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Tank 41H Drained Saltcake Core Sample Analysis (HTF-E-03-033 – HTF-E-03-035)

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Summary

Three samples were received that correspond to approximately the top 26" of drained Tank 41H saltcake. The saltcake had an average bulk density of 1.91 g/mL. Two of the samples were extracted with 30 psi N₂, the test on the upper sample was stopped after one week, and the other sample continued for one month.

The bulk of the salt was light in color, hard packed, and had 3 – 4 wt % water. The primary composition of the bulk saltcake was 72 – 82 wt % NaNO₃, 4 – 12 wt % Na₆(SO₄)₂CO₃, and 3 – 9 wt % of an unidentified form of Na₂CO₃. Being drained saltcake, it had relatively small amounts of NaOH and NaNO₂.

A thin (<1") layer at the top of the saltcake was composed of loose, dark, powdery solids that had in the range of 15 to 20 wt% water. The primary salt composition of the top layer was 28 wt % Na₃H(CO₃)₂*2H₂O, 8 wt % Na₇F(PO₄)₂*19H₂O, 7 wt % Na₃PO₄, 8 wt % NaNO₃, 3.7 wt % NaOH, 2.7 wt % Na₂SO₄, and 1.5 wt % NaNO₂. This material contained a significantly greater quantity of additional water-insoluble solids than did the bulk saltcake.

Dissolution of several portions of salt with flush water indicated that the upper and lower samples had ¹³⁷Cs concentrations of 0.178 and 0.313 Ci per gallon of saltcake, respectively, averaging to 0.25 Ci per gallon of saltcake in the top 26" of saltcake. This corresponds to a ¹³⁷Cs concentration of roughly 0.07 Ci/gal in a 6 M Na⁺ solution of dissolved saltcake. Initial testing on very small portions of salt revealed that the bulk saltcake had an average ¹³⁷Cs concentration of 0.373 Ci/gal, with the thin layer at the top of the saltcake having a ¹³⁷Cs concentration of 1.13 Ci/gal. Combining the data from both tests in a conservative manner, the dissolution of the top 26" of Tank 41H saltcake may yield a 6 M Na⁺ solution with as high as 0.10 Ci/gal of ¹³⁷Cs.

Plutonium analysis of salt dissolved with flush water indicates that an aqueous 6 M Na⁺ solution could contain soluble ²³⁸Pu ranging from 9.3E+4 pCi/mL to 5.8E+5 pCi/mL, with an average ²³⁸Pu of 2.2E+5 pCi/mL.

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List of Abbreviations

ADS	Analytical Development Section
DI	de-ionized
EDS	X-ray energy dispersive spectroscopy
FW	flush water
HLW	high-level waste
IC	ion chromatograph
ICP-ES	inductively coupled plasma – emission spectroscopy
ICP-MS	inductively coupled plasma – mass spectroscopy
LCS	Low Curie Salt
n.d.	not determined
SEM	scanning electron microscopy
SPF	Saltstone Processing Facility
SRS	Savannah River Site
SRTC	Savannah River Technology Center
TIC	Total Inorganic Carbon
XRD	X-ray diffraction

Introduction

The Savannah River Site (SRS) has 49 carbon steel tanks that currently house 37 million gallons of High Level Waste (HLW) in the form of salt supernate, saltcake, and sludge solids. The saltcake in several of the SRS tanks was identified as candidates for the Low Curie Salt (LCS) process¹. LCS involves removing supernatant liquid, draining the saltcake interstitial liquid, and dissolving the remaining saltcake as a feed for the Saltstone Processing Facility (SPF).

The Closure Business Unit (CBU) will dissolve salt in Tank 41H for use as a feed to the LCS process. Initial draining of Tank 41H interstitial liquid did not meet Salt Engineering's expectations, and a subsequent study found that several potential combinations of salt porosity and residual liquid content could describe the in-tank saltcake draining behavior.² To mitigate programmatic risk, Salt Engineering requested analysis of core samples from the top three feet of Tank 41H saltcake for residual cesium and moisture content.

The following are the primary objectives of the physical and chemical analysis of the Tank 41H drained salt samples:

- Determine ¹³⁷Cs concentration in "drained" Tank 41H saltcake to confirm acceptability for processing in the SPF.
- Determine liquid retention properties of saltcake to estimate rate and efficiency of draining.
- Determine volume of water in saltcake.

Additional chemical analyses were performed to provide information on salt elemental, ionic, and radiological composition to aid in assessment of the suitability of processing dissolved material from the top of Tank 41H in the SPF. Later phases of this saltcake characterization employed actual process dissolution fluid at near its projected fluid to saltcake ratio. These tests are outlined in the task technical and quality assurance plan.³

Background

Savannah River Technology Center (SRTC) performed previous characterization of the Tank 41H saltcake.^{4,5,6,7,8,9} One set of previous samples was of the saltcake beneath the B-3 riser, making it comparable to this set of samples from beneath the B-3 riser. Between the prior B-3 riser sample and the samples documented in this report, several inches of the salt was dissolved in 1994, the supernatant liquid was removed in mid 2002, and the interstitial liquid was drained beginning in September 2002. Draining continued at the time that the samples covered in this report were pulled in April 2003. Subsequent to the completion of draining in May of 2003, flush water was added to several tank-top risers (including B-3) during June 2003, effectively dissolving the portion of salt analyzed in these samples. The analyses in this report represent the salt composition of the top three feet of saltcake below the B-3 riser as it appeared before the June 2003 dissolution campaign.

In comparison to other salt tanks at SRS, Tank 41H saltcake has the largest bank of characterization information. Of the 17 to 19 other tanks that currently house saltcake, recent (post 1990) characterization has been performed on salt samples only from Tanks 31H¹⁰, 37H^{11,12}, 38H^{8,13,14,15}, and 46F¹⁶. Recently, CBU and SRTC have begun a characterization program to provide saltcake information on additional HLW tanks, including Tanks 2F, 3F, 10H, 29H, and 38H.¹⁷

Samples

On April 3, 2003, three relatively undisturbed salt core samples were collected from riser B-3 of Tank 41H. Thin walled stainless tubes fitted with a cutting head were advanced into the salt using a sledgehammer. A 2" rod from a cone penetrometer was used as a guide pipe for the sampling tube

and rod (Figure 1). The guide pipe provided lateral stability in the unsupported region below the top of the tank and above the top of the salt and ensured re-entry of the sample tube in core hole opened by collection of the previous sample(s).

A rubber wipe ring was used to remove salt from the outside of the sampling rod and tube to minimize release of salt outside of the tank during removal. After completion of sampling the guide pipe was decontaminated using a flush ring to spray water on the outside of the pipe during removal. Personnel reported that this combination of decontamination equipment was effective.

The samples were capped in the field with a vented shipping cap and placed in a 9968 shipping container for transportation to SRTC shielded cells. Each shipping cap was equipped with an o-ring and automatically sealing vent to prevent the loss of salt or associated interstitial liquid during transportation. The samples were visually inspected upon the receipt of the samples in the shielded cells. There was no free liquid in the bags containing the samples, the tubes and caps did not appear to be wet, and there was only a light dusting of salt that appeared in the striations on the outside of the sample tubes.

The samples were delivered to SRTC and weighed on April 6. Table 1 contains a description of the three samples documented in this report. Figure 2 through Figure 4 contain photos of samples T41H-B3-1 through T41H-B3-3 (respectively) taken when the samples were first opened in the SRTC high-level shielded cells. The top two samples completely filled the sample tubes. The third sample tube was only partially advanced into the salt and contained approximately 2 inches of salt. A total of 575 grams of salt was collected using the thin walled sample tubes.

These samples were in 0.95 in. I.D., 1.13 in. O.D., 12.7 in. long sample tubes that had capped ends. The tubes could not be split open to access the sample, thus all access to the sample was through the ends of the tubes. The top of each had a threaded portion where a rod was attached during sampling and the bottom of each tube had a cutting blade to ease movement through the saltcake.

These samples were taken from the same hole into the top of the dry, drained Tank 41H saltcake surface. Thus, the three samples correspond to a depth profile of the salt in Tank 41H below the B-3 riser. The top of T41H-B3-1 corresponds to the surface of the saltcake. The bottom of T41H-B3-1 and the top of T41H-B3-2 are from approximately the same depth into the saltcake, as are the bottom of T41H-B3-2 and the top of T41H-B3-3.

The top sample T41H-B3-1, corresponding to the surface of Tank 41H saltcake beneath the B-3 riser, was loose, powdery, and darker than the other portions of saltcake examined. The remainder of salt at the ends of the tubes was light colored and hard packed. The overall appearance of the salt material was dry. The upper two samples were full, but the lower sample (T41H-B3-3) contained only a small amount of salt on the bottom cutting blade and a plug of hard saltcake that could be slid from end to end of the sampler (see Figure 4). Based on this on this observation, the bottom tube contained a sample of corresponding to approximately a two-inch depth of saltcake.

Table 1: Tank 41H saltcake sample description.

Relative Location	Tank Farm Name	Tube Name	Salt Interval (depth from surface)	Saltcake Mass (g)	Volume (cm ³)	Bulk Density (g/cm ³)
Top	HTF-E-03-033	T41H-B3-1	0 in. – 12 in.	268.6	139.4	1.93
Middle	HTF-E-03-034	T41H-B3-2	12 in. – 24 in.	273.9	143.7	1.91
Bottom	HTF-E-03-035	T41H-B3-3	24 in. – 26 in.	33.6	n.d.	n.d.

Figure 1: Diagram of sampling method to obtain salt from riser B-3 on Tank 41H.

Figure 2: Top sample (T41-B3-1) top (left) and bottom (right).

Figure 3: Middle sample (T41-B3-2) top (left) and bottom (right).

Figure 4: Bottom sample (T41H-B3-3) bottom; salt on cutter (left) and moving salt plug (right).

Experimental

This set of tests on the Tank 41H drained saltcake samples was designed to provide both a chemical and physical analysis. A major portion of samples T41H-B3-1 and T41H-B3-2 were used in the tempe cell pressure extraction tests. The bulk of these samples were not to be disturbed or consumed by chemical and radiological analyses until after the conclusion of the pressure extraction.

Figure 5 outlines the locations within the three samples (and relative to the surface of the Tank 41H saltcake) that saltcake was used in as-received, flush water dissolution, and moisture content analyses. As-received analysis was performed on small portions of salt from the accessible ends of the three samples. Flush water dissolution analysis was performed on larger portions of salt from sample T41H-B3-1 and T41H-B3-3. Sample T41H-B3-2 was involved in the 6-week tempe cell test and was not available for large-scale chemical characterization.

Figure 5: Location of salt used in tests and analyses

As-Received Analysis

An initial as-received salt characterization was performed on small portions of salt removed from the ends of the sample tubes. Before the initiation of the tempe cell pressure extraction tests, portions of salt were removed from the top and the bottom of samples T41H-B3-1 and -2 and from the bottom of sample T41H-B3-3. Each of these portions were scooped or chiseled out of the sample tube into a beaker. From the beaker, 0.2 g to 0.5 g of salt were transferred into shielded bottles containing 10 g of either 2 M HNO₃ or deionized (DI) water and briefly agitated. One dissolution in each fluid was performed for salt from each Location A through E, and a duplicate dissolution was performed for Location A and E.

The nitric acid dilutions/dissolutions were submitted for gamma scan for ¹³⁷Cs determination, inductively coupled plasma – emission spectroscopy (ICP-ES) for elemental analysis, and inductively coupled plasma – mass spectroscopy (ICP-MS) for certain actinide and fission product quantification. The DI water dilutions/dissolutions were submitted for gamma scan for ¹³⁷Cs determination, ion chromatography (IC) for anion characterization, and wet chemistry/titration for total base, free hydroxide, and CO₃²⁻ analysis. Portions of saltcake from Location A and Location E were submitted for scanning electron microscopy (SEM) with X-ray energy dispersive spectroscopy (EDS) and X-ray diffraction (XRD). SEM/EDS samples were prepared with a Au/Pd coating and the backing had veins of Ni, which lead to EDS results that indicate additional Au, Pd, and Ni.

Dissolution with Flush Water

A test designed to be more representative of an in-tank dissolution process was performed on two portions of the Tank 41H samples. The two locations of the saltcake material, as indicated by Figure 5 as Location F and Location G, corresponded to material from near the bottom half of sample T41H-B3-1 and from sample T41H-B3-3, respectively. Saltcake material was removed from the sample tubes through scraping and auguring, but the saltcake material was not mixed rigorously prior to portioning for the dissolution tests. 6 to 15 g portions of saltcake were added to 50 mL polypropylene centrifuge tubes. These portions of salt were dissolved for a pre-determined period of time via contact with tank farm flush water (FW) on a ratio of 2 g FW per 1 g salt (referred to as the first dissolution). The centrifuge tubes were shaken for several brief intervals during the contact period. The tubes were centrifuged, the supernatant brine was decanted, portions of the decanted brine were diluted in 2M HNO₃ or DI water, and the dilutions were submitted for analysis. The residual salt in the centrifuge tubes were dissolved with FW on a ratio of 0.5 g FW per 1 g of initial salt (referred to as the second dissolution). The tubes were centrifuged, the supernatant brine was decanted, portions of the decanted brine were diluted in 2M HNO₃ or DI water, and the dilutions were submitted for analysis. The residual solids were dissolved with 80 °C 2M HNO₃ and submitted for analysis.

Four tests were performed on Location F, each test using 15 g of saltcake. Two tests involved a short contact time, which was 6 hours for the first FW dissolution contact and 16 hours for the second FW dissolution contact. The other two tests involved a long contact time, which was 171 hours for the first FW dissolution contact and 43 hours for the second FW dissolution contact. Two short contact time tests were performed on Location G, each test using 6 to 7 g of saltcake.

Nitric acid dilutions were submitted for gamma scan for ¹³⁷Cs determination, ICP-ES for elemental analysis, ICP-MS for certain actinides and fission products quantification, and other radiochemical analyses for ²³⁸Pu, ²⁴¹Pu, and ⁹⁰Sr. DI water dilutions were submitted for IC for anion characterization, wet chemistry/titration for total base and free hydroxide, and total inorganic carbon (TIC) for carbonate/bicarbonate. A portion of the residual insoluble solids was submitted for SEM/EDS and XRD analysis.

Tempe Cell Pressure Extraction

A modified Tempe Cell was fabricated to perform pressure extraction of interstitial liquid. Pressure extraction allows sampling of interstitial liquid and collection of data for preparing a drainage curve for the salt. Each pressure extractor consisted of a stand, test caps, and a thin walled tube containing the undisturbed sample (see Figure 6 and Figure 7). O-rings and a ceramic disk (45 psi. air entry pressure) saturated with caustic brine (5M NaOH, 2M NaNO₃, 1M NaNO₂) were used to ensure air tight seals between the test caps and sample tube. The brine was selected to ensure chemical compatibility between the saturation fluid and salt.³

Samples T41H-B3-1 and T41H-B3-2 were placed in pressure extractors on April 10, 2003 and 30 psig. of nitrogen gas was applied to the top of each sample. Due to time constraints one sample, T41H-B3-1, was in a pressure extractor for only one week and the other sample was in a pressure extractor for six weeks.

Figure 6: Schematic of modified Tempe Cell used for pressure extraction of salt samples.

Figure 7: Two Tempe-cell pressure extraction apparatuses in Cell A4.

Physical Property Measurements

The bulk saltcake density of the as-received material was calculated using the weight of sample obtained and the visually determined volume of the filled sample tubes. The moisture content of the saltcake was estimated gravimetrically: small portions (1 to 5 g) of saltcake were dried at 115 °C (± 5 °C) to drive off water until a constant weight had been achieved.

Interstitial Fluid Sample Preparation by Centrifugal Filtration

Three 5 g portions of T41H-B3-3 were processed in 50 mL centrifuge filter tubes (0.45 μ m nylon membrane). This method, when tested on saltcake simulants with moistures of 15 % to 20%, has been shown to effectively remove a sample of interstitial fluid. This method was not effective on this actual waste sample, however, due to the low moisture of the drained saltcake sample and the limitations of the available centrifuge. Thus, no interstitial fluid was obtained for analysis.

Results

Data are presented in several formats within this report. The appendix contains presentations of results based on individual samples or tests. Within the body of the report, however, results are often presented as the average results of several samples or tests. When these averages are presented, the standard deviations are also provided. In some cases, usually when four or more results are being averaged together, we provide an additional statistic labeled "95% C.I.". This statistic is the half-width of the 95% confidence interval (C.I.) for the mean. It is the value that should be added and subtracted from the average to produce a two-sided 95% C.I. about the mean.

Several conventions have been adopted in this report when reporting method detection limits. An individual sample or test result is preceded by "<" to signify that it is below the method detection limit. Averages of below-detection-limit values are preceded by "<". The average method detection limit is reported as the lowest method detection limit when the lowest limit is more than a factor of five less than the average of the other detection limits. Otherwise, the average method detection limit is reported as the average of the detection limits of all replicates. Averages are preceded by "<=" when results above the detection limits are averaged together with method detection limit values. In cases where results above the detection limit would be averaged with detection limits that are greater than the actual value, the detection limit values are not included in the average and this is indicated in a note. No additional statistics are provided when method detection limit values are included in average results.

As-Received Analysis

The values for the ^{137}Cs analysis are reported in Table 2 on a volume basis (Ci/gal of saltcake). For this, the saltcake of all portions of the sample were taken to have a bulk density of 1.91 g/cm³. The data for individual samples are reported on a mass basis in the appendix in Table 15. The revised results are the basis of the analyses in this section, but the initial analytical values are included in Table 15 to allow for estimates where not enough sample remained to obtain true revised values (i.e., samples B1 and E4). Using the sample results for cesium and sodium, and again using the average bulk density, Table 3 was formed to estimate the ^{137}Cs activity of a 6M Na⁺ solution formed from the dissolution of the various portions of the Tank 41H sample. Table 4 and Table 5 contain the elemental and anion composition of the as-received samples, for which additional details are contained in Table 16 and Table 17 in the appendix. Table 18 contains the as-received actinide analysis by ICP-MS. Also in the appendix, Figure 9 and Figure 10 contain the SEM and EDS analysis of saltcake from Location A, respectively, and Figure 11 contains the same analyses of saltcake from Location E. Figure 12 and Figure 13 contain the XRD results for the as-received saltcake samples from Location A and Location E, respectively.

Table 2: As-received ¹³⁷Cs analysis (Ci/gal saltcake)

Location:	A		B & C		D & E		B,C,D,E		
	average	st.dev.	average	st.dev.	average	st.dev.	average	st.dev.	95% C.I.
acid dilution	1.33	0.02	0.329	0.129	0.414	0.021	0.380	0.081	0.100
water dilution	0.938	0.003	0.327	0.113	0.404	0.011	0.365	0.079	0.126
average	1.13	0.22	0.328	0.099	0.410	0.017	0.373	0.075	0.070

Table 3: Projected ¹³⁷Cs activity of a 6M Na⁺ solution formed from Tank 41H saltcake based on as-received analyses (Ci/gal solution)

Location:	A		B & C		D & E		B,C,D,E		
	average	st.dev.	average	st.dev.	average	st.dev.	average	st.dev.	95% C.I.
acid dilution	0.32	0.01	0.099	0.039	0.121	0.007	0.112	0.023	0.029
water dilution	0.226	0.001	0.099	0.034	0.118	0.003	0.108	0.023	0.036
average	0.27	0.05	0.099	0.030	0.119	0.005	0.110	0.022	0.020

Table 4: As-received ICP-ES analysis (g/100g saltcake)

Location:	A		B & C		D & E		B,C,D,E		
	average	st.dev.	average	st.dev.	average	st.dev.	average	st.dev.	95% C.I.
Ag	< 3.65E-04		< 6.46E-04		< 2.42E-04		< 4.04E-04		
Al	2.75E-01	9.72E-04	6.28E-02	2.16E-02	7.97E-02	4.49E-03	7.29E-02	1.46E-02	1.81E-02
B	< 1.28E-03		< 2.26E-03		< 8.49E-04		< 1.41E-03		
Ba	3.28E-03	3.65E-04	< 1.53E-03		< 5.76E-04		< 9.59E-04		
Ca	2.52E-02	4.98E-03	6.21E-03	3.52E-03	3.32E-03	1.06E-03	4.48E-03	2.49E-03	3.09E-03
Cd	< 1.91E-04		< 3.39E-04		< 1.27E-04		< 2.12E-04		
Ce	3.84E-03	1.33E-03	3.34E-03	7.26E-04	2.01E-03	4.79E-04	2.54E-03	8.81E-04	1.09E-03
Cr	2.30E-01	2.44E-02	5.74E-03	4.94E-03	5.70E-03	2.03E-04	5.72E-03	2.47E-03	3.07E-03
Cu	1.27E-03	3.12E-04	1.71E-03	1.16E-03	6.13E-04	1.79E-04	1.05E-03	8.43E-04	1.05E-03
Fe	9.04E-02	1.88E-02	3.08E-02	2.36E-02	4.54E-03	7.18E-04	1.50E-02	1.86E-02	2.31E-02
Gd	< 1.07E-03		< 1.89E-03		< 7.09E-04		< 1.18E-03		
K	< 5.08E-02		< 7.58E-02		< 2.84E-02		< 4.74E-02		
La	< 3.28E-04		< 5.82E-04		< 2.18E-04		< 3.64E-04		
Li	< 1.96E-03		< 3.47E-03		< 1.30E-03		< 2.17E-03		
Mg	1.21E-02	4.71E-03	1.68E-03	1.76E-03	1.62E-04	4.16E-05	7.69E-04	1.21E-03	1.50E-03
Mn	1.88E-02	3.40E-03	< 4.37E-04		< 2.42E-05		< 1.89E-04		
Mo	4.09E-03	2.44E-04	< 4.28E-03		< 1.67E-03		< 2.72E-03		
Na	3.00E+01	1.57E+00	2.39E+01	1.56E-02	2.48E+01	4.17E-01	2.44E+01	5.83E-01	7.24E-01
Ni	1.42E-03	2.31E-04	< 1.29E-03		< 4.09E-04		< 7.61E-04		
P	2.78E+00	4.67E-01	9.12E-02	6.83E-02	2.41E-02	8.97E-03	5.09E-02	5.06E-02	6.28E-02
Pb	3.38E-03	1.07E-03	< 2.58E-03		< 9.67E-04		< 1.61E-03		
S	6.79E-01	1.98E-01	1.28E+00	8.63E-01	2.33E+00	4.22E-01	1.91E+00	7.80E-01	9.68E-01
Sb	< 1.72E-02		< 3.05E-02		< 1.15E-02		< 1.91E-02		
Si ^(a)	5.48E-02	1.40E-03	8.60E-03	7.64E-03	2.88E-03	4.46E-04	5.17E-03	4.95E-03	6.15E-03
Sn	1.79E-02	4.28E-03	< 3.64E-03		< 1.37E-03		< 2.27E-03		
Sr	5.62E-03	9.37E-04	9.14E-04	3.53E-04	6.35E-04	1.86E-04	7.46E-04	2.68E-04	3.33E-04
Ti	7.59E-04	1.94E-04	< 6.22E-04		< 2.33E-04		< 3.89E-04		
V	2.37E-03	3.63E-04	< 1.62E-04		< 6.06E-05		< 1.01E-04		
Zn	3.05E-03	6.75E-05	1.13E-03	9.53E-05	3.81E-04	1.80E-04	6.82E-04	4.34E-04	5.39E-04
Zr	< 1.40E-03		< 1.84E-03		< 6.91E-04		< 1.15E-03		

Notes: a: Acid dissolution may not have dissolved all the silicon in the as-received samples.

Table 5: As-received Ion Chromatography and Wet Chemistry analyses (g/100g saltcake)

Location:	A		B & C		D & E		B,C,D,E		
	average	st.dev.	average	st.dev.	average	st.dev.	average	st.dev.	95% C.I.
NO ₃ ⁻	6.12E+00	5.90E-01	5.68E+01	3.98E+00	5.37E+01	9.59E-01	5.49E+01	2.71E+00	3.36E+00
NO ₂ ⁻	1.03E+00	9.12E-02	3.00E-01	3.26E-02	3.30E-01	1.05E-01	3.18E-01	7.78E-02	9.66E-02
SO ₄ ²⁻	1.76E+00	3.57E-01	3.04E+00	1.66E+00	5.16E+00	6.06E-01	4.31E+00	1.49E+00	1.85E+00
PO ₄ ³⁻	6.10E+00	4.96E-01	2.95E-01	1.64E-01	7.86E-02	5.26E-02	1.65E-01	1.49E-01	1.85E-01
Cl ⁻	<=9.40E-03		< 7.65E-02		< 8.91E-02		< 8.28E-02		
F ⁻	2.24E-01	3.79E-02	1.88E-01	1.58E-01	9.57E-02	1.70E-02	1.33E-01	9.43E-02	1.17E-01
C ₂ O ₄ ²⁻	5.77E-01	2.84E-02	1.34E-01	5.39E-02	1.58E-01	6.52E-02	1.49E-01	5.50E-02	6.84E-02
CHO ₂ ⁻	3.46E-02	9.51E-03	5.98E-02	5.08E-02	8.72E-02	1.76E-02	7.63E-02	3.20E-02	3.98E-02
Free OH ⁻	1.58E+00	3.91E-01	< 8.12E-01		2.41E-01 ^(a)		N/A		
CO ₃ ²⁻	1.50E+01	1.57E+00	< 2.87E+00		< 3.34E+00		< 5.13E+00		

Notes: a: Based on one real value obtained with better detection limits

Dissolution with Flush Water

At the initiation of the flush water dissolution tests, portions of saltcake were removed from the sample tubes to allow for the determination of the weight percent water. Table 6 contains an estimate of the moisture content of the saltcake from several locations in the samples. Saltcake from the top of the top sample (Location A) and from the bottom half of the top sample (Location F) was tested after the completion of the tempe cell pressure extraction tests. Saltcake from the bottom sample (Location G) was tested after a failed attempt to remove a portion of the interstitial fluid by centrifugal filtration. Although interstitial fluid was not removed from the samples before testing the moisture content, some drying may have occurred from the increased air contact that the pressure extraction and the centrifugal filtration processes introduce.

The water content of the thin layer at the top of the sample (Location A) is biased high due to the salt composition. From the XRD analysis, a portion of the salt from that location was natrophosphate ($\text{Na}_7\text{F}(\text{PO}_4)_2 \cdot 19\text{H}_2\text{O}$), which loses its waters of hydration when dried by the method that we used. Thus, the free water content of this material is lower than the 24.6 wt % that was measured. The free water content of the material from Location A was likely 15 to 20 wt %.

Table 6: Water content of Tank 41H saltcake (wt%)

sample location	moisture (wt%)		
	average	st.dev.	95% C.I.
A	24.6%	0.9%	1.5%
F	3.0%	0.4%	0.7%
G	3.5%	0.3%	2.3%

Table 7, Table 8, and Table 9 contain the results of the flush water dissolution tests of salt from Location F at short and long dissolution contact times and Location G at a short contact time. Values for the fluid removed during the first and second dissolutions and for the residual solid material are reported on a mass basis of the initial saltcake. Total quantities are provided for some analytes in the situations where a sum of the quantities of that analyte in the first dissolution, second dissolution, and residual solids would yield reliable results. For other analytes, a total content of the analyte can not be determined due to detection limits. Due to the low total base in these samples, TIC analysis was

performed instead of carbonate analysis. The carbonate values reported for the flush water tests are from the TIC analysis, and thus are a combination of carbonate and bicarbonate. Additional and more detailed results are reported for these tests in the appendix in Table 19 through Table 27.

A point of interest of Table 7 through Table 9 is the partitioning of radionuclides between the dissolved salt and the residual insoluble solids. For the three flush water dissolution tests, the ^{137}Cs was partitioned >99% into the dissolved solutions, with <1% in the residual insoluble solids. The short and long contact-time tests for Location F had total ^{238}Pu concentrations of $1.43\text{E}+6$ and $8.51\text{E}+5$ pCi/mL, respectively. For the short contact-time test, the ^{238}Pu was partitioned 77% into the dissolved solution and the remainder in the insoluble solids. In the long contact-time test, however, the ^{238}Pu was partitioned only 23% into the dissolved solution. The short contact-time test for Location G had a total ^{238}Pu concentration of $5.15\text{E}+5$ pCi/mL and a ^{238}Pu partitioning of 35% into the dissolved solution. From this set of three tests, no regular pattern is evident in the results for ^{238}Pu partitioning between the dissolved salt and the residual insoluble solids. There is a considerable amount of ^{238}Pu in both the dissolved salt and in the residual insoluble solids.

In the process used for this test, the first dissolution of saltcake yielded a solution that was approximately 4.6 M Na^+ . The current low curie salt process baselines upon a 6 M sodium solution fed forward from Tank 50H to the SPF. Based on adjusted from the data collected during the flush water dissolution testing (roughly 4.6 M Na^+ solution), 1 gallon of drained saltcake will make 3.52 ± 0.08 gallons of 6 M Na^+ solution. On a mass basis, 542 ± 12 g of drained saltcake will make 1 L of 6 M Na^+ solution.

The quantity of insoluble solids remaining after dissolution of saltcake was very small, less than 0.07 g of insoluble solids per 100 g of initial saltcake. This value is smaller than other values obtained during dissolution of saltcake for criticality analyses, which typically range from 0.2 to 2 g of insoluble solids per 100 g of saltcake.

Figure 14, Figure 15, and Figure 16 in the appendix contain the SEM, EDS, and XRD analyses of residual insoluble solids from FW dissolution of salt from Location F. The insoluble solids are primarily iron-containing compounds. The non-crystalline-oxide nature of the sample sent to XRD possibly indicates that a major component of the insoluble solids from Location F was metal fragments from removal of salt from the sample tube. Because of the hardness of the salt, a drill was used to remove Location F saltcake from the sample tube. The metal fragments could have been introduced during periods when the drill bit contacted the sample tube wall. The EDS revealed that sodium aluminosilicates were present, which also were associated with the elements chlorine, potassium, and calcium. Other particles were identified that contain considerable amounts of zinc.

Analysis of the flush water used in the dissolution testing revealed that it contained small but measurable levels (0.1 to 10 mg/L) of several metals, including Ca, Cu, Fe, Mg, Mn, Si, and S. Details are contained in Appendix Table 28. The iron was seen to be primarily insoluble, as the fluid contained a small amount of rust-colored solids. The flush water had small amounts (on the order of 1 mg/L) of chloride and fluoride ions and had a pH of 5 to 7.

Table 7: Analytical results for Tank 41H saltcake dissolution with flush water (Location F, short contact time)

	First Dissolution		Second Dissolution		Residual Solids	Total
	Avg.	St.Dev.	Avg.	St.Dev.		
ICP-ES (g/100g saltcake)						
Al	2.78E-02	1.42E-03	2.59E-04	9.75E-05	7.39E-05	2.82E-02
Ba	< 1.15E-03		< 9.98E-05		3.05E-05	
Ca	3.38E-03	2.71E-03	<=1.50E-04		4.10E-04	3.94E-03
Cd	< 2.54E-04		< 2.21E-05		1.62E-05	
Cr	1.32E-03	1.54E-04	< 3.15E-05		2.85E-04	1.64E-03
Cu	6.84E-04	1.91E-04	6.82E-05	1.67E-06	1.07E-04	8.60E-04
Fe	1.38E-03	4.64E-04	8.12E-05	5.06E-05	1.85E-02	1.99E-02
K	< 5.68E-02		<=5.89E-03		1.12E-03	
Mg	< 3.21E-04		< 2.78E-05		7.51E-05	
Mn	< 4.84E-05		< 4.20E-06		2.21E-04	
Mo	<=4.83E-03		< 2.78E-04		8.95E-05	
Na	2.50E+01	7.30E-01	9.63E-02	2.00E-02	8.91E-04	2.51E+01
Ni	< 8.17E-04		< 7.09E-05		3.80E-04	
P	3.49E-02	3.53E-03	< 3.63E-04		3.15E-04	
S	7.78E-01	2.91E-02	4.49E-03	3.34E-04	< 1.63E-04	7.83E-01
Si	2.00E-03	2.50E-04	4.44E-04	1.14E-04	2.08E-04	2.65E-03
Sr	<=5.01E-04		< 3.99E-05		8.13E-05	
Zn	< 1.94E-04		< 1.68E-05		1.87E-04	
IC Anions / Wet. Chem. / TIC (g/100g saltcake)						
NO ₃ ⁻	6.03E+01	8.98E-01	2.33E-01	4.81E-02	n.d.	6.05E+01
NO ₂ ⁻	1.83E-01	7.05E-03	5.82E-04 ^(a)		n.d.	1.83E-01
SO ₄ ²⁻	2.24E+00	6.14E-02	8.61E-03	2.64E-03	n.d.	2.24E+00
PO ₄ ³⁻	5.80E-02	1.57E-02	< 5.82E-04		n.d.	
Cl ⁻	< 1.57E-02		< 1.16E-04		n.d.	
F ⁻	<=4.80E-02		2.33E-04 ^(a)		n.d.	
C ₂ O ₄ ²⁻	1.34E-01	6.48E-03	3.10E-03 ^(a)		n.d.	
CHO ₂ ⁻	4.10E-02 ^(a)		< 5.82E-04		n.d.	
CO ₃ ²⁻	1.84E+00	2.27E-01	3.02E-02	5.43E-03	n.d.	1.87E+00
Free OH ⁻	4.63E-01	1.42E-01	< 1.91E-02		n.d.	
ICP-MS (g/100g saltcake)						
M-88 (Sr)	6.58E-06	2.32E-06	3.76E-07	9.14E-08	1.04E-06	7.99E-06
M-99 (Tc,Rh)	4.16E-05	1.75E-06	2.41E-07	3.32E-08	1.16E-06	4.30E-05
M-232 (Th,U)	2.39E-05	1.36E-05	<=3.3E-07		3.7E-07	
M-233 (U)	< 3.0E-06		< 2.6E-07		< 1.6E-07	
M-234 (U)	< 3.0E-06		< 2.6E-07		8.2E-07	
M-235 (U)	5.4E-06	3.2E-07	3.4E-07	4.1E-08	3.87E-06	9.57E-06
M-236 (U)	< 3.0E-06		< 2.6E-07		1.64E-06	
M-237 (Np)	6.3E-06	8.7E-07	< 2.6E-07		9.63E-07	
M-238 (U,Pu)	3.06E-04	1.42E-06	3.15E-05	2.98E-06	4.02E-04	7.39E-04
M-239 (Pu)	<=5.7E-06		<=2.6E-07		1.23E-06	
M-240 (Pu)	< 3.0E-06		< 2.6E-07		4.5E-07	
M-241 (Pu,Am)	< 3.0E-06		< 2.6E-07		2.2E-07	
M-242 (Pu)	< 3.0E-06		< 2.6E-07		< 1.6E-07	
Rad. Chem. (pCi/g saltcake)						
⁹⁰ Sr	7.57E+04	3.70E+04	3.36E+03	5.78E+01	3.35E+04	1.12E+05
¹³⁷ Cs	2.28E+07	1.40E+05	9.01E+04	2.24E+04	1.32E+05	2.30E+07
²³⁸ Pu	1.05E+06	7.87E+04	4.90E+04	1.15E+04	3.36E+05	1.43E+06
^{239/240} Pu	<=3.04E+03		<=2.58E+02		2.71E+03	
²⁴¹ Pu	<=6.70E+04		9.69E+03	8.66E+03	2.71E+04	8.54E+04

Note:
(a) denotes that the value reported is one actual value that was lower than the detection limit of another value

Table 8: Analytical results for Tank 41H saltcake dissolution with flush water (Location F, long contact time)

	First Dissolution		Second Dissolution		Residual Solids	Total
	Avg.	St.Dev.	Avg.	St.Dev.		
ICP-ES (g/100g saltcake)						
Al	3.12E-02	3.50E-03	7.57E-05	3.14E-05	2.64E-04	3.15E-02
Ba	< 1.01E-03		< 1.32E-05		5.13E-05	
Ca	< 1.23E-03		5.27E-05	1.66E-05	1.36E-03	
Ce	2.80E-03	1.69E-03	< 1.91E-05		< 1.65E-05	
Cr	1.43E-03	1.67E-04	< 4.40E-06		5.06E-04	1.94E-03
Cu	6.00E-04	2.34E-05	1.01E-05	3.99E-06	2.09E-04	8.19E-04
Fe	< 1.07E-04		1.21E-05	8.75E-06	4.48E-02	4.49E-02
K	< 5.00E-02		n.d.	n.d.	5.73E-04	
Mg	< 2.83E-04		< 3.91E-06		1.23E-04	
Mn	< 4.27E-05		< 4.89E-07		4.01E-04	
Na	2.57E+01	7.52E-03	7.19E-02	3.27E-02	2.12E-03	2.58E+01
Ni	< 7.20E-04		< 9.29E-06		8.67E-04	
P	3.01E-02	6.22E-03	<=4.28E-03		5.89E-04	
S	9.14E-01	5.57E-02	2.71E-03	1.11E-03	2.67E-04	9.17E-01
Si	2.46E-03	4.80E-04	1.99E-04	2.28E-05	5.18E-04	3.18E-03
Sr	< 4.06E-04		<=5.28E-03		2.93E-04	
Zn	4.07E-04	1.73E-04	< 2.44E-06		4.46E-04	
IC Anions / Wet. Chem. / TIC (g/100g saltcake)						
NO ₃ ⁻	5.47E+01	6.34E-01	1.36E-01	5.68E-02	n.d.	5.48E+01
NO ₂ ⁻	2.23E-01	1.61E-03	4.33E-04	1.05E-04	n.d.	2.23E-01
SO ₄ ²⁻	2.47E+00	6.01E-02	6.37E-03	1.76E-03	n.d.	2.47E+00
PO ₄ ³⁻	1.59E-01	4.77E-03	< 5.10E-04		n.d.	
Cl ⁻	< 1.17E-01		< 1.02E-04		n.d.	
F ⁻	7.22E-02	8.46E-04	2.30E-04	3.75E-05	n.d.	7.25E-02
C ₂ O ₄ ²⁻	1.38E-01	1.09E-02	3.57E-04	1.42E-04	n.d.	1.38E-01
CHO ₂ ⁻	< 5.86E-02		< 5.10E-04		n.d.	
CO ₃ ²⁻	3.42E+00	3.16E-01	3.56E-02	4.64E-03	n.d.	3.46E+00
Free OH ⁻	< 1.99E+00		< 1.73E-01		n.d.	
ICP-MS (g/100g saltcake)						
M-88 (Sr)	<=7.1E-06		n.d.	n.d.	2.65E-06	
M-99 (Tc,Rh)	4.35E-05	1.84E-06	n.d.	n.d.	1.37E-06	4.49E-05
M-232 (Th,U)	<=7.0E-06		n.d.	n.d.	6.6E-07	
M-233 (U)	< 4.2E-06		n.d.	n.d.	9.53E-08	
M-234 (U)	< 4.2E-06		n.d.	n.d.	1.19E-06	
M-235 (U)	5.5E-06	1.9E-06	n.d.	n.d.	7.21E-06	1.27E-05
M-236 (U)	< 4.2E-06		n.d.	n.d.	3.64E-06	
M-237 (Np)	< 4.2E-06		n.d.	n.d.	2.18E-06	
M-238 (U,Pu)	6.34E-04	2.86E-04	n.d.	n.d.	9.50E-04	1.58E-03
M-239 (Pu)	< 4.2E-06		n.d.	n.d.	4.03E-06	
M-240 (Pu)	< 4.2E-06		n.d.	n.d.	1.58E-06	
M-241 (Pu,Am)	< 4.2E-06		n.d.	n.d.	< 4.5E-07	
M-242 (Pu)	< 4.2E-06		n.d.	n.d.	< 3.0E-07	
Rad. Chem. (pCi/g saltcake)						
⁹⁰ Sr	5.57E+04	2.92E+04	5.43E+03	2.70E+03	1.45E+05	2.06E+05
¹³⁷ Cs	2.63E+07	5.45E+05	6.88E+04	4.46E+04	1.38E+05	2.65E+07
²³⁸ Pu	1.87E+05	2.05E+04	6.09E+03	4.51E+03	6.57E+05	8.51E+05
^{239/240} Pu	< 2.07E+03		< 7.10E+01		5.67E+03	
²⁴¹ Pu	2.91E+04	7.71E+03	5.67E+02	3.16E+02	1.16E+05	1.46E+05

Table 9: Analytical results for Tank 41H saltcake dissolution with flush water (Location G, short contact time)

	First Dissolution		Second Dissolution		Residual Solids	Total
	Avg.	St.Dev.	Avg.	St.Dev.		
ICP-ES (g/100g saltcake)						
Ag	< 8.28E-04		< 5.48E-05		1.15E-05	
Al	5.37E-02	9.90E-05	9.75E-04	7.39E-04	4.19E-03	5.88E-02
Ba	< 1.97E-03		< 1.30E-04		3.86E-05	
Ca	< 2.38E-03		< 1.57E-04		1.09E-03	
Cd	< 4.35E-04		< 2.88E-05		6.05E-06	
Ce	<=5.57E-03		<=2.48E-04		< 3.89E-05	
Cr	5.37E-03	2.73E-04	9.17E-05	5.07E-05	1.90E-03	7.36E-03
Cu	1.27E-03	1.34E-04	7.51E-05	2.18E-05	6.32E-05	1.41E-03
Fe	<=2.82E-04		< 1.37E-05		6.32E-03	
K	< 9.71E-02		< 6.42E-03		1.35E-03	
Mg	< 5.49E-04		< 3.63E-05		1.39E-04	
Mn	< 8.28E-05		< 5.48E-06		1.35E-04	
Mo	< 5.49E-03		< 3.63E-04		7.63E-05	
Na	2.56E+01	4.47E-01	4.08E-01	3.86E-01	1.03E-02	2.60E+01
Ni	< 1.40E-03		< 9.24E-05		4.74E-05	
P	2.92E-02	1.18E-02	<=8.25E-04		1.80E-04	
Pb	< 3.30E-03		< 2.18E-04		4.59E-05	
S	1.38E+00	1.74E-01	2.07E-02	1.62E-02	4.82E-04	1.40E+00
Si	3.58E-03	3.92E-04	4.23E-04	3.05E-05	6.91E-04	4.69E-03
Sr	< 7.87E-04		< 5.20E-05		2.38E-04	
Ti	< 7.97E-04		< 5.27E-05		1.11E-05	
Zn	< 3.31E-04		< 2.19E-05		1.56E-04	
Zr	< 2.36E-03		< 1.56E-04		3.28E-05	
IC Anions / Wet. Chem. / TIC (g/100g saltcake)						
NO ₃ ⁻	5.58E+01	1.76E+00	9.94E-01	9.66E-01	n.d.	5.68E+01
NO ₂ ⁻	3.10E-01	3.11E-02	6.07E-03	5.65E-03	n.d.	3.16E-01
SO ₄ ²⁻	3.93E+00	6.83E-01	6.41E-02	5.65E-02	n.d.	3.99E+00
PO ₄ ³⁻	5.18E-02	8.37E-03	<=3.28E-03		n.d.	
Cl ⁻	< 1.87E-02		< 1.38E-04		n.d.	
F ⁻	7.98E-02	6.45E-04	1.46E-03	1.49E-03	n.d.	8.12E-02
C ₂ O ₄ ²⁻	<=7.06E-02		2.79E-03	1.99E-03	n.d.	
CHO ₂ ⁻	7.62E-02	5.74E-03	1.50E-03	1.44E-03	n.d.	7.77E-02
CO ₃ ²⁻	6.19E+00	1.62E+00	1.69E-01	7.94E-02	n.d.	6.36E+00
Free OH ⁻	< 3.17E+00		< 2.85E-02		n.d.	
ICP-MS (g/100g saltcake)						
M-88 (Sr)	< 4.5E-06		< 3.0E-07		2.17E-06	
M-99 (Tc,Rh)	8.03E-05	5.92E-06	1.48E-06	1.37E-06	1.64E-06	8.35E-05
M-232 (Th,U)	9.0E-06	3.0E-06	< 3.4E-07		2.04E-07	
M-233 (U)	< 5.1E-06		< 3.4E-07		6.02E-07	
M-234 (U)	< 5.1E-06		< 3.4E-07		6.99E-06	
M-235 (U)	8.0E-06	1.1E-06	5.2E-07	1.9E-07	1.72E-05	2.57E-05
M-236 (U)	< 5.1E-06		< 3.4E-07		6.42E-06	
M-237 (Np)	< 5.1E-06		< 3.4E-07		6.59E-06	
M-238 (U,Pu)	1.24E-04	3.59E-06	1.14E-05	2.43E-06	1.97E-04	3.32E-04
M-239 (Pu)	< 5.1E-06		< 3.4E-07		1.45E-06	
M-240 (Pu)	< 5.1E-06		< 3.4E-07		3.70E-07	
M-241 (Pu,Am)	< 5.1E-06		< 3.4E-07		1.89E-07	
M-242 (Pu)	< 5.1E-06		< 3.4E-07		1.89E-07	
Rad. Chem. (pCi/g saltcake)						
⁹⁰ Sr	1.35E+04	5.95E+02	1.08E+03	7.62E+02	1.13E+04	2.58E+04
¹³⁷ Cs	4.29E+07	4.95E+06	6.61E+05	5.71E+05	1.39E+05	4.37E+07
²³⁸ Pu	1.71E+05	1.01E+05	6.98E+03	2.83E+03	3.37E+05	5.15E+05
^{239/240} Pu	< 3.63E+02		< 1.71E+01		2.16E+03	
²⁴¹ Pu	1.84E+04	6.39E+03	1.69E+03	2.83E+02	1.82E+04	3.83E+04

Tempe Cell Pressure Extraction

In the one-week duration of the test, no drainable liquid was forced from the upper-most saltcake sample (T41H-B3-1). This was not unexpected, however, due to the very low liquid content of the sample. Less than 3 mL was drained from sample T41H-B3-2 during six weeks of pressure extraction. Sample T41H-B3-2 contained 273.9 grams of sample, which consisted of 16.2 grams interstitial liquid and 257.7 grams salt. Twenty two percent (3.6 grams) of the residual interstitial liquid was removed during the tempe cell testing. A full description of the hydraulic results, including draining tests, porosity calculations, permeability measurements, interstitial liquid displacement observations, and drained salt dissolution data, is reported elsewhere.¹⁸

Discussion

Saltcake Composition

From analysis of both the as-received and FW dissolution samples, the composition of the bulk material is known. The bulk of the salt was light in color, hard packed, and had 3 – 4 wt % water. XRD analysis (Figure 13) revealed the salt to contain sodium nitrate (NaNO_3) and burkeite ($\text{Na}_6(\text{SO}_4)_2\text{CO}_3$), with the other crystals below the 5 wt % instrument detection limit. Based on ICP-ES, IC Anions, and wet chemistry titration, the saltcake composition (including the residual undrained interstitial liquid) can be estimated. The primary composition of the bulk of the Tank 41H sample was 72 – 82 wt % NaNO_3 , 4 – 12 wt % $\text{Na}_6(\text{SO}_4)_2\text{CO}_3$, and 3 – 9 wt % Na_2CO_3 or a similar carbonate compound. Note that the additional carbonate phase was not identified by XRD. Being drained saltcake, it had relatively small amounts of NaOH and NaNO_2 . The SEM and EDS analyses (Figure 11) showed two distinct compositions within the same salt agglomeration. The majority of the sample was a salt for which EDS could only identify Na, which is primarily NaNO_3 . EDS also identified a sodium salt that contained S, which was likely the burkeite.

A thin (<1") layer at the top of the saltcake was composed of loose, dark, powdery solids with 25 wt % water. In addition to sodium nitrate, XRD analysis (Figure 12) revealed several crystalline phases of phosphate and carbonate. The primary carbonate phase was trona ($\text{Na}_3\text{H}(\text{CO}_3)_2 \cdot 2\text{H}_2\text{O}$). A major nitrate phase was natrophosphate ($\text{Na}_7\text{F}(\text{PO}_4)_2 \cdot 19\text{H}_2\text{O}$), but there is not enough fluoride present for this to be the only phosphate phase. From the as-received analysis of the salt from Location A, the rough composition of this layer was 28 wt % $\text{Na}_3\text{H}(\text{CO}_3)_2 \cdot 2\text{H}_2\text{O}$, 8 wt % $\text{Na}_7\text{F}(\text{PO}_4)_2 \cdot 19\text{H}_2\text{O}$, 7 wt % Na_3PO_4 , 8 wt % NaNO_3 , 3.7 wt % NaOH , 2.7 wt % Na_2SO_4 , and 1.5 wt % NaNO_2 . The inclusion of larger amounts sodium hydroxide and sodium nitrite in this layer supports that there is a greater amount of interstitial liquid held in this layer. The free water content (the water contained in the interstitial liquid) is likely 15 to 20 wt %, not 25 wt % as measured, because the natrophosphate would lose its waters of hydration when dried at 115 °C. Visual inspection of the water-dissolved samples submitted to ADS revealed that this material contained a significantly greater quantity of additional water-insoluble solids than did the bulk saltcake. The SEM and EDS analyses (Figure 9 and Figure 10) showed a great quantity of rod-like salt structure for which EDS could only identify Na, which is likely trona. Two additional salt phases were evident by EDS, one that contains P and one that contains S.

Table 10 contains a projection, based on the flush water dissolution tests, of the composition of the brine resulting from the dissolution of the top 26" of Tank 41H saltcake after adjustment to 6 M Na^+ .

Table 10: Projected composition of a dissolved Tank 41H saltcake 6 M Na⁺ solution

Component	Conc. (M)
Na ⁺	6.00
NO ₃ ⁻	4.97
NO ₂ ⁻	0.028
OH ⁻	0.15
AlO ₂ ⁻	0.0076
CO ₃ ²⁻	0.34
SO ₄ ²⁻	0.16
PO ₄ ³⁻	0.0051
Cl ⁻	< 0.008
F ⁻	0.019
C ₂ O ₄ ²⁻	0.0070
CHO ₂ ⁻	0.0070
-/+	104%

Saltcake ¹³⁷Cs Content

Table 11 contains the results from the flush water dissolution tests. Although the saltcake from Location F was used in the one-week tempe cell test and the saltcake from Location G was unsuccessfully drained by centrifugation, no appreciable cesium had been removed from the samples before their use in the flush water dissolution tests. Here are the key observations for the saltcake ¹³⁷Cs content based on the flush water tests:

- The total ¹³⁷Cs concentration of the larger samples used in the flush water dissolution tests was less than that for the smaller samples used in the previous as-received analyses. The analyses based on these larger samples are more reliable.
- There is no significant insoluble cesium resulting from dissolution with flush water.
- There is little change in cesium in solution at contact times longer than 6 hours.

For the flush water dissolution, the primary mechanism for carryover of cesium into the second dissolution is the small amount of fluid remaining in the centrifuge tubes after the decant step, some of which was interstitial liquid in the residue. The final acid-dissolved solids did contain some ¹³⁷Cs activity, but it was only a small portion (<1%) of the total cesium in the salt sample.

Table 11: ¹³⁷Cs activity in Tank 41H saltcake determined through multiple contacts with flush water followed by acid dissolution of residual solids (Ci/gal saltcake).

Flush Water Test (Ci/gal saltcake)		First Dissolution		Second Dissolution	Residual Solids	Total
Location	Contact	average	st.dev.	average		
F	Short	0.165	0.001	0.00065	0.00095	0.166
F	Long	0.190	0.004	0.00050	0.00100	0.191
G	Short	0.310	0.036	0.00478	0.00100	0.316
Locations F & G, average for top 26 in. of saltcake:						0.25

Figure 8: Overview of the ^{137}Cs activity in the Tank 41H drained saltcake samples.

Figure 8 outlines the projected ^{137}Cs content in the top 26" of Tank 41H saltcake based on the salt characterization results contained in this report. The locations of the salt used in the as-received and flush-water-dissolution analyses, as defined in Figure 5, are plotted against the results for the ^{137}Cs activity. The vertical blue lines are the results for the flush water dissolution analysis. The dashed purple line at 0.25 Ci/gal is the result based on the average ^{137}Cs resulting from the flush water dissolution testing (Locations F and G). This corresponds to 0.07 Ci/gal of ^{137}Cs in a 6 M Na^+ solution.

The smaller red marks in Figure 8 are the results of the as-received sample analysis. The resulting dashed green line is a ^{137}Cs concentration profile estimate that considers all analyses in a conservative manner. The top 1" is considered to have the ^{137}Cs content of the acid dissolved salt from Location A. The remainder of the top 12" is considered to have the ^{137}Cs content of the weighted average of Location F and B. The salt between 12" to 24" from the saltcake surface is conservatively taken as the average of the as-received ^{137}Cs results for Locations C and D. The remainder of the sample, corresponding to 24" to 26" from the saltcake surface, is considered to have the ^{137}Cs content of the weighted average of Location G and E. This conservative estimate for ^{137}Cs corresponds to 0.35 Ci/gal of saltcake, which is 0.10 Ci/gal for a 6 M Na^+ solution.

Saltcake Strontium and Actinide Content

Table 12 contains a summary of actinides and strontium detected in the first dissolution of Tank 41H saltcake with flush water. The resulting salt solution was approximately 4.6 M Na⁺, but the results are reported on a basis of a 6 M Na⁺ solution assuming that all components remain soluble upon concentration. This assumption is conservative for most sparingly soluble components like the actinides and strontium, and thus the results reported on a 6 M Na⁺ basis are biased slightly high. The average values reported in Table 12 are the averages for salt from Locations F and G.

The amount of ²³⁸Pu in the dissolved Tank 41H saltcake is approaching the TRU limit of 100 nCi/g. Note that 2.16E+05 pCi/mL of ²³⁸Pu corresponds to about 13 µg/L, which is within the reasonable range of Pu solubility in such a solution. A similar dissolution of Tank 38H saltcake (10 grams of salt in 30 grams of inhibited water) yielded a solution with 3.3 M Na⁺ and 1.7E+05 pCi/mL ²³⁸Pu, so this also matches historical expectations.¹⁴

Table 12: Strontium and actinide content of dissolved Tank 41H saltcake (pCi/mL 6 M Na⁺ solution)

Sample:	F, short	F, long	G, short	Average	St. Dev.
⁹⁰ Sr	4.15E+04	2.99E+04	7.27E+03	2.15E+04	1.91E+04
²³² Th	1.43E-02	<=4.1E-03	5.34E-03	7.3E-03	6.2E-03
²³⁵ U	6.4E-02	6.4E-02	9.36E-02	7.9E-02	1.9E-02
²³⁷ Np	2.4E+01	< 1.6E+01	< 1.9E+01	<=2.0E+01	
²³⁸ U	5.67E-01	1.14E+00	2.24E-01	5.40E-01	4.76E-01
²³⁸ Pu	5.78E+05	1.00E+05	9.27E+04	2.16E+05	2.50E+05
^{239/240} Pu	<=1.71E+03	< 1.11E+03	< 1.96E+02	<=8.05E+02	
²⁴¹ Pu	<=3.69E+04	1.56E+04	9.95E+03	<=1.81E+04	

Sample ²³⁵U Enrichment

Table 13 contains data for the ²³⁵U enrichment of the fractions prepared during the flush water dissolution of Tank 41H saltcake. For all cases, the ²³⁵U enrichment is defined as the mass of ²³⁵U divided by the sum of the masses of ²³⁵U and ²³⁸U, multiplied by 100%. Salt from the upper-most sample (Location F) contained uranium of considerably less enrichment (1.1 wt%) compared with the salt from the lower-most sample (Location G; 6.1 wt%). The enrichment was evenly distributed within the brines from the first and second dissolution and the residual insoluble solids.

Table 13: ²³⁵U enrichment of Tank 41H salt (wt%)

	Location F		Location G		Average	
	Average	St. Dev	Average	St. Dev	Average	St. Dev
First Dissolution	1.3%	0.5%	6.1%	0.6%	3.7%	2.5%
Second Dissolution	1.1%	0.0%	4.3%	0.7%	2.7%	1.9%
Residual Solids	0.9%	0.1%	8.0%		4.4%	4.1%
Average	1.1%	0.2%	6.1%	1.9%	3.6%	

Effect of Dissolution Contact Time

The flush water dissolution tests on salt from Location F were performed at two dissolution contact times, a short time (Table 7; 6 hours for first dissolution and 16 hours for second dissolution) and a long time (Table 8; 171 hours for first dissolution and 43 hours for second dissolution). This test was designed to show how additional contact of dissolved salt with the residual insoluble materials would affect the composition of the fluid and the solids. The original intent was to investigate the time dependent solubility of cesium because preliminary as-received results suggested significant amounts of insoluble cesium. These preliminary results were later shown to be in error. The concept that there is a large percentage of cesium in Tank 41 that is, was, or will become insoluble during draining and dissolution is false. This solubility test did expose a few interesting phenomena that would have gone unnoticed had the test not been performed at two different contact times. Some components were either undergoing a reaction or are otherwise kinetically limited in reaching the system equilibrium of the first dissolution within 6 hours, compared with 171 hours.

The fluid decanted from the first dissolution of the short contact time tests appears to be supersaturated or otherwise kinetically dependent with respect to several components. This manifests itself in the results for the first dissolution, where a high concentration is noted for the short contact time test and a low concentration is noted for the long contact time test. It can also manifest itself as a greater amount of that component present in the residual insoluble solids from the long contact time test. A potential supersaturation during the short contact time test was most evident for Fe, but it also appears to factor into the Ca and Pu results. Conversely, Zn appears to be a sparingly soluble component that has not reached equilibrium by the 6 hours of the short contact time test.

Conclusions

Three samples were received that correspond to approximately the top 26" of drained Tank 41H saltcake. The saltcake had an average bulk density of 1.91 g/mL. Two of the samples were extracted with 30 psi N₂, the test on the upper sample was stopped after one week, and the other sample continued for one month.

The bulk of the salt was light in color, hard packed, and had 3 – 4 wt % water. The primary composition of the bulk saltcake was 72 – 82 wt % NaNO₃, 4 – 12 wt % Na₆(SO₄)₂CO₃, and 3 – 9 wt % of an unidentified form of Na₂CO₃. Being drained saltcake, it had relatively small amounts of NaOH and NaNO₂.

A thin (<1") layer at the top of the saltcake was composed of loose, dark, powdery solids that had in the range of 15 to 20 wt% water. The primary salt composition of the top layer was 28 wt % Na₃H(CO₃)₂*2H₂O, 8 wt % Na₇F(PO₄)₂*19H₂O, 7 wt % Na₃PO₄, 8 wt % NaNO₃, 3.7 wt % NaOH, 2.7 wt % Na₂SO₄, and 1.5 wt % NaNO₂. This material contained a significantly greater quantity of additional water-insoluble solids than did the bulk saltcake.

Dissolution of several portions of salt with flush water indicated that the upper and lower samples had ¹³⁷Cs concentrations of 0.178 and 0.313 Ci per gallon of saltcake, respectively, averaging to 0.25 Ci per gallon of saltcake in the top 26" of saltcake. This corresponds to a ¹³⁷Cs concentration of roughly 0.07 Ci/gal in a 6 M Na⁺ solution of dissolved saltcake. Initial testing on very small portions of salt revealed that the bulk saltcake had an average ¹³⁷Cs concentration of 0.373 Ci/gal, with the thin layer at the top of the saltcake having a ¹³⁷Cs concentration of 1.13 Ci/gal. Combining the data from both tests in a conservative manner, the dissolution of the top 26" of Tank 41H saltcake may yield a 6 M Na⁺ solution with as high as 0.10 Ci/gal of ¹³⁷Cs.

Plutonium analysis of salt dissolved with flush water indicates that an aqueous 6 M Na⁺ solution could contain soluble ²³⁸Pu ranging from 9.3E+4 pCi/mL to 5.8E+5 pCi/mL, with an average ²³⁸Pu of 2.2E+5 pCi/mL.

Quality Assurance

This work satisfies the requirements of the original task technical and quality assurance plan.³ Laboratory Notebook WSRC-NB-2003-00068, Laboratory Notebook WSRC-NB-2003-00072, subsequent notebooks, and various ADS notebooks contain the experimental data.

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Appendix

Table 14: Key to Sample Names

As-Received Analysis		
Location	Samples	Dissolution
A	A1, A2	Acid
A	A3, A4	Water
B	B1	Acid
B	B2	Water
C	C1	Acid
C	C2	Water
D	D1	Acid
D	D2	Water
E	E1, E2	Acid
E	E3, E4	Water
Flush Water Dissolution Analysis		
Location	Samples	Contact Time
F	F1, F2	Short
F	F3, F4	Long
G	G1, G2	Short

Table 15: As-received samples ¹³⁷Cs analysis (pCi/g)

Sample	Acid Dissolution	Sample	Water Dissolution
A1	1.81E+08	A3	1.30E+08
A2	1.85E+08	A4	1.30E+08
B1	3.29E+07 ^(a)	B2	3.41E+07
C1	5.81E+07	C2	5.62E+07
D1	5.78E+07	D2	5.70E+07
E1	5.99E+07	E3	5.48E+07
E2	5.43E+07	E4	-- ^(b)

notes: a: estimated, not enough sample to rerun

b: not enough sample to rerun

Table 16: ICP-ES results for the as-received sample acid dissolutions (g/100g saltcake)

Sample:	A1	A2	B1	C1	D1	E1	E2
Ag	< 2.51E-04	< 4.78E-04	< 1.00E-03	< 2.92E-04	< 3.10E-04	< 1.98E-04	< 2.19E-04
Al	2.75E-01	2.74E-01	4.75E-02	7.81E-02	7.87E-02	8.46E-02	7.58E-02
B	< 8.78E-04	< 1.67E-03	< 3.50E-03	< 1.02E-03	< 1.09E-03	< 6.95E-04	< 7.66E-04
Ba	3.54E-03	3.03E-03	< 2.38E-03	< 6.94E-04	< 7.36E-04	< 4.71E-04	< 5.20E-04
Ca	2.17E-02	2.88E-02	8.70E-03	3.72E-03	4.53E-03	2.58E-03	2.85E-03
Cd	< 1.32E-04	< 2.51E-04	< 5.25E-04	< 1.53E-04	< 1.63E-04	< 1.04E-04	< 1.15E-04
Ce	2.89E-03	4.78E-03	3.85E-03	2.83E-03	2.33E-03	2.25E-03	1.46E-03
Cr	2.47E-01	2.13E-01	2.25E-03	9.24E-03	5.93E-03	5.61E-03	5.55E-03
Cu	1.05E-03	1.49E-03	2.53E-03	8.87E-04	8.14E-04	4.69E-04	5.55E-04
Fe	1.04E-01	7.71E-02	1.41E-02	4.75E-02	5.19E-03	3.77E-03	4.65E-03
Gd	< 7.33E-04	< 1.40E-03	< 2.93E-03	< 8.54E-04	< 9.07E-04	< 5.81E-04	< 6.40E-04
K	4.55E-02	< 5.61E-02	< 1.17E-01	< 3.42E-02	< 3.63E-02	< 2.33E-02	< 2.57E-02
La	2.26E-04	< 4.30E-04	< 9.00E-04	< 2.63E-04	< 2.79E-04	< 1.79E-04	< 1.97E-04
Li	< 1.35E-03	< 2.57E-03	< 5.38E-03	< 1.57E-03	< 1.67E-03	< 1.07E-03	< 1.18E-03
Mg	1.54E-02	8.73E-03	2.93E-03	4.34E-04	2.09E-04	< 1.31E-04	< 1.45E-04
Mn	2.13E-02	1.64E-02	< 1.00E-04	7.74E-04	< 3.10E-05	< 1.98E-05	< 2.19E-05
Mo	3.92E-03	4.26E-03	< 6.63E-03	< 1.93E-03	< 0.002054	1.43E-03	1.53E-03
Na	2.89E+01	3.12E+01	2.39E+01	2.39E+01	2.43E+01	2.51E+01	2.51E+01
Ni	1.58E-03	1.26E-03	< 1.69E-03	8.87E-04	< 5.23E-04	< 3.35E-04	< 3.69E-04
P	3.11E+00	2.45E+00	4.29E-02	1.39E-01	3.28E-02	2.46E-02	1.49E-02
Pb	4.14E-03	2.62E-03	< 3.99E-03	< 1.16E-03	< 1.24E-03	< 7.91E-04	< 8.73E-04
S	5.39E-01	8.19E-01	1.89E+00	6.68E-01	1.84E+00	2.56E+00	2.59E+00
Sb	< 1.18E-02	< 2.26E-02	< 4.73E-02	< 1.38E-02	< 1.46E-02	< 9.38E-03	< 1.03E-02
Si ^(a)	5.58E-02	5.38E-02	1.40E-02	3.20E-03	3.14E-03	2.37E-03	3.15E-03
Sn	2.09E-02	1.48E-02	< 5.63E-03	< 1.64E-03	1.75E-03	< 1.12E-03	< 1.23E-03
Sr	4.95E-03	6.28E-03	1.16E-03	6.64E-04	8.49E-04	5.16E-04	5.39E-04
Ti	8.96E-04	6.22E-04	< 9.63E-04	< 2.81E-04	< 2.98E-04	< 1.91E-04	< 2.11E-04
V	2.62E-03	2.11E-03	< 2.50E-04	< 7.30E-05	< 7.75E-05	< 4.96E-05	< 5.47E-05
Zn	3.10E-03	3.00E-03	1.20E-03	1.07E-03	5.89E-04	2.75E-04	2.79E-04
Zr	1.44E-03	< 1.36E-03	< 2.85E-03	< 8.32E-04	< 8.84E-04	< 5.66E-04	< 6.24E-04

Notes: a: Acid dissolution may not have dissolved all the silicon in the as-received samples

Table 17: IC Anions and Wet Chemistry results for the as-received sample water dissolutions (g/100g saltcake)

Sample:	A3	A4	B2	C2	D2	E3	E4
NO ₃ ⁻	6.54E+00	5.71E+00	5.96E+01	5.40E+01	5.26E+01	5.40E+01	5.44E+01
NO ₂ ⁻	1.10E+00	9.70E-01	3.23E-01	2.77E-01	4.51E-01	2.65E-01	2.74E-01
SO ₄ ²⁻	2.01E+00	1.51E+00	4.21E+00	1.86E+00	4.75E+00	4.87E+00	5.85E+00
PO ₄ ³⁻	5.75E+00	6.45E+00	1.80E-01	4.11E-01	7.52E-02	2.78E-02	1.33E-01
Cl ⁻	9.53E-03	< 9.28E-03	< 2.39E-02	< 4.78E-03	< 7.91E-03	< 5.57E-03	< 5.11E-02
F ⁻	1.97E-01	2.51E-01	2.99E-01	7.65E-02	8.31E-02	8.91E-02	1.15E-01
C ₂ O ₄ ²⁻	5.97E-01	5.57E-01	9.58E-02	1.72E-01	1.90E-01	8.35E-02	2.02E-01
CHO ₂ ⁻	4.13E-02	2.78E-02	9.58E-02	2.39E-02	7.91E-02	7.52E-02	1.07E-01
Free OH ⁻	1.30E+00	1.85E+00	< 4.07E+00	< 8.12E-01	< 1.35E+00	< 9.47E-01	2.41E-01
CO ₃ ²⁻	1.61E+01	1.38E+01	< 1.44E+01	< 2.87E+00	< 4.75E+00	< 3.34E+00	< 3.07E-01

Table 18: ICP-MS actinide results for the as-received acid dissolutions (g/100g saltcake)

Sample:	A1	A2	B1	C1	D1	E1	E2
Mass 232 (Th,U)	9.4E-05	< 1.8E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	< 7.3E-05	< 8.1E-05
Mass 233 (U)	< 9.2E-05	< 1.8E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	< 7.3E-05	< 8.1E-05
Mass 234 (U)	9.7E-05	< 1.8E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	< 7.3E-05	< 8.1E-05
Mass 235 (U)	2.66E-04	2.1E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	8.4E-05	1.1E-04
Mass 236 (U)	9.7E-05	< 1.8E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	< 7.3E-05	< 8.1E-05
Mass 237 (Np)	1.91E-04	2.0E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	< 7.3E-05	< 8.1E-05
Mass 238 (U,Pu)	3.04E-03	1.34E-03	< 3.7E-04	< 1.1E-04	3.5E-04	2.41E-04	4.98E-04
Mass 239 (Pu)	1.88E-04	< 1.8E-04	< 3.7E-04	< 1.1E-04	< 1.1E-04	< 7.3E-05	< 8.1E-05
Total U	3.50E-03	1.55E-03	< 3.7E-04	< 1.1E-04	3.5E-04	3.25E-04	6.05E-04
²³⁵ U/Tot.U (wt. frac)	0.0761	0.14	--	--	--	0.26	0.18

Note: Mass 230, 231, and 240 through 247 are below the method detection limit for all samples
The "<" value for a given column is the method detection limit for that analysis

Figure 9: Scanning electron micrographs of salt Location A, the top of sample T41H-B3-1. Secondary electron (right) and back-scattered electron (left) images, 250-times (top) and 1000-times (bottom) magnification. Labeled points are the EDS analyses.

Figure 10: EDS analysis of salt from Location A, the top of sample T41H-B3-1

Figure 11: Scanning electron micrographs and EDS analysis of salt Location E, the bottom of sample T41H-B3-3. Secondary electron (right) and back-scattered electron (left) images, 50-times (top) and 500-times (bottom) magnification. Labeled points are the EDS analyses.

Figure 12: XRD analysis of salt from Location A

Figure 13: XRD analysis of salt from Location E

Table 19: ICP-ES results for Tank 41H saltcake dissolution during the first contact with flush water (g/100g saltcake)

Sample:	F1	F2	F3	F4	G1	G2
Ag	< 5.41E-04	< 4.27E-04	< 4.65E-04	< 3.89E-04	< 8.60E-04	< 7.96E-04
Al	2.88E-02	2.68E-02	2.87E-02	3.37E-02	5.36E-02	5.38E-02
B	< 1.90E-03	< 1.49E-03	< 1.63E-03	< 1.36E-03	< 3.01E-03	< 2.79E-03
Ba	< 1.29E-03	< 1.01E-03	< 1.10E-03	< 9.23E-04	< 2.04E-03	< 1.89E-03
Ca	5.29E-03	1.47E-03	< 1.34E-03	< 1.12E-03	< 2.47E-03	< 2.29E-03
Cd	< 2.84E-04	< 2.24E-04	< 2.44E-04	< 2.04E-04	< 4.51E-04	< 4.18E-04
Ce	< 1.83E-03	1.83E-03	1.61E-03	3.99E-03	8.44E-03	< 2.69E-03
Cr	1.43E-03	1.21E-03	1.31E-03	1.55E-03	5.18E-03	5.56E-03
Cu	8.19E-04	5.49E-04	6.16E-04	5.83E-04	1.36E-03	1.17E-03
Fe	1.06E-03	1.71E-03	< 1.16E-04	< 9.72E-05	3.65E-04	< 1.99E-04
Gd	< 1.58E-03	< 1.25E-03	< 1.36E-03	< 1.14E-03	< 2.51E-03	< 2.33E-03
K	< 6.35E-02	< 5.00E-02	< 5.45E-02	< 4.56E-02	< 1.01E-01	< 9.34E-02
La	< 4.87E-04	< 3.84E-04	< 4.19E-04	< 3.50E-04	< 7.74E-04	< 7.17E-04
Li	< 2.91E-03	< 2.29E-03	< 2.50E-03	< 2.09E-03	< 4.62E-03	< 4.28E-03
Mg	< 3.59E-04	< 2.83E-04	< 3.08E-04	< 2.58E-04	< 5.69E-04	< 5.28E-04
Mn	< 5.41E-05	< 4.27E-05	< 4.65E-05	< 3.89E-05	< 8.60E-05	< 7.96E-05
Mo	6.84E-03	< 2.83E-03	< 3.08E-03	< 2.58E-03	< 5.69E-03	< 5.28E-03
Na	2.55E+01	2.45E+01	2.57E+01	2.57E+01	2.52E+01	2.59E+01
Ni	< 9.14E-04	< 7.20E-04	< 7.85E-04	< 6.56E-04	< 1.45E-03	< 1.34E-03
P	3.74E-02	3.24E-02	2.58E-02	3.45E-02	2.08E-02	3.75E-02
Pb	< 2.16E-03	< 1.70E-03	< 1.85E-03	< 1.55E-03	< 3.43E-03	< 3.18E-03
S	7.99E-01	7.58E-01	9.53E-01	8.75E-01	1.26E+00	1.50E+00
Sb	< 2.56E-02	< 2.02E-02	< 2.20E-02	< 1.84E-02	< 4.06E-02	< 3.76E-02
Si	2.17E-03	1.82E-03	2.80E-03	2.12E-03	3.30E-03	3.85E-03
Sn	< 3.05E-03	< 2.40E-03	< 2.62E-03	< 2.19E-03	< 4.83E-03	< 4.48E-03
Sr	5.96E-04	< 4.05E-04	< 4.42E-04	< 3.69E-04	< 8.17E-04	< 7.57E-04
Ti	< 5.21E-04	< 4.11E-04	< 4.48E-04	< 3.74E-04	< 8.27E-04	< 7.66E-04
Zn	< 2.17E-04	< 1.71E-04	2.85E-04	5.30E-04	< 3.44E-04	< 3.19E-04
Zr	< 1.54E-03	< 1.22E-03	< 1.33E-03	< 1.11E-03	< 2.45E-03	< 2.27E-03

Table 20: ICP-ES results for Tank 41H saltcake dissolution during the second contact with flush water (g/100g saltcake)

Sample:	F1	F2	F3	F4	G1	G2
Ag	< 4.03E-05	< 4.37E-05	< 5.45E-06	< 5.30E-06	< 5.93E-05	< 5.02E-05
Al	1.90E-04	3.27E-04	5.35E-05	9.79E-05	1.50E-03	4.53E-04
B	< 1.41E-04	< 1.53E-04	< 1.98E-05	< 1.93E-05	< 2.08E-04	< 1.76E-04
Ba	< 9.58E-05	< 1.04E-04	< 1.34E-05	< 1.30E-05	< 1.41E-04	< 1.19E-04
Ca	1.73E-04	< 1.26E-04	6.44E-05	4.10E-05	< 1.71E-04	< 1.44E-04
Cd	< 2.12E-05	< 2.30E-05	< 2.97E-06	< 2.89E-06	< 3.11E-05	< 2.64E-05
Ce	< 1.36E-04	< 1.48E-04	< 1.93E-05	< 1.88E-05	< 2.00E-04	2.96E-04
Cr	< 3.03E-05	< 3.28E-05	< 4.46E-06	< 4.34E-06	1.28E-04	5.59E-05
Cu	6.71E-05	6.94E-05	1.29E-05	7.23E-06	9.05E-05	5.97E-05
Fe	4.54E-05	1.17E-04	5.95E-06	1.83E-05	< 1.48E-05	< 1.26E-05
Gd	< 1.18E-04	< 1.28E-04	< 1.64E-05	< 1.59E-05	< 1.74E-04	< 1.47E-04
K	< 4.73E-03	7.05E-03	--	--	< 6.96E-03	< 5.89E-03
La	< 3.63E-05	< 3.94E-05	< 4.95E-06	< 4.82E-06	< 5.34E-05	< 4.52E-05
Li	< 2.17E-04	< 2.35E-04	< 3.02E-05	< 2.94E-05	< 3.19E-04	< 2.70E-04
Mg	< 2.67E-05	< 2.90E-05	< 3.96E-06	< 3.86E-06	< 3.93E-05	< 3.33E-05
Mn	< 4.03E-06	< 4.37E-06	< 4.95E-07	< 4.82E-07	< 5.93E-06	< 5.02E-06
Mo	< 2.67E-04	< 2.90E-04	< 3.77E-05	< 3.67E-05	< 3.93E-04	< 3.33E-04
Na	8.22E-02	1.10E-01	4.88E-02	9.50E-02	6.81E-01	1.35E-01
Ni	< 6.81E-05	< 7.38E-05	< 9.41E-06	< 9.16E-06	< 1.00E-04	< 8.48E-05
P	< 3.48E-04	< 3.77E-04	< 4.91E-05	1.75E-04	1.22E-03	< 4.33E-04
Pb	< 1.61E-04	< 1.74E-04	< 2.28E-05	< 2.22E-05	< 2.37E-04	< 2.00E-04
S	4.25E-03	4.72E-03	1.93E-03	3.50E-03	3.22E-02	9.29E-03
Sb	< 1.91E-03	< 2.07E-03	< 2.68E-04	< 2.60E-04	< 2.80E-03	< 2.37E-03
Si	5.24E-04	3.63E-04	2.15E-04	1.83E-04	4.45E-04	4.02E-04
Sn	< 2.27E-04	< 2.46E-04	3.22E-05	< 3.09E-05	< 3.34E-04	< 2.83E-04
Sr	< 3.83E-05	< 4.15E-05	7.43E-06	< 5.30E-06	< 5.64E-05	< 4.77E-05
Ti	< 3.88E-05	< 4.21E-05	< 5.45E-06	< 5.30E-06	< 5.71E-05	< 4.84E-05
Zn	< 1.61E-05	< 1.75E-05	< 2.48E-06	< 2.41E-06	< 2.37E-05	< 2.01E-05
Zr	< 1.15E-04	< 1.25E-04	< 1.64E-05	< 1.59E-05	< 1.69E-04	< 1.43E-04

Table 21: ICP-ES results for the acid dissolution of solid residue from the flush water tests (g/100g saltcake)

Sample:	F1	F3+F4	G1+G2
Ag	< 9.52E-06	1.26E-05	< 1.15E-05
Al	7.39E-05	2.64E-04	4.19E-03
B	< 3.33E-05	< 1.71E-05	< 4.03E-05
Ba	3.05E-05	5.13E-05	3.86E-05
Ca	4.10E-04	1.36E-03	1.09E-03
Cd	1.62E-05	7.45E-05	< 6.05E-06
Ce	< 3.21E-05	< 1.65E-05	< 3.89E-05
Cr	2.85E-04	5.06E-04	1.90E-03
Cu	1.07E-04	2.09E-04	6.32E-05
Fe	1.85E-02	4.48E-02	6.32E-03
Gd	< 2.79E-05	< 1.82E-05	< 3.37E-05
K	1.12E-03	5.73E-04	1.35E-03
La	< 8.57E-06	< 4.40E-06	< 1.04E-05
Li	< 5.12E-05	< 2.63E-05	< 6.19E-05
Mg	7.51E-05	1.23E-04	1.39E-04
Mn	2.21E-04	4.01E-04	1.35E-04
Mo	8.95E-05	1.56E-04	< 7.63E-05
Na	8.91E-04	2.12E-03	1.03E-02
Ni	3.80E-04	8.67E-04	4.74E-05
P	3.15E-04	5.89E-04	1.80E-04
Pb	< 3.80E-05	2.66E-05	< 4.59E-05
S	< 1.63E-04	2.67E-04	4.82E-04
Sb	< 4.50E-04	< 2.31E-04	< 5.44E-04
Si ^(a)	2.08E-04	5.18E-04	6.91E-04
Sn	< 5.36E-05	< 2.75E-05	< 6.48E-05
Sr	8.13E-05	2.93E-04	2.38E-04
Ti	< 9.17E-06	1.33E-05	< 1.11E-05
Zn	1.87E-04	4.46E-04	1.56E-04
Zr	< 2.71E-05	2.20E-05	< 3.28E-05

Notes: (a) Acid dissolution may not have dissolved all the silicon in these water-insoluble materials

Table 22: Estimated composition of a 6M Na⁺ solution resulting from the dissolution of Tank 41H saltcake, based on the ICP-ES results for the first contact with flush water (mg/L)

Sample:	F1	F2	F3	F4	G1	G2
Ag	< 2.93E+00	< 2.41E+00	< 2.50E+00	< 2.09E+00	< 4.70E+00	< 4.25E+00
Al	1.56E+02	1.51E+02	1.54E+02	1.81E+02	2.93E+02	2.87E+02
B	< 1.02E+01	< 8.42E+00	< 8.74E+00	< 7.30E+00	< 1.64E+01	< 1.49E+01
Ba	< 6.95E+00	< 5.71E+00	< 5.93E+00	< 4.96E+00	< 1.12E+01	< 1.01E+01
Ca	2.86E+01	8.27E+00	< 7.18E+00	< 6.00E+00	< 1.35E+01	< 1.22E+01
Cd	< 1.54E+00	< 1.26E+00	< 1.31E+00	< 1.10E+00	< 2.47E+00	< 2.23E+00
Ce	< 9.88E+00	1.03E+01	8.65E+00	2.14E+01	4.62E+01	< 1.43E+01
Cr	7.72E+00	6.82E+00	7.06E+00	8.32E+00	2.83E+01	2.97E+01
Cu	4.43E+00	3.10E+00	3.31E+00	3.13E+00	7.46E+00	6.26E+00
Fe	5.71E+00	9.65E+00	< 6.24E-01	< 5.22E-01	2.00E+00	< 1.06E+00
Gd	< 8.57E+00	< 7.04E+00	< 7.31E+00	< 6.10E+00	< 1.37E+01	< 1.24E+01
K	< 3.43E+02	< 2.82E+02	< 2.93E+02	< 2.45E+02	< 5.51E+02	< 4.98E+02
La	< 2.64E+00	< 2.16E+00	< 2.25E+00	< 1.88E+00	< 4.23E+00	< 3.82E+00
Li	< 1.57E+01	< 1.29E+01	< 1.34E+01	< 1.12E+01	< 2.53E+01	< 2.28E+01
Mg	< 1.94E+00	< 1.59E+00	< 1.65E+00	< 1.38E+00	< 3.11E+00	< 2.81E+00
Mn	< 2.93E-01	< 2.41E-01	< 2.50E-01	< 2.09E-01	< 4.70E-01	< 4.25E-01
Mo	3.70E+01	< 1.59E+01	< 1.65E+01	< 1.38E+01	< 3.11E+01	< 2.81E+01
Na	1.38E+05	1.38E+05	1.38E+05	1.38E+05	1.38E+05	1.38E+05
Ni	< 4.94E+00	< 4.06E+00	< 4.21E+00	< 3.52E+00	< 7.93E+00	< 7.17E+00
P	2.02E+02	1.83E+02	1.38E+02	1.85E+02	1.14E+02	2.00E+02
Pb	< 1.17E+01	< 9.59E+00	< 9.96E+00	< 8.32E+00	< 1.87E+01	< 1.69E+01
S	4.32E+03	4.27E+03	5.12E+03	4.70E+03	6.87E+03	8.01E+03
Sb	< 1.38E+02	< 1.14E+02	< 1.18E+02	< 9.86E+01	< 2.22E+02	< 2.01E+02
Si	1.18E+01	1.03E+01	1.50E+01	1.14E+01	1.80E+01	2.05E+01
Sn	< 1.65E+01	< 1.35E+01	< 1.40E+01	< 1.17E+01	< 2.64E+01	< 2.39E+01
Sr	3.22E+00	< 2.28E+00	< 2.37E+00	< 1.98E+00	< 4.46E+00	< 4.03E+00
Ti	< 2.82E+00	< 2.32E+00	< 2.40E+00	< 2.01E+00	< 4.52E+00	< 4.09E+00
Zn	< 1.17E+00	< 9.62E-01	1.53E+00	2.84E+00	< 1.88E+00	< 1.70E+00
Zr	< 8.35E+00	< 6.85E+00	< 7.12E+00	< 5.95E+00	< 1.34E+01	< 1.21E+01
g salt / L 6M Na ⁺ sol.	541	564	537	537	547	533
gal 6M Na ⁺ sol. / gal salt	3.53	3.39	3.56	3.56	3.49	3.58

Table 23: IC Anions, Total Inorganic Carbon, and Wet Chemistry results for Tank 41H saltcake dissolution during the first contact with flush water (g/100g saltcake)

Sample:	F1	F2	F3	F4	G1	G2
NO ₃ ⁻	5.97E+01	6.09E+01	5.43E+01	5.52E+01	5.46E+01	5.71E+01
NO ₂ ⁻	1.78E-01	1.88E-01	2.21E-01	2.24E-01	2.88E-01	3.32E-01
SO ₄ ²⁻	2.28E+00	2.19E+00	2.42E+00	2.51E+00	3.45E+00	4.41E+00
PO ₄ ³⁻	6.90E-02	4.69E-02	1.63E-01	1.56E-01	5.77E-02	4.58E-02
Cl ⁻	< 1.97E-02	< 1.17E-02	< 1.30E-01	< 1.04E-01	< 1.44E-02	< 2.29E-02
F ⁻	< 1.97E-02	7.62E-02	7.16E-02	7.28E-02	7.93E-02	8.02E-02
C ₂ O ₄ ²⁻	1.38E-01	1.29E-01	1.30E-01	1.46E-01	1.30E-01	< 1.15E-02
CHO ₂ ⁻	< 9.86E-02	4.10E-02	< 6.51E-02	< 5.20E-02	7.21E-02	8.02E-02
CO ₃ ²⁻	2.00E+00	1.68E+00	3.65E+00	3.20E+00	5.05E+00	7.33E+00
Free OH ⁻	5.63E-01	3.63E-01	< 2.21E+00	< 1.77E+00	< 2.45E+00	< 3.90E+00

Table 24: IC Anions, Total Inorganic Carbon, and Wet Chemistry results for Tank 41H saltcake dissolution during the second contact with flush water (g/100g saltcake)

Sample:	F1	F2	F3	F4	G1	G2
NO ₃ ⁻	1.98E-01	2.67E-01	9.58E-02	1.76E-01	1.68E+00	3.12E-01
NO ₂ ⁻	< 5.62E-03	5.82E-04	3.59E-04	5.08E-04	1.01E-02	2.07E-03
SO ₄ ²⁻	6.75E-03	1.05E-02	5.12E-03	7.62E-03	1.04E-01	2.41E-02
PO ₄ ³⁻	< 5.62E-03	< 5.82E-04	< 5.12E-04	< 5.08E-04	5.87E-03	< 6.90E-04
Cl ⁻	< 1.12E-03	< 1.16E-04	< 1.02E-04	< 1.02E-04	< 1.68E-03	< 1.38E-04
F ⁻	< 1.12E-03	2.33E-04	2.56E-04	2.03E-04	2.52E-03	4.14E-04
C ₂ O ₄ ²⁻	< 5.62E-03	5.82E-04	2.56E-04	4.57E-04	4.19E-03	1.38E-03
CHO ₂ ⁻	< 5.62E-03	< 5.82E-04	< 5.12E-04	< 5.08E-04	2.52E-03	4.83E-04
CO ₃ ²⁻	2.64E-02	3.40E-02	3.23E-02	3.89E-02	2.25E-01	1.12E-01
Free OH ⁻	< 1.91E-02	< 1.98E-01	< 1.74E-01	< 1.73E-01	< 2.85E-02	< 2.34E-01

Table 25: Rad. Chem. results for Tank 41H saltcake dissolution with flush water

First Dissolution (pCi/g saltcake)						
Sample:	F1	F2	F3	F4	G1	G2
⁹⁰ Sr	1.02E+05	4.95E+04	3.51E+04	7.64E+04	1.39E+04	1.30E+04
¹³⁷ Cs	2.27E+07	2.29E+07	2.59E+07	2.67E+07	3.94E+07	4.64E+07
²³⁸ Pu	1.10E+06	9.92E+05	2.02E+05	1.73E+05	2.42E+05	9.95E+04
^{239/240} Pu	< 8.17E+01	6.01E+03	< 2.39E+03	< 1.75E+03	< 3.40E+02	< 3.87E+02
²⁴¹ Pu	7.93E+04	< 5.48E+04	2.37E+04	3.46E+04	2.29E+04	1.39E+04

Second Dissolution (pCi/g saltcake)						
Sample:	F1	F2	F3	F4	G1	G2
⁹⁰ Sr	3.32E+03	3.40E+03	3.53E+03	7.34E+03	1.62E+03	5.43E+02
¹³⁷ Cs	7.43E+04	1.06E+05	3.72E+04	1.00E+05	1.07E+06	2.58E+05
²³⁸ Pu	4.09E+04	5.71E+04	2.90E+03	9.28E+03	8.99E+03	4.98E+03
^{239/240} Pu	< 9.54E+00	5.07E+02	< 5.07E+01	< 9.12E+01	< 2.76E+01	< 6.62E+00
²⁴¹ Pu	3.57E+03	1.58E+04	3.44E+02	7.91E+02	1.89E+03	1.49E+03

Residual Solids (pCi/g saltcake)			
Sample:	F1	F3+F4	G1+G2
⁹⁰ Sr	3.35E+04	1.45E+05	1.13E+04
¹³⁷ Cs	1.32E+05	1.38E+05	1.39E+05
²³⁸ Pu	3.36E+05	6.57E+05	3.37E+05
^{239/240} Pu	2.71E+03	5.67E+03	2.16E+03
²⁴¹ Pu	2.71E+04	1.16E+05	1.82E+04

Table 26: Actinide results by ICP-MS for Tank 41H saltcake dissolution with flush water

First Dissolution (g/100g saltcake)						
	F1	F2	F3	F4	G1	G2
Mass 232 (Th,U)	3.35E-05	1.42E-05	9.7E-06	< 4.3E-06	1.11E-05	6.9E-06
Mass 233 (U)	< 3.3E-06	< 2.6E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 234 (U)	< 3.3E-06	< 2.6E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 235 (U)	5.6E-06	5.1E-06	4.1E-06	6.9E-06	8.8E-06	7.2E-06
Mass 236 (U)	< 3.3E-06	< 2.6E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 237 (Np)	6.9E-06	5.7E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 238 (U,Pu)	3.07E-04	3.05E-04	4.32E-04	8.37E-04	1.26E-04	1.21E-04
Mass 239 (Pu)	< 3.3E-06	8.06E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 240 (Pu)	< 3.3E-06	< 2.6E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 241 (Pu,Am)	< 3.3E-06	< 2.6E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06
Mass 242 (Pu)	< 3.3E-06	< 2.6E-06	< 4.1E-06	< 4.3E-06	< 5.3E-06	< 4.9E-06

Second Dissolution (g/100g saltcake)						
	F1	F2	F3	F4	G1	G2
Mass 232 (Th,U)	3.92E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 233 (U)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 234 (U)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 235 (U)	3.08E-07	3.66E-07	--	--	6.52E-07	3.78E-07
Mass 236 (U)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 237 (Np)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 238 (U,Pu)	2.94E-05	3.36E-05	--	--	1.31E-05	9.67E-06
Mass 239 (Pu)	< 2.5E-07	2.72E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 240 (Pu)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 241 (Pu,Am)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07
Mass 242 (Pu)	< 2.5E-07	< 2.7E-07	--	--	< 3.6E-07	< 3.1E-07

Residual Solids (g/100g saltcake)			
Sample:	F1	F3+F4	G1+G2
Each Mass 230-231	< 1.6E-07	< 8.0E-08	< 1.9E-07
Mass 232 (Th,U)	3.66E-07	6.60E-07	2.04E-07
Mass 233 (U)	< 1.6E-07	9.53E-08	6.02E-07
Mass 234 (U)	8.17E-07	1.19E-06	6.99E-06
Mass 235 (U)	3.87E-06	7.21E-06	1.72E-05
Mass 236 (U)	1.64E-06	3.64E-06	6.42E-06
Mass 237 (Np)	9.63E-07	2.18E-06	6.59E-06
Mass 238 (U,Pu)	4.02E-04	9.50E-04	1.97E-04
Mass 239 (Pu)	1.23E-06	4.03E-06	1.45E-06
Mass 240 (Pu)	4.54E-07	1.58E-06	3.70E-07
Mass 241 (Pu,Am)	2.19E-07	4.53E-07	< 1.9E-07
Mass 242 (Pu)	< 1.6E-07	2.98E-07	< 1.9E-07
Each Mass 243-247	< 1.6E-07	< 8.0E-08	< 1.9E-07

Note: Masses between 230 and 247 that are not listed are below that sample's detection limit

Table 27: Fission product results by ICP-MS for Tank 41H saltcake dissolution with flush water (g/100g saltcake).

	First Dissolution						Second Dissolution						Residual Solids		
	F1	F2	F3	F4	G1	G2	F1	F2	F3	F4	G1	G2	F1	F3+F4	G1+G2
Mass 85 (Rb)	1.04E-05	1.08E-05	1.00E-05	1.30E-05	1.69E-05	2.01E-05	1.52E-07	1.42E-07	--	--	6.36E-07	2.50E-07	1.48E-08	< 5.6E-08	< 1.3E-07
Mass 86 (Sr)	1.14E-06	5.95E-07	< 3.1E-06	< 5.2E-07	< 1.2E-06	< 1.1E-06	< 5.4E-08	< 5.9E-08	--	--	< 8.0E-08	< 6.8E-08	1.07E-07	2.72E-07	< 1.6E-07
Mass 87 (Rb,Sr)	1.98E-05	1.89E-05	1.96E-05	2.00E-05	3.15E-05	3.84E-05	1.34E-07	1.50E-07	--	--	9.12E-07	2.61E-07	8.41E-08	1.87E-07	2.01E-07
Mass 88 (Sr)	8.22E-06	4.94E-06	< 1.3E-05	1.49E-06	< 4.7E-06	< 4.3E-06	3.11E-07	4.40E-07	--	--	< 3.2E-07	< 2.7E-07	1.04E-06	2.65E-06	2.17E-06
Mass 89 (Y)	< 1.3E-06	< 1.0E-06	< 5.6E-06	< 9.3E-07	< 2.1E-06	< 1.9E-06	< 9.7E-08	1.08E-07	--	--	< 1.4E-07	< 1.2E-07	6.35E-07	6.83E-07	8.04E-07
Mass 90 (Sr,Zr)	5.03E-06	4.43E-06	1.18E-05	4.60E-06	6.43E-06	4.84E-06	2.28E-07	4.99E-07	--	--	2.67E-07	2.12E-07	2.42E-06	5.68E-06	2.29E-06
Mass 91 (Zr)	1.95E-06	1.82E-06	5.79E-06	2.24E-06	2.26E-06	1.44E-06	7.05E-08	4.36E-07	--	--	9.82E-08	6.01E-08	1.16E-06	3.60E-06	1.79E-06
Mass 92 (Mo,Zr)	2.88E-05	2.49E-05	< 6.0E-06	1.81E-05	1.44E-05	1.50E-05	2.13E-07	6.77E-07	--	--	4.60E-07	1.75E-07	8.81E-06	1.90E-05	2.99E-06
Mass 93 (Nb,Zr)	3.43E-06	4.20E-06	6.49E-06	2.48E-06	1.53E-06	< 8.4E-07	1.99E-07	7.97E-07	--	--	6.32E-08	6.43E-08	6.06E-06	1.03E-05	2.11E-06
Mass 94 (Mo,Zr)	1.81E-05	1.56E-05	< 1.1E-06	1.27E-05	1.01E-05	9.75E-06	1.71E-07	6.68E-07	--	--	3.56E-07	1.45E-07	6.32E-06	1.41E-05	2.85E-06
Mass 95 (Mo)	7.23E-05	6.75E-05	5.03E-05	7.17E-05	8.95E-05	1.05E-04	3.10E-07	1.43E-06	--	--	2.49E-06	6.46E-07	8.05E-06	1.63E-05	8.79E-07
Mass 96 (Mo, Ru)	2.94E-05	2.69E-05	< 4.2E-06	1.85E-05	1.46E-05	1.66E-05	2.11E-07	7.68E-07	--	--	3.83E-07	1.23E-07	9.17E-06	2.05E-05	2.66E-06
Mass 97 (Mo)	5.59E-05	5.38E-05	4.33E-05	6.14E-05	7.65E-05	8.99E-05	2.51E-07	1.32E-06	--	--	2.14E-06	5.57E-07	5.02E-06	1.02E-05	6.42E-07
Mass 98 (Mo,Ru)	8.14E-05	7.70E-05	< 4.8E-06	7.84E-05	9.06E-05	1.09E-04	3.71E-07	1.61E-06	--	--	2.56E-06	6.60E-07	1.20E-05	2.40E-05	< 2.4E-07
Mass 99 (Tc,Ru)	4.29E-05	4.04E-05	4.22E-05	4.48E-05	7.61E-05	8.45E-05	2.18E-07	2.64E-07	--	--	2.46E-06	5.13E-07	1.16E-06	1.37E-06	1.64E-06
Mass 100 (Mo,Ru)	5.78E-05	5.68E-05	4.80E-05	6.65E-05	8.11E-05	9.66E-05	2.36E-07	1.51E-06	--	--	2.25E-06	6.25E-07	4.93E-06	1.02E-05	6.33E-07
Mass 101 (Ru)	3.75E-06	3.51E-06	< 3.5E-06	4.13E-06	5.65E-06	5.42E-06	< 6.1E-08	< 6.6E-08	--	--	2.97E-07	4.92E-07	1.42E-07	4.26E-07	< 1.1E-07
Mass 102 (Ru,Pd)	3.22E-06	3.16E-06	< 2.8E-06	3.88E-06	4.62E-06	5.10E-06	< 4.8E-08	< 5.2E-08	--	--	2.71E-07	4.32E-07	1.38E-07	4.94E-07	2.51E-07
Mass 103 (Rh)	1.06E-05	1.13E-05	1.21E-05	1.11E-05	1.77E-05	1.87E-05	1.99E-07	3.30E-07	--	--	5.50E-07	1.78E-07	3.07E-06	4.20E-06	6.67E-06
Mass 104 (Ru,Pd)	1.61E-06	1.68E-06	< 5.7E-06	2.73E-06	2.45E-06	2.80E-06	< 9.9E-08	< 1.1E-07	--	--	< 1.5E-07	2.06E-07	2.27E-07	5.67E-07	< 2.8E-07
Mass 105 (Pd)	1.61E-06	1.42E-06	< 2.1E-06	2.57E-06	1.53E-06	1.77E-06	4.45E-08	8.53E-08	--	--	7.51E-08	< 4.5E-08	4.62E-07	1.06E-06	< 1.0E-07
Mass 106 (Pd,Cd)	1.77E-06	1.72E-06	< 2.2E-06	2.02E-06	1.64E-06	1.86E-06	7.12E-08	1.16E-07	--	--	7.62E-08	< 4.8E-08	6.74E-07	1.69E-06	< 1.1E-07
Mass 107 (Ag,Pd)	4.85E-06	5.12E-06	< 1.1E-05	2.21E-06	< 3.9E-06	< 3.6E-06	2.99E-07	4.76E-07	--	--	< 2.7E-07	< 2.3E-07	5.05E-06	8.78E-06	1.08E-06
Mass 108 (Pd,Cd)	2.86E-06	1.95E-06	< 4.7E-06	1.38E-06	< 1.7E-06	< 1.6E-06	< 8.1E-08	< 8.8E-08	--	--	< 1.2E-07	< 1.0E-07	2.85E-07	8.85E-07	< 2.3E-07
Mass 109 (Ag)	3.86E-06	4.14E-06	< 3.4E-06	1.02E-06	1.33E-06	< 1.2E-06	2.68E-07	5.04E-07	--	--	1.10E-07	< 7.4E-08	4.58E-06	8.19E-06	9.60E-07
Mass 110 (Pd,Cd)	< 2.8E-06	< 2.2E-06	< 1.2E-05	< 2.0E-06	< 4.5E-06	< 4.1E-06	< 2.1E-07	< 2.3E-07	--	--	< 3.1E-07	< 2.6E-07	2.88E-06	9.75E-06	1.53E-06
Mass 111 (Cd)	< 1.8E-06	< 1.4E-06	< 7.6E-06	< 1.3E-06	< 2.8E-06	< 2.6E-06	< 1.3E-07	1.52E-07	--	--	< 1.9E-07	< 1.6E-07	2.77E-06	9.73E-06	1.56E-06
Mass 112 (Sn,Cd)	3.09E-06	2.46E-06	< 4.5E-06	1.89E-06	< 1.7E-06	1.70E-06	1.10E-07	2.90E-07	--	--	< 1.2E-07	< 9.8E-08	4.92E-06	1.72E-05	2.88E-06
Mass 133 (Cs)	6.24E-05	5.69E-05	6.17E-05	6.25E-05	9.53E-05	1.14E-04	1.93E-07	2.64E-07	--	--	2.76E-06	6.36E-07	3.77E-07	2.95E-07	2.99E-07
Mass 134 (Ba)	< 3.4E-06	< 2.7E-06	< 1.4E-05	< 2.4E-06	< 5.4E-06	< 5.0E-06	< 2.5E-07	< 2.7E-07	--	--	< 3.7E-07	< 3.1E-07	4.04E-07	9.33E-07	4.37E-07
Mass 135 (Ba,Cs)	9.14E-06	8.99E-06	9.65E-06	9.64E-06	1.58E-05	1.83E-05	< 5.4E-08	8.88E-08	--	--	4.05E-07	1.28E-07	8.08E-07	1.92E-06	8.66E-07
Mass 136 (Ba)	< 2.5E-06	< 1.9E-06	< 1.1E-05	< 1.8E-06	< 3.9E-06	< 3.6E-06	< 1.8E-07	< 2.0E-07	--	--	< 2.7E-07	< 2.3E-07	8.80E-07	2.15E-06	9.10E-07
Mass 137 (Cs,Ba)	7.11E-05	6.24E-05	3.36E-05	3.31E-05	6.31E-05	6.08E-05	2.34E-06	2.72E-06	--	--	1.85E-06	8.11E-07	3.01E-05	2.60E-05	3.68E-05
Mass 138 (Ba)	7.03E-06	6.30E-06	< 4.6E-06	3.20E-06	5.91E-06	5.58E-06	2.91E-07	5.58E-07	--	--	2.86E-07	3.63E-07	8.32E-06	2.07E-05	8.94E-06
Mass 139 (La)	< 8.1E-07	< 6.3E-07	< 3.5E-06	2.88E-07	< 1.3E-06	< 1.2E-06	< 6.0E-08	6.86E-08	--	--	< 8.8E-08	< 7.5E-08	4.35E-07	7.42E-07	4.84E-07
Mass 140 (Ce)	1.60E-06	1.12E-06	< 9.4E-07	4.53E-07	4.03E-07	< 3.2E-07	7.69E-08	1.09E-07	--	--	2.77E-08	< 2.0E-08	1.28E-06	1.77E-06	8.67E-07
Mass 141 (Pr)	2.50E-07	2.24E-07	< 1.5E-07	< 2.5E-08	2.25E-07	9.02E-08	1.64E-08	2.33E-08	--	--	9.27E-09	1.41E-08	2.64E-07	5.27E-07	2.52E-07
Mass 142 (Ce,Nd)	4.06E-07	3.10E-07	< 1.3E-06	2.24E-07	< 5.0E-07	< 4.6E-07	< 2.3E-08	3.20E-08	--	--	< 3.4E-08	< 2.9E-08	4.17E-07	7.10E-07	3.57E-07
Mass 182 (W)	6.56E-06	5.63E-06	5.05E-06	4.00E-06	2.25E-06	2.78E-06	< 5.3E-08	< 5.8E-08	--	--	< 7.8E-08	< 6.6E-08	3.25E-07	4.22E-07	< 1.5E-07
Mass 183 (W)	3.79E-06	2.95E-06	< 1.7E-06	2.16E-06	1.12E-06	1.18E-06	< 2.9E-08	< 3.2E-08	--	--	4.39E-08	< 3.6E-08	1.72E-07	1.76E-07	< 8.3E-08
Mass 184 (W)	7.87E-06	6.66E-06	5.07E-06	4.58E-06	2.41E-06	2.97E-06	4.59E-08	5.66E-08	--	--	7.75E-08	3.00E-08	3.75E-07	4.55E-07	1.84E-07
Mass 185	< 6.5E-07	< 5.1E-07	< 2.8E-06	< 4.6E-07	< 1.0E-06	< 9.5E-07	< 4.8E-08	< 5.2E-08	--	--	< 7.1E-08	< 6.0E-08	< 1.1E-08	< 5.8E-08	< 1.4E-07
Mass 186 (W)	7.33E-06	6.40E-06	< 4.7E-06	4.51E-06	2.31E-06	2.75E-06	< 8.2E-08	< 8.9E-08	--	--	< 1.2E-07	< 1.0E-07	3.69E-07	4.61E-07	< 2.4E-07
Mass 196 (Hg,Pt)	1.99E-07	1.80E-07	< 6.7E-07	< 1.1E-07	3.64E-07	< 2.3E-07	< 1.2E-08	< 1.3E-08	--	--	< 1.7E-08	< 1.5E-08	< 2.8E-09	< 1.4E-08	< 3.3E-08
Mass 197	< 3.7E-07	< 2.9E-07	< 1.6E-06	< 2.6E-07	< 5.9E-07	< 5.4E-07	< 2.7E-08	< 3.0E-08	--	--	< 4.0E-08	< 3.4E-08	< 6.5E-09	< 3.3E-08	< 7.8E-08
Mass 198 (Hg)	2.81E-06	3.13E-06	< 2.3E-06	2.46E-06	4.81E-06	4.37E-06	1.23E-07	9.51E-08	--	--	2.51E-07	9.97E-08	2.74E-07	6.39E-07	4.25E-07
Mass 199 (Hg)	4.73E-06	5.23E-06	< 9.0E-06	4.10E-06	8.06E-06	8.08E-06	2.38E-07	1.98E-07	--	--	3.45E-07	< 1.9E-07	4.44E-07	1.04E-06	7.48E-07
Mass 200 (Hg)	5.45E-06	7.43E-06	< 8.4E-06	5.60E-06	1.02E-05	9.93E-06	2.79E-07	2.29E-07	--	--	4.82E-07	< 1.8E-07	6.20E-07	1.43E-06	1.04E-06
Mass 201 (Hg)	3.29E-06	3.67E-06	< 1.3E-05	3.01E-06	5.81E-06	5.52E-06	< 2.2E-07	< 2.4E-07	--	--	< 3.2E-07	< 2.7E-07	3.76E-07	8.00E-07	5.93E-07
Mass 202 (Hg)	7.40E-06	8.47E-06	5.10E-06	7.48E-06	1.38E-05	1.32E-05	3.61E-07	3.03E-07	--	--	6.67E-07	< 2.8E-07	8.20E-07	1.82E-06	1.35E-06
Mass 203	< 3.0E-07	< 2.4E-07	< 1.3E-06	< 2.2E-07	< 4.8E-07	< 4.5E-07	< 2.3E-08	< 2.5E-08	--	--	< 3.3E-08	< 2.8E-08	< 5.3E-09	< 2.7E-08	< 6.5E-08
Mass 204 (Hg,Pb)	2.51E-06	2.98E-06	< 2.8E-06	2.48E-06	3.73E-06	3.37E-06	1.25E-07	1.19E-07	--	--	1.74E-07	6.32E-08	6.15E-07	1.25E-06	8.88E-07
Mass 205	< 3.5E-07	< 2.8E-07	< 1.5E-06	< 2.5E-07	< 5.6E-07	< 5.2E-07	< 2.6E-08	< 2.8E-08	--	--	< 3.8E-08	< 3.3E-08	< 6.2E-09	< 3.2E-08	< 7.5E-08
Mass 206 (Pb)	1.09E-05	9.61E-06	< 6.7E-06	3.81E-06	4.56E-06	< 2.3E-06	3.27E-07	4.61E-07	--	--	1.76E-07	3.47E-07	6.67E-06	1.35E-05	8.10E-06
Mass 207 (Pb)	1.03E-05	9.01E-06	< 4.9E-06	3.17E-06	4.26E-06	2.20E-06	3.26E-07	3.96E-07	--	--	1.74E-07	2.95E-07	5.95E-06	1.18E-05	7.00E-06
Mass 208 (Pb)	2.36E-05	2.00E-05	2.01E-05	7.23E-06	9.54E-06	4.97E-06	7.17E-07	9.74E-07	--	--	4.53E-07	7.25E-07	1.41E-05	2.74E-05	1.67E-05

Table 28: Metals contained in tank farm flush water used in dissolution tests.

ICP-ES (mg/L)	Metals in Flush Water	
	soluble	total
Ca	3.67	3.88
Cu	0.11	0.15
Fe	0.13	0.66
Mg	0.39	0.40
Mn	0.036	0.038
Si	5.11	5.21
Sr	0.01	0.01
S	4.22	4.27

Figure 14: Scanning electron micrographs of the insoluble solids resulting from the FW dissolution of saltcake from Location F, the lower 60% of sample T41H-B3-1. Secondary electron (right) and back-scattered electron (left) images, 50-times (top) and 500-times (bottom) magnification. Labeled points are the EDS analyses.

Figure 15: EDS of the insoluble solids resulting from the FW dissolution of saltcake from Location F, the lower 60% of sample T41H-B3-1.

Figure 16: XRD analysis of insoluble solids from Location F