

Dose Contribution from High Level Waste Uranium and Plutonium (U)

by

M. C. Chandler

Westinghouse Savannah River Company

Savannah River Site

Aiken, South Carolina 29808

P. L. Gray

P. D. d'Entremont

J. E. Marra

T. M. Monahan

MASTER

DOE Contract No. DE-AC09-89SR18035

This paper was prepared in connection with work done under the above contract number with the U. S. Department of Energy. By acceptance of this paper, the publisher and/or recipient acknowledges the U. S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering this paper, along with the right to reproduce and to authorize others to reproduce all or part of the copyrighted paper.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED



DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

INTRODUCTION

Radiological source terms for safety analyses traditionally have been curie lists of radionuclides. Converting the source term to dose values allows each radionuclide to be evaluated for its impact on dose, which is the purpose of the source term. This report is one in a series of reports establishing source terms for High Level Waste (HLW) by evaluating the dose impact of each radionuclide. These reports will be used in establishing the source terms to be used in HLW Safety Analysis Reports.

The purpose of this report is to document the bounding element dose impact of uranium and plutonium in HLW. This technique (use of dose rather than curies) demonstrates vividly the relative importance of these nuclides in accident analyses. A large amount of available data permitted dose values to be established for uranium and plutonium; therefore, these two elements were evaluated independent of other nuclides.

Solubility and adsorption data, available for these elements, allow bounding conditions to be established for their contribution to dose for various HLW processes.

SUMMARY

The worst case dose contributions of plutonium and uranium for HLW supernate and precipitate have been established. The maximum source dose inventory (SDI)* values determined by this study are $1.3 \text{ E}+7$ rem per liter (supernate) and $2.3 \text{ E}+7$ rem per gram of MST (precipitate solids). In both cases plutonium dominates the dose potential. This data is independent of contributions from other radionuclides whose impact should be added to that from uranium and plutonium.

The SDI calculations include the contributions of decay product radionuclides produced by radioactive decay of uranium and plutonium isotopes.

* **Source Dose Inventory (SDI):** For a defined source of radionuclides, the SDI is the calculated committed effective dose equivalent (in rem) that would be received by a fictitious person or persons who ingested 100% of the inventory of that source. The SDI is useful in comparing the hazard from different sources, and in determining which of several related sources should be used as the bounding source in accident analysis.

MASTER

DISCUSSION

HLW Source Term Development

This report takes advantage of an extensive amount of data, developed for criticality safety purposes, to develop source dose inventory data for High Level Waste. The plutonium dose contribution developed by this report is the key to developing source term dose values for HLW.

Plutonium isotopes have very high dose values versus most other radionuclides. Developing the plutonium dose values from this extensive body of data firmly establishes a comparative value to determine the significance and importance of all other radionuclides. As an example, based on data developed in the Analysis section of this report, uranium contributes 7.7 E-1 rem per liter in F-Area supernate whereas plutonium contributes 1.1 E+5 rem per liter. Clearly uranium is insignificant to the potential dose from F-Area supernate.

Even without solubility data a determination of comparative dose significance can be made based on the dose value of individual radionuclides. As an example, the normalized elemental source dose value (NESD)** for uranium in F-area is 4.3 E+1 rem/gram. A concentration of 25.6 grams per liter of uranium would be required to contribute 1.0% of the plutonium dose value. Limited sample data can confirm if such uranium concentrations are possible for uranium to contribute to the source term. This type of analysis will be performed in subsequent reports to define the complete HLW source term.

Contribution to Dose from Radioactive Decay Products

Uranium and plutonium isotopes are decaying constantly to other radionuclides. Appendix A evaluates the potential dose impact of these decay products assuming they accompany uranium and plutonium during accidental release. The analysis shows that there are three nuclides (U-233, U-235, and Pu-241) for which the source term inventory increases as the nuclide decays. This increase occurs because the dose contributed by daughter

** Normalized Elemental Source Dose (NESD): The NESD is the SDI for a particular element in a source, normalized to express the fictitious ingestion dose equivalent for all isotopes of that element per unit of that element, ignoring other elements in the source. It is expressed in "rem/unit of element", for example "rem/gram of plutonium".

nuclides increases faster than the decrease in dose of the decaying parent. To ensure that the source dose inventories in this report were conservative, an adjustment factor was included in reporting doses for these three nuclides. The adjustment factor was computed to bound the maximum dose accounting for 200 years of decay. For all other plutonium and uranium nuclides the daughter products did not increase the source dose inventory.

By adjusting the parent radionuclides dose value, decay products are accounted for in the source term. These decay products would only require further evaluation of source term impact if they were present in waste due to processes other than radioactive decay from the uranium or plutonium parent isotopes.

These adjustment factors were used in Appendix B to develop adjusted uranium and plutonium NESD values. The U-233 adjustment factor increased the uranium NESD by 30% for H canyon HM waste streams. The U-235 adjustment factor only increased the uranium NESD value by 1%. The Pu-241 adjustment factor increased the NESD value for Purex plutonium by 13% but only 1 to 2% for the other waste streams.

Adjusted Normalized Elemental Source Dose

The normalized elemental source doses that were used as input to this report were developed previously and reported in reference 2. In reference 2, the uranium and plutonium NESD (rem/gram of element) and total dose (rem) were determined for monthly waste transfers from F canyon and H canyon to the tank farms. Those data covered 38 years of operation in F and H area. For each waste stream, the top thirty months were also identified.

In Appendix B of this report, the top thirty monthly uranium and plutonium NESD values were adjusted for decay product contribution using the factors determined in Appendix A for each waste stream.

Since the maximum NESD value may represent only a single month's value and would be mixed with many other monthly transfers in the waste tanks a weighted average NESD value was determined for the top thirty months of transfers. The weighted average NESD value was determined by multiplying the monthly NESD value by the element's total rem value for that month divided by the total rem transferred in the top thirty transfers. This rem weighted average value of the top thirty transfers will be more representative of actual conditions and was used in the Analysis section to define the uranium and plutonium source dose values.

ANALYSIS

Source Dose Inventory Development Data

The following data is the basis for the plutonium and uranium contribution to the source dose inventory (SDI) for HLW.

- Plutonium and uranium solubility in HLW supernate is bounded by values of 1.7 mg/liter and 18.0 mg/liter respectively. [1]
- The plutonium and uranium adjusted NESD values are bounded by values listed below. The reported values have been adjusted to account for the in-growth of radioactive decay products as defined in Appendix A and the impact on the NESD values for plutonium and uranium as determined in Appendix B.

	<u>Decay Product Adjusted NESD (rem/gram)</u>
<u>Plutonium</u>	
F-Area	6.7 E+7
H-Area Purex (pre 1960)	3.8 E+7
H-Area	7.9 E+9
 <u>Uranium</u>	
F-area	4.3 E+1
H-area	1.2 E+6

- Plutonium and uranium maximum loading onto monosodium titanate (MST) in the In-Tank Precipitation process is bounded by values of 0.29 wt% and 1.8 wt% of MST respectively. [3]

Plutonium and Uranium Supernate Bounding Source Dose Inventory

The plutonium and uranium SDI (rem/L) values are defined below based on the bounding solubility value for the element multiplied by the NESD value.

F-Area Pu	$1.7 \text{ mg/liter} \times 6.7 \text{ E}+7 \text{ rem/gram} = 1.1 \text{ E}+5 \text{ rem/liter}$
H-Area Pu	$1.7 \text{ mg/liter} \times 7.9 \text{ E}+9 \text{ rem/gram} = 1.3 \text{ E}+7 \text{ rem/liter}$
 F-Area U	 $18.0 \text{ mg/liter} \times 4.3 \text{ E}+1 \text{ rem/gram} = 7.7 \text{ E}-1 \text{ rem/liter}$
H-Area U	$18.0 \text{ mg/liter} \times 1.2 \text{ E}+6 \text{ rem/gram} = 2.2 \text{ E}+4 \text{ rem/liter}$

As demonstrated above, uranium has an insignificant impact on the source dose inventory on either H or F Area HLW supernate.

Plutonium and Uranium ITP MST Bounding Source Dose Inventory

The plutonium and uranium source dose inventory (SDI) value for monosodium titanate are defined by utilizing the maximum elemental MST loading value and NESD values.

F-Area Pu 0.29 wt% MST x 6.7 E+7 rem/g, Pu = 1.9 E+5 rem/g, MST
H-Area Pu 0.29 wt% MST x 7.9 E+9 rem/g, Pu = 2.3 E+7 rem/g, MST

F-Area U 1.8 wt% MST x 4.3 E+1 rem/g, U = 7.7 E-1 rem/g, MST
H-Area U 1.8 wt% MST x 1.2 E+6 rem/g, U = 2.2 E+4 rem/g, MST

As demonstrated above, uranium has an insignificant impact on the source dose inventory of monosodium titanate.

Plutonium and Uranium Precipitate Slurry Bounding Source Dose Inventory

To evaluate the plutonium and uranium SDI of the precipitate slurry the following methodology demonstrated in the example below should be used.

Example:

Assume a 10 wt% precipitate slurry and a solution density of 1200 g/L, yields the following.

$$10 \text{ wt\%} \times 1200 \text{ g/L} \times 2.3 \text{ E+7 rem/g, MST} = 2.76 \text{ E+9 rem/liter}$$

CONCLUSION

This report defines a bounding plutonium and uranium normalized elemental source dose term and a source dose term for HLW supernate and monosodium titanate. The dose terms for uranium and plutonium rely upon a large set of data for the elemental dose terms and bounding physical data to establish the supernate and MST dose terms. From this data the bounding plutonium source dose term is seen to be significant and will allow

for comparison analysis of all other radionuclides in the HLW supernate, sludge and precipitate total source terms.

REFERENCES

1. D.T. Hobbs, T.B. Edwards and S.D. Fleischman, "Solubility of Plutonium and Uranium in Alkaline Salt Solutions (U)", WSRC-TR-93-056, February 12, 1993
2. M.C. Chandler and D.K. Strege, "Bounding Uranium and Plutonium Isotopic Distributions for High Level Waste Accident Analyses (U)," WSRC-TR-93-870, August 6, 1993
3. D.T. Hobbs and S.D. Fleischman, "Fissile Solubility and Monosodium Titanate Loading Tests (U)," WSRC-RP-92-1273, February 12, 1993

APPENDIX A

RADIOACTIVE DECAY PRODUCT CONTRIBUTION ANALYSIS

The data presented in the attached datasheets, pages 19 to 28, represents the analysis of the relationship between the major uranium and plutonium isotopes and subsequent daughters or decay product radionuclide. The quantity relationship between the parent radionuclide and daughters is developed and combined with the individual radionuclide dose values [a] to evaluate the total dose contribution of the parent and daughters. This is important because the decay products are expected to remain present with the plutonium and uranium either in HLW supernate, sludge or precipitate. During accident scenarios the total mixture of radionuclide, parent and decay products, would be present and therefore their impact on dose is evaluated.

Following is a discussion of the equations used to define the quantity relationship between the parent radionuclide and decay products presented in the attached data sheets. In addition, a discussion of each data sheet is provided including a discussion of the impact on specific uranium and plutonium radionuclide.

Uranium and Plutonium Decay Equation

In the data sheet analysis each uranium and plutonium isotope is assumed to consist of a single unit (atoms or moles). In the analysis the decay of the parent (uranium or plutonium isotope) is defined by the following decay equation. [b]

$$(A.1.) \quad N_A = N_{A_0} e^{-\lambda_A t}$$

N_A = Resulting amount of radionuclide, A.

N_{A_0} = Original amount of radionuclide, A.

λ_A = $\ln 2 / t_{1/2}$ or $0.6931 / t_{1/2}$, yr^{-1}

where, $t_{1/2}$ = Radionuclide, A, half-life, yrs

t = Time, yrs

First Decay Product Decay Equation

The following equation is used to define the amount of the first daughter, or decay product, radionuclide B. [c]

$$(A.2) \quad N_B = [(\lambda_A \times N_{A_0}) / (\lambda_B - \lambda_A)] \times (e^{-\lambda_A t} - e^{-\lambda_B t}) + N_{B_0} e^{-\lambda_B t}$$

In all the calculations, $N_{B_0} = 0.0$ and $N_{A_0} = 1.0$ for the uranium and plutonium parents.

Second and Third Decay Product Decay Equations

Where the second or third daughter radionuclide half-life was many time less than the parent, equilibrium was assumed and therefore the following equation was used. [d]

$$(A.3) \quad N_B = (\lambda_A \times N_A) / \lambda_B$$

Where the second daughter half-life was very small versus the parent and the third daughter, the second daughter was conservatively ignored in determining the amount of the third daughter. This is acceptable because the second daughter decays almost immediately to the third daughter. In this case the following adaptation of equation A.2. was used.

$$(A.4) \quad N_C = [(\lambda_A \times N_{A_0}) / (\lambda_C - \lambda_A)] \times (e^{-\lambda_A t} - e^{-\lambda_C t})$$

Whenever the daughter half-life was many times greater than the parent, either a maximum amount of the parent was assumed to equal N_{A_0} or a future quantity of the parent was assumed to equal N_{A_0} . These are conservatively assumptions defining a greater quantity of the daughter radionuclide than would actually be present. This had little effect on the dose values.

$$(A.5) \quad N_{C_1} = [(\lambda_A \times N_{B_2}) / (\lambda_B - \lambda_A)] \times (e^{-\lambda_A t} - e^{-\lambda_B t})$$

Time to Equilibrium Equation

Also included with the data in Appendix A are determinations of time to equilibrium for the radionuclide (assumes isolation of the parent, no parent

in-growth). Time to equilibrium was determined by the following equation.
 [e]

$$(A.6.) \quad t_{md} = [2.3 * \log (\lambda_B / \lambda_A)] / (\lambda_B - \lambda_A)$$

Radioactive Decay Product Contribution Discussion

Using the data developed in the attached data sheets, the decay products that will contribute to the dose value of the parent radionuclide can be identified. Of the major plutonium and uranium isotopes, only four decay products contribute to the cumulative dose value: Am-241 from Pu-241 decay, Th-229 from U-233 decay, and Pa-231 and Ac-227 from U-235 decay. Based on the difference between the parent's dose value and the dose value including decay products, a dose adjustment factor was determined for each of the parent radionuclide, see attached data sheets. These values were then used to adjusted the uranium and plutonium elemental dose values, see Appendix B and below.

	ICRP-30 <u>rem/gram</u>	Adjustment <u>Factor</u>	Adjusted <u>rem/gram</u>
Plutonium-241	1.03 E+9	1.67	1.72 E+9
Uranium-233	1.25 E+6	1.30	1.63 E+6
Uranium-235	2.59 E+2	1.25	3.24 E+2

Below is a discussion of each of the data sheets for the major uranium and plutonium isotopes. The adjustment factors for the three decay product impacted radionuclides is also discussed in the sections below.

Major Uranium Isotopes and Decay Products

Uranium-233, (Appendix A, Data Sheet 1. page 19)



The decay scheme above represents the radioactive decay of uranium-233. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 1.

<u>Radionuclide</u>	<u>Decay Equation</u>
U-233	A.1
Th-229	A.2
Ra-225	A.3
Ac-225	A.3

The ingrowth of thorium-229 as a decay product of uranium-233 can contribute to the waste source dose inventory when waste contains uranium-233. The ingrowth of Th-229 however is very minimal and does not begin contributing over 10 percent of the U-233 dose value until after 50 years. A conservative dose adjustment factor of 1.3 is used for the Th-229 contribution to the U-233 dose value. This adjustment value would not be achieved until well over a hundred years. The impact of U-233 and Th-229 to the total source dose is trivial versus the H-area plutonium dose dominated by Pu-238.

The long half lives of U-233 and Th-229 preclude Ra-225 and Ac-225 from contributing significantly to the dose potential, though both have relatively high rem/gram values.

Uranium-234, (Appendix A, Data Sheet 2. page 20)



The decay scheme above represents the radioactive decay of uranium-234. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 2.

<u>Radionuclide</u>	<u>Decay Equation</u>
U-234	A.1
Th-230	A.2
Ra-226	A.3
Rn-222	A.3

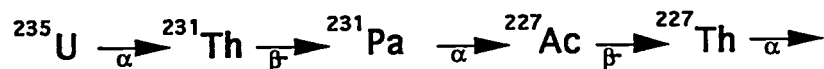
Uranium-234 and thorium-230 both have very long half lives and the decay products will not contribute to the dose until after many hundreds of years. Uranium-234 has a high rem/gram value versus other naturally occurring

uranium isotopes but its low abundance will preclude it from dominating the total uranium dose value. In nature, the uranium-234 abundance is defined by the half-life of the parent, uranium-238, resulting in a secular equilibrium abundance value of only 0.0056 atom percent.

Since uranium-234 is less abundant than uranium-235 in nature, its abundance increases only if uranium-235 is enriched. The uranium-234 abundance also increases in enriched uranium as the uranium-235 abundance decreases due to fissioning. However, the uranium-234 abundance has never been more than a few percent.

Though uranium-234 influences the uranium source dose value it remains trivial versus the H-area plutonium dose dominated by Pu-238.

Uranium-235, (Appendix A, Data Sheet 3. page 21)



The decay scheme above represents the radioactive decay of uranium-235. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 3.

<u>Radionuclide</u>	<u>Decay Equation</u>
U-235	A.1
Th-231	A.3
Pa-231	A.4
Ac-227	A.3
Th-227	A.3

The decay products of uranium-235 have significantly higher dose values than U-235 but the relatively long half-life of U-235 prevents them from contributing to the total dose significantly. The immediate decay product, Th-231, has a very short half-life and contributes little to dose but rapidly decays to protactinium-231. Pa-231 decays to actinium-227 then thorium 227 both having shorter half-lives than Pa-231, resulting in their quickly reaching equilibrium with Pa-231.

As shown in the data sheet only the ingrowth of Pa-231 and Ac-227 influence the U-235 dose value, within a 200 year period. To account for this influence

a dose adjustment factor of 1.25 is used to increase the U-235 dose value. However, unless the uranium can be completely separated from the plutonium in waste, the U-235, Pa-231 and Ac-227 contribution to dose is trivial compared to the dose from H-area plutonium.

Uranium-236, (Appendix A, Data Sheet 4. page 22)

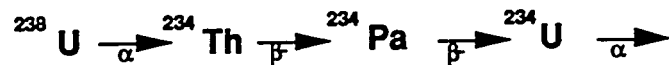


The decay scheme above represents the radioactive decay of uranium-236. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 4.

<u>Radionuclide</u>	<u>Decay Equation</u>
U-236	A.1
Th-232	A.2
Ra-228	A.3
Ac-228	A.3

Uranium-236 and the first decay product thorium-232 both have long half lives and very low dose; their decay products do not contribute to the dose. The intentional ingrowth of uranium-236 in recycled uranium fuel however does cause uranium-236 to contribute to the total uranium normalized elemental dose value as demonstrated in reference 2 and Appendix B.

Uranium-238, (Appendix A, Data Sheet 5. page 23)



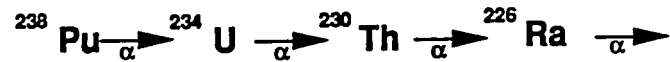
The decay scheme above represents the radioactive decay of uranium-238. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 5.

<u>Radionuclide</u>	<u>Decay Equation</u>
U-238	A.1
Th-234	A.3
Pa-234	A.3
U-234	A.5

Uranium-238 has a much longer half-life than its decay products. Consequently, its decay products do not contribute to the dose for several hundred years. Uranium-234 will eventually contribute to the dose of U-238 but an increase will occur only in depleted uranium because the U-234 content was initially reduced during uranium-235 enrichment. In depleted uranium, the ingrowth of U-234 will never exceed the equilibrium value of natural uranium.

Major Plutonium Isotopes and Decay Products

Plutonium-238, (Appendix A, Data Sheet 6. page 24)

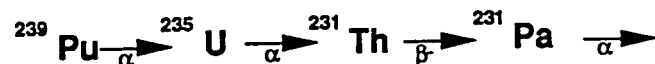


The decay scheme above represents the radioactive decay of plutonium-238. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 6.

<u>Radionuclide</u>	<u>Decay Equation</u>
Pu-238	A.1
U-234	A.2
Th-230	A.5
Ra-226	A.5

Plutonium-238 has a shorter half-life than its immediate decay product uranium-234, resulting in a relatively quick increase in the amount of U-234. Though the abundance of uranium-234 increases quickly, the dose contribution from U-234 compared to the dose from Pu-238 is insignificant. Even if an equal quantity of each were present, the uranium-234 dose contribution would remain insignificant. The decay products of uranium-234 were already shown to not contribute to the dose, see above section on uranium-234.

Plutonium-239, (Appendix A, Data Sheet 7. page 25)

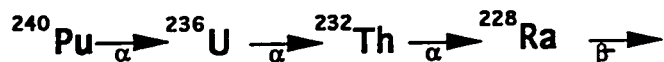


The decay scheme above represents the radioactive decay of plutonium-239. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 7.

<u>Radionuclide</u>	<u>Decay Equation</u>
Pu-239	A.1
U-235	A.2
Th-231	A.3
Pa-231	A.3

Similar to the discussion above, plutonium-239 has a shorter half-life than its immediate decay product uranium-235, resulting in a relatively quick increase in the amount of U-235. Though the abundance of uranium-235 increases quickly, the dose value of U-235 versus the value for Pu-239 is so insignificant there is no contribution to dose. Even if an equal quantity of each were present the uranium-235 dose contribution would remain insignificant. The decay products of uranium-235 were already shown to not contribute to the dose, see above section on uranium-235.

Plutonium-240, (Appendix A, Data Sheet 8. page 26)



The decay scheme above represents the radioactive decay of plutonium-240. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 8.

<u>Radionuclide</u>	<u>Decay Equation</u>
Pu-240	A.1
U-236	A.2
Th-232	A.5
Ra-228	A.3

Plutonium-239 has a shorter half-life than its decay products uranium-236 and thorium-232. The long half-life for U-236 results in a relatively quick increase in the amount of U-236. Though the abundance of uranium-236 increases quickly, the dose contribution compared to Pu-240 is insignificant. Even if an equal quantity of each were present the U-236 dose contribution would remain insignificant. The decay products of U-236 were already shown to not contribute to the dose, see above section on uranium-236.

Plutonium-241, (Appendix A, Data Sheet 9. page 27)

The decay scheme above represents the radioactive decay of plutonium-241. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 9.

<u>Radionuclide</u>	<u>Decay Equation</u>
Pu-241	A.1
Am-241	A.2
Np-237	A.5
Pa-233	A.3

Similar to plutonium isotopes 238, 239 and 240, plutonium-241 has a short half-life versus its immediate decay product americium-241 which reaches a fairly constant amount within 50 years. The decay product of americium 241, neptunium-237 has a much longer half-life and will be accumulating from the decay of the americium. The rapid ingrowth of Am-241 and its high dose value influences the Pu-241 dose value. The cumulative dose value for this decay chain reaches a maximum within 55 years. This maximum cumulative value is 1.67 time the dose value for plutonium-241 alone, and will be used to adjust the Pu-241 dose values.

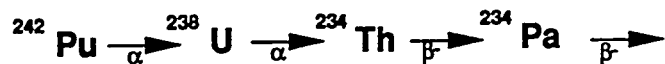
The above discussion address the amount of Am-241 associated with the decay of plutonium (Pu-241) contained in waste. A second source of Am-241 (again formed from the decay of Pu-241) enters the waste tanks independent of the parent Pu-241 when plutonium is chemically separated from the bulk plutonium in the reactor fuel and target materials.

In the standard H-area separation process, plutonium contained in the recycled fuel is not recovered and is discarded to the waste tanks. Therefore, the Am-241 entering the H-area waste tanks has not been chemically separated from the majority of the plutonium. However, a small amount of H-area waste plutonium was retained in H-canyon for a number of years and later released to the tanks. This amount of Am-241 that would have entered the tanks after chemical separation from the stored waste plutonium should be trivial. The amount of Am-241 in H-area waste is particularly trivial when

compared to the accompanying quantity of Pu-238 in the H-area waste plutonium. (see Appendix B, page 38)

Am-241 from F-area operations is expected to be minimal due to weapons grade plutonium isotopic specifications and the F-canyon processing scheme. In producing weapons grade plutonium, depleted uranium (U-238) is utilized in the reactors to absorb neutrons and convert to Pu-239. Higher isotopes of plutonium, Pu-240, Pu-241, and Pu-242, are also produced by additional neutron absorption, though in decreasing quantities as the atomic mass increases. [f] The Pu-241 content of plutonium in F-area has historically been less than 0.33 percent as exemplified in the total F-area plutonium loss values. [f] Both the very low Pu-241 content of plutonium in F-area and the limited storage time of the target material limit the amount of Am-241 produced. During chemical processing the very small amount of Am-241 either produced in the reactor or resulting from decay is separated from the plutonium and sent to waste. In addition, the F-Area Pu-241 and Am-241 combination would have to be increased significantly to impact the bounding plutonium source dose value exhibited by H-Area plutonium which is dominated by Pu-238.

Plutonium-242, (Appendix A, Data Sheet 10. page 28)



The decay scheme above represents the radioactive decay of plutonium-242. The following list identifies the decay equation used for each radioisotope to generate data in Data Sheet 10.

<u>Radionuclide</u>	<u>Decay Equation</u>
Pu-240	A.1
U-238	A.2
Th-234	A.3
Pa-234	A.3

Similar to plutonium isotopes 238, 239 and 240, plutonium-231 has a shorter half-life than its immediate decay product uranium-238. The fairly long half-life of plutonium-231 however limits the increase in the amount of uranium-238 ingrowth, equilibrium is not reached until after thousands of years. Independent of the amount of U-238 ingrowth, the difference between dose values would again indicate that if an equal quantity of each were present the U-238 dose contribution would remain insignificant. The decay

products of U-238 were already shown to not contribute to the dose, see above section on uranium-238.

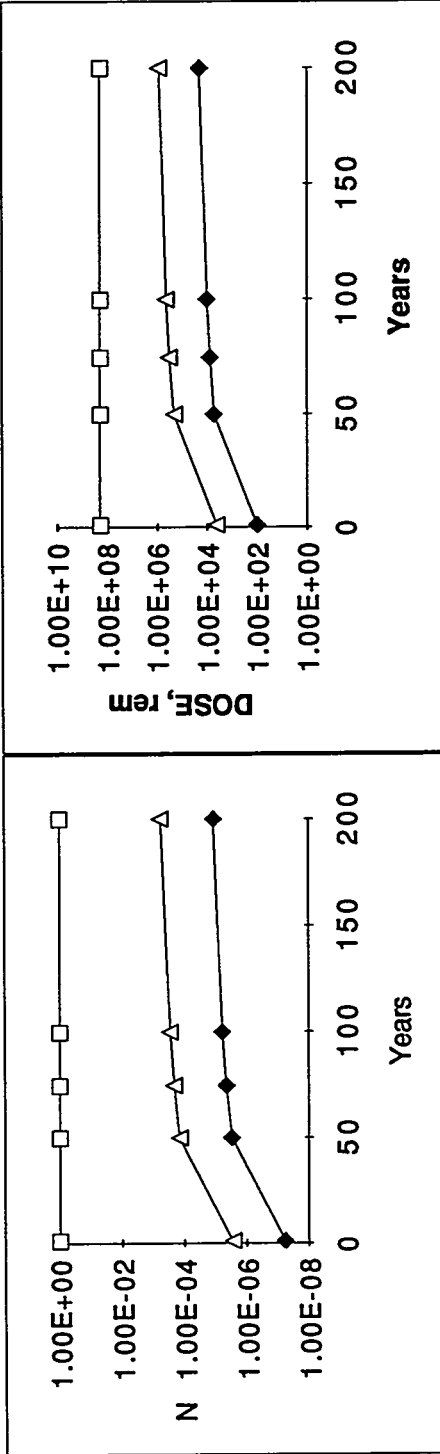
Appendix A References

- a. M.C. Chandler and D.K. Strege, "Bounding Uranium and Plutonium Isotopic Distributions for High Level Waste Accident Analyses (U)," WSRC-TR-93-870, August 6, 1993
- b. "Introduction to Health Physics," by H. Cember, Northwestern University, Pergamon Press, page 101, equation 4.41
- c. reference b. , page 102, equation 4.50
- d. reference b. , page 100, equation 4.39
- e. reference b. , page 104, equation 4.55
- f. W.S. Cavin, "Separations Waste Sludge Spreadsheet (U)," WSRC-TR-93-135, Rev. 1, 7/28/93

U234,Th230,Ra226,Rn222

Element >>>	U	Th	Ra	Rn	Parent to Daughter Time to equilibrium, yrs
Isotope >>>	234	230	226	222	
t-1/2, yrs >	2.45E+05	7.70E+04	1.60E+03	1.05E-02	
Rem/gram >>	8.08E+05	6.46E+06	7.81E+06	0.00E+00	Th
lamda >>>	2.83E-06	9.00E-06	4.33E-04	6.62E+01	Ra
	N (A.1)	N (A.2)	N (A.3)	N (A.3)	Rn
1	1.00E+00	2.83E-06	5.89E-08	3.86E-13	1.87E+05
50	1.00E+00	1.42E-04	2.94E-06	1.93E-11	9.12E+03
75	1.00E+00	2.13E-04	4.42E-06	2.89E-11	
100	1.00E+00	2.83E-04	5.89E-06	3.85E-11	
200	9.99E-01	5.66E-04	1.18E-05	7.70E-11	1.80E-01
VS	1EM	1EM	1EM	1EM	
1	1.89E+08	4.21E+03	1.04E+02	0.00E+00	
50	1.89E+08	2.11E+05	5.20E+03	0.00E+00	
75	1.89E+08	3.16E+05	7.79E+03	0.00E+00	
100	1.89E+08	4.21E+05	1.04E+04	0.00E+00	
200	1.89E+08	8.41E+05	2.08E+04	0.00E+00	

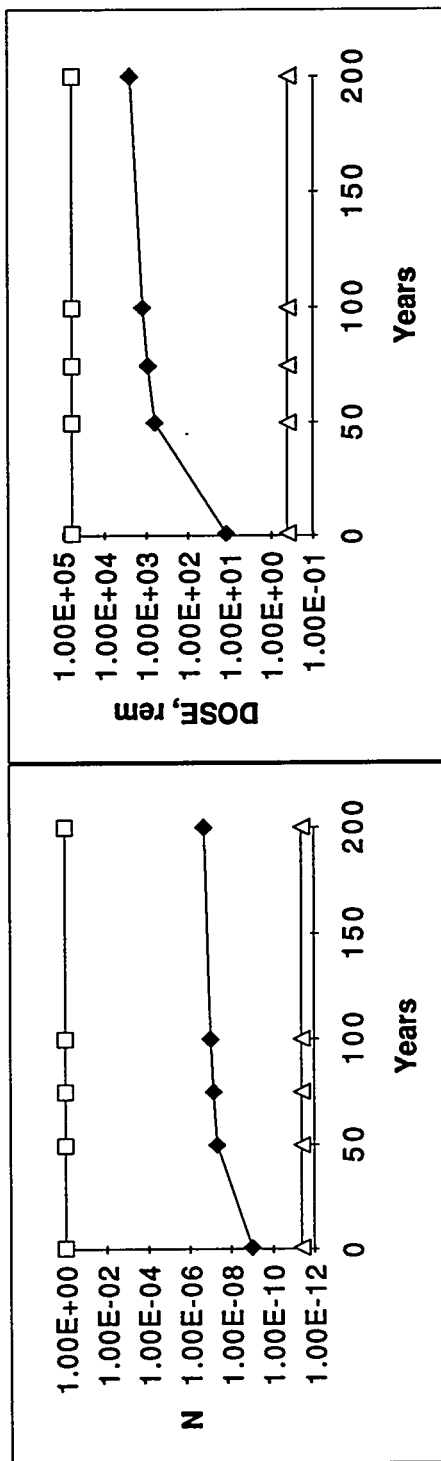
No increase
to the Parent
dose



□ Parent Radionuclide
△ 1st Decay Product
◆ 2nd Decay Product
3rd Decay Product not plotted

U235,Th231,Pa231,Ac227,Th227

Element >>>	U	Th	Pa	Ac	Th	Th	Pa	Ac
Isotope >>>	235	231	231	227	227	231	231	227
t-1/2, yrs >	7.04E+08	2.91E-03	3.28E+04	2.18E+01	5.12E-02	1.10E-01	6.82E-02	2.30E+02
Rem/gram >>	2.59E+02	4.31E+08	5.40E+07	4.85E+11	4.92E+11	1.10E-01	6.82E-02	2.30E+02
lamda >>>	9.85E-10	2.38E+02	2.12E-05	3.18E-02	1.35E+01	4.71E+05	<<Pa231toU235 equilibrium	
VI\$	N (A,1)	N (A,3)	N (A,4)	N (A,3)	N (A,3)			
1	1.00E+00	4.14E-12	9.85E-10	6.55E-13	1.54E-15			
50	1.00E+00	4.14E-12	4.92E-08	3.27E-11	7.70E-14			
75	1.00E+00	4.14E-12	7.38E-08	4.90E-11	1.15E-13			
100	1.00E+00	4.14E-12	9.84E-08	6.54E-11	1.54E-13			
200	1.00E+00	4.14E-12	1.97E-07	1.31E-10	3.07E-13			
VI\$	rem	rem	rem	rem	rem	Cummulative	Parent dose	
1	6.09E+04	4.12E-01	1.23E+01	7.21E+01	1.72E-01	6.09E+04	1.00	
50	6.09E+04	4.12E-01	6.14E+02	3.60E+03	8.60E+00	6.51E+04	1.07	
75	6.09E+04	4.12E-01	9.21E+02	5.40E+03	1.29E+01	6.72E+04	1.10	
100	6.09E+04	4.12E-01	1.23E+03	7.20E+03	1.72E+01	6.93E+04	1.14	
200	6.09E+04	4.12E-01	2.45E+03	1.44E+04	3.43E+01	7.77E+04	1.28	



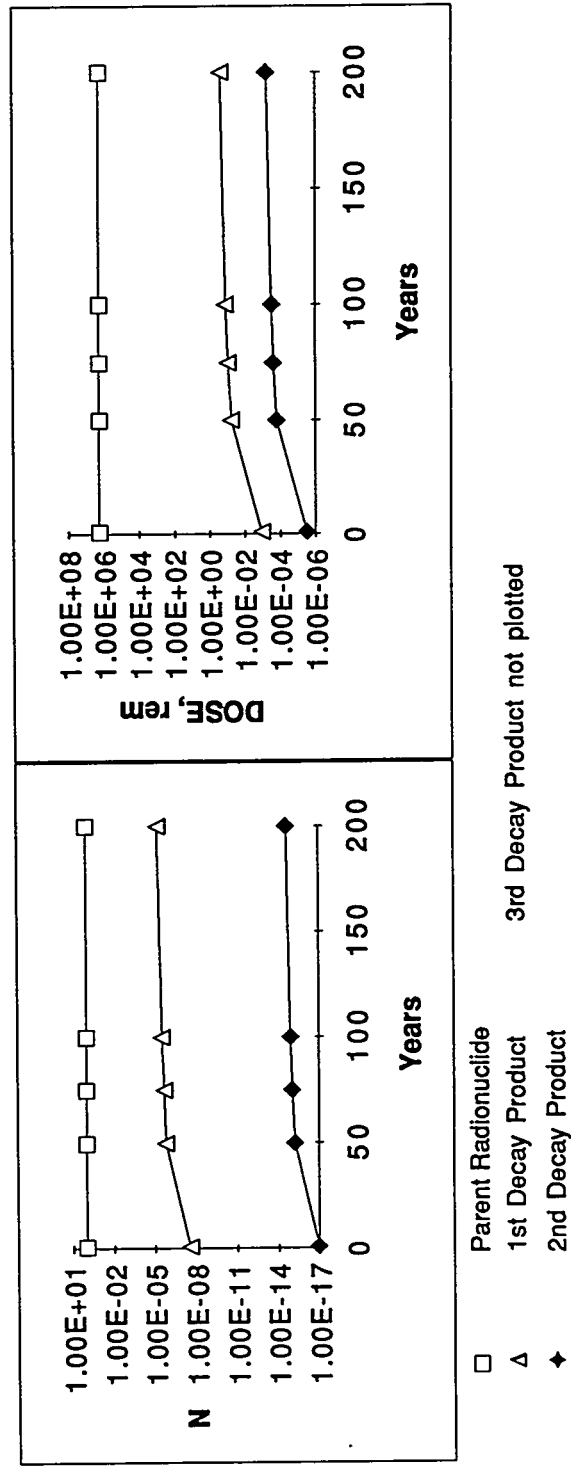
□ Parent Radionuclide
 △ 1st Decay Product
 ◆ 2nd Decay Product
 ✦ 3rd Decay Product not plotted
 ✧ 4th Decay Product not plotted

U236,Th232,Ra228,Ac228

Element >>>	U	Th	Ra	Ac
Isotope >>>	236	232	228	228
t-1/2, yrs >	2.34E+07	1.41E+10	5.75E+00	7.00E-04
Rem/gram >>	7.76E+03	1.76E+02	1.15E+09	0.00E+00
lamda >>>	2.96E-08	4.93E-11	1.21E-01	9.90E+02
YLS	N (A.1)	N (A.2)	N (A.3)	N (A.3)
1	1.00E+00	2.96E-08	1.21E-17	1.47E-21
50	1.00E+00	1.48E-06	6.06E-16	7.37E-20
75	1.00E+00	2.22E-06	9.09E-16	1.11E-19
100	1.00E+00	2.96E-06	1.21E-15	1.47E-19
200	1.00E+00	5.92E-06	2.42E-15	2.95E-19
YLS	1.00E+00	1.00E+00	1.00E+00	1.00E+00
1	1.83E+06	1.21E-03	3.18E-06	0.00E+00
50	1.83E+06	6.04E-02	1.59E-04	0.00E+00
75	1.83E+06	9.06E-02	2.38E-04	0.00E+00
100	1.83E+06	1.21E-01	3.18E-04	0.00E+00
200	1.83E+06	2.42E-01	6.35E-04	0.00E+00

Parent to Daughter Time to equilibrium, yrs	Th	Ra	Ac
	2.16E+08	1.79E+02	9.09E-03

Cummulative	1.83E+06	1.83E+06	1.83E+06	1.83E+06	1.83E+06
No increase to the Parent dose					



□ Parent Radionuclide
 Δ 1st Decay Product
 ◆ 2nd Decay Product
 3rd Decay Product not plotted

U238,Th234,Pa234,U234

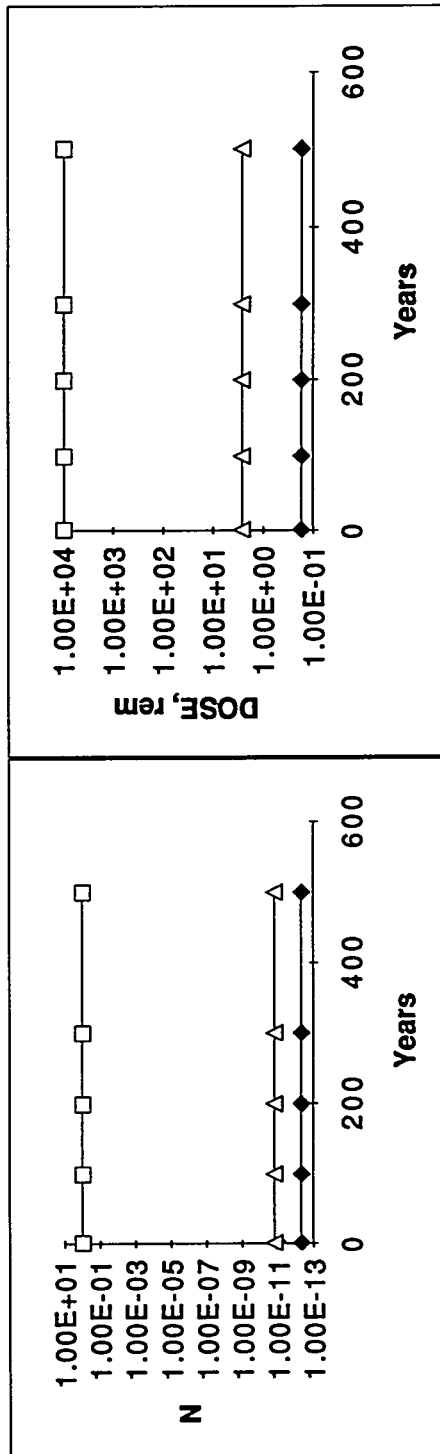
Element >>>	U 238	Th 234	Pa 234	U 234
Isotope >>>	4.47E+09	6.60E-02	2.22E-03	2.45E+05
t-1/2, yrs >>>	4.03E+01	7.64E+08	1.48E+09	8.08E+05
Rem/gram >>	1.55E-10	1.05E+01	3.12E+02	2.83E-06
lamda >>>	N (A.1)	N (A.3)	N (A.3)	N (A.4)
YFS	1.00E+00	1.48E-11	4.97E-13	1.55E-10
100	1.00E+00	1.48E-11	4.97E-13	1.55E-08
200	1.00E+00	1.48E-11	4.97E-13	3.10E-08
300	1.00E+00	1.48E-11	4.97E-13	4.65E-08
500	1.00E+00	1.48E-11	4.97E-13	7.75E-08
YFS	9.59E+03	2.64E+00	1.72E-01	2.93E-02
1	9.59E+03	2.64E+00	1.72E-01	2.93E+00
100	9.59E+03	2.64E+00	1.72E-01	5.86E+00
200	9.59E+03	2.64E+00	1.72E-01	8.79E+00
300	9.59E+03	2.64E+00	1.72E-01	1.46E+01
500	9.59E+03	2.64E+00	1.72E-01	1.46E+01

Parent to Daughter Time to equilibrium, yrs	Th	Pa	U
	2.37E+00	1.12E-02	5.93E-02
	3.46E+06	<<<U234 to U238 Equilibrium ignores Th234 and Pa234 due to very short half-lives	

Dose relative to original	Cummulatively Parent_Dose	Parent_Dose
1.0003	9.59E+03	1.0003
1.0006	9.60E+03	1.0006
1.0009	9.60E+03	1.0009
1.0012	9.60E+03	1.0012
1.0018	9.61E+03	1.0018

U234 set to equilibrium with U238

Insignificant increase to the Parent_dose

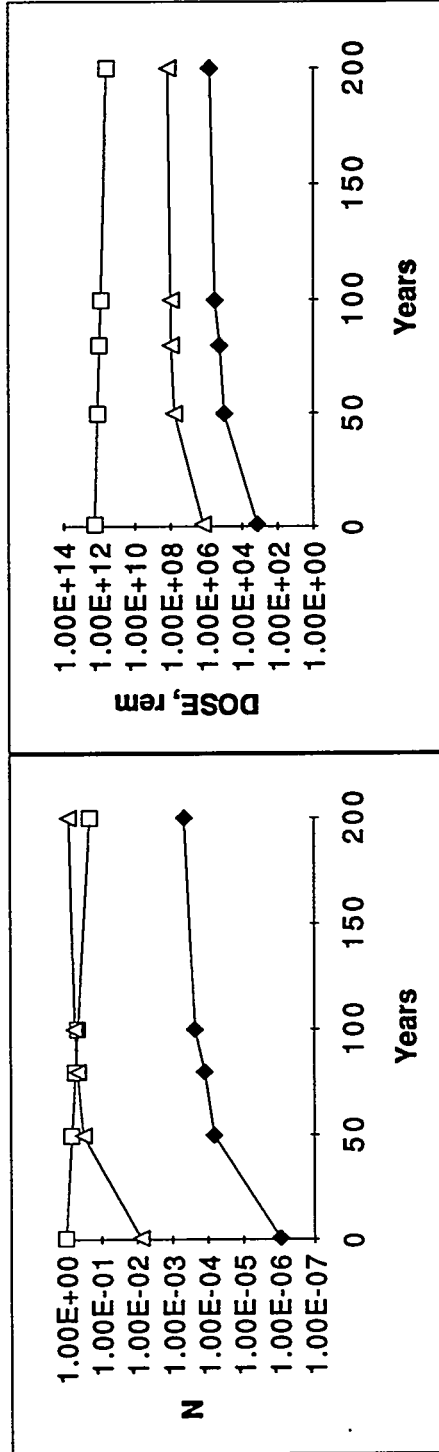


□ Parent Radionuclide
△ 1st Decay Product
◆ 2nd Decay Product
★ 3rd Decay Product not plotted

Pu238,U234,Th230,Ra226

Element >>>	Pu 238	U 234	Th 230	Ra 226	Parent to Daughter Time to Equilibrium, yrs
Isotope >>>	8.78E+01	2.44E+05	7.70E+04	1.60E+03	U 1.00E+03
Rem/gram >>	7.88E+09	8.08E+05	6.46E+06	7.81E+06	Th 1.87E+05
lamda >>>	7.89E-03	2.84E-06	9.00E-06	4.33E-04	Ra 9.12E+03
YIS	N (A.1)	N (A.2)	N (A.5)	N (A.5)	
1	9.92E-01	7.86E-03	9.26E-07	5.98E-10	
50	6.74E-01	3.26E-01	6.65E-05	5.52E-08	
80	5.32E-01	4.68E-01	1.24E-04	1.59E-07	
100	4.54E-01	5.46E-01	2.25E-04	3.96E-07	
200	2.06E-01	7.93E-01	4.50E-04	7.76E-07	
YIS	10M	10M	10M	10M	Cumulatively
1	1.86E+12	1.49E+06	1.38E+03	1.06E+00	1.86E+12
50	1.26E+12	6.17E+07	9.88E+04	9.74E+01	1.26E+12
80	9.97E+11	8.85E+07	1.84E+05	2.81E+02	9.97E+11
100	8.52E+11	1.03E+08	3.35E+05	7.00E+02	8.52E+11
200	3.87E+11	1.50E+08	6.69E+05	1.37E+03	3.87E+11

No increase
to the Parent
dose

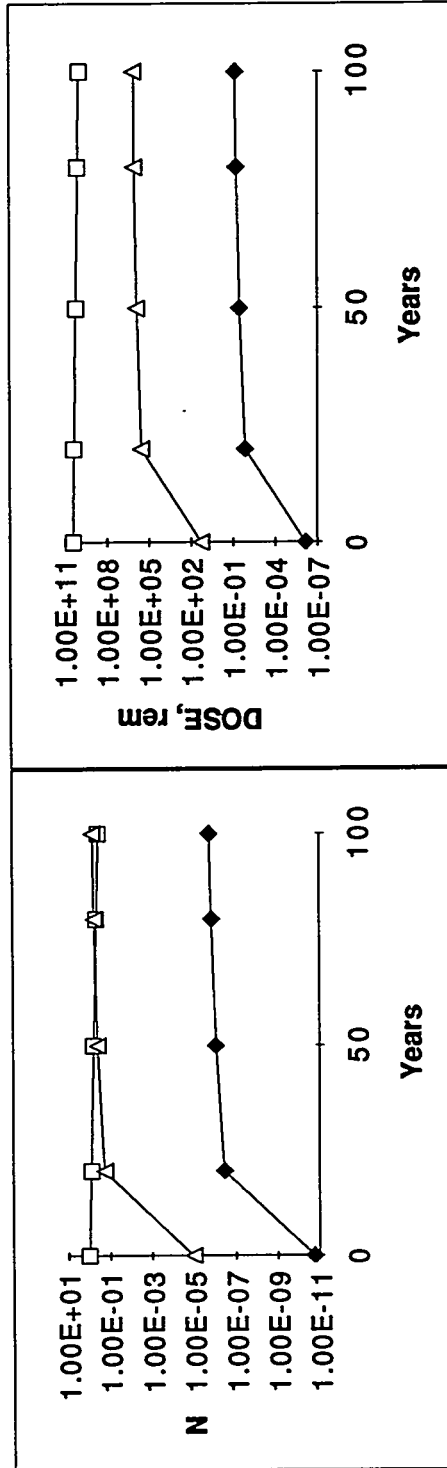


Pu240,U236,Th232,Ra228

Element >>>	Pu 240	U 236	Th 232	Ra 228	Parent to Daughter Time to Equilibrium, yrs
Isotope >>>	6.57E+01	2.34E+07	1.41E+10	5.75E+00	U
t-1/2, yrs >>>	1.16E+08	7.76E+03	1.76E+02	1.15E+09	Th
Rem/gram >>	1.06E-02	2.96E-08	4.93E-11	1.21E-01	Ra
lamda >>>	N (A.1)	N (A.2)	N (A.5)	N (A.3)	
Y/S	1.00E+00	1.06E-05	1.78E-11	7.27E-21	
0	8.10E-01	1.90E-01	3.55E-07	7.27E-21	
20	5.90E-01	4.10E-01	8.88E-07	7.27E-21	
50	4.30E-01	5.70E-01	1.42E-06	7.27E-21	
80	3.48E-01	6.52E-01	1.78E-06	7.27E-21	
100					
Y/S	rem	rem	rem	rem	Cummulative
0	2.78E+10	1.93E+01	7.25E-07	1.91E-09	2.78E+10
20	2.25E+10	3.48E+05	1.45E-02	1.91E-09	2.25E+10
50	1.64E+10	7.51E+05	3.63E-02	1.91E-09	1.64E+10
80	1.20E+10	1.04E+06	5.80E-02	1.91E-09	1.20E+10
100	9.69E+09	1.19E+06	7.25E-02	1.91E-09	9.69E+09

Th232 forced to conditions faster than possible by assuming U236 quantity in decay equation to be 0.6, no dose impact

No increase to the Parent dose



□ Parent Radionuclide
△ 1st Decay Product
◆ 2nd Decay Product
3rd Decay Product not plotted

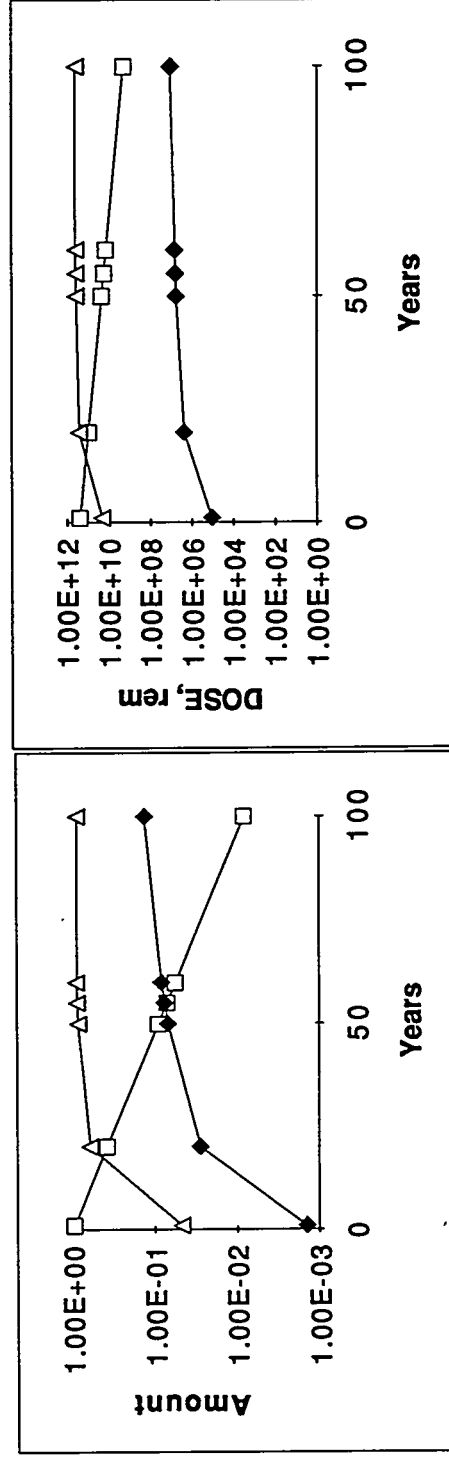
Pu241,Am241,Np237,Pa233

Element >>>	Pu 241	Am 241	Np 237	Pa 233
Isotope >>>	1.44E+01	4.32E+02	2.14E+06	7.40E-02
t-1/2, yrs >	1.03E+09	1.79E+09	3.45E+05	1.79E+08
Rem/gram >>	4.81E-02	1.60E-03	3.24E-07	9.37E+00
lambda >>>	N (A.1)	N (A.2)	N (A.5)	N (A.3)
YIS	9.53E-01	4.70E-02	1.43E-03	4.93E-11
1	3.82E-01	6.07E-01	2.81E-02	4.93E-11
20	9.01E-02	8.62E-01	6.86E-02	4.93E-11
50	7.08E-02	8.74E-01	7.51E-02	4.93E-11
55	5.57E-02	8.82E-01	8.16E-02	4.93E-11
60	8.12E-03	8.73E-01	1.32E-01	4.93E-11
100				
YIS	2.37E+11	2.03E+10	1.17E+05	2.06E+00
1	9.48E+10	2.62E+11	2.30E+08	2.06E+00
20	2.24E+10	3.72E+11	5.61E+06	2.06E+00
50	1.76E+10	3.77E+11	6.14E+06	2.06E+00
55	1.38E+10	3.80E+11	6.68E+06	2.06E+00
60	2.02E+09	3.77E+11	1.08E+07	2.06E+00
100				

Parent to Daughter Time to Equilibrium, yrs	Am	Np	Pa
	7.30E+01	5.30E+03	1.83E+00

Np237 forced to conditions faster than possible due to assuming Am241 quantity in decay equation to be .89, no dose impact

YIS	Dose relative to decreasing		Dose relative to original	
	Parent_dose	Parent_dose	Parent_dose	Parent_dose
1	1.09	1.09	1.09	1.09
20	3.76	3.57E+11	3.76	1.51
50	17.61	3.94E+11	17.61	1.67
55	22.44	3.95E+11	22.44	1.67
60	28.52	3.94E+11	28.52	1.67
100	187.76	3.79E+11	187.76	1.60

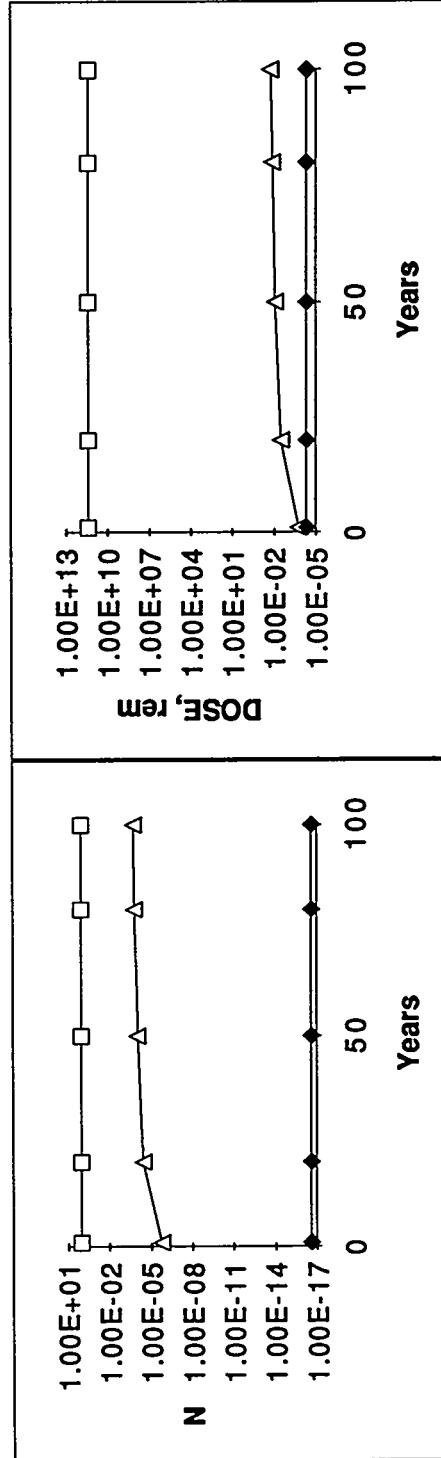


□ Parent Radionuclide
 △ 1st Decay Product
 ◆ 2nd Decay Product
 3rd Decay Product not plotted

Pu242,U238,Th234,Pa234

Element >>>	Pu	U	Th	Pa	Parent to Daughter Time to Equilibrium, yrs
Isotope >>>	242	238	234	234	U Th Pa
t-1/2, yrs >>>	3.76E+05	4.47E+09	6.60E-02	2.22E-03	5.08E+06 2.37E+00 1.12E-02
Rem/gram >>	1.03E+09	4.03E-01	7.64E+09	1.48E+09	
lamda >>>	1.84E-06	1.55E-10	1.05E+01	3.12E+02	
yr\$	<u>N (A.1)</u>	<u>N (A.2)</u>	<u>N (A.3)</u>	<u>N (A.3)</u>	
1	1.00E+00	1.84E-06	2.72E-17	9.16E-19	
20	1.00E+00	3.69E-05	2.72E-17	9.16E-19	
50	1.00E+00	9.22E-05	2.72E-17	9.16E-19	
80	1.00E+00	1.48E-04	2.72E-17	9.16E-19	
100	1.00E+00	1.84E-04	2.72E-17	9.16E-19	
yr\$	<u>10m</u>	<u>10m</u>	<u>10m</u>	<u>10m</u>	Cummulative
1	2.49E+11	1.77E-04	4.87E-05	3.17E-07	2.49E+11
20	2.49E+11	3.54E-03	4.87E-05	3.17E-07	2.49E+11
50	2.49E+11	8.84E-03	4.87E-05	3.17E-07	2.49E+11
80	2.49E+11	1.42E-02	4.87E-05	3.17E-07	2.49E+11
100	2.49E+11	1.77E-02	4.87E-05	3.17E-07	2.49E+11

No Increase
to the Parent
dose



APPENDIX B

HIGH LEVEL WASTE SOURCE DOSE ANALYSIS

The attached data sheets contain the analysis of the decay product adjusted normalized elemental source dose values. The analysis utilized the normalized elemental source dose values from Appendix A in the referenced report, "Bounding Uranium and Plutonium Isotopic Distributions for High Level Waste Accident Analyses." Only the tables containing the top 30 values were considered in this analysis.

The analysis involved adjusting the individual radionuclides total rem values for Pu-241, U-233 and U-235 in the tables using the adjustment factors developed in Appendix A of this report. The individual isotope rem contributions were then summed to define the Adjusted Monthly Source Dose Inventory (SDI). This new adjusted monthly rem value was then divided by the previous value to determine the factor need to increase the Normalized Elemental Source Dose value, rem/gram.

Next each monthly adjusted NESD value was multiplied by the total rem value divided by the total of the top thirty rem values to determine a rem weighted monthly NESD. These monthly weighted values were then summed to obtain the average weighted NESD. A summary table of each process stream analysis in the attached data sheets is provided below.

Plutonium Normalized

<u>Elemental Source Dose, rem/gram</u>	<u>High</u>	<u>Low</u>	<u>Weighted Average</u>	<u>Higher Months (Yrs)</u> ***
F-Canyon Purex High Heat Waste	1.35 E+8	4.60 E+7	6.69 E+7	7 ('65-'73)
F-Canyon Purex Low Heat Waste	8.17 E+7	4.30 E+7	5.98 E+7	10 ('65-'75)
H-Canyon Purex High Heat Waste	3.84 E+7	3.81 E+7	3.82 E+7	15 ('58-'59)
H-Canyon Purex Low Heat Waste	3.84 E+7	3.81 E+7	3.82 E+7	15 ('58-'59)
H-Canyon HM High Heat Waste	7.88 E+9	2.90 E+9	4.00 E+9	21 ('65-'68)
H-Canyon HM Low Heat Waste	7.88 E+9	7.88 E+9	7.88 E+9	0

Uranium Normalized

<u>Elemental Source Dose, rem/gram</u>	<u>High</u>	<u>Low</u>	<u>Weighted Average</u>	<u>Higher Months (Yrs)</u>
F-Canyon Purex High Heat Waste	4.27 E+1	4.23 E+1	4.25 E+1	3 (2/'66,1/'85)
F-Canyon Purex Low Heat Waste	4.26 E+1	4.23 E+1	4.25 E+1	3 ('66)
H-Canyon Purex High Heat Waste	4.21 E+1	4.21 E+1	4.21 E+1	0
H-Canyon Purex Low Heat Waste	4.21 E+1	4.21 E+1	4.21 E+1	0
H-Canyon HM High Heat Waste	1.61 E+6	1.68 E+4	1.10 E+6	10 ('68-'73)
H-Canyon HM Low Heat Waste	1.61 E+6	1.77 E+4	1.17 E+6	11 ('68-'74)

*** Higher Months (Yrs) the number of months transfers had greater NESD values than the weighted average and the year range these transfers occurred.

TOP 30 MONTHLY PLUTONIUM
NORMALIZED ELEMENTAL SOURCE DOSES

F-Canyon Purex Process High Heat Waste

Date	MONTHLY PLUTONIUM SDI (rem)					Adjusted Monthly PLUTONIUM SDI (rem)	Fraction Increase of PLUTONIUM SDI (rem)	Monthly PLUTONIUM NESD (rem/gram)	Am-241	Rem
	Pu-238	Pu-239	Pu-240	Pu-241 & Am-241	Pu-242				Adjusted PLUTONIUM NESD (rem/gram)	Weighted Monthly NESD (rem/gram)
Jul-65	0	1.14E+09	8.15E+09	7.91E+09	3.24E+07	1.72E+10	1.23	1.10E+08	1.35E+08	1.29E+07
May-68	0	1.25E+09	3.09E+09	3.53E+09	5.38E+06	7.87E+09	1.22	9.08E+07	1.11E+08	4.86E+06
Apr-73	0	6.32E+05	6.15E+07	1.26E+08	2.29E+06	1.90E+08	1.36	7.62E+07	1.04E+08	1.10E+05
Jun-65	0	2.47E+09	4.76E+09	4.44E+09	1.72E+07	1.17E+10	1.18	7.57E+07	8.93E+07	5.82E+06
May-73	0	4.23E+07	3.87E+09	7.94E+09	1.59E+08	1.20E+10	1.36	7.15E+07	9.73E+07	6.51E+06
Aug-65	0	1.23E+09	1.22E+09	1.01E+09	5.21E+05	3.46E+09	1.13	6.06E+07	6.86E+07	1.32E+06
Aug-71	0	1.12E+09	1.70E+09	1.96E+09	2.90E+07	4.82E+09	1.20	6.04E+07	7.22E+07	1.94E+06
Mar-74	0	2.72E+09	1.90E+09	2.29E+09	3.06E+06	6.92E+09	1.15	5.69E+07	6.56E+07	2.53E+06
Feb-74	0	2.50E+09	1.72E+09	2.04E+09	2.81E+06	6.26E+09	1.15	5.64E+07	6.49E+07	2.27E+06
Jun-68	0	2.39E+09	1.29E+09	1.27E+09	5.10E+05	4.96E+09	1.11	5.06E+07	5.63E+07	1.56E+06
Jul-68	0	6.65E+08	3.60E+08	3.52E+08	1.42E+05	1.38E+09	1.11	5.06E+07	5.63E+07	4.33E+05
Oct-65	0	1.42E+09	7.58E+08	5.64E+08	1.84E+06	2.74E+09	1.09	4.77E+07	5.20E+07	7.96E+05
Mar-71	0	1.10E+08	5.34E+07	2.98E+07	1.51E+04	1.93E+08	1.07	4.57E+07	4.87E+07	5.25E+04
Jul-71	0	2.34E+09	1.13E+09	5.88E+08	3.21E+05	4.06E+09	1.06	4.54E+07	4.82E+07	1.09E+06
Jun-71	0	6.76E+08	2.67E+08	1.41E+08	4.54E+04	1.08E+09	1.05	4.32E+07	4.55E+07	2.75E+05
Sep-91	0	7.27E+09	1.63E+09	2.66E+09	3.25E+05	1.16E+10	1.10	4.27E+07	4.70E+07	3.03E+06
Jun-91	0	3.90E+09	8.73E+08	1.43E+09	1.75E+05	6.20E+09	1.10	4.27E+07	4.70E+07	1.63E+06
May-91	0	1.18E+08	2.64E+07	4.33E+07	5.29E+03	1.88E+08	1.10	4.27E+07	4.70E+07	4.93E+04
Jun-90	0	1.26E+10	2.82E+09	4.37E+09	5.64E+05	1.98E+10	1.10	4.24E+07	4.65E+07	5.13E+06
Dec-90	0	1.92E+09	4.30E+08	6.67E+08	8.60E+04	3.02E+09	1.10	4.24E+07	4.65E+07	7.82E+05
May-90	0	1.15E+09	2.58E+08	4.00E+08	5.16E+04	1.81E+09	1.10	4.24E+07	4.65E+07	4.69E+05
Nov-90	0	2.95E+07	6.61E+06	1.03E+07	1.32E+03	4.64E+07	1.10	4.24E+07	4.65E+07	1.20E+04
Nov-89	0	6.53E+09	1.46E+09	2.15E+09	2.92E+05	1.01E+10	1.09	4.21E+07	4.60E+07	2.60E+06
Jun-89	0	8.86E+07	1.98E+07	2.92E+07	3.97E+03	1.38E+08	1.09	4.21E+07	4.60E+07	3.53E+04
Jul-89	0	8.92E+09	2.00E+09	2.94E+09	4.00E+05	1.39E+10	1.09	4.21E+07	4.60E+07	3.55E+06
Aug-89	0	4.88E+09	1.09E+09	1.61E+09	2.18E+05	7.57E+09	1.09	4.21E+07	4.60E+07	1.94E+06
Feb-89	0	3.84E+09	8.60E+08	1.26E+09	1.72E+05	5.97E+09	1.09	4.21E+07	4.60E+07	1.53E+06
Sep-89	0	3.13E+09	7.01E+08	1.03E+09	1.40E+05	4.86E+09	1.09	4.21E+07	4.60E+07	1.25E+06
Dec-89	0	2.98E+09	6.68E+08	9.83E+08	1.34E+05	4.63E+09	1.09	4.21E+07	4.60E+07	1.19E+06
Mar-89	0	2.98E+09	6.68E+08	9.83E+08	1.34E+05	4.63E+09	1.09	4.21E+07	4.60E+07	1.19E+06

Average Weighted NESD = 6.69E+07

**TOP 30 MONTHLY URANIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

F-Canyon Purex Process High Heat Waste

Date	MONTHLY URANIUM SDI (rem)					Adjusted Monthly Uranium SDI (rem)	Fraction Increase of Uranium SDI (rem)	Monthly Uranium NESD (rem/gram)	Adjusted	Rem
	U-233	U-234	Pa-231,Ac-227	U-236	U-238				Monthly Uranium NESD (rem/gram)	Monthly Uranium NESD (rem/gram)
Nov-85	0	0	3.32E+06	0	4.88E+07	5.21E+07	1.01	4.21E+01	4.27E+01	1.12E+01
Jan-66	0	0	1.16E+05	0	1.80E+06	1.91E+06	1.01	4.20E+01	4.26E+01	4.10E-01
Sep-66	0	0	1.64E+04	0	2.54E+05	2.70E+05	1.01	4.20E+01	4.26E+01	5.80E-02
May-66	0	0	1.24E+05	0	1.94E+06	2.06E+06	1.01	4.20E+01	4.25E+01	4.43E-01
Jul-66	0	0	2.50E+05	0	3.95E+06	4.20E+06	1.01	4.20E+01	4.25E+01	9.01E-01
May-70	0	0	5.42E+05	0	8.93E+06	9.47E+06	1.01	4.19E+01	4.24E+01	2.03E+00
Mar-67	0	0	5.10E+05	0	8.40E+06	8.91E+06	1.01	4.19E+01	4.24E+01	1.91E+00
Feb-68	0	0	3.78E+05	0	6.22E+06	6.60E+06	1.01	4.19E+01	4.24E+01	1.41E+00
Dec-68	0	0	2.67E+05	0	4.39E+06	4.66E+06	1.01	4.19E+01	4.24E+01	9.96E-01
Mar-68	0	0	2.62E+05	0	4.32E+06	4.58E+06	1.01	4.19E+01	4.24E+01	9.80E-01
Dec-67	0	0	1.69E+05	0	2.78E+06	2.94E+06	1.01	4.19E+01	4.24E+01	6.30E-01
Mar-69	0	0	1.34E+05	0	2.21E+06	2.35E+06	1.01	4.19E+01	4.24E+01	5.02E-01
Apr-67	0	0	1.29E+05	0	2.12E+06	2.25E+06	1.01	4.19E+01	4.24E+01	4.82E-01
Jul-70	0	0	7.47E+05	0	1.23E+07	1.30E+07	1.01	4.19E+01	4.24E+01	2.79E+00
Jan-69	0	0	4.65E+05	0	7.66E+06	8.12E+06	1.01	4.19E+01	4.24E+01	1.74E+00
Nov-68	0	0	4.60E+05	0	7.58E+06	8.04E+06	1.01	4.19E+01	4.24E+01	1.72E+00
May-68	0	0	4.42E+05	0	7.28E+06	7.72E+06	1.01	4.19E+01	4.24E+01	1.65E+00
Apr-69	0	0	4.08E+05	0	6.71E+06	7.12E+06	1.01	4.19E+01	4.24E+01	1.52E+00
Sep-67	0	0	3.13E+05	0	5.15E+06	5.47E+06	1.01	4.19E+01	4.24E+01	1.17E+00
Nov-67	0	0	2.48E+05	0	4.08E+06	4.33E+06	1.01	4.19E+01	4.24E+01	9.26E-01
Oct-68	0	0	2.31E+05	0	3.81E+06	4.04E+06	1.01	4.19E+01	4.24E+01	8.65E-01
Aug-67	0	0	2.06E+05	0	3.39E+06	3.60E+06	1.01	4.19E+01	4.24E+01	7.70E-01
Jan-67	0	0	1.27E+05	0	2.09E+06	2.21E+06	1.01	4.19E+01	4.24E+01	4.73E-01
Jan-68	0	0	1.26E+05	0	2.07E+06	2.19E+06	1.01	4.19E+01	4.24E+01	4.69E-01
Dec-66	0	0	1.20E+05	0	1.98E+06	2.10E+06	1.01	4.19E+01	4.24E+01	4.49E-01
Oct-67	0	0	1.01E+05	0	1.67E+06	1.77E+06	1.01	4.19E+01	4.24E+01	3.79E-01
Aug-70	0	0	4.71E+05	0	7.77E+06	8.24E+06	1.01	4.19E+01	4.24E+01	1.76E+00
Apr-65	0	0	3.36E+05	0	5.59E+06	5.92E+06	1.01	4.19E+01	4.24E+01	1.27E+00
Mar-65	0	0	4.18E+05	0	7.08E+06	7.50E+06	1.01	4.19E+01	4.24E+01	1.60E+00
Aug-66	0	0	2.47E+05	0	4.32E+06	4.57E+06	1.01	4.18E+01	4.23E+01	9.74E-01

Average Weighted NESD = 4.25E+01

**TOP 30 MONTHLY PLUTONIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

F-Canyon Purex Process Low Heat Waste

Date	MONTHLY PLUTONIUM SDI (rem)					Adjusted Monthly PLUTONIUM SDI (rem)	Fraction Increase of PLUTONIUM SDI (rem)	Monthly PLUTONIUM NESD (rem/gram)	Am-241 Adjusted PLUTONIUM NESD (rem/gram)	Rem Weighted Monthly NESD (rem/gram)
	Pu-238	Pu-239	Pu-240	Pu-241 & Am-241	Pu-242					
Jul-65	0	3.25E+09	7.85E+09	7.37E+09	2.94E+07	1.85E+10	1.19	8.17E+07	9.72E+07	3.86E+06
Jun-68	0	7.90E+09	8.08E+09	8.71E+09	9.72E+06	2.47E+10	1.16	6.43E+07	7.49E+07	3.98E+06
Aug-65	0	6.71E+09	7.36E+09	6.19E+09	1.22E+07	2.03E+10	1.14	6.22E+07	7.09E+07	3.09E+06
Aug-71	0	2.78E+09	4.41E+09	6.11E+09	9.24E+07	1.34E+10	1.22	6.13E+07	7.51E+07	2.16E+06
Aug-75	0	3.09E+09	2.43E+09	3.15E+09	4.05E+06	8.67E+09	1.17	6.04E+07	7.07E+07	1.32E+06
Sep-70	0	1.63E+10	1.22E+10	1.39E+10	1.49E+07	4.23E+10	1.15	5.78E+07	6.66E+07	6.06E+06
May-73	0	1.31E+09	1.82E+09	3.26E+09	6.00E+07	6.45E+09	1.25	5.67E+07	7.11E+07	9.86E+05
May-75	0	3.68E+09	3.29E+09	5.35E+09	6.64E+07	1.24E+10	1.21	5.59E+07	6.77E+07	1.80E+06
Mar-74	0	2.87E+10	1.68E+10	1.92E+10	2.49E+07	6.47E+10	1.14	5.30E+07	6.01E+07	8.37E+06
Feb-74	0	1.54E+10	8.87E+09	1.03E+10	1.33E+07	3.46E+10	1.14	5.28E+07	5.99E+07	4.45E+06
Jun-75	0	3.96E+09	2.09E+09	2.45E+09	2.82E+06	8.51E+09	1.13	5.14E+07	5.82E+07	1.06E+06
Jul-68	0	1.20E+10	6.50E+09	6.36E+09	2.56E+06	2.49E+10	1.11	5.06E+07	5.63E+07	3.01E+06
Dec-79	0	3.18E+09	1.85E+09	1.46E+09	9.00E+05	6.48E+09	1.10	5.01E+07	5.50E+07	7.67E+05
Jan-78	0	1.59E+09	7.87E+08	6.73E+08	2.19E+05	3.05E+09	1.10	4.83E+07	5.30E+07	3.47E+05
Sep-77	0	5.46E+08	2.72E+08	2.24E+08	6.43E+04	1.04E+09	1.09	4.81E+07	5.27E+07	1.18E+05
Dec-77	0	1.61E+09	8.01E+08	6.49E+08	2.23E+05	3.06E+09	1.09	4.80E+07	5.24E+07	3.45E+05
Nov-77	0	2.13E+09	1.06E+09	8.58E+08	2.95E+05	4.05E+09	1.09	4.80E+07	5.24E+07	4.56E+05
Oct-77	0	1.15E+09	5.70E+08	4.62E+08	1.59E+05	2.18E+09	1.09	4.80E+07	5.24E+07	2.46E+05
Sep-65	0	3.88E+09	2.00E+09	1.32E+09	6.46E+05	7.21E+09	1.08	4.73E+07	5.10E+07	7.91E+05
Jul-70	0	1.07E+10	4.75E+09	4.57E+09	7.45E+06	2.01E+10	1.10	4.71E+07	5.18E+07	2.23E+06
Jun-70	0	5.05E+09	2.45E+09	1.68E+09	1.05E+06	9.18E+09	1.08	4.66E+07	5.03E+07	9.93E+05
Aug-70	0	1.73E+10	7.09E+09	6.61E+09	5.90E+06	3.10E+10	1.09	4.61E+07	5.04E+07	3.36E+06
Aug-68	0	1.18E+10	4.49E+09	3.63E+09	1.59E+06	1.99E+10	1.08	4.45E+07	4.80E+07	2.06E+06
Sep-68	0	1.40E+10	5.18E+09	4.05E+09	1.87E+06	2.32E+10	1.08	4.40E+07	4.73E+07	2.36E+06
Mar-71	0	9.28E+09	3.93E+09	2.55E+09	1.81E+07	1.58E+10	1.07	4.36E+07	4.66E+07	1.58E+06
Jan-80	0	7.73E+09	2.57E+09	2.32E+09	1.02E+06	1.26E+10	1.08	4.35E+07	4.70E+07	1.27E+06
Jul-71	0	7.70E+09	3.11E+09	1.60E+09	5.18E+05	1.24E+10	1.05	4.33E+07	4.57E+07	1.22E+06
Nov-79	0	8.53E+09	2.83E+09	2.43E+09	1.13E+06	1.38E+10	1.08	4.33E+07	4.65E+07	1.38E+06
Feb-78	0	4.87E+08	1.62E+08	1.31E+08	3.21E+04	7.80E+08	1.07	4.31E+07	4.62E+07	7.74E+04
Feb-92	0	2.95E+07	6.61E+06	1.14E+07	1.32E+03	4.76E+07	1.11	4.30E+07	4.76E+07	4.87E+03
Average Weighted NESD =										5.98E+07

**TOP 30 MONTHLY URANIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

F-Canyon Purex Process Low Heat Waste

Date	MONTHLY URANIUM SDI (rem)					Adjusted	Fraction	Monthly	Adjusted	Rem
	U-233	U-234	Pa-231,Ac-227	U-236	U-238	Monthly	Increase of	Uranium	Monthly	Weighted
	U-235 &					Uranium	Uranium	NESD	NESD	NESD
						SDI (rem)	SDI (rem)	(rem/gram)	(rem/gram)	(rem/gram)
Sep-66	0	0	1.46E+05	0	2.25E+06	2.39E+06	1.01	4.20E+01	4.26E+01	4.40E-01
Jul-66	0	0	4.52E+05	0	7.26E+06	7.71E+06	1.01	4.20E+01	4.25E+01	1.41E+00
May-66	0	0	3.23E+05	0	5.26E+06	5.58E+06	1.01	4.20E+01	4.25E+01	1.02E+00
Aug-67	0	0	4.10E+05	0	6.75E+06	7.16E+06	1.01	4.19E+01	4.24E+01	1.31E+00
Nov-68	0	0	3.25E+05	0	5.35E+06	5.68E+06	1.01	4.19E+01	4.24E+01	1.04E+00
Oct-68	0	0	2.67E+05	0	4.39E+06	4.66E+06	1.01	4.19E+01	4.24E+01	8.54E-01
Apr-69	0	0	2.64E+05	0	4.35E+06	4.62E+06	1.01	4.19E+01	4.24E+01	8.47E-01
Apr-67	0	0	2.64E+05	0	4.35E+06	4.62E+06	1.01	4.19E+01	4.24E+01	8.47E-01
Dec-68	0	0	2.09E+05	0	3.45E+06	3.66E+06	1.01	4.19E+01	4.24E+01	6.70E-01
Mar-67	0	0	7.92E+05	0	1.30E+07	1.38E+07	1.01	4.19E+01	4.24E+01	2.54E+00
Jan-68	0	0	6.49E+05	0	1.07E+07	1.13E+07	1.01	4.19E+01	4.24E+01	2.08E+00
Jan-67	0	0	5.67E+05	0	9.34E+06	9.91E+06	1.01	4.19E+01	4.24E+01	1.82E+00
Jul-70	0	0	3.65E+05	0	6.01E+06	6.37E+06	1.01	4.19E+01	4.24E+01	1.17E+00
Sep-67	0	0	3.46E+05	0	5.70E+06	6.04E+06	1.01	4.19E+01	4.24E+01	1.11E+00
Jan-69	0	0	3.04E+05	0	5.01E+06	5.31E+06	1.01	4.19E+01	4.24E+01	9.74E-01
Mar-68	0	0	2.75E+05	0	4.54E+06	4.81E+06	1.01	4.19E+01	4.24E+01	8.82E-01
Nov-67	0	0	2.47E+05	0	4.06E+06	4.31E+06	1.01	4.19E+01	4.24E+01	7.90E-01
Apr-68	0	0	2.41E+05	0	3.97E+06	4.21E+06	1.01	4.19E+01	4.24E+01	7.73E-01
Feb-68	0	0	1.66E+05	0	2.74E+06	2.91E+06	1.01	4.19E+01	4.24E+01	5.33E-01
Oct-67	0	0	1.30E+05	0	2.14E+06	2.27E+06	1.01	4.19E+01	4.24E+01	4.16E-01
Dec-67	0	0	5.29E+04	0	8.71E+05	9.24E+05	1.01	4.19E+01	4.24E+01	1.69E-01
Mar-69	0	0	5.31E+05	0	8.74E+06	9.28E+06	1.01	4.19E+01	4.24E+01	1.70E+00
Dec-66	0	0	3.99E+05	0	6.57E+06	6.97E+06	1.01	4.19E+01	4.24E+01	1.28E+00
May-68	0	0	1.50E+05	0	2.47E+06	2.62E+06	1.01	4.19E+01	4.24E+01	4.80E-01
Apr-65	0	0	1.03E+06	0	1.72E+07	1.82E+07	1.01	4.19E+01	4.24E+01	3.34E+00
Sep-68	0	0	1.13E+05	0	1.92E+06	2.04E+06	1.01	4.19E+01	4.24E+01	3.73E-01
Mar-65	0	0	1.21E+06	0	2.07E+07	2.19E+07	1.01	4.19E+01	4.23E+01	4.00E+00
Jan-66	0	0	1.14E+06	0	1.97E+07	2.08E+07	1.01	4.19E+01	4.23E+01	3.81E+00
Aug-66	0	0	8.09E+05	0	1.42E+07	1.50E+07	1.01	4.18E+01	4.23E+01	2.75E+00
Nov-64	0	0	8.66E+05	0	1.54E+07	1.63E+07	1.01	4.18E+01	4.23E+01	2.97E+00

Average Weighted NESD = 4.24E+01

**TOP 30 MONTHLY PLUTONIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon Purex Process High Heat Waste

Date	MONTHLY PLUTONIUM SDI (rem)					Adjusted	Fraction	Monthly	Am-241	Rem
	Pu-238	Pu-239	Pu-240	Pu-241 & Am-241	Pu-242	Monthly PLUTONIUM SDI (rem)	Increase of PLUTONIUM SDI (rem)	PLUTONIUM NESD (rem/gram)	Adjusted PLUTONIUM NESD (rem/gram)	Weighted Monthly NESD (rem/gram)
Mar-59	0	6.85E+09	1.53E+09	4.56E+08	3.07E+05	8.84E+09	1.02	3.76E+07	3.84E+07	6.65E+05
Jan-59	0	1.10E+10	2.47E+09	7.33E+08	4.93E+05	1.42E+10	1.02	3.76E+07	3.84E+07	1.07E+06
Feb-59	0	6.68E+09	1.49E+09	4.44E+08	2.99E+05	8.62E+09	1.02	3.76E+07	3.84E+07	6.48E+05
Feb-58	0	1.71E+10	3.82E+09	1.08E+09	7.65E+05	2.20E+10	1.02	3.75E+07	3.83E+07	1.65E+06
Apr-58	0	2.09E+10	4.67E+09	1.32E+09	9.35E+05	2.69E+10	1.02	3.75E+07	3.83E+07	2.02E+06
Jun-58	0	1.66E+10	3.72E+09	1.05E+09	7.44E+05	2.14E+10	1.02	3.75E+07	3.83E+07	1.60E+06
Oct-58	0	1.50E+10	3.35E+09	9.43E+08	6.69E+05	1.92E+10	1.02	3.75E+07	3.83E+07	1.44E+06
Jan-58	0	1.46E+10	3.27E+09	9.22E+08	6.55E+05	1.88E+10	1.02	3.75E+07	3.83E+07	1.41E+06
Sep-58	0	1.31E+10	2.92E+09	8.24E+08	5.85E+05	1.68E+10	1.02	3.75E+07	3.83E+07	1.26E+06
Mar-58	0	1.12E+10	2.50E+09	7.04E+08	5.00E+05	1.44E+10	1.02	3.75E+07	3.83E+07	1.08E+06
May-58	0	1.11E+10	2.47E+09	6.97E+08	4.95E+05	1.42E+10	1.02	3.75E+07	3.83E+07	1.07E+06
Aug-58	0	8.78E+09	1.96E+09	5.53E+08	3.93E+05	1.13E+10	1.02	3.75E+07	3.83E+07	8.47E+05
Jul-58	0	5.41E+09	1.21E+09	3.41E+08	2.42E+05	6.96E+09	1.02	3.75E+07	3.83E+07	5.22E+05
Nov-58	0	7.98E+08	1.79E+08	5.03E+07	3.57E+04	1.03E+09	1.02	3.75E+07	3.83E+07	7.70E+04
Dec-58	0	1.57E+10	3.51E+09	9.90E+08	7.03E+05	2.02E+10	1.02	3.75E+07	3.83E+07	1.51E+06
Jun-57	0	1.24E+10	2.77E+09	7.40E+08	5.54E+05	1.59E+10	1.02	3.75E+07	3.82E+07	1.19E+06
May-57	0	9.51E+09	2.13E+09	5.69E+08	4.26E+05	1.22E+10	1.02	3.75E+07	3.82E+07	9.13E+05
Nov-57	0	1.73E+10	3.86E+09	1.03E+09	7.73E+05	2.21E+10	1.02	3.75E+07	3.82E+07	1.66E+06
Oct-57	0	1.22E+10	2.74E+09	7.31E+08	5.48E+05	1.57E+10	1.02	3.75E+07	3.82E+07	1.17E+06
Apr-57	0	1.20E+10	2.69E+09	7.19E+08	5.38E+05	1.54E+10	1.02	3.75E+07	3.82E+07	1.15E+06
Dec-57	0	1.20E+10	2.69E+09	7.19E+08	5.38E+05	1.54E+10	1.02	3.75E+07	3.82E+07	1.15E+06
Feb-57	0	1.16E+10	2.60E+09	6.94E+08	5.20E+05	1.49E+10	1.02	3.75E+07	3.82E+07	1.11E+06
Mar-57	0	9.22E+09	2.06E+09	5.51E+08	4.13E+05	1.18E+10	1.02	3.75E+07	3.82E+07	8.85E+05
Jul-57	0	6.94E+09	1.55E+09	4.15E+08	3.11E+05	8.91E+09	1.02	3.75E+07	3.82E+07	6.67E+05
Jan-57	0	1.13E+10	2.53E+09	6.77E+08	5.07E+05	1.45E+10	1.02	3.75E+07	3.82E+07	1.09E+06
Sep-57	0	1.06E+10	2.37E+09	6.32E+08	4.74E+05	1.36E+10	1.02	3.75E+07	3.82E+07	1.02E+06
Aug-57	0	6.77E+09	1.51E+09	4.05E+08	3.03E+05	8.69E+09	1.02	3.75E+07	3.82E+07	6.50E+05
Feb-56	0	5.08E+10	1.14E+10	2.88E+09	2.27E+06	6.50E+10	1.02	3.74E+07	3.81E+07	4.85E+06
Jul-56	0	3.26E+10	7.31E+09	1.85E+09	1.46E+06	4.18E+10	1.02	3.74E+07	3.81E+07	3.12E+06
Jun-56	0	7.33E+09	1.64E+09	4.15E+08	3.28E+05	9.38E+09	1.02	3.74E+07	3.81E+07	7.00E+05

Average Weighted NESD = 3.82E+07

**TOP 30 MONTHLY URANIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon Purex Process High Heat Waste

Date	MONTHLY URANIUM SDI (rem)					Adjusted	Fraction	Monthly	Adjusted	Rem
	U-233	U-234	Pa-231,Ac-227	U-236	U-238	Monthly	Increase of	Uranium	Uranium	Weighted
	U-235					Uranium	Uranium	NESD	NESD	Monthly
					SDI (rem)	SDI (rem)	(rem/gram)	(rem/gram)	(rem/gram)	NESD
Sep-55	0	0	4.62E+05	0	9.21E+06	9.67E+06	1.01	4.17E+01	4.21E+01	2.09E+00
Apr-57	0	0	3.29E+05	0	6.57E+06	6.90E+06	1.01	4.17E+01	4.21E+01	1.49E+00
Jun-58	0	0	6.90E+05	0	1.38E+07	1.45E+07	1.01	4.17E+01	4.21E+01	3.13E+00
Oct-58	0	0	5.24E+05	0	1.05E+07	1.10E+07	1.01	4.17E+01	4.21E+01	2.37E+00
Jul-56	0	0	4.80E+05	0	9.57E+06	1.01E+07	1.01	4.17E+01	4.21E+01	2.17E+00
Jan-57	0	0	4.44E+05	0	8.85E+06	9.29E+06	1.01	4.17E+01	4.21E+01	2.01E+00
Aug-55	0	0	3.95E+05	0	7.89E+06	8.29E+06	1.01	4.17E+01	4.21E+01	1.79E+00
Dec-55	0	0	3.81E+05	0	7.61E+06	7.99E+06	1.01	4.17E+01	4.21E+01	1.73E+00
Feb-59	0	0	3.77E+05	0	7.53E+06	7.91E+06	1.01	4.17E+01	4.21E+01	1.71E+00
Feb-56	0	0	3.73E+05	0	7.45E+06	7.82E+06	1.01	4.17E+01	4.21E+01	1.69E+00
Jan-56	0	0	3.55E+05	0	7.09E+06	7.44E+06	1.01	4.17E+01	4.21E+01	1.61E+00
Oct-55	0	0	3.49E+05	0	6.97E+06	7.32E+06	1.01	4.17E+01	4.21E+01	1.58E+00
Dec-56	0	0	3.33E+05	0	6.65E+06	6.98E+06	1.01	4.17E+01	4.21E+01	1.51E+00
Oct-56	0	0	3.23E+05	0	6.45E+06	6.77E+06	1.01	4.17E+01	4.21E+01	1.46E+00
Apr-56	0	0	3.23E+05	0	6.45E+06	6.77E+06	1.01	4.17E+01	4.21E+01	1.46E+00
Dec-57	0	0	3.21E+05	0	6.41E+06	6.73E+06	1.01	4.17E+01	4.21E+01	1.45E+00
Jul-58	0	0	3.19E+05	0	6.37E+06	6.69E+06	1.01	4.17E+01	4.21E+01	1.44E+00
May-58	0	0	2.99E+05	0	5.97E+06	6.27E+06	1.01	4.17E+01	4.21E+01	1.35E+00
Nov-56	0	0	2.69E+05	0	5.37E+06	5.64E+06	1.01	4.17E+01	4.21E+01	1.22E+00
Aug-56	0	0	2.57E+05	0	5.13E+06	5.38E+06	1.01	4.17E+01	4.21E+01	1.16E+00
Sep-56	0	0	2.37E+05	0	4.73E+06	4.96E+06	1.01	4.17E+01	4.21E+01	1.07E+00
Mar-57	0	0	2.29E+05	0	4.57E+06	4.79E+06	1.01	4.17E+01	4.21E+01	1.04E+00
Jul-57	0	0	1.99E+05	0	3.96E+06	4.16E+06	1.01	4.17E+01	4.21E+01	9.00E-01
Mar-59	0	0	1.85E+05	0	3.68E+06	3.87E+06	1.01	4.17E+01	4.21E+01	8.36E-01
Nov-55	0	0	1.79E+05	0	3.56E+06	3.74E+06	1.01	4.17E+01	4.21E+01	8.09E-01
Mar-58	0	0	1.73E+05	0	3.44E+06	3.62E+06	1.01	4.17E+01	4.21E+01	7.82E-01
Sep-58	0	0	1.53E+05	0	3.04E+06	3.20E+06	1.01	4.17E+01	4.21E+01	6.91E-01
Aug-57	0	0	1.16E+05	0	2.32E+06	2.44E+06	1.01	4.17E+01	4.21E+01	5.27E-01
Jan-58	0	0	1.14E+05	0	2.28E+06	2.40E+06	1.01	4.17E+01	4.21E+01	5.18E-01
Jan-59	0	0	1.00E+05	0	2.00E+06	2.10E+06	1.01	4.17E+01	4.21E+01	4.54E-01
Average Weighted NESD =									4.21E+01	

**TOP 30 MONTHLY PLUTONIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon Purex Process Low Heat Waste

Date	MONTHLY PLUTONIUM SDI (rem)					Adjusted Monthly PLUTONIUM SDI (rem)	Fraction Increase of PLUTONIUM SDI (rem)	Monthly PLUTONIUM NESD (rem/gram)	Am-241	Rem
	Pu-238	Pu-239	Pu-240	Pu-241 & Am-241	Pu-242				Adjusted PLUTONIUM NESD (rem/gram)	Weighted Monthly NESD (rem/gram)
Jan-59	0	5.91E+08	1.32E+08	3.93E+07	2.65E+04	7.62E+08	1.02	3.76E+07	3.84E+07	6.40E+05
Feb-59	0	5.91E+08	1.32E+08	3.93E+07	2.65E+04	7.62E+08	1.02	3.76E+07	3.84E+07	6.40E+05
Mar-59	0	2.36E+08	5.29E+07	1.57E+07	1.06E+04	3.05E+08	1.02	3.76E+07	3.84E+07	2.56E+05
Dec-58	0	5.91E+08	1.32E+08	3.73E+07	2.65E+04	7.60E+08	1.02	3.75E+07	3.83E+07	6.36E+05
Apr-58	0	9.16E+08	2.05E+08	5.78E+07	4.10E+04	1.18E+09	1.02	3.75E+07	3.83E+07	9.86E+05
Jan-58	0	8.57E+08	1.92E+08	5.40E+07	3.84E+04	1.10E+09	1.02	3.75E+07	3.83E+07	9.22E+05
Feb-58	0	7.98E+08	1.79E+08	5.03E+07	3.57E+04	1.03E+09	1.02	3.75E+07	3.83E+07	8.59E+05
Jun-58	0	6.20E+08	1.39E+08	3.91E+07	2.78E+04	7.98E+08	1.02	3.75E+07	3.83E+07	6.68E+05
May-58	0	5.61E+08	1.26E+08	3.54E+07	2.51E+04	7.22E+08	1.02	3.75E+07	3.83E+07	6.04E+05
Jul-58	0	5.61E+08	1.26E+08	3.54E+07	2.51E+04	7.22E+08	1.02	3.75E+07	3.83E+07	6.04E+05
Sep-58	0	3.55E+08	7.93E+07	2.24E+07	1.59E+04	4.56E+08	1.02	3.75E+07	3.83E+07	3.82E+05
Mar-58	0	8.27E+08	1.85E+08	5.22E+07	3.70E+04	1.06E+09	1.02	3.75E+07	3.83E+07	8.91E+05
Aug-58	0	4.73E+08	1.06E+08	2.98E+07	2.12E+04	6.08E+08	1.02	3.75E+07	3.83E+07	5.09E+05
Nov-58	0	4.14E+08	9.26E+07	2.61E+07	1.85E+04	5.32E+08	1.02	3.75E+07	3.83E+07	4.45E+05
Oct-58	0	4.14E+08	9.26E+07	2.61E+07	1.85E+04	5.32E+08	1.02	3.75E+07	3.83E+07	4.45E+05
Jun-57	0	1.63E+09	3.64E+08	9.72E+07	7.28E+04	2.09E+09	1.02	3.75E+07	3.82E+07	1.74E+06
Feb-57	0	1.65E+09	3.70E+08	9.89E+07	7.41E+04	2.12E+09	1.02	3.75E+07	3.82E+07	1.77E+06
Mar-57	0	1.57E+09	3.50E+08	9.36E+07	7.01E+04	2.01E+09	1.02	3.75E+07	3.82E+07	1.68E+06
Apr-57	0	1.57E+09	3.50E+08	9.36E+07	7.01E+04	2.01E+09	1.02	3.75E+07	3.82E+07	1.68E+06
May-57	0	1.48E+09	3.31E+08	8.83E+07	6.62E+04	1.90E+09	1.02	3.75E+07	3.82E+07	1.58E+06
Jul-57	0	1.36E+09	3.04E+08	8.13E+07	6.09E+04	1.74E+09	1.02	3.75E+07	3.82E+07	1.46E+06
Sep-57	0	1.30E+09	2.91E+08	7.77E+07	5.82E+04	1.67E+09	1.02	3.75E+07	3.82E+07	1.39E+06
Aug-57	0	1.00E+09	2.25E+08	6.01E+07	4.50E+04	1.29E+09	1.02	3.75E+07	3.82E+07	1.08E+06
Nov-57	0	7.68E+08	1.72E+08	4.59E+07	3.44E+04	9.86E+08	1.02	3.75E+07	3.82E+07	8.23E+05
Dec-57	0	6.80E+08	1.52E+08	4.06E+07	3.04E+04	8.72E+08	1.02	3.75E+07	3.82E+07	7.28E+05
Oct-57	0	5.61E+08	1.26E+08	3.36E+07	2.51E+04	7.21E+08	1.02	3.75E+07	3.82E+07	6.01E+05
Jan-57	0	1.68E+09	3.77E+08	1.01E+08	7.54E+04	2.16E+09	1.02	3.75E+07	3.82E+07	1.80E+06
May-56	0	3.69E+09	8.27E+08	2.09E+08	1.65E+05	4.73E+09	1.02	3.74E+07	3.81E+07	3.94E+06
Sep-56	0	1.27E+09	2.84E+08	7.20E+07	5.69E+04	1.63E+09	1.02	3.74E+07	3.81E+07	1.35E+06
Jun-56	0	6.62E+09	1.48E+09	3.75E+08	2.96E+05	8.47E+09	1.02	3.74E+07	3.81E+07	7.06E+06

Average Weighted NESD = 3.82E+07

**TOP 30 MONTHLY URANIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon Purex Process Low Heat Waste

Date	MONTHLY URANIUM SDI (rem)					Adjusted Monthly Uranium SDI (rem)	Fraction Increase of Uranium SDI (rem)	Monthly Uranium NESD (rem/gram)	Adjusted Uranium NESD (rem/gram)	Rem Weighted Monthly NESD (rem/gram)
	U-233	U-234	U-235 &		U-238					
			Pa-231,Ac-227	U-236						
May-56	0	0	8.43E+04	0	1.68E+06	1.77E+06	1.01	4.17E+01	4.21E+01	1.31E+00
Feb-56	0	0	8.23E+04	0	1.64E+06	1.72E+06	1.01	4.17E+01	4.21E+01	1.28E+00
Aug-58	0	0	4.22E+04	0	8.41E+05	8.83E+05	1.01	4.17E+01	4.21E+01	6.53E-01
Feb-57	0	0	1.45E+05	0	2.88E+06	3.03E+06	1.01	4.17E+01	4.21E+01	2.24E+00
Jun-57	0	0	1.41E+05	0	2.80E+06	2.94E+06	1.01	4.17E+01	4.21E+01	2.18E+00
Mar-57	0	0	1.36E+05	0	2.72E+06	2.86E+06	1.01	4.17E+01	4.21E+01	2.12E+00
Apr-57	0	0	1.36E+05	0	2.72E+06	2.86E+06	1.01	4.17E+01	4.21E+01	2.12E+00
Dec-56	0	0	1.34E+05	0	2.68E+06	2.82E+06	1.01	4.17E+01	4.21E+01	2.08E+00
Dec-55	0	0	1.20E+05	0	2.40E+06	2.52E+06	1.01	4.17E+01	4.21E+01	1.87E+00
Nov-56	0	0	1.18E+05	0	2.36E+06	2.48E+06	1.01	4.17E+01	4.21E+01	1.84E+00
Jul-57	0	0	1.18E+05	0	2.36E+06	2.48E+06	1.01	4.17E+01	4.21E+01	1.84E+00
Sep-56	0	0	1.10E+05	0	2.20E+06	2.31E+06	1.01	4.17E+01	4.21E+01	1.71E+00
Jun-56	0	0	1.04E+05	0	2.08E+06	2.19E+06	1.01	4.17E+01	4.21E+01	1.62E+00
Aug-56	0	0	1.04E+05	0	2.08E+06	2.19E+06	1.01	4.17E+01	4.21E+01	1.62E+00
Jul-56	0	0	9.43E+04	0	1.88E+06	1.98E+06	1.01	4.17E+01	4.21E+01	1.46E+00
Aug-57	0	0	8.83E+04	0	1.76E+06	1.85E+06	1.01	4.17E+01	4.21E+01	1.37E+00
Mar-56	0	0	8.63E+04	0	1.72E+06	1.81E+06	1.01	4.17E+01	4.21E+01	1.34E+00
Apr-56	0	0	8.63E+04	0	1.72E+06	1.81E+06	1.01	4.17E+01	4.21E+01	1.34E+00
Oct-56	0	0	8.63E+04	0	1.72E+06	1.81E+06	1.01	4.17E+01	4.21E+01	1.34E+00
Apr-58	0	0	8.03E+04	0	1.60E+06	1.68E+06	1.01	4.17E+01	4.21E+01	1.24E+00
Jan-58	0	0	7.23E+04	0	1.44E+06	1.51E+06	1.01	4.17E+01	4.21E+01	1.12E+00
Feb-58	0	0	7.03E+04	0	1.40E+06	1.47E+06	1.01	4.17E+01	4.21E+01	1.09E+00
Mar-58	0	0	7.03E+04	0	1.40E+06	1.47E+06	1.01	4.17E+01	4.21E+01	1.09E+00
Nov-57	0	0	6.82E+04	0	1.36E+06	1.43E+06	1.01	4.17E+01	4.21E+01	1.06E+00
Aug-55	0	0	6.42E+04	0	1.28E+06	1.35E+06	1.01	4.17E+01	4.21E+01	9.95E-01
Dec-57	0	0	6.02E+04	0	1.20E+06	1.26E+06	1.01	4.17E+01	4.21E+01	9.33E-01
Jun-58	0	0	5.42E+04	0	1.08E+06	1.14E+06	1.01	4.17E+01	4.21E+01	8.40E-01
Jan-59	0	0	5.22E+04	0	1.04E+06	1.09E+06	1.01	4.17E+01	4.21E+01	8.09E-01
Feb-59	0	0	5.22E+04	0	1.04E+06	1.09E+06	1.01	4.17E+01	4.21E+01	8.09E-01
Dec-58	0	0	5.02E+04	0	1.00E+06	1.05E+06	1.01	4.17E+01	4.21E+01	7.78E-01
Average Weighted NESD =									4.21E+01	

**TOP 30 MONTHLY PLUTONIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon HM Process High Heat Waste

Date	MONTHLY PLUTONIUM SDI (rem)					Adjusted Monthly PLUTONIUM SDI (rem)	Fraction Increase of PLUTONIUM SDI (rem)	Am-241	Rem
	Pu-238	Pu-239	Pu-240	Pu-241 & Am-241	Pu-242			Adjusted PLUTONIUM NESD (rem/gram)	Weighted Monthly NESD (rem/gram)
May-65	4.22E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E+11	1.00E+00	7.88E+09	7.23E+07
Jan-66	1.17E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E+11	1.00E+00	7.88E+09	2.01E+07
Jun-66	1.17E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E+11	1.00E+00	7.88E+09	2.01E+07
Apr-65	9.17E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.17E+10	1.00E+00	7.88E+09	1.57E+07
Jul-66	8.01E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.01E+10	1.00E+00	7.88E+09	1.37E+07
Jun-65	7.95E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.95E+10	1.00E+00	7.88E+09	1.36E+07
Feb-67	6.21E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.21E+10	1.00E+00	7.88E+09	1.06E+07
Mar-66	6.16E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E+10	1.00E+00	7.88E+09	1.06E+07
May-67	3.11E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.11E+10	1.00E+00	7.88E+09	5.32E+06
Jan-68	2.50E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+10	1.00E+00	7.88E+09	4.29E+06
May-68	1.25E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E+10	1.00E+00	7.88E+09	2.15E+06
Mar-68	6.26E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E+09	1.00E+00	7.88E+09	1.07E+06
Oct-68	6.26E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E+09	1.00E+00	7.88E+09	1.07E+06
Mar-67	6.21E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.21E+09	1.00E+00	7.88E+09	1.06E+06
Mar-65	6.11E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.11E+09	1.00E+00	7.88E+09	1.05E+06
Apr-66	1.66E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E+11	1.00E+00	7.88E+09	2.85E+07
May-66	1.66E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E+11	1.00E+00	7.88E+09	2.85E+07
Aug-65	6.11E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.11E+10	1.00E+00	7.88E+09	1.05E+07
Feb-66	4.93E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.93E+10	1.00E+00	7.88E+09	8.45E+06
Sep-69	3.79E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.79E+10	1.00E+00	7.88E+09	6.49E+06
Aug-77	6.34E+12	1.16E+09	0.00E+00	1.36E+11	0.00E+00	6.48E+12	1.01E+00	7.04E+09	9.93E+08
May-70	9.27E+12	3.96E+10	2.53E+10	5.71E+10	6.99E+07	9.40E+12	1.00E+00	3.46E+09	7.07E+08
Apr-70	7.79E+12	3.36E+10	2.12E+10	4.89E+10	5.86E+07	7.89E+12	1.00E+00	3.44E+09	5.90E+08
Aug-70	3.30E+12	1.55E+10	9.05E+09	1.96E+10	2.46E+07	3.35E+12	1.00E+00	3.31E+09	2.41E+08
Mar-70	3.03E+12	1.43E+10	8.24E+09	1.96E+10	2.27E+07	3.07E+12	1.00E+00	3.29E+09	2.20E+08
Sep-70	2.79E+12	1.34E+10	7.66E+09	1.79E+10	2.08E+07	2.83E+12	1.00E+00	3.27E+09	2.01E+08
Jul-70	5.27E+12	2.60E+10	1.42E+10	3.45E+10	3.78E+07	5.34E+12	1.00E+00	3.23E+09	3.75E+08
Dec-70	1.81E+12	9.45E+09	4.99E+09	1.14E+10	1.32E+07	1.84E+12	1.00E+00	3.14E+09	1.26E+08
Jun-70	2.91E+12	1.68E+10	7.66E+09	2.01E+10	2.08E+07	2.95E+12	1.00E+00	2.98E+09	1.91E+08
Oct-70	1.19E+12	7.23E+09	3.25E+09	6.74E+09	9.45E+06	1.21E+12	1.00E+00	2.90E+09	7.64E+07

Average Weighted NESD = 4.00E+09

**TOP 30 MONTHLY URANIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon HM Process High Heat Waste

Date	MONTHLY URANIUM SDI (rem)					Adjusted Monthly Uranium SDI (rem)	Fraction Increase of Uranium SDI (rem)	Monthly Uranium NESD (rem/gram)	Adjusted Uranium NESD (rem/gram)	Rem Weighted Monthly NESD (rem/gram)
	U-233 &		U-235 &							
	Th-229	U-234	Pa-231,Ac-227	U-236	U-238					
Jan-70	2.34E+08	1.31E+06	1.43E+01	0.00E+00	1.19E+01	2.35E+08	1.30	1.24E+06	1.61E+06	3.24E+04
Jul-72	3.04E+07	2.15E+05	1.85E+00	1.47E+01	1.53E+00	3.06E+07	1.30	1.24E+06	1.61E+06	4.20E+03
Aug-72	1.39E+08	9.84E+05	8.45E+00	6.75E+01	7.01E+00	1.40E+08	1.30	1.24E+06	1.61E+06	1.92E+04
Aug-73	2.90E+08	2.21E+06	4.12E+01	1.41E+02	1.69E+01	2.93E+08	1.30	1.24E+06	1.61E+06	4.02E+04
Sep-73	4.18E+08	3.18E+06	5.94E+01	2.03E+02	2.43E+01	4.21E+08	1.30	1.24E+06	1.61E+06	5.78E+04
Oct-73	1.66E+08	1.26E+06	2.36E+01	8.07E+01	9.64E+00	1.67E+08	1.30	1.24E+06	1.61E+06	2.30E+04
Nov-73	1.46E+09	1.11E+07	2.07E+02	7.08E+02	8.46E+01	1.47E+09	1.30	1.24E+06	1.61E+06	2.01E+05
May-68	1.18E+09	5.09E+07	0.00E+00	0.00E+00	0.00E+00	1.23E+09	1.28	1.21E+06	1.56E+06	1.64E+05
Mar-68	7.39E+08	3.19E+07	0.00E+00	0.00E+00	0.00E+00	7.70E+08	1.28	1.21E+06	1.56E+06	1.03E+05
Apr-68	2.72E+08	1.18E+07	0.00E+00	0.00E+00	0.00E+00	2.84E+08	1.28	1.21E+06	1.56E+06	3.78E+04
Aug-74	3.19E+09	7.10E+07	2.10E+05	1.02E+06	2.77E+04	3.27E+09	1.29	7.19E+05	9.28E+05	2.59E+05
May-72	2.20E+08	3.04E+06	1.71E+04	3.31E+05	6.57E+02	2.24E+08	1.29	6.88E+05	8.91E+05	1.70E+04
Jun-72	2.20E+08	3.04E+06	1.71E+04	3.31E+05	6.57E+02	2.24E+08	1.29	6.88E+05	8.91E+05	1.70E+04
Feb-69	8.92E+08	4.16E+07	1.30E+05	6.75E+05	2.18E+03	9.34E+08	1.28	6.37E+05	8.17E+05	6.51E+04
Oct-69	2.62E+08	4.74E+06	7.05E+04	3.38E+05	1.86E+03	2.67E+08	1.29	4.36E+05	5.63E+05	1.28E+04
Jan-69	4.23E+08	2.43E+07	1.65E+05	8.61E+05	2.75E+03	4.44E+08	1.28	3.58E+05	4.57E+05	1.75E+04
Dec-69	3.33E+08	7.81E+06	1.20E+05	6.74E+05	3.68E+03	3.41E+08	1.29	3.46E+05	4.46E+05	1.30E+04
Feb-70	2.88E+08	1.24E+07	2.10E+05	1.28E+06	6.99E+03	3.02E+08	1.28	1.99E+05	2.56E+05	6.58E+03
Nov-69	3.12E+08	1.34E+07	2.43E+05	1.26E+06	6.86E+03	3.27E+08	1.28	1.97E+05	2.53E+05	7.05E+03
Jul-73	1.69E+08	1.15E+07	2.56E+05	3.64E+05	2.51E+03	1.81E+08	1.27	1.39E+05	1.78E+05	2.75E+03
Dec-73	2.88E+07	1.35E+07	1.59E+05	2.32E+06	6.34E+03	4.47E+07	1.18	3.88E+04	4.56E+04	1.74E+02
Jan-71	0.00E+00	1.03E+07	8.87E+04	2.21E+06	4.07E+03	1.26E+07	1.00	1.88E+04	1.88E+04	2.03E+01
May-75	0.00E+00	6.40E+06	4.33E+04	1.70E+06	3.19E+03	8.15E+06	1.00	1.85E+04	1.85E+04	1.29E+01
Dec-75	0.00E+00	6.63E+06	5.88E+04	1.45E+06	3.16E+03	8.15E+06	1.00	1.79E+04	1.79E+04	1.24E+01
Jun-75	0.00E+00	1.24E+06	9.15E+03	3.42E+05	6.46E+02	1.59E+06	1.00	1.76E+04	1.77E+04	2.40E+00
Mar-74	0.00E+00	3.51E+06	3.78E+04	6.34E+05	1.55E+03	4.18E+06	1.00	1.73E+04	1.73E+04	6.17E+00
Dec-70	0.00E+00	7.18E+06	8.32E+04	1.19E+06	2.99E+03	8.46E+06	1.00	1.71E+04	1.72E+04	1.24E+01
Nov-76	0.00E+00	2.18E+06	2.60E+04	2.54E+05	1.13E+03	2.46E+06	1.00	1.71E+04	1.71E+04	3.60E+00
Nov-75	0.00E+00	5.46E+07	5.79E+05	1.08E+07	2.56E+04	6.60E+07	1.00	1.70E+04	1.70E+04	9.58E+01
Mar-72	0.00E+00	3.53E+06	3.77E+04	7.58E+05	1.56E+03	4.33E+06	1.00	1.68E+04	1.68E+04	6.21E+00

Average Weighted NESD = 1.10E+06

TOP 30 MONTHLY PLUTONIUM
NORMALIZED ELEMENTAL SOURCE DOSES

H-Canyon HM Process Low Heat Waste

Date	MONTHLY PLUTONIUM SDI (rem)					Adjusted Monthly PLUTONIUM SDI (rem)	Fraction Increase of PLUTONIUM SDI (rem)	Monthly PLUTONIUM NESD (rem/gram)	Am-241	Rem
	Pu-238	Pu-239	Pu-240	Pu-241 & Am-241	Pu-242				Adjusted PLUTONIUM NESD (rem/gram)	Weighted Monthly NESD (rem/gram)
May-65	331E+11	0	0	0	0	331E+11	1.00	7.88E+09	7.88E+09	1.11E+09
May-84	1.50E+11	0	0	0	0	1.50E+11	1.00	7.88E+09	7.88E+09	5.05E+08
Jan-83	1.13E+11	0	0	0	0	1.13E+11	1.00	7.88E+09	7.88E+09	3.80E+08
Aug-85	1.04E+11	0	0	0	0	1.04E+11	1.00	7.88E+09	7.88E+09	3.51E+08
Feb-88	9.86E+10	0	0	0	0	9.86E+10	1.00	7.88E+09	7.88E+09	3.32E+08
Dec-84	8.36E+10	0	0	0	0	8.36E+10	1.00	7.88E+09	7.88E+09	2.81E+08
Feb-77	7.46E+10	0	0	0	0	7.46E+10	1.00	7.88E+09	7.88E+09	2.51E+08
Oct-85	7.34E+10	0	0	0	0	7.34E+10	1.00	7.88E+09	7.88E+09	2.47E+08
Oct-66	6.91E+10	0	0	0	0	6.91E+10	1.00	7.88E+09	7.88E+09	2.33E+08
Jan-71	5.23E+10	0	0	0	0	5.23E+10	1.00	7.88E+09	7.88E+09	1.76E+08
May-70	5.03E+10	0	0	0	0	5.03E+10	1.00	7.88E+09	7.88E+09	1.69E+08
Jan-86	3.70E+10	0	0	0	0	3.70E+10	1.00	7.88E+09	7.88E+09	1.24E+08
Feb-66	3.70E+10	0	0	0	0	3.70E+10	1.00	7.88E+09	7.88E+09	1.24E+08
Mar-72	3.69E+10	0	0	0	0	3.69E+10	1.00	7.88E+09	7.88E+09	1.24E+08
Jan-73	3.67E+10	0	0	0	0	3.67E+10	1.00	7.88E+09	7.88E+09	1.24E+08
Aug-77	3.62E+10	0	0	0	0	3.62E+10	1.00	7.88E+09	7.88E+09	1.22E+08
Mar-79	3.44E+10	0	0	0	0	3.44E+10	1.00	7.88E+09	7.88E+09	1.16E+08
Jul-71	2.05E+10	0	0	0	0	2.05E+10	1.00	7.88E+09	7.88E+09	6.88E+07
Jun-77	1.89E+10	0	0	0	0	1.89E+10	1.00	7.88E+09	7.88E+09	6.35E+07
Aug-82	1.85E+10	0	0	0	0	1.85E+10	1.00	7.88E+09	7.88E+09	6.21E+07
Aug-86	1.79E+10	0	0	0	0	1.79E+10	1.00	7.88E+09	7.88E+09	6.02E+07
Jul-65	1.17E+10	0	0	0	0	1.17E+10	1.00	7.88E+09	7.88E+09	3.94E+07
Oct-68	9.32E+09	0	0	0	0	9.32E+09	1.00	7.88E+09	7.88E+09	3.13E+07
Oct-70	9.16E+09	0	0	0	0	9.16E+09	1.00	7.88E+09	7.88E+09	3.08E+07
Aug-73	9.12E+09	0	0	0	0	9.12E+09	1.00	7.88E+09	7.88E+09	3.07E+07
Mar-68	7.67E+09	0	0	0	0	7.67E+09	1.00	7.88E+09	7.88E+09	2.58E+07
May-90	7.52E+09	0	0	0	0	7.52E+09	1.00	7.88E+09	7.88E+09	2.53E+07
Oct-67	6.51E+09	0	0	0	0	6.51E+09	1.00	7.88E+09	7.88E+09	2.19E+07
Sep-78	1.63E+08	0	0	0	0	1.63E+08	1.00	7.88E+09	7.88E+09	5.47E+05
Jun-79	7.87E+11	0	0	0	0	7.87E+11	1.00	7.88E+09	7.88E+09	2.65E+09
Average Weighted NESD =									7.88E+09	

**TOP 30 MONTHLY URANIUM
NORMALIZED ELEMENTAL SOURCE DOSES**

H-Canyon HM Process Low Heat Waste

Date	MONTHLY URANIUM SDI (rem)					Adjusted Monthly Uranium SDI (rem)	Fraction Increase of Uranium SDI (rem)	Monthly Uranium NESD (rem/gram)	Adjusted Uranium NESD (rem/gram)	Rem Weighted Monthly NESD
	U-233 & Th-229	U-234	U-235 & Pa-231,Ac-227	U-236	U-238					
Jul-72	3.04E+07	2.15E+05	1.85E+00	1.47E+01	1.53E+00	3.06E+07	1.30	1.24E+06	1.61E+06	8.22E+03
Oct-73	4.15E+07	3.15E+05	5.89E+00	2.02E+01	2.41E+00	4.18E+07	1.30	1.24E+06	1.61E+06	1.12E+04
Aug-73	3.35E+07	2.55E+05	4.76E+00	1.63E+01	1.95E+00	3.38E+07	1.30	1.24E+06	1.61E+06	9.07E+03
Sep-73	3.83E+07	2.91E+05	5.44E+00	1.86E+01	2.22E+00	3.86E+07	1.30	1.24E+06	1.61E+06	1.04E+04
Jul-74	1.57E+09	1.19E+07	2.23E+02	7.62E+02	9.10E+01	1.58E+09	1.30	1.24E+06	1.61E+06	4.24E+05
Nov-73	1.72E+08	1.31E+06	2.45E+01	8.38E+01	1.00E+01	1.74E+08	1.30	1.24E+06	1.61E+06	4.67E+04
May-68	5.89E+08	2.55E+07	0.00E+00	0.00E+00	0.00E+00	6.14E+08	1.28	1.21E+06	1.56E+06	1.60E+05
Feb-69	7.67E+07	3.08E+06	1.34E+02	2.40E+02	4.16E+00	7.98E+07	1.29	1.20E+06	1.55E+06	2.06E+04
Jan-69	6.79E+07	2.73E+06	1.18E+02	2.13E+02	3.68E+00	7.07E+07	1.29	1.20E+06	1.55E+06	1.83E+04
Aug-72	5.62E+08	5.01E+06	1.07E+04	9.61E+04	6.16E+02	5.68E+08	1.30	1.06E+06	1.37E+06	1.30E+05
Oct-69	3.12E+08	2.16E+06	8.86E+03	4.24E+04	2.47E+02	3.14E+08	1.30	1.04E+06	1.34E+06	7.06E+04
Jan-70	1.23E+08	1.07E+06	7.58E+03	4.24E+04	2.37E+02	1.24E+08	1.30	8.57E+05	1.11E+06	2.31E+04
Nov-69	9.03E+07	8.98E+05	8.21E+03	4.24E+04	2.35E+02	9.12E+07	1.30	7.54E+05	9.77E+05	1.49E+04
Mar-68	3.69E+08	1.79E+07	3.89E+04	2.01E+05	6.46E+02	3.87E+08	1.28	7.34E+05	9.41E+05	6.09E+04
Dec-69	7.26E+07	7.81E+05	7.58E+03	4.24E+04	2.34E+02	7.35E+07	1.30	7.06E+05	9.14E+05	1.12E+04
Jun-72	1.40E+07	1.94E+05	1.09E+03	2.11E+04	4.19E+01	1.43E+07	1.29	6.88E+05	8.91E+05	2.12E+03
May-72	1.40E+07	1.94E+05	1.09E+03	2.11E+04	4.19E+01	1.43E+07	1.29	6.88E+05	8.91E+05	2.12E+03
Jun-74	1.95E+08	3.72E+06	2.30E+04	1.36E+05	4.84E+02	1.99E+08	1.29	6.83E+05	8.83E+05	2.93E+04
Dec-73	4.53E+08	8.80E+06	4.69E+04	6.73E+05	2.16E+03	4.62E+08	1.29	6.23E+05	8.04E+05	6.22E+04
Aug-74	3.53E+08	5.86E+06	9.07E+04	1.97E+05	1.21E+03	3.59E+08	1.29	4.96E+05	6.41E+05	3.85E+04
Feb-70	9.51E+06	4.10E+05	6.94E+03	4.24E+04	2.31E+02	9.97E+06	1.28	1.99E+05	2.56E+05	4.26E+02
Apr-68	1.48E+08	1.30E+07	1.29E+05	6.75E+05	2.13E+03	1.61E+08	1.27	1.97E+05	2.50E+05	6.75E+03
Jun-68	3.86E+08	5.45E+07	7.78E+05	4.05E+06	1.29E+04	4.46E+08	1.25	1.00E+05	1.26E+05	9.36E+03
Jul-73	2.44E+07	2.99E+06	6.05E+04	8.60E+04	5.86E+02	2.75E+07	1.26	9.47E+04	1.19E+05	5.48E+02
Oct-71	2.93E+07	3.81E+06	6.80E+04	4.24E+05	1.81E+03	3.35E+07	1.25	8.06E+04	1.01E+05	5.66E+02
Sep-71	1.79E+07	8.98E+06	1.60E+05	1.00E+06	4.27E+03	2.80E+07	1.17	3.17E+04	3.72E+04	1.74E+02
Jan-71	0.00E+00	3.87E+06	3.32E+04	8.27E+05	1.52E+03	4.73E+06	1.00	1.88E+04	1.88E+04	1.49E+01
May-75	0.00E+00	1.22E+06	8.27E+03	3.25E+05	6.09E+02	1.56E+06	1.00	1.85E+04	1.85E+04	4.81E+00
Dec-75	0.00E+00	8.29E+05	7.34E+03	1.82E+05	3.95E+02	1.02E+06	1.00	1.79E+04	1.79E+04	3.04E+00
Jun-75	0.00E+00	1.26E+06	9.35E+03	3.50E+05	6.60E+02	1.62E+06	1.00	1.76E+04	1.77E+04	4.79E+00
Average Weighted NESD =										1.17E+06