Contract No:

This document was prepared in conjunction with work accomplished under Contract No. 89303321CEM000080 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

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Summary of Savannah River Site FY21 Salt Waste Qualification Data and Characterization Data from Salt Waste Batches Processed Since 2008

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August 2022

SRNL-STI-2022-00161, Revision 0

SRNL.DOE.GOV

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Printed in the United States of America

Prepared for
U.S. Department of Energy

Keywords: *SWPF, ISDP, ISWP, Salt Waste Processing Facility, Interim Salt Disposition Program, Integrated Salt Waste Processing*

Retention: *Permanent*

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Savannah River National Laboratory is operated by Battelle Savannah River Alliance for the U.S. Department of Energy under Contract No. 89303321CEM000080.

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EXECUTIVE SUMMARY

The Savannah River National Laboratory analyzed samples from Savannah River Site Waste Tank 41H and 21H to support qualification of Salt Waste Processing Facility Waste Batches 3 and 4 (the FY21 Salt Batch Qualification samples) for processing. Neither of the samples displayed any unusual or unexpected characteristics such as large amounts of solids, floating solids, or unusual color. Characterization of these samples confirmed similar chemical composition and characteristics to previous salt waste batches. These results were initially provided to Savannah River Remediation (Liquid Waste Operations Sub-contractor) as External Sample Results LIMS Reports. The analytical results (both expedited and routine) are now summarized and discussed in this technical report.

SWPF Salt Batches 3 and 4 were similar in chemical composition and contained 5.6 to 5.9 M Na^+, 0.20 to 0.24 M AlO_2^-, 2.3 to 2.4 M OH^-, 1.8 to 2.5 M NO_3^-, 0.4 to 0.6 M NO_2^-, 0.3 to 0.4 M CO_3^{2-}, 0.1 to 0.2 M SO_4^{2-} and other minor chemical components. Total mercury concentrations ranged from 30 to 65 mg/L (1.6E-04 to 3.5E-04 M) with Batch 4 containing the highest (>2x Batch 3) concentration. Cs-137 activities in the filtered samples ranged from 3.4E+08 dpm/mL (0.58 Ci/gal) for Batch 4 to 4.5E+08 dpm/mL (0.77 Ci/gal) for Batch 3 (34% higher for Batch 3). The total beta activity for filtered Batch 4 was 3.7E+08 dpm/mL (0.63 Ci/gal) and for filtered Batch 3 was 5.2E+08 dpm/mL (0.89 Ci/gal), which was only 10-16% higher, respectively, than the Cs-137 (primary beta emitter) activities for these samples. Ba-137m activities were calculated from the cesium data by multiplying the Cs-137 activities by 0.946 based on the fact that 94.6% of the Cs-137 decays to Ba-137m by beta decay and a secular equilibrium exists between these isotopes. The total gamma activities for the filtered samples (3.2E+08 dpm/mL or 0.55 Ci/gal for Batch 4 and 4.3E+08 dpm/mL or 0.73 Ci/gal for Batch 3) were similar to the calculated Ba-137m activities for each sample, since Ba-137m is the dominant gamma emitter in the samples. Slurry digestion and analysis revealed that sample filtration had little impact on the total gamma and beta activities for the samples indicating that these activities were primarily associated with soluble species.

Following cesium removal, the total beta activity range for the samples decreased dramatically (>2 orders of magnitude) to 1.9E+06 dpm/mL for filtered Batch 4 and 3.0E+06 dpm/mL for filtered Batch 3. The total alpha activity (following Cs removal) ranged from 4.7E+05 to 4.9E+05 dpm/mL for filtered and unfiltered Salt Batch 3 samples, respectively. The Pu-238 activity (1.2E+05 dpm/mL for both filtered and unfiltered samples) for Batch 3 was significantly lower than the total alpha (plutonium is a primary alpha emitter in tank waste). The as-received Batch 3 sample contained 5.5 times greater alpha activity than the as-received Batch 4 sample which contained 9.1E+04 dpm/mL total alpha. Batch 4 sample filtration resulted in a 74% reduction in alpha activity to 2.3E+04 dpm/mL. In contrast, the Pu-238 activity (7.3E+04 dpm/mL) for this sample was only reduced by 25% following filtration. Activities for radionuclides other than Cs-137 and Ba-137m in the samples were primarily associated with Sr-90/Y-90, Tc-99, Pu-238 and Pu-241.

Comparisons of the chemical and radionuclide compositions of Salt Waste Processing Facility Batches 1 and 2 to Batches 3 and 4 revealed that the four salt batches were similar. The total sodium concentrations of the salt batches have exhibited a consistent downward trend ranging from 6.5 M Na^+ for Batch 1 to 5.6 M Na^+ for Batch 4. The major anion concentrations and the radionuclide concentrations for the four batches were similar. The total mercury concentration was highest in SWPF Batch 1, where the mercury was 119 mg/L while the mercury concentrations in Batches 2 through 4 were below 65 mg/L. Cs-137 activities have averaged 3.8E+08 dpm/mL (0.65 Ci/gal) for the four SWPF salt batches. In general, the activities of the primary radionuclides of the salt batches processed through SWPF have been quite consistent.

In addition, historical waste characterization data from all salt batches previously processed through both the Interim Salt Waste Processing facility and the Salt Waste Processing Facility dating back to 2008 have

been summarized and compared in this report to facilitate future comparisons of or references to previous salt batch characteristics. Trends in the chemical concentrations and radionuclide activities were generally consistent for most species across the 14 salt qualification batches. The average density value of 1.28 g/mL is consistent with the average sodium concentration of 6.1 M. Hydroxide and nitrate were the dominant anions and the average concentration for each was 2.2 M. Maximum concentration values observed for sodium, hydroxide, and nitrate (major ions present) were 11, 24, and 46% higher than the average values. Minimum concentration values observed for sodium, hydroxide, and nitrate were 17, 73, and 34% below the average. The average concentrations of nitrite, carbonate, sulfate, and other minor anions were below 1.0 M. The average mercury concentration was 59 mg/L. The average gamma activity of 2.5E+08 dpm/mL (0.43 Ci/gal) correlates well to the average calculated Ba-137m activity (dominant gamma emitter). The average beta activity of 3.1E+08 dpm/mL (0.52 Ci/gal) is also similar to the average Cs-137 activity (dominant beta emitter). The average Cs-removed beta activity of 2.1E+06 dpm/mL is two orders of magnitude below the total beta and corresponds to the total activities from other beta emitters (with Sr-90 and Y-90 being significant contributors). The average (Cs-removed) alpha activity of 1.4E+05 dpm/mL is in the same range as the sum of the activities of the plutonium isotopes, which are the primary alpha contributors. Maximum gamma and beta activities were 102 and 97% higher than (~2x) the average values, respectively. Minimum gamma and beta activities were 40 and 14% of the average values, respectively. The maximum alpha activity was 3.4x larger than the average, while the minimum value was 16% of the average value. Variability in the radionuclide activities was significantly greater than variability in the chemical compositions.

Note: This report focuses on the characterization of the salt batch qualification sub-samples. Prior to processing for cesium removal, the qualification batches were transferred to process feed tanks which contained the heel from the previous salt batch. In addition, in some cases NaOH reagent was added to adjust the waste free hydroxide. These activities resulted in minor changes to the final waste compositions processed. The final compositions were estimated based on these blending and adjustment activities and the calculated compositions are provided in various Liquid Waste Operations Sub-contractor reports which are not summarized in this document.

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LIST OF ABBREVIATIONS

ARP	Actinide Removal Process
ISDP	Interim Salt Disposition Program
ISWP	Integrated Salt Waste Processing
LIMS	Laboratory Information Management Software
MST	Monosodium Titanate
MCU	Modular Caustic-Side Solvent Extraction Unit
RSD	Relative Standard Deviation
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Units
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation
SRMC	Savannah River Mission Completion
SWPF	Salt Waste Processing Facility
TTQAP	Task Technical and Quality Assurance Plan
TTR	Task Technical Request
VDS	Variable Depth Samples
WAC	Waste Acceptance Criteria

1.0 Introduction

Numerous aqueous radioactive dissolved salt waste batch sub-samples retrieved primarily from Savannah River Site (SRS) waste Tank 21H (except for Macrobatch 1 and 2 sub-samples which were retrieved directly from Tank 49H and the Macrobatch 3 sub-samples which were retrieved from Tanks 21H and 24H) have been transferred to Tank 49H and then treated for cesium and, in some cases, actinide and strontium removal since 2008. The decontaminated waste solutions have been transferred to SRS Tank 50H which serves as the feed tank for the Saltstone Disposal Facility (SDF). The first 10 salt batches (Macrobatches 1 through 10) were prepared and characterized to ensure that facility Waste Acceptance Criteria (WAC) were met and were subsequently processed through an Interim Salt Waste Processing (ISWP) system which included the Actinide Removal Process (ARP) and the Modular Caustic-Side Solvent Extraction Unit (MCU). The Integrated Salt Disposition Program (ISDP) was conducted to process waste through the ISWP. Some waste batches were not treated by the ARP since actinide removal by monosodium titanate (MST) media was not necessary. Four additional waste batches have been prepared for processing through the recently constructed Salt Waste Processing Facility (SWPF) since 2017, which involves a solvent extraction process focused on the removal of cesium. Characterization of the total 14 waste batches for qualification (primarily from Tank 21H) against ISDP and the SWPF Waste Acceptance Criteria has been conducted by the Savannah River National Laboratory (SRNL) and reported in numerous technical reports as well as External SWPF Sample Results LIMS (Laboratory Inventory Management System) Reports. The qualified batches from Tank 21H were subsequently transferred to Tank 49H where they were mixed with the Tank 49H heel from the previous salt batch processed. In some cases, concentrated caustic solution was also added to Tank 49H to increase the free hydroxide concentration. The concentrations and activities of the blended Tank 49H composite solutions which represented the final feed solutions for the ISDP were typically estimated by calculation and reported in Liquid Waste Operations Sub-contractor documents. This summary focuses on the SRNL characterization data used to qualify the batches rather than the calculated final Tank 49H blend compositions. SRS Tank 50H has served as both the receipt tank for ISDP and SWPF decontaminated waste as well as the feed tank for the SDF where the decontaminated dissolved salt solutions are immobilized in a grout waste form in large Saltstone Disposal Units (SDU) at the Savannah River Site. Separate reports provide the characterization data for the Cs-decontaminated salt solutions which should be very similar in composition to the feed solutions (except for cesium and in some cases actinides and strontium).

Characterization results for the fiscal year 2021 (FY21) salt batches prepared for processing through SWPF (Batches 3 and 4) were provided in LIMS sample results reports rather than formal technical reports. This report will provide, discuss, and record in an easier to reference format, the recent results for SWPF Batches 3 and 4 and will summarize the characterization data for all of the dissolved salt waste batches processed since 2008.

This report satisfies the requirement in the Task Technical and Quality Assurance Plan (TTQAP)[i] to provide annual technical reports of the compiled salt batch qualification data to Savannah River Remediation (SRR; current Liquid Waste Operations Sub-contractor Savannah River Mission Completion - SRMC). This is the first summary of salt characterization results covering all ISDP and SWPF salt qualification batches through 2021. Following this report, it is expected that future reports will be issued on a semi-annual basis summarizing salt batches characterized since the previous summary report. During the interim period between summary reports it is expected that analytical results will continue to be provided to the Liquid Waste Operations Sub-contractor through External SWPF Sample Results LIMS Reports.

Since one goal of this report was to provide a summary of the FY21 Salt Batch Qualification efforts, the Salt Batch 3 and 4 results were described separately and first in Section 3.0. Then the four SWPF salt qualification batches were compared in Section 4.0. The ten ISDP salt qualification batches were compared to each other in Section 5.0. In Section 6.0 the compositional statistics and trends for all 14 salt qualification batches were compared.

2.0 Experimental

2.1 Sample Receipt and Preparation

Samples were retrieved from SRS Tanks 41H and 21H for characterization of SWPF Salt Batches 3 and 4, respectively, and transferred to SRNL for characterization. The Batch 3 qualification sample was a composite of three tank farm samples with the following identification numbers: HTF-41-21-1, -2, and -3. The Batch 4 qualification sample was a composite of four tank farm samples with the following identification numbers: HTF-21-21-59, -60, -61, and -62.

The densities of filtered (0.45 µm filter) and unfiltered sub-samples of each batch were determined in duplicate, and the average result was reported. For the total mercury and methyl mercury measurements on SWPF Batches 3 and 4, approximately 1.5 mL sub-samples were diluted into 39 mL of ultrapure water in glass vials with Teflon caps with very little headspace, which follows the recommended method for preparing these types of samples. For weight percent insoluble solids measurements on SWPF Batches 3 and 4, approximately 300 mL of the well-mixed salt solution (weighed on an electronic balance) was transferred through a 0.2 µm porosity nylon filter to collect the insoluble solids. The solids and filter were washed with several ~50 mL portions of deionized water to remove the soluble salts. The solids were then dried to constant mass. In some cases, the weight percent insoluble solids levels were determined by turbidity. For other unfiltered samples, well-mixed solution was removed from the cells without dilution for analysis or was digested in acid in the shielded cells prior to analysis. For samples requiring filtration and containing visible settling solids, filtration was conducted using a 0.45 µm syringe filter and the filtrate was submitted for analysis, or the sample was allowed to settle, and the liquid was decanted for analysis.

Other analytical results compiled for comparison in this report which were initially provided in separate technical reports were prepared as described in the referenced reports. In general, most solutions contained few insoluble solids and analyses were conducted on either filtered or settled/decanted solutions if solids were visible or on unfiltered solution if no solids were apparent. For total mercury, strontium, and plutonium analyses, unfiltered and stirred slurries were submitted for digestion and analysis.

2.2 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in Manual E7 2.60. This is Safety Class work. SRNL documents the extent and type of review for Safety Class work using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2. The work performed, all analyses, and the review process for this report complies with those requirements. Results from this report and those reports for which results are compiled and summarized are not RW- 0333P (enhanced Quality Assurance requirements) as per the Technical Task Request (TTR).[ii] Design verification of this report was performed by document and spreadsheet review.

3.0 Characterization Results for the FY21 SWPF Salt Batches (3 and 4)

SRNL analyzed samples from Tanks 41H and 21H in FY21 to support qualification of SWPF Salt Waste Batches 3 and 4, respectively, for processing. Analytical results for these samples were initially provided to the Liquid Waste Operations Sub-contractor as External SWPF Sample Results LIMS Reports as Project Numbers LW-AD-PROJ-201203-4[iii] (Batch 3) and LW-AD-PROJ-210624-2[iv] (Batch 4). Both expedited and routine analysis results for each sample are provided in the referenced reports (A-1 and A-2 for Batch 3 and A-3 and A-4 for Batch 4) and included in the data summaries below.

As shown in Table 3-1, the sample densities for Salt Batches 3 and 4 were similar and ranged from 1.26 to 1.31 g/mL with little difference between filtered and unfiltered samples. The samples contained little or no insoluble solids. The sodium concentrations ranged from 5.6 to 5.9 M and aluminum ranged from 0.21 to 0.24 M. The hydroxide concentrations ranged from 2.3 to 2.4 M. The measured nitrate concentration for the Batch 3 sample of 2.5 M was 39% higher than was measured for the Batch 4 sample of 1.8 M. The nitrite (range: 0.49 to 0.56 M), carbonate (range: 0.30 to 0.39 M), and sulfate (range: 0.11 to 0.16 M) concentrations of the two batches were generally similar. Formate and fluoride concentrations (not shown in Table 3-1) were <0.01 M. The total anion and total cation molar equivalents (charge balance) calculated from the analytical results for the samples were in good agreement (10.4% excess anion for Batch 3 and 6.2% excess anion for Batch 4). Total mercury concentrations ranged from 33 to 65 mg/L (1.6E-04 to 3.2E-04 M) with Batch 4 containing the highest (>2x Batch 3) concentration.

The radionuclide activities measured for Salt Batches 3 and 4 are provided in Table 3-2 and Table 3-3. The Cs-137 activities for the filtered samples ranged from 3.4E+08 dpm/mL for the Batch 4 sample to 4.5E+08 dpm/mL for the Batch 3 sample (34% higher for Batch 3). The total gamma activities (primarily resulting from Ba-137m in the Cs-137 decay chain) were approximately 5% lower than the Cs-137 activities for each sample, as expected based on the fact that the Ba-137m activity is 94.6% of the Cs-137 activity due to secular equilibrium between these isotopes. Prior to cesium removal, the total beta activity for as-received Batch 4 was 3.9E+08 dpm/mL and for as-received Batch 3 was 5.8E+08 dpm/mL, which corresponds to only 18-32% higher, respectively, than the Cs-137 activities (Cs-137 dominates beta activity) for these samples. Sample filtration had little impact on the total gamma and beta activities for the samples indicating that these activities were primarily associated with soluble species.

Table 3-1. SWPF Salt Batches 3 and 4 Density and Composition.

SWPF Batch	**3**[a]	**4**[a]
	g/mL	
Density	1.31	1.26
	1.30[b]	1.26[b]
	Wt. % (mg/L)	
Insoluble Solids	<0.010% (<130)	0.009% (107)
Component	mg/L (M)	
Na^+	1.35E+05 (5.87)	1.29E+05 (5.61)
Al	5.53E+03 (0.205)	6.42E+03 (0.238)
K^+	715 (0.018)	470 (0.012)
Si	15.2 (0.0005)	<18.3 (<0.0007)
OH^-	3.96E+04 (2.33)	4.09E+04 (2.40)
NO_3^-	1.52E+05 (2.45)	1.14E+05 (1.84)
CO_3^{2-}	1.80E+04 (0.30)	2.32E+04 (0.39)
NO_2^-	2.59E+04 (0.563)	2.23E+04 (0.485)
SO_4^{2-}	1.53E+04 (0.159)	1.02E+04 (0.106)
PO_4^{3-}	621 (0.007)	299 (0.003)
$C_2O_4^{2-}$	425 (0.005)	297 (0.003)
Cl^-	168 (0.005)	191 (0.005)
Total Hg	32.6 (1.63E-04)[b]	64.6 (3.22E-04)[b]
Total Organic Carbon	157 (NA)[c]	210 (NA)[c]
Methyl Mercury	16.2 (7.51E-05)[b]	16.2 (7.51E-05)[b]

[a] filtered unless otherwise indicated
[b] unfiltered
[c] NA = not applicable

Following cesium removal, the total beta activity range for the samples decreaseddramatically to 3.2E+06 dpm/mL for both as-received Batches 3 and 4. (Note that the half-life for Ba-137m gamma decay is 2.6 minutes, so the barium activity decays away in the samples relatively quickly following Cs-137 removal.) The Cs-removed total alpha activity for Salt Batch 3 ranged from 4.7E+05 to 4.9E+05 dpm/mL for filtered and unfiltered samples, respectively. The as-received Batch 3 sample contained 5.5 times greater alpha activity than the as-received Batch 4 sample. Batch 4 sample filtration resulted in a 74% reduction in alpha activity (from 9.1E+04 to 2.3E+04 dpm/mL). (Note: See the comments below regarding inconsistencies between Pu-238 and total alpha data for the filtered Batch 4 sample.)

Activities for radionuclides other than Cs-137 and Ba-137m in the samples were primarily associated with Sr-90/Y-90, Tc-99, Pu-238 and Pu-241. Sr-90 and Y-90 are both beta emitters and are also in secular equilibrium with one another resulting in identical activities (100% conversion of Sr-90 to Y-90 during decay) for these radionuclides (range for unfiltered samples: 1.2E+06 dpm/mL for Batch 3 to 1.4E+06 dpm/mL for Batch 4). For the Batch 4 sample, filtration reduced the Sr-90/Y-90 activity by 39% indicating that a significant portion of the material was insoluble (not observed for Batch 3 sample). Tc-99 is also a significant beta emitter (range for as-received samples: 1.2E+05 dpm/mL for Batch 3 to 1.1E+05 dpm/mL for Batch 4). Pu-238 was the dominant measured alpha emitter and the activity of this radionuclide in the unfiltered Batch 4 sample (7.3E+04 dpm/mL) was only 20% lower than the total alpha result (9.1E+04 dpm/mL). In contrast, the Pu-238 activity for the filtered Batch 4 sample (5.8E+04 dpm/mL) was 2.5 times higher than the total alpha activity (2.3E+04 dpm/mL). However, total alpha measurements are intended to provide a gross estimate of the alpha activity while the Pu-238 method is more accurate. The filtered sample results also indicate that only 20% insoluble Pu-238 was present in the Batch 4 sample. The Pu- 238 results for the Batch 3 sample (1.2E+05 dpm/mL for both filtered and unfiltered samples, respectively) were significantly (~75%) lower than the total alpha results and indicated

Table 3-2. SWPF Salt Batches 3 and 4 Radionuclide Activities (units: dpm/mL).

SWPF Batch	3 (filtered)	3 (unfiltered)	4 (filtered)	4 (unfiltered)
Radionuclide	dpm/mL			
Cs-137	4.5E+08	---	3.4E+08	---
Ba-137m	4.3E+08	---	3.2E+08	---
Total Gamma	4.3E+08	4.3E+08	3.2E+08	3.1E+08
Beta Count	5.2E+08	5.8E+08	3.7E+08	3.9E+08
Total Beta (Cs-Removed)	3.0E+06	3.2E+06	1.9E+06	3.2E+06
Total Alpha (Cs-Removed)	4.7E+05	4.9E+05	<2.3E+04	<9.1E+04
Sr-90/Y-90	1.3E+06	1.2E+06	8.6E+05	1.4E+06
Tc-99	1.2E+05	---	1.1E+05	---
Pu-238	1.2E+05	1.2E+05	5.8E+04	7.3E+04
Pu-239	2002	2731	1490	2153
Pu-240	884	<5.5E+03	1234	1359
Pu-241	2.8E+04	---	1.7E+04	---
H-3	3863	---	8480	---
C-14	8836	---	2149	---
Sn-126	1523	---	1.1E+04	---
U-233	132	<4.5E+02	<214	<218
U-234	444	417	264	273
I-129	60	---	48	---
Np-237	12	---	<16	---

Table 3-3. SWPF Salt Batches 3 and 4 Radionuclide Activities (units: µCi/mL).

SWPF Batch	3 (filtered)	3 (unfiltered)	4 (filtered)	4 (unfiltered)
Radionuclide	µCi/mL			
Cs-137	2.0E+02	---	1.5E+02	---
Ba-137m	1.9E+02	---	1.4E+02	---
Total Gamma	1.9E+02	2.0E+02	1.4E+02	1.4E+02
Beta Count	2.4E+02	2.6E+02	1.7E+02	1.8E+02
Total Beta (Cs-Removed)	1.4E+00	1.5E+00	8.7E-01	1.4E+00
Total Alpha (Cs-Removed)	2.1E-01	2.2E-01	<1.0E-02	<4.1E-02
Sr-90/Y-90	5.9E-01	5.2E-01	3.9E-01	6.3E-01
Tc-99	5.6E-02	---	4.9E-02	---
Pu-238	5.3E-02	5.6E-02	2.6E-02	3.3E-02
Pu-239	9.0E-04	1.2E-03	6.7E-04	9.7E-04
Pu-240	4.0E-04	<2.5E-03	5.6E-04	6.1E-04
Pu-241	1.3E-02	---	7.7E-03	---
H-3	1.7E-03	---	3.8E-03	---
C-14	4.0E-03	---	9.7E-04	---
Sn-126	6.9E-04	---	5.1E-03	---
U-233	6.0E-05	<2.0E-4	<9.6E-5	<9.8E-05
U-234	2.0E-04	1.9E-4	1.2E-04	1.2E-04
I-129	2.7E-05	---	2.2E-05	---
Np-237	5.6E-06	---	<7.1E-6	---

that essentially all of this isotope was soluble. Based on the analyses conducted, the identities of the other alpha emitters contributing to the high total alpha results for the Batch 3 sample are unknown. Pu-241 activities for the filtered samples ranged from 3E+04 dpm/mL for Batch 3 to 2E+04 dpm/mL for Batch 4. Radionuclides observed in the SWPF Salt Batches at activity levels below 10 dpm/mL are not included in Table 3-2, but are provided in the individual reports in the references.[iii,iv]

4.0 Summary and Comparisons of all SWPF Dissolved Salt Batch (1-4) Compositions

Two additional Salt Batches have been processed through SWPF. SWPF Batch 1 was originally referred to as Macrobatch 11 and the characterization of this sample was provided in report SRNL-STI-2017- 00698.[v] Batch 1 was the first Tank 21H sample processed through SWPF. SWPF Batch 2 analysis results were reported in SRNL-STI-2019-00621, Rev. 1[vi] and SRNL-STI-2019-00661, Rev. 0[vii]. References for the SWPF Characterization reports are summarized in Table 4-1. The analytical results for Salt Batches 1 and 2 are summarized in Table 4-2, Table 4-3, and Table 4-4 Data trends for all of the SWPF salt batches (1-4) are provided in Figure 4-1 through Figure 4-6. *Note: Radionuclide data in tables throughout this report is provided in units of both dpm/mL and µCi/mL. In the discussion in the text and in the figures, dpm/mL is the unit utilized.*

As shown in Figure 4-1, little variation was observed in the measured densities for both filtered and unfiltered samples (range for all data: 1.26 to 1.31 g/mL) from SWPF Batches 1-4. Consistency in the density data between filtered and unfiltered SWPF samples was not surprising since few insoluble solids have been present in any samples (range of insoluble solids: 0.003 to 0.440 wt. %; Batch 3: <0.01 wt. %)

Table 4-1. Reports Utilized for SWPF Salt Batch Composition Data Summaries.

SWPF Batch	Qualification Tank	Reference
1	21H	SRNL-STI-2017-00698, Rev. 1
2		SRNL-STI-2019-00621, Rev. 1 and SRNL-STI-2019-00661, Rev. 0
3	41H	LW-AD-PROJ-201203-4*
4	21H	LW-AD-PROJ-201224-2*

* External SWPF Analytical Sample Results Reports (SRNL LIMS Reports)[iii,iv].

Table 4-2. SWPF Salt Batches 1 and 2 Density and Composition.

SWPF Batch	1[a]	2[a]
	g/mL	
Density	1.27	1.28
	---	1.31[b]
	Wt. %	
Insoluble Solids	0.440%	0.0030%
Component	mg/L (M)	
Na^+	1.49E+05 (6.48)	1.43E+05 (6.22)
Al	7.02E+03 (0.260)	6.92E+03 (0.256)
K^+	399 (0.010)	440 (0.011)
Si	21.6 (0.00077)	13.2 (0.00047)
OH^-	4.75E+04 (2.79)	4.48E+04 (2.63)
NO_3^-	1.02E+05 (1.65)	1.21E+05 (1.95)
CO_3^{2-}	1.95E+04 (0.325)	2.14E+04 (0.356)
NO_2^-	3.85E+04 (0.837)	3.36E+04 (0.730)
SO_4^{2-}	4.72E+03 (0.0491)	6.90E+03 (0.0718)
PO_4^{3-}	382 (0.0040)	365 (0.0038)
$C_2O_4^{2-}$	413 (0.0047)	361 (0.0041)
Cl^-	473 (0.0133)	319 (0.0090)
Total Hg	94.2 (4.70E-04)	---
Total Hg (unfiltered)	119 (5.93E-04)[b]	35.5 (1.77E-04)[b]
Total Organic Carbon	296 (NA)[c]	180 (NA)[c]
Methyl Mercury	68.0 (3.15E-04)	29.7 (1.48E-04)

[a] filtered unless otherwise indicated
[b] unfiltered
[c] NA = not applicable

as shown in Figure 4-2. Trends in the metal and anion concentrations for filtered samples are provided in Figure 4-3. Sodium concentrations ranged from 5.6 to 6.5 M with the sodium concentration decreasing with each SWPF batch processed. For all four SWPF Salt Batches, aluminum represented the second highest metal in solution with concentrations ranging from 0.21 to 0.26 M. Aluminum should primarily exist in caustic solution as the anionic species AlO_2^-. The hydroxide anion concentrations ranged from 2.3 to 2.8 M while the nitrate concentrations ranged from 1.6 to 2.5 M. OH^- and NO_3 were the dominant anionic species in the solutions. Nitrite concentrations in the four salt batches ranged from 0.48 to 0.84 M while carbonate concentrations ranged from 0.32 to 0.39 M. Sulfate concentrations ranged from 0.07 to

0.16 M. Other anions (phosphate, oxalate, chloride, fluoride, and formate) were below 0.02 M. Trends in the mercury (total and methyl mercury) concentrations for the SWPF batches are provided in Figure 4-4. The total mercury concentrations in the filtered samples ranged from 32 to 119 mg/L with the highest mercury concentration being observed for Batch 1. In general, the primary chemical compositions of Salt Batches processed through SWPF have been quite consistent.

Total gamma, total beta, Cs-removed total beta, total alpha, and Cs-removed total alpha activities for filtered and unfiltered Salt Batches 1-4 are provided in Figure 4-5. Gamma and beta activities are similar for individual samples (due to the dominance of the Cs-137/Ba-137m system discussed above) and are generally consistent between waste batches (beta and gamma range for both filtered and unfiltered samples: 3.1E+08 to 5.8E+08 dpm/mL). Removal of Cs-137 and Ba-137m (due to decay) from the system results in approximately a 2 order of magnitude decrease in beta activity for all samples (range: 1.9E+06 to 3.6E+06 dpm/mL). Small variations in the Cs-removed beta activities were observed between samples. Batch 3 contained the highest Cs-removed alpha activity (4.9E+05 dpm/mL). Alpha activities for Batches 1 and 2 (not shown in Figure 4-5) were below detectable limits (<2E+04 dpm/mL) while the alpha activity of Batch 4 was only 1.8E+04 dpm/mL.

Trends in the activities of specific radionuclides for Batches 1-4 are provided in Figure 4-6. Cs-137 and its daughter radionuclide Ba-137m (not shown in the figure) dominate the overall sample activity and account for the bulk of the gamma and beta activity. In the Batch 2 sample characterization report it is assumed that the Ba-137 activity is equal to the total gamma (3.8E+08 dpm/mL). Small variations were observed in the Cs-137 activities of the batches as was observed for the total beta and gamma activities shown in Figure 4-5. Small variations were also observed between batches for the next two most radioactive nuclides, Sr-90 and Pu-238, which contribute to the beta and alpha activities, respectively. For each of the most radioactive nuclides (Cs-137, Ba-137m, Sr-90, and Pu-238) the highest activities were observed for Salt Batch 3. Other radionuclides observed in the SWPF Salt Batches at lower activity levels are not included in Table 4-3 and Table 4-4, but results are provided in the individual data reports. In general, the activities of the primary radionuclides of the Salt Batches processed through SWPF have been quite consistent.

Table 4-3. SWPF Salt Batches 1 and 2 Radionuclide Activities (units: dpm/mL).

SWPF Batch	1 (filtered)	1 (unfiltered)	2 (filtered)	2 (unfiltered)
Radionuclide	dpm/mL			
Cs-137	3.4E+08	---	4.0E+08	4.0E+08
Ba-137m	3.2E+08	---	3.8E+08	3.8E+08
Total Gamma	3.2E+08	---	3.8E+08	3.8E+08
Beta Count	3.6E+08	---	4.3E+08	4.3E+08
Total Beta (Cs-Removed)	1.9E+06	---	2.0E+06	1.9E+06
Total Alpha (Cs-Removed)	<8.6E+04	---	<1.0E+05	<9.4E+04
Sr-90/Y-90	5.8E+05	---	6.5E+05	8.7E+05
Tc-99	9.3E+04	---	9.3E+04	---
Pu-238	6.6E+04	---	6.3E+04	6.2E+04
Pu-239	1898	---	3152	2553
Pu-240	<2531	---	1376	1110
Pu-241	2.1E+04	---	4.1E+04	---
H-3	2908	---	8436	---
C-14	1214	---	2171	---
Sn-126	839	---	1168	---
U-233	56	---	42	<446
U-234	251	---	249	<289
I-129	64	---	<98	---
Np-237	8.1	---	15	---

Table 4-4. SWPF Salt Batches 1 and 2 Radionuclide Activities (units: µCi/mL).

SWPF Batch	1 (filtered)	1 (unfiltered)	2 (filtered)	2 (unfiltered)
Radionuclide	µCi/mL			
Cs-137	1.5E+02	---	1.8E+02	1.8E+02
Ba-137m	1.5E+02	---	1.7E+02	1.7E+02
Total Gamma	1.5E+02	---	1.7E+02	1.7E+02
Beta Count	1.6E+02	---	1.9E+02	2.0E+02
Total Beta (Cs-Removed)	8.6E-01	---	8.9E-01	8.7E-01
Total Alpha (Cs-Removed)	<3.9E-02	---	<4.6E-02	<4.2E-2
Sr-90/Y-90	2.6E-01	---	3.0E-01	3.9E-01
Tc-99	4.2E-02	---	4.2E-02	---
Pu-238	3.0E-02	---	2.9E-02	2.8E-02
Pu-239	8.6E-04	---	1.4E-03	1.2E-03
Pu-240	<1.1E-3	---	6.2E-04	5.0E-04
Pu-241	9.4E-03	---	1.9E-02	---
H-3	1.3E-03	---	3.8E-03	---
C-14	5.5E-04	---	9.8E-04	---
Sn-126	3.8E-04	---	5.3E-04	---
U-233	2.5E-05	---	1.9E-05	<2.0E-4
U-234	1.1E-04	---	1.1E-04	<1.3E-4
I-129	2.9E-05	---	<4.4E-5	---
Np-237	3.7E-06	---	6.7E-06	---

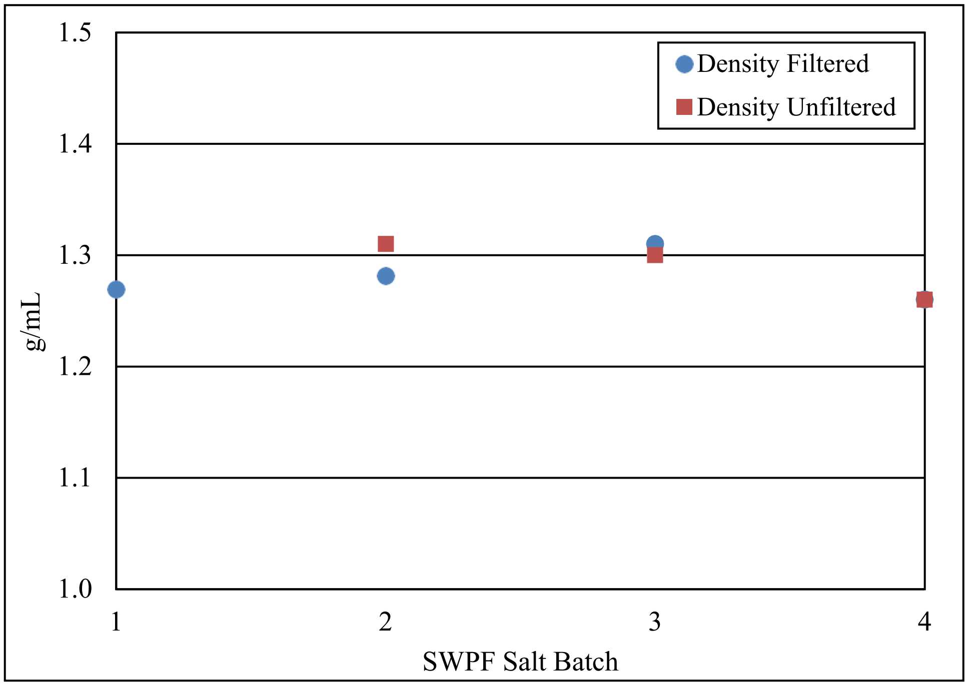

Figure 4-1. Density Trends for SWPF Batch Qualification Samples (for Batch 4 densities of filtered and unfiltered were identical)

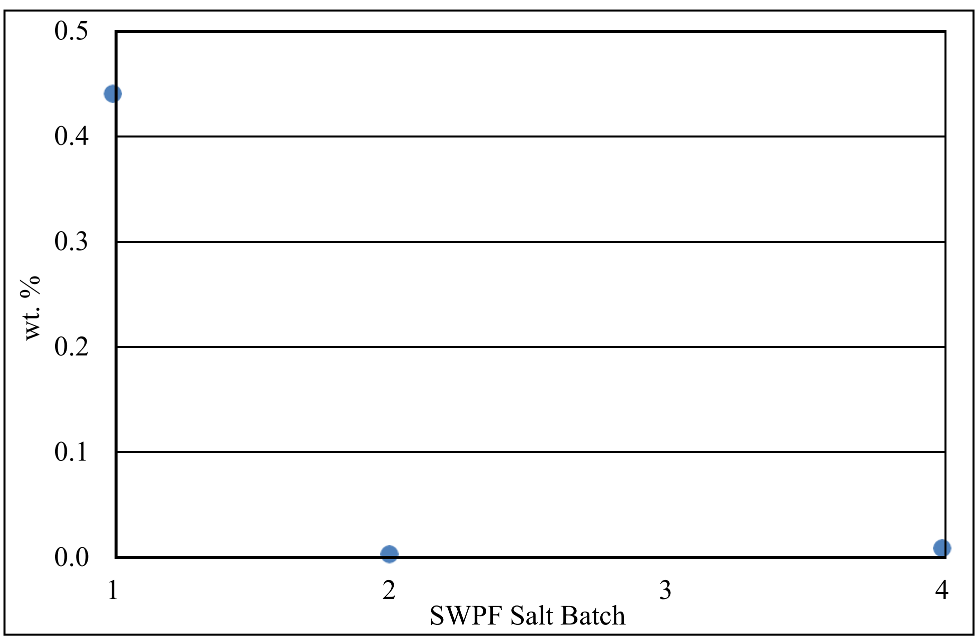

Figure 4-2. Weight Percent Insoluble Solids Data for SWPF Batch Qualification Samples (Batch 3 not shown: <0.01 wt. %)

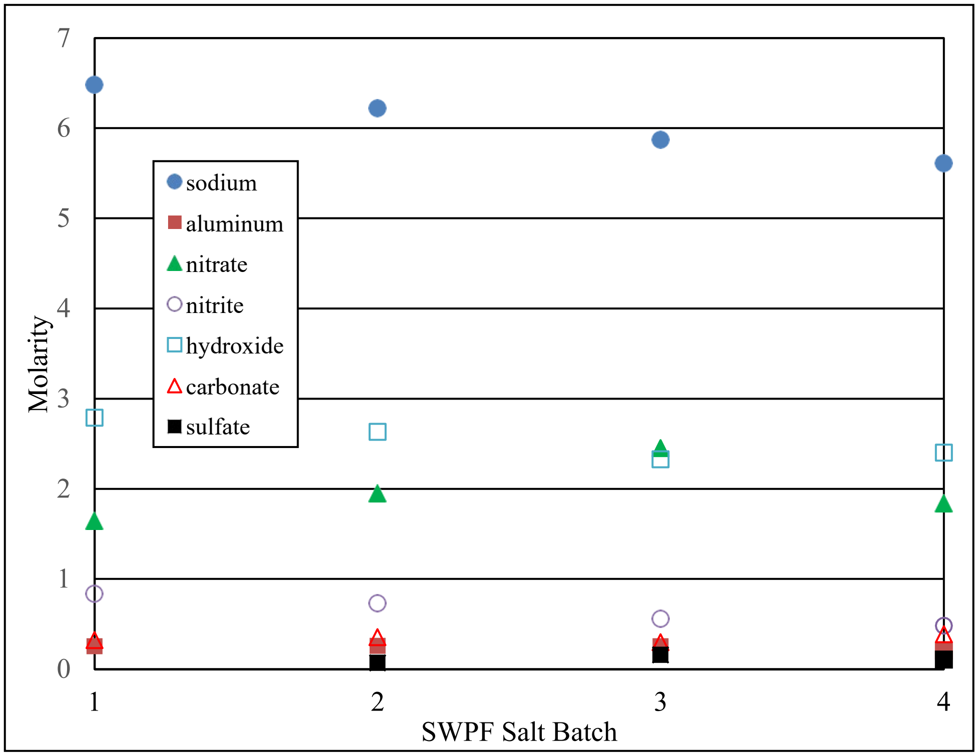

Figure 4-3. Concentrations of Primary Metals and Anions Reported for SWPF Qualification Samples.

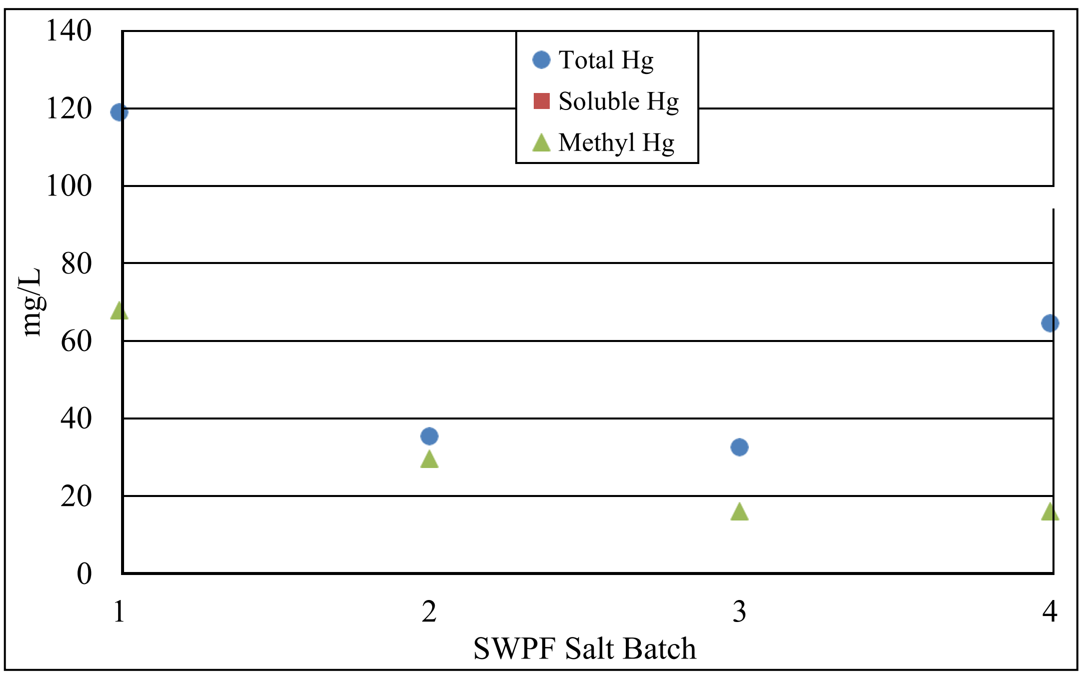

Figure 4-4. Concentrations of Mercury Reported for SWPF Qualification Samples (Total Hg – unfiltered, stirred samples; Soluble Hg for Salt Batch 1 only – filtered sample).

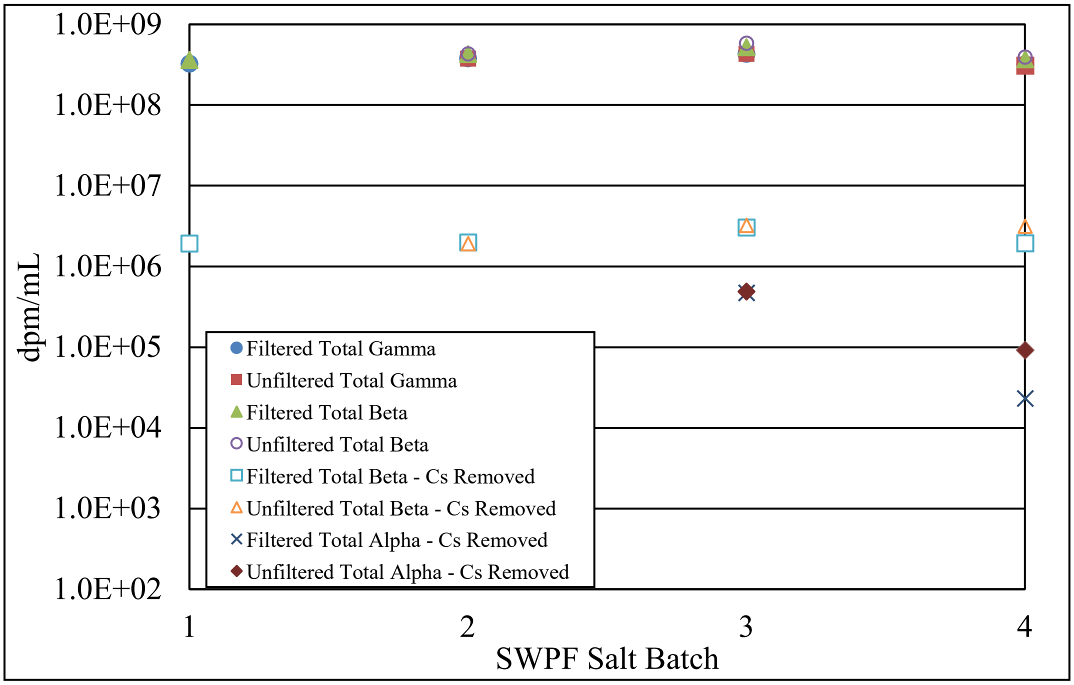

Figure 4-5. Total Gamma, Total Beta, Cs-Removed Total Beta, and Cs-Removed Total Alpha Activities for Filtered and Unfiltered SWPF Qualification Batches (Batch 1 and 2 Cs-removed alpha not shown: <1E+05 dpm/mL).

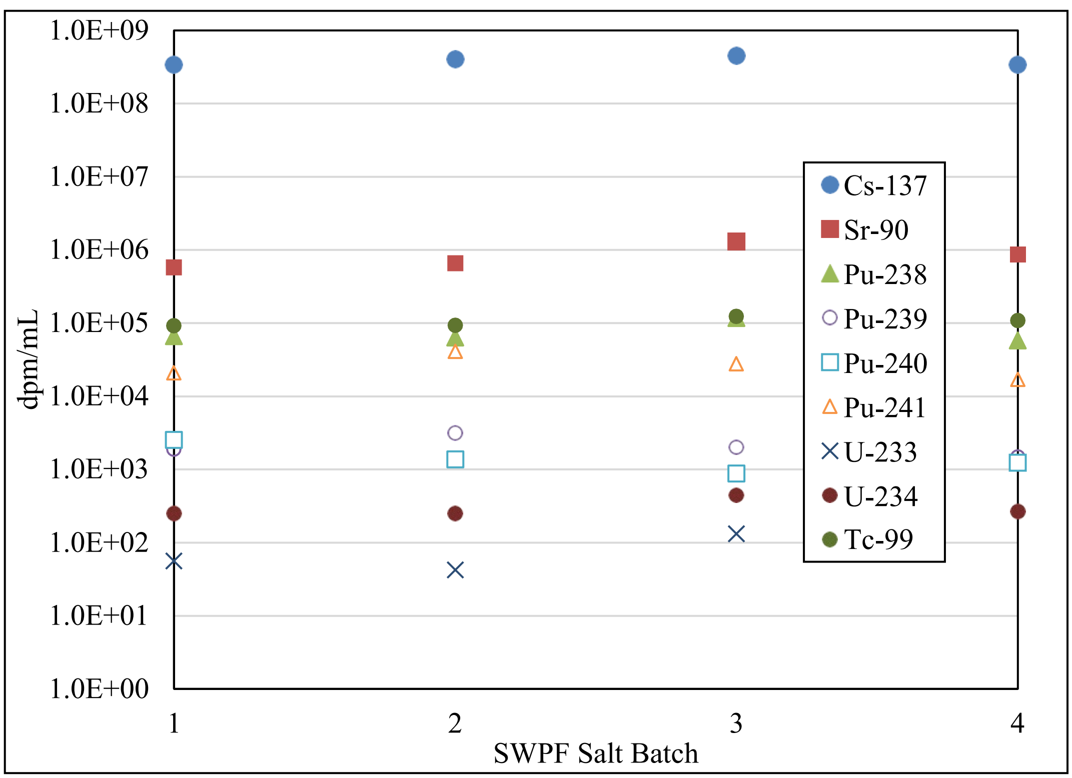

Figure 4-6. Selected Soluble Radionuclide Activities Reported for SWPF Qualification Samples (Batch 4 U-233 not shown: <43 dpm/mL).

5.0 Summary and Comparisons of ISDP Dissolved Salt Waste Macrobatches (1-10)

Data are summarized in this section from the reports indicated in

Table 5-1 which provide characterization data from the ten Integrated Salt Disposition Program Salt macrobatches processed through the ISWP facility. Note that SWPF Batch 1 was initially referred to as Macrobatch 11.[v]

As shown in Figure 5-1, the densities of the Salt Macrobatches were generally consistent ranging from 1.25 to 1.30 mg/L. As shown in Figure 5-2, the insoluble solids content of the Macrobatches was typically low (<0.6 wt. %) except for the Macrobatch 3 sample which contained 1.0 wt. % solids. Metal and anion concentrations provided in Figure 5-3 and Figure 5-4 indicate that the sodium concentrations of the initial Macrobatches were lower (5.0-5.5 M) while later batches were more concentrated (6.0-7.0 M Na^+). Free hydroxide and nitrate were the dominant anions in all batches. The total mercury concentrations (unfiltered samples) of the earlier Macrobatches were lower and the later Macrobatches were higher with Macrobatch 8 having the highest value of 129 mg/L (Figure 5-5). The lowest total (unfiltered) mercury (9 mg/L) was reported for Macrobatch 1, although Macrobatches 2 and 6 were also low (<15 mg/L).

The total alpha, Cs-removed alpha, total beta, Cs-removed beta, and gamma activities for the ISDP Batches are provided in Figure 5-6. The total beta and gamma ranged from 4E+07 to 6E+08 dpm/mL. The Cs-removed beta was near 2E+06 dpm/mL for all samples analyzed. The Cs-removed total alpha ranged from ~2E+04 to 1E+05 dpm/mL for the three batches (1-3) where activity above the detection limit was observed. Trends in the activities of specific radionuclides for Macrobatches 1-10 are provided in Figure 5-7. Cs-137 and its daughter radionuclide Ba-137m (not directly measured or shown in the figure) dominate the overall sample activity and account for the bulk of the gamma and beta activities. As was the case for the total beta and gamma activities, the Cs-137 activities ranged from ~1E+08 to 5E+08 dpm/mL. The activities of the secondary beta emitters Sr-90 and Tc-99 were typically around 1E+06 and 1E+05 dpm/mL, respectively. The activities of the primary alpha emitter, Pu-238, in the Macrobatch samples were typically in the range 1E+04 to 1E+05 dpm/mL which was similar to the total alpha activities. The activities of other plutonium isotopes typically ranged from 1E+03 to 1E+04 dpm/mL. Activities associated with the total uranium isotopes were typically in the range from 1E+02 to 1E+03 dpm/mL.

Table 5-1. Reports Utilized for ISDP Salt Batch Composition Data Summaries.

ISDP Batch	Qualification Tank	Report #
1	49H	WSRC-STI-2008-00117[viii]
2		X-ESR-H-00157[a,ix] and SRNL-STI-2008-00446[x]
3	21H, 23H, and 24H	SRNL-STI-2009-00805[xi,xii], X-ESR-H-00209, Rev 0[xiii,b]
4	21H	SRNL-STI-2011-00061[xiv]
5		SRNL-STI-2012-00076[xv]
6		SRNL-STI-2012-00707[xvi]
7		SRNL-STI-2013-00437[xvii]
8		SRNL-STI-2014-00561[xviii]
9		SRNL-STI-2015-00622[xix]
10		SRNL-STI-2017-00055[xx]

[a] Analysis data for this Macrobatch were calculated based on analysis of Tanks 22H and 41H which were subsequently added to Tank 49H along with 50 wt.% NaOH.[ix]

[b] A qualification sample was not analyzed from a single tank. Instead, samples from several tanks were analyzed and a composite composition was calculated in a separate Liquid Waste Operations Sub-contractor document.

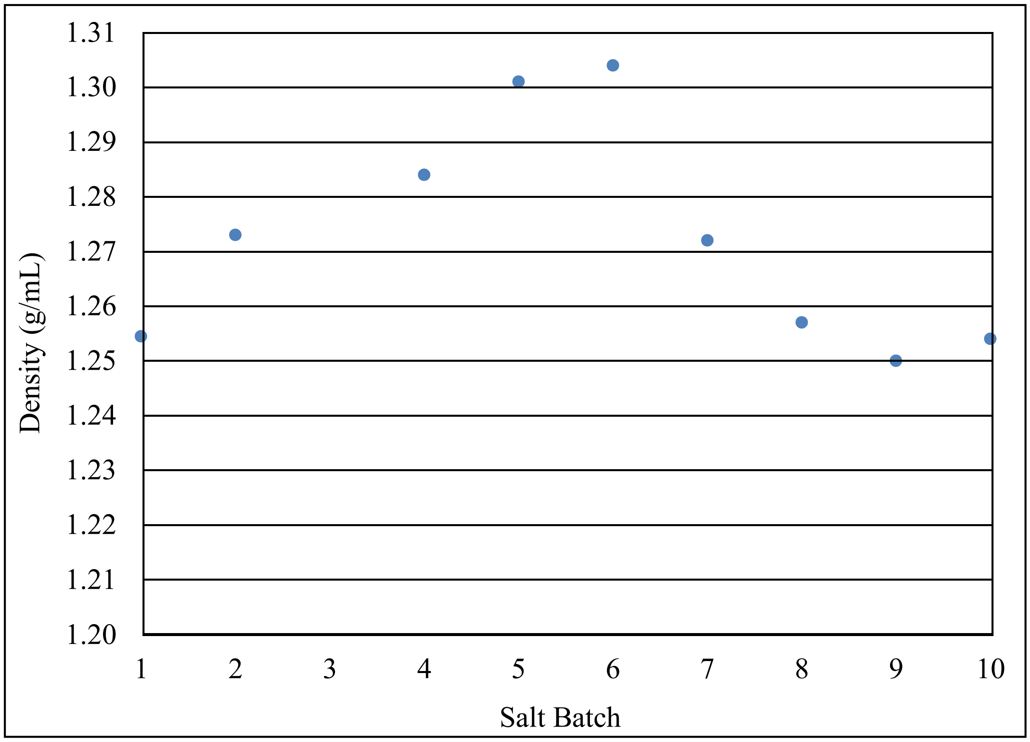

Figure 5-1. Density Trends for ISDP Qualification Samples (density for final Macrobatch 3 qualification sample not measured).

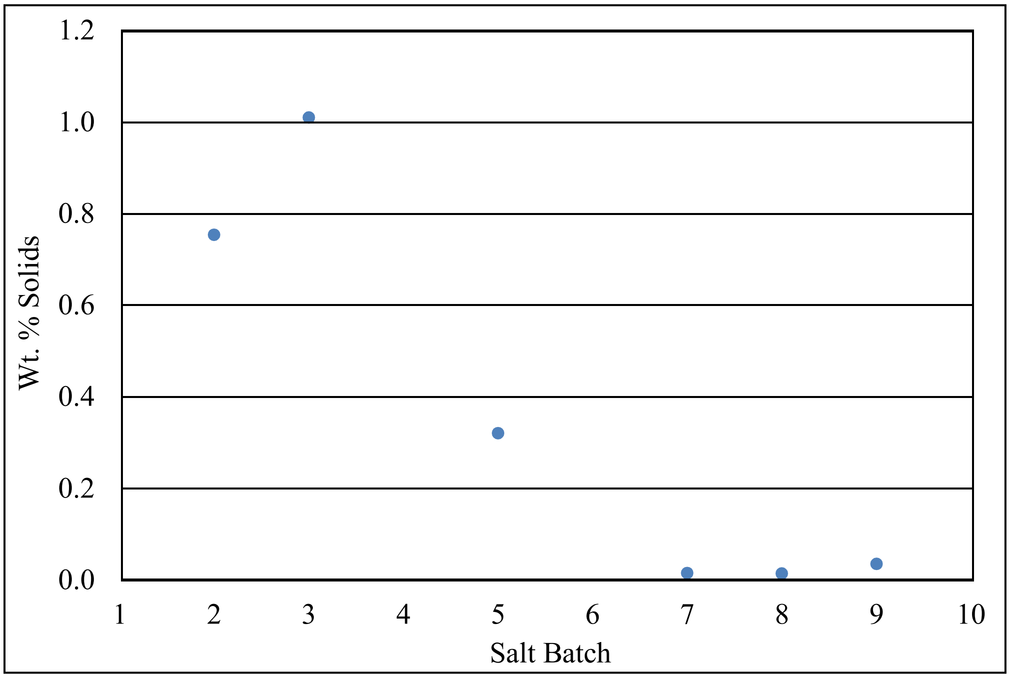

Figure 5-2. Weight Percent Insoluble Solids Trends for ISDP Qualification Samples (insoluble solids for Macrobatches 1, 4, and 6 were below detection; small amount of solids observed but not analyzed for Batch 10).

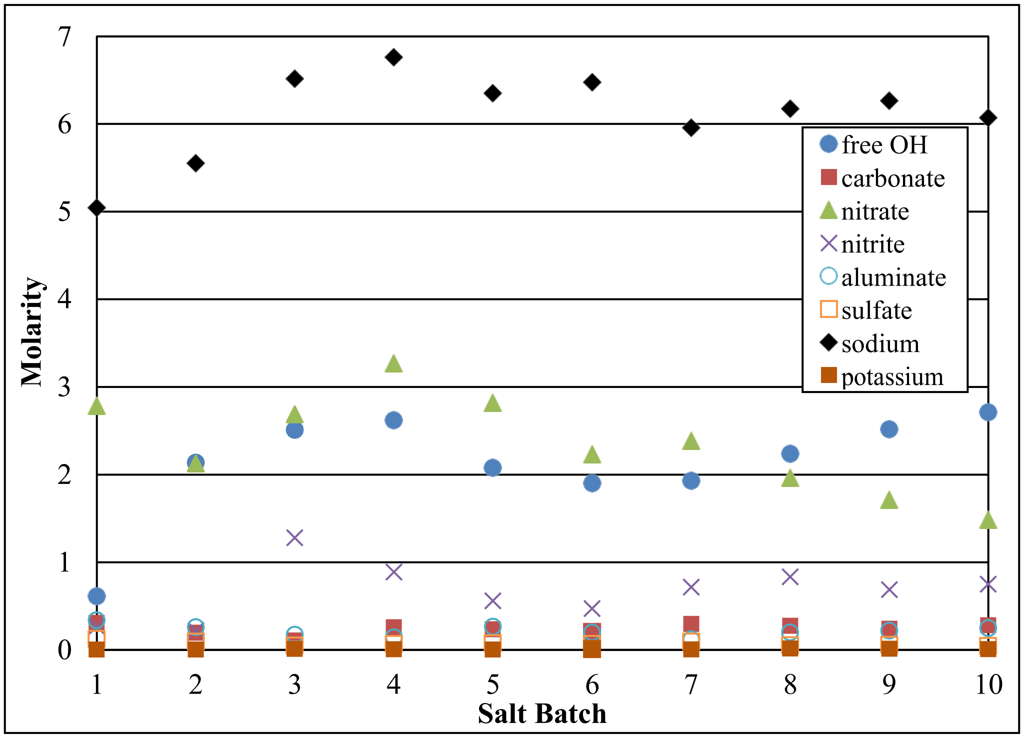

Figure 5-3. Selected Metal and Anion Molar Concentrations for ISDP Qualification Samples.

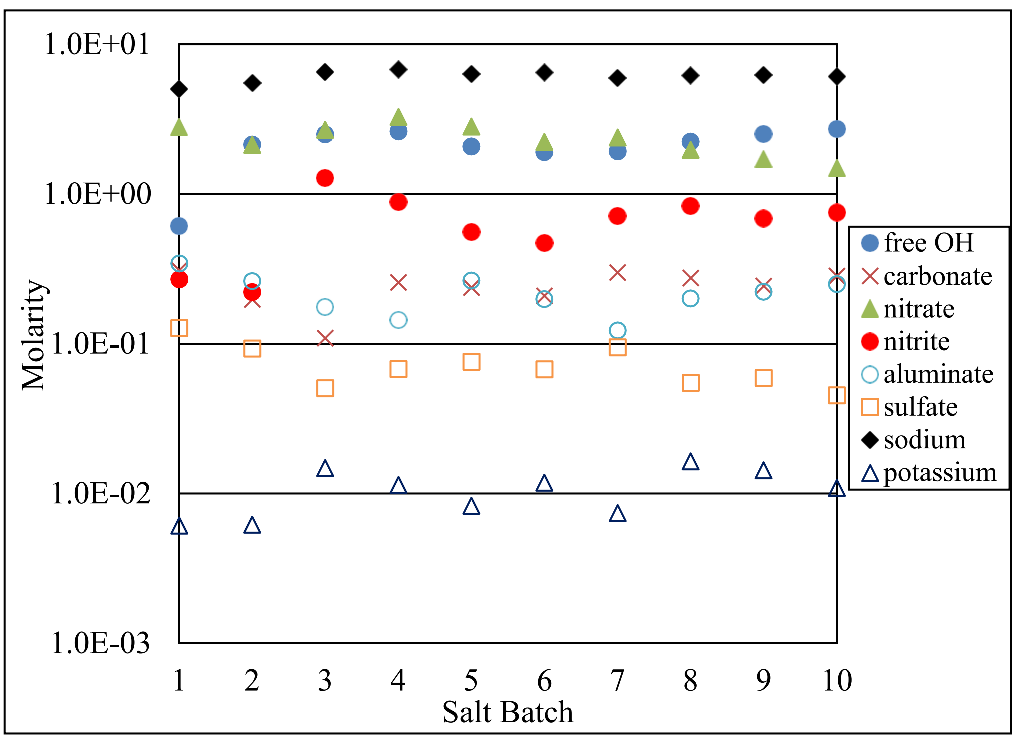

Figure 5-4. Selected Metal and Anion Molar Concentrations for ISDP Qualification Samples (logarithmic scale).

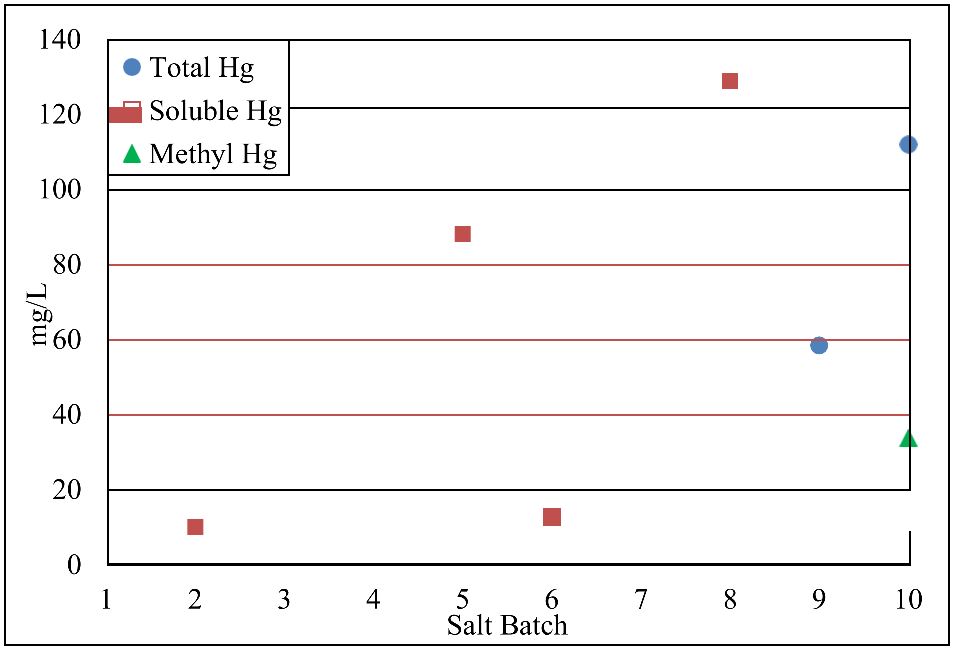

Figure 5-5. Mercury Concentrations for ISDP Qualification Samples (Total Hg – unfiltered, stirred samples; Soluble Hg – filtered samples).

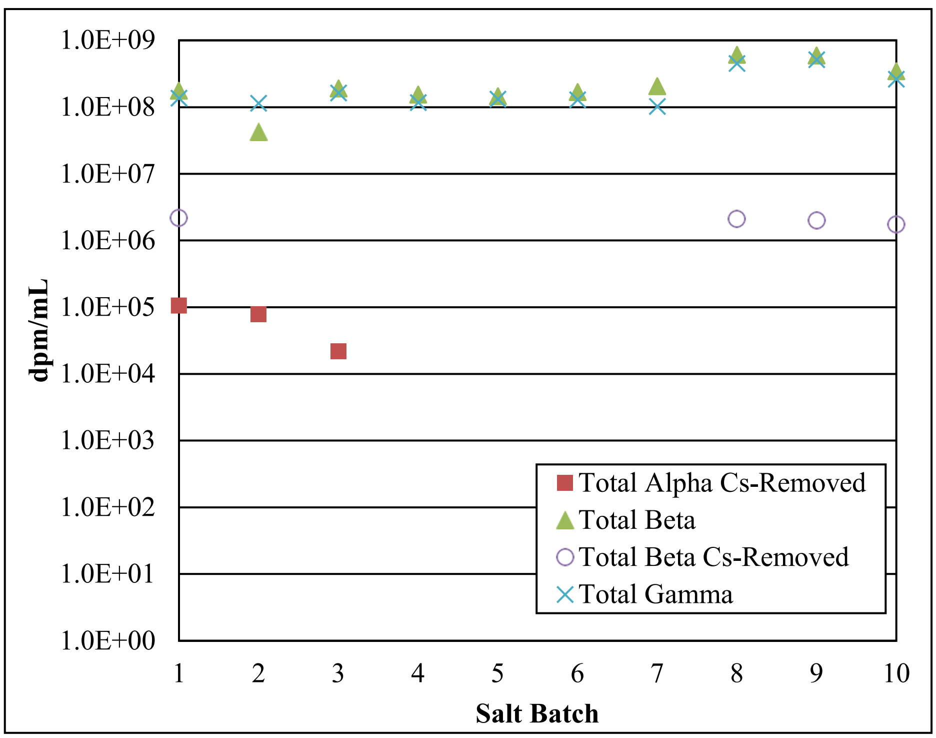

Figure 5-6. Total Alpha, Beta, and Gamma and Cs-Removed Alpha and Beta for ISDP Qualification Samples (Total Alpha results for Macrobatches 4-10 were below detection).

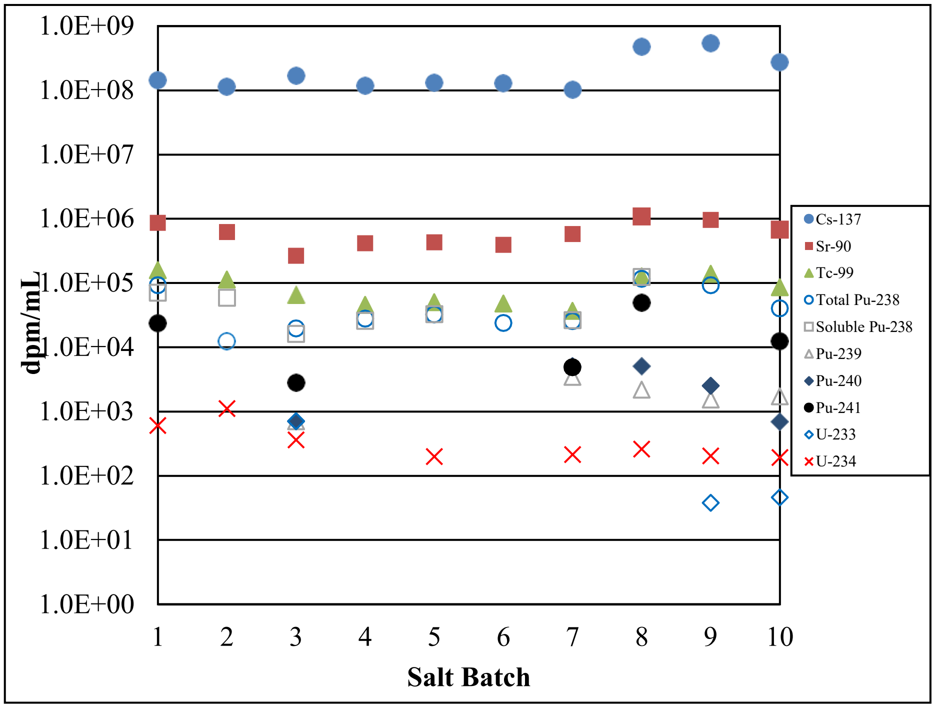

Figure 5-7. Selected Radionuclide Activities Reported for ISDP Qualification Samples (results below detection not shown).

In general, the activities of the primary radionuclides of the Macrobatches processed through the ISWP facility have been consistent.

6.0 Summary, Comparisons, and Statistical Analysis of all Fourteen ISDP and SWPF Dissolved Salt Waste Batches

Average, relative standard deviation, and maximum and minimum statistics of the characterization data for all fourteen salt waste batches are provided in Table 6-1 and Table 6-2. (*Note: Filtered sample analysis data was used for the statistical evaluations except for Hg which utilized unfiltered sample data for SWPF samples and a combination of filtered, unfiltered, and decanted data for ISDP batches. Note that insoluble solids containing mercury in tank farm samples tend to settle and filtered and unfiltered sample results are often in the same range, as seen for the ISDP Batch 1 sample in* Table 4-2. *Radionuclide results used for statistical evaluations are generally from filtered or decanted samples. A combination of filtered and unfiltered data was also used to calculate statistics for density.)* The average density value of 1.28 g/mL is consistent with the average sodium concentration of 6.1 M. Potassium, which can impact cesium removal, was present at an average concentration of 0.01 M. It is not expected, based on the potassium concentrations involved (see Table 3-1, Table 4-2, and Table 6-1), that the higher potassium in SWPF Batch 3 (the highest potassium concentration of all 14 salt batches) would significantly impact cesium removal performance relative to other salt waste batches. Hydroxide and nitrate were the dominant anions and the average concentration for each was 2.2 M. The average nitrite concentration was 0.7 M. The average carbonate concentration was near 0.25 M, while the sulfate concentration was 0.08 M. The average mercury concentration was 59 mg/L (2.9E-04 M). As shown in Table 6-2, the average gamma activity for all 14 salt qualification batches of 2.5E+08 dpm/mL is identical to the average Ba-137m activity, which was calculated from the measured Cs-137 activity. This indicates that Ba-137m is the dominant gamma emitter in the salt waste due to the Cs-137/Ba-137m couple discussed in earlier sections. The average beta activity of 3.1E+08 dpm/mL is slightly greater than the average Cs-137 activity (the dominant beta emitter) of

2.7E+08 dpm/mL. The average Cs-removed beta activity of 2.1E+06 dpm/mL is approximately two orders of magnitude below the total beta and corresponds to the total activities from other beta emitters (with Sr-90 and Y-90 being significant contributors). The average (Cs-removed) alpha activity of 1.4E+05 dpm/mL is slightly greater than the sum of the activities from the plutonium isotopes (which are primary alpha contributors) of 8.3E+04 dpm/mL.

Trends in the chemical concentrations were quite consistent for most species across the 14 salt qualification batches. The sodium concentrations increased in the first four ISDP Salt Batches up to the maximum value observed of 6.8 M (ISDP Batch 4). Since that time the qualification salt batches for both facilities have contained 6±0.5 M Na^+ (see Figure 4-3 and Figure 5-3 for trends in the metal and anion concentrations for the 14 batches). The minimum sodium (5.1 M) and the minimum hydroxide (0.6 M) concentrations were observed for ISDP qualification Batch 1. Otherwise, the hydroxide concentrations for all fourteen batches were in or near the range of 2-3 M. The maximum hydroxide concentration of 2.8 M was observed for SWPF Batch 1. In some cases, NaOH reagent was added to adjust the waste composition prior to processing for cesium removal and these additions are not captured in the summarized qualification data. In addition, the qualification waste batches were mixed with the process feed tank heels remaining from the previous batches, so the qualification sample concentrations (and especially the hydroxide in some cases) do not represent the final concentrations of the solutions processed. However, given the fact that the compositions of most waste batches are similar, and the heel volumes are relatively small, these effects should not be large, and the qualification batch compositions are close to the final processed compositions. In most cases SRR, calculated the final waste compositions based on the compositions and volumes of the qualification batches and heels involved and the reagents added. These calculated compositions could be summarized in a future revision of this report. The concentration of nitrate (the other major anion in the waste) ranged from 1.5 M (ISDP Batch 10) to 3.3 M (ISDP Batch 4). Maximum concentrations observed for sodium, hydroxide, and nitrate (major ions present) were 11, 24, and 46% higher than the average values. Minimum concentration values observed for sodium, hydroxide, and nitrate were 17, 73, and 34% below the average. The nitrite concentrations were typically below 1 M with the maximum (1.3 M) being observed for ISDP Batch 3. The carbonate anion concentrations ranged from 0.1 to 0.4 M with the maximum being observed for SWPF Batch 4. The average aluminate concentration was 0.22 M with the maximum (0.34 M) and minimum (0.12 M) values being observed for ISDP Batches 1 and 7, respectively. Mercury concentrations increased with successive ISDP salt batches through Batch 6 and the maximum was observed for ISDP Batch 8 (129 mg/L). Trends in the mercury data are provided in Figure 4-4 and Figure 5-5. The first SWPF salt batch contained 119 mg Hg/L while the three most recent SWPF salt batches have contained lower mercury concentrations below 70 mg/L. The minimum mercury concentration of 9 mg/L was observed for ISDP Batch 1.

Radionuclide activity trends were also quite consistent for most species in the 14 salt qualification batches (see Figure 4-5, Figure 4-6, Figure 5-6, and Figure 5-7). The minimum gamma activity of 1.0E+08 dpm/mL was observed for ISDP Batch 7 and the maximum of 5.1E+08 dpm/mL was observed for ISDP Batch 9. Gamma activities were generally in or near the range from 1E+08 to 1E+09 dpm/mL. Total beta activities have ranged from 4.2E+07 (ISDP Batch 2) to 6.1E+08 dpm/mL (ISDP Batch 8). The lowest total alpha activity (2.2E+04 dpm/mL) was observed for ISDP Batch 3 and the highest total alpha (4.7E+05 dpm/mL) was observed for SWPF Batch 3. Maximum gamma and beta activities were 102 and 97% higher than (~2x) the average values. Minimum gamma and beta activities were 40 and 14% of the average values. The maximum alpha activity was 3.4x larger than the average, while the minimum value was 16% of the average value. Trends in the beta and Cs-137 activities generally tracked the total gamma activities due to the dominating activities associated with the Cs-137/Ba-137m decay series. (Note: For some ISDP sample results, the Cs-137 and gamma results are exactly the same, indicating that these were assumed to be identical and reported as such.) The lowest Cs-137 activity (1.0E+08 dpm/mL) was observed for ISDP Batch 7 and the highest Cs-137 activity (5.4E+08 dpm/mL) was observed for ISDP Batch 9. SWPF Salt Batches 1-4 have contained 3.8(±0.7)E+08 dpm/mL Cs-137. Sr-90 activities have been relatively consistent across all salt batches with the minimum activity (2.6E+05 dpm/mL) being observed for ISDP Batch 3 and the maximum activity (1.3E+06 dpm/mL) being observed for SWPF Batch 3. Tc-99 activities have also been relatively consistent with the minimum activity (3.7E+04 dpm/mL) being observed for ISDP Batch 7 and the maximum activity (1.6E+05 dpm/mL) being observed for ISDP Batch 1. Pu-238 is typically the plutonium isotope present at the highest activity. The highest Pu-238 activity (1.2E+05 dpm/mL) was observed for SWPF Batch 3 and the lowest activity (1.2E+04 dpm/mL) was observed for ISDP Batch 2.

Table 6-1. Physical and Chemical Composition Statistics for All Fourteen Salt Waste Batches.

Statistic	Density (g/mL)	M								Total Hg (mg/L)[a]
		Na^+	K^+	AlO_2^-	OH^-	NO_3^-	NO_2^-	SO_4^{2-}	CO_3^{2-}	
Average	1.277	6.10	0.011	0.224	2.24	2.24	0.66	0.08	0.27	58.8
%RSD	1.7%	7.5%	32.1%	24.6%	24.4%	23.1%	40.6%	41.0%	26.1%	67.7%
Max	1.31	6.76	0.018	0.34	2.79	3.27	1.28	0.16	0.39	129.0
Min	1.25	5.05	0.006	0.12	0.61	1.49	0.22	0.05	0.11	9.17

[a] Based on unfiltered sample data for SWPF batches and a combination of filtered, unfiltered and decanted data for ISDP batches.

Table 6-2. Gamma, Beta, and Alpha Activity Statistics for All Fourteen Salt Waste Batches.

Statistics	Gamma	Beta	Beta – Cs[a]	Alpha – Cs[a]
	dpm/mL			
Average	2.5E+08	3.1E+08	2.1E+06	1.4E+05
%RSD	57.1%	58.5%	19.0%	134.6%
Max	5.1E+08	6.1E+08	3.0E+06	4.7E+05
Min	1.0E+08	4.2E+07	1.7E+06	2.2E+04
Statistics	µCi/mL			
Average	1.1E+02	1.4E+02	9.5E-01	6.3E-02
%RSD	57.1%	58.5%	19.0%	134.6%
Max	2.3E+02	2.7E+02	1.4E+00	2.1E-01
Min	4.6E+01	1.9E+01	7.8E-01	9.8E-03

[a] corresponds to beta and alpha activities measured following removal of Cs-137

Table 6-3. Selected Radionuclide Activity Statistics for All Fourteen Salt Waste Batches.

Statistics	Cs-137	Ba-137m	Sr-90/Y-90	Tc-99	Pu-238	Pu-239	Pu-240	Pu-241
	dpm/mL							
Average	2.7E+08	2.5E+08	6.9E+05	9.2E+04	5.6E+04	2.0E+03	2.2E+03	2.2E+04
%RSD	58.6%	58.6%	42.2%	41.7%	64.0%	42.0%	84.9%	69.8%
Max	5.4E+08	5.1E+08	1.3E+06	1.6E+05	1.2E+05	3.5E+03	5.1E+03	5.0E+04
Min	1.0E+08	9.7E+07	2.6E+05	3.7E+04	1.2E+04	7.1E+02	7.0E+02	2.8E+03
Statistics	µCi/mL							
Average	1.2E+02	1.1E+02	3.1E-01	4.2E-02	2.5E-02	9.1E-04	9.9E-04	1.0E-02
%RSD	58.6%	58.6%	42.2%	41.7%	64.0%	42.0%	84.9%	69.8%
Max	2.4E+02	2.3E+02	5.9E-01	7.2E-02	5.3E-02	1.6E-03	2.3E-03	2.2E-02
Min	4.6E+01	4.4E+01	1.2E-01	1.7E-02	5.6E-03	3.2E-04	3.2E-04	1.3E-03

7.0 Conclusions

Salt Waste Processing Facility Waste Batches 3 and 4 were analyzed at the Savannah River National Laboratory and shown to have similar compositions to previous salt waste batches. In addition, characterization data for all salt qualification batches processed through the ISWP facility and the SWPF has been evaluated and summarized. Trends in the chemical concentrations and radionuclide activities were quite consistent for most species across the 14 batches. The average waste density value of 1.28 g/mL is consistent with the average sodium concentration of 6.1 M. Hydroxide and nitrate were the dominant anions and the average concentration for each was 2.2 M. The average concentrations of nitrite, carbonate, sulfate, and other minor anions were below 1.0 M, while the average mercury concentration was 59 mg/L. The average gamma activity for the 14 qualification batches of 2.5E+08 dpm/mL (0.43 Ci/gal) correlates well to the average calculated Ba-137m activity (dominant gamma emitter). The average beta activity of 3.1E+08 dpm/mL (0.52 Ci/gal) is also similar to the average Cs-137 activity (dominant beta emitter). The average Cs-removed beta activity of 2.1E+06 dpm/mL is two orders of magnitude below the total beta and corresponds to the total activities from other beta emitters (with Sr-90 and Y-90 being significant contributors). The average (Cs-removed) alpha activity of 1.4E+05 dpm/mL is in the same range as the sum of the plutonium isotopes which are the primary alpha contributors. Concentration and activity trends and maximum and minimum statistics for the major species (Na^+, Al, OH^-, and NO_3^-) did not vary to a large degree (within ±75%) from the average values across the 14 salt batches. For sodium, the dominant cation, the data varied by ±20%. The radionuclide content variability was significantly larger across the 14 batches: ±130%.

8.0 Recommendations, Path Forward or Future Work

It is recommended that future salt batches be analyzed using the SRNL cesium- and strontium-removed alpha method. It is recommended that future revisions of this report or separate salt batch summary reports include: 1) a summary of the final calculated compositions of the wastes processed through the ISWP facility and the SWPF taking into account the impacts of the process feed tank heel compositions and added NaOH reagent, and, 2) comparisons of the final blended salt waste feed compositions prior to radionuclide removal against the Tank 50H characterization data for the salt batches following waste treatment. This would provide a thorough compositional summary of the many gallons of salt waste decontaminated and processed for disposal in saltstone at the Savannah River Site.

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