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Leaching of Irradiated LWR Fuel Pellets in Deionized and Typical Ground Water

July 1976

Prepared for the Energy Research
and Development Administration
under Contract E(45-1)-1830

Battelle
Pacific Northwest Laboratories

BNWL-2057

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LEACHING OF IRRADIATED LWR FUEL
PELLETS IN DEIONIZED AND TYPICAL
GROUND WATER

Y. B. Katayama

July 1976

Battelle-Northwest

Pacific Northwest Laboratories

This paper is based on work performed under U.S. Energy Research and Development Administration Contract E(45-1):1830.

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INTRODUCTION

This report presents results of leach test experiments on enriched, 5.81 wt% ^{235}U , UO_2 fuel pellet fragments removed from light water reactor (LWR) fuel rods irradiated to an average burnup of 54,450 MWD/MTU. These results are discussed and correlated with similar information about common solidified high-level waste forms. Leach test data were needed to evaluate the relative radiological hazards of storing irradiated fuel rods.

SUMMARY AND CONCLUSIONS

Leach tests were performed on irradiated LWR fuel pellet fragments at 25°C in static Hanford ground water, deionized water and building distilled water. The following conclusions were made:

- The relative leachability of the elements decrease in the order of $\text{Cs} > \text{Sb} > \text{Sr} + \text{Y} > \text{Pu} > \text{Cm}$.
- The leach rates, g of solid/cm²-day, normalized to behavior of specific radioisotopes have the following value after the indicated weeks of leaching:

	<u>Hanford Ground Water (21 weeks)</u>	<u>Building Distilled Water (21 weeks)</u>	<u>Deionized Water (20 weeks)</u>
Cs-137	5×10^{-6}	5×10^{-5}	7×10^{-6}
Sb-125	1×10^{-6}	2×10^{-6}	2×10^{-6}
Sr-90 + Y-90	4×10^{-7}	1×10^{-6}	1×10^{-6}
Pu-239 + 240	1×10^{-8}	4×10^{-7}	3×10^{-7}
Cm-244	4×10^{-9}	5×10^{-8}	4×10^{-9}

The leach tests are continuing and the leach rates are expected to level out at a value lower than the ones reported.

- Two release mechanisms were observed for each radioisotope over the time interval studied. The short term mechanism was linear for ^{244}Cm and logarithmic for the other radioisotopes. This short term mechanism ranged in duration from 5 to 31 days. In every case the long term mechanism was logarithmic and could be fitted to the following expression:

$$\text{Fraction released} = Bt^m.$$

The value for m was found to be 0.07 for Hanford ground water, 0.31 for deionized water, and 0.06 to 0.35 for building distilled water.

- The deionized water was a reference leachant. The Hanford ground water represented typical arid ground water where ionic species retarded the effective diffusional release of the radioisotope to the leachant. The building distilled water was a comparison leachant to the WSEP leach tests and resulted in intermediate leach rates.
- The cesium based periodic leach rate for irradiated fuel fragments are similar to the cesium based leach rate for borosilicate glass containing radioactive waste, WSEP melt SS-13.

EXPERIMENTAL PARAMETERS

Material

The material used in this investigation was fuel fragments removed from LWR fuel rods irradiated to an average burnup of 54,450 MWD/MTU. This 5.81 wt% ^{235}U enriched fuel had a pre-irradiation composition as given in Table 1, and the geometric density was 93.6% of theoretical density. The initial irradiation date was December, 1968, and the discharge date was October, 1973, with a total of 32,800 hours irradiation which includes 27,800 hours at effective full power.

TABLE 1. CHEMICAL ANALYSIS OF FUEL PELLETS
(5.81 w/o U-235 Enrichment)

<u>Element</u>	<u>ppm</u>
Al	10
B	0.22
Bi	<0.4
Ca	20
Cd	<0.4
Co	<1
Cr	28
Cu	<0.4
Fe	30
In	<2
Mg	5.7
Mn	0.83
Mo	4.2
Ni	12
Pb	<1
Si	42
Sn	<1
Ti	<1
V	<1
W	<10
Zn	<20
C	<10
N	<40
F	<5
%u	88.17
%u-235	5.84
Gd	<0.03
Eu	<0.03
Sm	<0.03
Dy	<0.03
No. of Samples	10
No. of Pellets/Sample	1
Avg. ppm	8
Range, ppm	3/11
} Moisture Content	

Equipment

A leach apparatus of the type devised by Paige⁽¹⁾, shown in Figure 1, was used for leaching the fuel fragments. The same apparatus had been used previously for leaching radioactive solidified wastes from the Waste Solidification Engineering Prototype (WSEP) program at the Pacific Northwest Laboratories.⁽²⁾ For comparison purposes, building distilled water was one of the leach liquids investigated. The other leachants were deionized water and Hanford ground water, representing a typical arid region ground water composition, Table 2.

TABLE 2. GROUND WATER COMPOSITION IN PPM IMPURITY

	<u>Typical Arid Ground Water⁽³⁾</u>	<u>Hanford Ground Water</u>
Sulfate	15	20
Nitrate	1	4.2
Chloride	8	3.1
Bicarbonate	125	168
Sodium	20	25
Potassium	5	5.4
Calcium	25	31
Magnesium	5	7.1
pH	6.8 - 8.2	7.9

All the tests were done in ambient temperatures of approximately 25°C within C-Cell, a radiochemical engineering cell in the 324 Building.

Procedure

Large fuel fragment particles were selected for the leach tests in batches of 4 to 5 gram size. These fragment batches were photographed, dimensionally measured and weighed in a tared stainless steel mesh basket. The basket was loaded into a leach apparatus and the leachant added on a Monday to accommodate the preplanned sampling schedule.

FIGURE 1. Slow-Leach Test Used at the Pacific Northwest Laboratory

Analytical samples of leachant were taken at the following intervals: 1 day, 1 day, 1 day, 1 day, 3 days, 7 days, 7 days, 7 days, 30 days, 30 days, 30 days. After each sampling, the leach apparatus was drained and fresh leachant added.

EXPERIMENTAL RESULTS AND DISCUSSION

Calculations

The periodic leach rate, R_p , which has the dimensions of grams of solid/cm²-day was calculated from the following expression:

$$R_p = \frac{A_p}{A_o} \frac{W}{ST_p} \quad (1)$$

where A_p = radioactivity of isotope leached during leachant renewal period, p

A_o = radioactivity of isotope initially present in sample

S = surface area of sample (cm²)

W = weight of sample (grams)

T_p = duration (days) of leach period.

The radioactivity, A_p , was determined by radiochemical analyses. Measurements for ¹³⁷Cs and ¹³⁴Cs activities were made by gamma scan analysis of the leach solution. The high concentration of radioactive cesium interfered with the accurate counting of other gamma emitting radioisotopes. Cesium was extracted from the leach solution with tetraphenylboron after complexing the other elements with ethylenediamine-tetraacetic acid salts in a basic solution. This step lowered the cesium activity sufficiently for the counting of ¹²⁵Sb, ¹⁵⁴Eu, ¹⁴⁴Ce and ¹⁰⁶Ru. The actinides, ²³⁹Pu + ²⁴⁰Pu, ²⁴²Cm, ²⁴⁴Cm and ²⁴¹Am + ²³⁸Pu were extracted from the leach solution sample and quantified by alpha energy analysis. Interference of the ²⁴¹Am determination by ²³⁸Pu is normally corrected by determining the ²³⁸Pu to ²³⁹Pu + ²⁴⁰Pu ratio and applying a correction factor to the ²⁴¹Am + ²³⁸Pu readings. However this method was not applicable for the fuel fragment leach solutions because the A_o

value for ^{238}Pu increases with time. The ^{241}Am was selectively separated from ^{238}Pu and alpha counted in one of the deionized water leach test series, Z-6. $^{90}\text{Sr} + ^{90}\text{Y}$ concentrations were determined by counting after solution stripping.

The radioactivity of isotopes initially present in the sample, A_0 , were taken from the ORIGEN code.⁽⁴⁾ This special ORIGEN code printout included the applicable irradiation and post-irradiation history for the fuel pellet fragments used in the leach tests.⁽⁵⁾ The use of a constant A_0 assumed uniform distribution of activity in the irradiated fuel pellet. Cesium and antimony have been found to be enriched on surfaces of gaps, cracks and pores in irradiated oxide fuel pins and have been occasionally detected in the central void of irradiated oxide fuels.⁽⁶⁾ Newly broken surfaces free of this enrichment may have been formed during fuel fragment removal.

The surface area of the sample, S , was approximated by selectively measuring the dimensions of some of the large particles and applying geometric approximations to photographs of the particles. Examination of the as-received fuel fragments in the hot cell revealed rough dull surfaces typical of high surface solids. Mendel⁽⁷⁾ has reported that the leach rate of radioisotopes in high surface solids when expressed in $\text{g}/\text{cm}^2\text{-day}$ usually yield relatively high values, up to 8000 times greater, when the geometric surface area is used in place of the actual surface area. This effect would give maximum leach rate values. Tingey and Felix^(8,9) have reported on the radiolysis of water by the radiation from high-level waste. The rough textured fracture surface would be amenable for accumulation of adsorbed gases from the radiolytic decomposition of static leachant at the pellet fragment-water interface. This accumulation would then decrease the effective area for diffusion of ions and would have the effect of giving lower leach rate values. Figure 2 is a photograph of the fuel fragments for run Z-5 as viewed through the C-Cell periscope.

FIGURE 2. Fuel fragments. Leach test run Z-5.

The weight, W , of the sample was measured at the start of the leach testing and will be weighed at the termination of the leach program. Periodic measurements, at various leachant renewal periods, were not made. The complexity of remotely weighing samples and the chances for chemical and physical changes at the leaching surfaces during drying were all affirmations of this decision.

The duration of leachant renewal period, T_p , was chosen to coincide with the recommended sampling frequency proposed by Hespe.⁽¹⁰⁾ An exception was the shortening of the weekly sampling period from 8 to 3 weeks, primarily for economic reasons.

Leach Rates

Figure 3 is a graph, based on ^{137}Cs release, where the periodic leach rate is plotted against the days of cumulative leaching. Leach rate trend lines for the three leachants, Hanford ground water, building distilled water, and deionized water, are plotted on this graph along with

FIGURE 3. Leach Rate of Irradiated Fuel Pellet Based on ¹³⁷Cs

the leach rate curve for an in-can-melted borosilicate glass from WSEP run SS-13.⁽¹¹⁾ The borosilicate glass leach rate curve, based on cesium analysis, approximates the cesium based periodic leach rate for fuel fragments.

The periodic leach rate data for all the radioisotopes analyzed are tabulated in the appendix. Selective leaching of the radioisotopes is evident upon examination of the periodic leach rate data. The leach rate based on cesium is 1000 times greater than the curium based leach rate with the other reported elements spread in between. This unequal leach rate of certain elements has been reported by many investigators and was tabulated for many different forms of solidified waste by Mendel.⁽⁷⁾ The relative leachability of elements for the irradiated fuel has been added to this tabulation, Table 3.

Leach Mechanisms

Figures 4 to 7 are graphs in which the fraction of radioisotopes released are plotted against the days of cumulative leach. These logarithmic graphs show that a combination of different mechanisms have taken place. The obvious curved portion of the logarithmic plot for ^{244}Cm was found to be of linear behavior and can be represented by the general equation:

$$F_R = nt + a \quad (2)$$

where F_R is fraction curium released, t is time (days) and n and a are the slope and intercept of the curve, respectively. The data points below the dashed portion of the curve represent a sample surface conditioning anomaly.

The transition from the initial to the long term mechanism occurred in 5 to 31 days. In all cases the long time mechanism is linear on the logarithmic plot and can be represented by the general equation:

$$\log F_R = m \log t + b \quad (3)$$

TABLE 3. Relative Leachability of Elements⁽⁷⁾

Solid Type	Relative Leachability	Reference
Silicate Glass	Cs > Sr > Fe > Zr	Eliassen, 1961 ⁽¹²⁾
Asphalt	Cs > Sr > Ce	Burns, 1971, p. 591 ⁽¹³⁾
Alumina Calcine	Cs, Sr > Ru, Ce, Al	Paige, July 1966 ⁽¹⁾
Lead Glass	Cs > Al > Pb, Sr, Ce	Paige, February 1966 ⁽¹⁴⁾
Phosphate Ceramic	Na, Cs > Sr > Zr-Nb > Ru, Ce	Allemann, 1965 ⁽¹⁵⁾
Borosilicate Glass	Cs, Na > Zr-Nb > Ru, Ce	Allemann, 1965 ⁽¹⁵⁾
Borosilicate Glass	Na > Si > B > Cs > Sr > Ce, Tb	Elliot, 1967 ⁽¹⁶⁾
Borosilicate Glass	Na > B > Si	Heimerl, 1971, p. 34 ⁽¹⁷⁾
Phosphate Glass	Cs > Na, Sr > Ru > Ce	Mendel, 1972 ⁽¹¹⁾
Irradiated Fuel	Cs > Sb > Sr-Y > Pu > Cm

FIGURE 4. Fraction of ^{244}Cm Released to Leachant

FIGURE 5. Fraction of $^{239}\text{Pu} + ^{240}\text{Pu}$ Released to Leachant

FIGURE 6. Fraction of $^{90}\text{Sr} + ^{90}\text{Y}$ Released to Leachant

FIGURE 7. Fraction of ^{137}Cs Released to Leachant

where m is the slope and b is the intercept. This relationship in the classical form is:

$$F_R = Bt^m \quad (4)$$

The values for m are indicative of the leach mechanisms and are tabulated in Table 4. For Hanford ground water the long term leach mechanisms are near identical with an average exponent of 0.07 ± 0.01 . For deionized water the average value for the exponent is $0.31^{+0.01}_{-0.03}$. The building distilled water exponent values are widespread, 0.35 to 0.06, indicating different leach mechanisms. This is probably attributable to the varying quality of the building distilled water,⁽¹⁸⁾ hence varying ionic concentrations.

TABLE 4. Long Term Leach Mechanisms, exponent m

	<u>Hanford Ground Water</u>	<u>Building Distilled Water</u>	<u>Deionized Water</u>
Pu-239 + 240	0.07	0.26	0.30
Sr-90 + Y-90	0.07	0.35	0.32
Cm-244	0.08	0.16	0.28
Cs-137	0.06	0.06	0.32

It is beyond the scope of this report to analyze the leach mechanisms. However the large difference in the exponent values for deionized water and Hanford ground water warrants some discussion. An exponent of 0.5 would indicate a constant diffusion coefficient for the radioisotopes released. The 0.31 exponent for deionized water probably reflects an inverse relationship of the diffusion coefficient for the radioisotope with its ionic concentration in the leachant. In Hanford ground water the exponent of 0.07 reflects the major role of dissolved chemicals in the suppression of leach rate. The varying exponent for the building distilled water from 0.06 to 0.35 re-emphasizes the need for constant leachant composition during leach testing. Deionized water is a reproducible leachant which gives conservative results and allows for comparison of data with those of other investigations.

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APPENDIX

LEACH TEST RESULTSLEACH TEST IDENTIFICATION NUMBER Z-2LABORATORY WHERE TESTS PERFORMED Battelle-Northwest

ANALYST _____

DATE RESULTS REPORTED _____

Part A. Description of Leach SpecimenSpecimen Identification Number Z-2Proportion of Waste Incorporated in Mixture Irradiated LWR fuel pellet Weight %

or _____ Volume%

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

Type and Composition of the Immobilization Material _____

Preparation of Specimen _____

Storage Conditions _____

Appearance:

LEACH TEST RESULTS

Page ___ of ___

LEACH TEST IDENTIFICATION NUMBER Z-2
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part B. Description of Leach Test Procedure

Sample Preparation* _____

Initial Weight of Sample, W 5.1833 grams
Volume of Sample, V _____
Surface Area of Sample, S 11.7 cm²
Method of Surface Area Determination geometric approximation

Diagram of Leach Apparatus: Paige type

Leachant Hanford Ground Water
Leachant Volume, V_L 500 ml
Sampling Procedure drain leachant and refill at sampling

Analytical Techniques:
pH Instrument Identification and Calibration _____

Constituent a₁, Analytical Procedure, Standard Deviation of Method _____

Constituent a₂, Analytical Procedure, Standard Deviation of Method _____

*If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

Z-2

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED

ANALYST

DATE RESULTS REPORTS

Part C. Experimental Data

Constituent Analyzed, A Cesium-137

Initial Amount in Sample A_0 0.8716 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{W}{St_n} \right)$	Σa_1	$\Sigma \frac{a_1}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			3.65 +7	4.46 +3		8.22 -3	4.18 -3		9.43 -3
8-19-75	8-20-75	1	2			2.78 +6			6.26 -4	3.17 -4	8.85 -3	1.01 -2
8-20-75	8-21-75	1	3			1.62 +6			3.65 -4	1.85 -4	9.21 -3	1.06 -2
8-21-75	8-22-75	1	4			1.32 +6			2.97 -4	1.50 -4	9.51 -3	1.09 -2
8-22-75	8-25-75	3	7			3.00 +6			6.76 -4	1.14 -4	1.02 -2	1.17 -2
8-25-75	9-2-75	8	15			3.48 +6			7.84 -4	4.96 -5	1.10 -2	1.26 -2
9-2-75	9-8-75	6	21			2.57 +6			5.79 -4	4.86 -5	1.15 -2	1.32 -2
9-8-75	9-18-75	10	31			2.76 +6			6.22 -4	3.15 -5	1.22 -2	1.40 -2
9-18-75	10-17-75	29	60			1.23 +6			2.77 -4	4.84 -6	1.24 -2	1.43 -2
10-17-75	11-18-75	32	92			2.09 +6			4.71 -4	7.44 -6	1.29 -2	1.48 -2
11-18-75	12-17-75	29	121			1.42 +6			3.20 -4	5.58 -6	1.32 -2	1.52 -2
12-17-75	1-15-76	29	150			1.11 +6			2.50 -4	4.36 -6	1.35 -2	1.55 -2
1-15-76												

** Concentration in leachate, show units.

*** a_1 = corrected concentration $\times V_L$ $\times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium-134
Initial Amount in Sample A_0 1.295 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{S t_n} \right)$	Σa_i	$\frac{\Sigma a_i}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	21	0.986				8.11 -3			
8-19-75	8-20-75	1	2	21	0.986				5.71 -4			
8-20-75	8-21-75	1	3	20	0.987				3.35 -4			
8-21-75	8-22-75	1	4	19	0.987				2.76 -4			
8-22-75	8-25-75	3	7	16	0.989				6.26 -4			
8-25-75	9-2-75	8	15	16	0.989				7.83 -4			
9-2-75	9-8-75	6	21	18	0.988				5.93 -4			
9-8-75	9-18-75	10	31	44	0.971				6.45 -4			
9-18-75	10-17-75	29	60	16	0.989				2.78 -4			
10-17-75	11-18-75	32	92	30	0.980				4.04 -4			
11-18-75	12-17-75	29	121	45	0.970				2.60 -4			
12-17-75	1-15-76	29	150	16	0.989				1.93 -4			
1-15-76												

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** Concentration in leachate, show units.

*** a_i = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Z-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Plutonium-239 + 240
Initial Amount in Sample A_0 4.3680×10^{-5} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK ()	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{W}{S t_n} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			1.36 +2			3.06 -8	3.10 -6	3.06 -8	7.00 -6
8-19-75	8-20-75	1	2			7.3 +1			1.64 -8	1.66 -6	4.70 -8	1.08 -5
8-20-75	8-21-75	1	3			5.7 +1			1.28 -8	1.30 -6	5.98 -8	1.37 -5
8-21-75	8-22-75	1	4			5.6 +1			1.26 -8	1.28 -6	7.24 -8	1.66 -5
8-22-75	8-25-75	3	7			7.4 +1			1.67 -8	5.62 -7	8.91 -8	2.04 -5
8-25-75	9-2-75	8	15			2.08 +1			4.68 -9	5.92 -8	9.38 -8	2.14 -5
9-2-75	9-8-75	6	21			9.2 0			2.07 -9	3.50 -8	9.58 -8	2.20 -5
9-8-75	9-18-75	10	31			2.4 +1			5.41 -9	5.48 -8	1.01 -7	2.32 -5
9-18-75	10-17-75	29	60			2.0 +1			4.50 -9	1.57 -8	1.06 -7	2.42 -5
10-17-75	11-18-75	32	92			8.2 0			1.85 -9	5.86 -9	1.08 -7	2.47 -5
11-18-75	12-17-75	29	121			2.0 +1			4.50 -9	1.57 -8	1.12 -7	2.57 -5
12-17-75	1-15-76	29	150			2.33 +1			5.25 -9	1.83 -8	1.18 -7	2.70 -5
1-15-76												

** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_L x factor to convert to same units as A_0 .

Page ____ of ____

DATE RESULTS REPORTS _____

Experimental Data

Constituent Analyzed, A	Curium-242
Initial Amount in Sample A_0	1.825×10^{-2} Ci

[illegible]

*** a_1 = corrected concentration $\times V_L$ x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER 7-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium-244
 Initial Amount in Sample A_0 0.028734 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{Si_n} \right)$	Σa_i	$\frac{\Sigma a_i n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			4.70 +2	<2		1.06 -7	1.63 -6	1.06 -7	3.68 -6
8-19-75	8-20-75	1	2			4.5 +1			1.01 -8	1.56 -7	1.16 -7	4.04 -6
8-20-75	8-21-75	1	3			6.6 +1			1.49 -8	2.29 -7	1.31 -7	4.55 -6
8-21-75	8-22-75	1	4			4.1 +1			9.23 -9	1.42 -7	1.40 -7	4.98 -6
8-22-75	8-25-75	3	7			3.6 +1			8.11 -9	4.16 -8	1.48 -7	5.16 -6
8-25-75	9-2-75	8	15			2.09 +1			4.71 -9	9.07 -9	1.53 -7	5.32 -6
9-2-75	9-8-75	6	21			3.1 +1			6.98 -9	1.79 -8	1.60 -7	5.56 -6
9-8-75	9-18-75	10	31			1.7 +1			3.83 -9	5.90 -9	1.64 -7	5.70 -6
9-18-75	10-17-75	29	60			2.0 +1			4.50 -9	2.39 -9	1.68 -7	5.85 -6
10-17-75	11-18-75	32	92			6.1 0			1.37 -9	6.60 -10	1.69 -7	5.89 -6
11-18-75	12-17-75	29	121			2.16 +1			4.86 -9	2.58 -9	1.74 -7	6.06 -6
12-17-75	1-15-76	29	150			4.09 +1			1.12 -8	5.07 -9	1.85 -7	6.45 -6
1-15-75												

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** Concentration in leachate, show units.

*** a_i = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST RESULTS

of

LEACH TEST IDENTIFICATION NUMBER Z-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Antimony-125
Initial Amount in Sample A_0 3.684×10^{-2} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml) ^{..}	BLANK ()	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{Si_n} \right)$	Σa_i	$\frac{C_{an}}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	164	0.917	2.85 +4			7.02 -6			
8-19-75	8-20-75	1	2	163	0.917	8.87 +3			2.18 -6			
8-20-75	8-21-75	1	3	162	0.918	6.52 +3			1.60 -6			
8-21-75	8-22-75	1	4	161	0.918	6.71 +3			1.65 -6			
8-22-75	8-25-75	3	7	158	0.920	1.27 +4			3.11 -6			
8-25-75	9-2-75	8	15	150	0.924	1.38 +4			3.36 -6			
9-2-75	9-8-75	6	21	246	0.875	8.4 +3			2.16 -6			
9-8-75	9-18-75	10	31	237	0.880	6.79 +3			1.74 -6			
9-18-75	10-17-75	29	60	209	0.894	7.05 +3			1.78 -6			
10-17-75	11-18-75	32	92	177	0.910	1.24 +4			3.07 -6			
11-18-75	12-17-75	29	121	50	0.975	1.08 +4			2.49 -6			
12-17-75	1-15-76	29	150	22	0.989	1.06 +4			2.41 -6			

** Concentration in leachate, show units.

*** a_i = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Europium-154
Initial Amount in Sample A_0 0.062968 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK ()	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{S t_n} \right)$	$\sum a_i$	$\frac{\sum a_i}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			4.5 +2			1.01 -7	7.11 -7	1.01 -7	1.61 -6
8-19-75	8-20-75	1	2			2.0 +2			6.53 -8	4.59 -7	1.67 -7	2.65 -6
8-20-75	8-21-75	1	3			2.1 +2			4.73 -8	3.32 -7	2.14 -7	3.40 -6
8-21-75	8-22-75	1	4			1.4 +2			3.15 -8	2.21 -7	2.46 -7	3.90 -6
8-22-75	8-25-75	3	7			3.3 +2			7.43 -8	1.74 -7	3.20 -7	5.08 -6
8-25-75	9-2-75	8	15									
9-2-75	9-8-75	6	21									
9-8-75	9-18-75	10	31			1.7 +2						
9-18-75	10-17-75	29	60			<1 +2						
10-17-75	11-18-75	32	92			<1 +2						
11-18-75	12-17-75	29	121			<1 +2				<5.45 -8		
12-17-75	1-15-76	29	150			3.1 +2				1.69 -8		

** Concentration in leachate, show units.

*** a_i = corrected concentration $\times V_i \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Ruthenium-106
Initial Amount in Sample A_0 0.8969 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED ($\mu\text{Ci}/\text{m}^2$)**	BLANK ()	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{W}{S t_n} \right)$	Σa_1	$\frac{E_{an}}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	164	0.778	3.71 +4			1.07 -5			
8-19-75	8-20-75	1	2	163	0.778	7.75 +3			2.24 -6			
8-20-75	8-21-75	1	3	162	0.779	5.18 +3			1.50 -6			
8-21-75	8-22-75	1	4	161	0.781	4.23 +3			1.22 -6			
8-22-75	8-25-75	3	7	158	0.785	5.71 +3			1.64 -6			
8-25-75	9-2-75	8	15	150	0.796	3.98 +3			1.13 -6			
9-2-75	9-8-75	6	21	246	0.665	3.25 +3			1.10 -6			
9-8-75	9-18-75	10	31	237	0.677	3.16 +3			1.05 -6			
9-18-75	10-17-75	29	60	209	0.715	6.07 +2			1.91 -7			
10-17-75	11-18-75	32	92	177	0.759	1.13 +3			3.35 -7			
11-18-75	12-17-75	29	121	50	0.932	2.08 +3			5.03 -7			
12-17-75	1-15-76	29	150	22	0.970	2.12 +3			4.92 -7			

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** Concentration in leachate, show units.

*** a_1 = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-2

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental DataConstituent Analyzed, A Strontium-90 + Yttrium-90Initial Amount in Sample A_0 1.3389 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK ()	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	$\sum a_1$	$\frac{\sum a_1}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			2.0 +6			4.50 -4	1.40 -4	4.50 -4	3.36 -4
8-19-75	8-20-75	1	2			1.4 +5			3.15 -5	1.04 -5	4.82 -4	3.60 -4
8-20-75	8-21-75	1	3			5.4 +4			1.22 -5	4.02 -6	4.04 -4	3.60 -4
8-21-75	8-22-75	1	4			2.0 +4			1.30 -5	5.06 -6	5.12 -4	3.93 -4
8-22-75	8-25-75	3	7			7.2 +4			1.62 -5	1.70 -6	5.28 -4	3.95 -4
8-25-75	9-2-75	8	15			6.0 +4			1.55 -5	6.42 -7	5.44 -4	4.06 -4
9-2-75	9-8-75	6	21			6.0 +4			1.55 -5	8.57 -7	5.50 -4	4.18 -4
9-8-75	9-18-75	10	31			7.2 +4			1.76 -5	5.81 -7	5.77 -4	4.31 -4
9-18-75	10-17-75	29	60			3.8 +4			1.08 -5	2.26 -7	5.07 -4	4.46 -4
10-17-75	11-18-75	32	92			2.1 +5			4.73 -5	4.89 -7	6.44 -4	4.81 -4
11-18-75	12-17-75	29	121			1.66 +5			3.74 -5	4.27 -7	6.81 -4	5.09 -4
12-17-75	1-15-76	29	150			1.7 +5			3.33 -5	4.37 -7	7.20 -4	5.38 -4
1-15-75												

** Concentration in leachate, show units.

*** a_1 = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Z-3
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part A. Description of Leach Specimen

Specimen Identification Number Z-3
Proportion of Waste Incorporated in Mixture Irradiated LWR fuel pellet Weight %
or _____ Volume%
(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

Type and Composition of the Immobilization Material

Preparation of Specimen

Storage Conditions

Appearance:

LEACH TEST RESULTS

Page ___ of ___

LEACH TEST IDENTIFICATION NUMBER Z-3
 LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
 ANALYST _____
 DATE RESULTS REPORTED _____

Part B. Description of Leach Test Procedure

Sample Preparation* _____

Initial Weight of Sample, W 5.0482 gms
 Volume of Sample, V _____
 Surface Area of Sample, S 11.4 cm²
 Method of Surface Area Determination geometric approximation

Diagram of Leach Apparatus: Paige type

Leachant Hanford Ground Water
 Leachant Volume, V_l 500 ml
 Sampling Procedure Drain leachant and refill at sampling.

Analytical Techniques:
 pH Instrument Identification and Calibration _____

Constituent a₁, Analytical Procedure, Standard Deviation of Method _____

Constituent a₂, Analytical Procedure, Standard Deviation of Method _____

*If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-3

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium 137
Initial Amount in Sample A_0 0.8489 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			4.69 + 7	4.53 + 3		1.06 - 2	5.53 - 3	1.06 - 2	1.25 - 2
8-19-75	8-20-75	1	2			5.64 6			1.27 - 3	6.66 - 4	1.19 - 2	1.40 - 2
8-20-75	8-21-75	1	3			2.40 + 6			5.41 - 4	2.83 - 4	1.24 - 2	1.46 - 2
8-21-75	8-22-75	1	4			1.66 + 6			3.74 - 4	1.96 - 4	1.28 - 2	1.51 - 2
8-22-75	8-25-75	3	7			3.27 + 6			7.36 - 4	1.29 - 4	1.35 - 2	1.59 - 2
8-25-75	9-02-75	8	15			5.24 + 6			1.18 - 3	7.73 - 5	1.47 - 2	1.73 - 2
9-02-75	9-08-75	6	21			3.27 + 6			7.36 - 4	6.43 - 5	1.54 - 2	1.82 - 2
9-08-75	9-18-75	10	31			2.50 + 6			5.63 - 4	2.95 - 5	1.60 - 2	1.88 - 2
9-18-75	10-17-75	29	60			3.37 + 6			7.59 - 4	1.37 - 5	1.68 - 2	1.97 - 2
10-17-75	11-18-75	32	92			1.99 + 6			4.48 - 4	7.34 - 6	1.72 - 2	2.03 - 2
11-18-75	12-17-75	29	121			1.47 + 6			3.31 - 4	5.98 - 6	1.75 - 2	2.07 - 2
12-17-75	1-15-76	29	150			1.17 + 6			2.64 - 4	4.76 - 6	1.78 - 2	2.10 - 2

** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_L x factor to convert to same units as A_0 .

Page of

DATE RESULTS REPORTS _____

Experimental Data
Constituent Analyzed, A Cesium-134
Initial Amount in Sample A₀ 1.2613 Ci

[illegible]

*** a_1 = corrected concentration $\times V_L$ $\times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-3

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Plutonium 239 + 240
 Initial Amount in Sample A_0 4.2542×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	$\sum a_1$	$\frac{\sum a_1}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			8.3 + 1	<2		1.87 - 8	1.94 - 6	1.87 - 8	4.40 - 6
8-19-75	8-20-75	1	2			9.9 + 1			2.23 - 8	2.32 - 6	4.10 - 8	9.65 - 6
8-20-75	8-21-75	1	3			8.2 + 1			1.85 - 8	1.92 - 6	5.95 - 8	1.40 - 5
8-21-75	8-22-75	1	4			4.9 + 1			1.10 - 8	1.15 - 6	7.05 - 8	1.66 - 5
8-22-75	8-25-75	3	7			9.1 + 1			2.05 - 8	2.12 - 6	9.10 - 8	2.14 - 5
8-25-75	9-02-75	8	15			2.7 + 1			6.08 - 9	7.90 - 8	9.71 - 8	2.28 - 5
9-02-75	9-08-75	6	21			3.6 + 1			8.11 - 9	1.40 - 7	1.05 - 7	2.47 - 5
9-08-75	9-18-75	10	31			1.51 + 1			3.40 - 9	3.52 - 8	1.09 - 7	2.55 - 5
9-18-75	10-17-75	29	60			2.2 + 1			4.96 - 9	1.78 - 8	1.13 - 7	2.67 - 5
10-17-75	11-18-75	32	92			8.5 0			1.91 - 9	6.21 - 9	1.14 - 7	2.70 - 5
11-18-75	12-17-75	29	121			<10			(2.25 - 9)	(8.08 - 9)	1.17 - 7	2.75 - 5
12-17-75	1-15-76	29	150			<10			(2.25 - 9)	(8.08 - 9)	1.19 - 7	2.81 - 5

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** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST IDENTIFICATION NUMBER Z-3

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental DataConstituent Analyzed, A Curium 242
Initial Amount in Sample A_0 1.777×10^{-2} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{S t_n} \right)$	Σa_i	$\frac{\Sigma a_i}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	30	0.907	3.04 + 2	<2		7.55 - 8			
8-19-75	8-20-75	1	2	29	0.911	4.7 + 1			1.16 - 8			
8-20-75	8-21-75	1	3	28	0.914	3.6 + 1			8.87 - 9			
8-21-75	8-22-75	1	4	27	0.917	2.0 + 1			4.91 - 9			
8-22-75	8-25-75	3	7	24	0.926	3.3 + 1			8.03 - 9			
8-25-75	9-02-75	8	15	31	0.905	4.6 + 1			1.14 - 8			
9-02-75	9-08-75	6	21	25	0.923	1.8 + 1			4.39 - 9			
9-08-75	9-18-75	10	31	26	0.920	2.5 + 1			6.12 - 9			
9-18-75	10-17-75	29	60	19	0.942	9.8 0			2.34 - 9			
10-17-75	11-18-75	32	92	196	0.449	0.8 0			4.01 - 10			
11-18-75	12-17-75	29	121	37	0.886	3.86 0			9.81 - 10			
12-17-75	1-15-76	29	150	8	0.975	6.69 0			1.43 - 9			

** Concentration in leachate, show units.

*** a_i = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page 01

LEACH TEST IDENTIFICATION NUMBER Z-3

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium 244
 Initial Amount in Sample A_0 0.027985 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{S_{i,n}} \right)$	Σa_i	$\frac{\Sigma a_i n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			3.18 + 2	<2		7.16 - 8	1.14 - 6	7.16 - 8	2.56 - 6
8-19-75	8-20-75	1	2			4.0 + 1			9.01 - 9	1.43 - 7	8.06 - 8	2.88 - 6
8-20-75	8-21-75	1	3			4.5 + 1			1.01 - 8	1.61 - 7	9.08 - 8	3.24 - 6
8-21-75	8-22-75	1	4			2.0 + 1			4.50 - 9	7.4 - 8	9.53 - 8	3.40 - 6
8-22-75	8-25-75	3	7			2.4 + 1			5.41 - 9	2.86 - 8	1.01 - 7	3.60 - 6
8-25-75	9-02-75	8	15			6.0 + 1			1.35 - 8	2.68 - 8	1.14 - 7	4.08 - 6
9-02-75	9-08-75	6	21			1.8 + 1			4.05 - 9	1.07 - 8	1.18 - 7	4.22 - 6
9-08-75	9-18-75	10	31			3.7 + 1			8.33 - 9	1.32 - 8	1.27 - 7	4.52 - 6
9-18-75	10-17-75	29	60			1.5 + 1			3.38 - 9	1.85 - 9	1.30 - 7	4.64 - 6
10-17-75	11-18-75	32	92			2.2 0			4.96 - 10	2.45 - 10	1.30 - 7	4.66 - 6
11-18-75	12-17-75	29	121			9.65 0			2.17 - 9	1.19 - 9	1.33 - 7	4.74 - 6
12-17-75	1-15-76	29	150			1.50 + 1			3.38 - 9	1.85 - 9	1.36 - 7	4.86 - 6

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** Concentration in leachate, show w/units.

*** Corrected concentration x V x factor to convert to same units as A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Z-4
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part A. Description of Leach Specimen

Specimen Identification Number Z-4
Proportion of Waste Incorporated in Mixture Irradiated LWR fuel pellet Weight %
or _____ Volume%
(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

Type and Composition of the Immobilization Material

Preparation of Specimen

Storage Conditions

Appearance:

LEACH TEST RESULTS

Page ___ of ___

LEACH TEST IDENTIFICATION NUMBER Z-4
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part B. Description of Leach Test Procedure

Sample Preparation* _____

Initial Weight of Sample, W 4.3392 gm

Volume of Sample, V _____

Surface Area of Sample, S 9.82 cm²Method of Surface Area Determination geometric approximationDiagram of Leach Apparatus: Paige typeLeachant 324 Building waterLeachant Volume, V_L 500 mlSampling Procedure drain leachant and refill at sampling

Analytical Techniques:

pH Instrument Identification and Calibration _____

Constituent a₁, Analytical Procedure, Standard Deviation of Method _____Constituent a₂, Analytical Procedure, Standard Deviation of Method _____

*If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium-137
 Initial Amount in Sample A_0 0.7297 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml) **	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			2.50 +7	8.70 +2		5.63 -3	3.40 -3	5.63 -3	7.72 -3
8-19-75	8-20-75	1	2			5.51 +6			1.24 -3	7.40 -4	6.87 -3	9.41 -3
8-20-75	8-21-75	1	3			2.97 +6			6.69 -4	4.04 -4	7.54 -3	1.03 -2
8-21-75	8-22-75	1	4			2.32 +6			5.23 -4	3.16 -4	8.06 -3	1.10 -2
8-22-75	8-25-75	3	7			3.68 +6			8.29 -4	1.67 -4	8.89 -3	1.22 -2
8-25-75	9-2-75	8	15			7.35 +6			1.66 -3	1.24 -4	1.06 -2	1.45 -2
9-2-75	9-8-75	6	21			3.80 +6			3.76 -4	8.82 -5	1.14 -2	1.57 -2
9-8-75	9-18-75	10	31			3.52 +6			7.93 -4	4.79 -5	1.22 -2	1.67 -2
9-18-75	10-17-75	29	60			4.31 +6			9.71 -4	2.02 -5	1.32 -2	1.81 -2
10-17-75	11-18-75	32	92			2.07 +6			4.66 -4	8.80 -6	1.37 -2	1.87 -2
11-18-75	12-17-75	29	121			1.09 +6			2.46 -4	5.11 -6	1.30 -2	1.91 -2
12-17-75	1-15-76	29	150			1.07 +6			2.41 -4	5.02 -6	1.41 -2	1.94 -2

** Concentration in leachate, show units.

*** a_1 = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

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EACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED

ANALYST

DATE RESULTS REPORTS

Part C. Experimental Data

Cesium-134	Constituent Analyzed, A
1.084 CT	Initial Amount in Sample A ₀

Initial Amount in Sample A_0

TIME AND DATE		IN	OUT	t_n	TOTAL t	DAYS DECAY	DECAY FACTOR	AS ANALYZED (%)	BLANK (d/m/ml)	CORRECTED CONC.	$a_1 \dots$	$\frac{a_1}{a_0} \left(\frac{S_1}{S_0} \right)$	Σa_1	$\frac{a_0}{a_n}$
		8-18-75	8-19-75	1	1	21	0.986	2.55 +7	<2.94 +5		5.82 -3			
		8-19-75	8-20-75	1	1	21	0.986	5.63 +6			1.29 -3			
		8-20-75	8-21-75	1	1	20	0.987	2.89 +6			6.59 -4			
		8-21-75	8-22-75	1	4	19	0.987	2.32 +6			5.29 -4			
		8-22-75	8-25-75	3	7	16	0.989	3.66 +6			8.33 -4			
		8-25-75	9-2-75	8	15	16	0.989	7.39 +6			1.68 -3			
		9-2-75	9-8-75	6	21	18	0.988	3.84 +6			8.75 -4			
		9-8-75	9-18-75	10	31	44	0.971	3.43 +6			7.96 -4			
		9-18-75	10-17-75	29	60	16	0.989	4.52 +6			1.03 -3			
		10-17-75	11-18-75	32	92	30	0.980	1.81 +6			4.16 -4			
		11-18-75	12-17-75	29	121	45	0.970	9.01 +5			2.09 -4			
		12-17-75	1-15-76	29	150	16	0.989	8.88 +5			2.02 -4			

• Concentration in leachate, show units.

... a_1 =corrected concentration $\times V_1$ x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Plutonium-239 + 240
 Initial Amount in Sample A_0 3.6566×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1 ***	$\frac{a_1}{A_0} \left(\frac{w}{5t_n} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			5.02 +2	<2		1.13 -7	1.36 -5	1.13 -7	3.09 -5
8-19-75	8-20-75	1	2			5.32 +2			1.20 -7	1.45 -5	2.33 -7	6.35 -5
8-20-75	8-21-75	1	3			4.30 +2			0.80 -8	1.10 -5	3.32 -7	9.05 -5
8-21-75	8-22-75	1	4			3.93 +2			0.85 -8	1.07 -5	4.20 -7	1.15 -4
8-22-75	8-25-75	3	7			4.91 +2			1.11 -7	4.44 -6	5.31 -7	1.45 -4
8-25-75	9-2-75	8	15			1.56 +3			3.51 -7	5.30 -6	8.82 -7	2.42 -4
9-2-75	9-8-75	6	21			7.30 +2			1.66 -7	3.36 -6	1.05 -6	2.87 -4
9-8-75	9-18-75	10	31			5.63 +2			1.27 -7	1.53 -6	1.18 -6	3.22 -4
9-18-75	10-17-75	29	60			5.1 +1			1.15 -8	4.78 -8	1.10 -6	3.24 -4
10-17-75	11-18-75	32	92			2.51 +2			5.65 -8	2.13 -7	1.25 -6	3.41 -4
11-18-75	12-17-75	29	121			2.64 +2			5.05 -8	2.48 -7	1.31 -6	3.57 -4
12-17-75	1-15-76	29	150			3.27 +2			7.36 -8	3.06 -7	1.38 -6	3.77 -4

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** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium-242
Initial Amount in Sample A_0 1.5276×10^{-2} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{Si_n} \right)$	Σa_i	$\frac{\Sigma a_i n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	30	0.907	1.63 +3	<?		4.05 -7			
8-19-75	8-20-75	1	2	29	0.911	1.54 +2			3.81 -8			
8-20-75	8-21-75	1	3	28	0.914	1.21 +2			2.98 -8			
8-21-75	8-22-75	1	4	27	0.917	0.5 +1			2.33 -8			
8-22-75	8-25-75	3	7	24	0.926	2.61 +2			6.35 -8			
8-25-75	9-2-75	8	15	31	0.905	1.53 +3			3.81 -7			
9-2-75	9-8-75	6	21	25	0.923	3.36 +2			8.20 -8			
9-8-75	9-18-75	10	31	26	0.920	1.18 +3			2.89 -7			
9-18-75	10-17-75	29	60	19	0.942	1.18 +2			2.82 -8			
10-17-75	11-18-75	32	92	196	0.449	1.47 +2			7.37 -8			
11-18-75	12-17-75	29	121	37	0.886	2.58 +2			6.56 -8			
12-17-75	1-15-76	29	150	8	0.975	5.12 +2			1.18 -7			

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** Concentration in leachate, show units.
*** a_i = corrected concentration $\times V_i \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED Battelle-Northwest, C-Cell, 324 Bldg.

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium-244
Initial Amount in Sample A_0 0.024054 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			1.67 +3	<2		3.76 -7	6.91 -6	3.76 -7	1.56 -5
8-19-75	8-20-75	1	2			1.17 +2	<2		2.64 -8	4.84 -7	4.02 -7	1.67 -5
8-20-75	8-21-75	1	3			1.13 +2	<2		2.54 -8	4.68 -7	4.28 -7	1.78 -5
8-21-75	8-22-75	1	4			9.7 +1	<2		2.18 -8	4.02 -7	4.50 -7	1.87 -5
8-22-75	8-25-75	3	7			2.50 +2	<2		5.63 -8	3.45 -7	5.06 -7	2.10 -5
8-25-75	9-2-75	8	15			1.59 +3	<2		3.58 -7	8.23 -7	8.64 -7	3.59 -5
9-2-75	9-8-75	6	21			3.38 +2	<2		7.61 -8	2.33 -7	9.40 -7	3.91 -5
9-8-75	9-18-75	10	31			1.17 +3	<2		2.64 -7	4.84 -7	1.20 -6	5.00 -5
9-18-75	10-17-75	29	60			1.44 +2	<2		3.24 -8	2.06 -8	1.24 -6	5.14 -5
10-17-75	11-18-75	32	92			3.82 +2			8.60 -8	4.94 -8	1.33 -6	5.51 -5
11-18-75	12-17-75	29	121			4.53 +2	<2		1.02 -7	6.47 -8	1.43 -6	5.94 -5
12-17-75	1-15-76	29	150			8.73 +2	<2		1.07 -7	1.25 -7	1.62 -6	6.76 -5

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** Concentration in leachate, show units.
*** a_1 = corrected concentration x V_1 x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Antimony-125
 Initial Amount in Sample A_0 3.084×10^{-2} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK ()	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{W}{Si_n} \right)$	$\sum a_1$	$\frac{\sum a_1}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	164	0.917	2.16 +4			5.30 -6	6.16×10^{-5}		
8-19-75	8-20-75	1	2	163	0.917	1.90 +4			4.67 -6			
8-20-75	8-21-75	1	3	162	0.918	1.30 +4			3.19 -6			
8-21-75	8-22-75	1	4	161	0.918	9.6 +3			2.36 -6			
8-22-75	8-25-75	3	7	158	0.920	1.76 +4			4.31 -6			
8-25-75	9-2-75	8	15	150	0.924	4.08 +4			9.94 -6			
9-2-75	9-8-75	6	21	246	0.875	1.40 +4			3.60 -6			
9-8-75	9-18-75	10	31	237	0.880	1.24 +4			3.17 -6			
9-18-75	10-17-75	29	60	209	0.894	2.64 +4			6.65 -6			
10-17-75	11-18-75	32	92	74	0.962	2.38 +4			5.57 -6			
11-18-75	12-17-75	29	121	50	0.975	1.61 +4			3.72 -6			
12-17-75	1-15-76	29	150	22	0.989	1.50 +4			3.42 -6			

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** Concentration in leachate, show units.

*** a_1 = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

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DATE RESULTS REPORTS _____

Experimental Data

Constituent Analyzed, A	Europium-154
Initial Amount in Sample A ₀	0.252714 Ci

[illegible]

*** a_1 = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Ruthenium-106
Initial Amount in Sample A_0 7.509×10^{-1} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK ()	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{w}{Si_n} \right)$	Σa_i	$\frac{\Sigma a_i}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	164	0.917	5.39 +4			1.32 -5			
8-19-75	8-20-75	1	2	163	0.917	1.98 +4			4.86 -6			
8-20-75	8-21-75	1	3	162	0.918	1.40 +4			3.43 -6			
8-21-75	8-22-75	1	4	161	0.918	1.24 +4			3.04 -6			
8-22-75	8-25-75	3	7	158	0.920	2.0 +4			4.90 -6			
8-25-75	9-2-75	8	15	150	0.924	3.08 +4			7.51 -6			
9-2-75	9-8-75	6	21	246	0.875	1.15 +4			2.96 -6			
9-8-75	9-18-75	10	31	237	0.880	1.10 +4			2.81 -6			
9-18-75	10-17-75	29	60	209	0.894	1.94 +4			4.89 -6			
10-17-75	11-18-75	32	92	74	0.962	1.11 +4			2.60 -6			
11-18-75	12-17-75	29	121	50	0.975	5.54 +3			1.28 -6			
12-17-75	1-15-76	29	150	22	0.989	4.10 +3			9.34 -7			

** Concentration in leachate, show units.

*** a_i = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-4

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cerium-144
Initial Amount in Sample A_0 1.098 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/m) **	BLANK ()	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	$\sum a_1$	$\frac{\sum a_n}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1	164	0.712	5.59 +4			1.77 -5			
8-19-75	8-20-75	1	2	163	0.714	3.76 +3			1.19 -6			
8-20-75	8-21-75	1	3	162	0.716	<1.0 +3			<3.15 -7			
8-21-75	8-22-75	1	4	161	0.717	2.27 +3			7.13 -7			
8-22-75	8-25-75	3	7	158	0.723	<2.8 +2			<8.72 -8			
8-25-75	9-2-75	8	15	150	0.737	1.19 +4			1.51 -7			
9-2-75	9-8-75	6	21	246	0.568	<4.93 +2			<1.95 -7			
9-8-75	9-18-75	10	31	237	0.584	5.09 +3			1.96 -6			
9-18-75	10-17-75	29	60	209	0.633	3.89 +3			1.38 -6			
10-17-75	11-18-75	32	92	74	0.870	4.22 +3			1.09 -6			
11-18-75	12-17-75	29	121	50	0.912	<1.07 +3			<2.64 -7			
12-17-75	1-15-76	29	150	22	0.961	<1.64 +3			<3.84 -7			

** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_L x factor to convert to same units as A_0 .

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Z-5
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part A. Description of Leach Specimen

Specimen Identification Number Z-5
Proportion of Waste Incorporated in Mixture Irradiated LWR fuel pellet Weight %
or _____ Volume%
(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

Type and Composition of the Immobilization Material

Preparation of Specimen

Storage Conditions

Appearance:

LEACH TEST RESULTS

Page ___ of ___

LEACH TEST IDENTIFICATION NUMBER 7-5
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part B. Description of Leach Test Procedure

Sample Preparation* _____

Initial Weight of Sample, W 5.3041 gm
Volume of Sample, V _____
Surface Area of Sample, S 12.0 cm²
Method of Surface Area Determination geometric approximation

Diagram of Leach Apparatus: Paine type

Leachant 324 Building water
Leachant Volume, V_L 500 ml
Sampling Procedure drain leachant and refill at sampling

Analytical Techniques:
pH Instrument Identification and Calibration _____

Constituent a₁, Analytical Procedure, Standard Deviation of Method _____

Constituent a₂, Analytical Procedure, Standard Deviation of Method _____

*If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-5

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium-137

Initial Amount in Sample A_0 0.8919 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i ***	$\frac{a_i}{A_0} \left(\frac{w}{S t_n} \right)$	Σa_i	$\frac{\Sigma a_i}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			4.03 +7	1.62 +2		0.08 -3	4.51 -3	9.08 -3	1.02 -2
8-19-75	8-20-75	1	2			6.72 +6			1.51 -3	7.53 -4	1.06 -2	1.19 -2
8-20-75	8-21-75	1	3			3.30 +6			7.43 -4	3.70 -4	1.13 -2	1.27 -2
8-21-75	8-22-75	1	4			2.10 +6			4.03 -4	2.45 -4	1.18 -2	1.33 -2
8-22-75	8-25-75	3	7			3.06 +6			6.80 -4	1.14 -4	1.25 -2	1.40 -2
8-25-75	9-2-75	8	15			3.00 +6			8.00 -4	5.50 -5	1.34 -2	1.50 -2
9-2-75	9-8-75	6	21			4.80 +6			1.00 -3	8.06 -5	1.45 -2	1.62 -2
9-8-75	9-18-75	10	31			3.86 +6			8.69 -4	4.32 -5	1.54 -2	1.72 -2
9-18-75	10-17-75	29	60			2.80 +6			6.51 -4	1.12 -5	1.60 -2	1.80 -2
10-17-75	11-18-75	32	92			1.05 +6			2.36 -4	3.68 -6	1.62 -2	1.82 -2
11-18-75	12-17-75	29	121			1.27 +6			2.41 -4	4.00 -6	1.65 -2	1.85 -2
12-17-75	1-15-76	29	150			1.34 +6			3.02 -4	5.18 -6	1.68 -2	1.88 -2

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** Concentration in leachate, show units.

*** a_i = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED

ANALYST

DATE RESULTS REPORTS

Part C. Experimental Data

Experimental Data	Constituent Analyzed, A	Cesium-134
	Initial Amount in Sample A_0	1.325 Ci

[illegible]

•• Concentration in leachate, show units.

... a_1 = corrected concentration $\times V_L$ x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-5

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Plutonium-239 + 240
Initial Amount in Sample A_0 4.4698×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{St_n} \right)$	Σa_1	$\frac{\Sigma a_1}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			3.25 +2	<2		7.32 -8	7.24 -6	7.32 -8	1.64 -5
8-19-75	8-20-75	1	2			5.8 +1			1.31 -8	1.29 -6	8.63 -8	1.93 -5
8-20-75	8-21-75	1	3			3.92 +2			8.83 -8	8.74 -6	1.74 -7	3.90 -5
8-21-75	8-22-75	1	4			3.27 +2			7.36 -8	7.28 -6	2.48 -7	5.55 -5
8-22-75	8-25-75	3	7			4.83 +2			1.09 -7	1.08 -6	3.57 -7	8.00 -5
8-25-75	9-2-75	8	15			4.9 +2			1.10 -7	1.37 -6	4.67 -7	1.04 -4
9-2-75	9-8-75	6	21			1.95 +3			4.39 -7	7.24 -6	9.06 -7	2.03 -4
9-8-75	9-18-75	10	31			1.27 +3			2.86 -7	2.84 -6	1.19 -6	2.67 -4
9-18-75	10-17-75	29	60			5.02 +2			1.13 -7	3.86 -7	1.31 -6	2.92 -4
10-17-75	11-18-75	32	92			2.87 +2			6.46 -8	2.00 -7	1.37 -6	3.08 -4
11-18-75	12-17-75	29	121			7.06 +2			1.59 -7	5.44 -7	1.62 -6	3.63 -4
12-17-75	1-15-76	29	150			7.97 +2			1.80 -7	6.12 -7	1.80 -6	4.04 -4

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** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_L x factor to convert to same units as A_0 .

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DATE RESULTS REPORTS _____

Experimental Data

Constituent Analyzed, A	Curium-242
Initial Amount in Sample A_0	1.867×10^{-2} Ci

[illegible]

*** a_1 = corrected concentration $\times V_1 \times$ factor to convert to same units as A_2 .

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DATE RESULTS REPORTS

0.029403 Ci

[illegible]

- Concentration in leachate, show units.
- Corrected concentration $\times V$ factor to convert to same units as A.

LEACH TEST RESULTS

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LEACH TEST IDENTIFICATION NUMBER Z-5

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Strontium-90 + Yttrium-90

Initial Amount in Sample A_0 1.3701

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	$a_i \dots$	$\frac{a_i}{A_0} \left(\frac{w}{St_n} \right)$	Σa_i	$\frac{a_{an}}{A_0}$
IN	OUT											
8-18-75	8-19-75	1	1			2.0 +6		$V=8.33$	4.50 -4	1.46 -4	4.50 -4	3.20 -4
8-19-75	8-20-75	1	2			5.2 +4		$V=8.36$	1.17 -5	3.70 -6	4.62 -4	3.37 -4
8-20-75	8-21-75	1	3			4.2 +4			0.46 -6	3.06 -6	4.72 -4	3.44 -4
8-21-75	8-22-75	1	4			5.7 +4			1.23 -5	4.15 -6	4.84 -4	3.54 -4
8-22-75	8-25-75	3	7			6.3 +4			1.42 -5	1.53 -6	4.09 -4	3.64 -4
8-25-75	9-2-75	8	15			3.5 +5			7.88 -5	3.18 -6	5.77 -4	4.21 -4
9-2-75	9-8-75	6	21			6.3 +5			1.42 -4	7.64 -6	7.19 -4	5.25 -4
9-8-75	9-18-75	10	31			6.0 +5			1.35 -4	4.37 -6	8.54 -4	6.24 -4
9-18-75	10-17-75	29	60			4.6 +5			1.04 -4	1.15 -6	9.58 -4	6.90 -4
10-17-75	11-18-75	32	92			2.0 +5			4.50 -5	4.55 -7	1.00 -3	7.32 -4
11-18-75	12-17-75	29	121			5.8 +5			1.31 -4	1.45 -6	1.13 -3	8.25 -4
12-17-75	1-15-76	29	150			7.2 +5			1.62 -4	1.31 -6	1.29 -3	9.44 -4

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** Concentration in leachate, show units.
 *** a_i = corrected concentration x V, x factor to convert to same units as A_0 .

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Z-6
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part A. Description of Leach Specimen

Specimen Identification Number Z-6
Proportion of Waste Incorporated in Mixture Irradiated LWR fuel pellet Weight %
or _____ Volume %
(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

Type and Composition of the Immobilization Material

Preparation of Specimen

Storage Conditions

Appearance:

LEACH TEST RESULTS

Page ___ of ___

LEACH TEST IDENTIFICATION NUMBER Z-6
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part B. Description of Leach Test Procedure

Sample Preparation* _____

Initial Weight of Sample, W 5.5675 gm
Volume of Sample, V _____
Surface Area of Sample, S 12.58 cm²
Method of Surface Area Determination geometric approximation

Diagram of Leach Apparatus: Paige type

Leachant Deionized water
Leachant Volume, V_L 500 ml
Sampling Procedure drain leachant and refill at sampling

Analytical Techniques:
pH Instrument Identification and Calibration _____

Constituent a₁, Analytical Procedure, Standard Deviation of Method _____

Constituent a₂, Analytical Procedure, Standard Deviation of Method _____

*If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-6

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium-137

Initial Amount in Sample A_0 0.9362 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)...	BLANK ()	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{W}{SI_n} \right)$	ΣB_i	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
2-1-75	12-2-75	1	1			1.51 +6			3.40 -4	1.60 -4	3.40 -4	3.63 -4
2-2-75	12-3-75	1	2			0.15 +5			2.06 -4	0.70 -5	5.46 -4	5.83 -4
2-3-75	12-4-75	1	3			5.62 +5			1.22 -4	6.02 -5	6.74 -4	7.20 -4
2-4-75	12-5-75	1	4			5.22 +5			1.31 -4	6.17 -5	8.05 -4	8.60 -4
2-5-75	12-8-75	3	7			1.01 +6			2.27 -4	3.57 -5	1.03 -3	1.10 -3
2-8-75	12-15-75	7	14			1.42 +6			3.20 -4	2.15 -5	1.35 -3	1.44 -3
2-15-75	12-22-75	7	21			1.10 +6			2.62 -4	1.80 -5	1.62 -3	1.73 -3
2-22-75	12-29-75	7	28			9.45 +5			2.13 -4	1.43 -5	1.83 -3	1.96 -3
2-29-75	1-26-76	28	56			2.17 +6			4.89 -4	8.22 -6	2.32 -3	2.48 -3
1-26-76	2-23-76	28	84			1.35 +6			3.04 -4	5.13 -6	2.62 -3	2.80 -3
2-23-76	4-23-76	60	144			2.39 +6			4.38 -4	4.24 -6	3.16 -3	3.38 -3

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* Concentration in leachate, show units.
 ** a_i = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-6

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium-134
Initial Amount in Sample A_0 1.2912 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/m)**	BLANK (d/m/m)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{W}{S_{1n}} \right)$	$\sum a_1$	$\frac{\sum a_1}{A_0}$
IN	OUT											
12-1-75	12-2-75	1	1	51	0.966	1.30 +6	4.7 +3		3.03 -4			
12-2-75	12-3-75	1	2	59	0.961	7.81 +5			1.83 -4			
12-3-75	12-4-85	1	3	58	0.961	4.75 +5			1.11 -4			
12-4-75	12-5-75	1	4	57	0.962	5.06 +5			1.18 -4			
12-5-75	12-8-75	3	7	54	0.964	8.46 +5			1.98 -4			
12-8-75	12-15-75	7	14	47	0.969	1.18 +6			2.74 -4			
12-15-75	12-22-75	7	21	40	0.973	9.87 +5			2.28 -4			
12-22-75	12-29-75	7	28	33	0.978	7.85 +5			1.81 -4			
12-29-75	1-26-76	28	56	11	0.993	1.81 +6			4.10 -4			
1-26-76	2-23-76	28	84	79	0.947	1.00 +6			2.38 -4			
2-23-76	4-23-76	60	144	19	0.987	1.78 +6			4.06 -4			

** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_1 x factor to convert to same units as A_0 .

Page ____ of ____

DATE RESULTS REPORTS _____

rt C. Experimental Data

Constituent Analyzed, A	Antimony-125
Initial Amount in Sample A ₀	3.7432×10^{-2} Ci

[illegible]

• Concentration in leachate, show units.

** a_i = corrected concentration $\times V_i \times$ factor to convert to same units as A_0 .

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LEACH TEST RESULTS

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LEACH TEST IDENTIFICATION NUMBER Z-6

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Plutonium-239 + 240
 Initial Amount in Sample A_0 4.6918×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	a/a_0 BLANK (d/m/ml)	CORRECTED CONC. (a/T)	a_1 ***	$\frac{a_1}{A_0} \left(\frac{W}{S t_n} \right)$	Σa_1	$\frac{C_{an}}{A_0}$
IN	OUT											
12-1-75	12-2-75	1 1	1			2.26 +3	1.53 -4		5.09 -7	4.80 -5	5.09 -7	1.08 -4
12-2-75	12-3-75	1 1	2			6.97 +2	3.3 -5		1.55 -7	1.46 -5	6.64 -7	1.42 -4
12-3-75	12-4-75	1 1	3			5.05 +2	2.4 -5		1.14 -7	1.07 -5	7.77 -7	1.66 -4
12-4-75	12-5-75	1 1	4			4.78 +2	2.3 -5		1.08 -7	1.01 -5	8.85 -7	1.88 -4
12-5-75	12-8-75	3 6	7			1.08 +3	5.2 -5	8.10-8	2.43 -7	7.64 -6	1.13 -6	2.40 -4
12-8-75	12-15-75	7 10	14			1.39 +3	7.5 -6	4.44-8	3.11 -7	4.18 -6	1.44 -6	3.06 -4
12-15-75	12-22-75	7 14	21			7.84 +2	5.4 -6	2.52-8	1.77 -7	2.36 -6	1.62 -6	3.44 -4
12-22-75	12-29-75	7 14	28			6.46 +2	4.4 -6	2.08-8	1.46 -7	1.96 -6	1.76 -6	3.75 -4
12-29-75	1-26-76	28 175	56			6.45 +4	1.1 -6	5.18-7	1.45 -5	4.88 -5	1.63 -5	3.47 -3
1-26-76	2-23-76	28 56	84			3.82 +2	6.5 -7	3.07-9	8.60 -8	2.90 -7	1.64 -5	3.29 -3
2-23-76	4-23-76	60 120	144			9.30 +2	7.4 -7	3.48-9	2.09 -7	3.29 -7	1.66 -5	3.54 -3

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** Concentration in leachate, show units.

*** a_1 =corrected concentration $\times V_L$ $\times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

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LEACH TEST IDENTIFICATION NUMBER Z-6

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium-242
Initial Amount in Sample A_0 1.224×10^{-2} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_i ***	$\frac{a_i}{A_0} \left(\frac{w}{Si_n} \right)$	Σa_i	$\frac{\Sigma a_i n}{A_0}$
IN	OUT											
2-1-75	12-2-75	1	1	52	0.840	4.13 +1	<3		1.11 -8			
2-2-75	12-3-75	1	2	51	0.844	8.48 +0			2.26 -9			
2-3-75	12-4-75	1	3	50	0.847	3.71 +0			9.86 -10			
2-4-75	12-5-75	1	4	49	0.850	3.67 +1			9.72 -9			
2-5-75	12-8-75	3	7	46	0.859	1.80 +1			4.72 -9			
2-8-75	12-15-75	7	14	39	0.880	7.12 +0			1.82 -9			
2-15-75	12-22-75	7	21	32	0.902	1.05 +1			2.62 -9			
2-22-75	12-29-75	7	28	25	0.923	1.08 +1			4.59 -9			
2-29-75	1-26-76	28	56	10	0.969	6.0 +1			1.58 -8			
1-26-76	2-23-76	28	84	99	0.696	1.0 +1			3.24 -9			
2-23-76	4-23-76	60	144	39	0.880	2.5 +1			6.40 -9			

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* Concentration in leachate, show units.

** a_i = corrected concentration x V_L x factor to convert to same units as A_0 .

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DATE RESULTS REPORTS _____

Experimental Data

Constituent Analyzed, A	Curium-244
Initial Amount in Sample A_0	0.030863 Ci

[illegible]

*** a_i = corrected concentration x V_i x factor to convert to same units as A_0 .

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LEACH TEST RESULTS

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LEACH TEST IDENTIFICATION NUMBER Z-6

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Am-241
 Initial Amount in Sample A_0 2.474×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/m) ^{..}	BLANK (d/m/m)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{w}{S_{In}} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
12-1-75	12-2-75	1	1			5.6 +1			1.26 -8	2.25 -6	1.26 -8	5.10 -6
12-2-75	12-3-75	1	2			2.8 +1			6.31 -9	1.13 -6	1.89 -8	7.65 -6
12-3-75	12-4-85	1	3			6.5 +1			1.46 -8	2.61 -6	3.36 -8	1.36 -5
12-4-75	12-5-75	1	4			1.53 +2			3.45 -8	6.17 -6	6.80 -8	2.75 -5
12-5-75	12-8-75	3	7			2.0 +1			4.50 -9	2.68 -7	7.25 -8	2.93 -5
12-8-75	12-15-75	7	14			3.1 +1			6.98 -9	1.78 -7	7.95 -8	3.21 -5
12-15-75	12-22-75	7	21			1.4 +1			3.15 -9	8.05 -8	8.27 -8	3.34 -5
12-22-75	12-29-75	7	28			2.2 +1			4.96 -9	1.27 -7	8.76 -8	3.54 -5
12-29-75	1-26-76	28	56			1.09 +2			2.46 -8	1.57 -7	1.12 -7	4.53 -5
1-26-76	2-23-76	28	84			5.9 +1			1.33 -8	8.50 -8	1.25 -7	5.07 -5
2-23-76	4-23-76	60	144			6.0 +1			1.35 -8	4.02 -8	1.39 -7	5.62 -5

* Concentration in leachate, show units.

** a_1 = corrected concentration $\times V_L \times$ factor to convert to same units as A_0 .

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Z-7
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part A. Description of Leach Specimen

Specimen Identification Number Z-7
Proportion of Waste Incorporated in Mixture Irradiated LWR fuel pellet Weight %
or _____ Volume%
(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

Type and Composition of the Immobilization Material _____

Preparation of Specimen _____

Storage Conditions _____

Appearance: _____

LEACH TEST RESULTS

Page ___ of ___

LEACH TEST IDENTIFICATION NUMBER Z-7
LABORATORY WHERE TESTS PERFORMED Battelle-Northwest
ANALYST _____
DATE RESULTS REPORTED _____

Part B. Description of Leach Test Procedure

Sample Preparation* _____

Initial Weight of Sample, W 4.4313 gm
Volume of Sample, V _____
Surface Area of Sample, S 10.01 cm²
Method of Surface Area Determination geometric approximation

Diagram of Leach Apparatus: _____

Leachant Deionized water
Leachant Volume, V_L 500 ml
Sampling Procedure drain leachant and refill after sampling

Analytical Techniques:
pH Instrument Identification and Calibration _____

Constituent a₁, Analytical Procedure, Standard Deviation of Method _____

Constituent a₂, Analytical Procedure, Standard Deviation of Method _____

*If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

Page 1 of 1

LEACH TEST IDENTIFICATION NUMBER Z-7

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Cesium-137Initial Amount in Sample A_0 0.7452 Ci

TIME AND DATE:		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (a ₀ /T)	CORRECTED CONC. (a/T)	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{W}{Si_n} \right)$	Σa_i	$\frac{\Sigma a_i}{A_0}$
IN	OUT											
12-1-75	12-2-75	1	1			2.44 +6	7.4 - 4		5.50 -4	3.27 -4	5.50 -4	7.38 -4
12-2-75	12-3-75	1	2			6.41 +5	1.9 - 4		1.44 -4	8.59 -5	6.94 -4	9.31 -4
12-3-75	12-4-75	1	3			7.96 +5	2.4 - 4		1.77 -4	1.05 -4	8.71 -4	1.17 -3
12-4-75	12-5-75	1	4			4.54 +5	1.4 - 4		1.02 -4	6.08 -5	9.73 -4	1.31 -3
12-5-75	12-8-75	3	7			7.09 +5	8.0 - 5	6.00 -5	1.80 -4	3.57 -5	1.15 -3	1.55 -3
12-8-75	12-15-75	7	14			1.80 +6	8.2 - 5	6.08 -5	4.26 -4	3.62 -5	1.58 -3	2.12 -3
12-15-75	12-22-75	7	21			6.26 +5	2.7 - 5	2.01 -5	1.41 -4	1.20 -5	1.72 -3	2.31 -3
12-22-75	12-29-75	7	28			1.11 +6	4.8 - 5	3.57 -5	2.50 -4	2.12 -5	1.97 -3	2.64 -3
12-29-75	1-26-76	28	56			1.30 +6	1.4 - 5	1.07 -5	2.93 -4	6.22 -6	2.26 -3	3.04 -3
1-26-76	2-23-76	28	84			9.94 +5	1.1 - 5	8.00 -6	2.24 -4	4.75 -6	2.48 -3	3.33 -3
2-23-76	4-23-76	60	144			1.47 +6	7.4 - 6	5.51 -6	3.31 -4	3.28 -6	2.82 -3	3.78 -3

** Concentration in leachate, show units.

*** a_i = corrected concentration x V_L x factor to convert to same units as A_0 .

Page ____ of ____

DATE RESULTS REPORTS _____

Initial Amount in Sample A₀ 1.0277 Ci

[illegible]

*** a_1 = corrected concentration x V_1 x factor to convert to same units as A_{50}

LEACH TEST RESULTS

- Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-7

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Plutonium-239 + 240

Initial Amount in Sample A_0 3.7344×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)**	BLANK (d/m/ml)	CORRECTED CONC. ()	a_1^{***}	$\frac{a_1}{A_0} \left(\frac{W}{S t_n} \right)$	Σa_1	$\frac{\Sigma a_1}{A_0}$
IN	OUT											
12-1-75	12-2-75	1	1			9.15 +2	<2		2.06 -7	2.44 -5	2.06 -7	5.50 -5
12-2-75	12-3-75	1	2			5.40 +2			1.22 -7	1.44 -5	3.28 -7	8.80 -5
12-3-75	12-4-75	1	3			3.99 +2			8.99 -8	1.06 -5	4.18 -7	1.12 -4
12-4-75	12-5-75	1	4			3.08 +2			6.94 -8	8.22 -6	4.87 -7	1.30 -4
12-5-75	12-8-75	3	7			7.63 +2			1.72 -7	6.80 -6	6.59 -7	1.76 -4
12-8-75	12-15-75	7	14			1.07 +3			2.41 -7	4.08 -6	9.00 -7	2.41 -4
12-15-75	12-22-75	7	21			4.98 +2			1.12 -7	1.90 -6	1.01 -6	2.71 -4
12-22-75	12-29-75	7	28			9.05 +2			2.04 -7	3.44 -6	1.22 -6	3.26 -4
12-29-75	1-26-76	28	56			1.08 +3			2.43 -7	1.03 -6	1.46 -6	3.90 -4
1-26-76	2-23-76	28	84			6.10 +2			1.37 -7	5.80 -7	1.60 -6	4.27 -4
2-23-76	4-23-76	60	144			6.81 +2			1.53 -7	3.02 -7	1.75 -6	4.69 -4

** Concentration in leachate, show units.

*** a_1 = corrected concentration x V_1 x factor to convert to same units as A_0 .

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LEACH TEST RESULTS

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LEACH TEST IDENTIFICATION NUMBER Z-7

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium-242
 Initial Amount in Sample A_0 9.743×10^{-3} Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/ml)...	BLANK (d/m/ml)	CORRECTED CONC. ()	$a_1 \dots$	$\frac{a_1}{A_0} \left(\frac{w}{S_{1n}} \right)$	Σa_1	$\frac{\Sigma a_n}{A_0}$
IN	OUT											
2-1-75	12-2-75	1	1	52	0.840	1.32 +2	<2		3.70 -8			
2-2-75	12-3-75	1	2	51	0.844	1.84 +1			4.91 -9			
2-3-75	12-4-75	1	3	50	0.847	8.72 +1			2.32 -8			
2-4-75	12-5-75	1	4	49	0.850	5.37 +1			1.42 -8			
2-5-75	12-8-75	3	7	46	0.859	2.22 +1			5.98 -9			
2-8-75	12-15-75	7	14	39	0.880	4.52 +1			6.20 -8			
2-15-75	12-22-75	7	21	32	0.902	2.87 +1			7.17 -9			
2-22-75	12-29-75	7	28	25	0.923	1.13 +2			2.76 -8			
2-29-75	1-26-76	28	56	10	0.969	1.02 +2			2.37 -8			
1-26-76	2-23-76	28	84	99	0.696	1.5 +1			4.85 -8			
2-23-76	4-23-76	60	144	39	0.880	4.1 +1			1.05 -8			

Concentration in leachate, show units.

** a_1 - corrected concentration x V_1 x factor to convert to same units as A_0 .

LEACH TEST RESULTS

Page ____ of ____

LEACH TEST IDENTIFICATION NUMBER Z-7

LABORATORY WHERE TESTS PERFORMED _____

ANALYST _____

DATE RESULTS REPORTS _____

Part C. Experimental Data

Constituent Analyzed, A Curium-244
Initial Amount in Sample A_0 0.024565 Ci

TIME AND DATE		t_n	TOTAL T	DAYS DECAY	DECAY FACTOR	AS ANALYZED (d/m/m)**	BLANK (d/m/m)	CORRECTED CONC. ()	a_i^{***}	$\frac{a_i}{A_0} \left(\frac{W}{St_n} \right)$	Σa_i	$\frac{\Sigma a_i n}{A_0}$
IN	OUT											
12-1-75	12-2-75	1	1			2.31 +2	<2		5.20 -8	9.38 -7	5.20 -8	2.12 -6
12-2-75	12-3-75	1	2			3.00 +1			6.76 -9	1.22 -7	5.88 -8	2.30 -6
12-3-75	12-4-75	1	3			1.31 +2			2.05 -8	5.32 -7	8.23 -8	3.50 -6
12-4-75	12-5-75	1	4			6.08 +1			1.57 -8	2.83 -7	1.04 -7	4.23 -6
12-5-75	12-8-75	3	7			4.51 +1			1.02 -8	6.10 -8	1.14 -7	4.65 -6
12-8-75	12-15-75	7	14			0.20 +1			2.09 -8	5.38 -8	1.35 -7	5.50 -6
12-15-75	12-22-75	7	21			5.15 +1			1.16 -8	2.09 -8	1.47 -7	5.97 -6
12-22-75	12-29-75	7	28			1.01 +2			4.30 -8	1.11 -7	1.90 -7	7.72 -6
12-29-75	1-26-76	28	56			1.75 +2			3.04 -8	2.54 -8	2.29 -7	9.33 -6
1-26-76	2-23-76	28	84			4.5 +1			1.01 -8	6.50 -9	2.39 -7	9.73 -6
2-23-76	4-23-76	60	144			8.8 +1			1.98 -8	5.05 -9	2.59 -7	1.05 -5

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** Concentration in leachate, show units.

*** a_i corrected concentration x V_i x factor to convert to same units as A_0 .

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DATE RESULTS REPORTS _____

Experimental Data

Constituent Analyzed, A	Antimony-125
Initial Amount in Sample A ₀	2.979×10^{-2} Ci

[illegible]

*** a_1 = corrected concentration $\times V_1 \times$ factor to convert to same units as A_0 .

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DATE RESULTS REPORTS _____

Constituent Analyzed, A Strontium-90 + Yttrium-90
Initial Amount in Sample A_0 1.1447 Ci

[illegible]

***a₁=corrected concentration x V₁ x factor to convert to same units as A₀.

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DATE RESULTS REPORTS _____

Initial Amount in Sample A_0 0.053833 Ci

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***A_c=corrected concentration x V_c x factor to convert to same units as A₀.

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DATE RESULTS REPORTS _____

Experimental Data

Constituent Analyzed, A	Cerium-144
Initial Amount in Sample A ₀	0.8974 Ci

[illegible]

***a_i = corrected concentration x V_i x factor to convert to same units as A₀.

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TE RESULTS REPORTS

Experimental Data
Constituent Analyzed, A Ruthenium-106
Initial Amount in Sample A₀ 0.6504 Ci

[illegible]

* a_1 = corrected concentration x V_1 x factor to convert to same units as A_0 .

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