.00E-04	1.52E-22	1.64E+09	2.50E-13	0.00%	0.001	2.50E-16	0.00%
Pm-148m	1.61E-16	1.00E-04	1.70E-20	2.14E+08	3.64E-12	0.00%	0.001	3.64E-15	0.00%
Sm-147	2.90E-01	3.50E-04	1.07E-04	1.65E+00	1.77E-04	0.00%	0.001	1.77E-07	0.00%
Sm-151	5.64E-02	3.50E-04	2.08E-05	7.63E+05	1.58E+01	0.00%	0.001	1.58E-02	0.00%
Eu-152	1.06E-04	1.30E-04	1.44E-08	3.81E+07	5.50E-01	0.00%	0.001	5.50E-04	0.00%
Eu-154	2.25E-03	1.30E-04	3.07E-07	6.86E+07	2.11E+01	0.00%	0.001	2.11E-02	0.00%
Eu-155	6.00E-03	1.30E-04	8.21E-07	1.81E+07	1.49E+01	0.00%	0.001	1.49E-02	0.00%
Eu-156	8.71E-39	1.30E-04	1.19E-42	6.06E+08	7.22E-34	0.00%	0.001	7.22E-37	0.00%
Gd-152	3.81E-06	1.00E-04	4.01E-10	5.15E-03	2.07E-12	0.00%	0.001	2.07E-15	0.00%
Tb-160	4.62E-13	1.00E-04	4.86E-17	2.48E+08	1.21E-08	0.00%	0.001	1.21E-11	0.00%
Ra-224	9.39E-16	3.00E-04	2.97E-19	4.67E+11	1.39E-07	0.00%	0.001	1.39E-10	0.00%
Th-228	1.82E-13	1.00E-05	1.92E-18	2.54E+11	4.87E-07	0.00%	0.001	4.87E-10	0.00%
U-232	3.39E-12	3.00E-04	1.07E-15	1.48E+10	1.58E-05	0.00%	0.001	1.58E-08	0.00%
U-234	3.10E-18	3.00E-04	9.79E-22	8.08E+05	7.91E-16	0.00%	0.001	7.91E-19	0.00%
U-235	2.61E-02	3.00E-04	8.25E-06	2.59E+02	2.14E-03	0.00%	0.001	2.14E-06	0.00%
U-236	8.14E-04	3.00E-04	2.57E-07	7.76E+03	1.99E-03	0.00%	0.001	1.99E-06	0.00%
U-238	1.53E+01	3.00E-04	4.83E-03	4.03E+01	1.95E-01	0.00%	0.001	1.95E-04	0.00%

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fractions	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	<u>Volatile Conditions</u>		Release Fraction Values	<u>Evaporative Conditions</u>	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Np-237	2.64E-03	3.00E-04	8.33E-07	3.45E+05	2.88E-01	0.00%	0.001	2.88E-04	0.00%
Pu-236	1.74E-12	3.00E-04	5.51E-16	8.53E+10	4.70E-05	0.00%	0.001	4.70E-08	0.00%
Pu-238	2.75E-06	3.00E-04	8.67E-09	7.88E+09	6.84E+01	0.00%	0.001	6.84E-02	0.00%
Pu-239	1.73E-01	3.00E-04	5.47E-06	3.16E+07	1.73E+03	0.02%	0.001	1.73E+00	0.00%
Pu-240	9.98E-03	3.00E-04	3.15E-06	1.16E+08	3.66E+02	0.00%	0.001	3.66E-01	0.47%
Pu-241	1.11E-03	3.00E-04	3.52E-07	1.03E+09	3.63E+02	0.00%	0.001	3.63E-01	0.00%
Pu-242	4.65E-06	3.00E-04	1.47E-08	1.89E+06	2.77E-02	0.00%	0.001	2.77E-05	0.00%
Am-241	1.60E-02	3.00E-04	5.04E-06	1.79E+09	9.03E+03	0.11%	0.001	9.03E+00	0.01%
Am-242m	8.72E-06	3.00E-04	2.75E-09	4.96E+09	1.37E+01	0.00%	0.001	1.37E-02	0.00%
Am-243	8.81E-07	3.00E-04	2.78E-10	1.04E+08	2.89E-02	0.00%	0.001	2.89E-05	0.00%
Cm-242	4.56E-08	3.00E-04	1.44E-11	5.62E+10	8.09E-01	0.00%	0.001	8.09E-04	0.00%
Cm-243	1.07E-07	3.00E-04	3.36E-11	1.81E+10	6.09E-01	0.00%	0.001	6.09E-04	0.00%
Cm-244	1.42E-08	3.00E-04	4.49E-12	2.18E+10	9.79E-02	0.00%	0.001	9.79E-05	0.00%
Cm-245	8.10E-11	3.00E-04	2.56E-14	9.27E+07	2.37E-06	0.00%	0.001	2.37E-09	0.00%
Cm-246	7.65E-13	3.00E-04	2.42E-16	1.65E+08	3.99E-08	0.00%	0.001	3.99E-11	0.00%
Cm-247	7.97E-16	3.00E-04	2.52E-19	4.55E+04	1.15E-14	0.00%	0.001	1.15E-17	0.00%
Cm-248	4.19E-18	3.00E-04	1.32E-21	8.08E+06	1.07E-14	0.00%	0.001	1.07E-17	0.00%
Bk-249	2.30E-24	3.00E-04	7.27E-28	2.17E+09	1.58E-18	0.00%	0.001	1.58E-21	0.00%
Cf-249	1.26E-22	3.00E-04	3.99E-26	2.20E+09	8.78E-17	0.00%	0.001	8.78E-20	0.00%
					<u>8.59E+06</u>			<u>8.56E+04</u>	

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fractions	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	5.74E-06	1.00E+00	6.04E-06	9.22E+05	5.57E+00	0.00%	1	5.57E+00	0.02%
Cr-51	2.33E-63	5.00E-02	1.23E-64	2.40E+07	2.95E-57	0.00%	0.001	2.95E-60	0.00%
Co-60	3.30E-04	1.90E-04	6.60E-08	1.70E+08	1.12E+01	0.00%	0.001	1.12E-02	0.00%
Se-79	6.89E-03	1.00E-01	7.25E-04	6.20E+02	4.50E-01	0.00%	0.01	4.50E-03	0.00%
Rb-87	2.86E-01	9.50E-01	2.86E-01	2.87E-04	8.20E-05	0.00%	0.001	8.20E-08	0.00%
Sr-89	7.61E-33	2.50E-04	2.00E-36	1.07E+09	2.14E-27	0.00%	0.001	2.14E-30	0.00%
Sr-90	4.64E-01	2.50E-04	1.22E-04	1.81E+08	2.21E+04	0.78%	0.001	2.21E+01	0.08%
Y-90	1.21E-04	2.50E-04	3.18E-08	4.46E+09	1.42E+02	0.01%	0.001	1.42E-01	0.00%
Y-91	3.82E-29	1.00E-04	4.02E-33	1.08E+09	4.34E-24	0.00%	0.001	4.34E-27	0.00%
Zr-93	8.34E-01	9.60E-06	8.43E-06	8.04E+02	6.78E-03	0.00%	0.001	6.78E-06	0.00%
Zr-95	4.73E-26	1.00E-06	4.98E-31	3.86E+08	1.92E-22	0.00%	0.001	1.92E-25	0.00%
Nb-95	5.47E-26	1.00E-06	5.75E-31	1.76E+08	1.01E-22	0.00%	0.001	1.01E-25	0.00%
Nb-95m	3.31E-29	1.00E-06	3.49E-34	8.08E+08	2.82E-25	0.00%	0.001	2.82E-28	0.00%
Tc-99	9.85E-01	1.00E+00	1.04E+00	1.27E+02	1.32E+02	0.00%	0.001	1.32E-01	0.00%
Ru-103	1.18E-42	5.00E-01	6.19E-43	2.51E+08	1.55E-34	0.00%	0.01	1.55E-36	0.00%
Ru-106	9.72E-06	5.00E-01	5.11E-06	1.47E+09	7.52E+03	0.27%	0.01	7.52E+01	0.27%
Pd-107	1.99E-01	1.00E-04	2.10E-05	6.68E+00	1.40E-04	0.00%	0.001	1.40E-07	0.00%
Cd-115m	1.30E-40	5.00E-02	6.86E-42	1.65E+09	1.13E-32	0.00%	0.001	1.13E-35	0.00%
In-115	1.16E-02	5.00E-02	6.12E-04	1.77E-05	1.08E-08	0.00%	0.001	1.08E-11	0.00%
Sn-121m	2.79E-06	4.00E-02	1.18E-07	3.48E+05	4.09E-02	0.00%	0.001	4.09E-05	0.00%
Sn-123	1.03E-15	4.00E-02	4.34E-17	2.47E+08	1.07E-08	0.00%	0.001	1.07E-11	0.00%
Sn-126	3.29E-02	4.00E-02	1.38E-03	2.44E+03	3.38E+00	0.00%	0.001	3.38E-03	0.00%
Sb-124	9.07E-33	6.00E-03	5.73E-35	3.67E+08	2.10E-26	0.00%	0.001	2.10E-29	0.00%
Sb-125	5.17E-04	6.00E-03	3.27E-06	1.01E+07	3.30E+01	0.00%	0.001	3.30E-02	0.00%
Sb-126	1.56E-10	4.00E-02	6.58E-12	8.36E+08	5.50E-03	0.00%	0.001	5.50E-06	0.00%
Te-127m	7.08E-18	5.00E-04	3.72E-21	1.79E+08	6.67E-13	0.00%	0.01	6.67E-15	0.00%
Te-129m	1.46E-51	5.00E-04	7.66E-55	6.03E+08	4.62E-46	0.00%	0.01	4.62E-48	0.00%
I-129	2.15E-01	1.00E+00	2.26E-01	3.18E+01	7.20E+00	0.00%	0.5	3.60E+00	0.01%
Cs-134	7.95E-05	9.50E-01	7.95E-05	6.08E+07	4.83E+03	0.17%	0.01	4.83E+01	0.17%
Cs-135	1.62E-01	9.50E-01	1.62E-01	5.18E+00	8.39E-01	0.00%	0.01	8.39E-03	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	99.25%	0.01	2.77E+04	99.39%
Ce-141	1.62E-51	1.00E-04	1.70E-55	2.42E+08	4.12E-47	0.00%	0.001	4.12E-50	0.00%
Ce-144	1.72E-06	1.00E-04	1.81E-10	1.12E+09	2.02E-01	0.00%	0.001	2.02E-04	0.00%
Nd-144	1.18E+00	1.00E-04	1.24E-04	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Pm-147	9.40E-03	1.00E-04	9.89E-07	3.15E+07	3.12E+01	0.00%	0.001	3.12E-02	0.00%
Pm-148	4.35E-45	1.00E-04	4.57E-49	1.64E+09	7.50E-40	0.00%	0.001	7.50E-43	0.00%
Pm-148m	4.85E-43	1.00E-04	5.10E-47	2.14E+08	1.09E-38	0.00%	0.001	1.09E-41	0.00%
Sm-147	4.88E-01	3.50E-04	1.80E-04	1.65E+00	2.97E-04	0.00%	0.001	2.97E-07	0.00%
Sm-151	6.59E-02	3.50E-04	2.43E-05	7.63E+05	1.85E+01	0.00%	0.001	1.85E-02	0.00%
Eu-152	7.79E-05	1.30E-04	1.07E-08	3.81E+07	4.06E-01	0.00%	0.001	4.06E-04	0.00%
Eu-154	1.26E-03	1.30E-04	1.73E-07	6.86E+07	1.19E+01	0.00%	0.001	1.19E-02	0.00%
Eu-155	1.78E-03	1.30E-04	2.44E-07	1.81E+07	4.41E+00	0.00%	0.001	4.41E-03	0.00%
Gd-152	4.80E-06	1.00E-04	5.05E-10	5.15E-03	2.60E-12	0.00%	0.001	2.60E-15	0.00%
Tb-160	3.61E-28	1.00E-04	3.80E-32	2.48E+08	9.41E-24	0.00%	0.001	9.41E-27	0.00%
Ra-224	7.70E-16	3.00E-04	2.43E-19	4.67E+11	1.14E-07	0.00%	0.001	1.14E-10	0.00%
Th-228	1.50E-13	1.00E-05	1.58E-18	2.54E+11	4.00E-07	0.00%	0.001	4.00E-10	0.00%
U-232	5.71E-12	3.00E-04	1.80E-15	1.48E+10	2.67E-05	0.00%	0.001	2.67E-08	0.00%
U-234	3.90E-18	3.00E-04	1.23E-21	8.08E+05	9.96E-16	0.00%	0.001	9.96E-19	0.00%
U-235	3.29E-02	3.00E-04	1.04E-05	2.59E+02	2.69E-03	0.00%	0.001	2.69E-06	0.00%
U-236	1.02E-03	3.00E-04	3.24E-07	7.76E+03	2.51E-03	0.00%	0.001	2.51E-06	0.00%
U-238	1.93E+01	3.00E-04	6.08E-03	4.03E+01	2.45E-01	0.00%	0.001	2.45E-04	0.00%
Np-237	3.32E-03	3.00E-04	1.05E-06	3.45E+05	3.62E-01	0.00%	0.001	3.62E-04	0.00%
Pu-236	1.93E-13	3.00E-04	6.10E-17	8.53E+10	5.20E-06	0.00%	0.001	5.20E-09	0.00%
Pu-238	3.24E-05	3.00E-04	1.02E-08	7.88E+09	8.05E+01	0.00%	0.001	8.05E-02	0.00%
Pu-239	2.18E-01	3.00E-04	6.89E-05	3.16E+07	2.18E+03	0.08%	0.001	2.18E+00	0.01%
Pu-240	1.26E-02	3.00E-04	3.97E-06	1.16E+08	4.60E+02	0.02%	0.001	4.60E-01	0.00%
Pu-241	8.76E-04	3.00E-04	2.77E-07	1.03E+09	2.85E+02	0.01%	0.001	2.85E-01	0.00%
Pu-242	5.86E-05	3.00E-04	1.85E-08	1.89E+06	3.50E-02	0.00%	0.001	3.50E-05	0.00%
Am-241	2.03E-02	3.00E-04	6.42E-06	1.79E+09	1.15E+04	0.41%	0.001	1.15E+01	0.04%
Am-242m	1.05E-05	3.00E-04	3.31E-09	4.96E+09	1.64E+01	0.00%	0.001	1.64E-02	0.00%

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31A Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fractions	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	<u>Volatile Conditions</u>		Release Fraction Values	<u>Evaporative Conditions</u>	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Am-243	1.11E-06	3.00E-04	3.50E-10	1.04E+08	3.64E-02	0.00%	0.001	3.64E-05	0.00%
Cm-242	2.54E-08	3.00E-04	8.02E-12	5.62E+10	4.51E-01	0.00%	0.001	4.51E-04	0.00%
Cm-243	1.05E-07	3.00E-04	3.32E-11	1.81E+10	6.01E-01	0.00%	0.001	6.01E-04	0.00%
Cm-244	1.22E-08	3.00E-04	3.86E-12	2.18E+10	8.40E-02	0.00%	0.001	8.40E-05	0.00%
Cm-245	1.02E-10	3.00E-04	3.22E-14	9.27E+07	2.98E-06	0.00%	0.001	2.98E-09	0.00%
Cm-246	9.62E-13	3.00E-04	3.04E-16	1.65E+08	5.01E-08	0.00%	0.001	5.01E-11	0.00%
Cm-247	1.00E-15	3.00E-04	3.17E-19	4.55E+04	1.44E-14	0.00%	0.001	1.44E-17	0.00%
Cm-248	5.28E-18	3.00E-04	1.67E-21	8.08E+06	1.35E-14	0.00%	0.001	1.35E-17	0.00%
Bk-249	9.12E-28	3.00E-04	2.88E-31	2.17E+09	6.25E-22	0.00%	0.001	6.25E-25	0.00%
Cf-249	1.59E-22	3.00E-04	5.01E-26	2.20E+09	1.10E-16	0.00%	0.001	1.10E-19	0.00%
					<u>2.82E+06</u>			<u>2.79E+04</u>	

**PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTION**

**Mark 31A Fuel Assembly
5 years**

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
H-3	7.93E-06	1.00E+00	8.35E-06	6.11E+05	5.10E+00	0.00%
Cr-51	6.59E-24	5.00E-02	3.47E-25	1.20E+07	4.16E-18	0.00%
Co-60	9.80E-04	1.90E-04	1.96E-07	2.94E+07	5.76E+00	0.00%
Se-79	5.47E-03	1.00E-01	5.76E-04	5.56E+02	3.20E-01	0.00%
Rb-87	2.27E-01	9.50E-01	2.27E-01	4.17E-04	9.46E-05	0.00%
Sr-89	8.43E-12	2.50E-04	2.22E-15	2.53E+08	5.61E-07	0.00%
Sr-90	4.71E-01	2.50E-04	1.24E-04	1.81E+07	2.25E+03	0.05%
Y-90	1.23E-04	2.50E-04	3.23E-08	5.43E+09	1.75E+02	0.00%
Y-91	1.76E-10	1.00E-04	1.85E-14	2.18E+08	4.03E-06	0.00%
Zr-93	6.64E-01	9.60E-06	6.71E-06	4.02E+00	2.70E-05	0.00%
Zr-95	2.30E-09	1.00E-05	2.42E-14	7.30E+07	1.77E-06	0.00%
Nb-95	2.66E-09	1.00E-05	2.79E-14	8.63E+07	2.41E-06	0.00%
Nb-95m	1.61E-12	1.00E-05	1.69E-17	7.35E+08	1.24E-08	0.00%
Tc-99	7.83E-01	1.00E+00	8.24E-01	2.20E+01	1.81E+01	0.00%
Ru-103	5.44E-15	5.00E-01	2.86E-15	8.70E+07	2.49E-07	0.00%
Ru-106	7.37E-03	5.00E-01	3.88E-03	7.03E+07	2.73E+05	5.75%
Pd-107	1.58E-01	1.00E-04	1.67E-05	7.20E-02	1.20E-06	0.00%
Cd-115m	4.66E-16	5.00E-02	2.45E-17	3.81E+08	9.34E-09	0.00%
In-115	9.24E-03	5.00E-02	4.86E-04	7.28E-07	3.54E-10	0.00%
Sn-121m	2.55E-06	4.00E-02	1.07E-07	5.08E+04	5.45E-03	0.00%
Sn-123	2.73E-07	4.00E-02	1.15E-08	6.33E+07	7.28E-01	0.00%
Sn-125	2.39E-60	4.00E-02	1.00E-61	1.14E+07	1.15E-54	0.00%
Sn-126	2.61E-02	4.00E-02	1.10E-03	4.82E+02	5.30E-01	0.00%
Sb-124	1.32E-14	6.00E-03	8.36E-17	1.63E-69	1.36E-85	0.00%
Sb-125	5.20E-03	6.00E-03	3.29E-05	2.69E+06	8.84E+01	0.00%
Sb-126	1.24E-10	4.00E-02	5.23E-12	6.10E+06	3.19E-05	0.00%
Te-127m	6.87E-08	5.00E-04	3.62E-11	7.45E+07	2.69E-03	0.00%
Te-129m	9.60E-19	5.00E-04	5.05E-22	2.98E+08	1.51E-13	0.00%
I-129	1.71E-01	1.00E+00	1.80E-01	4.94E+01	8.88E+00	0.00%
I-131	2.60E-08	1.00E+00	2.73E-08	6.57E+09	1.80E+02	0.00%
Cs-134	1.39E-03	9.50E-01	1.39E-03	9.58E+07	1.33E+05	2.81%
Cs-135	1.29E-01	9.50E-01	1.29E-01	8.17E+00	1.05E+00	0.00%
Cs-136	1.49E-45	9.50E-01	1.49E-45	8.03E+08	1.20E-36	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	91.38%
Ba-140	4.05E-44	5.00E-04	2.13E-47	6.13E+08	1.31E-38	0.00%
La-140	6.11E-45	1.00E-03	6.43E-48	4.29E+09	2.76E-38	0.00%
Ce-141	8.10E-18	1.00E-04	8.53E-22	7.41E+07	6.32E-14	0.00%
Ce-144	1.00E-02	1.00E-04	1.05E-06	6.38E+07	6.73E+01	0.00%
Pr-143	1.35E-41	1.00E-03	1.42E-44	3.03E+08	4.30E-36	0.00%
Nd-144	9.26E-01	1.00E-04	9.75E-05	0.00E+00	0.00E+00	0.00%
Nd-147	1.28E-51	1.00E-04	1.35E-55	3.16E+08	4.27E-47	0.00%
Pm-147	1.05E-01	1.00E-04	1.10E-05	8.81E+05	9.73E+00	0.00%
Pm-148	1.45E-18	1.00E-04	1.52E-22	1.56E+09	2.38E-13	0.00%
Pm-148m	1.61E-16	1.00E-04	1.70E-20	1.50E+08	2.55E-12	0.00%
Sm-147	2.90E-01	3.50E-04	1.07E-04	4.19E-03	4.48E-07	0.00%
Sm-151	5.64E-02	3.50E-04	2.08E-05	8.95E+03	1.86E-01	0.00%
Eu-152	1.06E-04	1.30E-04	1.44E-08	1.04E+06	1.50E-02	0.00%
Eu-154	2.25E-03	1.30E-04	3.07E-07	2.40E+06	7.38E-01	0.00%
Eu-155	6.00E-03	1.30E-04	8.21E-07	6.05E+05	4.97E-01	0.00%
Eu-156	8.71E-39	1.30E-04	1.19E-42	4.79E+08	5.71E-34	0.00%
Gd-152	3.81E-06	1.00E-04	4.01E-10	3.22E-06	1.29E-15	0.00%
Tb-160	4.62E-13	1.00E-04	4.86E-17	7.23E+07	3.52E-09	0.00%
Ra-224	9.39E-16	3.00E-04	2.97E-19	5.31E+10	1.57E-08	0.00%
Th-228	1.82E-13	1.00E-05	1.92E-18	3.11E+08	5.96E-10	0.00%

PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 31A Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
U-232	3.39E-12	3.00E-04	1.07E-15	2.86E+07	3.06E-08	0.00%
U-234	3.10E-18	3.00E-04	9.79E-22	1.62E+03	1.59E-18	0.00%
U-235	2.61E-02	3.00E-04	8.25E-06	5.41E-01	4.46E-06	0.00%
U-238	8.14E-04	3.00E-04	2.57E-07	1.62E+01	4.16E-06	0.00%
U-238	1.53E+01	3.00E-04	4.83E-03	7.73E-02	3.73E-04	0.00%
Np-237	2.64E-03	3.00E-04	8.33E-07	2.75E+03	2.29E-03	0.00%
Pu-236	1.74E-12	3.00E-04	5.51E-16	6.93E+08	3.82E-07	0.00%
Pu-238	2.75E-05	3.00E-04	8.67E-09	6.51E+07	5.65E-01	0.00%
Pu-239	1.73E-01	3.00E-04	5.47E-05	2.67E+05	1.46E+01	0.00%
Pu-240	9.98E-03	3.00E-04	3.15E-06	9.75E+05	3.07E+00	0.00%
Pu-241	1.11E-03	3.00E-04	3.52E-07	8.86E+06	3.12E+00	0.00%
Pu-242	4.65E-05	3.00E-04	1.47E-08	1.61E+04	2.36E-04	0.00%
Am-241	1.60E-02	3.00E-04	5.04E-06	1.54E+07	7.77E+01	0.00%
Am-242m	8.72E-06	3.00E-04	2.75E-09	4.08E+07	1.12E-01	0.00%
Am-243	8.81E-07	3.00E-04	2.78E-10	8.97E+05	2.50E-04	0.00%
Cm-242	4.56E-08	3.00E-04	1.44E-11	3.64E+08	5.24E-03	0.00%
Cm-243	1.07E-07	3.00E-04	3.36E-11	1.50E+08	5.05E-03	0.00%
Cm-244	1.42E-08	3.00E-04	4.49E-12	1.86E+08	8.35E-04	0.00%
Cm-245	8.10E-11	3.00E-04	2.56E-14	7.73E+05	1.98E-08	0.00%
Cm-246	7.65E-13	3.00E-04	2.42E-16	1.38E+06	3.33E-10	0.00%
Cm-247	7.97E-16	3.00E-04	2.52E-19	3.80E+02	9.56E-17	0.00%
Cm-248	4.19E-18	3.00E-04	1.32E-21	6.80E+04	9.01E-17	0.00%
Bk-249	2.30E-24	3.00E-04	7.27E-28	1.00E+07	7.27E-21	0.00%
Cf-249	1.26E-22	3.00E-04	3.99E-26	1.84E+07	7.34E-19	0.00%
					<u>4.74E+06</u>	

PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 31A Fuel Assembly
15 years

Isotope	Normalized isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
H-3	5.74E-06	1.00E+00	6.04E-06	6.11E+05	3.69E+00	0.00%
Cr-51	2.33E-63	5.00E-02	1.23E-64	1.20E+07	1.47E-57	0.00%
Co-60	3.30E-04	1.90E-04	6.60E-08	2.94E+07	1.94E+00	0.00%
Se-79	6.89E-03	1.00E-01	7.25E-04	5.56E+02	4.03E-01	0.00%
Rb-87	2.86E-01	9.50E-01	2.86E-01	4.17E-04	1.19E-04	0.00%
Sr-89	7.61E-33	2.50E-04	2.00E-36	2.53E+08	5.07E-28	0.00%
Sr-90	4.64E-01	2.50E-04	1.22E-04	1.81E+07	2.21E+03	0.05%
Y-90	1.21E-04	2.50E-04	3.18E-08	5.43E+09	1.72E+02	0.00%
Y-91	3.82E-29	1.00E-04	4.02E-33	2.18E+08	8.76E-25	0.00%
Zr-93	8.34E-01	9.60E-06	8.43E-06	4.02E+00	3.39E-05	0.00%
Zr-95	4.73E-26	1.00E-06	4.98E-31	7.30E+07	3.64E-23	0.00%
Nb-95	5.47E-26	1.00E-06	5.75E-31	8.63E+07	4.97E-23	0.00%
Nb-95m	3.31E-29	1.00E-06	3.49E-34	7.35E+08	2.56E-25	0.00%
Tc-99	9.85E-01	1.00E+00	1.04E+00	2.20E+01	2.28E+01	0.00%
Ru-103	1.18E-42	5.00E-01	6.19E-43	8.70E+07	5.38E-35	0.00%
Ru-106	9.72E-06	5.00E-01	5.11E-06	7.03E+07	3.60E+02	0.01%
Pd-107	1.99E-01	1.00E-04	2.10E-05	7.20E-02	1.51E-06	0.00%
Cd-115m	1.30E-40	5.00E-02	6.86E-42	3.81E+08	2.61E-33	0.00%
In-115	1.16E-02	5.00E-02	6.12E-04	7.28E-07	4.46E-10	0.00%
Sn-121m	2.79E-06	4.00E-02	1.18E-07	5.08E+04	5.97E-03	0.00%
Sn-123	1.03E-15	4.00E-02	4.34E-17	6.33E+07	2.75E-09	0.00%
Sn-126	3.29E-02	4.00E-02	1.38E-03	4.82E+02	6.67E-01	0.00%
Sb-124	9.07E-33	6.00E-03	5.73E-35	1.63E+08	9.34E-27	0.00%
Sb-125	5.17E-04	6.00E-03	3.27E-06	2.69E+06	8.79E+00	0.00%
Sb-126	1.56E-10	4.00E-02	6.58E-12	6.10E+06	4.01E-05	0.00%
Te-127m	7.08E-18	5.00E-04	3.72E-21	7.45E+07	2.77E-13	0.00%
Te-129m	1.46E-51	5.00E-04	7.66E-55	2.98E+08	2.28E-46	0.00%
I-129	2.15E-01	1.00E+00	2.26E-01	4.94E+01	1.12E+01	0.00%
Cs-134	7.95E-05	9.50E-01	7.95E-05	9.58E+07	7.61E+03	0.18%
Cs-135	1.62E-01	9.50E-01	1.62E-01	8.17E+00	1.32E+00	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	99.79%
Ce-141	1.62E-51	1.00E-04	1.70E-55	7.41E+07	1.26E-47	0.00%
Ce-144	1.72E-06	1.00E-04	1.81E-10	6.38E+07	1.15E-02	0.00%
Nd-144	1.18E+00	1.00E-04	1.24E-04	0.00E+00	0.00E+00	0.00%
Pm-147	9.40E-03	1.00E-04	9.89E-07	8.81E+05	8.72E-01	0.00%
Pm-148	4.35E-45	1.00E-04	4.57E-49	1.56E+09	7.14E-40	0.00%
Pm-148m	4.85E-43	1.00E-04	5.10E-47	1.50E+08	7.65E-39	0.00%
Sm-147	4.88E-01	3.50E-04	1.80E-04	4.19E-03	7.54E-07	0.00%
Sm-151	6.59E-02	3.50E-04	2.43E-05	8.95E+03	2.17E-01	0.00%
Eu-152	7.79E-05	1.30E-04	1.07E-08	1.04E+06	1.11E-02	0.00%
Eu-154	1.26E-03	1.30E-04	1.73E-07	2.40E+06	4.15E-01	0.00%
Eu-155	1.78E-03	1.30E-04	2.44E-07	6.05E+05	1.47E-01	0.00%
Gd-152	4.80E-06	1.00E-04	5.05E-10	3.22E-06	1.63E-15	0.00%
Tb-160	3.61E-28	1.00E-04	3.80E-32	7.23E+07	2.74E-24	0.00%
Ra-224	7.70E-16	3.00E-04	2.43E-19	5.31E+10	1.29E-08	0.00%
Th-228	1.50E-13	1.00E-05	1.58E-18	3.11E+08	4.90E-10	0.00%
U-232	5.71E-12	3.00E-04	1.80E-15	2.86E+07	5.16E-08	0.00%
U-234	3.90E-18	3.00E-04	1.23E-21	1.62E+03	2.00E-18	0.00%
U-235	3.29E-02	3.00E-04	1.04E-05	5.41E-01	5.62E-06	0.00%
U-236	1.02E-03	3.00E-04	3.24E-07	1.62E+01	5.24E-06	0.00%
U-238	1.93E+01	3.00E-04	6.08E-03	7.73E-02	4.70E-04	0.00%
Np-237	3.32E-03	3.00E-04	1.05E-06	2.75E+03	2.89E-03	0.00%
Pu-236	1.93E-13	3.00E-04	6.10E-17	6.93E+08	4.23E-08	0.00%
Pu-238	3.24E-05	3.00E-04	1.02E-08	6.51E+07	6.65E-01	0.00%

APPENDIX A

WSRC-TR-94-0276
Revision 1
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DOSE CONTRIBUTIONMark 31A Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
Pu-239	2.18E-01	3.00E-04	6.89E-05	2.67E+05	1.84E+01	0.00%
Pu-240	1.26E-02	3.00E-04	3.97E-06	9.75E+05	3.87E+00	0.00%
Pu-241	8.76E-04	3.00E-04	2.77E-07	8.86E+06	2.45E+00	0.00%
Pu-242	5.86E-05	3.00E-04	1.85E-08	1.61E+04	2.98E-04	0.00%
Am-241	2.03E-02	3.00E-04	6.42E-06	1.54E+07	9.88E+01	0.00%
Am-242m	1.05E-05	3.00E-04	3.31E-09	4.08E+07	1.35E-01	0.00%
Am-243	1.11E-06	3.00E-04	3.50E-10	8.97E+05	3.14E-04	0.00%
Cm-242	2.54E-08	3.00E-04	8.02E-12	3.64E+08	2.92E-03	0.00%
Cm-243	1.05E-07	3.00E-04	3.32E-11	1.50E+08	4.98E-03	0.00%
Cm-244	1.22E-08	3.00E-04	3.86E-12	1.86E+08	7.17E-04	0.00%
Cm-245	1.02E-10	3.00E-04	3.22E-14	7.73E+05	2.49E-08	0.00%
Cm-246	9.62E-13	3.00E-04	3.04E-16	1.38E+06	4.19E-10	0.00%
Cm-247	1.00E-15	3.00E-04	3.17E-19	3.80E+02	1.20E-16	0.00%
Cm-248	5.28E-18	3.00E-04	1.67E-21	6.80E+04	1.13E-16	0.00%
Bk-249	9.12E-28	3.00E-04	2.88E-31	1.00E+07	2.88E-24	0.00%
Cf-249	1.59E-22	3.00E-04	5.01E-26	1.84E+07	9.23E-19	0.00%
					<u>4.34E+06</u>	

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	9.11E-06	1.00E+00	9.59E-06	9.22E+05	8.84E+00	0.00%	1	8.84E+00	0.01%
Cr-51	3.02E-24	5.00E-02	1.59E-25	2.40E+07	3.81E-18	0.00%	0.001	3.81E-21	0.00%
Co-60	4.49E-04	1.90E-04	8.98E-08	1.70E+08	1.53E+01	0.00%	0.001	1.53E-02	0.00%
Se-79	5.40E-03	1.00E-01	5.68E-04	6.20E+02	3.52E-01	0.00%	0.01	3.52E-03	0.00%
Rb-87	2.30E-01	9.50E-01	2.30E-01	2.87E-04	6.61E-05	0.00%	0.001	6.61E-08	0.00%
Sr-89	9.16E-12	2.50E-04	2.41E-15	1.07E+09	2.58E-06	0.00%	0.001	2.58E-09	0.00%
Sr-90	4.81E-01	2.50E-04	1.26E-04	1.81E+08	2.29E+04	0.27%	0.001	2.29E+01	0.03%
Y-90	1.25E-04	2.50E-04	3.29E-08	4.46E+09	1.47E+02	0.00%	0.001	1.47E-01	0.00%
Y-91	1.89E-10	1.00E-04	1.99E-14	1.08E+09	2.15E-06	0.00%	0.001	2.15E-08	0.00%
Zr-93	6.70E-01	9.60E-06	6.77E-06	8.04E+02	5.44E-03	0.00%	0.001	5.44E-06	0.00%
Zr-95	2.43E-09	1.00E-05	2.56E-14	3.86E+08	9.89E-06	0.00%	0.001	9.89E-09	0.00%
Nb-95	2.81E-09	1.00E-05	2.96E-14	1.76E+08	5.21E-06	0.00%	0.001	5.21E-09	0.00%
Nb-95m	1.70E-12	1.00E-05	1.79E-17	8.08E+08	1.45E-08	0.00%	0.001	1.45E-11	0.00%
Tc-99	7.81E-01	1.00E+00	8.22E-01	1.27E+02	1.04E+02	0.00%	0.001	1.04E-01	0.00%
Ru-103	5.74E-15	5.00E-01	3.02E-15	2.51E+08	7.59E-07	0.00%	0.01	7.59E-09	0.00%
Ru-106	7.04E-03	5.00E-01	3.70E-03	1.47E+09	5.44E+06	65.28%	0.01	5.44E+04	65.52%
Pd-107	1.51E-01	1.00E-04	1.59E-05	6.68E+00	1.06E-04	0.00%	0.001	1.06E-07	0.00%
Cd-115m	4.11E-16	5.00E-02	2.16E-17	1.65E+09	3.57E-08	0.00%	0.001	3.57E-11	0.00%
In-115	7.64E-03	5.00E-02	4.02E-04	1.77E-05	7.12E-09	0.00%	0.001	7.12E-12	0.00%
Sn-121m	2.49E-06	4.00E-02	1.05E-07	3.48E+06	3.64E-02	0.00%	0.001	3.64E-05	0.00%
Sn-123	2.37E-07	4.00E-02	9.97E-09	2.47E+08	2.46E+00	0.00%	0.001	2.46E-03	0.00%
Sn-125	2.60E-60	4.00E-02	1.10E-61	1.52E+09	1.67E-52	0.00%	0.001	1.67E-55	0.00%
Sn-126	2.35E-02	4.00E-02	9.90E-04	2.44E+03	2.42E+00	0.00%	0.001	2.42E-03	0.00%
Sb-124	1.05E-14	6.00E-03	6.61E-17	3.67E+08	2.43E-08	0.00%	0.001	2.43E-11	0.00%
Sb-125	4.56E-03	6.00E-03	2.88E-05	1.01E+07	2.91E+02	0.00%	0.001	2.91E-01	0.00%
Sb-126	1.12E-10	4.00E-02	4.71E-12	8.36E+08	3.94E-03	0.00%	0.001	3.94E-06	0.00%
Te-127m	6.60E-08	5.00E-04	3.47E-11	1.79E+08	6.21E-03	0.00%	0.01	6.21E-05	0.00%
Te-129m	1.02E-18	5.00E-04	5.35E-22	6.03E+08	3.23E-13	0.00%	0.01	3.23E-15	0.00%
I-129	1.65E-01	1.00E+00	1.73E-01	3.18E+01	5.52E+00	0.00%	0.5	2.76E+00	0.00%
I-131	7.52E-70	1.00E+00	7.92E-70	3.97E+09	3.14E-60	0.00%	0.5	1.57E-60	0.00%
Cs-134	1.47E-03	9.50E-01	1.47E-03	6.08E+07	8.97E+04	1.08%	0.01	8.97E+02	1.08%
Cs-135	9.40E-02	9.50E-01	9.40E-02	5.18E+00	4.87E-01	0.00%	0.01	4.87E-03	0.00%
Cs-136	1.70E-45	9.50E-01	1.70E-45	5.47E+08	9.29E-37	0.00%	0.01	9.29E-39	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	33.22%	0.01	2.77E+04	33.34%
Ba-140	4.87E-44	5.00E-04	2.56E-47	2.63E+08	6.73E-39	0.00%	0.001	6.73E-42	0.00%
La-140	7.34E-45	1.00E-03	7.72E-48	2.45E+09	1.89E-38	0.00%	0.001	1.89E-41	0.00%
Ce-141	8.94E-18	1.00E-04	9.41E-22	2.42E+08	2.28E-13	0.00%	0.001	2.28E-16	0.00%
Ce-144	1.02E-02	1.00E-04	1.08E-06	1.12E+09	1.20E+03	0.01%	0.001	1.20E+00	0.00%
Pr-143	1.62E-41	1.00E-03	1.70E-44	4.92E+08	8.38E-38	0.00%	0.001	8.38E-39	0.00%
Nd-144	9.32E-01	1.00E-04	9.81E-05	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Nd-147	1.55E-51	1.00E-04	1.63E-55	5.02E+08	8.20E-47	0.00%	0.001	8.20E-50	0.00%
Pm-147	1.07E-01	1.00E-04	1.12E-05	3.15E+07	3.54E+02	0.00%	0.001	3.54E-01	0.00%
Pm-148	1.08E-18	1.00E-04	1.13E-22	1.64E+09	1.86E-13	0.00%	0.001	1.86E-16	0.00%
Pm-148m	1.20E-16	1.00E-04	1.26E-20	2.14E+08	2.70E-12	0.00%	0.001	2.70E-15	0.00%
Sm-147	2.94E-01	3.50E-04	1.08E-04	1.65E+00	1.79E-04	0.00%	0.001	1.79E-07	0.00%
Sm-151	5.17E-02	3.50E-04	1.91E-05	7.63E+05	1.45E+01	0.00%	0.001	1.45E-02	0.00%
Eu-152	1.11E-04	1.30E-04	1.52E-08	3.81E+07	5.79E-01	0.00%	0.001	5.79E-04	0.00%
Eu-154	2.01E-03	1.30E-04	2.75E-07	6.86E+07	1.89E+01	0.00%	0.001	1.89E-02	0.00%
Eu-155	5.49E-03	1.30E-04	7.51E-07	1.81E+07	1.36E+01	0.00%	0.001	1.36E-02	0.00%
Eu-156	9.77E-39	1.30E-04	1.34E-42	6.06E+08	8.10E-34	0.00%	0.001	8.10E-37	0.00%
Gd-152	3.11E-06	1.00E-04	3.27E-10	5.15E-03	1.68E-12	0.00%	0.001	1.68E-15	0.00%
Tb-160	3.57E-13	1.00E-04	3.75E-17	2.48E+08	9.31E-09	0.00%	0.001	9.31E-12	0.00%
Ra-224	1.49E-11	3.00E-04	4.69E-15	4.67E+11	2.19E-03	0.00%	0.001	2.19E-06	0.00%
Th-228	2.89E-09	1.00E-05	3.03E-14	2.54E+11	7.70E-03	0.00%	0.001	7.70E-06	0.00%
U-232	5.36E-08	3.00E-04	1.69E-11	1.48E+10	2.50E-01	0.00%	0.001	2.50E-04	0.00%
U-234	2.86E-18	3.00E-04	9.02E-22	8.08E+05	7.29E-16	0.00%	0.001	7.29E-19	0.00%
U-235	2.34E-02	3.00E-04	7.38E-06	2.59E+02	1.91E-03	0.00%	0.001	1.91E-06	0.00%
U-236	8.10E-04	3.00E-04	2.56E-07	7.76E+03	1.99E-03	0.00%	0.001	1.99E-06	0.00%
U-238	1.40E+01	3.00E-04	4.43E-03	4.03E+01	1.79E-01	0.00%	0.001	1.79E-04	0.00%
Np-237	2.20E-03	3.00E-04	6.94E-07	3.45E+05	2.39E-01	0.00%	0.001	2.39E-04	0.00%

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction Values	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Pu-236	2.76E-08	3.00E-04	8.72E-12	8.53E+10	7.44E-01	0.00%	0.001	7.44E-04	0.00%
Pu-238	1.97E-05	3.00E-04	6.21E-09	7.88E+08	4.89E+01	0.00%	0.001	4.89E-02	0.00%
Pu-239	1.64E-01	3.00E-04	5.19E-05	3.16E+07	1.64E+03	0.02%	0.001	1.64E+00	0.00%
Pu-240	1.00E-02	3.00E-04	3.17E-06	1.16E+08	3.68E+02	0.00%	0.001	3.68E-01	0.00%
Pu-241	9.53E-04	3.00E-04	3.01E-07	1.03E+09	3.10E+02	0.00%	0.001	3.10E-01	0.00%
Pu-242	4.39E-05	3.00E-04	1.39E-08	1.89E+08	2.62E-02	0.00%	0.001	2.62E-05	0.00%
Am-241	1.34E-02	3.00E-04	4.24E-06	1.79E+09	7.59E+03	0.09%	0.001	7.59E+00	0.01%
Am-242m	5.96E-06	3.00E-04	1.89E-09	4.96E+09	9.33E+00	0.00%	0.001	9.33E-03	0.00%
Am-243	6.75E-07	3.00E-04	2.13E-10	1.04E+08	2.22E-02	0.00%	0.001	2.22E-05	0.00%
Cm-242	3.19E-08	3.00E-04	1.01E-11	5.62E+10	5.67E-01	0.00%	0.001	5.67E-04	0.00%
Cm-243	6.48E-08	3.00E-04	2.05E-11	1.81E+10	3.70E-01	0.00%	0.001	3.70E-04	0.00%
Cm-244	9.00E-07	3.00E-04	2.84E-10	2.18E+10	6.20E+00	0.00%	0.001	6.20E-03	0.00%
Cm-245	4.03E-11	3.00E-04	1.27E-14	9.27E+07	1.18E-06	0.00%	0.001	1.18E-09	0.00%
Cm-246	4.16E-13	3.00E-04	1.31E-16	1.65E+08	2.17E-08	0.00%	0.001	2.17E-11	0.00%
Cm-247	3.35E-16	3.00E-04	1.06E-19	4.55E+04	4.82E-15	0.00%	0.001	4.82E-18	0.00%
Cm-248	1.48E-18	3.00E-04	4.67E-22	8.08E+06	3.77E-15	0.00%	0.001	3.77E-18	0.00%
Bk-249	8.34E-25	3.00E-04	2.63E-28	2.17E+09	5.72E-19	0.00%	0.001	5.72E-22	0.00%
Cf-249	4.58E-23	3.00E-04	1.45E-26	2.20E+09	3.18E-17	0.00%	0.001	3.18E-20	0.00%
					<u>8.34E+06</u>			<u>8.31E+04</u>	

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Volatile Conditions		Release Fraction	Evaporative Conditions	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
H-3	6.52E-07	1.00E+00	6.86E-07	9.22E+05	6.33E-01	0.00%	1	6.33E-01	0.00%
Cr-51	1.07E-63	5.00E-02	5.63E-65	2.40E+07	1.35E-57	0.00%	0.001	1.35E-60	0.00%
Co-60	1.51E-04	1.90E-04	3.02E-08	1.70E+08	5.14E+00	0.00%	0.001	5.14E-03	0.00%
Se-79	6.80E-03	1.00E-01	7.15E-04	6.20E+02	4.44E-01	0.00%	0.01	4.44E-03	0.00%
Rb-87	2.90E-01	9.50E-01	2.90E-01	2.87E-04	8.32E-05	0.00%	0.001	8.32E-08	0.00%
Sr-89	8.27E-33	2.50E-04	2.18E-36	1.07E+09	2.33E-27	0.00%	0.001	2.33E-30	0.00%
Sr-90	4.73E-01	2.50E-04	1.24E-04	1.81E+08	2.25E+04	0.80%	0.001	2.25E+01	0.08%
Y-90	1.23E-04	2.50E-04	3.24E-08	4.46E+09	1.44E+02	0.01%	0.001	1.44E-01	0.00%
Y-91	4.11E-29	1.00E-04	4.33E-33	1.08E+09	4.67E-24	0.00%	0.001	4.67E-27	0.00%
Zr-83	8.43E-01	9.60E-06	8.52E-06	8.04E+02	6.85E-03	0.00%	0.001	6.85E-06	0.00%
Zr-95	5.01E-26	1.00E-05	5.27E-31	3.86E+08	2.04E-22	0.00%	0.001	2.04E-25	0.00%
Nb-95	5.79E-26	1.00E-05	6.09E-31	1.76E+08	1.07E-22	0.00%	0.001	1.07E-25	0.00%
Nb-95m	3.51E-29	1.00E-05	3.69E-34	8.08E+08	2.98E-25	0.00%	0.001	2.98E-28	0.00%
Tc-99	9.83E-01	1.00E+00	1.04E+00	1.27E+02	1.31E+02	0.00%	0.001	1.31E-01	0.00%
Ru-103	1.24E-42	5.00E-01	6.53E-43	2.51E+08	1.64E-34	0.00%	0.01	1.64E-36	0.00%
Ru-106	9.28E-06	5.00E-01	4.88E-06	1.47E+09	7.18E+03	0.25%	0.01	7.18E+01	0.26%
Pd-107	1.90E-01	1.00E-04	2.00E-05	6.68E+00	1.33E-04	0.00%	0.001	1.33E-07	0.00%
Cd-115m	1.15E-40	5.00E-02	6.05E-42	1.65E+09	9.99E-33	0.00%	0.001	9.99E-36	0.00%
In-115	9.62E-03	5.00E-02	5.06E-04	1.77E-05	8.96E-09	0.00%	0.001	8.96E-12	0.00%
Sn-121m	2.73E-06	4.00E-02	1.15E-07	3.48E+05	3.99E-02	0.00%	0.001	3.99E-05	0.00%
Sn-123	8.94E-16	4.00E-02	3.77E-17	2.47E+08	9.30E-09	0.00%	0.001	9.30E-12	0.00%
Sn-126	2.96E-02	4.00E-02	1.25E-03	2.44E+03	3.04E+00	0.00%	0.001	3.04E-03	0.00%
Sb-124	7.19E-33	6.00E-03	4.54E-35	3.67E+08	1.67E-26	0.00%	0.001	1.67E-29	0.00%
Sb-125	4.53E-04	6.00E-03	2.86E-06	1.01E+07	2.89E+01	0.00%	0.001	2.89E-02	0.00%
Sb-126	1.41E-10	4.00E-02	5.93E-12	8.36E+08	4.95E-03	0.00%	0.001	4.95E-06	0.00%
Te-127m	6.79E-18	5.00E-04	3.58E-21	1.79E+08	6.40E-13	0.00%	0.01	6.40E-15	0.00%
Te-129m	1.54E-51	5.00E-04	8.11E-55	6.03E+08	4.89E-46	0.00%	0.01	4.89E-48	0.00%
I-129	2.07E-01	1.00E+00	2.18E-01	3.18E+01	6.95E+00	0.00%	0.5	3.47E+00	0.01%
Cs-134	6.42E-05	9.50E-01	6.42E-05	6.08E+07	3.90E+03	0.14%	0.01	3.90E+01	0.14%
Cs-135	1.18E-01	9.50E-01	1.18E-01	5.18E+00	6.13E-01	0.00%	0.01	6.13E-03	0.00%
Cs-137	1.00E+00	9.50E-01	1.00E+00	2.77E+06	2.77E+06	98.35%	0.01	2.77E+04	99.46%
Ce-141	1.78E-51	1.00E-04	1.88E-55	2.42E+08	4.55E-47	0.00%	0.001	4.55E-50	0.00%
Ce-144	1.75E-06	1.00E-04	1.84E-10	1.12E+09	2.06E-01	0.00%	0.001	2.06E-04	0.00%
Nd-144	1.19E+00	1.00E-04	1.25E-04	0.00E+00	0.00E+00	0.00%	0.001	0.00E+00	0.00%
Pm-147	9.57E-03	1.00E-04	1.01E-06	3.15E+07	3.17E+01	0.00%	0.001	3.17E-02	0.00%
Pm-148	3.23E-45	1.00E-04	3.40E-49	1.64E+09	5.57E-40	0.00%	0.001	5.57E-43	0.00%
Pm-148m	3.60E-43	1.00E-04	3.79E-47	2.14E+08	8.11E-39	0.00%	0.001	8.11E-42	0.00%
Sm-147	4.95E-01	3.50E-04	1.82E-04	1.65E+00	3.01E-04	0.00%	0.001	3.01E-07	0.00%
Sm-151	6.05E-02	3.50E-04	2.23E-05	7.63E+05	1.70E+01	0.00%	0.001	1.70E-02	0.00%
Eu-152	8.20E-05	1.30E-04	1.12E-08	3.81E+07	4.27E-01	0.00%	0.001	4.27E-04	0.00%
Eu-154	1.13E-03	1.30E-04	1.55E-07	6.86E+07	1.06E+01	0.00%	0.001	1.06E-02	0.00%
Eu-155	1.63E-03	1.30E-04	2.23E-07	1.81E+07	4.03E+00	0.00%	0.001	4.03E-03	0.00%
Gd-152	3.91E-06	1.00E-04	4.12E-10	5.15E-03	2.12E-12	0.00%	0.001	2.12E-15	0.00%
Tb-160	2.78E-28	1.00E-04	2.93E-32	2.48E+08	7.27E-24	0.00%	0.001	7.27E-27	0.00%
Ra-224	1.22E-11	3.00E-04	3.85E-15	4.67E+11	1.80E-03	0.00%	0.001	1.80E-06	0.00%
Th-228	2.37E-09	1.00E-05	2.49E-14	2.54E+11	6.33E-03	0.00%	0.001	6.33E-06	0.00%
U-232	9.04E-08	3.00E-04	2.86E-11	1.48E+10	4.23E-01	0.00%	0.001	4.23E-04	0.00%
U-234	3.59E-18	3.00E-04	1.14E-21	8.08E+05	9.17E-16	0.00%	0.001	9.17E-19	0.00%
U-235	2.94E-02	3.00E-04	9.29E-06	2.59E+02	2.41E-03	0.00%	0.001	2.41E-06	0.00%
U-236	1.02E-03	3.00E-04	3.22E-07	7.76E+03	2.50E-03	0.00%	0.001	2.50E-06	0.00%
U-238	1.77E+01	3.00E-04	5.58E-03	4.03E+01	2.25E-01	0.00%	0.001	2.25E-04	0.00%
Np-237	2.77E-03	3.00E-04	8.73E-07	3.45E+05	3.01E-01	0.00%	0.001	3.01E-04	0.00%
Pu-236	3.06E-09	3.00E-04	9.65E-13	8.53E+10	8.23E-02	0.00%	0.001	8.23E-05	0.00%
Pu-238	2.32E-05	3.00E-04	7.31E-09	7.88E+09	5.76E+01	0.00%	0.001	5.76E-02	0.00%
Pu-239	2.07E-01	3.00E-04	6.54E-05	3.16E+07	2.07E+03	0.07%	0.001	2.07E+00	0.01%
Pu-240	1.26E-02	3.00E-04	3.99E-06	1.16E+08	4.63E+02	0.02%	0.001	4.63E-01	0.00%
Pu-241	7.49E-04	3.00E-04	2.36E-07	1.03E+09	2.43E+02	0.01%	0.001	2.43E-01	0.00%
Pu-242	5.54E-05	3.00E-04	1.75E-08	1.89E+06	3.30E-02	0.00%	0.001	3.30E-05	0.00%
Am-241	1.71E-02	3.00E-04	5.39E-06	1.79E+09	9.66E+03	0.34%	0.001	9.66E+00	0.03%
Am-242m	7.16E-06	3.00E-04	2.26E-09	4.96E+09	1.12E+01	0.00%	0.001	1.12E-02	0.00%

PUREX SUPERNATE RADIONUCLIDE INHALATION DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	<u>Volatile Conditions</u>		Release Fraction Values	<u>Evaporative Conditions</u>	
					Dose (rem/g Cs-137)	Percent Dose		Dose (rem/g Cs-137)	Percent Dose
Am-243	8.48E-07	3.00E-04	2.68E-10	1.04E+08	2.79E-02	0.00%	0.001	2.79E-06	0.00%
Cm-242	1.73E-08	3.00E-04	5.48E-12	5.62E+10	3.03E-01	0.00%	0.001	3.08E-04	0.00%
Cm-243	6.40E-08	3.00E-04	2.02E-11	1.81E+10	3.66E-01	0.00%	0.001	3.66E-04	0.00%
Cm-244	7.73E-09	3.00E-04	2.44E-12	2.18E+10	5.32E-02	0.00%	0.001	5.32E-06	0.00%
Cm-245	5.07E-11	3.00E-04	1.60E-14	9.27E+07	1.48E-06	0.00%	0.001	1.48E-09	0.00%
Cm-246	5.23E-13	3.00E-04	1.66E-16	1.65E+08	2.73E-08	0.00%	0.001	2.73E-11	0.00%
Cm-247	4.22E-16	3.00E-04	1.33E-19	4.55E+04	6.07E-15	0.00%	0.001	6.07E-18	0.00%
Cm-248	1.86E-18	3.00E-04	5.87E-22	8.08E+06	4.75E-15	0.00%	0.001	4.75E-18	0.00%
Bk-249	3.31E-28	3.00E-04	1.04E-31	2.17E+09	2.27E-22	0.00%	0.001	2.27E-25	0.00%
Cf-249	5.76E-23	3.00E-04	1.82E-26	2.20E+09	4.00E-17	0.00%	0.001	4.00E-20	0.00%
					<u>2.82E+06</u>			<u>2.79E+04</u>	

PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 31B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
H-3	9.11E-06	1.00E+00	9.59E-06	6.11E+05	5.66E+00	0.00%
Cr-51	3.02E-24	5.00E-02	1.59E-25	1.20E+07	1.91E-18	0.00%
Co-60	4.49E-04	1.90E-04	8.98E-08	2.94E+07	2.64E+00	0.00%
Se-79	5.40E-03	1.00E-01	5.68E-04	5.56E+02	3.16E-01	0.00%
Rb-87	2.30E-01	9.50E-01	2.30E-01	4.17E-04	9.61E-05	0.00%
Sr-89	9.16E-12	2.50E-04	2.41E-15	2.53E+08	6.10E-07	0.00%
Sr-90	4.81E-01	2.50E-04	1.26E-04	1.81E+07	2.29E+03	0.05%
Y-90	1.25E-04	2.50E-04	3.29E-08	5.43E+09	1.79E+02	0.00%
Y-91	1.89E-10	1.00E-04	1.99E-14	2.18E+08	4.34E-06	0.00%
Zr-93	6.70E-01	9.60E-06	6.77E-06	4.02E+00	2.72E-05	0.00%
Zr-95	2.43E-09	1.00E-05	2.56E-14	7.30E+07	1.87E-06	0.00%
Nb-95	2.81E-09	1.00E-05	2.96E-14	8.63E+07	2.55E-06	0.00%
Nb-95m	1.70E-12	1.00E-05	1.79E-17	7.35E+08	1.32E-08	0.00%
Tc-99	7.81E-01	1.00E+00	8.22E-01	2.20E+01	1.81E+01	0.00%
Ru-103	5.74E-15	5.00E-01	3.02E-15	8.70E+07	2.63E-07	0.00%
Ru-106	7.04E-03	5.00E-01	3.70E-03	7.03E+07	2.60E+05	5.50%
Pd-107	1.51E-01	1.00E-04	1.59E-05	7.20E-02	1.14E-06	0.00%
Cd-115m	4.11E-16	5.00E-02	2.16E-17	3.81E+08	8.24E-09	0.00%
In-115	7.64E-03	5.00E-02	4.02E-04	7.28E-07	2.93E-10	0.00%
Sn-121m	2.49E-06	4.00E-02	1.05E-07	5.08E+04	5.32E-03	0.00%
Sn-123	2.37E-07	4.00E-02	9.97E-09	6.33E+07	6.31E-01	0.00%
Sn-125	2.60E-60	4.00E-02	1.10E-61	1.14E+07	1.25E-54	0.00%
Sn-126	2.35E-02	4.00E-02	9.90E-04	4.82E+02	4.77E-01	0.00%
Sb-124	1.05E-14	6.00E-03	6.61E-17	1.63E+08	1.08E-08	0.00%
Sb-125	4.56E-03	6.00E-03	2.88E-05	2.69E+06	7.74E+01	0.00%
Sb-126	1.12E-10	4.00E-02	4.71E-12	6.10E+06	2.87E-05	0.00%
Te-127m	6.60E-08	5.00E-04	3.47E-11	7.45E+07	2.59E-03	0.00%
Te-129m	1.02E-18	5.00E-04	5.35E-22	2.98E+08	1.59E-13	0.00%
I-129	1.65E-01	1.00E+00	1.73E-01	4.94E+01	8.57E+00	0.00%
I-131	7.52E-70	1.00E+00	7.92E-70	6.57E+09	5.20E-60	0.00%
Ce-134	1.47E-03	9.50E-01	1.47E-03	9.58E+07	1.41E+05	2.98%
Ce-135	9.40E-02	9.50E-01	9.40E-02	8.17E+00	7.68E-01	0.00%
Ce-136	1.70E-45	9.50E-01	1.70E-45	8.03E+08	1.36E-36	0.00%
Ce-137	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	91.46%
Ba-140	4.87E-44	5.00E-04	2.56E-47	6.13E+08	1.57E-38	0.00%
La-140	7.34E-45	1.00E-03	7.72E-48	4.29E+09	3.31E-38	0.00%
Ce-141	8.94E-18	1.00E-04	9.41E-22	7.41E+07	6.97E-14	0.00%
Ce-144	1.02E-02	1.00E-04	1.08E-06	6.38E+07	6.86E+01	0.00%
Pr-143	1.62E-41	1.00E-03	1.70E-44	3.03E+08	5.16E-36	0.00%
Nd-144	9.32E-01	1.00E-04	9.81E-05	0.00E+00	0.00E+00	0.00%
Nd-147	1.55E-51	1.00E-04	1.63E-55	3.16E+08	5.16E-47	0.00%
Pm-147	1.07E-01	1.00E-04	1.12E-05	8.81E+05	9.90E+00	0.00%
Pm-148	1.08E-18	1.00E-04	1.13E-22	1.56E+09	1.77E-13	0.00%
Pm-148m	1.20E-16	1.00E-04	1.26E-20	1.50E+08	1.89E-12	0.00%
Sm-147	2.94E-01	3.50E-04	1.08E-04	4.19E-03	4.54E-07	0.00%
Sm-151	5.17E-02	3.50E-04	1.91E-05	8.95E+03	1.71E-01	0.00%
Eu-152	1.11E-04	1.30E-04	1.52E-08	1.04E+06	1.58E-02	0.00%
Eu-154	2.01E-03	1.30E-04	2.75E-07	2.40E+06	6.61E-01	0.00%
Eu-155	5.49E-03	1.30E-04	7.51E-07	6.05E+05	4.54E-01	0.00%
Eu-156	9.77E-39	1.30E-04	1.34E-42	4.79E+08	6.40E-34	0.00%
Gd-152	3.11E-06	1.00E-04	3.27E-10	3.22E-06	1.05E-15	0.00%
Tb-160	3.57E-13	1.00E-04	3.75E-17	7.23E+07	2.71E-09	0.00%
Ra-224	1.49E-11	3.00E-04	4.69E-15	5.31E+10	2.49E-04	0.00%
Th-228	2.88E-09	1.00E-05	3.03E-14	3.11E+08	9.43E-06	0.00%

PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 31B Fuel Assembly
5 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
U-232	5.36E-08	3.00E-04	1.69E-11	2.86E+07	4.84E-04	0.00%
U-234	2.86E-18	3.00E-04	9.02E-22	1.62E+03	1.46E-18	0.00%
U-235	2.34E-02	3.00E-04	7.38E-06	5.41E-01	3.99E-06	0.00%
U-236	8.10E-04	3.00E-04	2.56E-07	1.62E+01	4.14E-06	0.00%
U-238	1.40E+01	3.00E-04	4.43E-03	7.73E-02	3.43E-04	0.00%
Np-237	2.20E-03	3.00E-04	6.94E-07	2.75E+03	1.91E-03	0.00%
Pu-236	2.76E-08	3.00E-04	8.72E-12	6.93E+08	6.04E-03	0.00%
Pu-238	1.97E-05	3.00E-04	6.21E-09	6.51E+07	4.04E-01	0.00%
Pu-239	1.64E-01	3.00E-04	5.19E-05	2.67E+05	1.39E+01	0.00%
Pu-240	1.00E-02	3.00E-04	3.17E-06	9.75E+05	3.09E+00	0.00%
Pu-241	9.53E-04	3.00E-04	3.01E-07	8.86E+06	2.67E+00	0.00%
Pu-242	4.39E-05	3.00E-04	1.39E-08	1.61E+04	2.23E-04	0.00%
Am-241	1.34E-02	3.00E-04	4.24E-06	1.54E+07	6.53E+01	0.00%
Am-242m	5.96E-06	3.00E-04	1.88E-09	4.06E+07	7.67E-02	0.00%
Am-243	6.75E-07	3.00E-04	2.13E-10	8.97E+05	1.91E-04	0.00%
Cm-242	3.19E-08	3.00E-04	1.01E-11	3.64E+08	3.67E-03	0.00%
Cm-243	6.48E-08	3.00E-04	2.05E-11	1.50E+08	3.07E-03	0.00%
Cm-244	9.00E-07	3.00E-04	2.84E-10	1.86E+08	5.29E-02	0.00%
Cm-245	4.03E-11	3.00E-04	1.27E-14	7.73E+05	9.83E-09	0.00%
Cm-246	4.16E-13	3.00E-04	1.31E-16	1.38E+06	1.81E-10	0.00%
Cm-247	3.35E-16	3.00E-04	1.06E-19	3.80E+02	4.02E-17	0.00%
Cm-248	1.48E-18	3.00E-04	4.67E-22	6.80E+04	3.17E-17	0.00%
Bk-249	8.34E-25	3.00E-04	2.63E-28	1.00E+07	2.63E-21	0.00%
Cf-249	4.58E-23	3.00E-04	1.45E-26	1.84E+07	2.66E-19	0.00%
					<u>4.73E+06</u>	

PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTIONMark 31B Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Ce-137)	Solubility Fraction	Normalized Supernate Content (g/g Ce-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Ce-137)	Percent Dose
H-3	6.52E-07	1.00E+00	6.86E-07	6.11E+05	4.10E-01	0.00%
Cr-51	1.07E-63	5.00E-02	5.63E-65	1.20E+07	6.75E-58	0.00%
Co-60	1.51E-04	1.90E-04	3.02E-08	2.94E+07	8.89E-01	0.00%
Se-79	6.80E-03	1.00E-01	7.15E-04	5.56E+02	3.98E-01	0.00%
Rb-87	2.90E-01	9.50E-01	2.90E-01	4.17E-04	1.21E-04	0.00%
Sr-89	8.27E-33	2.50E-04	2.18E-36	2.53E+08	5.51E-28	0.00%
Sr-90	4.73E-01	2.50E-04	1.24E-04	1.81E+07	2.25E+03	0.05%
Y-90	1.23E-04	2.50E-04	3.24E-08	5.43E+09	1.76E+02	0.00%
Y-91	4.11E-29	1.00E-04	4.33E-33	2.18E+08	9.43E-25	0.00%
Zr-93	8.43E-01	9.60E-06	8.52E-06	4.02E+00	3.43E-05	0.00%
Zr-95	5.01E-28	1.00E-05	5.27E-31	7.30E+07	3.85E-23	0.00%
Nb-95	5.79E-28	1.00E-05	6.09E-31	8.63E+07	5.26E-23	0.00%
Nb-95m	3.51E-29	1.00E-05	3.69E-34	7.35E+08	2.71E-25	0.00%
Tc-99	9.83E-01	1.00E+00	1.04E+00	2.20E+01	2.28E+01	0.00%
Ru-103	1.24E-42	5.00E-01	6.53E-43	8.70E+07	5.68E-35	0.00%
Ru-106	9.28E-06	5.00E-01	4.88E-06	7.03E+07	3.43E+02	0.01%
Pd-107	1.90E-01	1.00E-04	2.00E-05	7.20E-02	1.44E-06	0.00%
Cd-115m	1.15E-40	5.00E-02	6.05E-42	3.81E+08	2.31E-33	0.00%
In-115	9.62E-03	5.00E-02	5.06E-04	7.28E-07	3.69E-10	0.00%
Sn-121m	2.73E-06	4.00E-02	1.15E-07	5.08E+04	5.83E-03	0.00%
Sn-123	8.94E-16	4.00E-02	3.77E-17	6.33E+07	2.38E-09	0.00%
Sn-126	2.96E-02	4.00E-02	1.25E-03	4.82E+02	6.01E-01	0.00%
Sb-124	7.19E-33	6.00E-03	4.54E-35	1.63E+08	7.40E-27	0.00%
Sb-125	4.53E-04	6.00E-03	2.86E-06	2.69E+06	7.70E+00	0.00%
Sb-126	1.41E-10	4.00E-02	5.93E-12	6.10E+06	3.61E-05	0.00%
Te-127m	6.79E-18	5.00E-04	3.58E-21	7.45E+07	2.68E-13	0.00%
Te-129m	1.54E-51	5.00E-04	8.11E-55	2.98E+08	2.42E-46	0.00%
I-129	2.07E-01	1.00E+00	2.18E-01	4.94E+01	1.08E+01	0.00%
Ce-134	6.42E-05	9.50E-01	6.42E-05	9.58E+07	6.15E+03	0.14%
Ce-135	1.18E-01	9.50E-01	1.18E-01	8.17E+00	9.67E-01	0.00%
<u>Ce-137</u>	1.00E+00	9.50E-01	1.00E+00	4.33E+06	4.33E+06	<u>99.79%</u>
Ce-141	1.78E-51	1.00E-04	1.88E-55	7.41E+07	1.39E-47	0.00%
Ce-144	1.75E-06	1.00E-04	1.84E-10	6.38E+07	1.18E-02	0.00%
Nd-144	1.19E+00	1.00E-04	1.25E-04	0.00E+00	0.00E+00	0.00%
Pm-147	9.57E-03	1.00E-04	1.01E-06	8.81E+05	8.87E-01	0.00%
Pm-148	3.23E-45	1.00E-04	3.40E-49	1.56E+09	5.30E-40	0.00%
Pm-148m	3.60E-43	1.00E-04	3.79E-47	1.50E+08	5.69E-39	0.00%
Sm-147	4.95E-01	3.50E-04	1.82E-04	4.19E-03	7.64E-07	0.00%
Sm-151	6.05E-02	3.50E-04	2.23E-05	8.95E+03	1.99E-01	0.00%
Eu-152	8.20E-05	1.30E-04	1.12E-08	1.04E+06	1.17E-02	0.00%
Eu-154	1.13E-03	1.30E-04	1.55E-07	2.40E+06	3.71E-01	0.00%
Eu-155	1.63E-03	1.30E-04	2.23E-07	6.05E+05	1.35E-01	0.00%
Gd-152	3.91E-06	1.00E-04	4.12E-10	3.22E-06	1.33E-15	0.00%
Tb-160	2.78E-28	1.00E-04	2.93E-32	7.23E+07	2.12E-24	0.00%
Ra-224	1.22E-11	3.00E-04	3.85E-15	5.31E+10	2.04E-04	0.00%
Th-228	2.37E-09	1.00E-05	2.49E-14	3.11E+08	7.76E-06	0.00%
U-232	9.04E-08	3.00E-04	2.86E-11	2.86E+07	8.17E-04	0.00%
U-234	3.59E-18	3.00E-04	1.14E-21	1.62E+03	1.84E-18	0.00%
U-235	2.94E-02	3.00E-04	9.29E-06	5.41E-01	5.03E-06	0.00%
U-236	1.02E-03	3.00E-04	3.22E-07	1.62E+01	5.22E-06	0.00%
U-238	1.77E+01	3.00E-04	5.58E-03	7.73E-02	4.31E-04	0.00%
Np-237	2.77E-03	3.00E-04	8.73E-07	2.75E+03	2.40E-03	0.00%
Pu-236	3.06E-09	3.00E-04	9.65E-13	6.93E+08	6.69E-04	0.00%
Pu-238	2.32E-05	3.00E-04	7.31E-09	6.51E+07	4.76E-01	0.00%

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PUREX SUPERNATE RADIONUCLIDE INGESTION
DOSE CONTRIBUTION

Mark 31B Fuel Assembly
15 years

Isotope	Normalized Isotopic Content (g/g Cs-137)	Solubility Fraction	Normalized Supernate Content (g/g Cs-137)	Dose Conversion (ICRP-30, rem/g)	Dose (rem/g Cs-137)	Percent Dose
Pu-239	2.07E-01	3.00E-04	6.54E-05	2.67E+05	1.74E+01	0.00%
Pu-240	1.26E-02	3.00E-04	3.99E-06	9.75E+05	3.89E+00	0.00%
Pu-241	7.49E-04	3.00E-04	2.36E-07	8.86E+06	2.09E+00	0.00%
Pu-242	5.54E-05	3.00E-04	1.75E-08	1.61E+04	2.81E-04	0.00%
Am-241	1.71E-02	3.00E-04	5.39E-06	1.54E+07	8.31E+01	0.00%
Am-242m	7.16E-06	3.00E-04	2.26E-09	4.08E+07	9.23E-02	0.00%
Am-243	8.48E-07	3.00E-04	2.68E-10	8.97E+05	2.40E-04	0.00%
Cm-242	1.73E-08	3.00E-04	5.48E-12	3.64E+08	1.99E-03	0.00%
Cm-243	6.40E-08	3.00E-04	2.02E-11	1.50E+08	3.03E-03	0.00%
Cm-244	7.73E-09	3.00E-04	2.44E-12	1.86E+08	4.54E-04	0.00%
Cm-245	5.07E-11	3.00E-04	1.60E-14	7.73E+05	1.24E-08	0.00%
Cm-246	5.23E-13	3.00E-04	1.65E-16	1.38E+06	2.28E-10	0.00%
Cm-247	4.22E-16	3.00E-04	1.33E-19	3.80E+02	5.07E-17	0.00%
Cm-248	1.86E-18	3.00E-04	5.87E-22	6.80E+04	3.99E-17	0.00%
Bk-249	3.31E-28	3.00E-04	1.04E-31	1.00E+07	1.04E-24	0.00%
Cf-249	5.76E-23	3.00E-04	1.82E-26	1.84E+07	3.35E-19	0.00%
					<u>4.34E+06</u>	

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F-AREA SUPERNATE RADIONUCLIDE CONTRIBUTION EVAPORATIVE CONDITIONS

ECC Legler

HHS Legler

ECC Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal

HHS Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal

Isotopes	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose
Am-241	2.90E-05	1.51E+01	0.48%	1.60E-05	8.35E+00	0.23%	1.51E+01	0.15%	8.35E+00	0.07%
Ba-137	8.20E+00	0.00E+00	0.00%	6.20E+00	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Cs-144	1.70E-04	5.97E-02	0.00%	7.50E-01	2.63E+02	7.40%	5.97E-02	0.00%	2.63E+02	2.34%
Cm-244	9.20E-07	2.48E-01	0.01%	5.10E-07	1.37E-01	0.00%	2.48E-01	0.00%	1.37E-01	0.00%
Cs-137	8.90E+00	2.85E+03	91.15%	6.70E+00	2.15E+03	60.27%	9.61E+03	95.35%	9.61E+03	85.49%
H-3	4.10E-03	3.89E-01	0.01%	5.00E-03	4.75E-01	0.01%	3.89E-01	0.00%	4.75E-01	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%	1.70E+00	7.63E+00	0.21%	0.00E+00	0.00%	7.63E+00	0.07%
Pm-147	3.40E-02	1.16E+00	0.04%	4.30E-01	1.46E+01	0.41%	1.16E+00	0.01%	1.46E+01	0.13%
Pr-144	1.70E-04	7.13E-06	0.00%	7.50E-01	3.14E-02	0.00%	7.13E-06	0.00%	3.14E-02	0.00%
Pu-238	9.70E-07	4.47E-01	0.01%	8.10E-07	3.73E-01	0.01%	Pu 2.54E+02	2.52%	Pu 2.54E+02	2.26%
Pu-239	2.00E-05	1.02E+01	0.33%	1.60E-05	8.15E+00	0.23%				
Pu-240	4.70E-06	2.40E+00	0.08%	3.60E-06	1.84E+00	0.05%				
Pu-241	4.90E-03	4.90E+01	1.57%	2.70E-03	2.70E+01	0.76%				
Rh-106	2.90E-04	5.78E-05	0.00%	2.10E-01	4.18E-02	0.00%	5.78E-05	0.00%	4.18E-02	0.00%
Ru-106	2.90E-04	1.27E+00	0.04%	2.10E-01	9.21E+02	25.88%	1.27E+00	0.01%	9.21E+02	8.20%
Sr-89	0.00E+00	0.00E+00	0.00%	3.00E-02	1.11E+00	0.03%	0.00E+00	0.00%	1.11E+00	0.01%
Sr-90	1.50E-01	1.95E+02	6.25%	1.10E-01	1.43E+02	4.02%	1.95E+02	1.94%	1.43E+02	1.27%
U-235	4.00E-09	4.80E-04	0.00%	2.20E-09	2.64E-04	0.00%	4.80E-04	0.00%	2.64E-04	0.00%
U-238	1.30E-07	1.56E-02	0.00%	1.30E-07	1.56E-02	0.00%	1.56E-02	0.00%	1.56E-02	0.00%
Y-90	1.50E-01	1.23E+00	0.04%	1.10E-01	9.03E-01	0.03%	1.23E+00	0.01%	9.03E-01	0.01%
Y-91	0.00E+00	0.00E+00	0.00%	5.00E-02	2.20E+00	0.06%	0.00E+00	0.00%	2.20E+00	0.02%
Zr-95	0.00E+00	0.00E+00	0.00%	7.60E-01	1.36E+01	0.38%	0.00E+00	0.00%	1.36E+01	0.12%
		3.13E+03			3.56E+03		1.01E+04		1.12E+04	

Pu-238
Pu-239
Pu-240
Pu-241

gram/gal	mg/L
5.67E-08	1.50E-05
3.22E-04	8.50E-02
2.07E-05	5.47E-03
4.76E-05	1.26E-02
	1.03E-01

gram/gal	mg/L
4.74E-08	1.25E-05
2.57E-04	6.80E-02
1.59E-05	4.19E-03
2.62E-05	6.93E-03
	7.91E-02

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F-AREA SUPERNATE RADIONUCLIDE CONTRIBUTION VOLATILE CONDITIONS

ECC Legler				HHS Legler			ECC Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal		HHS Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal	
Isotopes	Concentration (Cl/gal)	Dose (rem/gal)	% of Dose	Concentration (Cl/gal)	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose
Am-241	2.90E-05	1.51E+04	2.70%	1.60E-05	8.35E+03	1.04%	1.51E+04	1.06%	8.35E+03	0.47%
Ba-137	8.20E+00	0.00E+00	0.00%	6.20E+00	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Ce-144	1.70E-04	5.97E+01	0.01%	7.50E-01	2.63E+05	32.94%	5.97E+01	0.00%	2.63E+05	14.94%
Cm-244	9.20E-07	2.48E+02	0.04%	5.10E-07	1.37E+02	0.02%	2.48E+02	0.02%	1.37E+02	0.01%
Cs-137	8.90E+00	2.85E+05	50.86%	6.70E+00	2.15E+05	26.84%	9.61E+05	67.28%	9.61E+05	54.52%
H-3	4.10E-03	3.89E-01	0.00%	5.00E-03	4.75E-01	0.00%	3.89E-01	0.00%	4.75E-01	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%	1.70E+00	7.63E+03	0.95%	0.00E+00	0.00%	7.63E+03	0.43%
Pm-147	3.40E-02	1.16E+03	0.21%	4.30E-01	1.46E+04	1.83%	1.16E+03	0.08%	1.46E+04	0.83%
Pr-144	1.70E-04	7.13E-03	0.00%	7.50E-01	3.14E+01	0.00%	7.13E-03	0.00%	3.14E+01	0.00%
Pu-238	9.70E-07	4.47E+02	0.08%	8.10E-07	3.73E+02	0.05%	Pu 2.54E+05	17.78%	Pu 2.54E+05	14.41%
Pu-239	2.00E-05	1.02E+04	1.82%	1.60E-05	8.15E+03	1.02%				
Pu-240	4.70E-06	2.40E+03	0.43%	3.60E-06	1.84E+03	0.23%				
Pu-241	4.90E-03	4.90E+04	8.74%	2.70E-03	2.70E+04	3.38%				
Rh-106	2.90E-04	5.78E-02	0.00%	2.10E-01	4.18E+01	0.01%	5.78E-02	0.00%	4.18E+01	0.00%
Ru-106	2.90E-04	1.27E+02	0.02%	2.10E-01	9.21E+04	11.53%	1.27E+02	0.01%	9.21E+04	5.23%
Sr-89	0.00E+00	0.00E+00	0.00%	3.00E-02	1.11E+03	0.14%	0.00E+00	0.00%	1.11E+03	0.06%
Sr-90	1.50E-01	1.95E+05	34.86%	1.10E-01	1.43E+05	17.92%	1.95E+05	13.68%	1.43E+05	8.13%
U-235	4.00E-09	4.80E-01	0.00%	2.20E-09	2.64E-01	0.00%	4.80E-01	0.00%	2.64E-01	0.00%
U-238	1.30E-07	1.56E+01	0.00%	1.30E-07	1.56E+01	0.00%	1.56E+01	0.00%	1.56E+01	0.00%
Y-90	1.50E-01	1.23E+03	0.22%	1.10E-01	9.03E+02	0.11%	1.23E+03	0.09%	9.03E+02	0.05%
Y-91	0.00E+00	0.00E+00	0.00%	5.00E-02	2.20E+03	0.28%	0.00E+00	0.00%	2.20E+03	0.13%
Zr-95	0.00E+00	0.00E+00	0.00%	7.60E-01	1.36E+04	1.71%	0.00E+00	0.00%	1.36E+04	0.77%
		5.60E+05			7.99E+05		1.43E+06		1.76E+06	

	gram/gal	mg/L
Pu-238	5.67E-08	1.50E-05
Pu-239	3.22E-04	8.50E-02
Pu-240	2.07E-05	5.47E-03
Pu-241	4.76E-05	1.26E-02
		1.03E-01

	gram/gal	mg/L
	4.74E-08	1.25E-05
	2.57E-04	6.80E-02
	1.59E-05	4.19E-03
	2.62E-05	6.93E-03
		7.91E-02

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H-AREA SUPERNATE RADIONUCLIDE CONTRIBUTION EVAPORATIVE CONDITIONS

ECC Legler				HHS Legler			ECC Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal		HHS Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal	
Isotopes	Concentration (Cl/gal)	Dose (rem/gal)	% of Dose	Concentration (Cl/gal)	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose
Am-241	2.90E-05	1.51E+01	0.14%	1.60E-05	8.35E+00	0.06%	1.51E+01	0.04%	8.35E+00	0.02%
Ba-137	8.40E+00	0.00E+00	0.00%	8.90E+00	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Ce-144	6.10E-03	2.14E+00	0.02%	3.80E+00	1.33E+03	9.23%	2.14E+00	0.01%	1.33E+03	2.89%
Cm-244	9.20E-07	2.48E-01	0.00%	5.10E-07	1.37E-01	0.00%	2.48E-01	0.00%	1.37E-01	0.00%
Cs-137	9.10E+00	2.91E+03	27.30%	9.60E+00	3.07E+03	21.27%	9.61E+03	23.92%	9.61E+03	20.78%
H-3	4.10E-03	3.89E-01	0.00%	5.00E-03	4.75E-01	0.00%	3.89E-01	0.00%	4.75E-01	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%	1.20E+00	5.39E+00	0.04%	0.00E+00	0.00%	5.39E+00	0.01%
Pm-147	1.10E-01	3.74E+00	0.04%	2.00E+00	6.80E+01	0.47%	3.74E+00	0.01%	6.80E+01	0.15%
Pr-144	6.10E-03	2.56E-04	0.00%	3.80E+00	1.59E-01	0.00%	2.56E-04	0.00%	1.59E-01	0.00%
Pu-238	1.60E-02	7.37E+03	69.08%	9.90E-03	4.56E+03	31.57%	Pu 3.03E+04	75.38%	Pu 2.99E+04	64.61%
Pu-239	1.10E-04	5.61E+01	0.53%	6.80E-05	3.47E+01	0.24%				
Pu-240	0.00E+00	0.00E+00	0.00%	0.00E+00	0.00E+00	0.00%				
Pu-241	4.90E-03	4.90E+01	0.46%	2.70E-03	2.70E+01	0.19%				
Rh-106	5.40E-03	1.08E-03	0.00%	1.10E+00	2.19E-01	0.00%	1.08E-03	0.00%	2.19E-01	0.00%
Ru-106	5.40E-03	2.37E+01	0.22%	1.10E+00	4.83E+03	33.40%	2.37E+01	0.06%	4.83E+03	10.44%
Sr-89	0.00E+00	0.00E+00	0.00%	4.00E-02	1.48E+00	0.01%	0.00E+00	0.00%	1.48E+00	0.00%
Sr-90	1.80E-01	2.34E+02	2.20%	3.70E-01	4.82E+02	3.33%	2.34E+02	0.58%	4.82E+02	1.04%
U-235	1.30E-09	1.56E-04	0.00%	7.30E-10	8.75E-05	0.00%	1.56E-04	0.00%	8.75E-05	0.00%
U-238	1.10E-09	1.32E-04	0.00%	5.90E-10	7.08E-05	0.00%	1.32E-04	0.00%	7.08E-05	0.00%
Y-90	1.80E-01	1.48E+00	0.01%	3.70E-01	3.04E+00	0.02%	1.48E+00	0.00%	3.04E+00	0.01%
Y-91	0.00E+00	0.00E+00	0.00%	7.30E-02	3.22E+00	0.02%	0.00E+00	0.00%	3.22E+00	0.01%
Zr-95	0.00E+00	0.00E+00	0.00%	1.20E+00	2.15E+01	0.15%	0.00E+00	0.00%	2.15E+01	0.05%
		1.07E+04			1.45E+04		4.02E+04		4.62E+04	

	gram/gal	mg/L
Pu-238	9.36E-04	2.47E-01
Pu-239	1.77E-03	4.67E-01
Pu-240	0.00E+00	0.00E+00
Pu-241	4.76E-05	1.26E-02
		7.27E-01

	gram/gal	mg/L
	5.79E-04	1.53E-01
	1.09E-03	2.89E-01
	0.00E+00	0.00E+00
	2.62E-05	6.93E-03
		4.49E-01

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H-AREA SUPERNATE RADIONUCLIDE CONTRIBUTION VOLATILE CONDITIONS

ECC Legler				HHS Legler			ECC Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal		HHS Pu & Cs Fixed Pu=1 mg/L Cs= 30 Cl/gal	
Isotopes	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose	Dose (rem/gal)	% of Dose
Am-241	2.90E-05	1.51E+04	0.19%	1.60E-05	8.35E+03	0.11%	1.51E+04	0.05%	8.35E+03	0.03%
Ba-137	8.40E+00	0.00E+00	0.00%	8.90E+00	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Ce-144	6.10E-03	2.14E+03	0.03%	3.80E+00	1.33E+06	18.17%	2.14E+03	0.01%	1.33E+06	4.01%
Cm-244	9.20E-07	2.48E+02	0.00%	5.10E-07	1.37E+02	0.00%	2.48E+02	0.00%	1.37E+02	0.00%
Cs-137	9.10E+00	2.91E+05	3.83%	9.60E+00	3.07E+05	4.19%	9.61E+05	3.05%	9.61E+05	2.89%
H-3	4.10E-03	3.89E-01	0.00%	5.00E-03	4.75E-01	0.00%	3.89E-01	0.00%	4.75E-01	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%	1.20E+00	5.39E+03	0.07%	0.00E+00	0.00%	5.39E+03	0.02%
Pm-147	1.10E-01	3.74E+03	0.05%	2.00E+00	6.80E+04	0.93%	3.74E+03	0.01%	6.80E+04	0.20%
Pr-144	6.10E-03	2.56E-01	0.00%	3.80E+00	1.59E+02	0.00%	2.56E-01	0.00%	1.59E+02	0.00%
Pu-238	1.60E-02	7.37E+06	91.83%	9.90E-03	4.56E+06	62.14%	Pu 3.03E+07	96.13%	Pu 2.99E+07	89.86%
Pu-239	1.10E-04	5.61E+04	0.70%	6.80E-05	3.47E+04	0.47%				
Pu-240	0.00E+00	0.00E+00	0.00%	0.00E+00	0.00E+00	0.00%				
Pu-241	4.90E-03	4.90E+04	0.61%	2.70E-03	2.70E+04	0.37%				
Rh-106	5.40E-03	1.08E+00	0.00%	1.10E+00	2.19E+02	0.00%	1.08E+00	0.00%	2.19E+02	0.00%
Ru-106	5.40E-03	2.37E+03	0.03%	1.10E+00	4.83E+05	6.57%	2.37E+03	0.01%	4.83E+05	1.45%
Sr-89	0.00E+00	0.00E+00	0.00%	4.00E-02	1.48E+03	0.02%	0.00E+00	0.00%	1.48E+03	0.00%
Sr-90	1.80E-01	2.34E+05	2.92%	3.70E-01	4.82E+05	6.56%	2.34E+05	0.74%	4.82E+05	1.45%
U-235	1.30E-09	1.56E-01	0.00%	7.30E-10	8.75E-02	0.00%	1.56E-01	0.00%	8.75E-02	0.00%
U-238	1.10E-09	1.32E-01	0.00%	5.90E-10	7.08E-02	0.00%	1.32E-01	0.00%	7.08E-02	0.00%
Y-90	1.80E-01	1.48E+03	0.02%	3.70E-01	3.04E+03	0.04%	1.48E+03	0.00%	3.04E+03	0.01%
Y-91	0.00E+00	0.00E+00	0.00%	7.30E-02	3.22E+03	0.04%	0.00E+00	0.00%	3.22E+03	0.01%
Zr-95	0.00E+00	0.00E+00	0.00%	1.20E+00	2.15E+04	0.29%	0.00E+00	0.00%	2.15E+04	0.06%
		8.03E+06			7.34E+06		3.15E+07		3.32E+07	

Pu-238
Pu-239
Pu-240
Pu-241

gram/gal	mg/L
9.36E-04	2.47E-01
1.77E-03	4.67E-01
0.00E+00	0.00E+00
4.76E-05	1.26E-02
	7.27E-01

gram/gal	mg/L
5.79E-04	1.53E-01
1.09E-03	2.89E-01
0.00E+00	0.00E+00
2.62E-05	6.93E-03
	4.49E-01

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F-AREA SUPERNATE RADIONUCLIDE CONTRIBUTION
INGESTION

Isotopes	ECC Legler			HHS Legler		
	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose
Am-241	2.90E-05	1.30E+02	0.03%	1.60E-05	7.18E+01	0.02%
Ba-137	8.20E+00	0.00E+00	0.00%	6.20E+00	0.00E+00	0.00%
Ce-144	1.70E-04	3.40E+00	0.00%	7.50E-01	1.50E+04	3.97%
Cm-244	9.20E-07	2.12E+00	0.00%	5.10E-07	1.17E+00	0.00%
Cs-137	8.90E+00	4.46E+05	95.35%	6.70E+00	3.35E+05	88.67%
H-3	4.10E-03	2.58E-01	0.00%	5.00E-03	3.15E-01	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%	1.70E+00	3.74E+03	0.99%
Pm-147	3.40E-02	3.23E+01	0.01%	4.30E-01	4.09E+02	0.11%
Pr-144	1.70E-04	1.87E-02	0.00%	7.50E-01	8.25E+01	0.02%
Pu-238	9.70E-07	3.69E+00	0.00%	8.10E-07	3.08E+00	0.00%
Pu-239	2.00E-05	8.61E+01	0.02%	1.60E-05	6.89E+01	0.02%
Pu-240	4.70E-06	2.02E+01	0.00%	3.60E-06	1.55E+01	0.00%
Pu-241	4.90E-03	4.21E+02	0.09%	2.70E-03	2.32E+02	0.06%
Rh-106	2.90E-04	1.77E-01	0.00%	2.10E-01	1.28E+02	0.03%
Ru-106	2.90E-04	6.09E+00	0.00%	2.10E-01	4.41E+03	1.17%
Sr-89	0.00E+00	0.00E+00	0.00%	3.00E-02	2.62E+02	0.07%
Sr-90	1.50E-01	1.95E+04	4.18%	1.10E-01	1.43E+04	3.79%
U-235	4.00E-09	1.00E-03	0.00%	2.20E-09	5.51E-04	0.00%
U-238	1.30E-07	2.99E-02	0.00%	1.30E-07	2.99E-02	0.00%
Y-90	1.50E-01	1.50E+03	0.32%	1.10E-01	1.10E+03	0.29%
Y-91	0.00E+00	0.00E+00	0.00%	5.00E-02	4.45E+02	0.12%
Zr-95	0.00E+00	0.00E+00	0.00%	7.60E-01	2.58E+03	0.68%
		<u>4.67E+05</u>			<u>3.78E+05</u>	

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H-AREA SUPERNATE RADIONUCLIDE CONTRIBUTION
INGESTION

Isotopes	ECC Legler			HHS Legler		
	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose	Concentration (Ci/gal)	Dose (rem/gal)	% of Dose
Am-241	2.90E-05	1.30E+02	0.02%	1.60E-05	7.18E+01	0.01%
Ba-137	8.40E+00	0.00E+00	0.00%	8.90E+00	0.00E+00	0.00%
Ce-144	6.10E-03	1.22E+02	0.02%	3.80E+00	7.60E+04	11.17%
Cm-244	9.20E-07	2.12E+00	0.00%	5.10E-07	1.17E+00	0.00%
Cs-137	9.10E+00	4.56E+05	83.88%	9.60E+00	4.81E+05	70.62%
H-3	4.10E-03	2.58E-01	0.00%	5.00E-03	3.15E-01	0.00%
Nb-95	0.00E+00	0.00E+00	0.00%	1.20E+00	2.64E+03	0.39%
Pm-147	1.10E-01	1.05E+02	0.02%	2.00E+00	1.90E+03	0.28%
Pr-144	6.10E-03	6.71E-01	0.00%	3.80E+00	4.18E+02	0.06%
Pu-238	1.60E-02	6.09E+04	11.22%	9.90E-03	3.77E+04	5.54%
Pu-239	1.10E-04	4.74E+02	0.09%	6.80E-05	2.93E+02	0.04%
Pu-240	0.00E+00	0.00E+00	0.00%	0.00E+00	0.00E+00	0.00%
Pu-241	4.90E-03	4.21E+02	0.08%	2.70E-03	2.32E+02	0.03%
Rh-106	5.40E-03	3.30E+00	0.00%	1.10E+00	6.71E+02	0.10%
Ru-106	5.40E-03	1.13E+02	0.02%	1.10E+00	2.31E+04	3.39%
Sr-89	0.00E+00	0.00E+00	0.00%	4.00E-02	3.49E+02	0.05%
Sr-90	1.80E-01	2.34E+04	4.32%	3.70E-01	4.82E+04	7.08%
U-235	1.30E-09	3.26E-04	0.00%	7.30E-10	1.83E-04	0.00%
U-238	1.10E-09	2.53E-04	0.00%	5.90E-10	1.36E-04	0.00%
Y-90	1.80E-01	1.80E+03	0.33%	3.70E-01	3.70E+03	0.54%
Y-91	0.00E+00	0.00E+00	0.00%	7.30E-02	6.50E+02	0.10%
Zr-95	0.00E+00	0.00E+00	0.00%	1.20E+00	4.07E+03	0.60%
		<u>5.43E+05</u>			<u>6.81E+05</u>	

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RADIONUCLIDE DOSE CONTRIBUTION TO H-AREA SUPERNATE Dose Percentage

Isotope	Volatile Conditions									Volatile Conditions		
	>1%			(0.1 - 1)%			(0.01 - 0.1)%			<0.01		
	ECC	HHS	Mark 16B	ECC	HHS	Mark 16B	ECC	HHS	Mark 16B	ECC	HHS	Mark 16B
Am-241				0.188	0.114	0.1						
Ba-137												
Ce-144		18.17					0.027		0.022			
Cm-244										0.003		0.002
Cs-137	3.629	4.188	53.134									
H-3												
Nb-95							0.073					
Pm-147				0.926			0.047			0.004		
Pr-144										0.002		
Pu-238	91.83	62.14	8.824									
Pu-239	0.698			0.472					0.079			
Pu-240									0.058			
Pu-241	0.61			0.368	0.212							
Rh-106							0.03			0.003		
Ru-106		6.575	25.755									
Sr-89							0.02					
Sr-90	2.919	6.563			0.553							
U-235												
U-238												
Y-90							0.018	0.041		0.004		
Y-91								0.044				
Zr-95				0.293								

^aPu isotopes concentration fixed at 1 mg/ml, Cs = 30 Ci/gal

^{aa} All Pu isotopes included.

^{**}Not included in Mark 16B calculations.