PART TITLE: WVDP WASTE FORM QUALIFICATION REPORT - CANISTERED WASTE FORM SPECIFICATIONS

ITEM TITLE: RADIONUCLIDE INVENTORY SPECIFICATION

1.2 Radionuclide Inventory Specification[1]*

The producer shall report the inventory of radionuclide (in Curies) that have half-lives longer than 10 years and that are, or will be, present in concentrations greater than 0.05 percent of the total radioactive inventory for each waste type, indexed to the years 2015 and 3115.

1.2.1 Radionuclide Inventory Projections

The producer shall provide in the WQR estimates of the total quantities of individual radionuclides to be shipped to the repository, for each waste type. The producer shall also report the upper limit of these radionuclides for any canistered waste form, and an average calculated radionuclide inventory per canister for each waste type. The method to be used to obtain the required data shall be described by the producer in the WCP. The data shall be provided in the WQR. Radionuclide inventory estimates not available for reporting in the initial WQR shall be included in an addendum to the WQR.

WVDP COMPLIANCE STRATEGY

The estimated total quantities of individual radionuclides will be based upon an ongoing waste characterization program for West Valley Demonstration Project (WVDP) HLW. Projected total quantities will be calculated based on ORIGEN2[2] simulation runs on fuel campaign data. The average estimated inventory in the canisters will be based upon filling canisters nominally 85 percent full and will account for radionuclide ingrowth.

Upper limits per canister will be based on a canister 100% full and upper limits of error derived from analysis of the original HLW production data at West Valley and actual HLW sample analysis.

1.2.2 Radionuclide Inventory During Production

The producer shall provide in the Production Records estimates of the inventories of individual reportable radionuclides for each canister and for each waste type. The producer shall also report the estimated error of these estimates in the WQR.

WVDP COMPLIANCE STRATEGY

WVNS plans to meet the WAPS requirement solely with glass shards removed from the top of the canistered glass, measuring the inventory of key radionuclides and relating these values to the other required radionulcide values through the use of scaling

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* The specification, as provided in Reference (1), is reproduced here in boldface print.

factors derived from the WVDP waste characterization program. Sampling frequency, precision, and accuracy will be based upon the results of qualification testing. The glass shards will be demonstrated to be representative of the canister glass in WQR 1.1.

The WQR will include a list of all radionuclides to be shipped with half-lives longer than 10 years and that are or will be present in concentrations greater than 0.01 percent of the total radioactive inventory for each waste type indexed to the years 2015 and 3115.

IMPLEMENTATION

Radionuclide Inventory Estimate

The radionuclide inventory for the West Valley Demonstration Project was estimated using the ORIGEN2[2] computer code simulating each of the Nuclear Fuel Services (NFS) irradiated fuel campaigns. The NFS campaign summary is provided in Table 1[3]. Iterative runs of the ORIGEN2 code were performed until the ^{235}U predictions matched the NFS processing data[4]. In addition to the ORIGEN2 runs, further calculations were performed to decay, process and sum the irradiated campaigns as well as incorporate the special, non-irradiated fuel and flushout operations[4]. These estimates have been supported, as summarized below, using radiochemical analyses of samples removed from Tanks 8D-2 and 8D-4[5].

Samples were removed from the PUREX waste tank, 8D-2, prior to initiating the waste pretreatment operations. Core samples of the PUREX sludge and interstitial supernatant were removed from four separate locations in the tank. These individual cores were then consolidated into a single sample. Liquid samples were also extracted from the THOREX solution storage tank. Aliquots were then removed from the PUREX and THOREX samples, dried and shipped to the Pacific Northwest Laboratories (PNL) for radiochemical analysis. The samples were analyzed for those isotopes 1) expected to be reportable, as defined by this Waste Acceptance Product Specification (i.e., halflife greater than ten years and present at more than 0.05 percent of the total radioactive inventory) per the ORIGEN2 projections, and 2) where the PNL analytical methods had been previously verified[6].

The results from the PNL sample analyses were projected to the tank farm scale by three methods. The THOREX sample data was scaled using Tank 8D-4 volume and specific gravity data[7]. The PUREX sludge data was generated using a ratio of the insoluble radionuclides to the sample iron content and then multiplying by the amount of iron transferred to 8D-2 during NFS processing[7]. The 8D-2 iron content information is based on NFS quarterly report data as summarized in the Western New York Service Center Study.[8] The quantity of soluble PUREX species (Cs, Se, Tc) were estimated using a ratio of the isotopes to ^{137}Cs from the sample and multiplying by the total ^{137}Cs measured during the previtrification HLW conditioning operations[9].

TABLE 1

NFS OPERATIONS SUMMARY[3]

Campaign Number	Reactor	Reprocessing Campaign Start Date	MTU	Approximate Burnup MWD/MTU
1	NRP	4/66	19.7	75
2	NPR	5/66	28.8	75
3	NPR	7/66	46.7	1287
4	Dresden	11/66	50.0	5000-10000
5	Yankee Rowe	6/67	49.8	11200
6	NPR	9/67	26.6	2700
7	NPR	12/67	26.1	2700
8	NPR	1/68	42.4	2700
9	NPR	5/68	38.8	2862
10	NPR	6/68	55.3	2862
11	Indian Point 1	11/68	16(U+Th)	13650
12	NPR	2/69	48.9	2862
13	Yankee Rowe	5/69	19.6	20500
14	NPR	8/69	30.3	--
15	Dresden 1	10/69	21.5	10900
16	Indian Point 1	11/69	15.6	15794
17	Yankee Rowe	6/70	9.3	24000
18	Pathfinder	8/70	9.6	2233
19	Big Rock Pt	11/70	18.4	9212
20	Indian Pt 1	1/71	7.6	23455
21	NPR	2/71	15.8	2870
22	Bonus - Superheater	4/71	2.4	1552
	Bonus - Boiler	4/71	1.7	3232
23	Humbolt Bay	5/71	20.8	10485
24	Yankee Rowe	7/71	9.4	24000
25	CVNPA	10/71	3.5	10089
26	Big Rock Pt	11/71	5.8	13555
27	SEFOR	12/71	--	--

The information from the ORIGEN2 calculation and the waste projections from the PNL analyses are listed in Table 2. The data in this table is the sum of the PUREX and THOREX wastes. A comparison of these results shows that all of the ORIGEN2 radionuclide calculations are within a factor of 3* of the PNL measured values (except for ^{79}Se value which was reported as less than the detection limit), and most within a few percent. Also, the two isotopes with the largest differences, ^{135}Cs and ^{237}Np, were not directly measured or large sample-to-sample variations were reported as discussed in Reference 5. The good agreement between these data sets demonstrates that the ORIGEN2 calculations credibly represent the West Valley HLW inventory. On this basis, the ORIGEN2 calculations are used as the waste source term for this report. The estimate of the uncertainty shown in Table 2 is based on the relative standard deviation (RSD) for those cases where the radionuclide was analyzed at PNL. A RSD of 100% was assumed for the remaining radionuclides and for Se-79 where the PNL value is based on the detection limit for this isotope.

The data presented in the remainder of this report represents a conservatively high estimate of the total radionuclide inventory, i.e., it does not account for material losses during the previtrification waste treatment operations. Specifically, removal of soluble elements (Cs, Se, Tc, etc.) during the sludge washing operations or incomplete transfer of the cesium loaded zeolite from 8D-1 to 8D-2 can not be factored into this assessment until these operations have been concluded. An updated assessment of the West Valley radionuclide inventory will be provided as an addendum to this report after the waste pretreatment operations have been completed.

Estimated Range of Canistered Waste-form Activity Variations

The ORIGEN2 radionuclide estimates were decayed to the year 3115 to determine those isotopes, with half lives in excess of 10 years, which exceed 0.01% of the total curies. This analysis was conducted in 10 year increments for the single West Valley waste type and is summarized in Appendix 1. The factor of 0.01% of the total activity adds conservatism to this analysis and was chosen to assure that all of the isotopes which could exceed the 0.05% criteria are listed. The reportable isotopes, including the approximate year when they initially exceed the 0.01% standard, are listed in Table 3.

The total estimated activities for each of the reportable radionuclides which would be shipped to the Repository, for the years of initial HLW vitrification (1996), 20[illegible] and 3115, are listed in Table 4. The estimated activity for all of the waste isotopes are provided in Appendix 2 for these years.

The estimated range of radionuclide variation in the canistered waste forms is presented in Table 5. These variations assume various canister filling scenarios, as discussed below, and include the effects of the estimated uncertainty in the radionuclide inventory. The values for this uncertainty, σ_i, are the relative standard deviations listed in Table 2. For example, the minimum curie content case

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* The Cs-135 value estimated by ORIGEN2 is conservative, i.e., higher than the PNL measured value. Given the variables of reactor exposure time, neutron flux distribution, and decay periods, a factor of 3 difference in predicted and measured values for an isotope is not unusual.

assumes a 300 canister campaign, 80% canister fill and the ORIGEN2 radionuclide content shown in Table 4 minus the uncertainty. The anticipated canister case assumes the calculated curie content, 300 canisters and an 85% fill height. The maximum case assumes the maximum radionuclide range, 250 canisters and a 100% filled canister. This calculation methodology is shown below:

Minimum case: The low estimated value for curies of each isotope (the estimated value minus its uncertainty) divided into 300 canisters containing the nominal 1900 kg of glass. This average campaign value was adjusted to an 80% full canister, 1800 kg,

$$((Ci_i - \sigma_i)/(300 \text{ canisters} \times 1900 \text{ kg glass/canister})) \times 1800 \text{ kg glass}$$

Nominal case: The reported curies split into 300 canisters, each containing 1900 kg of glass, or:

$$(Ci_i/(300 \text{ canisters} \times 1900 \text{ kg glass/canister})) \times 1900 \text{ kg glass}$$

Maximum case: The high estimated value for curies of each isotope (the estimated value plus its uncertainty) divided into 250 canisters containing the nominal 1900 kg of glass. This average campaign value was adjusted to a 100% full canister, 2250 kg, or:

$$((Ci_i + \sigma_i)/(250 \text{ canisters} \times 1900 \text{ kg glass/canister})) \times 2250 \text{ kg glass})$$

Table 2

Comparison of ORIGEN2 and PNL Analyses
(Combined PUREX and THOREX Wastes)

Radionuclide	ORIGEN2 Analyses Curies at 12-31-92	PNL Analyses Curies at 12-31-92	Relative Standard Deviation
C-14	1.37E+02	---	1.00E+02
Ni-59	1.06E+02	---	1.00E+02
Ni-63	1.84E+04	---	1.00E+02
Se-79	6.02E+01	<2.37E+02*	1.00E+02
Sr-90	6.24E+06	6.07E+06	1.90E+00
Zr-93	2.72E+02	---	1.00E+02
Nb-93m	1.96E+02	---	1.00E+02
Tc-99	1.70E+03	1.90E+03	8.32E+00
Pd-107	1.1E+01	---	1.00E+02
Sn-126	1.04E+02	---	1.00E+02
Cs-135	1.61E+02	6.17E+01	4.37E+01
Cs-137	6.74E+06	6.07E+06	6.38E+00
Sm-151	8.24E+04	---	1.00E+02
Ac-227	8.85E+00	---	1.00E+02
Th-232	1.64E+00	---	1.00E+02
Pa-231	1.52E+01	---	1.00E+02
U-233	9.53E+00	---	1.00E+02
U-234	4.54E+00	5.18E+00	9.91E+00
Np-236	9.47E+00	---	1.00E+02
Np-237	2.34E+01	3.51E+01	3.54E+01
Pu-238	8.22E+03	7.87E+03	3.04E+00
Pu-239	1.65E+03	1.93E+03	1.20E+01
Pu-240	1.21E+03	1.37E+03	9.09E+00
Pu-241	7.09E+04	7.78E+04	6.91E+00
Pu-242	1.65E+00	1.55E-00	4.29E+00
Am-241	5.35E+04	---	1.00E+02
Am-242m	2.93E+02	---	1.00E+02
Am-243	3.47E+02	---	1.00E+02
Cm-244	6.81E+03	---	1.00E+02

* Reported as less than the detection limit.

Table 3

Reportable Radionuclides and Half Lifes

Reportable Radionuclide	Year Isotope Becomes Reportable (±5)	Half Life (Years)[A]
Ni-63	current	9.20E+1[B]
Sr-90	current	2.91E+1
Cs-137	current	3.00E+1[B]
Sm-151	current	9.00E+1
Pu-238	current	8.78E+1[C]
Pu-241	current	1.44E+1
Am-241	current	4.32E+2
Cm-244	current	1.81E+1
Tc-99	2015	2.13E+5
Pu-239	2015	2.41E+4
Pu-240	2035	6.54E+3[C]
Am-243	2085	7.38E+3[D]
Zr-93	2095	1.53E+6
Nb-93m	2095	1.36E+1[D]
Cs-135	2115	2.30E+6
Am-242m	2115	1.52E+1[C]
C-14	2125	5.73E+3
Ni-59	2135	8.00E+4[B]
Sn-126	2135	1.00E+5
Se-79	2165	6.50E+4
Np-237	2205	2.14E+6
Ac-227	2235	2.18E+1[E]
Pa-231	2235	3.28E+4
Pd-107	2265	6.50E+6
U-233	2275	1.59E+5
Np-236	2275	1.15E+5[E]
U-234	2295	2.45E+5[D]
Pu-242	3065	3.87E+5[C]
Th-232	3085	1.41E+10[B]

A) Source of half life data is Chart of Nuclides, 14th Edition, April 1988[10] unless otherwise indicated
B) Health Physics and Radiological Health Handbook, 1984[11]
C) Chart of Nuclides, 11th Edition, April 1972[12]
D) Health Physics and Radiological Health Handbook, 1992[13]
E) Chart of Nuclides, 13th Edition, August 1983[14]

Table 4

Reportable Radionuclide Estimate**

Radionuclide	Total Curies 1996	Total Curies 2015	Total Curies 3115
C-14	1.37E+02	1.37E+02	1.20E+02
Ni-59	1.06E+02	1.06E+02	1.05E+02
Ni-63	8.17E+03	7.08E+03	1.78E+00
Se-79	6.02E+01	6.02E+01	5.95E+01
Sr-90	5.81E+06	3.70E+06	1.54E-05
Zr-93	2.72E+02	2.72E+02	2.72E+02
Nb-93m	2.07E+02	2.47E+02	2.72E+02
Tc-99	1.70E+03	1.70E+03	1.69E+03
Pd-107	1.10E+01	1.10E+01	1.10E+01
Sn-126	1.04E+02	1.04E+02	1.03E+02
Cs-135	1.61E+02	1.61E+02	1.61E+02
Cs-137	6.29E+06	4.05E+06	3.72E-05
Sm-151	8.05E+04	6.96E+04	1.46E+01
Ac-227	9.43E+00	1.20E+01	1.49E+01
Th-232	1.64E+00	1.64E+00	1.64E+00
Pa-231	1.52E+01	1.52E+01	1.48E+01
U-233	9.53E+00	9.53E+00	9.60E+00
U-234	4.61E+00	5.01E+00	7.61E+00
Np-236	9.47E+00	9.47E+00	9.41E+00
Np-237	2.35E+01	2.38E+01	3.28E+01
Pu-238	8.04E+03	6.95E+03	4.52E+00
Pu-239	1.65E+03	1.65E+03	1.61E+03
Pu-240	1.22E+03	1.22E+03	1.09E+03
Pu-241	6.13E+04	2.46E+04	8.06E-01
Pu-242	1.65E+00	1.65E+00	1.67E+00
Am-241	5.35E+04	5.31E+04	9.24E+03
Am-242m	2.89E+02	2.65E+02	1.76E+00
Am-243	3.47E+02	3.46E+02	3.12E+02
Cm-244	6.07E+03	2.93E+03	1.49E-15

** This table represents a conservatively high estimate of the total radionuclide inventory, specifically removal of soluble elements during the sludge washing or incomplete transfer of the cesium loaded zeolite from 8D-1 to 8D-2 has not been factored into these estimates as noted in the text.

Table 5

Estimated Canister Activity Range

	1996			2015			3115		
Radionuclide	Low, Curies	Nominal, Curies	High, Curies	Low, Curies	Nominal, Curies	High, Curies	Low, Curies	Nominal, Curies	High, Curies
C-14	0.00E+00	4.56E-01	1.30E+00	0.00E+00	4.55E-01	1.29E+00	0.00E+00	3.98E-01	1.13E+00
Ni-59	0.00E+00	3.53E-01	1.00E+00	0.00E+00	3.53E-01	1.00E+00	0.00E+00	3.50E-01	9.94E-01
Ni-63	0.00E+00	2.72E+01	7.74E+01	0.00E+00	2.36E+01	6.71E+01	0.00E+00	5.94E-03	1.69E-02
Se-79	0.00E+00	2.01E-01	5.70E-01	0.00E+00	2.01E-01	5.70E-01	0.00E+00	1.98E-01	5.63E-01
Sr-90	1.80E+04	1.94E+04	2.80E+04	1.14E+04	1.23E+04	1.78E+04	4.78E-08	5.15E-08	7.45E-08
Zr-93	0.00E+00	9.07E-01	2.58E+00	0.00E+00	9.07E-01	2.58E+00	0.00E+00	9.06E-01	2.58E+00
Nb-93m	0.00E+00	6.90E-01	1.96E+00	0.00E+00	8.24E-01	2.34E+00	0.00E+00	9.06E-01	2.58E+00
Tc-99	4.92E+00	5.67E+00	8.72E+00	4.92E+00	5.67E+00	8.72E+00	4.90E+00	5.65E+00	8.69E+00
Pd-107	0.00E+00	3.67E-02	1.04E-01	0.00E+00	3.67E-02	1.04E-01	0.00E+00	3.67E-02	1.04E-01
Sn-126	0.00E+00	3.47E-01	9.85E-01	0.00E+00	3.47E-01	9.85E-01	0.00E+00	3.44E-01	9.78E-01
Cs-135	2.88E-01	5.37E-01	1.09E+00	2.88E-01	5.37E-01	1.09E+00	2.88E-01	5.36E-01	1.09E+00
Cs-137	1.86E+04	2.10E+04	3.17E+04	1.20E+04	1.35E+04	2.04E+04	1.10E-07	1.24E-07	1.87E-07
Sm-151	0.00E+00	2.68E+02	7.63E+02	0.00E+00	2.32E+02	6.59E+02	0.00E+00	4.85E-02	1.38E-01
Ac-227	0.00E+00	3.14E-02	8.93E-02	0.00E+00	4.01E-02	1.14E-01	0.00E+00	4.95E-02	1.41E-01
Th-232	0.00E+00	5.47E-03	1.55E-02	0.00E+00	5.47E-03	1.55E-02	0.00E+00	5.47E-03	1.55E-02
Pa-231	0.00E+00	5.07E-02	1.44E-01	0.00E+00	5.06E-02	1.44E-01	0.00E+00	4.95E-02	1.41E-01
U-233	0.00E+00	3.18E-02	9.03E-02	0.00E+00	3.18E-02	9.03E-02	0.00E+00	3.20E-02	9.09E-02
U-234	1.31E-02	1.54E-02	2.40E-02	1.43E-02	1.67E-02	2.61E-02	2.17E-02	2.54E-02	3.96E-02
Np-236	0.00E+00	3.16E-02	8.97E-02	0.00E+00	3.16E-02	8.97E-02	0.00E+00	3.14E-02	8.91E-02
Np-237	4.79E-02	7.82E-02	1.50E-01	4.86E-02	7.93E-02	1.52E-01	6.70E-02	1.09E-01	2.10E-01

Table 5

Estimated Canister Activity Range

	1996			2015			3115		
Radionuclide	Low, Curies	Nominal, Curies	High, Curies	Low, Curies	Nominal, Curies	High, Curies	Low, Curies	Nominal, Curies	High, Curies
Pu-238	2.46E+01	2.68E+01	3.92E+01	2.13E+01	2.32E+01	3.39E+01	1.38E-02	1.51E-02	2.21E-02
Pu-239	4.58E+00	5.50E+00	8.75E+00	4.58E+00	5.50E+00	8.75E+00	4.47E+00	5.36E+00	8.53E+00
Pu-240	3.49E+00	4.05E+00	6.28E+00	3.51E+00	4.07E+00	6.31E+00	3.14E+00	3.65E+00	5.66E+00
Pu-241	1.80E+02	2.04E+02	3.11E+02	7.23E+01	8.19E+01	1.24E+02	2.37E-03	2.69E-03	4.08E-03
Pu-242	4.99E-03	5.50E-03	8.15E-03	4.99E-03	5.51E-03	8.16E-03	5.03E-03	5.55E-03	8.23E-03
Am-241	0.00E+00	1.78E+02	5.07E+02	0.00E+00	1.77E+02	5.03E+02	0.00E+00	3.08E+01	8.76E+01
Am-242m	0.00E+00	9.63E-01	2.74E+00	0.00E+00	8.83E-01	2.51E+00	0.00E+00	5.85E-03	1.66E-02
Am-243	0.00E+00	1.16E+00	3.28E+00	0.00E+00	1.15E+00	3.28E+00	0.00E+00	1.04E+00	2.96E+00
Cm-244	0.00E+00	2.02E+01	5.75E+01	0.00E+00	9.78E+00	2.78E+01	0.00E+00	4.96E-18	1.41E-17

Estimates of Reportable Radionuclide Concentrations During Production

The actual radionuclide content of the canistered waste forms will be estimated by analyzing the glass shard samples collected for satisfying the requirements of WAPS 1.1 and 1.3. The radionuclide information for ^{90}Sr, ^{137}Cs will be directly measured from these shards by beta and gamma energy analysis, respectively. The results for these strontium and cesium isotopes will be reported directly from the shard measurements. These two radionuclides, and their short-lived daughters, will represent over 98 percent of the total activity during the glass production time period.

The remaining reportable radionuclide inventory will be estimated using scaling factors, i.e. ratios developed for each reportable isotope to ^{90}Sr or ^{137}Cs. The ^{90}Sr and ^{137}Cs values measured from the shard samples would then be multiplied by the scaling factors to obtain the estimated inventories for the other reportable isotopes listed in Table 3. The quantity of ^{135}Cs will be determined by using a scaling factor and the ^{137}Cs measurement. The remaining reportable isotopes will be inferred from scaling factors and the measured ^{90}Sr activity.

Approximate scaling factors, based on the conservative estimates of the total waste activity to be shipped to the repository presented in this report, are listed in Table 6. These factors were developed by ratioing the reportable radionuclide concentration estimates for 1996, 2015 and 3015, e.g. the 1996 scaling factor for carbon-14 was determined by dividing the 1996 value of C-14 in Table 4 by the value of Sr-90 to get 2.36E-5. This procedure was repeated for each isotope, using either Sr-90 or Cs-137 as listed in Table 6, for 1996, 2015 and 3115.

The relative standard deviations listed for the scaling factors in Table 6 were calculated by combining the uncertainties from both Table 2 for both each reportable isotope and the scaling radionuclide. The relative standard deviation for each reportable radionuclide and its scaling isotope were combined by taking the square root of the sum of the squares of the individual RSDs.

The Production Records will contain the actual measurements and scaled data for the analyzed shards, and will identify the source canisters. The data reported for a canister which has been sampled will be the information collected and projected from that glass sample, including an adjustment for the measured glass level within that canister. The radionuclide information for the remaining canistered waste forms will be reported as the mean of all the shard analyses, including their uncertainty estimates, scaled to the glass level within that canister.

The scaling factors, and their associated uncertainties, will be adjusted in the future addendum to this report following the post blending waste analyses. These ratios factors will be established for the anticipated vitrification initiation date (1996), 2015 and 3115. Decay of the HLW source term data to develop these scaling factors will be performed using ORIGEN-S[15] or other qualified code.

DOCUMENTATION

The final estimate of the radionuclide inventory for the canistered West Valley waste forms will be provided in a future addendum to this report, following completion of the HLW pretreatment activities.

The final scaling factors, and their uncertainties, will be reported in a future addendum to this report. The measured and calculated radionuclide contents of the canistered waste forms will be entered into the Production Records.

Table 6

Radionuclide Scaling Factors and Estimated Errors

Radionuclide	Scaling Radionuclide	Scaling Factor 1996	Relative Standard Deviation	Scaling Factor 2015	Relative Standard Deviation	Scaling Factor 3115	Relative Standard Deviation
C-14	Sr-90	2.36E-05	100%	3.69E-05	100%	7.74E+06	100%
Ni-59	Sr-90	1.82E-05	100%	2.87E-05	100%	6.80E+06	100%
Ni-63	Sr-90	1.41E-03	100%	1.92E-03	100%	1.15E+05	100%
Se-79	Sr-90	1.04E-05	100%	1.63E-05	100%	3.85E+06	100%
Sr-90	-	1.00E+00	2%	1.00E+00	2%	1.00E+00	2%
Zr-93	Sr-90	4.68E-05	100%	7.36E-05	100%	1.76E+07	100%
Nb-93m	Sr-90	3.56E-05	100%	6.69E-05	100%	1.76E+07	100%
Tc-99	Sr-90	2.93E-04	9%	4.60E-04	9%	1.10E+08	9%
Pd-107	Sr-90	1.89E-06	100%	2.98E-06	100%	7.13E+05	100%
Sn-126	Sr-90	1.79E-05	100%	2.81E-05	100%	6.68E+06	100%
Cs-135	Cs-137	2.56E-05	44%	3.97E-05	44%	4.33E+06	44%
Cs-137	-	1.00E+00	6%	1.00E+00	6%	1.00E+00	6%
Sm-151	Sr-90	1.39E-02	100%	1.88E-02	100%	9.43E+05	100%
Ac-227	Sr-90	1.62E-06	100%	3.26E-06	100%	9.62E+05	100%
Th-232	Sr-90	2.82E-07	100%	4.44E-07	100%	1.06E+05	100%
Pa-231	Sr-90	2.62E-06	100%	4.11E-06	100%	9.62E+05	100%
U-233	Sr-90	1.64E-06	100%	2.58E-06	100%	6.22E+05	100%
U-234	Sr-90	7.94E-07	10%	1.36E-06	10%	4.93E+05	10%
Np-236	Sr-90	1.63E-06	100%	2.56E-06	100%	6.09E+05	100%
Np-237	Sr-90	4.04E-06	35%	6.44E-06	35%	2.13E+06	35%
Pu-238	Sr-90	1.38E-03	47%	1.88E-03	47%	2.93E+05	47%
Pu-239	Sr-90	2.84E-04	47%	4.46E-04	47%	1.04E+08	47%
Pu-240	Sr-90	2.09E-04	48%	3.31E-04	48%	7.09E+07	48%
Pu-241	Sr-90	1.06E-02	46%	6.65E-03	46%	5.22E+04	46%
Pu-242	Sr-90	2.84E-07	51%	4.47E-07	51%	1.08E+05	51%
Am-241	Sr-90	9.21E-03	100%	1.44E-02	100%	5.99E+08	100%
Am-242m	Sr-90	4.97E-05	100%	7.17E-05	100%	1.14E+05	100%
Am-243	Sr-90	5.97E-05	100%	9.36E-05	100%	2.02E+07	100%
Cm-244	Sr-90	1.04E-03	100%	7.94E-04	100%	9.64E-11	100%

REFERENCES

†1. Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form, WVDP-185, Rev. 10, 1996.

2. "ORIGEN2 Isotope Generation and Depletion Code-Matrix Exponential Method," CCC-371, Radiation Shielding Information Center, Oak Ridge National Laboratory, 1987.

3. "Characterization of Reactor Fuel Reprocessed at West Valley," WVDP-EIS-014, Rev. 0, 1992.

†4. "Existing WVDP Waste Activity Estimate Data," WVNS-DP-024, Rev. 0, 1994.

†5. "Validation of ORIGEN2 Radionuclide Analyses for the NFS Reprocessing Campaigns," WVNS-SR-011, Rev. 0, 1994.

†6. "PNL Radionuclide Analysis - 1988 & 1991," WVNS-DP-023, Rev. 0, 1994.

†7. "Reference Insoluble Waste and Decay Calculations for WQR Section 1.2," WVNS-CAL-109, Rev. 0, 1994.

8. "Western New York Nuclear Service Center Study," TID-28905-2, 1982.

†9. "Reference Soluble Waste Composition," WVNS-CAL-107, Rev. 0, 1994.

†10. "Chart of Nuclides," Revised to April 1988, General Electric Company, San Jose, California.

†11. Shleien, Bernard and Michael S. Terpilak, "The Health Physics and Radiological Health Handbook," May 1984.

†12. "Chart of Nuclides," Revised to April 1972, General Electric Company, San Jose, California.

†13. Shleien, Bernard, "The Health Physics and Radiological Health Handbook," Revised Edition, 1992.

†14. "Chart of Nuclides," Revised to August 1983, General Electric Company, San Jose, California.

15. "SCALE-4: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation," CCC-545, Radiation Shielding Information Center, Oak Ridge National Laboratory Radiation Shielding Information Center, 1990.

† These references are required to demonstrate conformance with the WCP compliance strategy.

Appendix 1

WVNS Memo CD:94:0160, "Decay of Radionuclide Inventory of West Valley Waste"

West Valley Nuclear Services Company, Inc.

P.O. Box 191 - 10282 Rock Springs Road
West Valley, New York 14171-0191
(716) 942-323F

Department : Vitrification Process Development

Ext/MS : 4868/M

Memo # : CD:94:0160

Date : December 20, 1994

Subject : Decay of Radionuclide Inventory of West Valley Waste

To : S. M. Barnes MS-M

cc : CD Letter Log MS-M

Reference : 1) WVNS-CAL-109, "Calculations for WQR Section 1.2"

2) Letter WD:86:0804, L. E. Rykken to W. W. Bixby, "Reference Radionuclide Content of High-Level Waste," dated November 10, 1986

Attached is the table listing the total number of curies and the curie percent of each radionuclide in the waste stream every hundred years, starting in 2015 and proceeding through 3115. The decays were carried out using the decay equations described in WVNS-CAL-109 in support of WQR Section 1.2. The initial source data for these calculations is from the November 1986 estimates of the WTF totals made by L. E. Rykken. Curie percents less than 0.01% are not displayed. The last column contains an indication of whether or not the isotope meets the criteria stated in the WCP Section 1.2, based on the preceding calculations and the half life of the isotope (not listed).

K. Firstenberg, Co-op

KF:LLN

Attachment: A) Table

VPD/1501LLN

RADIO-NUCLIDE	Raw Data 1987		Decayed Data 2015		Decayed Data 2115		Decayed Data 2215		Decayed Data 2315		Decayed 2415
	Curies	Ci %	Curies	Ci %	Curies	Ci %	Curies	Ci %	Curies	Ci %	Curies
3-H	9.74E+01		2.02E+01		7.30E-02		2.64E-04		9.56E-07		3.46E-09
14-C	1.37E+02		1.37E+02		1.35E+02		1.33E+02	0.065%	1.32E+02	0.212%	1.30E+02
55-Fe	1.56E+03		8.94E-01		2.36E-12		6.24E-24		1.65E-35		4.35E-47
60-Co	1.14E+03		2.87E+01		5.56E-05		1.08E-10		2.09E-16		4.06E-22
59-Ni	1.06E+02		1.06E+02		1.06E+02		1.06E+02	0.052%	1.06E+02	0.170%	1.06E+02
63-Ni	8.74E+03	0.029%	7.08E+03	0.046%	3.33E+03	0.214%	1.57E+03	0.766%	7.38E+02	1.189%	3.48E+02
79-Se	6.02E+01		6.02E+01		6.01E+01		6.01E+01	0.029%	6.00E+01	0.097%	5.99E+01
90-Sr	7.20E+06	23.904%	3.70E+06	23.896%	3.41E+05	21.917%	3.15E+04	15.391%	2.91E+03	4.690%	2.69E+02
90-Y	7.20E+06	23.904%	3.70E+06	23.902%	3.41E+05	21.922%	3.15E+04	15.395%	2.91E+03	4.691%	2.69E+02
93-Zr	2.72E+02		2.72E+02		2.72E+02	0.017%	2.72E+02	0.133%	2.72E+02	0.438%	2.72E+02
93m-Nb	1.69E+02		2.47E+02		2.72E+02	0.017%	2.72E+02	0.133%	2.72E+02	0.438%	2.72E+02
99-Tc	1.70E+03		1.70E+03	0.011%	1.70E+03	0.109%	1.70E+03	0.829%	1.70E+03	2.734%	1.70E+03
106-Ru	1.11E+02		5.01E-07		7.85E-37		1.23E-66		1.93E-96		< 1e-100
106-Rh	1.11E+02		5.01E-07		7.85E-37		1.23E-66		1.93E-96		< 1e-100
107-Pd	1.10E+01		1.10E+01		1.10E+01		1.10E+01		1.10E+01	0.018%	1.10E+01
113m-Cd	2.45E+03		6.48E+02		5.62E+00		4.88E-02		4.23E-04		3.67E-06
121m-Sn	1.82E+01		1.23E+01		3.09E+00		7.72E-01		1.93E-01		4.82E-02
126-Sn	1.04E+02		1.04E+02		1.04E+02		1.04E+02	0.051%	1.04E+02	0.167%	1.04E+02
125-Sb	1.54E+04	0.051%	1.40E+01		1.89E-10		2.57E-21		3.48E-32		4.73E-43
126-Sb	1.46E+01		1.46E+01		1.45E+01		1.45E+01		1.45E+01	0.023%	1.45E+01
126m-Sb	1.04E+02		1.04E+02		1.04E+02		1.04E+02	0.051%	1.04E+02	0.167%	1.04E+02
125m-Te	3.78E+03	0.013%	3.42E+00		4.64E-11		6.29E-22		8.54E-33		1.16E-43
129-I	2.10E-01		2.10E-01		2.10E-01		2.10E-01		2.10E-01		2.10E-01
134-Cs	1.42E+04	0.047%	1.15E+00		2.80E-15		6.83E-30		1.66E-44		4.06E-59
135-Cs	1.61E+02		1.61E+02		1.61E+02	0.010%	1.61E+02	0.079%	1.61E+02	0.259%	1.61E+02
137-Cs	7.74E+06	25.697%	4.05E+06	26.207%	4.02E+05	25.817%	3.99E+04	19.473%	3.96E+03	6.373%	3.93E+02
137m-Ba	7.32E+06	24.303%	3.83E+06	24.792%	3.80E+05	24.423%	3.77E+04	18.422%	3.74E+03	6.029%	3.71E+02
144-Ce	9.35E+00		1.41E-10		3.22E-49		7.32E-88		< 1e-100		< 1e-100
144-Pr	9.35E+00		1.41E-10		3.22E-49		7.32E-88		< 1e-100		< 1e-100
146-Pm	1.59E+01		4.67E-01		1.57E-06		5.28E-12		1.77E-17		5.97E-23
147-Pm	1.95E+05	0.647%	1.18E+02		3.83E-10		1.24E-21		4.02E-33		1.30E-44
151-Sm	8.63E+04	0.287%	6.96E+04	0.450%	3.22E+04	2.067%	1.49E+04	7.277%	6.90E+03	11.112%	3.19E+03
152-Eu	4.25E+02		1.02E+02		6.24E-01		3.82E-03		2.33E-05		1.43E-07
154-Eu	1.22E+05	0.405%	1.28E+04	0.083%	4.04E+00		1.28E-03		4.03E-07		1.27E-10
155-Eu	3.62E+04	0.120%	7.23E+02		6.17E-04		5.26E-10		4.49E-16		3.83E-22
207-Tl	7.50E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.50E+01
208-Tl	3.55E+00		2.74E+00		1.60E+00		1.16E+00		9.94E-01		9.30E-01
211-Pb	7.52E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
212-Pb	9.88E+00		7.62E+00		4.45E+00		3.23E+00		2.77E+00		2.59E+00
211-Bi	7.52E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
212-Bi	9.88E+00		7.62E+00		4.45E+00		3.23E+00		2.77E+00		2.59E+00
212-Po	6.33E+00		4.89E+00		2.85E+00		2.07E+00		1.77E+00		1.66E+00
215-Po	7.52E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
216-Po	9.88E+00		7.62E+00		4.45E+00		3.23E+00		2.77E+00		2.59E+00
219-Rn	7.52E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
220-Rn	9.88E+00		7.62E+00		4.45E+00		3.23E+00		2.77E+00		2.59E+00
223-Fr	1.04E-01		1.66E-01		2.08E-01		2.09E-01		2.08E-01		2.08E-01
223-Ra	7.52E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
224-Ra	9.88E+00		7.62E+00		4.45E+00		3.23E+00		2.77E+00		2.59E+00
228-Ra	1.48E+00		1.63E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00
227-Ac	7.52E+00		1.20E+01		1.50E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
228-Ac	1.48E+00		1.63E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00
227-Th	7.42E+00		1.19E+01		1.48E+01		1.49E+01		1.49E+01	0.024%	1.49E+01
228-Th	9.88E+00		7.62E+00		4.45E+00		3.23E+00		2.77E+00		2.59E+00
229-Th	2.07E-01		2.32E-01		3.19E-01		4.06E-01		4.92E-01		5.77E-01
230-Th	5.83E-02		5.95E-02		6.46E-02		7.06E-02		7.69E-02		8.35E-02
232-Th	1.64E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00
231-Pa	1.52E+01		1.52E+01		1.52E+01		1.51E+01		1.51E+01	0.024%	1.51E+01
232-U	7.41E+00		5.86E+00		2.76E+00		1.57E+00		1.12E+00		9.48E-01
233-U	9.53E+00		9.53E+00		9.54E+00		9.54E+00		9.55E+00	0.015%	9.56E+00
234-U	4.40E+00		5.01E+00		6.39E+00		7.03E+00		7.34E+00	0.012%	7.48E+00
235-U	1.01E-01		1.01E-01		1.01E-01		1.01E-01		1.02E-01		1.02E-01
236-U	2.96E-01		2.97E-01		3.01E-01		3.04E-01		3.08E-01		3.11E-01
238-U	8.54E-01		8.54E-01		8.54E-01		8.54E-01		8.54E-01		8.54E-01
236-Np	9.47E+00		9.47E+00		9.46E+00		9.46E+00		9.45E+00	0.015%	9.45E+00
237-Np	2.33E+01		2.38E+01		2.54E+01		2.68E+01	0.013%	2.79E+01	0.045%	2.89E+01
239-Np	3.47E+02		3.46E+02		3.43E+02	0.022%	3.40E+02	0.166%	3.36E+02	0.542%	3.33E+02
236-Pu	8.49E-01		8.43E-01		8.42E-01		8.42E-01		8.41E-01		8.41E-01
238-Pu	8.61E+03	0.029%	6.95E+03	0.045%	3.25E+03	0.209%	1.53E+03	0.749%	7.34E+02	1.182%	3.57E+02
239-Pu	1.65E+03		1.65E+03	0.011%	1.65E+03	0.106%	1.64E+03	0.801%	1.64E+03	2.637%	1.63E+03
240-Pu	1.21E+03		1.22E+03		1.22E+03	0.078%	1.20E+03	0.588%	1.19E+03	1.919%	1.18E+03
241-Pu	9.46E+04	0.314%	2.46E+04	0.159%	2.00E+02	0.013%	2.49E+00		8.73E-01		8.53E-01
242-Pu	1.65E+00		1.65E+00		1.66E+00		1.66E+00		1.66E+00		1.67E+00
241-Am	5.32E+04	0.177%	5.31E+04	0.344%	4.60E+04	2.952%	3.92E+04	19.116%	3.34E+04	53.710%	2.84E+04
242-Am	2.99E+02		2.64E+02		1.67E+02	0.011%	1.06E+02	0.052%	6.71E+01	0.108%	4.25E+01
242m-Am	3.01E+02		2.65E+02		1.68E+02	0.011%	1.06E+02	0.052%	6.74E+01	0.109%	4.27E+01
243-Am	3.47E+02		3.46E+02		3.43E+02	0.022%	3.40E+02	0.166%	3.36E+02	0.542%	3.33E+02
242-Cm	2.49E+02		2.19E+02		1.39E+02		8.78E+01	0.043%	5.57E+01	0.090%	3.53E+01
243-Cm	1.44E+02		7.29E+01		6.40E+00		5.63E-01		4.94E-02		4.34E-03
244-Cm	8.57E+03	0.028%	2.93E+03	0.019%	6.37E+01		1.38E+00		3.01E-02		6.53E-04
245-Cm	8.82E-01		8.80E-01		8.73E-01		8.66E-01		8.59E-01		8.52E-01
246-Cm	1.01E-01		1.01E-01		9.91E-02		9.77E-02		9.63E-02		9.49E-02
TOTALS:	3.01E+07	99.955%	1.55E+07	99.962%	1.56E+06	99.937%	2.05E+05	99.889%	6.21E+04	99.948%	4.04E+04

RADIO-NUCLIDE	Data	Decayed Data 2515		Decayed Data 2615		Decayed Data 2715		Decayed Data 2815		Decayed Data 2915	
	Ci %	Curies	Ci %	Curies	Ci %	Curies	Ci %	Curies	Ci %	Curies	Ci %
3-H		1.25E-11		4.53E-14		1.64E-16		5.93E-19		2.15E-21	
14-C	0.322%	1.29E+02	0.391%	1.27E+02	0.452%	1.25E+02	0.511%	1.24E+02	0.571%	1.22E+02	0.633%
55-Fe		1.15E-58		3.04E-70		8.03E-82		2.12E-93		< 1e-100	
60-Co		7.88E-28		1.53E-33		2.97E-39		5.76E-45		1.12E-50	
59-Ni	0.262%	1.06E+02	0.321%	1.05E+02	0.375%	1.05E+02	0.429%	1.05E+02	0.485%	1.05E+02	0.543%
63-Ni	0.861%	1.64E+02	0.498%	7.70E+01	0.274%	3.63E+01	0.148%	1.71E+01	0.079%	8.04E+00	0.042%
79-Se	0.148%	5.99E+01	0.182%	5.98E+01	0.213%	5.97E+01	0.243%	5.97E+01	0.275%	5.96E+01	0.308%
90-Sr	0.666%	2.49E+01	0.076%	2.30E+00		2.12E-01		1.96E-02		1.81E-03	
90-Y	0.667%	2.49E+01	0.076%	2.30E+00		2.12E-01		1.96E-02		1.81E-03	
93-Zr	0.674%	2.72E+02	0.828%	2.72E+02	0.967%	2.72E+02	1.108%	2.72E+02	1.253%	2.72E+02	1.405%
93m-Nb	0.674%	2.72E+02	0.828%	2.72E+02	0.967%	2.72E+02	1.108%	2.72E+02	1.253%	2.72E+02	1.405%
99-Tc	4.205%	1.70E+03	5.169%	1.70E+03	6.035%	1.70E+03	6.908%	1.70E+03	7.813%	1.69E+03	8.758%
106-Ru		< 1e-100		< 1e-100		< 1e-100		< 1e-100		< 1e-100	
106-Rh		< 1e-100		< 1e-100		< 1e-100		< 1e-100		< 1e-100	
107-Pd	0.027%	1.10E+01	0.034%	1.10E+01	0.039%	1.10E+01	0.045%	1.10E+01	0.051%	1.10E+01	0.057%
113m-Cd		3.18E-08		2.76E-10		2.39E-12		2.08E-14		1.80E-16	
121m-Sn		1.21E-02		3.01E-03		7.53E-04		1.88E-04		4.71E-05	
126-Sn	0.257%	1.04E+02	0.316%	1.04E+02	0.368%	1.03E+02	0.422%	1.03E+02	0.477%	1.03E+02	0.534%
125-Sb		6.41E-54		8.70E-65		1.18E-75		1.60E-86		2.17E-97	
126-Sb	0.036%	1.45E+01	0.044%	1.45E+01	0.052%	1.45E+01	0.059%	1.45E+01	0.067%	1.45E+01	0.075%
126m-Sb	0.257%	1.04E+02	0.316%	1.04E+02	0.368%	1.03E+02	0.422%	1.03E+02	0.477%	1.03E+02	0.534%
125m-Te		1.57E-54		2.13E-65		2.89E-76		3.92E-87		5.33E-98	
129-I		2.10E-01		2.10E-01		2.10E-01		2.10E-01		2.10E-01	
134-Cs		9.89E-74		2.41E-88		< 1e-100		< 1e-100		< 1e-100	
135-Cs	0.399%	1.61E+02	0.490%	1.61E+02	0.573%	1.61E+02	0.656%	1.61E+02	0.742%	1.61E+02	0.832%
137-Cs	0.973%	3.90E+01	0.119%	3.87E+00	0.014%	3.83E-01		3.80E-02		3.77E-03	
137m-Ba	0.920%	3.69E+01	0.112%	3.66E+00	0.013%	3.63E-01		3.60E-02		3.57E-03	
144-Ce		< 1e-100		< 1e-100		< 1e-100		< 1e-100		< 1e-100	
144-Pr		< 1e-100		< 1e-100		< 1e-100		< 1e-100		< 1e-100	
146-Pm		2.01E-28		6.75E-34		2.27E-39		7.63E-45		2.57E-50	
147-Pm		4.21E-56		1.36E-67		4.42E-79		1.43E-90		< 1e-100	
151-Sm	7.914%	1.48E+03	4.505%	6.85E+02	2.436%	3.17E+02	1.291%	1.47E+02	0.676%	6.79E+01	0.351%
152-Eu		8.74E-10		5.34E-12		3.27E-14		2.00E-16		1.22E-18	
154-Eu		4.02E-14		1.27E-17		4.02E-21		1.27E-24		4.01E-28	
155-Eu		3.26E-28		2.78E-34		2.37E-40		2.02E-46		1.73E-52	
207-Tl	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.49E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
208-Tl		9.06E-01		8.96E-01		8.92E-01		8.91E-01		8.90E-01	
211-Pb	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
212-Pb		2.52E+00		2.50E+00		2.49E+00	0.010%	2.48E+00	0.011%	2.48E+00	0.013%
211-Bi	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
212-Bi		2.52E+00		2.50E+00		2.49E+00	0.010%	2.48E+00	0.011%	2.48E+00	0.013%
212-Po		1.62E+00		1.60E+00		1.59E+00		1.59E+00		1.59E+00	
215-Po	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
216-Po		2.52E+00		2.50E+00		2.49E+00	0.010%	2.48E+00	0.011%	2.48E+00	0.013%
219-Rn	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
220-Rn		2.52E+00		2.50E+00		2.49E+00	0.010%	2.48E+00	0.011%	2.48E+00	0.013%
223-Fr		2.08E-01		2.07E-01		2.07E-01		2.06E-01		2.06E-01	
223-Ra	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
224-Ra		2.52E+00		2.50E+00		2.49E+00	0.010%	2.48E+00	0.011%	2.48E+00	0.013%
228-Ra		1.64E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00	
227-Ac	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
228-Ac		1.64E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00	
227-Th	0.037%	1.48E+01	0.045%	1.48E+01	0.053%	1.48E+01	0.060%	1.47E+01	0.068%	1.47E+01	0.076%
228-Th		2.52E+00		2.50E+00		2.49E+00	0.010%	2.48E+00	0.011%	2.48E+00	0.013%
229-Th		6.61E-01		7.45E-01		8.28E-01		9.10E-01		9.92E-01	
230-Th		9.00E-02		9.67E-02		1.03E-01		1.10E-01		1.17E-01	
232-Th		1.64E+00		1.64E+00		1.64E+00		1.64E+00		1.64E+00	
231-Pa	0.037%	1.50E+01	0.046%	1.50E+01	0.053%	1.50E+01	0.061%	1.49E+01	0.069%	1.49E+01	0.077%
232-U		8.81E-01		8.56E-01		8.46E-01		8.41E-01		8.40E-01	
233-U	0.024%	9.56E+00	0.029%	9.57E+00	0.034%	9.57E+00	0.039%	9.58E+00	0.044%	9.59E+00	0.050%
234-U	0.019%	7.55E+00	0.023%	7.59E+00	0.027%	7.60E+00	0.031%	7.61E+00	0.035%	7.61E+00	0.039%
235-U		1.02E-01		1.02E-01		1.02E-01		1.02E-01		1.02E-01	
236-U		3.15E-01		3.18E-01		3.22E-01		3.25E-01		3.29E-01	
238-U		8.54E-01		8.54E-01		8.54E-01		8.54E-01		8.54E-01	
236-Np	0.023%	9.44E+00	0.029%	9.43E+00	0.034%	9.43E+00	0.038%	9.42E+00	0.043%	9.42E+00	0.049%
237-Np	0.072%	2.98E+01	0.091%	3.05E+01	0.109%	3.11E+01	0.127%	3.17E+01	0.146%	3.21E+01	0.166%
239-Np	0.826%	3.30E+02	1.006%	3.27E+02	1.164%	3.24E+02	1.320%	3.21E+02	1.479%	3.18E+02	1.643%
236-Pu		8.40E-01		8.40E-01		8.39E-01		8.39E-01		8.38E-01	
238-Pu	0.884%	1.77E+02	0.539%	8.99E+01	0.320%	4.69E+01	0.191%	2.51E+01	0.116%	1.38E+01	0.071%
239-Pu	4.048%	1.63E+03	4.966%	1.63E+03	5.787%	1.62E+03	6.611%	1.62E+03	7.462%	1.62E+03	8.348%
240-Pu	2.921%	1.17E+03	3.553%	1.15E+03	4.107%	1.14E+03	4.653%	1.13E+03	5.208%	1.12E+03	5.778%
241-Pu		8.46E-01		8.39E-01		8.33E-01		8.26E-01		8.19E-01	
242-Pu		1.67E+00		1.67E+00		1.67E+00		1.67E+00		1.67E+00	
241-Am	70.386%	2.42E+04	73.716%	2.06E+04	73.334%	1.76E+04	71.522%	1.50E+04	68.921%	1.27E+04	65.825%
242-Am	0.105%	2.70E+01	0.082%	1.71E+01	0.061%	1.08E+01	0.044%	6.86E+00	0.032%	4.35E+00	0.022%
242m-Am	0.106%	2.71E+01	0.083%	1.72E+01	0.061%	1.09E+01	0.044%	6.90E+00	0.032%	4.37E+00	0.023%
243-Am	0.826%	3.30E+02	1.006%	3.27E+02	1.164%	3.24E+02	1.320%	3.21E+02	1.479%	3.18E+02	1.643%
242-Cm	0.087%	2.24E+01	0.068%	1.42E+01	0.050%	8.98E+00	0.037%	5.69E+00	0.026%	3.61E+00	0.019%
243-Cm		3.81E-04		3.35E-05		2.94E-06		2.59E-07		2.27E-08	
244-Cm		1.42E-05		3.08E-07		6.69E-09		1.45E-10		3.15E-12	
245-Cm		8.45E-01		8.38E-01		8.31E-01		8.24E-01		8.18E-01	
246-Cm		9.35E-02		9.21E-02		9.08E-02		8.95E-02		8.82E-02	
TOTALS:	99.924%	3.28E+04	99.908%	2.81E+04	99.877%	2.45E+04	99.934%	2.17E+04	99.929%	1.94E+04	99.921%

RADIO-NUCLIDE	Decayed Data 3015 Curies	Ci %	Decayed Data 3115 Curies	Ci %	List in WQR?
3-H	7.77E-24	-	2.81E-26		
14-C	1.21E+02	0.696%	1.20E+02	0.760%	Yes
55-Fe	< 1e-100		< 1e-100		
60-Co	2.17E-56		4.21E-62		
59-Ni	1.05E+02	0.604%	1.05E+02	0.667%	Yes
63-Ni	3.78E+00	0.022%	1.78E+00	0.011%	Yes
79-Se	5.95E+01	0.342%	5.95E+01	0.378%	Yes
90-Sr	1.67E-04		1.54E-05		Yes
90-Y	1.67E-04		1.54E-05		
93-Zr	2.72E+02	1.563%	2.72E+02	1.728%	Yes
93m-Nb	2.72E+02	1.563%	2.72E+02	1.728%	Yes
99-Tc	1.69E+03	9.744%	1.69E+03	10.766%	Yes
106-Ru	< 1e-100		< 1e-100		
106-Rh	< 1e-100		< 1e-100		
107-Pd	1.10E+01	0.063%	1.10E+01	0.070%	Yes
113m-Cd	1.56E-18		1.35E-20		
121m-Sn	1.18E-05		2.94E-06		
126-Sn	1.03E+02	0.594%	1.03E+02	0.656%	Yes
125-Sb	< 1e-100		< 1e-100		
126-Sb	1.45E+01	0.083%	1.44E+01	0.092%	
126m-Sb	1.03E+02	0.594%	1.03E+02	0.656%	
125m-Te	< 1e-100		< 1e-100		
129-I	2.10E-01		2.10E-01		
134-Cs	< 1e-100		< 1e-100		
135-Cs	1.61E+02	0.926%	1.61E+02	1.023%	Yes
137-Cs	3.74E-04		3.72E-05		Yes
137m-Ba	3.54E-04		3.51E-05		
144-Ce	< 1e-100		< 1e-100		
144-Pr	< 1e-100		< 1e-100		
146-Pm	8.63E-56		2.90E-61		
147-Pm	< 1e-100		< 1e-100		
151-Sm	3.14E+01	0.181%	1.46E+01	0.093%	Yes
152-Eu	7.48E-21		4.58E-23		
154-Eu	1.27E-31		4.00E-35		
155-Eu	1.47E-58		1.26E-64		
207-Tl	1.48E+01	0.085%	1.48E+01	0.094%	
208-Tl	8.90E-01		8.90E-01		
211-Pb	1.49E+01	0.086%	1.49E+01	0.094%	
212-Pb	2.48E+00	0.014%	2.48E+00	0.016%	
211-Bi	1.49E+01	0.086%	1.49E+01	0.094%	
212-Bi	2.48E+00	0.014%	2.48E+00	0.016%	
212-Po	1.59E+00		1.59E+00	0.010%	
215-Po	1.49E+01	0.086%	1.49E+01	0.094%	
216-Po	2.48E+00	0.014%	2.48E+00	0.016%	
219-Rn	1.49E+01	0.086%	1.49E+01	0.094%	
220-Rn	2.48E+00	0.014%	2.48E+00	0.016%	
223-Fr	2.05E-01		2.05E-01		
223-Ra	1.49E+01	0.086%	1.49E+01	0.094%	
224-Ra	2.48E+00	0.014%	2.48E+00	0.016%	
228-Ra	1.64E+00		1.64E+00	0.010%	
227-Ac	1.49E+01	0.086%	1.49E+01	0.094%	Yes
228-Ac	1.64E+00		1.64E+00	0.010%	
227-Th	1.47E+01	0.084%	1.46E+01	0.093%	
228-Th	2.48E+00	0.014%	2.48E+00	0.016%	
229-Th	1.07E+00		1.15E+00		
230-Th	1.23E-01		1.30E-01		
232-Th	1.64E+00		1.64E+00	0.010%	Yes
231-Pa	1.49E+01	0.086%	1.48E+01	0.094%	Yes
232-U	8.38E-01		8.38E-01		
233-U	9.59E+00	0.055%	9.60E+00	0.061%	Yes
234-U	7.61E+00	0.044%	7.61E+00	0.048%	Yes
235-U	1.03E-01		1.03E-01		
236-U	3.32E-01		3.35E-01		
238-U	8.54E-01		8.54E-01		
236-Np	9.41E+00	0.054%	9.41E+00	0.060%	Yes
237-Np	3.25E+01	0.187%	3.28E+01	0.209%	Yes
239-Np	3.15E+02	1.812%	3.12E+02	1.984%	
236-Pu	8.38E-01		8.37E-01		
238-Pu	7.81E+00	0.045%	4.52E+00	0.029%	Yes
239-Pu	1.61E+03	9.269%	1.61E+03	10.221%	Yes
240-Pu	1.11E+03	6.363%	1.09E+03	6.959%	Yes
241-Pu	8.12E-01		8.06E-01		Yes
242-Pu	1.67E+00		1.67E+00	0.011%	Yes
241-Am	1.09E+04	62.397%	9.24E+03	58.746%	Yes
242-Am	2.76E+00	0.016%	1.75E+00	0.011%	
242m-Am	2.77E+00	0.016%	1.76E+00	0.011%	Yes
243-Am	3.15E+02	1.812%	3.12E+02	1.984%	Yes
242-Cm	2.29E+00	0.013%	1.45E+00		
243-Cm	2.00E-09		1.75E-10		
244-Cm	6.85E-14		1.49E-15		Yes
245-Cm	8.11E-01		8.04E-01		
246-Cm	8.69E-02		8.56E-02		
TOTALS:	1.74E+04	99.912%	1.57E+04	99.945%	29

Appendix 2

WVNS Memo CD:94:0159, "Decay of Radionuclide Inventory of West Valley Waste"

West Valley Nuclear Services Company, Inc.

P.O. Box 191 - 10282 Rock Springs Road
West Valley, New York 14171-0191
(716) 942-3235

Department : Vitrification Process Development

Ext/MS : 4868/M

Memo # : CD:94:0159

Date : December 20, 1994

Subject : Decay of Radionuclide Inventory of West Valley Waste

To : S. M. Barnes MS-M

cc : CD Letter Log MS-M

Reference : 1) Letter WD:86:0804, L. E. Rykken to W. W. Bixby, "Reference Radionuclide Content of High-Level Waste," dated November 10, 1986

2) WVNS-CAL-109, "Calculations for WQR Section 1.2"

Attached is the table listing the total number of curies and the curie percent of each radionuclide in the waste stream for the years 1996, 2015 and 3115. The initial source data, which is not listed in the table, is from the November 1986 estimates of the WTF totals made by L. E. Rykken. The decays were carried out using the decay equations described in WVNS-CAL-109 in support of WQR Section 1.2. Curie percents less than 0.01% are not displayed.

K. Firstenberg, Co-op

KF:LLN

Attachment: A) Table

VPD/1500LLN

RADIO-NUCLIDE	Actual Values (Curies) Decayed Data 1996	Decayed Data 2115	Decayed Data 3115	Curie Percent Decayed Data 1996	Decayed Data 2115	Decayed Data 3115
3-H	5.87E+01	7.30E-02	2.81E-26			
14-C	1.37E+02	1.35E+02	1.20E+02			0.760%
55-Fe	1.42E+02	2.36E-12	<1E-100			
60-Co	3.49E+02	5.56E-05	4.21E-62			
59-Ni	1.06E+02	1.06E+02	1.05E+02			0.667%
63-Ni	8.17E+03	3.33E+03	1.78E+00	0.034%	0.214%	0.011%
79-Se	6.02E+01	6.01E+01	5.95E+01			0.378%
90-Sr	5.81E+06	3.41E+05	1.54E-05	24.036%	21.917%	
90-Y	5.81E+06	3.41E+05	1.54E-05	24.042%	21.922%	
93-Zr	2.72E+02	2.72E+02	2.72E+02		0.017%	1.728%
93m-Nb	2.07E+02	2.72E+02	2.72E+02		0.017%	1.728%
99-Tc	1.70E+03	1.70E+03	1.69E+03		0.109%	10.766%
106-Ru	2.31E-01	7.85E-37	0.00E+00			
106-Rh	2.31E-01	7.85E-37	0.00E+00			
107-Pd	1.10E+01	1.10E+01	1.10E+01			0.070%
113m-Cd	1.60E+03	5.62E+00	1.35E-20			
121m-Sn	1.61E+01	3.09E+00	2.94E-06			
126-Sn	1.04E+02	1.04E+02	1.03E+02			0.656%
125-Sb	1.62E+03	1.89E-10	<1E-100			
126-Sb	1.46E+01	1.45E+01	1.44E+01			0.092%
126m-Sb	1.04E+02	1.04E+02	1.03E+02			0.656%
125m-Te	3.97E+02	4.64E-11	<1E-100			
129-I	2.10E-01	2.10E-01	2.10E-01			
134-Cs	6.87E+02	2.80E-15	<1E-100			
135-Cs	1.61E+02	1.61E+02	1.61E+02		0.010%	1.023%
137-Cs	6.29E+06	4.02E+05	3.72E-05	26.006%	25.817%	
137m-Ba	5.95E+06	3.80E+05	3.51E-05	24.601%	24.423%	
144-Ce	3.11E-03	3.22E-49	0.00E+00			
144-Pr	3.11E-03	3.22E-49	0.00E+00			
146-Pm	5.11E+00	1.57E-06	2.90E-61			
147-Pm	1.80E+04	3.83E-10	<1E-100	0.075%		
151-Sm	8.05E+04	3.22E+04	1.46E+01	0.333%	2.067%	0.093%
152-Eu	2.69E+02	6.24E-01	4.58E-23			
154-Eu	5.91E+04	4.04E+00	4.00E-35	0.244%		
155-Eu	1.03E+04	6.17E-04	1.26E-64	0.043%		
207-Tl	9.40E+00	1.50E+01	1.48E+01			0.094%
208-Tl	3.09E+00	1.60E+00	8.90E-01			
211-Pb	9.43E+00	1.50E+01	1.49E+01			0.094%
212-Pb	8.62E+00	4.45E+00	2.48E+00			0.016%
211-Bi	9.43E+00	1.50E+01	1.49E+01			0.094%
212-Bi	8.62E+00	4.45E+00	2.48E+00			0.016%
212-Po	5.52E+00	2.85E+00	1.59E+00			0.010%
215-Po	9.43E+00	1.50E+01	1.49E+01			0.094%
216-Po	8.62E+00	4.45E+00	2.48E+00			0.016%
219-Rn	9.43E+00	1.50E+01	1.49E+01			0.094%

RADIO-NUCLIDE	Actual Values (Curies) Decayed Data 1996	Decayed Data 2115	Decayed Data 3115	Curie Percent Decayed Data 1996	Decayed Data 2115	Decayed Data 3115
220-Rn	8.62E+00	4.45E+00	2.48E+00			0.016%
223-Fr	1.30E-01	2.08E-01	2.05E-01			
223-Ra	9.43E+00	1.50E+01	1.49E+01			0.094%
224-Ra	8.62E+00	4.45E+00	2.48E+00			0.016%
228-Ra	1.58E+00	1.64E+00	1.64E+00			0.010%
227-Ac	9.43E+00	1.50E+01	1.49E+01			0.094%
228-Ac	1.58E+00	1.64E+00	1.64E+00			0.010%
227-Th	9.30E+00	1.48E+01	1.46E+01			0.093%
228-Th	8.62E+00	4.45E+00	2.48E+00			0.016%
229-Th	2.15E-01	3.19E-01	1.15E+00			
230-Th	5.87E-02	6.46E-02	1.30E-01			
232-Th	1.64E+00	1.64E+00	1.64E+00			0.010%
231-Pa	1.52E+01	1.52E+01	1.48E+01			0.094%
232-U	6.87E+00	2.76E+00	8.38E-01			
233-U	9.53E+00	9.54E+00	9.60E+00			0.061%
234-U	4.61E+00	6.39E+00	7.61E+00			0.048%
235-U	1.01E-01	1.01E-01	1.03E-01			
236-U	2.96E-01	3.01E-01	3.35E-01			
238-U	8.54E-01	8.54E-01	8.54E-01			
236-Np	9.47E+00	9.46E+00	9.41E+00			0.060%
237-Np	2.35E+01	2.54E+01	3.28E+01			0.209%
239-Np	3.47E+02	3.43E+02	3.12E+02		0.022%	1.984%
236-Pu	8.43E-01	8.42E-01	8.37E-01			
238-Pu	8.04E+03	3.25E+03	4.52E+00	0.033%	0.209%	0.029%
239-Pu	1.65E+03	1.65E+03	1.61E+03		0.106%	10.221%
240-Pu	1.22E+03	1.22E+03	1.09E+03		0.078%	6.959%
241-Pu	6.13E+04	2.00E+02	8.06E-01	0.254%	0.013%	
242-Pu	1.65E+00	1.66E+00	1.67E+00			0.011%
241-Am	5.35E+04	4.60E+04	9.24E+03	0.221%	2.952%	58.746%
242-Am	2.87E+02	1.67E+02	1.75E+00		0.011%	0.011%
242m-Am	2.89E+02	1.68E+02	1.76E+00		0.011%	0.011%
243-Am	3.47E+02	3.43E+02	3.12E+02		0.022%	1.984%
242-Cm	2.38E+02	1.39E+02	1.45E+00			
243-Cm	1.16E+02	6.40E+00	1.75E-10			
244-Cm	6.07E+03	6.37E+01	1.49E-15	0.025%		
245-Cm	8.81E-01	8.73E-01	8.04E-01			
246-Cm	1.01E-01	9.91E-02	8.56E-02			
TOTALS:	2.42E+07	1.56E+06	1.57E+04	99.947%	99.937%	99.945%

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CONCURRENCE

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CONCURRENCE AND SIGNATURE TAB

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SIGNATURE

Mr. Andre-Claude LaCoste, Directeur
Direction de la Surete des Installations Nucleaires
99 Rue de Grenelle
75353 Paris 07 SP
France

SUBJECT: West Valley Legacy Waste

Dear Mr. LaCoste:

On March 7, 2001, the United States Nuclear Regulatory Commission (NRC) briefed the Directorate for the Safety of Nuclear Installations (DSIN) on West Valley Legacy Waste. During this briefing the DSIN asked about the design specifications for the High-Level Waste (HLW) canisters used at West Valley. DSIN also asked about the relationship between the original volume of HLW to be vitrified and the total number of HLW canisters produced. After discussing these questions with the Department of Energy's West Valley Demonstration Project Office, NRC prepared its responses. NRC's responses are enclosed.

If you have any questions, please contact Ms. Amy M. Snyder at (301) 415-7644.

Sincerely,
/RA/
John Greeves, Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: Questions and Responses
WVDP-185
WVDP-186

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NAME	J Greeves	H Faulkner	J John Lee	
DATE	/ /01	4/20/01	4/20/01	

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RESPONSE TO QUESTIONS CONCERNING

Enclosure

Mr. Andre-Claude LaCoste, Directeur
Direction de la Surete des Installations Nucleaires
99 Rue de Grenelle
75353 Paris 07 SP
France

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OFC	DWM		OIP		OIP			
NAME	J Greeves		H Faulkner		J Dunn Lee			
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