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**ASSESSMENT OF URANIUM, PLUTONIUM, AND NP-237
CONTENT OF HIGH LEVEL LIQUID WASTE ON E-AREA
VAULT PACKAGE LIMITS**

by

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**HIGH LEVEL WASTE ENGINEERING
HIGH LEVEL ENGINEERING SUPPORT**

WSRC-TR-94-227⁰

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**ASSESSMENT OF URANIUM, PLUTONIUM
AND NP-237 CONTENT OF HIGH LEVEL
LIQUID WASTE ON E-AREA VAULT
PACKAGE LIMITS**

BY

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**Technical Report WSRC-TR-94-227, Rev. 0, "Assessment of Uranium, Plutonium
and Np-237 Content of High Level Liquid Waste on E-Area Vault Package Limits
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INTRODUCTION

The purpose of this report is to assess the waste tank inventory of uranium, plutonium and Np-237 to determine any potential impacts on waste certification for the E-Area vaults (EAV). Procedure WAC 3.10, Rev. 1, of the 1S Manual imposes administrative control limits for radioactive material in waste packages sent to the EAV. Waste tank supernate contains trace amounts of U, Pu, and Np. Thus any material contaminated with supernate and placed in a B-25 waste package may contain one or more of these elements' radioactive isotopes. This report uses material inventory data, solubility data and tank volumes to determine the potential for waste packages, contaminated with waste tank supernate, to exceed the administrative control limits of procedure WAC 3.10, Rev. 1, for U-233, U-234, U-235, U-236, U-238, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242.

SUMMARY

It is extremely unlikely that waste packages contaminated with waste tank supernate will exceed the Low Activity Waste Vault (LAWV) limits for the isotopes of uranium and plutonium. For many isotopes the volume of supernate required to reach the limit is in excess of the B-25 waste package volume. In addition, all but five tanks were shown to be bound by the Cs-137 content. This means that the waste package limit for Cs-137 would be reached before the limit for the subject actinides.

For the tanks not bound by Cs-137, actual sample concentrations were substituted for bounding solubility limits when available. The volume of supernate to reach the limit increased with the actual sample concentrations indicating that the calculation method was conservative. Due to the limited sample data and solubility data for Np-237, similar demonstrations were not performed for this isotope.

DISCUSSION

Uranium, plutonium and neptunium are only slightly soluble in alkaline waste. Therefore when acidic canyon waste streams are neutralized, prior to receipt in the tank farm, the bulk of these elements precipitate and settle with other alkaline insoluble elements in the sludge. The uranium, plutonium and Np-237 content in tanks containing sludge has been well characterized [1], both from a total mass and isotopic perspective. Thus it is possible to determine the average isotopic content for Pu and U in the majority of the waste tanks.

To determine the potential for exceeding the EAV waste package limits, a bounding supernate concentration was calculated for each isotope of concern per tank. Using this concentration it was possible to calculate the required volume of supernate necessary to exceed the package limits. The volume of supernate necessary to exceed the waste package limits was then

compared to the volume of supernate necessary to exceed the Cs-137 limit. This indicates whether the particular isotope is bound by the Cs-137 concentration, meaning the Cs-137 package limit would be exceeded prior to exceeding the U, Pu or Np-237 limit.

The EAV administrative control limits for Np-237 and the isotopes of U and Pu are reproduced below from Table 2 of procedure WAC 3.10, Rev. 1. The most conservative package limits are those for the Low Activity Waste Vaults (LAWV). These limits will be used as the criteria henceforth in this report. Note that the ILTV Crucibles U-235 limit of $9.3\text{E-}6$ Ci/Pkge is less than the LAWV limit of $1.1\text{E-}4$. The ILTV Crucibles vault is specifically designed to handle waste from the Tritium facility and is not designated to receive material contaminated with waste tank supernate.

Table 1. EAV Waste Package Administrative Control Limits for U, Pu and Np-237 [6].

<u>Isotope</u>	<u>LAWV (Ci/Pkg.)</u>	<u>ILNTV Combust. (Ci/Pkg.)</u>	<u>ILNTV Non-Combust. (Ci/Pkg.)</u>	<u>ILTV Bulk (Ci/Pkg.)</u>	<u>ILTV Crucibles (Ci/Pkg.)</u>	<u>LLWSB (Ci/Pkg.)</u>
Np-237	2.2E-5	7.8E-5	4.7E-4	1.1E-4	1.6E-4	2.3E-1
U-233	2.2E-5	3.3E-5	3.3E-5	3.3E-5	3.3E-5	3.3E-5
U-234	7.5E-3	7.5E-3	2.3E-2	7.5E-2	7.9E-3	2.3E-1
U-235	1.1E-4	1.1E-4	1.1E-4	1.1E-4	9.3E-6	1.1E-4
U-236	1.4E-3	2.3E-3	1.8E+0	2.3E-2	1.8E-2	2.3E-1
U-238	2.3E-3	2.3E-3	1.2E-1	2.3E-2	1.8E-2	2.3E-1
Pu-238	9.1E-2	2.3E-1	1.8E+0	2.3E-1	1.8E-1	2.3E-1
Pu-239	9.1E-2	2.3E-1	1.8E+0	2.3E-1	1.8E-1	2.3E-1
Pu-240	9.1E-2	2.3E-1	1.8E+0	2.3E-1	1.8E-1	2.3E-1
Pu-241	1.1E+0	2.7E+0	2.2E+1	2.7E+0	2.2E+0	2.7E+0
Pu-242	9.1E-2	2.3E-1	1.8E+0	2.3E-1	1.8E-1	2.3E-1

Calculation Results

Calculation results for U, Pu and Np-237 are discussed in the following sections. Each section describes the calculation method in sufficient detail for an independent reviewer to duplicate. Table 2 below, provides the specific activities for the isotopes addressed.

Table 2. Specific Activities of Np-237 and U and Pu Isotopes of Interest [7]

<u>Isotope</u>	<u>Specific Activity (Curies/gram)</u>
Np-237	7.049E-4
U-233	9.680E-3
U-234	6.248E-3
U-235	2.161E-6
U-236	6.469E-5
U-238	3.362E-7
Pu-238	1.712E+1
Pu-239	6.216E-2
Pu-240	2.279E-1
Pu-241	1.030E+2
Pu-242	3.818E-3

Uranium

Uranium tank inventory values are listed in Appendix 1, Table 1. Beside the mass value for each isotope is the isotopic wt. % of the tank total U inventory. In Appendix 1, Table 2 are the required volumes of supernate in each tank to reach the LAWV package limit for each isotope. This volume of supernate was calculated with the following equation and is referred to throughout the remainder of the report as the limiting volume:

Volume of supernate for U-23X LAWV Limit:

$$= \frac{\text{U-23X (g)}}{\text{Total U (g)}} \times \frac{20.0 \text{ mg U}}{\text{liter}} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{3.785 \text{ l}}{\text{gallon}} \times \text{Sp Activity U-23X (Ci/g)}$$

= Gallon of U-23X per waste package.

Where:

U-23X is the isotope of uranium being considered.

20.0 mg/l is the solubility limit of U in alkaline waste[10]

The uranium isotopes' limiting volumes are compared to the Cs-137 limiting volume for each tank in Appendix 1, Table 2. The Cs-137 limiting volumes were determined from the most recent sample data available [9] and are presented in Appendix 4, Table 1. If the limiting uranium volume is greater than the limiting Cs-137 volume, then Cs-137 bounds the uranium isotope. If the reverse is true, then the uranium isotope is not bound and is so designated. No

Cs-137 sample data is available for tank 3F, therefore a comparison is not made. Since the fill history and uranium isotopic distribution for tank 3F is similar to that of tanks 1F and 2F, similar results are expected. The LAWV waste package limit for Cs-137 is 0.76 Ci [6]. Below is a summary table of the uranium calculations for all tanks evaluated.

Table 3. Uranium Characteristics Summary

No.	Parameter	U-233	U-234	U-235	U-236	U-238
1	Minimum Limiting Volume (gals)	1	1050	952	793	90500
2	Average Limiting Volume (gals)	436	521000	135000	603000	90900
3	# Tanks not bound by Cs-137	2	0	0	0	0
4	Min Isotopic Wt. % Evaluated	0.00	0.00	0.17	0.00	10.42
5	Max Isotopic Wt. % Evaluated	3.58	1.52	70.65	36.05	99.83

From the calculations, only two tanks have a uranium isotope that is not bound by Cs-137. These two tanks are 15H and 21H and for both tanks the isotope is U-233. Tank 15H has the highest U-233 isotopic wt. % in the tank farm and the fourth lowest Cs-137 concentration. However a waste package must contain no less than one gallon of tank 15H supernate to reach the limit. Supernate sampling from the slurring and transfer of 15H sludge to tank 42H demonstrates the conservative margin of using the bounding U concentration of 20.0 mg/l. The U concentration in the decanted supernate from the transfer was 1.2 mg/l [8]. Substituting this value in place of 20.0 mg/l, yields an increase in the limiting volume to 14 gallons.

For tanks such as 15H, where sample data does exist, more accurate limiting volumes can be calculated. There is not much guidance on the amount of supernate that may end up in a waste package, even though the liquid content per package is limited [6]. It does not seem likely that 14 gallons of liquid waste would be put in a waste package. In this report, the only volume of supernate that is discounted is that in excess of the waste package volume.

Similar to tank 15H, tank 21H also has a low Cs-137 concentration. Of the tanks evaluated, tank 21H had the second lowest Cs-137 concentration which gave a limiting volume of 73 gallons. The U-233 limiting volume of 11 gallons is thus not bounded. The level of supernate in tank 21H is 34.7 inches which corresponds to a volume of 123 kgal (3540 gal/in). The total mass of U-233 in tank 21H is 18 grams giving a concentration of 0.04 mg/l. Substituting this concentration in place of the U-233 isotopic weight fraction times 20.0 mg/l gives a limiting volume of 15 gallons. Not much of an increase, but still conservative since the majority of the U inventory will be present in the sludge. The possibility of placing more than 15 gallons of tank 21H supernate in a waste package is not addressed.

The limiting volumes for U-234, U-235, U-236 and U-238 are all bound by Cs-137 for each tank. In addition, the minimum limiting volumes for these isotopes are in excess of the B-25 package volume of 673 gallons (90 ft³ at 7.48052 gal/ft³). On an overall mass basis, the average limiting volume for all the uranium isotopes is over 400 gallons. This average was

determined based on the isotopics of the entire tank farm uranium inventory. This average value represents the most likely cases as waste processing begins and waste from different tanks is combined and mixed.

Plutonium

Plutonium tank inventory values are listed in Appendix 2, Table 1. The format is identical to that used for uranium. The volume of supernate necessary to reach the LAWV package limit for each isotope is calculated similar to that for uranium except that the solubility limit of Pu in alkaline waste is 1.68 mg/l [2]. Below is a summary of the plutonium calculations for all tanks evaluated.

Table 4. Plutonium Characteristics Summary

<u>No.</u>	<u>Parameter</u>	<u>Pu-238</u>	<u>Pu-239</u>	<u>Pu-240</u>	<u>Pu-241</u>	<u>Pu-242</u>
1	Minimum Limiting Volume (gals)	0.84	245	521	39	225865
2	Average Limiting Volume (gals)	5.8	312	687	92	414035
3	# Tanks not bound by Cs-137	2	1	1	1	0
4	Min Isotopic Wt. % Evaluated	0.00	0.00	0.00	0.00	0.00
5	Max Isotopic Wt. % Evaluated	100.00	94.10	12.05	4.25	1.66

From the calculations, only three tanks have a plutonium isotope that is not bound by Cs-137. These three tanks are 15H (Pu-238), 17F (Pu-239, Pu-240, Pu-241) and 21H (Pu-238). Recall that tanks 15H and 21H were the only tanks with an unbounded U isotope. Tanks 15H, 17F and 21H have the fourth, first and second lowest Cs-137 concentration of all tanks evaluated.

The Cs-137 limiting volume for tank 15H is 26 gallons which does not bound the Pu-238 limiting volume of 6 gallons. As indicated in the solubility limits, Pu is much less soluble in alkaline waste than U. The Pu concentration in the decanted supernate from tank 15H to 42H sludge transfers was 8.2 grams in 642 kgal of supernate [8] which gives a concentration of 0.0034 mg/l. Substituting this concentration in place of the bounding concentration of 1.68 mg/l gives a limiting volume of 2900 gallons. This is in excess of the B-25 package volume and also in excess of the Cs-137 limiting volume. Though unnecessary, similar results could be achieved with the other Pu isotopes in tank 15H.

Three isotopes in tank 17F are not bound by the Cs-137 content, Pu-239, Pu-240, and Pu-241. The limiting volumes for these isotopes is 249, 942, and 551 gallons respectively, while the limiting volume for Cs-137 is 5710 gallons. No attempt is made to reduce the bounding estimates to more accurate values. The possibility of putting more than 249 gallons of tank 17F supernate in a waste package is not addressed.

Tank 21H has a Pu-238 limiting volume of 1.13 gallons which is not bound by the Cs-137 limiting volume of 73.1 gallons. The level of supernate in tank 21H is 34.7 inches which

corresponds to a volume of 123 kgal (3540 gal/in). The total mass of Pu-238 in tank 21H is 59 grams giving a concentration of 0.13 mg/l. Substituting this concentration in place of the Pu-238 isotopic weight fraction times 1.68 mg/l gives a limiting volume of 11 gallons. This assumes that the entire Pu inventory is distributed throughout the entire waste volume, which is conservative since Pu is predominantly in the sludge. The Pu-238 is still not bound by Cs-137 but the limiting volume was increased by almost a factor of ten. The possibility of placing more than 11 gallons of tank 21H supernate in a waste package is not addressed.

The limiting volume for Pu-242 is bound by Cs-137 for each tank and the minimum limiting volume for Pu-242 is in excess of the B-25 package volume. Therefore it is not possible that material contaminated with supernate will ever exceed the LAWV package limits for Pu-242. The minimum limiting volumes for the remaining Pu isotopes are not in excess of the B-25 volume however, it does not seem likely that quantities of supernate that large would be put in a B-25. As with the uranium isotopes, the average limiting volumes are in excess of the minimum.

Np-237

Np-237 tank inventory values are listed in Appendix 3, Table 1. The format is similar to that for U and Pu. The volume of supernate necessary to reach the LAWV limit is calculated somewhat different. Solubility limits for Np are not available. Therefore the Np-237 tank inventory was distributed throughout the entire tank waste volume to determine the concentration and thus the limiting volumes. This is considered to be conservative since the majority of Np will be in the sludge. Below is a summary of the Np-237 calculations for all tanks evaluated.

Table 5. Np-237 Characteristics Summary

<u>No.</u>	<u>Parameter</u>	<u>Np-237</u>
1	Minimum Limiting Volume (gals)	0.18
2	Average Limiting Volume (gals)	5.6
3	# Tanks not bound by Cs-137	4

Four tanks that contain Np-237 are not bound by Cs-137 per the calculation method used in this report. These four tanks are 8F, 12H, 15H and 21H. Since documented reliable Np-237 sample data or solubility data is not available, more accurate estimates of the limiting volumes for these tanks cannot be performed. The limiting volumes for each of these tanks in Appendix 3, Table 2 must be addressed to determine the likelihood of putting that volume of waste tank supernate in a B-25 waste package. One other option is to sample the supernate in these tanks for Np-237. Since Np remains primarily in the sludge after neutralization, distributing the entire tank Np inventory equally throughout the waste volume is considered to be a conservative approach to estimating the supernate concentration.

CONCLUSION

Of the 34 tanks evaluated, 5 contained Np-237 and/or isotopes of U and Pu whose calculated limiting volumes were not in excess of the Cs-137 limiting volumes as determined from sample data. These tanks are listed below. The remaining tanks not evaluated are predominantly evaporator concentrate receipt tanks. Due to the volume reduction of supernate after evaporation, these tanks will contain higher concentrations of Cs-137. Thus these tanks would not be limiting in this evaluation.

Table 6. Summary of Tanks with Isotopes not Bound by Cs-137.

<u>Tank</u>	<u>Isotope(s) Not Bound by Cs-137</u>	Isotope(s) with a Minimum Limiting Volume Less Than	
		<u>1 gallon</u>	<u>5 gallons</u>
8	Np-237	None	Np-237
12	Np-237	Np-237	Np-237
15	U-233, Pu-238, Np-237	U-233	U-233, Np-237
17	Pu-239, Pu-240, Pu-241	None	None
21	U-233, Pu-238, Np-237	None	Pu-238

Per the calculation method, only tanks 12 and 15 had an isotope with a limiting volume less than or equal to 1 gallon of supernate and were also not bound by the Cs-137 limiting volume. Actual sample data for tank 15 demonstrated that the actual limiting volume was much higher. Sample data for a similar analysis for tank 12 is currently unavailable, however similar results would be expected (i.e., actual Np-237 supernate concentration should be less than the calculated value of 13.8 mg/l) .

This report demonstrates by a conservative method, that for the majority of waste tanks, a significant volume of supernate would be required to exceed the administrative control limits for Np-237 and the isotopes of U and Pu. In addition, most waste tanks were shown to have a Cs-137 limiting volume that would preclude reaching the limiting volume for the actinides evaluated. For the tanks not bound by Cs-137 and where sample data was unavailable to lessen the conservatism, samples can be obtained and analyzed to examine their content further.

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Appendix 1

Table 1. Uranium Isotopic Waste Tank Inventory

	Total										
	Uranium	U-233	U-233	U-234	U-234	U-235	U-235	U-236	U-236	U-238	U-238
TANK #	(Kg)	(g)	wt. %	(g)	wt. %	(g)	wt. %	(g)	wt. %	(g)	wt. %
1	1315	0	0.00	0	0.00	8167	0.62	0	0.00	1.31E+06	99.38
2	61	0	0.00	0	0.00	376	0.62	0	0.00	6.02E+04	99.38
3	151	0	0.00	0	0.00	939	0.62	0	0.00	1.50E+05	99.38
4	9980	0	0.00	0	0.00	35951	0.36	0	0.00	9.94E+06	99.64
5	7425	0	0.00	0	0.00	48448	0.65	0	0.00	7.38E+06	99.35
6	7425	0	0.00	0	0.00	30763	0.41	0	0.00	7.39E+06	99.59
7	27414	0	0.00	0	0.00	175553	0.64	0	0.00	2.72E+07	99.36
8	20702	0	0.00	0	0.00	69757	0.34	0	0.00	2.06E+07	99.66
9	88	0	0.00	0	0.00	546	0.62	0	0.00	8.75E+04	99.38
10	17	0	0.00	0	0.00	106	0.62	0	0.00	1.69E+04	99.38
11	194	211	0.11	268	0.14	14631	7.56	4004	2.07	1.74E+05	90.12
12	2060	3955	0.19	374	0.03	31211	1.51	4391	0.21	2.02E+06	98.05
13	5533	4194	0.08	917	0.02	72487	1.31	9131	0.17	5.45E+06	98.43
14	237	39	0.02	8	0.00	1920	0.81	68	0.03	2.35E+05	99.14
15	40	1433	3.58	608	1.52	28308	70.65	5547	13.84	4.17E+03	10.42
17	250	0	0.00	0	0.00	625	0.25	0	0.00	2.50E+05	99.75
18	464	0	0.00	0	0.00	1454	0.31	0	0.00	4.63E+05	99.69
19	55	0	0.00	0	0.00	94	0.17	0	0.00	5.49E+04	99.83
21	6	18	0.28	27	0.43	1091	16.97	541	8.42	4.75E+03	73.91
22	29	111	0.38	62	0.21	2734	9.28	983	3.34	2.56E+04	86.80
26	6024	0	0.00	0	0.00	10241	0.17	0	0.00	6.01E+06	99.83
30	0	0	0.00	3	1.21	150	62.30	52	21.64	3.58E+01	14.85
32	84	0	0.00	444	0.53	18362	21.89	9622	11.47	5.54E+04	66.10
33	25682	0	0.00	0	0.00	43659	0.17	0	0.00	2.56E+07	99.83
34	24003	0	0.00	0	0.00	52761	0.22	0	0.00	2.40E+07	99.78
35	118	0	0.00	435	0.37	21852	18.58	12404	10.55	8.29E+04	70.50
36	0	0	0.00	1	0.48	65	26.81	40	16.32	1.37E+02	56.39
39	48	0	0.00	553	1.15	23438	48.81	12607	26.26	1.14E+04	23.78
40	4820	148	0.00	82	0.00	18611	0.39	1308	0.03	4.80E+06	99.58
41	0	0	0.00	2	1.30	66	43.51	55	36.05	2.91E+01	19.14
42	3444	777	0.02	443	0.01	33336	0.97	5720	0.17	3.40E+06	98.83
43	28	0	0.00	335	1.18	13713	48.44	7524	26.58	6.74E+03	23.80
47	4514	0	0.00	0	0.00	8629	0.19	0	0.00	4.51E+06	99.81
51	6863	79	0.00	78	0.00	24640	0.36	1448	0.02	6.84E+06	99.62
Total Mass	159077	10965		4841		794681		75444		1.58E+08	
Isotopics											
Minimum			0.00		0.00		0.17		0.00		10.42
Average			0.01		0.00		0.50		0.05		99.44
Maximum			3.58		1.52		70.65		36.05		99.83

Appendix 1

Table 2. Comparison of U Limiting Volumes to Cs-137 Limiting Volumes

	Volume of Supernate for Cs-137 Limit (gallons)	Volume of Supernate for U-233 Limit (gallons)	Volume of Supernate for U-234 Limit (gallons)	Volume of Supernate for U-235 Limit (gallons)	Volume of Supernate for U-236 Limit (gallons)	Volume of Supernate for U-238 Limit (gallons)	Tanks with U not bound by Cs-137
TANK #							
1	4.13E-02			1.08E+05		9.09E+04	
2	1.34E-01			1.08E+05		9.09E+04	
3	No sample			1.08E+05		9.09E+04	Not Bound by Cs-137
4	6.97E-02			1.87E+05		9.07E+04	
5	1.94E-02			1.03E+05		9.10E+04	
6	1.11E-01			1.62E+05		9.07E+04	
7	2.56E-01			1.05E+05		9.10E+04	
8	5.39E+00			2.00E+05		9.07E+04	
9	1.11E-01			1.08E+05		9.09E+04	
10	3.78E+00			1.08E+05		9.09E+04	
11	7.68E-01	2.75E+01	1.14E+04	8.90E+03	1.38E+04	1.00E+05	
12	8.23E-01	1.56E+01	5.69E+04	4.44E+04	1.34E+05	9.22E+04	
13	4.55E-02	3.96E+01	9.57E+04	5.13E+04	1.73E+05	9.18E+04	
14	2.23E-01	1.85E+02	4.58E+05	8.31E+04	9.95E+05	9.12E+04	
15	2.62E+01	8.40E-01	1.05E+03	9.52E+02	2.07E+03	8.68E+05	Not Bound by Cs-137
17	5.71E+03			2.69E+05		9.06E+04	
18	1.49E+00			2.15E+05		9.07E+04	
19	3.53E+01			3.96E+05		9.05E+04	
21	7.31E+01	1.08E+01	3.72E+03	3.96E+03	3.40E+03	1.22E+05	Not Bound by Cs-137
22	6.85E-01	7.97E+00	7.56E+03	7.25E+03	8.57E+03	1.04E+05	
26	1.24E-01			3.96E+05		9.05E+04	
30	5.98E-02		1.31E+03	1.08E+03	1.32E+03	6.09E+05	
32	1.47E-01		3.00E+03	3.07E+03	2.49E+03	1.37E+05	
33	3.82E-01			3.96E+05		9.05E+04	
34	3.23E-01			3.06E+05		9.06E+04	
35	9.25E-02		4.29E+03	3.62E+03	2.71E+03	1.28E+05	
36	1.84E-01		3.31E+03	2.51E+03	1.75E+03	1.60E+05	
39	1.65E-01		1.38E+03	1.38E+03	1.09E+03	3.80E+05	
40	4.52E+00	9.80E+02	9.29E+05	1.74E+05	1.05E+06	9.08E+04	
41	2.67E-01		1.22E+03	1.55E+03	7.93E+02	4.72E+05	
42	2.96E+00	1.33E+02	1.23E+05	6.95E+04	1.72E+05	9.14E+04	
43	5.10E-01		1.34E+03	1.39E+03	1.08E+03	3.80E+05	
47	1.93E-01			3.52E+05		9.05E+04	
51	2.16E+01	2.60E+03	1.39E+06	1.87E+05	1.36E+06	9.07E+04	
Minimum		8.40E-01	1.05E+03	9.52E+02	7.93E+02	9.05E+04	
Average		4.36E+02	5.21E+05	1.35E+05	6.03E+05	9.09E+04	

Appendix 2
Table 1. Plutonium Isotopic Waste Inventory

	Total										
	Plutonium	Pu-238	Pu-238	Pu-239	Pu-239	Pu-240	Pu-240	Pu-241	Pu-241	Pu-242	Pu-242
TANK #	(g)	(g)	wt %	(g)	wt %	(g)	wt %	(g)	wt %	(g)	wt %
1	2274	0	0.00	2139	94.08	130	5.74	3	0.12	2	0.07
2	338	0	0.00	318	94.10	19	5.74	0	0.09	0	0.07
3	407	0	0.00	383	94.09	23	5.74	0	0.11	0	0.07
4	10228	0	0.00	9616	94.02	586	5.73	18	0.18	7	0.07
5	8282	0	0.00	7755	93.64	505	6.10	13	0.15	9	0.11
6	4549	0	0.00	4095	90.03	388	8.53	16	0.35	46	1.00
7	63001	0	0.00	58978	93.61	3842	6.10	102	0.16	74	0.12
8	34156	0	0.00	31858	93.27	2046	5.99	85	0.25	166	0.49
9	107	0	0.00	100	94.10	6	5.74	0	0.09	0	0.07
10	54	0	0.00	51	94.10	3	5.74	0	0.09	0	0.07
11	38947	9516	24.43	23942	61.47	4098	10.52	868	2.23	521	1.34
12	52523	8632	16.44	37262	70.94	5617	10.69	527	1.00	484	0.92
13	29635	3259	11.00	23452	79.14	2646	8.93	172	0.58	105	0.35
14	1076	16	1.45	972	90.36	86	7.96	2	0.15	1	0.09
15	26112	3621	13.87	19588	75.02	2588	9.91	199	0.76	117	0.45
17	856	0	0.00	792	92.45	57	6.67	3	0.31	5	0.57
18	1669	0	0.00	1550	92.84	108	6.44	4	0.27	7	0.45
19	185	0	0.00	174	93.96	11	5.73	0	0.24	0	0.07
21	80	59	73.92	18	22.01	3	3.48	0	0.42	0	0.17
22	101	101	100.00	0	0.00	0	0.00	0	0.00	0	0.00
26	41072	0	0.00	38507	93.75	2347	5.72	189	0.46	29	0.07
30	864	224	25.92	493	57.06	96	11.17	37	4.25	14	1.60
32	98258	25575	26.03	56814	57.82	11504	11.71	2917	2.97	1448	1.47
33	17716	0	0.00	16612	93.77	1013	5.72	79	0.45	12	0.07
34	22313	0	0.00	20924	93.78	1276	5.72	98	0.44	16	0.07
35	94539	25866	27.36	52966	56.03	11051	11.69	3174	3.36	1481	1.57
36	139	39	27.88	77	55.55	17	12.05	4	2.93	2	1.59
39	139908	34102	24.37	82302	58.83	15593	11.15	5589	3.99	2322	1.66
40	17325	135	0.78	15960	92.12	1107	6.39	46	0.26	77	0.45
41	13	13	100.00	0	0.00	0	0.00	0	0.00	0	0.00
42	24957	2044	8.19	20631	82.66	2045	8.19	128	0.51	110	0.44
43	3014	882	29.27	1696	56.29	306	10.15	96	3.20	33	1.09
47	38819	0	0.00	36412	93.80	2220	5.72	160	0.41	27	0.07
51	24786	156	0.63	22864	92.25	1589	6.41	66	0.27	111	0.45
Total Mass	798302	114238		589302		72929		14597		7227	
Isotopics											
Minimum			0.00		0.00		0.00		0.00		0.00
Average			14.31		73.82		9.14		1.83		0.91
Maximum			100.00		94.10		12.05		4.25		1.66

Appendix 2

Table 2. Comparison of Pu Limiting Volumes to Cs-137 Limiting Volumes

	Volume of Supernate for Cs-137 Limit (gallons)	Volume of Supernate for Pu-238 Limit (gallons)	Volume of Supernate for Pu-239 Limit (gallons)	Volume of Supernate for Pu-240 Limit (gallons)	Volume of Supernate for Pu-241 Limit (gallons)	Volume of Supernate for Pu-242 Limit (gallons)	Tanks with Pu not bound by Cs-137
TANK #							
1	4.13E-02	-	2.45E+02	1.09E+03	1.44E+03	5.32E+06	
2	1.34E-01	-	2.45E+02	1.09E+03	1.89E+03	5.32E+06	
3	No sample	-	2.45E+02	1.09E+03	1.57E+03	5.32E+06	Not Bound by Cs-137
4	6.97E-02	-	2.45E+02	1.10E+03	9.37E+02	5.33E+06	
5	1.94E-02	-	2.46E+02	1.03E+03	1.11E+03	3.49E+06	
6	1.11E-01	-	2.56E+02	7.36E+02	4.74E+02	3.74E+05	
7	2.56E-01	-	2.46E+02	1.03E+03	1.04E+03	3.19E+06	
8	5.39E+00	-	2.47E+02	1.05E+03	6.71E+02	7.70E+05	
9	1.11E-01	-	2.45E+02	1.09E+03	1.91E+03	5.32E+06	
10	3.78E+00	-	2.45E+02	1.09E+03	1.78E+03	5.32E+06	
11	7.68E-01	3.42E+00	3.75E+02	5.97E+02	7.53E+01	2.80E+05	
12	8.23E-01	5.09E+00	3.25E+02	5.87E+02	1.67E+02	4.06E+05	
13	4.55E-02	7.60E+00	2.91E+02	7.03E+02	2.89E+02	1.06E+06	
14	2.23E-01	5.77E+01	2.55E+02	7.89E+02	1.13E+03	4.31E+06	
15	2.62E+01	6.03E+00	3.07E+02	6.34E+02	2.21E+02	8.40E+05	Not Bound by Cs-137
17	5.71E+03	-	2.49E+02	9.42E+02	5.51E+02	6.55E+05	Not Bound by Cs-137
18	1.49E+00	-	2.48E+02	9.75E+02	6.31E+02	8.35E+05	
19	3.53E+01	-	2.45E+02	1.10E+03	6.93E+02	5.33E+06	
21	7.31E+01	1.13E+00	1.05E+03	1.81E+03	3.98E+02	2.15E+06	Not Bound by Cs-137
22	6.85E-01	8.36E-01	-	-	-	-	
26	1.24E-01	-	2.46E+02	1.10E+03	3.65E+02	5.34E+06	
30	5.98E-02	3.22E+00	4.04E+02	5.62E+02	3.95E+01	2.35E+05	
32	1.47E-01	3.21E+00	3.98E+02	5.36E+02	5.66E+01	2.54E+05	
33	3.82E-01	-	2.46E+02	1.10E+03	3.76E+02	5.34E+06	
34	3.23E-01	-	2.46E+02	1.10E+03	3.84E+02	5.30E+06	
35	9.25E-02	3.06E+00	4.11E+02	5.37E+02	5.00E+01	2.39E+05	
36	1.84E-01	3.00E+00	4.14E+02	5.21E+02	5.73E+01	2.36E+05	
39	1.65E-01	3.43E+00	3.91E+02	5.63E+02	4.20E+01	2.26E+05	
40	4.52E+00	1.08E+02	2.50E+02	9.82E+02	6.36E+02	8.41E+05	
41	2.67E-01	8.36E-01	-	-	-	-	
42	2.96E+00	1.02E+01	2.79E+02	7.66E+02	3.28E+02	8.48E+05	
43	5.10E-01	2.86E+00	4.09E+02	6.18E+02	5.25E+01	3.42E+05	
47	1.93E-01	-	2.45E+02	1.10E+03	4.09E+02	5.34E+06	
51	2.16E+01	1.33E+02	2.50E+02	9.79E+02	6.30E+02	8.39E+05	
Minimum		8.36E-01	2.45E+02	5.21E+02	3.95E+01	2.26E+05	
Average		5.84E+00	3.12E+02	6.87E+02	9.19E+01	4.14E+05	

Appendix 3

Table 1. Np-237 Masses with Volume of Supernate to Reach LAWV B-25 Limit

		Total	Calculated	Volume of
		Tank	Np-237	Supernate
	Np-237	Volume	Conc.	for Np-237
TANK	(g)	(kgal)	(mg/l)	Limit
				(gallons)
1	9.09E+02	5.05E+02	4.76E-01	1.73E+01
2	3.00E+02	5.40E+02	1.47E-01	5.61E+01
3	5.36E+02	5.40E+02	2.62E-01	3.14E+01
4	4.23E+03	5.21E+02	2.15E+00	3.84E+00
5	5.94E+03	3.40E+01	4.62E+01	1.79E-01
6	1.22E+03	2.50E+01	1.29E+01	6.37E-01
7	1.19E+04	3.77E+02	8.35E+00	9.88E-01
8	4.47E+03	1.64E+02	7.19E+00	1.15E+00
9	2.85E+02	5.40E+02	1.40E-01	5.91E+01
10	6.18E+01	2.17E+02	7.52E-02	1.10E+02
11	1.57E+03	4.03E+02	1.03E+00	8.01E+00
12	1.13E+04	2.15E+02	1.38E+01	5.96E-01
13	2.09E+04	7.78E+02	7.10E+00	1.16E+00
14	7.77E+02	1.83E+02	1.12E+00	7.35E+00
15	5.04E+03	3.12E+02	4.27E+00	1.93E+00
17	0.00E+00			
18	0.00E+00			
19	0.00E+00			
21	1.49E+02	1.23E+02	3.21E-01	2.57E+01
22	3.33E+02	1.64E+02	5.36E-01	1.54E+01
26	0.00E+00			
30	1.17E+01	1.24E+03	2.49E-03	3.31E+03
32	1.63E+03	1.23E+03	3.49E-01	2.36E+01
33	1.01E+04	1.24E+03	2.16E+00	3.83E+00
34	8.82E+03	1.21E+03	1.92E+00	4.29E+00
35	1.39E+03	1.26E+03	2.93E-01	2.81E+01
36	2.82E+00	1.27E+03	5.88E-04	1.40E+04
39	1.95E+03	1.01E+03	5.12E-01	1.61E+01
40	4.43E+02	4.33E+02	2.70E-01	3.05E+01
41	5.23E+01	1.25E+03	1.11E-02	7.46E+02
42	3.23E+03	3.22E+02	2.65E+00	3.11E+00
43	1.51E+03	7.17E+02	5.58E-01	1.48E+01
47	0.00E+00			
51	4.24E+02	9.05E+02	1.24E-01	6.66E+01
Total Mass	9.95E+04	1.77E+04		
Avg. Vol.				5.56E+00
Min. Vol.				1.79E-01

Appendix 3

Table 2. Comparison of Np-237 Limiting Volumes to Cs-137 Limiting Volumes

	Volume of Supernate for Cs-137	Volume of Supernate for Np-237	
TANK #	Limit (gallons)	Limit (gallons)	Tanks with Np-237 not bound by Cs-137
1	4.13E-02	1.73E+01	
2	1.34E-01	5.61E+01	
3	No sample	3.14E+01	Not Bound by Cs-137
4	6.97E-02	3.84E+00	
5	1.94E-02	1.79E-01	
6	1.11E-01	6.37E-01	
7	2.56E-01	9.88E-01	
8	5.39E+00	1.15E+00	Not Bound by Cs-137
9	1.11E-01	5.91E+01	
10	3.78E+00	1.10E+02	
11	7.68E-01	8.01E+00	
12	8.23E-01	5.96E-01	Not Bound by Cs-137
13	4.55E-02	1.16E+00	
14	2.23E-01	7.35E+00	
15	2.62E+01	1.93E+00	Not Bound by Cs-137
17	5.71E+03	-	
18	1.49E+00	-	
19	3.53E+01	-	
21	7.31E+01	2.57E+01	Not Bound by Cs-137
22	6.85E-01	1.54E+01	
26	1.24E-01	-	
30	5.98E-02	3.31E+03	
32	1.47E-01	2.36E+01	
33	3.82E-01	3.83E+00	
34	3.23E-01	4.29E+00	
35	9.25E-02	2.81E+01	
36	1.84E-01	1.40E+04	
39	1.65E-01	1.61E+01	
40	4.52E+00	3.05E+01	
41	2.67E-01	7.46E+02	
42	2.96E+00	3.11E+00	
43	5.10E-01	1.48E+01	
47	1.93E-01	-	
51	2.16E+01	6.66E+01	

Appendix 4**Table 1. Most Recent Sample Results For Cs-137 Concentrations**

			Volume of
			Supernate
		Cs-137	for Cs-137
	Sample	Conc.	Limit
TANK	Date	Ci/gal	(gallons)
1	7/22/93	1.84E+01	4.13E-02
2	11/24/93	5.69E+00	1.34E-01
3	No sample Data For Comparison		
4	7/22/93	1.09E+01	6.97E-02
5	3/1/73	3.92E+01	1.94E-02
6	3/1/73	6.82E+00	1.11E-01
7	7/22/93	2.97E+00	2.56E-01
8	12/31/85	1.41E-01	5.39E+00
9	1/11/73	6.82E+00	1.11E-01
10	6/12/87	2.01E-01	3.78E+00
11	3/3/93	9.89E-01	7.68E-01
12	2/28/85	9.24E-01	8.23E-01
13	9/5/93	1.67E+01	4.55E-02
14	1/3/73	3.41E+00	2.23E-01
15	3/7/88	2.90E-02	2.62E+01
17	11/24/93	1.33E-04	5.71E+03
18	4/5/77	5.11E-01	1.49E+00
19	11/24/93	2.15E-02	3.53E+01
21	1/5/94	1.04E-02	7.31E+01
22	1/5/94	1.11E+00	6.85E-01
26	2/24/93	6.15E+00	1.24E-01
30	9/5/93	1.27E+01	5.98E-02
32	11/21/93	5.18E+00	1.47E-01
33	8/21/93	1.99E+00	3.82E-01
34	7/23/93	2.35E+00	3.23E-01
35	11/21/93	8.22E+00	9.25E-02
36	3/28/93	4.14E+00	1.84E-01
39	11/21/93	4.60E+00	1.65E-01
40	3/1/93	1.68E-01	4.52E+00
41	10/27/92	2.85E+00	2.67E-01
42	5/27/93	2.57E-01	2.96E+00
43	10/4/93	1.49E+00	5.10E-01
47	11/13/91	3.94E+00	1.93E-01
51	7/22/93	3.52E-02	2.16E+01

DATE

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9/6/94

END

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