Characterization of Tank 48H Samples for Alpha Activity and Actinide Isotopics

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Characterization of Tank 48H Samples for Alpha Activity and Actinide Isotopics (u)

Summary

The total alpha activity and actinide isotopics have been determined in samples of the contents in Tank 48H comprising Batch #1 of the In-Tank Precipitation (ITP) process. The total alpha activity in Tank 48H was determined to be 1350 curies, which was distributed between the salt solution (20%) and the undissolved solids (80%). Almost all (99.8%) of the alpha activity is due to Pu-238. The plutonium and uranium isotopics were consistent with that expected in the tank based on process knowledge of waste transferred into Tank 48H during the 1983 demonstration and recently from Tank 38H. The bounding total alpha, Pu-241 and Np-237 activity of the liquid phase was determined to be 410, 0.38 and 0.018 nCi/g, respectively. The Saltstone feed limits for total alpha activity, Pu-241, and Np-237 are 18 nCi/g, 600 nCi/g, and 0.03 nCi/g, respectively. Therefore, no removal of Pu-241 or Np-237 is required to meet the Saltstone feed limits in Batch #1. It was determined that a maximum of 780 kilograms of monosodium titanate (MST) were required to reduce the total alpha activity to meet the Saltstone feed requirement of no more than 18 nCi/g.

Introduction

This document reports the total alpha activity and actinide isotopic results for samples taken from Tank 48H prior to the addition of sodium tetraphenylborate and MST in Batch #1 of the ITP process. This information was used to determine the quantity of MST for Batch #1 of the ITP process and the total actinide content in the tank for dose calculations.

Experimental

A total of 18 samples were taken from Tank 48H in July, 1995 in support of the startup of the ITP process[1]. These samples are identified in consecutive order as ITP-127 through ITP-144. An additional 3 samples were taken in August, 1995 (ITP-146, ITP-147, and ITP-148). All of the samples were received into the Shielded Cells of the SRTC and prepared for analysis in accordance with the task plan for ITP support analyses [2]. A composite sample of the original 18 samples was prepared by mixing approximately 15 mL of each in a clean polyethylene bottle for eventual testing the Cells Unit Filter[3].

Total alpha activity was determined by one of two alpha counting methods: (1) alpha plate and (2) liquid scintillation. Precision of both methods was generally poor due to the high salt and gamma content. Improved precision was found upon acid digestion of the samples

and removal of cesium activity. Actinide isotopics were determined by inductively-coupled plasma mass spectroscopy.

Alpha activity and actinide isotopics were determined in the composite sample and the liquid phase of the composite sample after removal of undissolved solids. For the composite sample, a weighed amount of the slurry was dissolved in strong acid solution to dissolve all solids. To determine the liquid phase concentrations, the undissolved solids were separated from the liquid phase by filtering through a 0.45 μm pore size filter. The alpha activity and actinide isotopics in the undissolved solids were also determined. The solids that had been retained on filter papers from the individual weight percent solids determinations were dissolved in strong acid and then analyzed for alpha activity and actinide isotopics.

Results and Discussion

Alpha Activity of As-Received Samples

Table I provides the average total alpha activity for the first 10 of the 18 samples taken in July, all 3 of the second set of dip samples, and the composite sample prepared from the original set of 18 samples. The individual results are presented in Appendix 1. There was poor agreement among the replicate determinations for each sample as evidenced by the large relative errors (% RSD). Because of the poor agreement, the total alpha activity was not determined for the remaining 8 samples from the original set of 18 samples. Similar results were obtained with the composite sample, although there was much closer agreement in the alpha activities for the latter three determinations. The best agreement was obtained in duplicate determinations of the three August dip samples. These samples are presumed to contain very little solids since the slurry pumps had been off for long period of time, allowing the solids to settle. Thus, the alpha activities of these samples should be, and are, similar to that determined in the liquid phase after removal of solids by filtration (see Table II).

The poor reproducibility in the determination of the alpha activity is believed due to several factors including: (1) non-representative sampling of the undissolved solids, (2) high salt content, (3) high gamma activity and (4) presence of tetraphenylborate. The non-representative sampling is not believed to be the major cause since relatively good precision was obtained in the replicate determinations of the titanium concentrations (see reference 4). The combination of high salt content, high gamma activity and presence of organics makes the preparation of the standard plates for alpha counting very difficult. During drying and flaming of the plates, the sample often ran and splattered. Modifications to the analytical method were studied. Better precision was obtained when the samples were first heated in a mixture of nitric and hydrofluoric acids and after removal of cesium, which reduces the beta/gamma background.

Table I. Alpha Activity of Tank 48H Samples

Sample ID	Average Alpha Activity (dpm/mL)			
	Direct Plate	% RSD ^a	Liquid Scintillation	% RSD
ITP-127	2.39 ± 1.65 E+06	68.9	3.97 ± 3.55 E+05	89.6
ITP-128	5.80 ± 4.50 E+05	78.3	1.57 ± 0.89 E+06	56.8
ITP-129	1.17 ± 1.13 E+06	96.6	1.11 ± 1.03 E+06	92.3
ITP-130	2.55 ± 2.34 E+07	92.0	1.16 ± 1.15 E+07	98.8
ITP-131	1.97 ± 1.93 E+06	98.4	3.31 ± 3.95 E+05	119
ITP-132	6.70 ± 3.86 E+06	57.6	4.90 ± 3.10 E+06	63.4
ITP-133	7.71 ± 12.4 E+06	161	6.66 ± 10.7 E+06	161
ITP-134	1.00 ± 1.04 E+07	104	8.03 ± 6.47 E+05	80.5
ITP-135	2.40 ± 2.26 E+06	94.2	1.49 ± 1.81 E+05	121
ITP-136	nd	-	6.75 ± 7.42 E+05	110
Composite	5.0 E+06	-	nd	-
Composite	nd	-	1.27 ± 1.33 E+07	105
Composite	1.06 ± 0.63 E+06	59.3	1.49 ± 1.81 E+05	121
ITP-146	2.42 ± 0.11 E+05	4.68	2.08 ± 0.12 E+05	5.72
ITP-147	2.23 ± 0.13 E+05	5.71	1.88 ± 0.45 E+05	24.1
ITP-148	2.15 ± 0.10 E+05	4.60	1.96 ± 0.80 E+05	40.8

^a % RSD = (standard deviation/average)*100

Alpha Activity and Isotopic Abundance in the Supernatant Liquid and Undissolved Solids

Because of the lack of agreement among the replicate samples, it was decided to determine the tank alpha activity by separately determining the alpha activity in the liquid phase and the undissolved solids. The total tank activity was then determined by multiplying the individual activities by the volume of solution and quantity of undissolved solids and adding both together. Determination of the liquid phase alpha activity was also necessary to determine the quantity of MST required to meet the Saltstone feed limits[5].

Table II provides the total alpha activity and actinide isotopic content for the supernatant liquid and the undissolved solids in the Tank 48H samples. The solution phase values are those determined upon filtering a small portion of the composite sample through a 0.1 µm pore size nitrocellulose filter and analyzing the collected filtrate in triplicate. The undissolved solids values are the average of seven samples.

The analysis of the solids was performed by dissolving the dried solids from nine of the weight percent solids determinations separately in seven nitric acid/hydrofluoric acid solutions. The selected samples were chosen to include only those samples that had a minimum lapse time after pump operation had ceased so that the solids would be representative of the bulk solids in the tank. Because of the low solids content on several of the filters, samples ITP-131 and ITP-134 were combined into one sample as were samples ITP-139 and ITP-142. The nine solid included samples taken by both the variable depth sampler (VDS) and the dip method, from three different riser locations and spanned the range of elevations using the VDS. After determination of the actinide isotopics by

ICP/MS, there was sufficient sample to perform the alpha activity only for five of the seven samples.

The individual sample results are provided in Appendix II for the solids analyses. There were no significant differences among the samples except for the concentration of aluminum in the combined ITP-139 & ITP-142 sample. The very high aluminum concentration is not consistent with other analytical results, that showed similar values with the other solid samples. The boron and titanium results are consistent with that expected for the majority of solids in the tank being tetraphenylborate (TPB) salts (primarily potassium tetraphenylborate) and MST. Assuming the metals are present as either metal oxides or metal hydroxides, the solids are determined to be comprised of the following types: 76% TPB salts, 11% MST, and 13% metal oxides/hydroxides by weight.

Table II. Alpha Activity and Actinide Isotopics for Tank 48H

	Liquid Phase		Undissolved Solids	
	Conc.(mg/L)	% Abundance	Conc.(wt %)	% Abundance
U-233	$2.65 \pm 0.095 \text{ E-02}$	1.04	$3.63 \pm 0.55 \text{ E-04}$	1.41
U-234	$1.92 \pm 0.081 \text{ E-01}$	7.55	$1.14 \pm 0.15 \text{ E-03}$	4.40
U-235	$3.08 \pm 0.064 \text{ E-01}$	12.1	$3.20 \pm 0.40 \text{ E-03}$	12.4
U-236	$7.54 \pm 0.070 \text{ E-01}$	2.97	$6.06 \pm 0.73 \text{ E-04}$	2.35
U-238	$1.94 \pm 0.029 \text{ E+00}$	76.3	$2.05 \pm 0.25 \text{ E-02}$	79.4
Total U	$3.22 \pm 0.045 \text{ E+00}$		$2.58 \pm 0.32 \text{ E-02}$	
Total alpha	$3.60 \pm 3.62 \text{ E+05 dpm/mL}$		$2.2 \pm 1.3 \text{ E+08 dpm/g}$	
Pu-238 ^a	$9.47 \pm 9.56 \text{ E-03}$	86.1	$5.70 \pm 3.43 \text{ E-04}$	57.6
Pu-239	$1.50 \pm 0.17 \text{ E-03}$	13.6	$3.76 \pm 1.50 \text{ E-04}$	36.6
Pu-240	nd ^b	-	$4.58 \pm 2.07 \text{ E-05}$	4.71
Pu-241	nd ^b	-	$7.65 \pm 4.08 \text{ E-06}$	1.09
Total Pu	$1.10 \pm 1.40 \text{ E-02}$		$9.32 \pm 4.10 \text{ E-04}$	
Np-237	$2.89 \pm 0.081 \text{ E-02}$		$1.85 \pm 0.42 \text{ E-03}$	

^a Calculated assuming all of the measured alpha activity is Pu-238.

^b Trace quantity observed in ICP/MS, but below quantifiable value.

Total Alpha Content in Tank 48H

From the measured soluble and solids alpha activities and actinide isotopics, the total alpha activity for the contents of Tank 48H was determined. The following bases were used for the calculation:

- (1) Waste Volume in Tank 48H = 126 in. * 3510 gal/in. = 442,000 gal
- (2) Slurry Density = 1.207 g/mL [ref. 8]
- (3) Concentration of Undissolved Solids = 0.55 wt % [ref. 4]
- (4) Specific Activities of Uranium and Plutonium Isotopes are [ref. 8]
 2.16 E-06 Ci/g for U-235, 3.36 E-07 Ci/g for U-238, 17.12 Ci/g for Pu-238,
and 0.0613 Ci/g for Pu-239

The calculated alpha activities are provided in Table III for the liquid phase, undissolved solids, and the combined tank contents. The total alpha activity, which is essentially all due to Pu-238, is determined to be 1350 curies, which agrees well with a value of 1240 curies, that was predicted based on the tank contents from the 1983 demonstration and the supernate added from Tank 38H[9]. Based on the measured results, 80% of the total alpha activity is present in the undissolved solids and 20% in the liquid phase.

Table III. Calculated Alpha Activity in Tank 48H

	<u>Liquid Phase</u>	<u>Undissolved Solids</u>	<u>Total Contents</u>
Ci Pu-238	270	1080	1350
Ci Pu-239	0.153	2.56	2.71
Ci U-235	1.11E-03	7.68E-04	1.88E-03
Ci U-238	1.09E-03	7.65E-04	1.85E-03
Total alpha Ci	270	1080	1350

Saltstone Feed Limits

The Saltstone feed limits for total alpha activity, Pu-241, and Np-237 are 18 nCi/g, 600 nCi/g, and 0.03 nCi/g, respectively. The bounding total alpha activity of the liquid phase is determined to be 410 nCi/g. The bounding liquid phase activity was determined by adding 2 times the standard deviation to the average total alpha activity (see Table II) and converting into units of nCi/g using a density of 1.2 g/mL. To meet the total alpha activity limit of 18 nCi/g, a decontamination factor (DF) of 23 is required. Almost all of the alpha activity is due to Pu-238. Thus, the DF from total alpha can be estimated by that for plutonium. It is estimated that 780 kilograms of monosodium titanate (MST) are required to achieve this DF assuming a plutonium K_d of 4.8×10^4 mL/g for the MST and taking no credit for dilution of the ITP filtrate in waste currently stored in Tank 50H.

The Pu-241 content in the liquid phase was below that which could be quantified. Using the isotopic abundances for Pu-238 and Pu-241 found in the undissolved solids, the solution concentration of Pu-241 is estimated to be 0.38 nCi/g in the liquid phase. This concentration is well below the Saltstone feed limit of 600 nCi/g, and therefore, removal of Pu-241 is not required in Batch #1.

The bounding Np-237 concentration (same methodology as presented above for total alpha activity) in the liquid phase is determined to be 0.018 nCi/g, which is below the Saltstone feed limit of 0.030 nCi/g. Therefore, removal of Np-237 is not required in Batch #1 to meet the Saltstone feed limit.

Comparison of Calculated and Measured Alpha Activity in the As-Received Samples

The total alpha activity was measured in ten of the as-received samples (ITP-127 through ITP-136). Using the alpha activity determined for the liquid phase and the undissolved solids, an alpha activity was calculated using the average weight percent solids values for each of these samples. The results are shown in Table IV. Also included in Table IV, is the ratio of the measured and calculated alpha activities.

Table IV. Measured and Calculated Alpha Activities in Selected Tank 48H Samples

<u>Sample ID</u>	<u>Alpha Activity (dpm/mL)</u>		<u>Meas./Calc.</u>
	<u>Measured^a</u>	<u>Calculated</u>	
ITP-127	1.40 E+06	1.23 E+06	1.1
ITP-128	1.08 E+06	4.18 E+05	2.7
ITP-129	1.16 E+06	4.33 E+05	2.7
ITP-130	1.85 E+07	1.59 E+06	12
ITP-131	1.34 E+06	1.62 E+06	0.82
ITP-132	5.80 E+06	1.44 E+06	4.0
ITP-133	9.76 E+06	2.05 E+06	4.8
ITP-134	9.02 E+06	1.26 E+06	7.2
ITP-135	1.99 E+06	6.90 E+05	2.8
ITP-136	6.75 E+05	5.51 E+05	1.2

^a Average of three replicates determined by two independent alpha counting methods except ITP-130 and ITP-136 for which only two replicates were measured.

For most of the samples, there is reasonable agreement between the measured and calculated alpha activities. Replicate measurements of the alpha activity of the as-received samples and the filtrate showed considerable variation. The relative standard deviation of the replicates ranged from 49 to 104%. Therefore, a value of between 0.5 to 4.0 for the ratios is within the experimental uncertainty of the alpha counting measurements. Of the ten samples, only 3 samples lie outside this range. In only one case, sample ITP-131, was the measured value less than the calculated value.

To calculate the alpha activities on a volume basis, the densities of the samples were calculated using the average sodium concentrations from the data reported by C. Nash [4] for each sample and the expression for solution density as a function of sodium ion concentration reported by D. Walker[6]. For the calculation, no correction was made for the volume of solids. This assumption is reasonable since the volume occupied by the solids assuming all of the solids have density of 2.765 g/mL (density of monosodium titanate) is less than or equal to 0.2 volume percent of the total sample volume.

Quality Assurance

The results reported in this document were obtained in accordance with the requirements specified in references 1 and 2. Analytical results are recorded in laboratory notebooks, WSCR-NB-95-115 and WSRC-NB-95-317.

References

1. P. L. Rutland, "Sampling Plan for Tank 48," WSRC Inter-Office Memorandum, February 15, 1995.
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3. C. A. Nash, "Shielded Cells Filter Unit Task Technical Plan (u)," WSRC-RP-95-0406, April 3, 1995.
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5. "WSRC 241-82H Control Room Process Requirements (u)," WSRC-IM-91-63, revision 10, November, 1995.
6. D. D. Walker, Email memo to W. B. VanPelt, "Tank 48 Sample Results," October 12, 1995.
7. C. J. Coleman, unpublished results for the Tank 48H composite sample recorded in laboratory notebook, WSRC-NB-95-115, page 27.
8. "Accountability Manual - Accountability Standard Decay and Activity Values," DPSOP 23-11, revision 3, November, 1979.
9. W. B. VanPelt, "Tank 48 Waste Receipt Technical Review," G-TRC-H-01169, rev. 2, December 2, 1994.

Appendix 1
Alpha Activity of Tank 48H Samples

Sample ID	Type	ADS LIMS #	Direct Plate	Alpha Activity (dpm/mL)			Average
				Method 1 ^a	Method 2 ^b	Method 3 ^c	
ITP-127	VDS	53969	2.80 E6	8.00 E5			1.80 E6
ITP-127	VDS	53670	3.80 E6	2.60 E5			2.03 E6
ITP-127	VDS	53971	5.80 E5	1.30 E5			3.55 E5
ITP-128	VDS	53972	3.80 E5	7.20 E5	6.90 E5		5.97 E5
ITP-128	VDS	53973	1.10 E6		9.70 E5	9.40 E5	1.00 E6
ITP-128	VDS	53974	2.60 E5		2.45 E6	2.20 E6	1.64 E6
ITP-129	VDS	53975	1.90 E5		1.58 E5	1.60 E5	1.69 E5
ITP-129	VDS	53976	9.10 E5		1.02 E6	9.60 E5	9.63 E5
ITP-129	VDS	53977	2.40 E6		2.45 E6	2.20 E6	2.35 E6
ITP-130	VDS	53978					
ITP-130	VDS	53979	4.20 E7		1.97 E7		3.09 E7
ITP-130	VDS	53980	8.90 E6		3.50 E6		6.20 E6
ITP-131	VDS	53981	4.20 E6		1.50 E6		2.85 E6
ITP-131	VDS	53982	9.00 E5			6.10 E5	7.55 E5
ITP-131	VDS	53983	8.00 E5			5.20 E4	4.26 E5
ITP-132	VDS	53984	2.70 E6			1.90 E6	2.30 E6
ITP-132	VDS	53985	7.00 E6			4.70 E6	5.85 E6
ITP-132	VDS	53986	1.04 E7			8.10 E6	9.25 E6
ITP-133	VDS	53987	2.90 E5			2.80 E5	2.85 E5
ITP-133	VDS	53988	8.30 E5		2.40 E7	6.90 E5	8.51 E6
ITP-133	VDS	53989	2.20 E7			1.90 E7	2.05 E7
ITP-134	VDS	53990	4.30 E6			4.40 E6	4.35 E6
ITP-134	VDS	53991	2.20 E7			1.55 E7	1.88 E7
ITP-134	VDS	53992	3.70 E6			4.20 E6	3.95 E6
ITP-135	VDS	53993	1.80 E6			9.80 E5	1.39 E6
ITP-135	VDS	53994	4.90 E6			3.50 E6	4.20 E6
ITP-135	VDS	53995	5.00 E5		2.60 E5		3.80 E5
ITP-136	VDS	53996			1.50 E5		-
ITP-136	VDS	53997			1.20 E6		-
Composite	VDS/Dip		5.0 E6				-
Composite	VDS/Dip	56286			2.80 E7		-
Composite	VDS/Dip	56287			3.60 E6		-
Composite	VDS/Dip	56288			6.50 E6		-
Composite	VDS/Dip	57764	2.28 E5		1.70 E6		9.65 E5
Composite	VDS/Dip	57765	1.75 E5		1.05 E6		6.15 E5
Composite	VDS/Dip	57766	1.94 E5		4.40 E5		3.17 E5
ITP-146	Dip	57896	2.34E5	1.99E5			2.17E5
ITP-146	Dip	57899	2.50E5	2.16E5			2.33E5
ITP-147	Dip	57897	2.14E5	1.56E5			1.85E5
ITP-147	Dip	57900	2.32E5	2.20E5			2.26E5
ITP-148	Dip	57898	2.22E5	1.39E5			1.81E5
ITP-148	Dip	57901	2.08E5	2.52E5			2.30E5

^a Method 1 is direct PERALS

^b Method 2 is PERALS after cesium removal

^c Method 3 is PERALS after anion exchange

Appendix II

Analytical Results for Undissolved Solids Samples

Sample ID	ITP-127	ITP-130	ITP-132	ITP-143	ITP-144	ITP-131/134	ITP-139/142
Sampler	VDS	VDS	VDS	Dip	Dip	VDS/VDS	Dip/Dip
Riser	C3	C3	C3	C1	C3	C3/C3	B3/B3
Elevation (in.)	42	102	42	126	126	72/72	126/126
Time (min)	28	25	79	30	43	59/49	30/12
LIMS #	58905	58906	58907	58908	58909	58910	58911
Wt. Solids (g)	0.08	0.115	0.113	0.112	0.153	0.201	0.241
Acid Vol. (L)	0.02	0.02	0.02	0.02	0.02	0.04	0.04
Alpha Counting	dpm/g	dpm/g	dpm/g	dpm/g	dpm/g	dpm/g	dpm/g
PLATE		4.70E+08	3.36E+08	1.48E+08	1.03E+08		1.99E+08
PERALS		3.83E+08	2.48E+08		7.97E+07		1.56E+08
	wt %	wt %	wt %	wt %	wt %	wt %	wt %
Plate (as Pu-238)*		1.24E-03	8.85E-04	3.90E-04	2.72E-04		5.24E-04
PERALS (as Pu-238)*		1.01E-03	6.52E-04		2.10E-04		4.11E-04
ICP/MS Data	wt %	wt %	wt %	wt %	wt %	wt %	wt %
232	1.24E-04	1.31E-04	3.25E-04	1.24E-04	1.53E-04	1.36E-04	5.73E-05
233	3.71E-04	4.01E-04	4.02E-04	3.60E-04	2.46E-04	3.67E-04	3.98E-04
234	1.28E-03	1.10E-03	1.25E-03	1.06E-03	8.78E-04	1.07E-03	1.31E-03
235	3.39E-03	3.30E-03	3.69E-03	3.14E-03	2.44E-03	2.96E-03	3.45E-03
236	6.65E-04	6.55E-04	6.76E-04	5.53E-04	4.74E-04	5.88E-04	6.31E-04
237	1.83E-03	2.26E-03	2.42E-03	1.90E-03	1.43E-03	1.89E-03	1.24E-03
238	2.23E-02	2.17E-02	2.33E-02	1.96E-02	1.60E-02	1.91E-02	2.14E-02
239	6.60E-04	3.76E-04	3.44E-04	4.80E-04	2.92E-04	2.52E-04	2.33E-04
240	8.03E-05	6.90E-05	3.81E-05	4.32E-05	3.24E-05	2.69E-05	3.07E-05
241	1.18E-05	1.04E-05	6.55E-06	6.96E-06	1.14E-05	0.00E+00	6.47E-06
Total U ^b	2.80E-02	2.72E-02	2.93E-02	2.47E-02	2.00E-02	2.41E-02	2.72E-02
Total Pu ^c		1.46E-03	1.04E-03		5.45E-04		6.80E-04
Isotopic Abundance							
% U-233	1.32E+00	1.47E+00	1.37E+00	1.46E+00	1.23E+00	1.52E+00	1.46E+00
% U-234	4.55E+00	4.06E+00	4.25E+00	4.30E+00	4.39E+00	4.46E+00	4.81E+00
% U-235	1.21E+01	1.22E+01	1.26E+01	1.27E+01	1.22E+01	1.23E+01	1.27E+01
% U-236	2.37E+00	2.41E+00	2.31E+00	2.24E+00	2.37E+00	2.44E+00	2.32E+00
% U-238	7.96E+01	7.99E+01	7.95E+01	7.93E+01	7.98E+01	7.93E+01	7.88E+01
% Pu-238		6.89E+01	6.27E+01		3.85E+01		6.03E+01
% Pu-239		2.57E+01	3.30E+01		5.35E+01		3.42E+01
% Pu-240		4.72E+00	3.66E+00		5.94E+00		4.51E+00
% Pu-241		7.14E-01	6.30E-01		2.08E+00		9.52E-01
ICP-ES Data	wt %	wt %	wt %	wt %	wt %	wt %	wt %
Ca	1.78E-01	1.30E-01	1.39E-01	1.16E-01	8.73E-02	1.32E-01	2.07E-01
Cu	2.50E-02	9.37E-03	1.17E-02	1.74E-02	1.23E-02	1.33E-02	5.31E-02
Mg	7.71E-02	6.27E-02	6.78E-02	5.81E-02	4.64E-02	6.32E-02	6.60E-02
Mn	1.16E-01	1.02E-01	1.09E-01	9.53E-02	7.22E-02	1.00E-01	6.95E-01
Zn	2.99E-02	1.37E-02	1.32E-02	1.79E-02	1.50E-02	1.51E-02	4.23E-02
Al	1.03E+00	6.28E-01	1.26E+00	1.00E+00	2.93E+00	2.20E+00	5.33E+01
Ba	2.60E-02	2.41E-02	2.54E-02	2.03E-02	1.72E-02	2.27E-02	2.96E-02

Appendix II (continued)
Analytical Results for Undissolved Solids Samples

Sample ID	ITP-127	ITP-130	ITP-132	ITP-143	ITP-144	ITP- 131/134	ITP- 139/142
ICP-ES Data	wt %	wt %	wt %	wt %	wt %	wt %	wt %
Fe	6.67E-01	4.71E-01	4.87E-01	4.95E-01	3.59E-01	4.54E-01	8.57E-01
Na	3.62E+00	3.62E+00	4.39E+00	2.96E+00	7.45E+00	5.99E+00	6.67E+00
Ni	1.92E-02	1.25E-02	2.24E-02	1.93E-02	1.05E-02	1.99E-02	4.01E-02
Ti	6.24E+00	5.52E+00	5.87E+00	4.95E+00	3.84E+00	5.26E+00	5.28E+00
Total Ti	3.88E+00	3.37E+00	3.33E+00	2.77E+00	2.19E+00	2.75E+00	2.96E+00
B	3.08E+00	2.70E+00	2.90E+00	2.26E+00	1.89E+00	2.59E+00	2.54E+00
Cr	1.49E-01	1.26E-01	1.24E-01	1.12E-01	8.10E-02	1.14E-01	1.18E-01
P	3.59E-02	2.30E-02	1.16E-02	1.08E-02	2.67E-02	1.59E-02	4.31E-02
All except Ti & B	5.97E+00	5.22E+00	6.67E+00	4.93E+00	1.11E+01	9.14E+00	8.82E+00
Calc. KTPB ^a	1.02E+02	8.96E+01	9.63E+01	7.48E+01	6.27E+01	8.59E+01	8.41E+01
Calc. MST ^c	1.30E+01	1.15E+01	1.22E+01	1.03E+01	8.02E+00	1.10E+01	1.10E+01
Calc. Total	1.21E+02	1.06E+02	1.15E+02	9.01E+01	8.18E+01	1.06E+02	1.04E+02

^a Calculated assuming all of the alpha activity is due to Pu-238.

^b Total Uranium is calculated as the sum of masses 233, 234, 235, 236, & 238.

^c Total Plutonium is calculated as the sum of masses 239, 240 & 241 and the calculated Pu-238 concentration from the PERALS determination.

^d Calculated assuming all of the boron is present as KTPB. This overestimates the KTPB content since after 12 years of storage, significant amounts of the KTPB produced during the 1983 demonstration would have been decomposed by radiolysis.

^e Calculated assuming all of the titanium is present as MST (NaTi₂O₇H).

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B. G. Croley, 241-120H
W. B. Van Pelt, 241-120H
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