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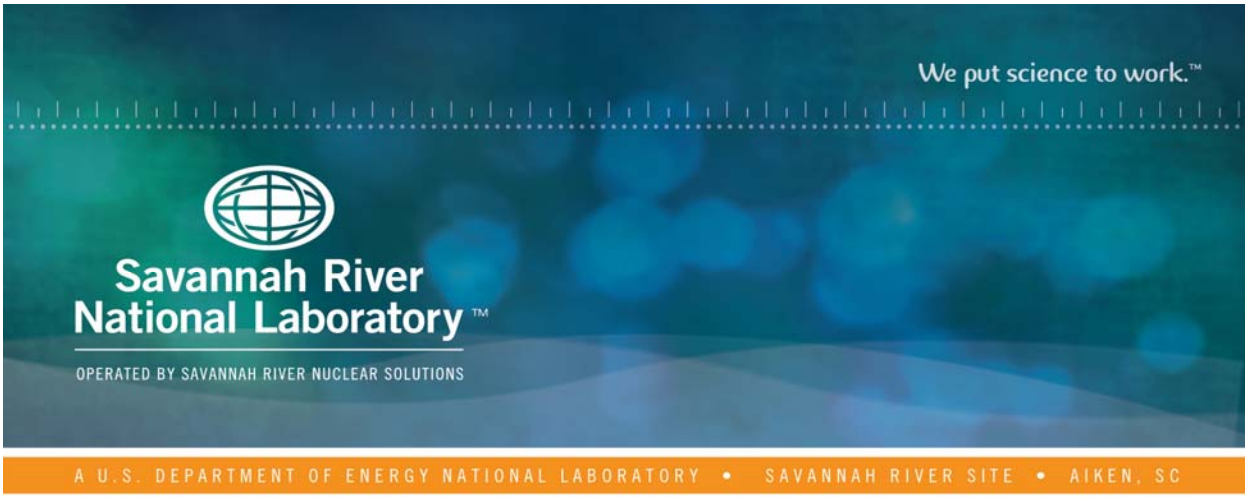

Preparation and Evaporation of Hanford Waste Treatment Plant Direct Feed Low Activity Waste Effluent Management Facility Simulant

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EXECUTIVE SUMMARY

The Hanford Waste Treatment and Immobilization Plant (WTP) Low Activity Waste (LAW) vitrification facility will generate an aqueous condensate recycle stream (LAW Melter Off-Gas Condensate, LMOGC) from the off-gas system. The baseline plan for disposition of this stream during full WTP operations is to send it to the WTP Pretreatment Facility, where it will be blended with LAW, concentrated by evaporation, and recycled to the LAW vitrification facility. However, during the Direct Feed LAW (DFLAW) scenario, planned disposition of this stream involves concentrating the condensate in a new evaporator at the Effluent Management Facility (EMF) and returning it to the LAW melter.

The LMOGC stream will contain components, e.g. halides and sulfates, that are volatile at melter temperatures, have limited solubility in glass waste forms, and present a material corrosion concern. Because this stream will recycle within WTP, these components are expected to accumulate in the LMOGC stream, exacerbating their impact on the number of LAW glass containers that must be produced. Diverting the stream reduces the halides and sulfates in the glass and is a key objective of this program. In order to determine the disposition path, it is key to experimentally determine the fate of contaminants. To do this, testing is needed to account for the buffering chemistry of the components, determine the achievable evaporation end point, identify insoluble solids that form, determine the formation and distribution of key regulatory-impacting constituents, and generate an aqueous stream that can be used in testing of the subsequent immobilization step.

This overall program examines the potential treatment and immobilization of the LMOGC stream to enable alternative disposal. The objective of this task was to (1) prepare a simulant of the LAW Melter Off-gas Condensate expected during DFLAW operations, (2) demonstrate evaporation in order to predict the final composition of the effluents from the EMF evaporator to aid in planning for their disposition, and (3) generate concentrated evaporator bottoms for use in immobilization testing. This phase of testing added more hazardous constituents to the core simulant formulation to examine their reactivity and fate during evaporation, and included antifoam in order to determine if organomercury species are formed. A future report will document the leaching properties of the hazardous constituents in the immobilized waste forms.

The results indicate that the simulant can easily be concentrated via evaporation. During the pH adjustment step in simulant preparation, ammonium was quickly converted to ammonia, and most of the ammonia was stripped from the simulated waste and partitioned to the condensate. Additionally, after evaporating to the target concentration of 15 weight % total solids (~6.5X the feed concentration) and cooling the simulant, a trace amount of zinc precipitated out of solution and it was slightly cloudy. The reason for zinc precipitation is not known, but the cloudiness is attributed to the antifoam since it was milky in appearance prior to use. With the exception of ammonia, analysis of the condensate indicated very low to below detectable levels of many of the constituents in the simulant, yielding very high decontamination factors (DF), which exceeded 11,000 based on sodium analysis.

Organomercury analysis indicated that trace amounts of monomethyl mercury formed and collected in the knock-out pot (a secondary condensate collection container). The concentration of the monomethyl mercury was marginally above the detection limit, but beneath the reporting

limit. There was also a difference in analysis results for total mercury and inorganic mercury, suggesting that there were other forms present. However, the specific analysis for metallic, methyl, and dimethyl mercury did not account for this difference. The difference in total and inorganic mercury analysis result is tentatively attributed to a matrix effect from the other transition metals in the simulant that react with the chemical reagents used in the sample preparation. The analysis of soluble mercury before and after evaporation and the analysis of inorganic mercury before and after evaporation have nearly identical concentration ratios, further indicating that the discrepancy is due to analysis interferences.

Measurement of organoarsenic compounds is by difference between the total and inorganic arsenic, not a direct measurement of their presence. Analyses indicate that more total arsenic was present than inorganic arsenic, suggesting that organoarsenic compounds may have formed in the evaporator. However, the results are within the quality control limits, so it cannot be confirmed that there is a statistically significant difference between total and inorganic arsenic. Similar to the mercury analysis, the ratios of total and inorganic arsenic have similar concentration ratios, further indicating that the discrepancy is due to analysis issues. It does not seem likely that organoarsenic species form, but further analytical analysis work would be needed to confirm if organoarsenic compounds form under these conditions by determining if there are interferences with the inorganic arsenic analysis method in this matrix and by using a method that directly quantifies organoarsenic compounds.

The evaporator concentrate generated during this test will be used in an upcoming test to generate an immobilized waste form and measure its leaching behavior.

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LIST OF ABBREVIATIONS

ACTL	Aiken Count Technology Laboratory
DFLAW	Direct Feed Low-Activity Waste
DI	deionized water
DOE	Department of Energy
EDS	energy dispersive X-ray spectroscopy
EMF	Effluent Management Facility
ETF	Effluent Treatment Facility
g	grams
hr	hour
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectroscopy
inHg	Inches of mercury (pressure)
Kg	kilogram
KOP	Knock-out Pot
L	Liter
LAW	Low Activity Waste (reject- hyphen is not routine convention at Hanford)
LMOGC	LAW Melter Off-Gas Condensate
M&TE	Measurement and Test Equipment
mg	milligram
mL	milliliter
PSAL	Process Science Analytical Laboratory in SRNL
RPD	Relative Percent Difference
SBS	Submerged Bed Scrubber
SEM	Scanning Electron Microscope
Sim	Simulant
SRNL	Savannah River National Laboratory
Std. Dev	Standard Deviation
UNC	Uncertainty
VSL	Vitreous State Laboratory – Catholic University
WESP	Wet Electrostatic Precipitator
WRPS	Washington River Protection Solutions
Wt%	Weight percent
WTP	Waste Treatment and Immobilization Plant

1.0 Introduction

The Hanford Low Activity Waste Melter Off-Gas Condensate (LMOGC) waste stream will be generated in the Waste Treatment and Immobilization Plant (WTP) by condensation and scrubbing of the Low Activity Waste (LAW) melter off-gas system by a Submerged Bed Scrubber (SBS) and Wet Electrostatic Precipitator (WESP), as shown in Figure 1-1. This stream, which will contain substantial amounts of chloride, fluoride, ammonium, and sulfate ions, as well as technetium-99 (^{99}Tc) and other radionuclides, will get recycled to the LAW melter after evaporation. During Direct Feed LAW (DFLAW) operations, the evaporation will be performed in the planned Effluent Management Facility (EMF), as shown in Figure 1-2. Under normal operations the evaporator bottoms will be returned to the LAW melter, but may be returned to the tank farm without evaporation when the EMF evaporator is unavailable [1]. The volatile halide and sulfate components that accumulate in this stream are only marginally soluble in glass, and often dictate the LAW glass waste loading [2], thereby impacting the total quantity of glass canisters produced. This further impacts WTP by increasing the number of glass canisters produced, extending the mission duration, and causing higher corrosion rates. The radionuclides present in this stream that are key contributors to the long-term dose consequences for onsite disposal are ^{99}Tc and iodine-129 (^{129}I) [3]. These radionuclides are volatile in the melter and accumulate in the LAW system. Diverting this LAW Melter Off-Gas Condensate stream to an alternate disposal path would have substantial beneficial impacts on the cost, life cycle, and operational complexity of WTP [4]. This work focuses on the non-radioactive constituents in this stream, but it should be recognized that disposition of ^{99}Tc and ^{129}I must also be appropriately managed.

1.1 Testing Basis and Objective

The scope of this task is to support Washington River Protection Solutions (WRPS) in determining the composition and behavior of the concentrate and condensate waste streams produced during evaporation of the LMOGC, determining waste stream compatibility with existing facilities, and planning alternate disposition options [5]. Analytical results of melter off-gas condensate samples from two DuraMelter-10 tests at Vitreous State Laboratory (VSL) at the Catholic University of America were used as the basis for the simulant of this stream [6]. This small-scale melter has been used extensively in testing for the Hanford WTP. The off-gas system is a scaled-down version of the system for WTP, including a SBS and WESP, which generated the aqueous condensate stream used as the basis for this simulant. At the time condensate samples used for the basis for the simulant were generated, the simulant being fed to the DuraMelter-10 were based on actual wastes expected during the DFLAW operations. Preparation and analysis of the core LMOGC simulant by SRNL has been described elsewhere [7]. This work added arsenic, selenium, cyanide, and mercury to the composition in order to quantify their fate and disposition. For this test, a vacuum evaporator system was assembled and is similar in construction to a system used previously [8]. Details of the experimental apparatus are described in Section 2.0 below. Evaporator conditions were selected to be similar to those used in prior testing for comparison and are consistent with the operating conditions of the 242-A evaporator at Hanford [9]. The target concentration for evaporation was 15 wt% solids in the concentrate, based on criteria by WTP for the evaporator, which correlated to 6.5X the simulant feed concentration.

During tests at VSL, the SBS and WESP condensate was found to be near neutral pH. Prior to evaporation in the EMF evaporator during DFLAW operations, the pH will be raised to 12 to minimize corrosion of the evaporator material [10]. Note that a significant cation in the stream is ammonium, which will largely convert to ammonia during this adjustment (>98% at pH=11 [11]), and will then largely vaporize in the evaporator. It is important to determine the distribution of ammonium and ammonia in the evaporator because the overhead condensate will be dispositioned in the Effluent Treatment Facility (ETF). This task will provide evidence of the partitioning of ammonia and other components to the ETF, so that the effects on the facility can be anticipated. Additionally, a significant component of this waste stream is boric acid, which will consume one equivalent of hydroxide ions to reach pH 11. It is important to experimentally determine the total equivalents of hydroxide consumed by the ammonium to ammonia conversion, and the boric acid reaction, to determine the amount needed to overcome any other buffers, such as forming zinc hydroxides, and actually raise the pH to the target. Then, during evaporation, it is important to determine that the target pH is high enough to maintain the high pH in the evaporator, which will then allow an accurate characterization of the bottoms to be obtained. Since solids can precipitate from the bottoms, it is important to experimentally validate the evaporation end point so that it can be determined if insoluble solids form, particularly if they impact the handling and disposition options by impacting contaminant leachability or if they form scale that adheres to the evaporator components, limiting heat transfer. Finally, hazardous components, As, Se, Hg, and cyanide, were added to the simulant to determine their distribution after evaporation. Samples were analyzed for organomercury compounds, since Hg has the potential to react with the added antifoam to produce organomercury compounds. The evaporator was also used to produce the concentrated simulant for subsequent use in immobilization testing.

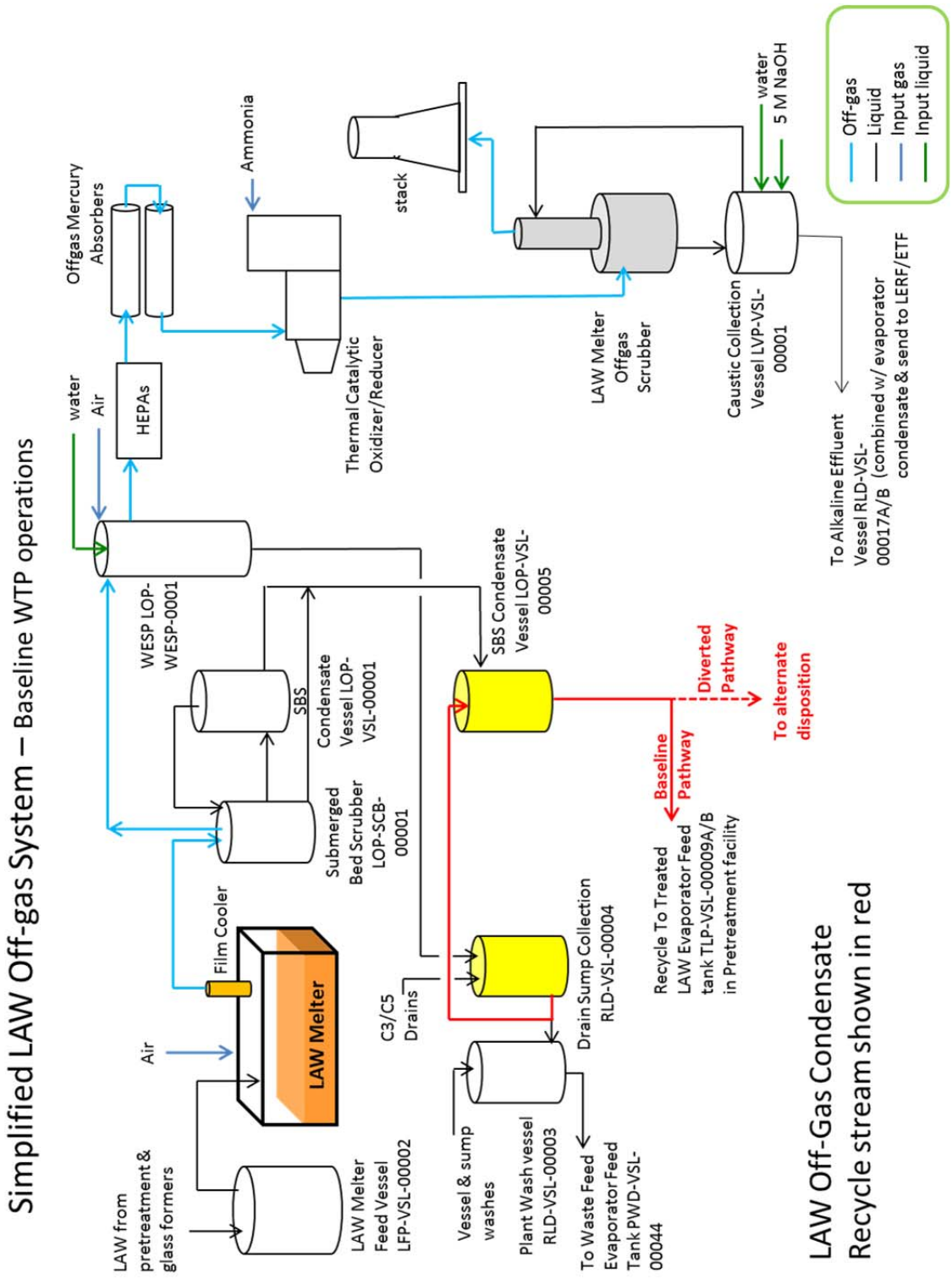

Figure 1-1. Simplified LAW Off-gas System

Note: (adapted from 24590-WTP-RPT-PT-02-005, Rev. 6; yellow indicates SBS/WESP LAW Off-Gas Condensate collection tanks, red lines indicate the collected off-gas condensate pathway)

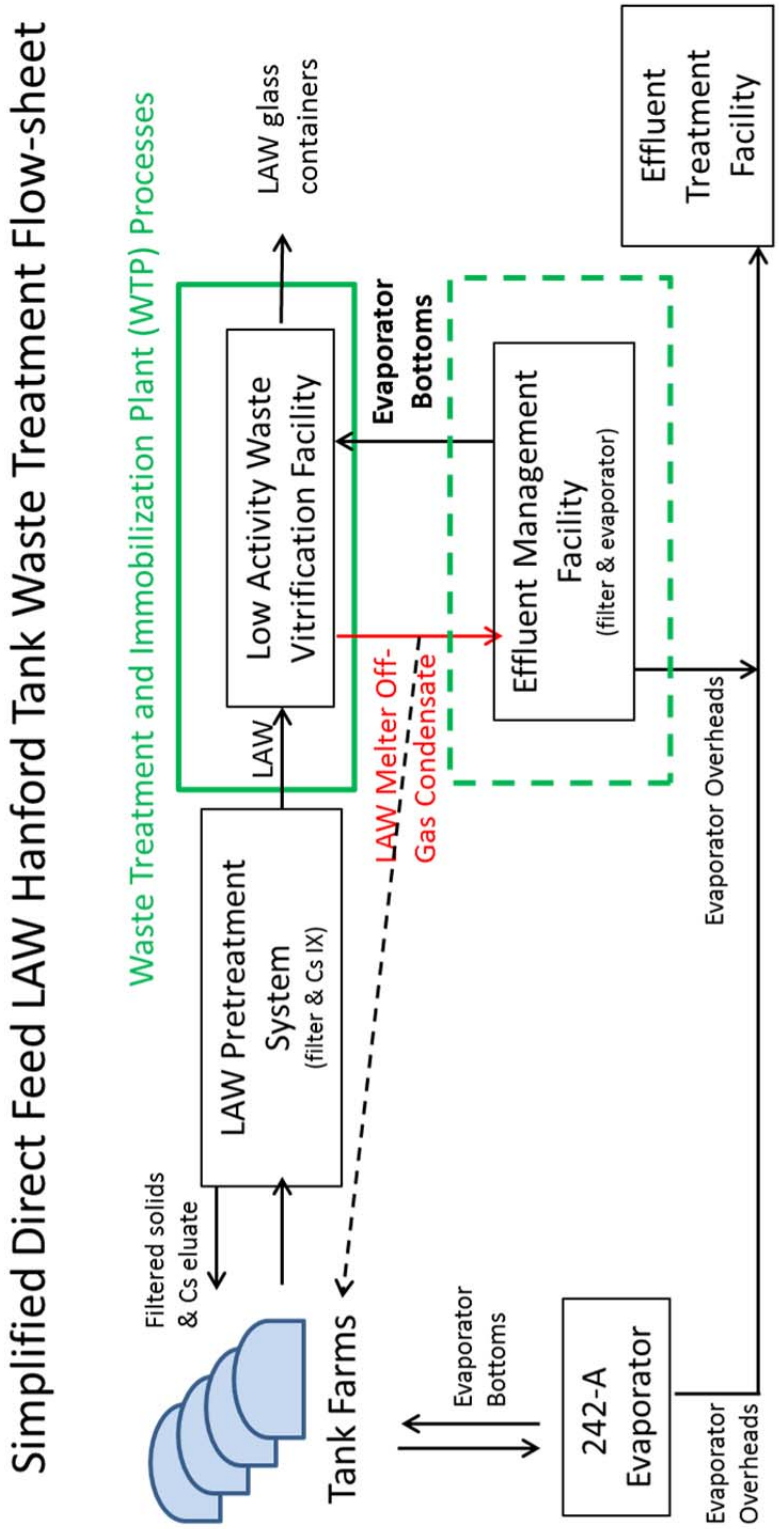

Figure 1-2. Simplified Schematic of the Direct Feed LAW (DFLAW) Scenario

1.2 Simulant Formulation

Results of the LMOGC stream analysis from VSL tests 4 and 6 were used as the basis for the core simulant chemical composition because these were generated while the melter was being fed a simulant of AN-105 and AN-104, respectively, which are in the queue for DFLAW processing. The preparation and analysis of the core simulant has been previously reported [6]. The target formulation is shown in Table 1-1. The amount of added silica was decreased compared to the previous formulation in order to add only the measured soluble amount. Selection of the Se and As species to add was based on the oxidation state of the volatile species. Selenium vaporizes from melters as SeO_2 at 317 °C, and As_2O_3 readily sublimes at 315 °C [12]

Table 1-1. EMF Core Condensate Simulant Formulation

Chemical	Formula	Target Mass (g)/L simulant*	Target Molarity
Potassium fluoride	KF	1.252	0.0216
Sodium chloride	NaCl	0.275	0.0047
Ammonium nitrate	NH_4NO_3	0.910	0.0114
Ammonium sulfate	$(NH_4)_2SO_4$	0.642	0.0049
Sodium sulfate	Na_2SO_4	0.963	0.0068
Potassium sulfate	K_2SO_4	2.20	0.0126
Ammonium chloride	NH_4Cl	2.343	0.0438
Silica	SiO_2	0.005	0.0001
Boric acid	$B(OH)_3$	5.250	0.0849
Zinc nitrate	$Zn(NO_3)_2$	0.241	0.0013
Sodium oxalate	$Na_2C_2O_4$	0.077	0.0006
Potassium hydroxide	KOH	0.980	0.0175
Sodium hydroxide (50 wt %)	NaOH	Adjust to pH 11.9	
Sodium chromate	Na_2CrO_4	0.108	0.0007
Sodium nitrite	$NaNO_2$	8.350	0.1210
Lithium carbonate	Li_2CO_3	0.213	0.0029
Arsenic(III) oxide	As_2O_3	0.079	4.0E-4
Selenium(IV) oxide	SeO_2	0.084	7.6E-4
Sodium cyanide	NaCN	0.027	5.5E-4
Mercury(II) nitrate monohydrate	$Hg(NO_3)_2 \cdot H_2O$	0.017	5.0E-5

*calculated weights assumes anhydrous reagent is used except mercury nitrate

Analytical results of the simulant used for this test are shown in Table 1-2. The results represent duplicate analyses of two samples; the first was collected when the simulant was first prepared, and the second was collected and analyzed in the course of this evaporation test. Most analytes are near the target. The mercury analysis is 29% above the target, but subsequent analysis by Eurofins Frontier Global Sciences indicates 10.2-10.4 mg/L (see Table 3-6). The silica is high as

well, but is likely due to trace quantities of silica in the other chemicals and the challenge of weighing 0.005-0.0101 mg of silicon dioxide during simulant production.

Table 1-2. EMF Core Simulant Filtrate Analysis Results

Species	Target (mg/L)	Result average (mg/L)	Std. Dev.*	Percent of Target
B	918	923	23	101
Cr	35	34.3	0.41	98.0
K	2511	2381	6.4	94.8
Li	40	42.1	0.48	105
Na	6765	6772	81	100
Si	2.8	6.10	0.26	218
Zn	83	72.5	10	87.4
As	60	62.6	3.3	104
Se	60	58.8	1.0	98.0
Hg	10	12.9	3.7	129
NH_4^+	1171	877	9.9**	74.9
Cl^-	1720	1681	5.0	97.7
F^-	409	408	2.1	99.7
NO_3^-	863	888	44	103
NO_2^-	5568	5900	53	106
SO_4^{-2}	2331	2525	96	108
CO_3^{-2}	173	NA	NA	NA
CN	14	15.4***	***	110
oxalate	50	< 100	-	-
Wt% solids	2.9	2.68	0.24	92.4
pH	11.9-12	12.3	0.1	-

* Standard deviation of the average of 4 measured values (single analyses of four samples).
**Two measurements of feed batch samples
*** single measurement of composited feed
NA = not analyzed; - = not applicable because of single measurement or less than detection limit

The simulant was prepared in three batches, two 2-L batches and one 1-L batch. The latter was originally prepared without Hg in order to obtain a "blank" for the mercury analysis, which was subsampled, and then Hg was spiked into the remaining 0.9 L. The composited batch, ~4.9 L of simulant, was clear yellow and was filtered prior to use to ensure that there were no insoluble solids. The density of the filtered simulant was 1.018 g/mL. The final, measured simulant pH was 12.3, slightly above the target (11.9-12). The total amount of 50 wt% sodium hydroxide solution added to achieve this pH was equivalent to 12.02 g/L based on the final liquid volume (in addition to the potassium hydroxide that was added during the preparation).

2.0 Experimental Procedure

2.1 Evaporator Test Apparatus

Figure 2-1 is a schematic of the EMF Evaporator Test Apparatus used for the simulant testing. During the design and construction, care was taken to have as few polymer parts as practicable. This would prevent the simulant in the evaporator pot and the off-gas from coming into contact with polymeric materials. This was as a precautionary measure, since if hydrophobic organometallic species like dimethylmercury formed, they might absorb into such materials and thereby avoid detection in the aqueous phases. The apparatus was constructed mostly with glass and stainless steel tubing. All testing was conducted inside a fume hood at SRNL's Aiken County Technical Laboratory (ACTL). The evaporator pot was a 1,000 mL modified glass beaker. The simulant was heated using a hot plate/stirrer (Torrey Pines Scientific) and continuously stirred with a glass-coated magnetic stir bar.

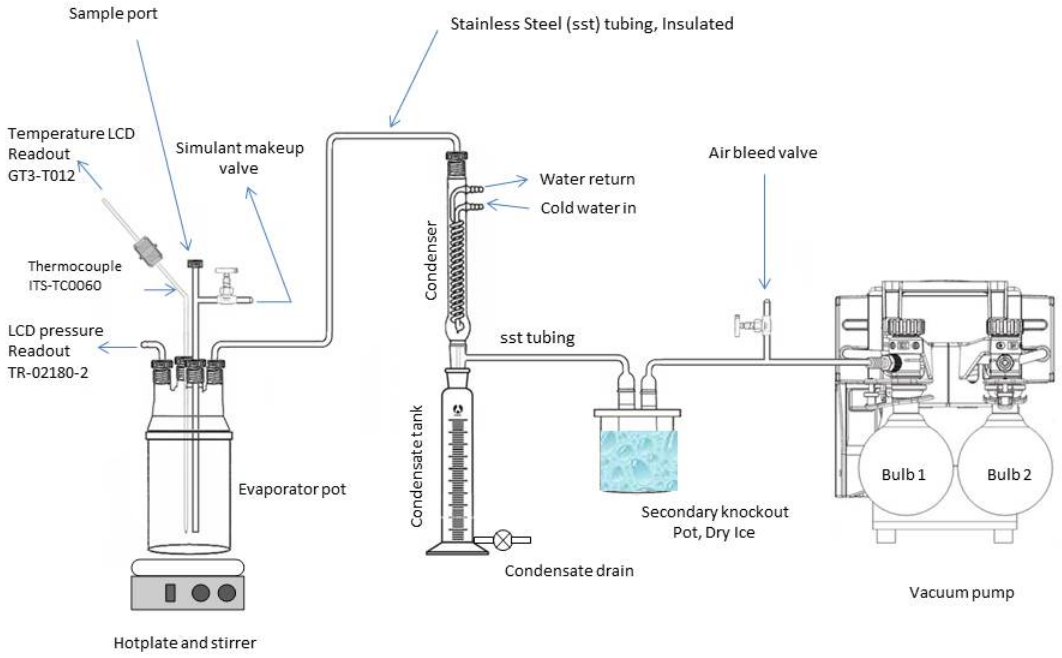

Figure 2-1. EMF Evaporator Test Apparatus

The contents of the pot were kept under a vacuum, typically at an absolute pressure of 2.4 inches of Hg (inHg) (equivalent to 60 torr). As a result, the simulant boiled at approximately 42 °C. The vapors traveled unrestricted to the glass condenser. There was no engineered demisting element designed into the off-gas line to knock out entrained particles, but the stainless steel line

was 58 cm high, which should have precluded entrainment. As the gases cooled in the condenser, the condensate drained into the glass Condensate Tank.

The Condenser was cooled using a Haake® Chiller (Model K20). The chiller, which was located outside the hood, maintained the cooling water at approximately 4 °C. Any vapors that passed through the condenser were condensed in the glass secondary Knockout Pot (KOP). The KOP was completely redesigned for this test campaign so that it was at a lower temperature to ensure that if any organomercury formed, it would be captured. The KOP was submersed in a Dewar with dry ice, where the temperature was maintained at approximately -78 °C. The vacuum in the system was created by a Vacuubrand® Diaphragm Vacuum pump, Type: MZ 2C. Figure 2-2 is an image of the EMF evaporator test apparatus.

Figure 2-2. Image of EMF Evaporator Apparatus

Figure 2-3 is an image of the KOP inserted in an aluminum tube submerged in the dry ice. The contents collected in the KOP were emptied each time the evaporator was shut down to empty the condensate tank. The contents collected inside the KOP were always frozen when it was disconnected and had to be thawed before they could be poured into the sample collection bottle. Care was taken to transfer the liquid as soon as it had thawed to minimize vapor losses. During the test campaign, two separate KOPs were used, one to allow time to thaw the collected contents and the other placed back into the dry ice to allow testing to continue.

Figure 2-3. Knockout Pot (KOP) in Dewar with Dry Ice

Table 2-1 is a list of Measurement and Test Equipment (M&TE) equipment used in the test apparatus during the EMF evaporator testing. (The numbers are unique identifiers that can be traced to calibration records.) The temperature of the simulant and the pressure in the system was monitored in the evaporator pot using a thermocouple and pressure transducer, respectively.

Table 2-1. M&TE Equipment used during the EMF Evaporator Testing

Equipment	M&TE
Pressure Transducer	TR-02180-2
Temperature LCD Readout	GT3-T012
Thermocouple, K type	ITS TC0060
Balance/scale	ITS-BL014
Balance/scale	ACTL-BL01

Before simulant testing, water was run through the EMF evaporator several times to ensure that all of the equipment and instruments were operating correctly. The water runs were conducted using only deionized (DI) water. The system operated under a vacuum at approximately 2.4

inHg and a temperature of 42 °C. This compares well with CRC Steam Tables [13] that show a boiling point of water at 108.0 °F (42.2 °C) at 1.2030 psia (2.45 inHg). The boil-off rate was approximately 5.2 mL/min. All equipment and instruments that made up the test apparatus operated as expected, as indicated by calibrated instrument readings and no evidence of pressure leaks.

The simulant used for the EMF testing was previously prepared and analyzed by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES) for metals and Ion Chromatography for anions and cations (ammonium). Before bench-scale EMF evaporator testing began, the approximate 4.9 liters of simulant was filtered using a 0.2 micron filter as shown in Figure 2-4 below. The feed simulant was filtered to remove insoluble solids, although none were visible prior to filtering. Similarly, no solids were visible after filtering the simulant.

Figure 2-4. Feed Simulant Filtration Step

As shown in the image, a vacuum (vacuum line is attached at the orange screw-on lid) was used to filter the simulant through the filter media. After filtering, there was 4,866.1 g of feed simulant, which was weighed into a separate container for use.

Xiameter ACP-3183 (lot# 0008884021) antifoam was added to the feed simulant during the evaporation (antifoam selection was specified by WRPS). The antifoam was diluted to 5% in DI water, and was cloudy white in appearance. To prepare the 5% antifoam solution, 3.0 mL of antifoam was mixed with 57 mL of DI water. The ACP-3183 mixed well with the DI water. For each 100 mL of simulant fed to the evaporator pot, 200 µL of diluted antifoam solution was added. This maintained a concentration of 100 mg/L of undiluted antifoam in the simulant throughout the experiment. Figure 2.5 is a picture of the concentrated Xiameter ACP-3183 antifoam, which is milky in appearance.

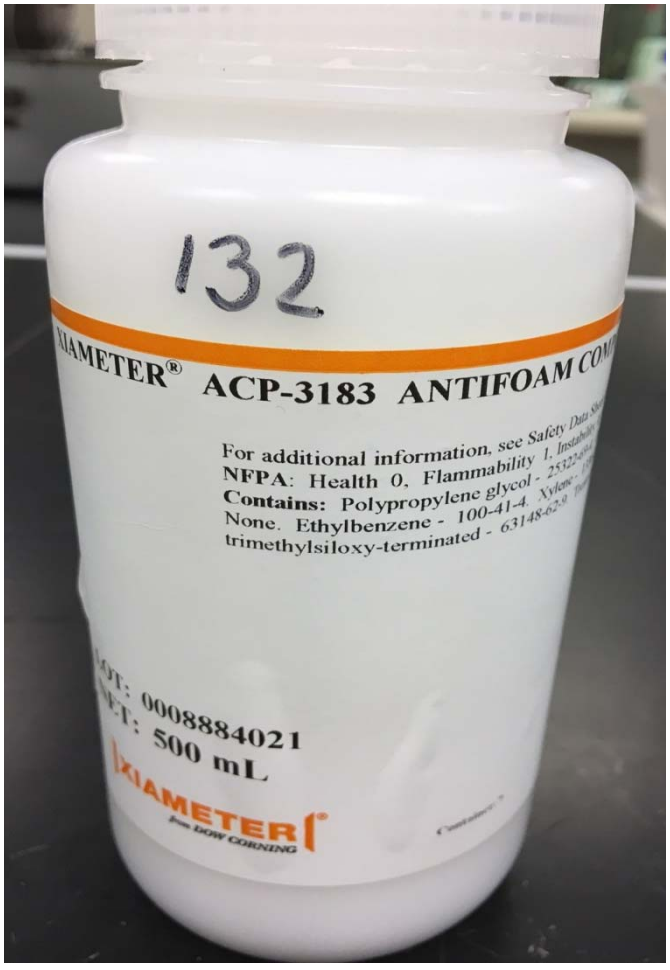

Figure 2-5. Xiameter ACP-3183 Antifoam

Initially, 400 mL of feed simulant with 800 µL of diluted antifoam was loaded into the evaporator pot. The pressure was adjusted to approximately 2.4 inches of mercury (inHg)

(equivalent 8.1 kPa; 60 torr, absolute, comparable to conditions used for previous boil-down tests performed by SRNL [8, 14] and the Hanford 242-A evaporator [9].

The simulant was heated using a hot plate and stirred continuously with a glass-coated magnetic stir-bar. The pressure in the system was 2.4 inHg and the solution boiled at approximately 42 °C. In order to achieve the desired concentration factor of 6.5X, and mimic a semi-continuous process, each time ~200 mL of condensate was collected ~200 mL of fresh simulant was added to the evaporator pot. During the first "concentration phase", a portion of the simulant was initially concentrated to the target concentration factor. As this phase progressed, after evaporating 200 mL from the evaporator pot, an additional 200 mL of (room temperature) feed simulant and 400 µL of diluted anti-foam was added to the pot to replenish the liquid level. This cycle was repeated until 1400 mL of simulant was evaporated down to an equivalent of 216 mL (accounting for extracted samples). At this point, boiling was paused and a ~ 100 mL sample was withdrawn from the evaporator pot, and the accumulated condensate was collected. These first concentrate and condensate samples were used in the organometallic analyses because they had been at evaporator temperature for the longest period of time of any subsequent sample and so was believed to be most likely to contain these species, if produced under these conditions. Fresh simulant was then added to the remaining concentrate in the evaporator pot, and boiling resumed. This was the "production phase," where some concentrated liquid from the evaporator pot was periodically removed, and fresh simulant and antifoam were added to restore the liquid level. At the end of the test campaign, the concentrated simulant density was 1.1 g/mL (including trace insoluble solids that formed after the liquid cooled).

Six 100 mL concentrated samples, collected from the pot at various points during the campaign when the concentration was projected to correspond to 6.5X, are detailed in Table 2-2. Correspondingly, seven condensate samples ~400-650 mL each) were pulled during the experiment. Each aliquot of feed and condensate were weighed and those masses were used to calculate concentrations in the evaporator pot to ensure that the experiment reached as close to the target 6.5X concentration factor as possible. In practice, the measured final concentration factors varied due to the ability to control the sample volume, and ranged from 6.26– 6.52X and averaged 6.40X, based on volume, for the six concentrated pot samples collected. (An example calculation is shown in Appendix A)

Table 2-2. Pot Sample Concentrations

Sample Name	Cumulative Total Simulant added to pot* (mL)	Cumulative Condensate & KOP collected (mL)	Concentrate density (g/mL)	Concentration Factor
Concentrate Pull 1	1402.8	1183.8	1.09	6.41X
Concentrate Pull 2	2101.4	1773.1	1.11	6.26X
Concentrate Pull 3	2802.8	2364.3	1.12	6.43X
Concentrate Pull 4	3504.3	2954.3	1.11	6.29X
Concentrate Pull 5	4205.7	3547.3	1.10	6.47X
Concentrate Pull 6	4706.7	3971.4	1.10	6.52X
			Average	6.40X

*Includes 200 µL of diluted antifoam added per 100 mL of feed simulant

2.2 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2. Results are recorded in Electronic Laboratory Notebook #O8825-00233-02. This report documents completion of Tasks 3.2 and 3.3 in the Task Technical and Quality Assurance Plan SRNL-RP-2015-01038, Rev. 1 [5].

3.0 Results and Discussion

3.1 Evaporator operation

The evaporator was operated under vacuum at approximately 2.4 inHg and boiling at approximately 42 °C for the entire test campaign. The temperature of the simulant and the pressure in the system was measured in the evaporator pot. The boil-off rate of the condensate was approximately 5.2 mL/min during the simulant test. As shown in Figure 3-1 the variance in pressure was minor over the entire test campaign, ranging from 2.21 inches Hg to 2.47 inches Hg. Likewise, only minor fluctuations in the temperature were observed. After initial heating, temperature readings ranged from 42.10 °C to 45.20 °C.

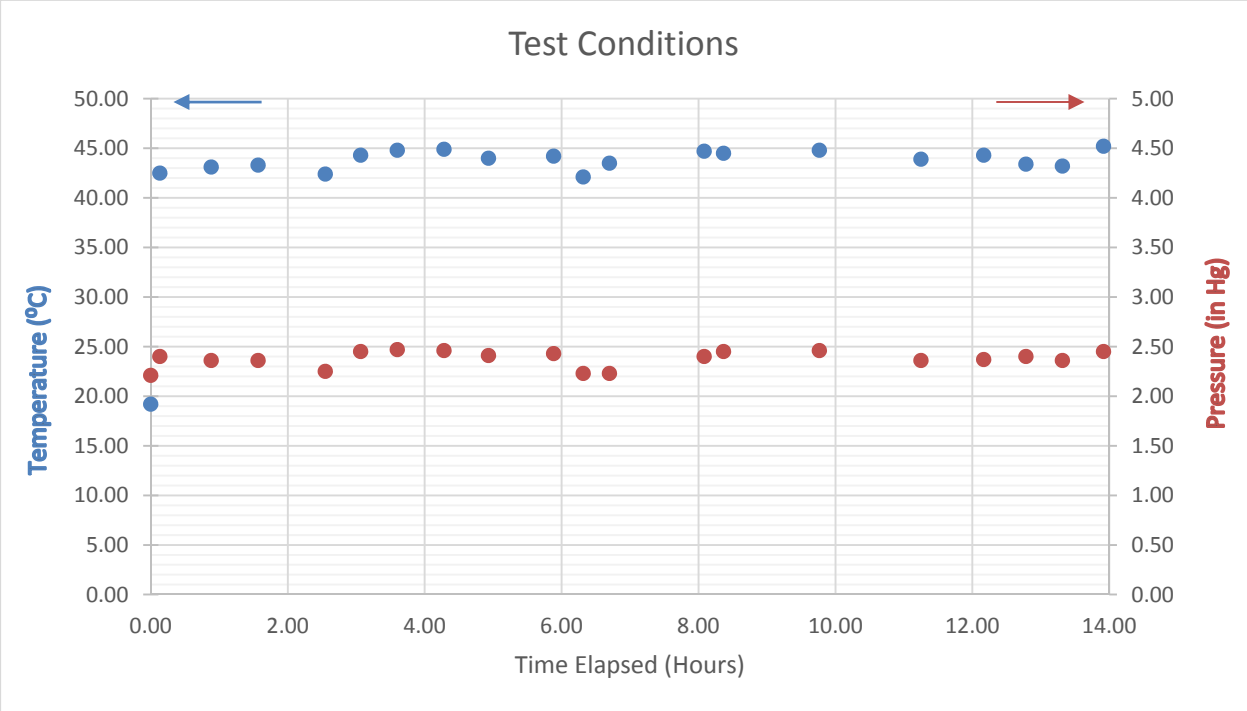

Figure 3-1. Test Conditions, Temperature and Pressure

Figure 3-2 is an image of the simulant boiling in the evaporator pot. The evaporator pot was typically insulated during operation, but insulation on the side of the evaporator pot was periodically moved to allow for visual observation. The liquid continued to boil during these brief evolutions and did not interrupt the experiment.

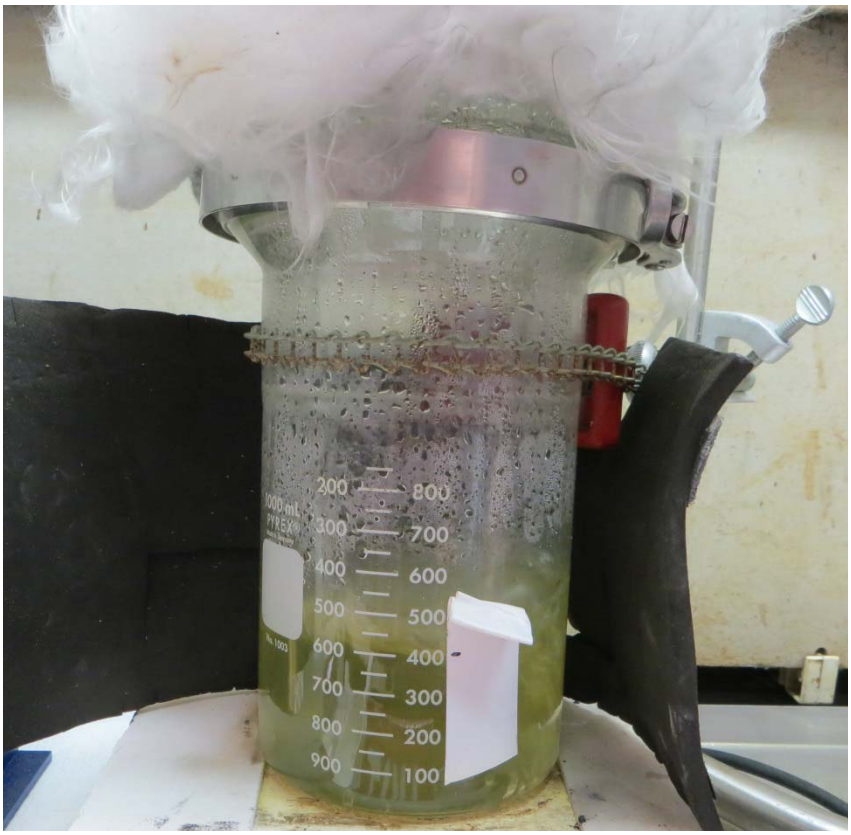

Figure 3-2. Simulant Boiling in the Evaporator Pot

The first 100 mL concentrate sample was pulled from the evaporator pot after boiling down (concentrating) to 6.41X, within ~1% of the target of 6.5X. This concentration was reached after the addition of approximately 1,400 mL of simulant and the collection of approximately 1,180 mL of condensate. All six of the 100 mL concentrate samples were taken from the pot at consecutive points when the concentration factor was re-established to ~6.5X. An image of the six samples is shown in Figure 3-3. Each 100 mL sample was removed from the evaporator pot using a large syringe to draw the liquid through stainless steel tubing into a glass bottle, and the sample was then weighed and the density was measured to obtain the actual volume of liquid withdrawn. All samples of liquid were collected and stored in glass bottles with polytetrafluoroethylene-lined caps.

Figure 3-3. Evaporator Concentrate Samples (~6.4X concentrated)

The evaporator was shut down seven times to collect the condensate from the condensate tank. Other than Condensate Pull 1, all the condensate was collected when the concentrate in the evaporator pot was calculated to be at 6.5X. Condensate Pull 1 was collected midway through the initial concentration phase, so the pot was not yet at 6.5X. Figure 3-4 is an image of the seven collections from the Condensate Tank. All of the condensate samples were clear and colorless.

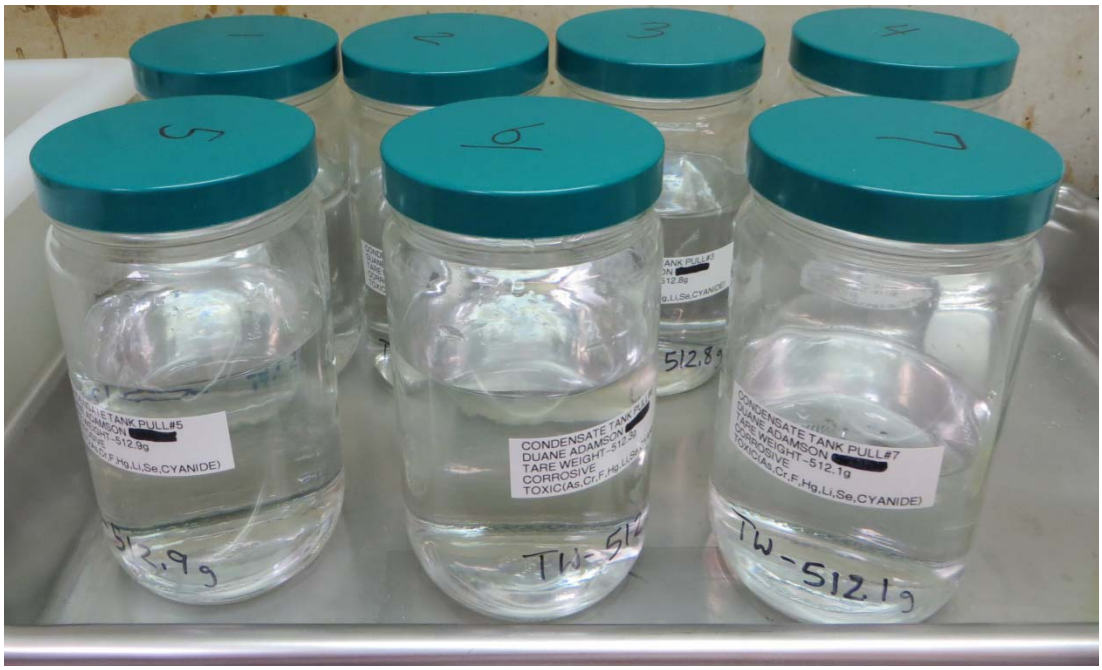

Figure 3-4. Condensate Samples Removed from Condensate Tank during the Test

At the end of the test campaign, the KOP had collected a total of 55.32 grams of condensate. The condensate collected in the KOP was collected each time the Condensate Tank was emptied. Typically, 7 to 8 mL were collected from the thawed KOP each time. The KOP condensate was kept in an ice chest to prevent the sample from warming up to room temperature, which could have allowed loss of semi-volatile species, such as the organomercury compounds. The KOP sample was stored in ice as it was accumulated, and the subsample sent for organomercury analysis was stored in a refrigerator overnight and shipped in coolers packed with gel packs and shipped via overnight delivery to the analytical laboratory. The KOP condensate was clear and colorless as depicted in Figure 3-5. In the image, the sample bottle appears frosted, but this is due to condensation from the air since it had just been removed from the ice chest. The KOP sample was also submitted for analysis for volatile organics, ammonia, total inorganic and organic carbon, and organomercury compounds.

Figure 3-5. Knockout Pot Sample Collected

Figure 3-6 is an image of the concentrated bottoms in the EMF evaporator pot at the end of the test campaign. There were traces of insoluble black solids visible in the pot. After the concentrate cooled, the solution appeared slightly cloudy with white precipitates, probably due to the antifoam, since it was cloudy when introduced to the evaporator.

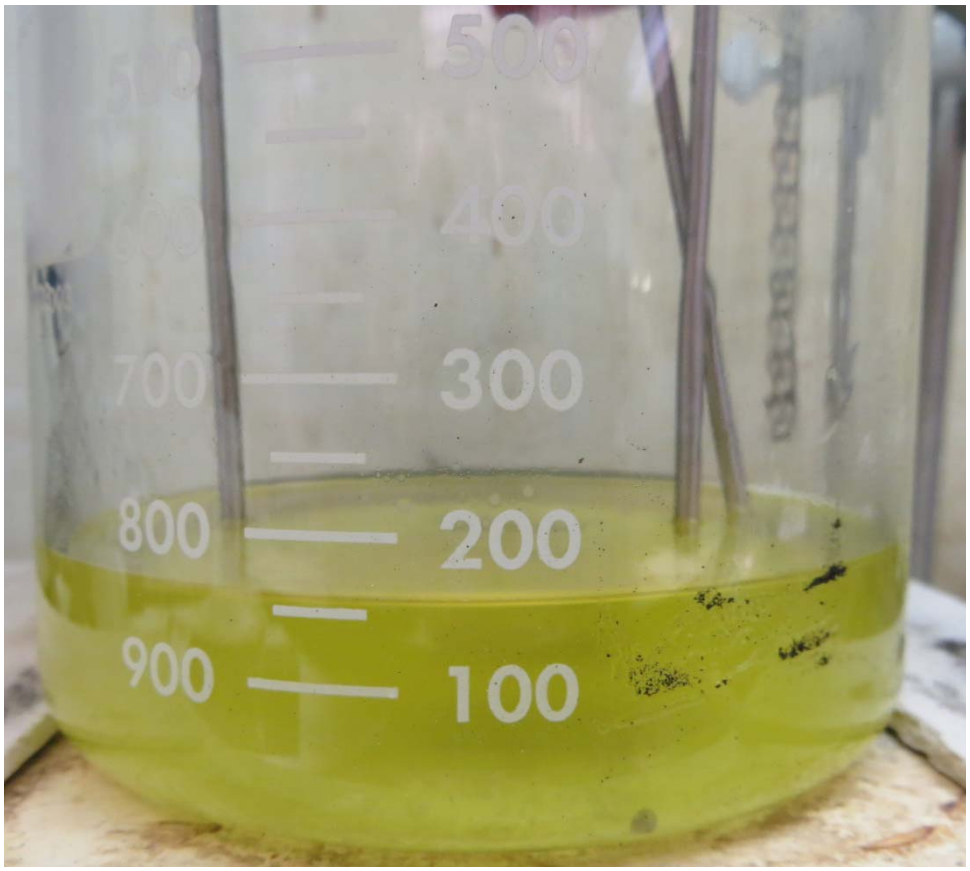

Figure 3-6. Evaporator Concentrate (~6.5X) at the End of Boil-down

A portion of the concentrate from the evaporator pot at the end of the test campaign was filtered to remove solids. Figure 3-7 is an image of the dried filter paper after filtering approximately 20 mL of the 6.5X concentrate. The filter paper was analyzed at the Process Science Analytical Laboratory in SRNL (PSAL) and using Scanning Electron Microscope scanning electron microscope (SEM) with Energy Dispersive X-ray Spectroscopy (EDS). It was concluded that it was not plausible to quantify the mass of insoluble solids because of the trace amount of insoluble solids versus the high soluble solids content, but is visually <<1 wt%. The insoluble solids did not dissolve in hydrofluoric acid at room temperature, and analysis of the HF solution did not indicate an increase in the relative amounts of Si or Zn.

Figure 3-7. Filter Paper (dried) after Filtering Concentrate

Figure 3-8 is from SEM/EDS analysis. It was determined that the dark particles were mostly Zn on the filter, as shown in Figure 3-9. There were also traces of Si that appears to be a fiber (probably from the glass fiber insulation).

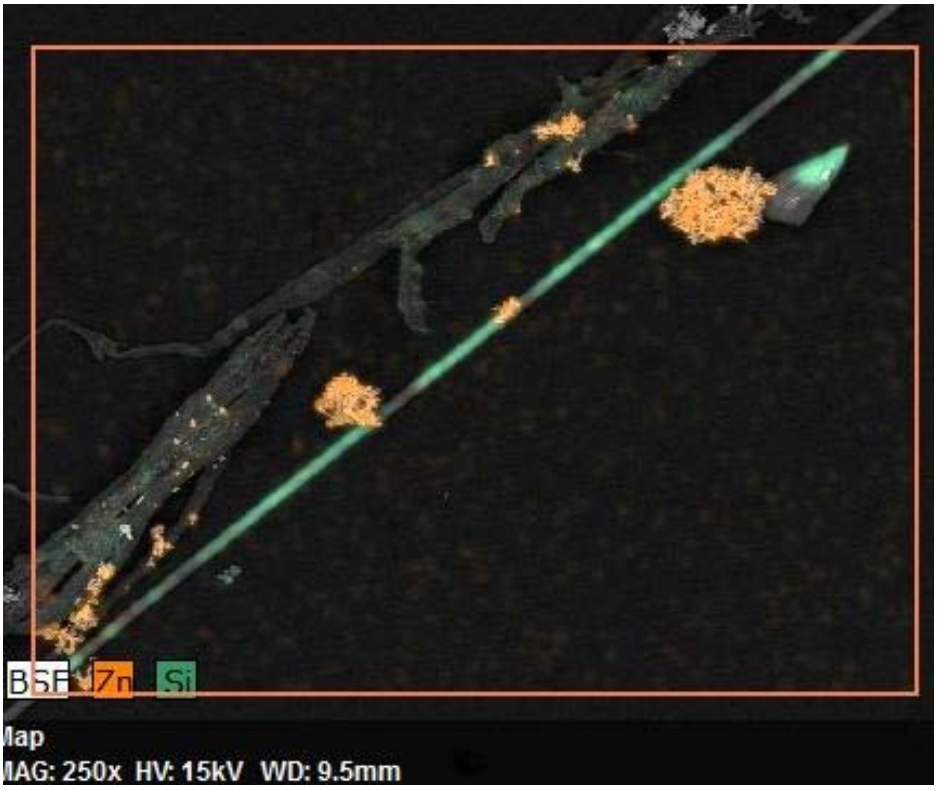

Figure 3-8. EDS Map of Solid on Concentrate Filter Paper

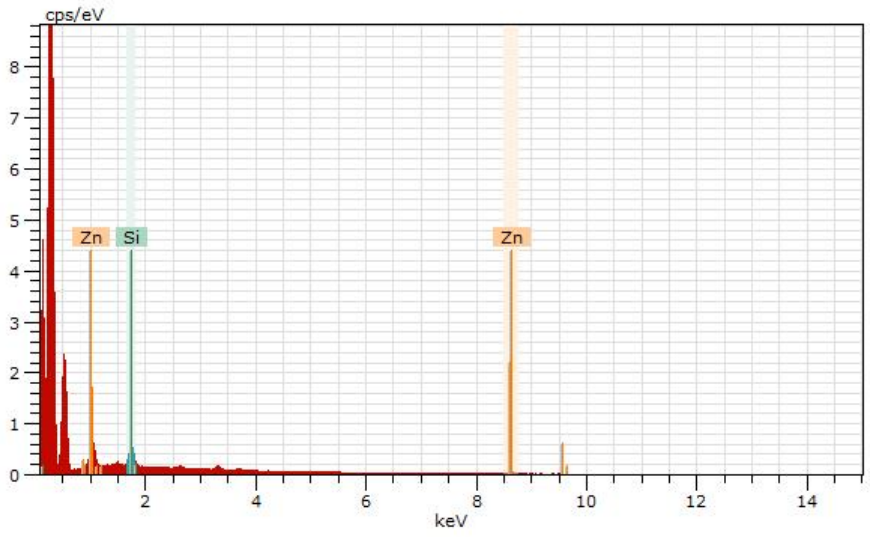

Figure 3-9. EDS Analysis of Solids on Concentrate Filter Paper

3.2 Sample Analysis Results

Evaporator Concentrate 1, Concentrate 3, Concentrate 5, and Concentrate 6 were analyzed for the same chemical species as the original EMF simulant. The concentrations of the individual species (metals, cations, and anions) are mainly uniform across the four concentrate samples, as depicted in Figure 3-10 and Figure 3-11. Weight percent (wt%) solids and the pH of the concentrate samples were also consistent. Weight percent solids ranged from 15.2% to 15.7% and the pH measurements ranged from 11.5-11.7.

Table 3-1. Concentrate Analytical Results

Species	Evaporator Concentrate 1		Evaporator Concentrate 3		Evaporator Concentrate 5		Evaporator Concentrate 6	
	Results (mg/L)	Std. Dev.	Results (mg/L)	Std. Dev.	Results (mg/L)	Std. Dev.	Results (mg/L)	Std. Dev.
B	5.82E+03	9.00E+01	5.70E+03	2.00E+02	6.18E+03	1.49E+02	6.06E+03	2.05E+02
Cr	2.01E+02	3.08E+00	2.05E+02	6.74E-01	2.12E+02	1.30E+01	2.09E+02	1.05E+01
K	1.64E+04	2.12E+02	1.60E+04	7.07E+01	1.59E+04	0.00E+00	1.55E+04	7.07E+01
Li	2.01E+02	1.90E+00	2.06E+02	1.07E-01	2.13E+02	1.14E+01	2.11E+02	9.69E+00
Na	4.56E+04	7.07E+01	4.38E+04	2.12E+02	4.40E+04	2.12E+02	4.29E+04	7.07E+01
Si	2.13E+01	1.05E+00	3.83E+01	3.93E+00	1.96E+01	1.18E-01	1.72E+01	1.31E+00
Zn	3.14E+02	7.47E+00	3.54E+02	1.21E+01	3.70E+02	2.30E+01	3.78E+02	1.70E+01
As	3.82E+02	3.35E+00	3.90E+02	6.00E+00	4.03E+02	2.39E+01	4.06E+02	1.89E+01
Se	3.65E+02	4.90E+00	3.74E+02	5.15E+00	3.84E+02	2.41E+01	3.84E+02	2.95E+01
Hg	9.59E+01	8.47E-01	9.34E+01	6.92E-01	9.34E+01	1.66E+00	8.81E+01	1.67E-01
NH_4^+	9.17E+01	-	NA	-	NA	-	7.88E+01	-
Cl^-	1.10E+04	7.07E+01	1.11E+04	2.12E+02	1.11E+04	2.12E+02	1.12E+04	7.07E+01
F^-	2.57E+03	7.07E+00	2.59E+03	5.66E+01	2.58E+03	4.24E+01	2.61E+03	2.12E+01
NO_3^-	6.15E+03	7.07E+00	6.20E+03	1.30E+02	6.17E+03	9.19E+01	6.21E+03	6.36E+01
NO_2^-	3.67E+04	7.17E+01	3.69E+04	7.07E+02	3.69E+04	4.96E+02	3.72E+04	4.24E+02
SO_4^{-2}	1.51E+04	0.00E+00	1.53E+04	3.54E+02	1.52E+04	1.41E+02	1.53E+04	1.41E+02
oxalate	3.30E+02	7.11E-01	3.31E+02	8.49E+00	3.31E+02	3.54E+00	3.33E+02	4.24E+00
Wt% solids	1.52E+01	-	1.57E+01	-	NA	-	1.57E+01	-
pH	1.15E+01	-	1.15E+01	-	NA	-	1.17E+01	-

NA = not analyzed; - = standard deviation is not applicable, since these were single measurements

The average concentrations calculated from the four concentrate samples are shown in Table 3-2 with the expected analytical results (based on the measured EMF simulant composition multiplied by a concentration factor of 6.5). The average concentrations generally align with the

expected results, except for Li, Si, Zn, and Hg. In general, these results help confirm that the concentration in the evaporator pot was consistently close to 6.5X as concentrate samples were pulled.

Table 3-2 Average Concentrate and Expected Analytical Results

Analytes/Analysis	Average Concentrate		Expected Result 6.5X Concentration Factor		Percent of Target
	Results (mg/L)	Std. Dev.	Results (mg/L)	Std. Dev.	
B	5.94E+03	2.16E+02	6.00E+03	1.48E+02	99.0
Cr	2.07E+02	4.79E+00	2.23E+02	2.67E+00	92.7
K	1.59E+04	3.68E+02	1.55E+04	4.14E+01	102
Li	2.08E+02	5.38E+00	2.74E+02	3.12E+00	75.9
Na	4.40E+04	1.12E+03	4.40E+04	5.27E+02	100
Si	2.41E+01	9.61E+00	3.97E+01	1.69E+00	60.8
Zn	3.54E+02	2.85E+01	4.71E+02	6.78E+01	75.1
As	3.95E+02	1.12E+01	4.07E+02	2.11E+01	97.1
Se	3.77E+02	9.14E+00	3.82E+02	6.57E+00	98.6
Hg	9.27E+01	3.29E+00	8.39E+01	2.41E+01	110
NH_4^+	8.53E+01	9.12E+00	*Concentration Factor of 6.5 not applicable due to ammonia volatility		
Cl^-	1.11E+04	8.16E+01	1.09E+04	3.25E+01	101
F^-	2.59E+03	1.68E+01	2.65E+03	1.38E+01	97.6
NO_3^-	6.18E+03	2.87E+01	5.77E+03	2.84E+02	107
NO_2^-	3.69E+04	2.27E+02	3.84E+04	3.42E+02	96.2
SO_4^{-2}	1.52E+04	8.54E+01	1.64E+04	6.26E+02	92.7
VOA	<0.25	-	N/A	N/A	N/A
Total Carbon	2.12E+02	8.50E+00	N/A	N/A	N/A
Total Inorganic Carbon	1.46E+02	6.03E+00	N/A	N/A	N/A
Total Organic Carbon	6.60E+01	2.50E+00	N/A	N/A	N/A

VOA = volatile organic analysis; NA = not analyzed; - = standard deviation is not applicable, since these were single measurements

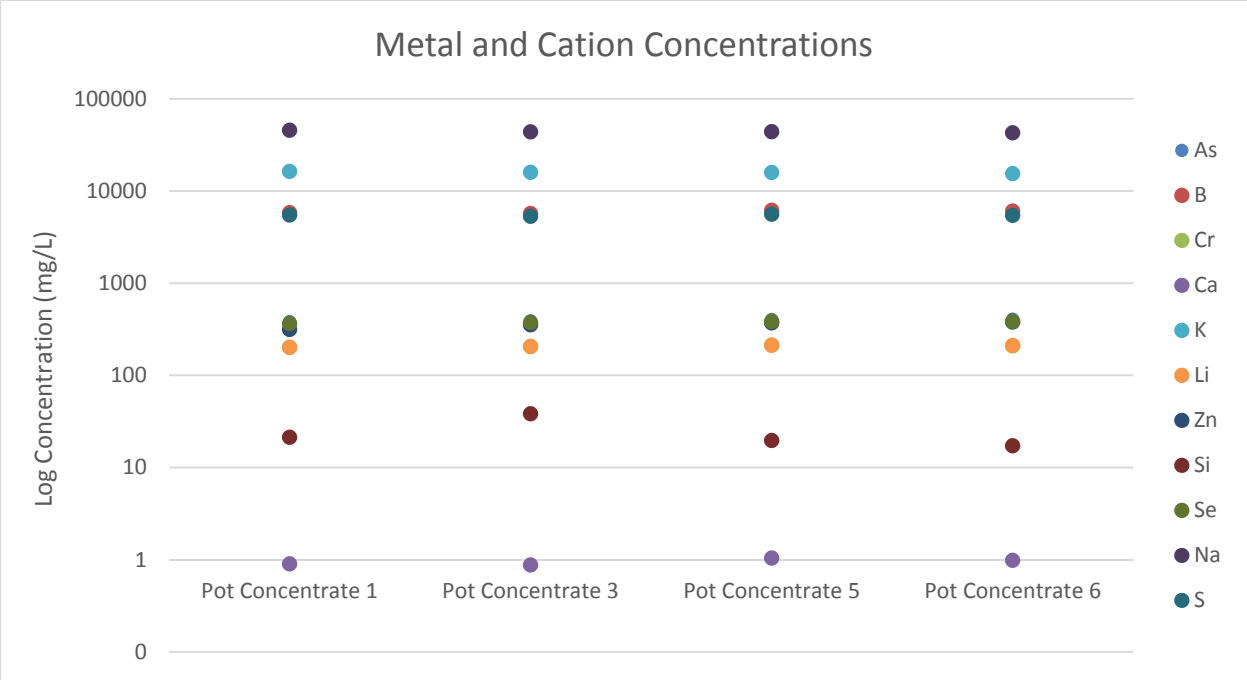

Figure 3-10. Concentrated Simulant, Cations

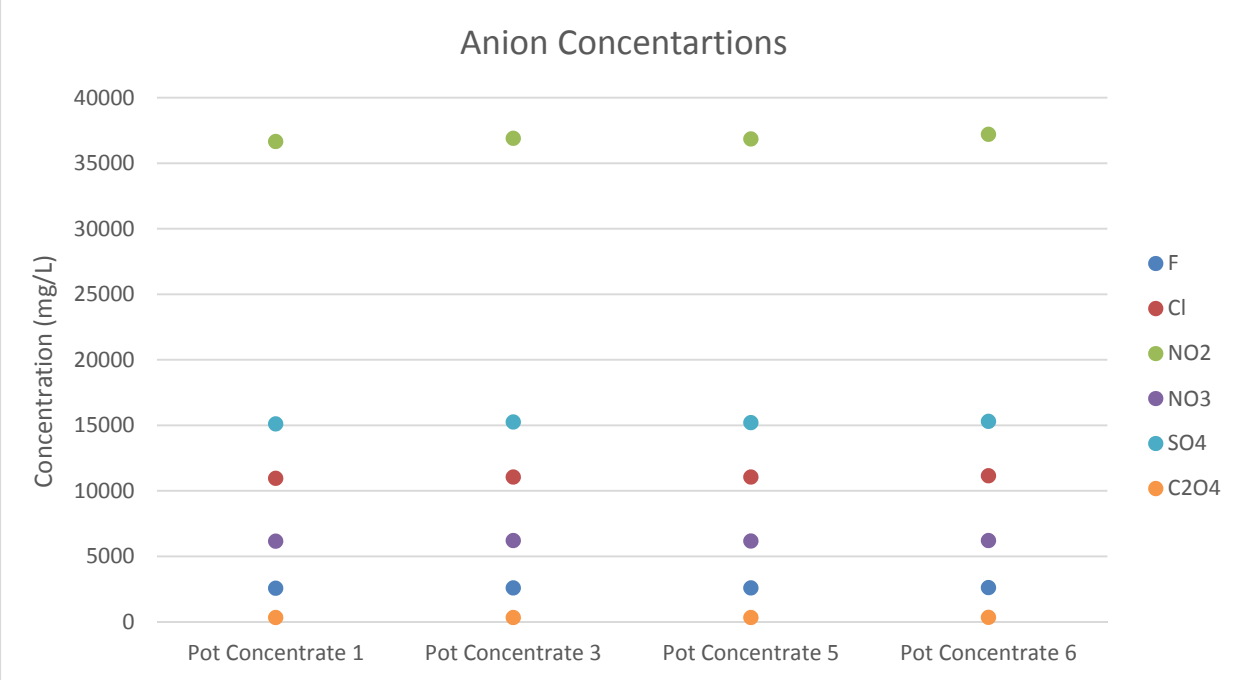

Figure 3-11. Concentrated Simulant, Anions

The mercury concentrations obtained from the same concentrate samples are depicted in Figure 3-12. The mercury concentration ranged from 95.9 mg/L (Pot Concentrate 1) to 88.1 mg/L (Pot Concentrate 6).

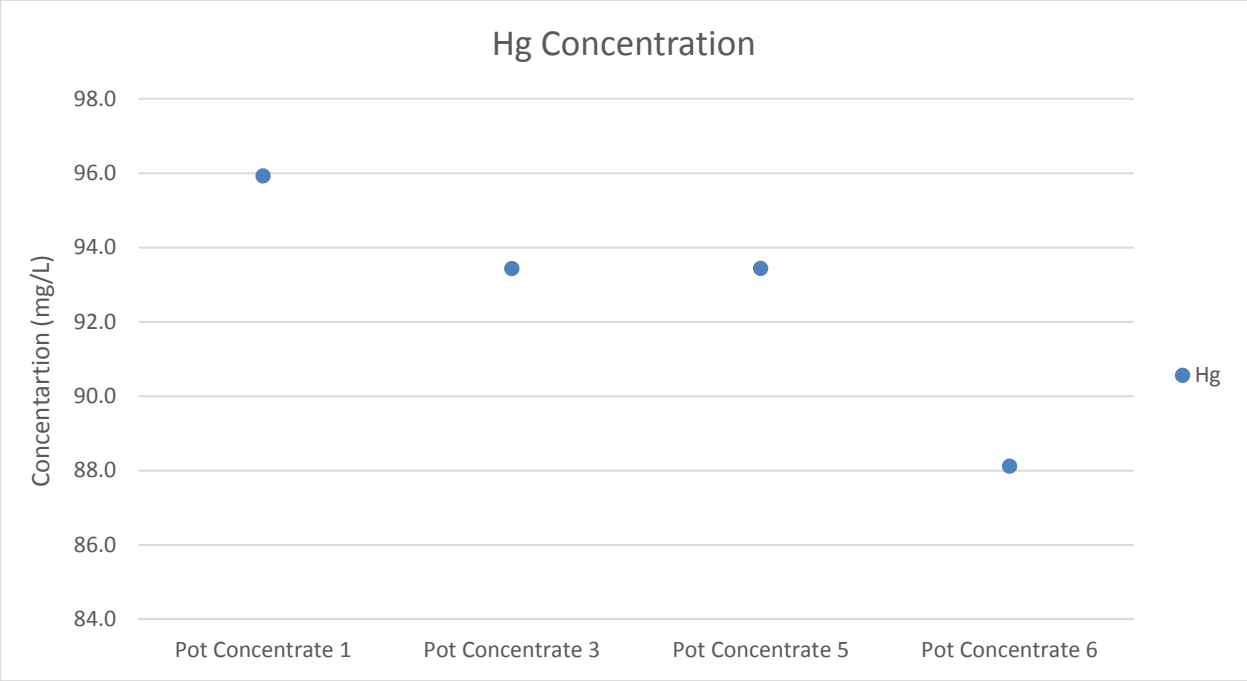

Figure 3-12. Mercury Concentration in the ~6.5X Concentrate

The measured concentrations of components in the simulant are tabulated in Appendix B. As discussed above, the contents of the condensate tank were emptied seven times during the run and stored in separate glass bottles. These storage bottles were subsampled and 20 mL of each was submitted for analysis. Table 3-3 gives the summary of results from the condensate analysis. The silicon in the condensate may have resulted from the glassware utilized in the EMF evaporator system or the glass storage bottles. Trace amounts of inorganic carbon are attributed to absorption of carbon dioxide from the air. All other analytes were below detection.

Table 3-3. **Condensate Analytical Results**

Sample	Na		Si		NH4+	pH	VOA	SVOA	TC	TIC	TOC
	Results (mg/L)	Std. Dev.	Results (mg/L)	Std. Dev.	Results (mg/L)	Results	Results (mg/L)		Results (µg C/mL)		
Condensate 1	2.91	0.072	3.70	0.132	562	11	< 0.05	<0.1	< 3	2.00	< 1
Condensate 2	3.80	0.292	5.01	0.812	706	10.9	< 0.05	<0.1	< 3	1.88	< 1
Condensate 3	2.86	0.024	< 1.00	-	545	10.9	< 0.05	<0.1	< 3	2.08	< 1
Condensate 4	3.54	0.029	7.03	0.054	552	10.9	< 0.05	<0.1	< 3	1.80	< 1
Condensate 5	3.98	0.009	5.06	0.078	555	10.8	< 0.05	<0.1	< 3	1.92	< 1
Condensate 6	3.69	0.005	< 1.00	-	580	10.9	< 0.05	<0.1	< 3	1.32	< 1
Condensate 7	3.26	0.042	4.50	0.409	565	10.8	< 0.05	<0.1	< 3	1.92	< 1

VOA = volatile organic analysis; SVOA = semivolatile organic analysis; TC = total carbon; TIC = total inorganic carbon, TOC = total organic carbon

The condensate ICP-OES results gave very low to below detectable levels of many of the constituents in the simulant, shown in Appendix B. Since sodium is the dominant species, any entrainment would be most easily detected by analyzing sodium. Other non-volatile components would be expected to have comparable entrainment behavior, and thus have comparable decontamination factors, but are beneath the analysis detection limits so cannot be calculated. The sodium concentration in the condensate is less than 4 mg/L. Therefore, the decontamination factor (i.e., evaporator concentrate concentration divided by condensate concentration) for sodium exceeds 11,000.

Ammonium (NH_4^+) was present in all the condensate samples as shown in Figure 3-13. The ammonia concentration typically ranged from 545 mg/L to 580 mg/L, except for Condensate 2. In this case, the ammonium concentration was 706 mg/L, but the reason this one is higher has not been identified.

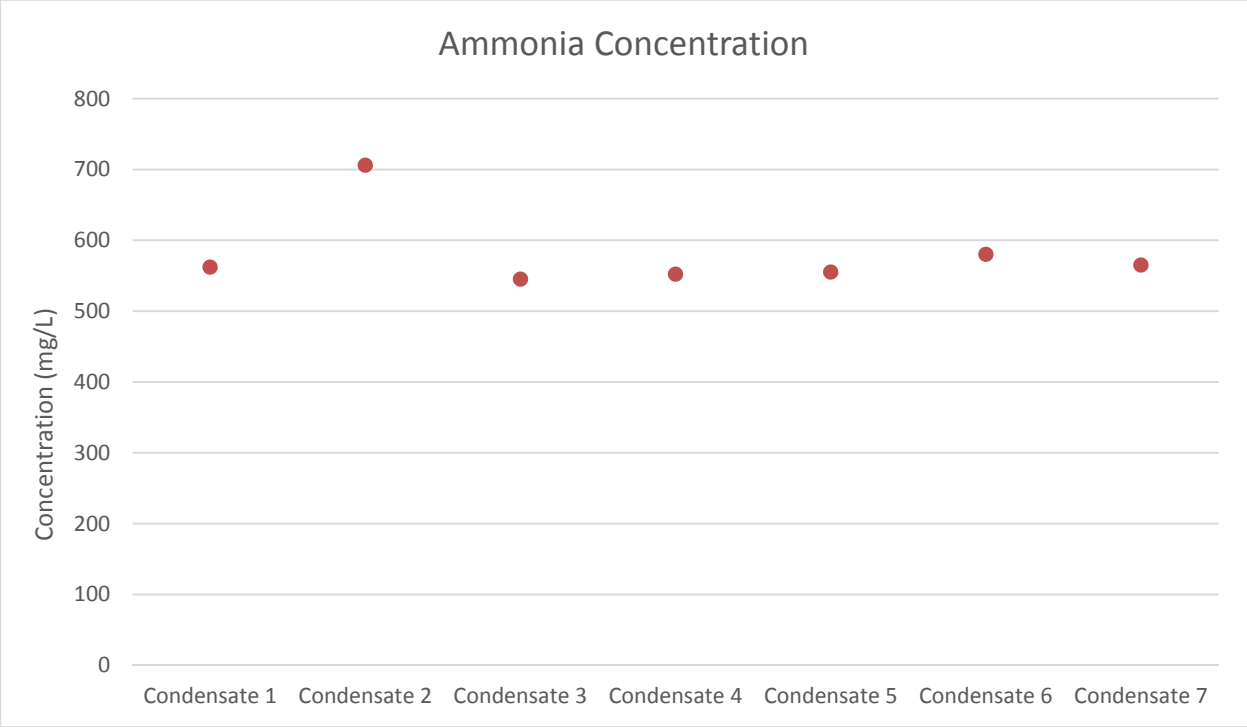

Figure 3-13. Ammonia Concentration in Condensate

Table 3-4 depicts a total volume and ammonium mass balance. A total of 4700 mL of simulant, containing 4122 mg of ammonium, was fed to the evaporator over the course of testing. From the condensate, KOP, and concentrate, 4729 mL of liquid was recovered. This liquid volume corresponds to a percent recovery of 100.6%. Due to its volatility, it was predicted that virtually all ammonium would convert to ammonia and evaporate and be present in the condensate. The condensate and concentrate, however, only contained approximately 2309 mg and 64 mg of ammonium, respectively. This corresponds to a percent recovery of 57.6%. Water and ammonia

are the two major volatile species in the experiment. Table 3-4 shows an excellent water balance, as calculated by volume. In contrast, ammonium shows a significant loss. The imbalance is unlikely due to analytical error in ammonium measurement in the condensate since the condensate had little other than ammonium and water and therefore should not have had interferences. There was instead perhaps interference in the evaporator concentrate analysis, since it has a wide range of potentially interfering species, or a reaction that caused its loss. The reason for the poor mass balance for ammonium is not currently known. Prior work [14] had good mass balance, and demonstrated that essentially all of the ammonia partitioned to the condensate.

Table 3-4. Total Volume and Ammonium Balance

Sample	Total Liquid Volume (mL)	NH4+ (mg/L)	NH4+ (mg)
Simulant + antifoam	4709	877	4122
Condensate 1	596	562	334
Condensate 2	573	706	404
Condensate 3	583	545	317
Condensate 4	584	552	322
Condensate 5	583	555	324
Condensate 6	586	580	339
Condensate 7	419	565	236
Knockout Pot	55	600	33
Concentrate	750[1]	85[2]	64[2]
SUM (Condensate, Knockout, Concentrate)	4729	-	2373
Percent Recovery	100.4%	-	57.6%

[1] Sum of collected concentrate
[2] Average value

The volume (55.32 mL) of condensate in the Knockout Pot was collected over time during the test campaign. Results of the analysis of the condensate collected in the knockout pot are shown in Table 3-5. The ammonium concentration is in line with the condensate samples. The extreme cold of the KOP did not change the ammonium to water ratio in KOP concentrate, indicating that ammonia probably did not exit the system. Physical loss of ammonia appears unlikely.

A Gas Chromatography-Mass Spectroscopy (GC-MS) of the KOP sample assigned the volatile organic species as two acrylate compounds based on the fragmentation pattern of the molecules in the ionizer. Whether these are actually the compounds present, or some similar species is not known. The origin of these species are not known, but could be due to trace organic materials in the system, such as polymeric bottle cap liners, stopcock grease, antifoam, or plastic tubing that connected the KOP to the vacuum pump.

Table 3-5. Knockout Pot Analysis Results

Analyte/Analysis	Concentration (mg/L)	% UNC
NH_4^+	600	10
Methyl Acrylate	1.3	20
Isobornyl Acrylate	0.85	20
All other SVOA	< 0.01	20
VOA	< 0.05	20
Total Carbon	<8	10
Total Inorganic Carbon	7.2	10
Total Organic Carbon	<1	10

VOA = volatile organic analysis
SVOA = semivolatile organic analysis
%UNC = percent uncertainty; 1 standard deviation

Table 3-6 and Table 3-7 are summary tables of the analysis that was performed by Eurofins Frontier Global Sciences Inc. (Bothell, WA). Details of the analysis are provided in Appendix C. The samples were prepared by subsampling the liquids and diluting them to the vendor-specified concentration. The water used for dilution, and bottles used for shipping were provided by Eurofins Frontier Global Sciences Inc. Samples for monomethyl mercury and inorganic arsenic were diluted into 0.18% degassed hydrochloric acid. All other samples were diluted into water and shipped in either clear or amber bottles, as specified by Eurofins. The bottles were shipped overnight in coolers packed with frozen gel packs in an attempt to maintain their temperature at 4 °C. One of the coolers did not arrive in the overnight shipment, and was not received by Eurofins until three days later. The temperature of the samples in that cooler upon arrival was 19.5 °C. Regardless of this, the samples in that cooler were analyzed as planned, since it is unlikely that significant changes would have occurred during storage.

Table 3-6. Eurofins Sample Analysis

Analyte	Sample Description	Dilution Corrected Concentration (mg/L)	Std. Dev.
Total Arsenic	EMF Simulant w/o Hg	6.43E+01	-
	EMF Simulant w/ Hg	7.05E+01	3.39E+00
	EMF Concentrate (Bottoms)	4.37E+02	3.92E+01
	EMF Condensate	2.9E-02	1.8E-04
	EMF Knockout pot	1.3E-02	1.9E-04
Inorganic Arsenic	EMF Simulant w/o Hg	5.99E+01	-
	EMF Simulant w/ Hg	4.98E+01	5.84E+00
	EMF Concentrate (Bottoms)	3.11E+02	4.35E+00
	EMF Condensate	1.01E-02	7.95E-04
	EMF Knockout pot	8.61E-04	2.90E-04
Total Mercury	EMF Simulant w/o Hg	1.55E-02	-
	EMF Simulant w/ Hg	1.04E+01	7.33E-01
	EMF Concentrate (Bottoms)	7.87E+01	8.34E+00
	EMF Condensate	2.83E-03	3.63E-05
	EMF Knockout pot	1.08E-03	5.85E-05
Dissolved Mercury	EMF Simulant w/o Hg	9.87E-03	-
	EMF Simulant w/ Hg	1.02E+01	6.92E-01
	EMF Concentrate (Bottoms)	7.06E+01	9.37E+00
	EMF Condensate	2.62E-03	3.06E-05
	EMF Knockout pot	8.51E-04	5.61E-05
Inorganic Mercury	EMF Simulant w/o Hg	1.15E-02	-
	EMF Simulant w/ Hg	4.65E+00	8.09E-01
	EMF Concentrate (Bottoms)	2.94E+01	6.85E+00
	EMF Condensate	2.16E-03	3.56E-04
	EMF Knockout pot	2.45E-04	9.82E-05
Mercury (0)	EMF Simulant w/o Hg	4.83E-03	-
	EMF Simulant w/ Hg	1.96E-02	2.28E-02
	EMF Concentrate (Bottoms)	7.20E-02	9.03E-03
	EMF Condensate	2.01E-04	1.12E-04
	EMF Knockout pot	1.08E-04	3.08E-05

The difference between the arsenic and inorganic arsenic measurements were intended to reveal if any organoarsenic compounds formed. The total arsenic for one sample of EMF simulant

w/Hg was 70.5 mg/L of which 49.8 mg/L was inorganic arsenic, which would suggest some organoarsenic had formed. However, this is not possible, since these are feed samples, and no organic compounds containing methyl groups had been added at that point, only oxalate ion. The EMF concentrate (bottoms) sample indicates 437 mg/L of arsenic and 311 mg/L of inorganic arsenic. This suggests that an organoarsenic compound was present, but is not conclusive, since these measurements are indirectly derived by difference, rather than directly by a quantitative organoarsenic method. Furthermore, the Relative Percent Difference (RPD) for the method for total arsenic measurement is 20%, and 35% for the inorganic arsenic, not including the error due to these large dilutions. The largest difference in the results are between the total and inorganic arsenic for the EMF Simulant with Hg, with 70.5 mg/L for the total and 49.8 mg/L for the inorganic arsenic. Applying the RPD to both of these values shows that the range of the results overlap, indicating that the total and inorganic arsenic concentrations are not statistically different, within the quality control limits. Further, inspection of the inorganic arsenic measurements reveals that the results of the EMF Concentrate sample was 311 mg/L, which is 6.2X the EMF Simulant w/ Hg (49.8 mg/L). The same ratio of 6.2X was measured for the total arsenic in EMF concentrate (437 mg/L) versus EMF simulant w/Hg (70.5 mg/L). Prior to addition of organic antifoam and evaporation, it was not possible for organoarsenic compounds to be present, so it is not possible that this could indicate organoarsenic compounds. Since the results indicate roughly the appropriate ratio of concentrations of total arsenic and inorganic arsenic in the evaporator feed to evaporator concentrate (6.2X vs. 6.4X), this further indicates that the difference between total arsenic and inorganic arsenic is due to analysis variance and not organoarsenic compounds.

The total soluble, dissolved, and inorganic mercury measurements indicate a small background of mercury contamination in the chemicals used to prepare the simulant, with ~0.02 mg/L in the simulant prepared without mercury. According to correspondence from Eurofins, this is not unusual. The total soluble and dissolved mercury indicate that the concentration in the EMF simulant with mercury was about as expected at ~10 mg/L, however, the inorganic mercury was only half of what was expected, which should have also been ~10 mg/L. The reason for this is not known, but is not due to the presence of other forms of mercury, since no methylated organic chemicals had been added at this point, and the mercury (0) measurement does not indicate that any of the mercuric nitrate added was reduced. Similar to the organoarsenic analysis results, the total and dissolved mercury are roughly twice the inorganic mercury analysis result, suggesting an organomercury compound. However, there are differences in the preparation of the total and soluble mercury samples before the analysis. During sample preparation, the total and soluble mercury samples are pre-oxidized with bromine monochloride, and then that solution is reduced with hydroxylamine hydrochloride, followed by stannous chloride addition that converts the mercury to metallic form for vapor analysis. Conversely, the sample preparation for inorganic mercury involves only treatment with the stannous chloride. It is plausible that the hydroxylamine hydrochloride reduces some of the other transition metals in the total and soluble mercury samples, such as chromium, which would otherwise be reduced by the subsequent stannous chloride addition. Since the inorganic mercury analysis method does not have this hydroxylamine hydrochloride addition, those metals would not be pre-reduced, and the stannous chloride may be consumed by those other transition metals, preventing complete reduction of mercury by stannous ion and causing a lower than expected result. Further work would be needed to confirm that this is the cause. Regardless, it is evident from the speciation results that the unaccounted for mercury is not present as metallic, methyl, or dimethyl mercury, so is not

expected to be problematic since they are not volatile since they are not in the condensate at appreciable concentration. Further, similar to the organoarsenic discussion above, the ratios between dissolved mercury before and after evaporation (70.6 mg/L vs. 10.2 mg/L or 6.9X) and between inorganic mercury before and after evaporation (29.4 mg/L vs. 4.65 mg/L or 6.3X) indicates that the discrepancy is analysis variability or a matrix effect.

The total soluble, dissolved, and inorganic mercury are consistent for the EMF condensate and knockout pot samples, with ~0.002 mg/L and ~0.0008 mg/L, respectively. These are probably due to trace carryover. The mercury (0) is consistently low in all of these samples.

As indicated in Table 3-7, methyl mercury and dimethyl mercury were below detection limits in all but one sample. Methyl mercury was detected in the Knockout pot sample with a concentration of 0.127 µg/L. This value, however, is below the reporting limit of 0.225 µg/L and only slightly above the detection limit of 0.116 µg/L. The results were reviewed by Eurofins Frontier Global Sciences Inc. and confirmed to be a valid, measured result.

Table 3-7. Eurofins Sample Analysis

Analyte	Sample Description	Dilution Corrected Concentration (µg/L)	Dilution Corrected Detection Limit (µg/L)	Dilution Corrected Reporting Limit (µg/L)
Methyl Mercury (as Mercury)	EMF Simulant w/o Hg	< 5.80E+00	5.80E+00	1.13E+01
	EMF Simulant w/ Hg	< 5.80E+00		
	EMF Concentrate (Bottoms)	< 2.90E+01	2.90E+01	5.63E+01
	EMF Condensate	< 1.16E-01	1.16E-01	2.25E-01
	EMF Knockout pot	1.27E-01		
Dimethyl Mercury	EMF Simulant w/o Hg	< 6.00E-01	6.00E-01	1.00E+00
	EMF Simulant w/ Hg	< 6.00E-01		
	EMF Concentrate (Bottoms)	< 3.00E+00	3.00E+00	5.00E+00
	EMF Condensate	< 1.20E-02	1.20E-02	2.00E-02
	EMF Knock out pot	< 1.20E-02		

Table 3-8 is a summary table of the cyanide analysis on the samples. The analysis was performed by Southwest Research Institute (SWRI) located in Warner Robins, GA. Results of the feed to the EMF were as expected, containing ~14 mg/L, although the EMF concentrate contained only 56.4 mg/L versus a calculated 91 mg/L. This is perhaps due to analytical analysis interference. The condensate samples did not contain appreciable cyanide, as expected, because the EMF feed is pH>12, which would tend to favor the cyanide ion and inhibit formation of semi-volatile hydrogen cyanide.

Table 3-8. SWRI Sample Analysis, Cyanide

Analyte	Sample Description	Result (mg/L)
Total Cyanide	EMF Feed w/o Hg	13.1*
	EMF Feed w/o Hg; Duplicate	14.2*
	EMF Feed w/ Hg	15.4
	EMF Concentrate Bottoms 1	56.4
	EMF Condensate 2	0.222
	EMF Condensate 4	0.235

*These are duplicate analysis of one sample;
Relative Percent Difference of duplicate analyses: 8.06%

4.0 Conclusions

- A simulant of the projected feed to the EMF evaporator at Hanford's WTP was successfully evaporated in a bench-scale EMF Evaporator.
- At the end of the test campaign, the simulant had been concentrated to the target 6.5X with a density of 1.10 g/mL.
- No insoluble solids were visible in the concentrate at the end of the test campaign when it was still hot, but it became slightly cloudy and trace amounts of dark insoluble solids appeared, estimated at much less than 1 wt%, as it cooled. SEM/EDS indicated that the solids contained zinc, and the cloudiness could be due to the antifoam.
- The evaporation caused most of the ammonia to strip and partition to the condensate stream, although the mass balance was poor for unknown reasons.
- Decontamination factor for this experiment exceeded 1.1E+04, based on sodium concentrations in the pot versus the condensate.
- Despite adding antifoam that contained organic chemicals, the mercury did not convert to dimethyl mercury and only trace amounts of monomethyl mercury were found in the knock-out pot sample, although it was below the analysis method reporting limit. Essentially all of the mercury remained in the pot in an inorganic form, >99.95%.
- While analysis results indicate that the majority of total arsenic and cyanide remained in the pot, there was detectable carryover of these into the condensate.
- Total and inorganic arsenic results in the evaporator feed and concentrate do not agree, and although this could indicate that some organoarsenic may have also formed in the evaporator pot, this is not considered likely. It cannot be confirmed that the total and inorganic concentrations are different because the analysis results overlap within the quality control limits. Also, the initial sample, prior to addition of organic chemicals that would be needed to form organoarsenic compounds, had the same ratio of total and inorganic arsenic, indicating that there is an interference in the analytical analysis method. Further, the analysis is an indirect method using a difference of total versus inorganic arsenic, and is not a direct method that would confirm its formation.
- A discrepancy was also seen with mercury analysis, where the total and soluble mercury were nearly twice the inorganic mercury measurement, suggesting another form was

present. However, the ratios of soluble and inorganic mercury in the evaporator feed and concentrate were very similar to the concentration factor, indicating that there are interferences in the analysis method. This is tentatively attributed to the sample preparation method that may not have consistently reduced all of the mercury to the metallic form prior to measurement.

5.0 Future Work

Further testing is underway to use the evaporator pot samples to perform immobilization tests. The objective of this testing is to determine if an immobilized waste form can be produced that passes the disposal criteria for the hazardous constituents.

6.0 References

1. Britton, M.D., Evaluation of EMF Evaporator Down Time Returns to Tank Farms, RPP-RPT-59257, Rev 0A, June, 2016

2. Vienna, J.D, Kim, D.S., Skorski, D.C., Matyas, J., Glass Property Models and Constraints for Estimating the Glass to be Produced at Hanford by Implementing Current Advanced Glass Formulation Efforts, PNNL-22631, EWG-RPT-003, July, 2013

3. Mann, F.M., Puigh, R.J., Khaleel, R., Finfrock, S., McGrail, B.P., Bacon, D.H., Serne, R.J., Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies, RPP-17675, Rev. 0, September 29, 2003.

4. Duignan, M.R., Adamson, D.J., Calloway, T.B., Fowley, M.D., Qureshi, Z.H., Steimke, J.L., Williams, M.R., Zamecnik, J.R., Final Report: RPP-WTP Semi-Integrated Pilot Plant, WSRC-TR-2005-00105, June, 2005.

5. McCabe, D.J., Task Technical and Quality Assurance Plan for (ICP) Secondary Liquid Waste Stream Technology Maturation, SRNL-RP-2015-01038, Rev. 1, November 16, 2016

6. Abramowitz, H., Brandys, M., Cecil, D'Angelo, N., Matlack, K.S., Muller, I.S., Pegg, I.L., Callow, R.A., Joseph, I., Technetium Retention in WTP LAW Glass with Recycle Flow-Sheet: DM10 Melter Testing, VSL-12R2640-1, Rev. 0, RPP-54130, September, 2012

7. McCabe, D.J., Nash, C.A., Adamson, D.J., Formulation and Preparation of Hanford Waste Treatment Plant Direct Feed Low Activity Waste Effluent Management Facility Core Simulant, SRNL-STI-2016-00313, Rev. 0, June, 2016.

8. Adamson, D.J., Nash, C.A. McCabe, D.J. Crawford, C.L., Wilmarth, W.R., Laboratory Evaporation Testing of Hanford Waste Treatment Plant Low Activity Waste Off-Gas Condensate Simulant, SRNL-STI-2013-00713, January, 2014

9. Tu, T.A., The Flammability Analysis and Time to Reach Lower Flammability Limit Calculations on the Waste Evaporation at 242-A Evaporator, RPP-CALC-29700, Rev. 1, October, 2007

10. 24590-BOF-3PS-MEVV-T0001, Rev 0, DFLAW Effluent Management Facility Process System (DEP) Evaporator System

11. *Ammonia*, National Research Council, University Park Press, Baltimore, MD (1979)

12. Volf, M.B. Chemical Approach to Glass, 1984, Glass Science and Technology, V. 7 Elsevier. QD139.G5 V6413 1984

13. *CRC Handbook of Chemistry and Physics*, 61st edition, 1980-1981, CRC Press, Boca Raton, FL

14. Adamson, D.J., Nash, C.A., McClane D. L., McCabe D.J., Evaporation of Hanford Waste Treatment Plant Direct Feed Low Activity Waste Effluent Management Facility Core Simulant, SRNL-STI-2016-00408, September, 20

7.0 Appendices

Appendix A. Concentration Factor Sample Calculation

Appendix B. PSAL Results

Appendix C. Analytical Development Results

Appendix D. Eurofins Results

Appendix E. Southwest Research Institute Results

7.1 Appendix A. Concentration Factor Sample Calculation

Concentration Factors were calculated as follows:

Concentration Factor = Incremental Feed Added (mL) / [Pre Sample Pot Level (mL) – Post Sample Pot Level (ml)*]

Pre Sample Pot Level (mL) = Incremental Feed Added (mL) – Condensate & KOP Removed (mL) + Post Sample Pot Level (ml)*]

Post Sample Level (mL) = Pre Sample Pot Level (mL) – Concentrate Removed (mL)

*Post sample pot level from previous sample pull

Sample Calculations

Concentrate Pull # 1:

Pre Sample Pot Level (mL) = 1402.8 mL – 1183.8 mL + 0 mL* = 219.0 mL

Post Sample Level (mL) = 219.0 mL – 100 mL = 119.0 mL

Concentration Factor = 1402.8 mL / [219.0 mL – 0* mL] = 6.41

Concentrate Pull # 2:

Pre Sample Pot Level (mL) = 701.4 mL – 589.3 mL + 119.0* = 231.1 mL

Post Sample Level (mL) = 231.1 mL – 100 mL = 131.1 mL

Concentration Factor = 701.4 mL / [231.1 mL – 119.0* mL] = 6.26

*Post sample pot level from previous sample pull

7.2 Appendix B. PSAL Results

Species/Analysis	As	B	Ca	Cr	K	Li	Na	S	Se	Si	Zn	Hg	F	Cl	NO_2	NO_3	SO_4	C_2O_4	Total Solids	pH
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%	-
Pot Concentrate 1-1	384	5750	0.796	204	16200	202	45500	5400	368	20.5	309	95.3	2560	10900	36600	6140	15100	329	15.2	11.5
Pot Concentrate 1-2	380	5890	1.00	199	16500	199	45600	5560	361	22.0	319	96.5	2570	11000	36700	6150	15100	330	NA	NA
Pot Concentrate 1-avg	**381.9**	**5820.0**	**0.9**	**201.4**	**16350.0**	**200.8**	**45550.0**	**5480.0**	**364.7**	**21.3**	**314.0**	**95.9**	**2565.0**	**10950.0**	**36650.0**	**6145.0**	**15100.0**	**329.5**	-	-
Std. Dev.	*3.35*	*98.99*	*0.15*	*3.08*	*212.13*	*1.90*	*70.71*	*113.14*	*4.90*	*1.05*	*7.47*	*0.85*	*7.07*	*70.71*	*70.71*	*7.07*	*0.00*	*0.71*	-	-
Pot Concentrate 3-1	386	5840	0.854	205	15900	206	43600	5410	370	35.5	345	92.9	2630	11200	37400	6290	15500	337	15.7	11.5
Pot Concentrate 3-2	395	5560	0.898	206	16000	206	43900	5220	377	41.1	362	93.9	2550	10900	36400	6110	15000	325	NA	NA
Pot Concentrate 3-avg	**390.4**	**5700.0**	**0.9**	**205.0**	**15950.0**	**205.6**	**43750.0**	**5315.0**	**373.7**	**38.3**	**353.8**	**93.4**	**2590.0**	**11050.0**	**36900.0**	**6200.0**	**15250.0**	**331.0**	-	-
Std. Dev.	*5.99*	*197.99*	*0.03*	*0.67*	*70.71*	*0.11*	*212.13*	*134.35*	*5.15*	*3.93*	*12.09*	*0.69*	*56.57*	*212.13*	*707.11*	*127.28*	*353.55*	*8.49*	-	-
Pot Concentrate 5-1	386	6280	1.06	203	15900	205	44100	5720	367	19.7	354	92.3	2550	10900	36500	6100	15100	328	NA	NA
Pot Concentrate 5-2	420	6070	1.02	221	15900	221	43800	5460	401	19.5	386	94.6	2610	11200	37200	6230	15300	333	NA	NA
Pot Concentrate 5-avg	**403.4**	**6175.0**	**1.0**	**211.8**	**15900.0**	**212.6**	**43950.0**	**5590.0**	**384.2**	**19.6**	**370.2**	**93.4**	**2580.0**	**11050.0**	**36850.0**	**6165.0**	**15200.0**	**330.5**	-	-
Std. Dev.	*23.93*	*148.49*	*0.02*	*12.96*	*0.00*	*11.42*	*212.13*	*183.85*	*24.10*	*0.12*	*22.60*	*1.66*	*42.43*	*212.13*	*494.97*	*91.92*	*141.42*	*3.54*	-	-
Pot Concentrate 6-1	419	6200	0.998	216	15500	218	42800	5330	405	18.1	390	88.0	2590	11100	36900	6160	15200	330	15.7	11.7
Pot Concentrate 6-2	393	5910	0.970	201	15400	204	42900	5540	363	16.3	366	88.2	2620	11200	37500	6250	15400	336	NA	NA
Pot Concentrate 6-avg	**405.9**	**6055.0**	**1.0**	**208.8**	**15450.0**	**210.7**	**42850.0**	**5435.0**	**384.0**	**17.2**	**377.9**	**88.1**	**2605.0**	**11150.0**	**37200.0**	**6205.0**	**15300.0**	**333.0**	-	-
Std. Dev.	*18.88*	*205.06*	*0.02*	*10.45*	*70.71*	*9.69*	*70.71*	*148.49*	*29.53*	*1.31*	*16.95*	*0.17*	*21.21*	*70.71*	*424.26*	*63.64*	*141.42*	*4.24*	-	-
Condensate 1-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.96	<1.00	<1.00	3.80	<1.00	<0.100	<100	<100	<100	<500	<500	<100	<0.10	11
Condensate 1-2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.86	<1.00	<1.00	3.61	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 1-avg	-	-	-	-	-	-	**3.69**	-	-	**3.70**	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.072*	-	-	0.132	-	-	-	-	-	-	-	-	-	-
Condensate 2-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.59	<1.00	<1.00	5.58	<1.00	<0.100	<100	<100	<100	<500	<500	<100	0.2	10.9
Condensate 2-2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	4.00	<1.00	<1.00	4.44	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 2-avg	-	-	-	-	-	-	**3.80**	-	-	**5.01**	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.292*	-	-	0.812	-	-	-	-	-	-	-	-	-	-
Condensate 3-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.87	<1.00	<1.00	<1.00	<1.00	<0.100	<100	<100	<100	<500	<500	<100	0.1	10.9
Condensate 3-3	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.84	<1.00	<1.00	<1.00	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 3-avg	-	-	-	-	-	-	**2.86**	-	-	-	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.0244*	-	-	-	-	-	-	-	-	-	-	-	-	-
Condensate 4-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.56	<1.00	<1.00	7.07	<1.00	<0.100	<100	<100	<100	<500	<500	<100	<0.10	10.9
Condensate 4-2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.52	<1.00	<1.00	6.99	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 4-avg	-	-	-	-	-	-	**3.54**	-	-	**7.03**	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.0285*	-	-	*0.0538*	-	-	-	-	-	-	-	-	-	-
Condensate 5-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.99	<1.00	<1.00	5.01	<1.00	<0.100	<100	<100	<100	<500	<500	<100	<0.10	10.8
Condensate 5-2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.97	<1.00	<1.00	5.12	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 5-avg	-	-	-	-	-	-	**3.98**	-	-	**5.06**	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.0091*	-	-	*0.0781*	-	-	-	-	-	-	-	-	-	-
Condensate 6-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.68	<1.00	<1.00	<1.00	<1.00	<0.100	<100	<100	<100	<500	<500	<100	<0.10	10.9
Condensate 6-2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.69	<1.00	<1.00	<1.00	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 6-avg	-	-	-	-	-	-	**3.69**	-	-	-	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.0054*	-	-	-	-	-	-	-	-	-	-	-	-	-
Condensate 7-1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.29	<1.00	<1.00	4.79	<1.00	<0.100	<100	<100	<100	<500	<500	<100	<0.10	10.8
Condensate 7-2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	3.23	<1.00	<1.00	4.21	<1.00	<0.100	<100	<100	<100	<500	<500	<100	NA	NA
Condensate 7-avg	-	-	-	-	-	-	**3.26**	-	-	**4.50**	-	-	-	-	-	-	-	-	-	-
Std. Dev.	-	-	-	-	-	-	*0.0422*	-	-	*0.4085*	-	-	-	-	-	-	-	-	-	-

7.3 Appendix C. Analytical Development Results

Sample	$NH4^+$ (10% unc)	VOA (20% unc)	SVOA (20% unc)	Methyl Acrylate (20% unc)	Isobornyl Acrylate (20 % unc)	Total Carbon (10 % unc)	Inorganic Carbon (10 % unc)	Organic Carbon (10 % unc)
	µg/mL	µg/mL	µg/mL	µg/mL	µg/mL	µg C/mL	µg C/mL	µg C/mL
EMF Condensate 1	562	< 0.05	< 0.1	NA	NA	< 3	2.00	< 1
EMF Condensate 2	706	< 0.05	< 0.1	NA	NA	< 3	1.88	< 1
EMF Condensate 3	545	< 0.05	< 0.1	NA	NA	< 3	2.08	< 1
EMF Condensate 4	552	< 0.05	< 0.1	NA	NA	< 3	1.80	< 1
EMF Condensate 5	555	< 0.05	< 0.1	NA	NA	< 3	1.92	< 1
EMF Condensate 6	580	< 0.05	< 0.1	NA	NA	< 3	1.32	< 1
EMF Condensate 7	565	< 0.05	< 0.1	NA	NA	< 3	1.92	< 1
KOP	600	< 0.05	<0.1	1.3	0.85	< 8	7.20	< 1
Pot Concentrate 1	91.7	< 0.25	NA	NA	NA	203	140	63.2
Pot Concentrate 2	75.8	< 0.25	NA	NA	NA	212	145	66.8
Pot Concentrate 3	NA	NA	NA	NA	NA	NA	NA	NA
Pot Concentrate 4	NA	NA	NA	NA	NA	NA	NA	NA
Pot Concentrate 5	NA	NA	NA	NA	NA	NA	NA	NA
Pot Concentrate 6	78.8	< 0.25	NA	NA	NA	220	152	68.0

7.4 Appendix D. Eurofins Results

eurofins | Frontier Global Sciences

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30 June 2017

Daniel McCabe
Savannah River Nuclear Solutions
SRNS, Bldg 773-42A
Aiken, SC 29808

RE: Mercury and Arsenic Speciation

Enclosed are the analytical results for samples received by Eurofins Frontier Global Sciences. All quality control measurements are within established control limits and there were no analytical difficulties encountered with the exception of those listed in the case narrative section of this report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Amy Goodall
Project Manager

eurofins | Frontier Global Sciences

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
G16945 Blank-A	1705610-01	Water	17-May-17 00:00	19-May-17 09:45
G16945 Blank-A Dissolved	1705610-02	Water	17-May-17 00:00	19-May-17 09:45
G16946 Blank-B	1705610-03	Water	17-May-17 00:00	19-May-17 09:45
G16190 Blank-C	1705610-04	Water	17-May-17 00:00	19-May-17 09:45
B170329 Blank-D	1705610-05	Water	17-May-17 00:00	19-May-17 09:45
G16948 Blank preserved-A	1705610-06	Water	17-May-17 00:00	19-May-17 09:45
B170341 Blank preserved-B	1705610-07	Water	17-May-17 00:00	19-May-17 09:45
G16949 Evap Feed-A	1705610-08	Water	17-May-17 00:00	19-May-17 09:45
G16949 Evap Feed-A Dissolved	1705610-09	Water	17-May-17 00:00	19-May-17 09:45
G16950 Evap Feed-B	1705610-10	Water	17-May-17 00:00	19-May-17 09:45
G16950 Evap Feed-B Dissolved	1705610-11	Water	17-May-17 00:00	19-May-17 09:45
G16951 Evap Feed-C	1705610-12	Water	17-May-17 00:00	19-May-17 09:45
G16952 Evap Feed-D	1705610-13	Water	17-May-17 00:00	19-May-17 09:45
G16191 Evap Feed-E	1705610-14	Water	17-May-17 00:00	19-May-17 09:45
G16192 Evap Feed-F	1705610-15	Water	17-May-17 00:00	19-May-17 09:45
B170343 Evap Feed-G	1705610-16	Water	17-May-17 00:00	19-May-17 09:45
B170345 Evap Feed-H	1705610-17	Water	17-May-17 00:00	19-May-17 09:45
G16954 Evap Feed Preserved-A	1705610-18	Water	17-May-17 00:00	19-May-17 09:45
G16955 Evap Feed Preserved-B	1705610-19	Water	17-May-17 00:00	19-May-17 09:45
B170331 Evap Feed Preserved-C	1705610-20	Water	17-May-17 00:00	19-May-17 09:45
B170344 Evap Feed Preserved-D	1705610-21	Water	17-May-17 00:00	19-May-17 09:45
G16956 Evap Concentrate-A	1705610-22	Water	17-May-17 00:00	19-May-17 09:45
G16956 Evap Concentrate-A Dissolved	1705610-23	Water	17-May-17 00:00	19-May-17 09:45
G16957 Evap Concentrate-B	1705610-24	Water	17-May-17 00:00	19-May-17 09:45
G16957 Evap Concentrate-B Dissolved	1705610-25	Water	17-May-17 00:00	19-May-17 09:45
G16958 Evap Concentrate-C	1705610-26	Water	17-May-17 00:00	19-May-17 09:45

Eurofins Frontier Global Sciences, Inc.

The results in this report only apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amy Goodall, Project Manager

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11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
G17012 Evap Concentrate-D	1705610-27	Water	17-May-17 00:00	19-May-17 09:45
G17008 Evap Concentrate-E	1705610-28	Water	17-May-17 00:00	19-May-17 09:45
G16199 Evap Concentrate-F	1705610-29	Water	17-May-17 00:00	19-May-17 09:45
B170334 Evap Concentrate-G	1705610-30	Water	17-May-17 00:00	19-May-17 09:45
B170339 Evap Concentrate-H	1705610-31	Water	17-May-17 00:00	19-May-17 09:45
G16962 Evap Conc Preserved-A	1705610-32	Water	17-May-17 00:00	19-May-17 09:45
G16964 Evap Conc Preserved-B	1705610-33	Water	17-May-17 00:00	19-May-17 09:45
B170328 Evap Conc Preserved-C	1705610-34	Water	17-May-17 00:00	19-May-17 09:45
B170340 Evap Conc Preserved-D	1705610-35	Water	17-May-17 00:00	19-May-17 09:45
G16965 Evap Condensate-A	1705610-36	Water	17-May-17 00:00	19-May-17 09:45
G16965 Evap Condensate-A Dissolved	1705610-37	Water	17-May-17 00:00	19-May-17 09:45
G16967 Evap Condensate-B	1705610-38	Water	17-May-17 00:00	19-May-17 09:45
G16967 Evap Condensate-B Dissolved	1705610-39	Water	17-May-17 00:00	19-May-17 09:45
G16968 Evap Condensate-C	1705610-40	Water	17-May-17 00:00	19-May-17 09:45
G16969 Evap Condensate-D	1705610-41	Water	17-May-17 00:00	19-May-17 09:45
G16200 Evap Condensate-E	1705610-42	Water	17-May-17 00:00	19-May-17 09:45
G16196 Evap Condensate-F	1705610-43	Water	17-May-17 00:00	19-May-17 09:45
B170335 Evap Condensate-G	1705610-44	Water	17-May-17 00:00	19-May-17 09:45
B170347 Evap Condensate-H	1705610-45	Water	17-May-17 00:00	19-May-17 09:45
G16973 Evap Cond Preserved-A	1705610-46	Water	17-May-17 00:00	19-May-17 09:45
G16974 Evap Cond Preserved-B	1705610-47	Water	17-May-17 00:00	19-May-17 09:45
B170337 Evap Cond Preserved-C	1705610-48	Water	17-May-17 00:00	19-May-17 09:45
B170338 Evap Cond Preserved-D	1705610-49	Water	17-May-17 00:00	19-May-17 09:45
G16970 Evap Knock Out-A	1705610-50	Water	17-May-17 00:00	19-May-17 09:45
G16970 Evap Knock Out-A Dissolved	1705610-51	Water	17-May-17 00:00	19-May-17 09:45
G16975 Evap Knock Out-B	1705610-52	Water	17-May-17 00:00	19-May-17 09:45

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
G16975 Evap Knock Out-B Dissolved	1705610-53	Water	17-May-17 00:00	19-May-17 09:45
G16976 Evap Knock Out-C	1705610-54	Water	17-May-17 00:00	19-May-17 09:45
G16977 Evap Knock Out-D	1705610-55	Water	17-May-17 00:00	19-May-17 09:45
G16197 Evap Knock Out-E	1705610-56	Water	17-May-17 00:00	19-May-17 09:45
G16198 Evap Knock Out-F	1705610-57	Water	17-May-17 00:00	19-May-17 09:45
B170330 Evap Knock Out-G	1705610-58	Water	17-May-17 00:00	19-May-17 09:45
B170333 Evap Knock Out-H	1705610-59	Water	17-May-17 00:00	19-May-17 09:45
G16978 Evap Knock Out Preserv-A	1705610-60	Water	17-May-17 00:00	19-May-17 09:45
G16980 Evap Knock Out Preserv-B	1705610-61	Water	17-May-17 00:00	19-May-17 09:45
B170336 Evap Knock Out Preserv-C	1705610-62	Water	17-May-17 00:00	19-May-17 09:45
B170342 Evap Knock Out Preserv-D	1705610-63	Water	17-May-17 00:00	19-May-17 09:45
Laboratory Filter Blank	1705610-64	Water	19-May-17 19:00	19-May-17 09:45
Laboratory Filter Blank	1705610-65	Water	24-May-17 18:00	19-May-17 09:45

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

SAMPLE RECEIPT

Client sent the samples in five coolers. Four of those coolers were at Eurofins Frontier Global Sciences (EFGS) on 5/19/2017 9:45:00 AM . The samples were received intact, on-ice within sealed coolers at 6.9, 3.4, 9.9, and 5.1 degrees Celsius.

The fifth cooler was received on 5/22/17 at ambient temperature and contained samples 'G16956 Evap Concentrate-A -> B170339 Evap Concentrate-H'. When this 5th cooler was received, the sample bottle for 1705610-27, 'G17012 Evap Concentrate-D', was found to have been broken in transit and the lab was unable to perform the analysis. The client was notified, and requested that we use one of the unpreserved bottles from the same set of samples. Volume was taken from sample 1705610-29, 'G16199 Evap Concentrate-F'.

SAMPLE PREPARATION AND ANALYSIS

Samples were prepared and analyzed for total and dissolved mercury by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.

Inorganic mercury speciation was also performed according to a modified EPA 1631E

Samples were prepared and analyzed for methyl mercury and dimethyl mercury by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with a modified EPA 1630.

Samples were prepared and analyzed for inorganic arsenic speciation by hydride generation cryogenic trapping gas chromatography atomic absorption spectrometry (HG-CT-GC-AAS) in accordance with EPA 1632.

Samples were prepared and analyzed for total recoverable metals by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 200.8 .

ANALYTICAL AND QUALITY CONTROL ISSUES

Method blanks were prepared for every preparation to assess possible blank contribution from the sample preparation procedure. The method blanks were carried through the entire analytical procedure. All blanks fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

Liquid spikes, certified reference material (CRM) or a quality control samples (QCS) were prepared for every preparation as a measure of accuracy. All liquid spikes, CRMs and/or QCS samples fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

As an additional measure of the accuracy of the methods used and to check for matrix interference, matrix spikes (MS) and matrix spike duplicates (MSD) were digested and analyzed. All of the matrix spike recoveries fell within the established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

A reasonable measure of the precision of the analytical methods is the relative percent difference (RPD) between a matrix spike recovery and a matrix spike duplicate recovery and between laboratory control sample recovery and laboratory control sample duplicate recoveries. All of the relative percent differences fell within established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

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Sample Receipt Checklist

EFGS Work Order: 1705610

Client: Savannah River Date & Time Received: 5/22/17 9:30 Date Labeled: 5/23/17 Labeled By: BM

Project: _____ Received By: _____ Label Verified

# of Coolers Received: 1 Samples Arrived By: ✓ Shipping Service ____ Courier ____ Hand ____ Other (Specify: _____)

Coolant: ☐ None/Ambient ☒ Loose Ice ☑ Gel Ice ☐ Dry Ice Coolant Required: Y / N Temp Blank Used: Y/N for Cooler(s): _____

Notify Project Manager if packages/coolers are received without coolant or with thawed coolant and at a temperature in excess of 6°C. PM notified: Y/N

Cooler Information:	Y/N/NA	Comments
The coolers do not appear to be tampered with:	Y	
Custody Seals are present and intact:	N	
Custody seals signed:	N	

TID: 5225 CF: 0 °C			Date/time: 5/22/17 9:30 By: BM		
Cooler 1: 19.5 °C	w/ CF: 19.5 °C		Cooler 4: °C	w/ CF:	°C
Cooler 2: °C	w/ CF:	°C	Cooler 5: °C	w/ CF:	°C
Cooler 3: °C	w/ CF:	°C	Cooler 6: °C	w/ CF:	°C

Chain of Custody:	Y/N/NA	Comments
Sample ID/Description:	Y	
Date and time of collection:	Y	
Sampled by:	Y	
Preservation type:	Y	
Requested analyses:	Y	
Required signatures:	Y	
Internal COC required:	NA	

Sample Condition/Integrity:	Y/N/NA	Comments
Sample containers intact/present:	Y	
Sample labels are present and legible:	Y	
Sample ID on container/bag matches COC:	Y	
Correct sample containers used:	Y	
Samples received within holding times:	Y	
Sample volume sufficient for requested analyses:	Y	
Correct preservative used for requested analyses:	Y	

Anomalies/Non-conformances (attach additional pages if needed):

Cooler 2: 7791 6954 1528

Sample G17012 Evap Concentrate D (1705610-27A) broken.

eurofins	Always check on-line for validity. **Potential Radioactive Shipment Receipt Report**	Level: **Work Instruction**
Document number: **EFQA-S-HS-WI7545**		
Old Reference:		
Version: **1**		Organisation level: **4-Business Unit**
Approved by: **UDWU, UPGS** Effective Date **21-SEP-2016**	Document users: **5_EUUSBO2_S-and-R**	Responsible: **5_EUUSBO2_QA**

1.) Basic Information
2.) Instrument Information
3.) Visual Inspection of outer package (cooler)
4.) Condition of Package Contents
5.) Instrument Operational Check
6.) Shipment Paperwork Check-Circle all that were received in package
7.) Measurements (Perform after approximately 5 minute warm up time)

1.) Basic Information

Name: Simon Waldelust Date: 5/22/17

Client Name: Savannah River

LIMS number: _____

2.) Instrument Information

Identification: GSM-110: S/N 7169

Last Calibrated: 9/22/16

3.) Visual Inspection of outer package (cooler)

(Good) Broken/Punctured Crushed Leaking

Other: _____

4.) Condition of Package Contents

(Good) Broken/Punctured Crushed Leaking

Other: _____

5.) Instrument Operational Check

Battery Charge Sufficient (circle one): (Yes) (No)*

Verify Response with check source(Po-210) (circle one): (Positive Response) (No Response)*

**Do not proceed if instrument does not have sufficient battery power or show a positive response.*

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Sample Receipt Checklist

EFGS Work Order: 1705610

Client: Savannah River Date & Time Received: 5/19/17 Date Labeled: 5/19/17 Labeled By: LM

Project: _____ Received By: _____ Label Verified By: _____

# of Coolers Received: 9 Samples Arrived By: ✓ Shipping Service ____ Courier ____ Hand ____ Other (Specify: _____)

Coolant: ☐ None/Ambient ☐ Loose Ice ☑ Gel Ice ☐ Dry Ice Coolant Required: (Y) / N Temp Blank Used: Y/N for Cooler(s): _____

Notify Project Manager if packages/coolers are received without coolant or with thawed coolant and at a temperature in excess of 6°C. PM notified: Y/N

Cooler Information:	Y/N/NA	Comments
The coolers do not appear to be tampered with:	Y	
Custody Seals are present and intact:	Y	
Custody seals signed:	Y	

TID: 5225	CF: 0.0 °C	Date/time: 5/19/17	By: BCW
Cooler 1: 6.9 °C	w/ CF: 6.9 °C	Cooler 4: 9.9 °C	w/ CF: 9.9 °C
Cooler 2: °C	w/ CF: °C	Cooler 5: 5.1 °C	w/ CF: 5.1 °C
Cooler 3: 3.4 °C	w/ CF: 3.4 °C	Cooler 6: °C	w/ CF: °C

Chain of Custody:	Y/N/NA	Comments
Sample ID/Description:	Y	
Date and time of collection:	Y	
Sampled by:	Y	
Preservation type:	Y	
Requested analyses:	Y	
Required signatures:	Y	
Internal COC required:	N	

Sample Condition/Integrity:	Y/N/NA	Comments
Sample containers intact/present:	Y	
Sample labels are present and legible:	Y	
Sample ID on container/bag matches COC:	Y	
Correct sample containers used:	Y	
Samples received within holding times:	Y	
Sample volume sufficient for requested analyses:	Y	
Correct preservative used for requested analyses:	Y	

Anomalies/Non-conformances (attach additional pages if needed):

Cooler 3: 7791 6954 1540 BCW 5/19/17

~~Cooler 5: 7791 6954 1685 BCW 5/19/17~~ 1860

Cooler 2

Cooler 5: 7791 6954 1355

Cooler 1: 7791 6954 1860

Cooler 4: 7791 6954 1675

Drum 1: 7791 6908 ~~3325~~ 2763 BCW 5/19/17

Drum 2: 7791 6908 3325

Drum 3: 7791 6908 3233

Drum 4: 7791 6908 3152

Drum 5: 7791 6908 3071

1705610

Chain of Custody Record & Laboratory Analysis Request: Air, Water, Sediments, Plant and Animal Tissue, Hydrocarbon & Other Samples

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Bothell, WA 98011
Phone: 425-686-1996
Fax: 425-686-3096
info@frontiergs.com
http://www.frontiergs.com

Client: Savannah River Nuclear Solutions	Contact: Susan Goodwin
Address: Aiken, SC 29808	Phone: 803-725-6072 Fax:
	E-mail: susan.goodwin@srs.gov
Project Name:	Contract/PO: 0000313073
Report To: Daniel McCabe	Invoice To: Susan Goodwin, SRNS, LLC
Address: SRNS, Bldg 773-42A Aiken, SC 29808	Address: SRNS, Bldg 773-41A, Aiken, SC 29808
Phone:803-725-8238 Fax: 803-725-8829	Phone: 803-725-6072 Fax:
E-mail: daniel.mccabe@srnl.doe.gov	E-mail: srns-acctspay@srs.gov

EFGS PM: Amy Goodall
Date:
TAT (business days): **20** (std)
15 10 5 4 3 2 24 hrs.
(For TAT < 10 days, contact PM. Surcharges apply for expedited TAT)
Saturday delivery? ☐ Y x N
(If yes, please contact PM)
EDD ☐ Y ☐ N
QA x Standard ☐ High

No.	Engraved Bottle ID	Sample ID	# of Bottles	Matrix	Date & Time	Sampled By	Field Filtered (Y/N)	Field Preserved: HNO_3 HCl BrCl Other (%)	Analyses Requested: Total/soluble Hg	Elemental/Ionic Hg	Dimethyl Hg	Arsenic	Methyl Hg	Inorganic Arsenic	Comments
1	G16945	Blank-A	1	WW	5/17/17 On bottle	HKH	N		X						
2	G16946	Blank-B	1	WW	5/17/17 On bottle	HKH	N			X					
3	G16190	Blank-C	1	WW	5/17/17 On bottle	HKH	N				X				
4	B170329	Blank-D	1	WW	5/17/17 On bottle	HKH	N					X			
5	G16948	Blank preserved-A	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
6	B170341	Blank preserved-B	1	WW	5/17/17 On bottle	HKH	N	HCl						x	

For Laboratory Use Only

COC Seal: Yes	Comments:
Cooler Temp:	
Carrier: FedEx	
VTSR: 9:45	
# of Coolers:	

Matrix Codes:
FW: Fresh Water
WW: Waste Water
SB: Sea and Brackish Water
SS: Soil and Sediment
TS: Plant and Animal Tissue
HC: Hydrocarbons
TR: Trap
OT: Other

Sample Disposal:
☐ Return (shipping fees may apply)
x Standard Disposal – 30 Days after report
☐ Retain for ____ weeks after report (storage fees may apply)

By signing, you declare that you agree with EFGS terms and conditions, and that you authorize EFGS to perform the specified analyses.

Customer Approval: _____ Date: _____

BGW
William Woldorf

1705610

Chain of Custody Record & Laboratory Analysis Request: Air, Water, Sediments, Plant and Animal Tissue, Hydrocarbon & Other Samples

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11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011
Phone: 425-686-1996
Fax: 425-686-3096
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Client: Savannah River Nuclear Solutions	Contact: Susan Goodwin
Address: Aiken, SC 29808	Phone: 803-725-6072 Fax:
	E-mail: susan.goodwin@srs.gov
Project Name:	Contract/PO: 0000313073
Report To: Daniel McCabe	Invoice To: Susan Goodwin, SRNS, LLC
Address: SRNS, Bldg 773-42A Aiken, SC 29808	Address: SRNS, Bldg 773-41A, Aiken, SC 29808
Phone:803-725-8238 Fax: 803-725-8829	Phone: 803-725-6072 Fax:
E-mail: daniel.mccabe@srnl.doe.gov	E-mail: srns-acctspay@srs.gov

EFGS PM: Amy Goodall
Date:
TAT (business days): **20** (std) 15 10 5 4 3 2 24 hrs.
(For TAT < 10 days, contact PM. Surcharges apply for expedited TAT)
Saturday delivery? ☐ Y x N
(If yes, please contact PM)
EDD ☐ Y ☐ N
QA x Standard ☐ High

No.	Engraved Bottle ID	Sample ID	# of Bottles	Matrix	Date & Time	Sampled By	Field Filtered (Y/N)	Field Preserved: HNO_3 HCl BrCl Other (%)	Analyses Requested: Total/soluble Hg	Elemental/Ionic Hg	Dimethyl Hg	Arsenic	Methyl Hg	Inorganic Arsenic	Comments
7	G16949	Evap Feed-A	1	WW	5/17/17 On bottle	HKH	N		X						
8	G16950	Evap Feed-B	1	WW	5/17/17 On bottle	HKH	N		X						
9	G16951	Evap Feed-C	1	WW	5/17/17 On bottle	HKH	N			X					
10	G16952	Evap Feed-D	1	WW	5/17/17 On bottle	HKH	N			X					
11	G16191	Evap Feed-E	1	WW	5/17/17 On bottle	HKH	N				X				
12	G16192	Evap Feed-F	1	WW	5/17/17 On bottle	HKH	N				X				
13	B170343	Evap Feed-G	1	WW	5/17/17 On bottle	HKH	N					X			
14	B170345	Evap Feed-H	1	WW	5/17/17 On bottle	HKH	N					X			
15	G16954	Evap Feed Preserved-A	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
16	G16955	Evap Feed Preserved-B	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
17	B170331	Evap Feed Preserved-C	1	WW	5/17/17 On bottle	HKH	N	HCl						X	
18	B170344	Evap Feed Preserved-D	1	WW	5/17/17 On bottle	HKH	N	HCl						X	

For Laboratory Use Only	
COC Seal:	Comments:
Cooler Temp:	
Carrier:	
VTSR:	
# of Coolers:	

Matrix Codes:
FW: Fresh Water
WW: Waste Water
SB: Sea and Brackish Water
SS: Soil and Sediment
TS: Plant and Animal Tissue
HC: Hydrocarbons
TR: Trap
OT: Other

Sample Disposal:
☐ Return (shipping fees may apply)
x Standard Disposal – 30 Days after report
☐ Retain for ____ weeks after report (storage fees may apply)

By signing, you declare that you agree with EFGS' terms and conditions, and that you authorize EFGS to perform the specified analyses.

Customer Approval: _____ Date: _____

1705610

Chain of Custody Record & Laboratory Analysis Request: Air, Water, Sediments, Plant and Animal Tissue, Hydrocarbon & Other Samples

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Client: Savannah River Nuclear Solutions	Contact: Susan Goodwin
Address: Aiken, SC 29808	Phone: 803-725-6072 Fax:
	E-mail: susan.goodwin@srs.gov
Project Name:	Contract/PO: 0000313073
Report To: Daniel McCabe	Invoice To: Susan Goodwin, SRNS, LLC
Address: SRNS, Bldg 773-42A Aiken, SC 29808	Address: SRNS, Bldg 773-41A, Aiken, SC 29808
Phone:803-725-8238 Fax: 803-725-8829	Phone: 803-725-6072 Fax:
E-mail: daniel.mccabe@srnl.doe.gov	E-mail: srns-acctspay@srs.gov

EFGS PM: Amy Goodall
Date:
TAT (business days): **20** (std) 15 10 5 4 3 2 24 hrs.
(For TAT < 10 days, contact PM. Surcharges apply for expedited TAT)
Saturday delivery? ☐ Y x N
(If yes, please contact PM)
EDD ☐ Y ☐ N
QA x Standard ☐ High

No.	Engraved Bottle ID	Sample ID	# of Bottles	Matrix	Date & Time	Sampled By	Field Filtered (Y/N)	Field Preserved: HNO_3 HCl BrCl Other (%)	Analyses Requested: Total/soluble Hg	Elemental/Ionic Hg	Dimethyl Hg	Arsenic	Methyl Hg	Inorganic Arsenic	Comments
19	G16956	Evap Concentrate-A	1	WW	5/17/17 On bottle	HKH	N		X						
20	G16957	Evap Concentrate-B	1	WW	5/17/17 On bottle	HKH	N		X						
21	G16958	Evap Concentrate-C	1	WW	5/17/17 On bottle	HKH	N			X					
22	G17012	Evap Concentrate-D	1	WW	5/17/17 On bottle	HKH	N			X					
23	G17008	Evap Concentrate-E	1	WW	5/17/17 On bottle	HKH	N				X				
24	G16199	Evap Concentrate-F	1	WW	5/17/17 On bottle	HKH	N				X				
25	B170334	Evap Concentrate-G	1	WW	5/17/17 On bottle	HKH	N					X			
26	B170339	Evap Concentrate-H	1	WW	5/17/17 On bottle	HKH	N					X			
27	G16962	Evap Conc Preserved-A	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
28	G16964	Evap Conc Preserved-B	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
29	B170328	Evap Conc Preserved-C	1	WW	5/17/17 On bottle	HKH	N	HCl						X	
30	B170340	Evap Conc Preserved-D	1	WW	5/17/17 On bottle	HKH	N	HCl						X	

For Laboratory Use Only	
COC Seal:	Comments:
Cooler Temp:	
Carrier:	
VTSR:	
# of Coolers:	

Matrix Codes:
FW: Fresh Water
WW: Waste Water
SB: Sea and Brackish Water
SS: Soil and Sediment
TS: Plant and Animal Tissue
HC: Hydrocarbons
TR: Trap
OT: Other

Sample Disposal:
☐ Return (shipping fees may apply)
x Standard Disposal – 30 Days after report
☐ Retain for ____ weeks after report (storage fees may apply)

By signing, you declare that you agree with EFGS' terms and conditions, and that you authorize EFGS to perform the specified analyses.

Customer Approval: _____ Date: _____

1705610

Chain of Custody Record & Laboratory Analysis Request: Air, Water, Sediments, Plant and Animal Tissue, Hydrocarbon & Other Samples

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Bothell, WA 98011
Phone: 425-686-1996
Fax: 425-686-3096
info@frontiergs.com
http://www.frontiergs.com

Client: Savannah River Nuclear Solutions	Contact: Susan Goodwin
Address: Aiken, SC 29808	Phone: 803-725-6072 Fax:
	E-mail: susan.goodwin@srs.gov
Project Name:	Contract/PO: 0000313073
Report To: Daniel McCabe	Invoice To: Susan Goodwin, SRNS, LLC
Address: SRNS, Bldg 773-42A Aiken, SC 29808	Address: SRNS, Bldg 773-41A, Aiken, SC 29808
Phone:803-725-8238 Fax: 803-725-8829	Phone: 803-725-6072 Fax:
E-mail: daniel.mccabe@srnl.doe.gov	E-mail: srns-acctspay@srs.gov

EFGS PM: Amy Goodall
Date:
TAT (business days): **20** (std) 15 10 5 4 3 2 24 hrs.
(For TAT < 10 days, contact PM. Surcharges apply for expedited TAT)
Saturday delivery? ☐ Y x N
(If yes, please contact PM)
EDD ☐ Y ☐ N
QA x Standard ☐ High

No.	Engraved Bottle ID	Sample ID	# of Bottles	Matrix	Date & Time	Sampled By	Field Filtered (Y/N)	Field Preserved: HNO_3 HCl BrCl Other (%)	Analyses Requested: Total/soluble Hg	Elemental/Ionic Hg	Dimethyl Hg	Arsenic	Methyl Hg	Inorganic Arsenic	Comments
31	G16965	Evap Condensate-A	1	WW	5/17/17 On bottle	HKH	N		X						
32	G16967	Evap Condensate-B	1	WW	5/17/17 On bottle	HKH	N		X						
33	G16968	Evap Condensate-C	1	WW	5/17/17 On bottle	HKH	N			X					
34	G16969	Evap Condensate-D	1	WW	5/17/17 On bottle	HKH	N			X					
35	G16200	Evap Condensate-E	1	WW	5/17/17 On bottle	HKH	N				X				
36	G16196	Evap Condensate-F	1	WW	5/17/17 On bottle	HKH	N				X				
37	B170335	Evap Condensate-G	1	WW	5/17/17 On bottle	HKH	N					X			
38	B170347	Evap Condensate-H	1	WW	5/17/17 On bottle	HKH	N					X			
39	G16973	Evap Cond Preserved-A	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
40	G16974	Evap Cond Preserved-B	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
41	B170337	Evap Cond Preserved-C	1	WW	5/17/17 On bottle	HKH	N							X	
42	B170338	Evap Cond Preserved-D	1	WW	5/17/17 On bottle	HKH	N							X	

For Laboratory Use Only	
COC Seal:	Comments:
Cooler Temp:	
Carrier:	
VTSR:	
# of Coolers:	

Matrix Codes:
FW: Fresh Water
WW: Waste Water
SB: Sea and Brackish Water
SS: Soil and Sediment
TS: Plant and Animal Tissue
HC: Hydrocarbons
TR: Trap
OT: Other

Relinquished By:

Sample Disposal:
☐ Return (shipping fees may apply)
x Standard Disposal – 30 Days after report
☐ Retain for ____ weeks after report (storage fees may apply)

By signing, you declare that you agree with EFGS' terms and conditions, and that you authorize EFGS to perform the specified analyses.

Customer Approval: _____ Date: _____

1705610

Chain of Custody Record & Laboratory Analysis Request: Air, Water, Sediments, Plant and Animal Tissue, Hydrocarbon & Other Samples

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Phone: 425-686-1996
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http://www.frontiergs.com

Client: Savannah River Nuclear Solutions	Contact: Susan Goodwin
Address: Aiken, SC 29808	Phone: 803-725-6072 Fax:
	E-mail: susan.goodwin@srs.gov
Project Name:	Contract/PO: 0000313073
Report To: Daniel McCabe	Invoice To: Susan Goodwin, SRNS, LLC
Address: SRNS, Bldg 773-42A Aiken, SC 29808	Address: SRNS, Bldg 773-41A, Aiken, SC 29808
Phone:803-725-8238 Fax: 803-725-8829	Phone: 803-725-6072 Fax:
E-mail: daniel.mccabe@srnl.doe.gov	E-mail: srns-acctspay@srs.gov

EFGS PM: Amy Goodall
Date:
TAT (business days):**20** (std)
15 10 5 4 3 2 24 hrs.
(For TAT < 10 days, contact PM. Surcharges apply for expedited TAT)
Saturday delivery? ☐ Y x N
(If yes, please contact PM)
EDD ☐ Y ☐ N
QA x Standard ☐ High

No.	Engraved Bottle ID	Sample ID	# of Bottles	Matrix	Date & Time	Sampled By	Field Filtered (Y/N)	Field Preserved: HNO_3 HCl BrCl Other (%)	Analyses Requested: Total/soluble Hg	Elemental/Ionic Hg	Dimethyl Hg	Arsenic	Methyl Hg	Inorganic Arsenic	Comments
43	G16970	Evap Knock Out-A	1	WW	5/17/17 On bottle	HKH	N		X						
44	G16975	Evap Knock Out-B	1	WW	5/17/17 On bottle	HKH	N		X						
45	G16976	Evap Knock Out-C	1	WW	5/17/17 On bottle	HKH	N			X					
46	G16977	Evap Knock Out-D	1	WW	5/17/17 On bottle	HKH	N			X					
47	G16197	Evap Knock Out-E	1	WW	5/17/17 On bottle	HKH	N				X				
48	G16198	Evap Knock Out-F	1	WW	5/17/17 On bottle	HKH	N				X				
49	B170330	Evap Knock Out-G	1	WW	5/17/17 On bottle	HKH	N					X			
50	B170333	Evap Knock Out-H	1	WW	5/17/17 On bottle	HKH	N					X			
51	G16978	Evap Knock Out Preserv-A	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
52	G16980	Evap Knock Out Preserv-B	1	WW	5/17/17 On bottle	HKH	N	HCl					X		
53	B170336	Evap Knock Out Preserv-C	1	WW	5/17/17 On bottle	HKH	N	HCl						X	
54	B170342	Evap Knock Out Preserv-D	1	WW	5/17/17 On bottle	HKH	N	HCl						X	

For Laboratory Use Only	
COC Seal:	Comments:
Cooler Temp:	
Carrier:	
VTSR:	
# of Coolers:	

Matrix Codes:
FW: Fresh Water
WW: Waste Water
SB: Sea and Brackish Water
SS: Soil and Sediment
TS: Plant and Animal Tissue
HC: Hydrocarbons
TR: Trap
OT: Other

Re
Na
Or
Da
Tracking number:

Sample Disposal:
☐ Return (shipping fees may apply)
x Standard Disposal – 30 Days after report
☐ Retain for ____ weeks after report (storage fees may apply)

By signing, you declare that you agree with EFGS' terms and conditions, and that you authorize EFGS to perform the specified analyses.

Customer Approval: _____ Date: _____

eurofins	Always check on-line for validity. **Potential Radioactive Shipment Receipt Report**	Level: **Work Instruction**
Document number: **EFQA-S-HS-WI7545**		
Old Reference:		
Version: **1**		Organisation level: **4-Business Unit**
Approved by: **UDWU, UPGS** Effective Date **21-SEP-2016**	Document users: **5_EUUSBO2_S-and-R**	Responsible: **5_EUUSBO2_QA**

1.) Basic Information
2.) Instrument Information
3.) Visual Inspection of outer package (cooler)
4.) Condition of Package Contents
5.) Instrument Operational Check
6.) Shipment Paperwork Check-Circle all that were received in package
7.) Measurements (Perform after approximately 5 minute warm up time)

1.) Basic Information

Name: Brian Waldrop Date: 5/19/17

Client Name: Savannah River (4 coolers)

LIMS number: _____

2.) Instrument Information

Identification: GSM-110: S/N 7169

Last Calibrated: 9/22/16

3.) Visual Inspection of outer package (cooler)

(Good) Broken/Punctured Crushed Leaking

Other: _____

4.) Condition of Package Contents

(Good) Broken/Punctured Crushed Leaking

Other: _____

5.) Instrument Operational Check

Battery Charge Sufficient (circle one): (Yes) (No)*

Verify Response with check source(Po-210) (circle one): (Positive Response) (No Response)*

**Do not proceed if instrument does not have sufficient battery power or show a positive response.*

eurofins	Always check on-line for validity. **Potential Radioactive Shipment Receipt Report**	Level: **Work Instruction**
Document number: **EFQA-S-HS-WI7545**		
Old Reference:		
Version: **1**		Organisation level: **4-Business Unit**
Approved by: **UDWU, UPGS** Effective Date **21-SEP-2016**	Document users: **5_EUUSBO2_S-and-R**	Responsible: **5_EUUSBO2_QA**

1.) Basic Information
2.) Instrument Information
3.) Visual Inspection of outer package (cooler)
4.) Condition of Package Contents
5.) Instrument Operational Check
6.) Shipment Paperwork Check-Circle all that were received in package
7.) Measurements (Perform after approximately 5 minute warm up time)

1.) Basic Information

Name: Biniam Woldeyt Date: 5/19/17

Client Name: Savannah River (5 drums)

LIMS number: _____

2.) Instrument Information

Identification: GSM-110: S/N 7169

Last Calibrated: 9/22/16

3.) Visual Inspection of outer package (cooler)

(Good) Broken/Punctured Crushed Leaking

Other: _____

4.) Condition of Package Contents

(Good) Broken/Punctured Crushed Leaking

Other: _____

5.) Instrument Operational Check

Battery Charge Sufficient (circle one): (Yes) (No)*

Verify Response with check source(Po-210) (circle one): (Positive Response) (No Response)*

**Do not proceed if instrument does not have sufficient battery power or show a positive response.*

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Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Arsenic

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-052 Closed Vessel Nitric Oven Digestion												
B170329 Blank-D	**1705610-05**	**12.3**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	
B170343 Evap Feed-G	**1705610-16**	**11.4**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	
B170345 Evap Feed-H	**1705610-17**	**11.7**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	
B170334 Evap Concentrate-G	**1705610-30**	**15.1**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	
B170339 Evap Concentrate-H	**1705610-31**	**14.1**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	
B170335 Evap Condensate-G	**1705610-44**	**0.27**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	J
B170347 Evap Condensate-H	**1705610-45**	**0.26**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	J
B170330 Evap Knock Out-G	**1705610-58**	**0.12**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	J
B170333 Evap Knock Out-H	**1705610-59**	**0.12**	0.10	0.30	µg/L	1	F706568	23-Jun-17	7F29015	29-Jun-17	EPA 200.8	J

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Dimethyl Mercury (as Mercury)

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: No Preparation												
G16190 Blank-C	1705610-04	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16191 Evap Feed-E	1705610-14	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16192 Evap Feed-F	1705610-15	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G17008 Evap Concentrate-E	1705610-28	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16199 Evap Concentrate-F	1705610-29	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16200 Evap Condensate-E	1705610-42	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16196 Evap Condensate-F	1705610-43	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16197 Evap Knock Out-E	1705610-56	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U
G16198 Evap Knock Out-F	1705610-57	ND	0.120	0.200	ng/L	2	F706410	08-Jun-17	7F09004	08-Jun-17	FGS-070	U

Amy Goodall, Project Manager

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Inorganic Arsenic

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-022 Preparation for Cryo Speciation of Waters												
B170341 Blank preserved-B	**1705610-07**	**10.2**	0.090	0.300	µg/L	30	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170331 Evap Feed Preserved-C	**1705610-20**	**10.1**	0.300	1.00	µg/L	100	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170344 Evap Feed Preserved-D	**1705610-21**	**8.37**	0.150	0.500	µg/L	50	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170328 Evap Conc Preserved-C	**1705610-34**	**11.6**	0.225	0.750	µg/L	75	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170340 Evap Conc Preserved-D	**1705610-35**	**12.4**	0.225	0.750	µg/L	75	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170337 Evap Cond Preserved-C	**1705610-48**	**0.099**	0.003	0.010	µg/L	1	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170338 Evap Cond Preserved-D	**1705610-49**	**0.089**	0.003	0.010	µg/L	1	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170336 Evap Knock Out Preserv-C	**1705610-62**	**0.010**	0.003	0.010	µg/L	1	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	
B170342 Evap Knock Out Preserv-D	**1705610-63**	**0.006**	0.003	0.010	µg/L	1	F706319	05-Jun-17	7F05013	05-Jun-17	EPA 1632	J

Amy Goodall, Project Manager

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Inorganic Mercury

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: No Preparation												
G16946 Blank-B	**1705610-03**	**2.29**	0.08	0.50	ng/L	1	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16951 Evap Feed-C	**1705610-12**	**847**	15.4	100	ng/L	200	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16952 Evap Feed-D	**1705610-13**	**999**	7.70	50.0	ng/L	100	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16958 Evap Concentrate-C	**1705610-26**	**1100**	15.4	100	ng/L	200	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G17012 Evap Concentrate-D	**1705610-27**	**1540**	7.70	50.0	ng/L	100	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16968 Evap Condensate-C	**1705610-40**	**24.6**	1.54	10.0	ng/L	20	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16969 Evap Condensate-D	**1705610-41**	**19.4**	0.77	5.00	ng/L	10	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16976 Evap Knock Out-C	**1705610-54**	**3.22**	0.08	0.50	ng/L	1	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	
G16977 Evap Knock Out-D	**1705610-55**	**1.79**	0.08	0.50	ng/L	1	F706613	27-Jun-17	7F28025	27-Jun-17	EPA 1631 Mod	

Amy Goodall, Project Manager

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Mercury

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EPA 1631E BrCl Oxidation												
G16945 Blank-A	**1705610-01**	**3.05**	0.08	0.50	ng/L	1	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16945 Blank-A Dissolved	**1705610-02**	**1.94**	0.08	0.50	ng/L	1	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16949 Evap Feed-A	**1705610-08**	**2270**	33.4	200	ng/L	400	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16949 Evap Feed-A Dissolved	**1705610-09**	**2220**	33.4	200	ng/L	400	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16950 Evap Feed-B	**1705610-10**	**2160**	33.4	200	ng/L	400	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16950 Evap Feed-B Dissolved	**1705610-11**	**2120**	33.4	200	ng/L	400	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16956 Evap Concentrate-A	**1705610-22**	**3280**	208	1250	ng/L	2500	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16956 Evap Concentrate-A Dissolved	**1705610-23**	**2880**	33.4	200	ng/L	400	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16957 Evap Concentrate-B	**1705610-24**	**3190**	208	1250	ng/L	2500	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16957 Evap Concentrate-B Dissolved	**1705610-25**	**2910**	33.4	200	ng/L	400	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16965 Evap Condensate-A	**1705610-36**	**28.7**	0.83	5.00	ng/L	10	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16965 Evap Condensate-A Dissolved	**1705610-37**	**26.6**	0.83	5.00	ng/L	10	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16967 Evap Condensate-B	**1705610-38**	**29.3**	0.83	5.00	ng/L	10	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16967 Evap Condensate-B Dissolved	**1705610-39**	**27.2**	0.83	5.00	ng/L	10	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16970 Evap Knock Out-A	**1705610-50**	**11.8**	0.83	5.00	ng/L	10	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16970 Evap Knock Out-A Dissolved	**1705610-51**	**9.40**	0.83	5.00	ng/L	10	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
G16975 Evap Knock Out-B	**1705610-52**	**11.0**	0.83	5.00	ng/L	10	F705667	24-May-17	7F01008	31-May-17	EPA 1631E	
G16975 Evap Knock Out-B Dissolved	**1705610-53**	**8.62**	0.83	5.00	ng/L	10	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	
Laboratory Filter Blank	1705610-64	ND	0.08	0.50	ng/L	1	F706305	24-May-17	7F05020	02-Jun-17	EPA 1631E	FB, U
Laboratory Filter Blank	1705610-65	ND	0.08	0.50	ng/L	1	F706331	24-May-17	7F06024	06-Jun-17	EPA 1631E	O-04, U

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Mercury (0)

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: No Preparation												
G16946 Blank-B	**1705610-03**	**0.96**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16951 Evap Feed-C	**1705610-12**	**0.73**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16952 Evap Feed-D	**1705610-13**	**6.84**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16958 Evap Concentrate-C	**1705610-26**	**3.51**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G17012 Evap Concentrate-D	**1705610-27**	**2.95**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16968 Evap Condensate-C	**1705610-40**	**1.24**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16969 Evap Condensate-D	**1705610-41**	**2.85**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16976 Evap Knock Out-C	**1705610-54**	**0.88**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	
G16977 Evap Knock Out-D	**1705610-55**	**1.32**	0.08	0.50	ng/L	1	F706612	27-Jun-17	7F28024	27-Jun-17	EPA 1631 Mod	

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Methyl Mercury (as Mercury)

Sample Name	Lab Number	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-013 Methyl Hg Distillation for Water												
G16948 Blank preserved-A	1705610-06	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16954 Evap Feed Preserved-A	1705610-18	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16955 Evap Feed Preserved-B	1705610-19	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16962 Evap Conc Preserved-A	1705610-32	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16964 Evap Conc Preserved-B	1705610-33	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16973 Evap Cond Preserved-A	1705610-46	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16974 Evap Cond Preserved-B	1705610-47	ND	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	U
G16978 Evap Knock Out Preserv-A	**1705610-60**	**1.17**	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	J
G16980 Evap Knock Out Preserv-B	**1705610-61**	**1.49**	1.16	2.25	ng/L	50	F706466	13-Jun-17	7F14013	13-Jun-17	EPA 1630/FGS-070	J

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SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F705667 - EPA 1631E BrCl Oxidation											
Blank (F705667-BLK1)					Prepared & Analyzed: 31-May-17						
Mercury	ND	0.08	0.50	ng/L							U
Blank (F705667-BLK2)					Prepared & Analyzed: 31-May-17						
Mercury	ND	0.08	0.50	ng/L							U
Blank (F705667-BLK3)					Prepared & Analyzed: 31-May-17						
Mercury	ND	0.08	0.50	ng/L							U
LCS (F705667-BS1)					Prepared & Analyzed: 31-May-17						
Mercury	15.64	0.08	0.50	ng/L	15.679		99.8	80-120			
LCS Dup (F705667-BSD1)					Prepared & Analyzed: 31-May-17						
Mercury	15.66	0.08	0.50	ng/L	15.679		99.9	80-120	0.122	24	
Duplicate (F705667-DUP1)		**Source: 1705610-08**			Prepared & Analyzed: 31-May-17						
Mercury	2280	33.4	200	ng/L		2275			0.243	24	
Matrix Spike (F705667-MS1)		**Source: 1705610-08**			Prepared & Analyzed: 31-May-17						
Mercury	10260	33.4	200	ng/L	8096.2	2275	98.6	71-125			
Matrix Spike (F705667-MS2)		**Source: 1705610-10**			Prepared & Analyzed: 31-May-17						
Mercury	10270	33.4	200	ng/L	8096.2	2161	100	71-125			
Matrix Spike Dup (F705667-MSD1)		**Source: 1705610-08**			Prepared & Analyzed: 31-May-17						
Mercury	10450	33.4	200	ng/L	8096.2	2275	101	71-125	1.87	24	
Matrix Spike Dup (F705667-MSD2)		**Source: 1705610-10**			Prepared & Analyzed: 31-May-17						
Mercury	10220	33.4	200	ng/L	8096.2	2161	99.5	71-125	0.459	24	

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SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706305 - EPA 1631E BrCl Oxidation											
Blank (F706305-BLK1)					Prepared & Analyzed: 02-Jun-17						
Mercury	0.16	0.08	0.50	ng/L							J
Blank (F706305-BLK2)					Prepared & Analyzed: 02-Jun-17						
Mercury	ND	0.08	0.50	ng/L							U
Blank (F706305-BLK3)					Prepared & Analyzed: 02-Jun-17						
Mercury	ND	0.08	0.50	ng/L							U
LCS (F706305-BS1)					Prepared & Analyzed: 02-Jun-17						
Mercury	15.42	0.08	0.50	ng/L	15.679		98.3	80-120			
LCS Dup (F706305-BSD1)					Prepared & Analyzed: 02-Jun-17						
Mercury	15.73	0.08	0.50	ng/L	15.679		100	80-120	2.01	24	
Duplicate (F706305-DUP1)		**Source: 1705600-02**			Prepared & Analyzed: 02-Jun-17						
Mercury	1.43	0.08	0.50	ng/L		1.52			6.21	24	
Matrix Spike (F706305-MS1)		**Source: 1705600-02**			Prepared & Analyzed: 02-Jun-17						
Mercury	6.09	0.08	0.50	ng/L	5.0601	1.52	90.4	71-125			
Matrix Spike (F706305-MS2)		**Source: 1705600-08**			Prepared & Analyzed: 02-Jun-17						
Mercury	6.26	0.08	0.50	ng/L	5.0601	1.58	92.6	71-125			
Matrix Spike Dup (F706305-MSD1)		**Source: 1705600-02**			Prepared & Analyzed: 02-Jun-17						
Mercury	6.38	0.08	0.50	ng/L	5.0601	1.52	96.1	71-125	4.64	24	
Matrix Spike Dup (F706305-MSD2)		**Source: 1705600-08**			Prepared & Analyzed: 02-Jun-17						
Mercury	6.42	0.08	0.50	ng/L	5.0601	1.58	95.6	71-125	2.44	24	

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SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
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Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706319 - EFGS-022 Preparation for Cryo Speciation of Waters											
Blank (F706319-BLK1)					Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	0.007	0.003	0.010	µg/L							J
Blank (F706319-BLK2)					Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	0.005	0.003	0.010	µg/L							J
LCS (F706319-BS1)					Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	0.032	0.003	0.010	µg/L	0.030000		107	50-150			
LCS Dup (F706319-BSD1)					Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	0.034	0.003	0.010	µg/L	0.030000		114	50-150	6.20	35	
Matrix Spike (F706319-MS1)		**Source: 1705860-12**			Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	6.065	0.150	0.500	µg/L	5.0000	1.309	95.1	50-150			AS
Matrix Spike (F706319-MS2)		**Source: 1705861-05**			Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	5.652	0.150	0.500	µg/L	5.0000	1.236	88.3	50-150			AS
Matrix Spike Dup (F706319-MSD1)		**Source: 1705860-12**			Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	5.611	0.150	0.500	µg/L	5.0000	1.309	86.0	50-150	7.79	35	AS
Matrix Spike Dup (F706319-MSD2)		**Source: 1705861-05**			Prepared & Analyzed: 05-Jun-17						
Inorganic Arsenic	5.136	0.150	0.500	µg/L	5.0000	1.236	78.0	50-150	9.58	35	AS
Batch F706331 - EPA 1631E BrCl Oxidation											
Blank (F706331-BLK1)					Prepared & Analyzed: 06-Jun-17						
Mercury	0.11	0.08	0.50	ng/L							J

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Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706331 - EPA 1631E BrCl Oxidation											
Blank (F706331-BLK2)					Prepared & Analyzed: 06-Jun-17						
Mercury	ND	0.08	0.50	ng/L							U
Blank (F706331-BLK3)					Prepared & Analyzed: 06-Jun-17						
Mercury	ND	0.08	0.50	ng/L							U
LCS (F706331-BS1)					Prepared & Analyzed: 06-Jun-17						
Mercury	15.24	0.08	0.50	ng/L	15.679		97.2	80-120			
LCS Dup (F706331-BSD1)					Prepared & Analyzed: 06-Jun-17						
Mercury	15.72	0.08	0.50	ng/L	15.679		100	80-120	3.04	24	
Duplicate (F706331-DUP1)		**Source: 1705849-01**			Prepared & Analyzed: 06-Jun-17						
Mercury	3.06	0.08	0.50	ng/L		2.97			2.88	24	
Matrix Spike (F706331-MS1)		**Source: 1705849-01**			Prepared & Analyzed: 06-Jun-17						
Mercury	12.80	0.08	0.50	ng/L	10.120	2.97	97.1	71-125			
Matrix Spike (F706331-MS2)		**Source: 1705849-02**			Prepared & Analyzed: 06-Jun-17						
Mercury	12.07	0.08	0.50	ng/L	10.120	2.50	94.6	71-125			
Matrix Spike Dup (F706331-MSD1)		**Source: 1705849-01**			Prepared & Analyzed: 06-Jun-17						
Mercury	12.91	0.08	0.50	ng/L	10.120	2.97	98.2	71-125	0.829	24	
Matrix Spike Dup (F706331-MSD2)		**Source: 1705849-02**			Prepared & Analyzed: 06-Jun-17						
Mercury	12.60	0.08	0.50	ng/L	10.120	2.50	99.8	71-125	4.24	24	
Batch F706410 - No Preparation											
Blank (F706410-BLK1)					Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	ND	0.060	0.100	ng/L							U

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Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706410 - No Preparation											
Blank (F706410-BLK2)					Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	ND	0.060	0.100	ng/L							U
Blank (F706410-BLK3)					Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	ND	0.060	0.100	ng/L							U
Blank (F706410-BLK4)					Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	ND	0.060	0.100	ng/L							U
LCS (F706410-BS1)					Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	1.17	0.060	0.100	ng/L	1.1018		106	75-125			
LCS Dup (F706410-BSD1)					Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	1.25	0.060	0.100	ng/L	1.1018		114	75-125	6.74	25	
Duplicate (F706410-DUP1)		**Source: 1705558-06**			Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	35.7	2.40	4.00	ng/L		31.9			11.3	35	
Matrix Spike (F706410-MS1)		**Source: 1705558-06**			Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	89.1	2.40	4.00	ng/L	44.072	31.9	130	65-130			
Matrix Spike (F706410-MS2)		**Source: 1705558-07**			Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	84.8	2.40	4.00	ng/L	44.072	36.3	110	65-130			
Matrix Spike Dup (F706410-MSD1)		**Source: 1705558-06**			Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	79.3	2.40	4.00	ng/L	44.072	31.9	108	65-130	11.6	35	
Matrix Spike Dup (F706410-MSD2)		**Source: 1705558-07**			Prepared & Analyzed: 08-Jun-17						
Dimethyl Mercury (as Mercury)	87.8	2.40	4.00	ng/L	44.072	36.3	117	65-130	3.48	35	

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Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706466 - EFGS-013 Methyl Hg Distillation for Water											
Blank (F706466-BLK1)					Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	ND	1.16	2.25	ng/L							U
Blank (F706466-BLK2)					Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	ND	1.16	2.25	ng/L							U
Blank (F706466-BLK3)					Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	ND	1.16	2.25	ng/L							U
LCS (F706466-BS1)					Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	126.6	1.16	2.25	ng/L	100.10		126	70-130			
LCS Dup (F706466-BSD1)					Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	112.8	1.16	2.25	ng/L	100.10		113	70-130	11.6	35	
Duplicate (F706466-DUP1)		**Source: 1705610-18RE1**			Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	ND	1.16	2.25	ng/L		ND				35	U
Matrix Spike (F706466-MS1)		**Source: 1705610-18RE1**			Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	11.79	1.16	2.25	ng/L	12.512	ND	94.2	65-130			
Matrix Spike Dup (F706466-MSD1)		**Source: 1705610-18RE1**			Prepared & Analyzed: 13-Jun-17						
Methyl Mercury (as Mercury)	8.552	1.16	2.25	ng/L	12.512	ND	68.3	65-130	31.8	35	
Batch F706612 - No Preparation											
Blank (F706612-BLK1)					Prepared & Analyzed: 27-Jun-17						
Mercury (0)	ND	0.08	0.50	ng/L							U

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Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706612 - No Preparation											
Blank (F706612-BLK2)					Prepared & Analyzed: 27-Jun-17						
Mercury (0)	0.08	0.08	0.50	ng/L							J
Blank (F706612-BLK3)					Prepared & Analyzed: 27-Jun-17						
Mercury (0)	ND	0.08	0.50	ng/L							U
Duplicate (F706612-DUP1)		**Source: 1705610-40RE2**			Prepared & Analyzed: 27-Jun-17						
Mercury (0)	1.21	0.08	0.50	ng/L		1.24			2.56	24	
Batch F706613 - No Preparation											
Blank (F706613-BLK1)					Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	ND	0.08	0.50	ng/L							U
Blank (F706613-BLK2)					Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	ND	0.08	0.50	ng/L							U
Blank (F706613-BLK3)					Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	ND	0.08	0.50	ng/L							U
LCS (F706613-BS1)					Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	18.10	0.08	0.50	ng/L	20.040		90.3	80-120			
LCS Dup (F706613-BSD1)					Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	16.05	0.08	0.50	ng/L	20.040		80.1	80-120	12.0	24	
Duplicate (F706613-DUP1)		**Source: 1705610-26RE1**			Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	1083	30.8	200	ng/L		1097			1.25	24	

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Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706613 - No Preparation											
Matrix Spike (F706613-MS1)		**Source: 1705610-26RE1**			Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	5718	30.8	200	ng/L	4008.0	1097	115	71-124			
Matrix Spike Dup (F706613-MSD1)		**Source: 1705610-26RE1**			Prepared & Analyzed: 27-Jun-17						
Inorganic Mercury	5690	30.8	200	ng/L	4008.0	1097	115	71-124	0.487	24	

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Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F706568 - EFGS-052 Closed Vessel Nitric Oven Digestion											
Blank (F706568-BLK1)					Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	0.14	0.10	0.30	µg/L							J
LCS (F706568-BS1)					Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	52.01	0.50	1.50	µg/L	50.010		104	85-115			
LCS Dup (F706568-BSD1)					Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	50.93	0.50	1.50	µg/L	50.010		102	85-115	2.08	20	
Matrix Spike (F706568-MS1)		**Source: 1706230-01**			Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	117.2	0.51	1.52	µg/L	100.02	6.09	111	70-130			
Matrix Spike (F706568-MS2)		**Source: 1706230-01**			Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	210.6	0.50	1.51	µg/L	205.00	6.09	99.8	70-130			AS
Matrix Spike Dup (F706568-MSD1)		**Source: 1706230-01**			Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	111.5	0.51	1.52	µg/L	100.02	6.09	105	70-130	5.01	20	
Matrix Spike Dup (F706568-MSD2)		**Source: 1706230-01**			Prepared: 23-Jun-17 Analyzed: 29-Jun-17						
Arsenic	222.0	0.50	1.51	µg/L	205.00	6.09	105	70-130	5.23	20	AS

eurofins | Frontier Global Sciences

11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

Savannah River Nuclear Solutions	Project: Mercury and Arsenic Speciation	
SRNS, Bldg 773-42A	Project Number: Mercury and Arsenic Speciation	**Reported:**
Aiken SC, 29808	Project Manager: Daniel McCabe	30-Jun-17 14:00

Notes and Definitions

U	Analyte was not detected and is reported as less than the LOD or as defined by the client. The LOD has been adjusted for any dilution or concentration of the sample.
O-04	This sample was analyzed outside of the recommended holding time.
J	The result is an estimated concentration.
FB	This blank is a filtration blank. Data is reported for informational purposes only.
AS	This MS and/or MSD is an analytical spike and/or an analytical spike duplicate.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

7.5 Appendix E. Southwest Research Institute Results

SOUTHWEST RESEARCH INSTITUTE®

6220 CULEBRA ROAD 78238-5166 • P.O. DRAWER 28510 78228-0510 • SAN ANTONIO, TEXAS, USA • (210) 684-5111 • WWW.SWRI.ORG

CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF ANALYTICAL AND ENVIRONMENTAL CHEMISTRY

July 6, 2017

Savannah River Nuclear Solutions, LLC
6160 Woodside Executive Court
Aiken, South Carolina 29808

Attention: Natalia E. Johnson

Subject:	Contract No.:	78769
	Delivery No:	SWR-17-W-17031
	SDG Number:	616432
	SwRI Project Number:	17995.24.00X
	SwRI Task Order Number:	170609-5
	SwRI Sample Receipt Number:	59851
	Samples Received	06.09.17
	Line Item(s):	282

Dear Ms. Johnson:

Please find the enclosed results for the five (5) overall samples received on the above referenced date. Should you have any questions, please feel free to contact me at 210-522-3320, or at jacqueline.ranger@swri.org.

JR: aa
Encl

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

Chain of Custody

CHAIN-OF-CUSTODY

☐ Organic ☒ Aqueous ☐ Soil ☐ Solid ☐ Sludge ☐ gr water ☐ Smears ☐ Swipes ☐ Gas

17031

Contract Number
0000078769

Customer Name: HILL, KATIE
Customer Department: E&CPT
Customer Address: 999-W 391
Customer Phone/Beeper: 819-8469 10395

LQB

Ship to: Company: SWR
Address: 9503 West Commerce
San Antonio, TX 78227
Attention: Michael Dammann, Project Manager

Savannah River Nuclear Solutions
Aiken, SC 29808
Environmental Services Section
Waste Sample Management Group

COC creation date. 6/5/17

Matrix: S=Soil,SO=Solid,SL=Sludge,O=Organic,A=Aqueous, SM=Smear

Sample Analysis Requested	Sample ID: W-1703I-00001 Sample 1	Sample ID: W-1703I-00002 Sample 2	Sample ID: W-1703I-00003 Sample 3
	Collect Date 6/8/17	Collect Date 6/8/17	Collect Date 6/8/17
	Collect Time 0900	Collect Time 0900	Collect Time 0900
	No. Containers 1	No. Containers 1	No. Containers 1
	Matrix A	Matrix A	Matrix A
Cyanide-Total (spectrophotometric manual) (282)	✓	✓	✓

Client: Savannah River Nuclear Solutions,LLC
SwRI Project # 17995.24.001
VTSR: 06/09/17 10:30
Battery Check: Y
Cooler/Container Wipe: <150 cpm
Total cpm-mR/h (samples): –150 cpm; <0.5 mR/hr
(see Radioactive Material Receiving Form for more information)

SwRI # 59851
Case: 17031
Sample(s) Received: Intact
Background Check: <150 cpm (Lab 103)
Temp.: 3.5°C (blue ice) / SN # 021055
Wipe Frisk Description: Coolers - (1)

TAT Days: 28
Activity Code: 08YRL3C08C
Comments:

RAD SCREEN REQUIRED? NO

STR Authorization

1 Pri
Sig
3 Pri
Sig

CHAIN-OF-CUSTODY

010003 Page 1 of 2

☐ Organic ☒ Aqueous ☐ Soil ☐ Solid ☐ Sludge ☐ gr water ☐ Smears ☐ Swipes ☐ Gas

17031

Contract Number
0000078769

Customer Name: HILL, KATIE
Customer Department: E&CPT
Customer Address: 999-W 391
Customer Phone/Beeper: 819-8469 10395

LQB

Ship to:
Company: SWR
Address: 9503 West Commerce
San Antonio, TX 78227
Attention: Michael Dammann, Project Manager

Savannah River Nuclear Solutions
Aiken, SC 29808
Environmental Services Section
Waste Sample Management Group

COC creation date. 6/5/17

Matrix: S=Soil,SO=Solid,SL=Sludge,O=Organic,A=Aqueous, SM=Smear

Sample Analysis Requested	Sample ID: W-17031-00004 Sample4	Sample ID: W-17031-00005 Sample5	Sample ID:
	Collect Date 6/8/17	Collect Date 6/8/17	Collect Date 6/8/17
	Collect Time 0900	Collect Time 0900	Collect Time 0900
	No. Containers 1	No. Containers 1	No. Containers 1
	Matrix A	Matrix A	Matrix A
Cyanide-Total (spectrophotometric manual) (282)	✓	✓	✓

Client: Savannah River Nuclear Solutions,LLC
SwRI Project # 17995.24.001
VTSR: 06/09/17 10:30
Battery Check: Y
Cooler/Container Wipe: <150 cpm
Total cpm-mR/h (samples): ~150 cpm; <0.5 mR/hr
(see Radioactive Material Receiving Form for more information)

SwRI # 59851
Case: 17031
Sample(s) Received: Intact
Background Check: <150 cpm (Lab 103)
Temp.: 3.5°C (blue ice) / SN # 021055
Wipe Frisk Description: Coolers - (1)

TAT Days	Activity Code	Comments	RAD SCREEN REQUIRED?	STR Authorization
28	08YRL3C08C		NO	

1 Reli
(Print)
(Sign)

3 Reli
(Print)
(Sign)

OSR 1-53 (Rev 05/01/2010)

Savannah River Site
Electronic Shipping Orders

ESO-RG-20170600026

ESO Submitted By	Date	ID
Karen Palmer	6/8/2017 8:25:57 AM	ESO-RG-20170600026
Current Status	**Current Assignee**	**Shipping Order Number**
Pending Approval	Traffic Services	

Emergency Contact Number: (803) 725-3333

Purchase Order/PCP Number	Return Authorization Number	Shipping Order Number
0000078769	N/A	
Supplier Contact Name	**Supplier Contact Phone**	
MICHAEL DAMMANN	210-522-5428	
Third Party Billing Address	ShipTo	
N/A	SOUTHWEST RESEARCH INSTITUTE 9503 WEST COMMERCE SAN ANTONIO, TX 78227	

Item No	Packages		HM	Short Description	Weight	
	No	Type			Pounds	Kilograms
ITM-0001	1	Cooler		EMF SIMULANT (JOB NUMBER 17030)	30	14
Totals					30	14

Expanded Description and HMTR Comments

Shipping Item Comments for: ITM-0001 - <No ELI Number>

Originator's Comments:

EMF SIMULANT (JOB NUMBER 17030)

Client: Savannah River Nuclear Solutions,LLC
SwRI Project # 17995.24.001
VTSR: 06/09/17 10:30
Battery Check: Y
Cooler/Container Wipe: <150 cpm
Total cpm-mR/h (samples): ~150 cpm; <0.5 mR/hr
(see Radioactive Material Receiving Form for more information)

SwRI # 59851
Case: 17031
Sample(s) Received: Intact
Background Check: <150 cpm (Lab 103)
Temp.: 3.5°C (blue ice) / SN # 021055
Wipe Frisk Description: Coolers - (1)

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

Sample Receipt Paperwork

Sample Receipt

Southwest Research Institute

Sample Receipt Number: 59851

VTSR: 06/09/17

Time: 10:30:00

Project: 17995.24.001
Case #: 17031
Client: Savannah River Nuclear Solutions, LLC

Manager: DAMMANN, MIKE
Logged in by: DXGARCIA
Creation Date: 06/09/17

Notes

Samples were received intact.

Fed Ex Tracking #(s): - 3.5°C (blue ice)
7793 3243 6580

Test requirements located on Task Order.

See chain-of-custody as part of the SRR system for more information.

ALL SAMPLE CONTAINERS / APPLICABLE ITEMS WERE RECEIVED OK.

Phases:
001 - admin
006 - metals/radchem
007 - drg

Backaround CPM: <150 cpm
Container Wipe CPM: <150 cpm
Total CPM: <150

System ID	Customer ID	CED	Matrix	Containers	Special Reqs.
616432	W-17031-00001	06/08/17	Aqueous	1	
616433	W-17031-00002	06/08/17	Aqueous	1	
616434	W-17031-00003	06/08/17	Aqueous	1	
616435	W-17031-00004	06/08/17	Aqueous	1	
616436	W-17031-00005	06/08/17	Aqueous	1	

Containers: 5 **Samples: 5**

These documents are associated with this receipt: 223187[COC for SRR 59851], 223189[Paperwork for SRR 59851]

Thermometer: 021055
Temperature: 3.5

59851 Savannah River Nuclear Solut

Southwest Research Institute

Laboratory Task Order

TO #: 170609-5 Revision: 0

Project(s): 17995.24.001
Manager(s): DAMMANN, MIKE
To Client: 07/06/17

SDG: 616432
VTSR: 06/09/17
CASE: 17031

SRR #'s: 59851
Client(s): Savannah River Nuclear Solutions, LLC

Instructions

Savannah River Nuclear Solutions, LLC. Contract 78769. Release Order # SWR-17-W-17031.
SDG is 616432

28-day TAT. Using 26-day TAT for Report/EDD.
FINAL DATA/HARDCOPY IS DUE TO THE CLIENT ON 07/07/2017.

5 overall simulant samples were received on 06/09/17, which are ALL listed here.

REQUIRED:
Cyanide-Total (spectrophotometric manual)

****
PER REQUEST:
_ Pay Item: 282 _ EPA 9012B Total and Amenable Cyanide

See SAVANNAH SOW EC & ACP for all requirements.
3.1.2.7 Analytical Requirements
3.1.2.11.1 Analytical Data Report
3.1.2.11.2 Laboratory Case Narrative
CONTACT: Ms. Natalia Johnson, natalia.johnson@srs.gov, 803.952.6203

Documents Related to this task order: 223187[COC for SRR 59851], 223189[Paperwork for SRR 59851]

Deliverables --> Hard Copy: no EDD: no PDF: -YES-

Test: CN_9014
Section: WETCHEM

Holding: 14 days from CED

Total Cyanide by SW846 9014

Cnt: 5

System ID	Type	Cont	Matrix	Customer ID	CED	Method Date
616432		1	Aqueous	W-17031-00001	08 Jun 17	22 Jun 17
616433		1	Aqueous	W-17031-00002	08 Jun 17	22 Jun 17
616434		1	Aqueous	W-17031-00003	08 Jun 17	22 Jun 17
616435		1	Aqueous	W-17031-00004	08 Jun 17	22 Jun 17
616436		1	Aqueous	W-17031-00005	08 Jun 17	22 Jun 17

Southwest Research Institute

: Report

Sample Custodian Signature:

1. Custody Seal — Present
2. Chain of Custody — Present
3. Sample Tags — Not Present N/A
   Sample Tag Numbers — Not on COC
4. SMO Forms — Present

Client: Savannah River Nuclear Solutions, LLC

Project: 17995.24.001

Case: 17031 / SDG: SEE T.6.

Sample Receipt: 59851

Airbill: 7793 3243 6580

Custody Seal #(s): N/A

Date Received	Time Received	COC Record	SMO Sample #	Corresponding		Traffic Rpt, Tags, COC Agree	Sample Condition
				Sample Tag #	SwRI #		
06/09/17	10:30:00	17031	W-17031-00001	N/A	616432	YES	Intact
06/09/17	10:30:00	17031	W-17031-00002	N/A	616433	YES	Intact
06/09/17	10:30:00	17031	W-17031-00003	N/A	616434	YES	Intact
06/09/17	10:30:00	17031	W-17031-00004	N/A	616435	YES	Intact
06/09/17	10:30:00	17031	W-17031-00005	N/A	616436	YES	Intact

SAMPLE LOG-IN SHEET

Lab Name: Southwest Research Institute			Page 1 of 1
Received By (Print Name): DAVID GARCIA			Log-in Date: 06/09/2017
Received By (Signature)			
Case Number: 17031	Sample Delivery Group No.: N/A		SAS Number: N/A

Remarks: 17995.24.001

1. Custody Seal(s)	Present/Absent* Intact/Broken		
2. Custody Seal Nos.	N/A		
3. Chain-of Custody Records	Present/Absent*		
4. Traffic Reports or Packing Lists	Present/Absent*		
5. Airbill	Airbill/Sticker Present/Absent*		
6. Airbill No.	7793 3243 6580		
7. Sample Tags	Present/Absent*		
Sample Tag Numbers	Listed/Not listed on Chain of Custody		
8. Sample Condition	Intact/Broken*/ Leaking		
9. Cooler Temperature	3.5C		
10. Does Information on custody records, traffic reports, and sample tags agree?	Yes/No*		
11. Date Received at Lab	06/09/2017		
12. Time Received	10:30:00		

EPA Sample #	Corresponding Sample Tag #	Corresponding Assigned Lab #	Remarks: Condition of Sample Shipment, etc
W-17031-00001	N/A	616432	Intact
W-17031-00002	N/A	616433	Intact
W-17031-00003	N/A	616434	Intact
W-17031-00004	N/A	616435	Intact
W-17031-00005	N/A	616436	Intact

Sample Transfer					
Fraction	INORG	Fraction			
Area #	R.13	Area #			
By	DAVID GARCIA	By			
On	06/09/2017	On			

* Contact SMO and attach record of resolution

Reviewe		Logbook No.	Sample Receipt (59851)
Date		Logbook Page No.	9846 SEC 3 OF 4

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

Total Cyanide
Case Narrative

Client: Savannah River Nuclear Solutions, LLC
SDG: 616432
SwRI Project Number: 17995.24.00X
SwRI Task Order Number: 170609-5

WETCHEM ANALYSES-Total Cyanide

The samples were prepared for Total Cyanide using SW 846 9010C and analyzed using 9012B. All holding times were met.

Instrument QC: All instrument QC criteria were met. The recoveries were within 90-110% for the initial and continuing calibration verifications. No analytes were detected above SwRI's reporting limits in the initial and continuing calibration blanks.

Total Cyanide QC: Cyanide was not detected in the prep blanks above SwRI's RLs. The aqueous laboratory control sample and its duplicate were within 80-120% recovery. SwRI system ID 616432 was QC'd. All matrix spike recoveries for total cyanide were within their specified criteria and did not require any data qualifiers. The duplicate RPD was 8.06%, which is less than 35%; therefore, no flag was required.

Description of "Q" column qualifiers on SwRI report forms: "U" indicates that an analyte was not detected above SwRI's reporting limit (RL). SwRI's RLs were used as CRDLs for reporting. "D" indicates the result is reported from a dilution.

Laboratory Qualifiers used on Certificate of Analysis and EDD:
"U" is used for non-detected analytes.

"I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the laboratory manager or his/her designee, as verified by the following signature. This report shall not be reproduced except in full without the written approval of SwRI."

_____

Date

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

Total Cyanide

SOUTHWEST RESEARCH INSTITUTE

WetChem Report

Cover Page

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5

SDG: 616432
SRR: 59851

Case: 17031
Project: 17995.24.001

Client Sample ID	Lab Sample ID
W-17031-00001	616432
W-17031-00001D	616432D
W-17031-00001MS	616432S
W-17031-00002	616433
W-17031-00003	616434
W-17031-00004	616435
W-17031-00005	616436

Comments:

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and the electronic data submitted has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature:

Name: Radonna Spies

Date:

Title: Principal Scientist

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form I

Certificate of Analysis

010014 **Client Sample ID**

W-17031-00001

Type: Unknown

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616432
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001
Receipt Date: 06/09/2017
Collection Date: 06/08/2017

CAS No.	Analyte	Result	Qual	M	RL	CRDL	DF	Prep Batch	Analysis Date/Time
57-12-5	Total Cyanide	13.1	D	KNO	0.250	0.500	10	20170621-P002	06/21/2017 19:03

Data Reporting Qualifiers (Qual)	***Columns***	***Instruments/Methods (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	RL - SwRI Reporting Limit	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	CRDL - Contract Req. Det. Limit	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form I

Certificate of Analysis

010015 **Client Sample ID**

W-17031-00002

Type: Unknown

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616433
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001
Receipt Date: 06/09/2017
Collection Date: 06/08/2017

CAS No.	Analyte	Result	Qual	M	RL	CRDL	DF	Prep Batch	Analysis Date/Time
57-12-5	Total Cyanide	15.4	D	KNO	0.250	0.500	50	20170621-P002	06/21/2017 19:03

Data Reporting Qualifiers (Qual)	***Columns***	***Instruments/Methods (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	RL - SwRI Reporting Limit	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	CRDL - Contract Req. Det. Limit	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form I

Certificate of Analysis

010016 **Client Sample ID**

W-17031-00003

Type: Unknown

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616434
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001
Receipt Date: 06/09/2017
Collection Date: 06/08/2017

CAS No.	Analyte	Result	Qual	M	RL	CRDL	DF	Prep Batch	Analysis Date/Time
57-12-5	Total Cyanide	56.4	D	KNO	1.25	2.50	250	20170621-P002	06/21/2017 20:39

Data Reporting Qualifiers (Qual)	***Columns***	***Instruments/Methods (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	RL - SwRI Reporting Limit	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	CRDL - Contract Req. Det. Limit	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form I

Certificate of Analysis

010017 **Client Sample ID**

W-17031-00004

Type: Unknown

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616435
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001
Receipt Date: 06/09/2017
Collection Date: 06/08/2017

CAS No.	Analyte	Result	Qual	M	RL	CRDL	DF	Prep Batch	Analysis Date/Time
57-12-5	Total Cyanide	0.222		KNO	0.00500	0.0100	1	20170621-P002	06/21/2017 20:39

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	RL - SwRI Reporting Limit	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	CRDL - Contract Req. Det. Limit	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form I

Certificate of Analysis

010018 **Client Sample ID**

W-17031-00005

Type: Unknown

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616436
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001
Receipt Date: 06/09/2017
Collection Date: 06/08/2017

CAS No.	Analyte	Result	Qual	M	RL	CRDL	DF	Prep Batch	Analysis Date/Time
57-12-5	Total Cyanide	0.235		KNO	0.00500	0.0100	1	20170621-P002	06/21/2017 20:39

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	RL - SwRI Reporting Limit	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	CRDL - Contract Req. Det. Limit	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form I

Certificate of Analysis

010019 **SwRI ID**

PB17F21PB1

Type: Blank

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: PB17F21PB1
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Solid, Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001
Receipt Date: NA
Collection Date: NA

CAS No.	Analyte	Result	Qual	M	RL	CRDL	DF	Prep Batch	Analysis Date/Time
57-12-5	Total Cyanide	0.00500	U	KNO	0.00500	0.0100	1	20170621-P002	06/21/2017 19:03

Comments: Water

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	RL - SwRI Reporting Limit	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	CRDL - Contract Req. Det. Limit	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE 010020

WetChem Report - Form IIA

Initial and Continuing Calibration Verification

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Result Units: mg/L
Associated Analytical Batches: 20170705-A003

SDG: 616432
SRR: 59851
Initial Calibration Source: See Raw Data
Continuing Calibration Source: See Raw Data

Case: 17031
Project: 17995.24.001

	Initial Calibration Verification				Continuing Calibration Verification						
Analyte	True	Found	%Rec	Limit	True	Found1	%Rec	Found2	%Rec	Limit	M
Total Cyanide	0.680	0.702	103.2%	90%-110%	0.680	0.686	100.9%	0.681	100.2%	90%-110%	KNO

Instruments/Methods (M)

KNO - Konelab/NA
NA - Not Applicable

Form IIA-IN

SOUTHWEST RESEARCH INSTITUTE 010021

WetChem Report - Form IIA

Initial and Continuing Calibration Verification

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Result Units: mg/L
Associated Analytical Batches: 20170705-A003

SDG: 616432
SRR: 59851
Initial Calibration Source: See Raw Data
Continuing Calibration Source: See Raw Data

Case: 17031
Project: 17995.24.001

	Continuing Calibration Verification								
Analyte	True	Found3	%Rec	Found4	%Rec	Found5	%Rec	Limit	M
Total Cyanide	0.680	0.688	101.2%	0.709	104.3%	0.719	105.7%	90%-110%	KNO

Instruments/Methods (M)

KNO - Konelab/NA
NA - Not Applicable

Form IIA-IN

WetChem Report - Form IIB

Low Level Check Standard

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Result Units: mg/L
Associated Analytical Batch: 20170705-A003

SDG: 616432
SRR: 59851

Case: 17031
Project: 17995.24.001

	LLC Standards				
Analyte	True	Found1	%Rec	Limit	M
Total Cyanide	0.00500	0.00394	78.8%	50%-150%	KNO

Instruments/Methods (M)
KNO - Konelab/NA
NA - Not Applicable

Form IIB-IN

WetChem Report - Form III

Blanks

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Preparation Blank Result Units: mg/L
Initial/Continuing Blank Result Units: RL

SDG: 616432
SRR: 59851
Preparation Blank Matrix: Aqueous
Associated Prep Batches: 20170621-P002

Case: 17031
Project: 17995.24.001
Associated Analytical Batches: 20170705-A003

	Preparation Blank		Initial Calibration Blank		Continuing Calibration Blank										
Analyte	Result	Qual	Found	Qual	Found1	Qual	Found2	Qual	Found3	Qual	Found4	Qual	Found5	Qual	M
Total Cyanide	0.00500	U	0.00500	U	0.00500	U	0.00500	U	0.00500	U	0.00500	U	0.00500	U	KNO

Data Reporting Qualifiers (Qual)	***Instruments/Methods (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	
X - Analytical spike criteria was not met	
E - Result is estimated due to interferences	
D - Result is reported from a dilution	
J - Duplicate criteria was not met	

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form VA

Matrix Spike/Matrix Spike Duplicate Sample Recovery

010024 **Client Sample ID**

W-17031-00001MS/MSD

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616432S
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001

Analyte	Parent Sample Result	Qual	MS Result	MS Spike Added	MS %Rec	MSD Result	MSD Spike Added	MSD %Rec	%RPD	Control Limit %Rec	Control Limit %RPD	M	Note
Total Cyanide	13.1	D	15.9	2.50	112.0%	-	-	-	-	75%-125%	-	KNO	#

Parent value exceeded 1 times the spike added, therefore MS/MSD %Recovery and %RPD are not required for evaluation.

Data Reporting Qualifiers (Qual)	***Columns***	***Instruments/Methods (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL)	M - Instrument	KNO - Konelab/NA
U - Result is less than the SwRI Reporting Limit (RL)	MS - Matrix Spike	NA - Not Applicable
J - Matrix spike and/or matrix spike duplicate criteria was not met	MSD - Matrix Spike Duplicate	
X - Analytical spike criteria was not met	Q - Qualifier	
E - Result is estimated due to interferences	RPD - Relative Percent Difference	
D - Result is reported from a dilution		
J - Duplicate criteria was not met		

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form VI

Duplicates

010025 **Client Sample ID**

W-17031-00001D

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: 616432D
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001

Analyte	Parent Sample Result	Qual	Duplicate Result	Qual	RPD	RPD Limit	Control Limit	M	Note
Total Cyanide	13.1	D	14.2	D	8.06%	20%	-	KNO	

Data Reporting Qualifiers (Qual)	***Columns***	***Instruments/Method (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL) U - Result is less than the SwRI Reporting Limit (RL) J - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution J - Duplicate criteria was not met	M - Instrument RPD - Relative Percent Difference	KNO - Konelab/NA NA - Not Applicable

Form VI-IN

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form VI

Duplicates

010026 **Client Sample ID**

LCS17F21JH2D

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: LCS17F21SW2
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
% Solids: NA

Case: 17031
Project: 17995.24.001

Analyte	Parent Sample Result	Qual	Duplicate Result	Qual	RPD	RPD Limit	Control Limit	M	Note
Total Cyanide	0.710		0.721	D	1.54%	20%	-	KNO	

Data Reporting Qualifiers (Qual)	***Columns***	***Instruments/Method (M)***
B - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the Contract Required Detection Limit (CRDL) U - Result is less than the SwRI Reporting Limit (RL) J - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution J - Duplicate criteria was not met	M - Instrument RPD - Relative Percent Difference	KNO - Konelab/NA NA - Not Applicable

Form VI-IN

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form VII

Laboratory Control Sample

010027 **SwRI ID**

LCS17F21JH2[2]

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: LCS17F21JH2
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
Associated Prep Batches: 20170621-P002

Case: 17031
Project: 17995.24.001
LCS Source: ERA

Analyte	True	Found	Qual	%Rec.	Limit	M	Analysis Date/Time
Total Cyanide	0.680	0.710	D	104.4%	85%-115%	KNO	06/21/2017 16:48

Instruments/Methods (M)

KNO - Konelab/NA
NA - Not Applicable

Form VII-IN

SOUTHWEST RESEARCH INSTITUTE
WetChem Report - Form VII
Laboratory Control Sample

010028 **SwRI ID**

LCS17F21SW2[2]

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: LCS17F21SW2
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
Associated Prep Batches: 20170621-P002

Case: 17031
Project: 17995.24.001
LCS Source: ERA

Analyte	True	Found	Qual	%Rec.	Limit	M	Analysis Date/Time
Total Cyanide	0.680	0.721	D	106.0%	85%-115%	KNO	06/21/2017 16:48

Instruments/Methods (M)
KNO - Konelab/NA
NA - Not Applicable

Form VII-IN

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form VII

Laboratory Control Sample

010029 **SwRI ID**

LCS17F21JH3[2]

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: LCS17F21JH3
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
Associated Prep Batches: 20170621-P002

Case: 17031
Project: 17995.24.001
LCS Source:

Analyte	True	Found	Qual	%Rec.	Limit	M	Analysis Date/Time
Total Cyanide	0.500	0.472		94.4%	90%-110%	KNO	06/21/2017 16:48

Instruments/Methods (M)

KNO - Konelab/NA
NA - Not Applicable

Form VII-IN

SOUTHWEST RESEARCH INSTITUTE

WetChem Report - Form VII

Laboratory Control Sample

010030 **SwRI ID**

LCS17F21JH4[2]

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Lab ID: LCS17F21JH4
Result Units: mg/L

SDG: 616432
SRR: 59851
Matrix: Aqueous
Associated Prep Batches: 20170621-P002

Case: 17031
Project: 17995.24.001
LCS Source:

Analyte	True	Found	Qual	%Rec.	Limit	M	Analysis Date/Time
Total Cyanide	0.0500	0.0476		95.2%	90%-110%	KNO	06/21/2017 16:48

Instruments/Methods (M)

KNO - Konelab/NA
NA - Not Applicable

Form VII-IN

WetChem Report - Form IX

Detection Limits

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Result Units: mg/L

SDG: 616432
SRR: 59851
Instrument: Konelab

Case: 17031
Project: 17995.24.001
Date: 01/09/2014

Analyte	Wavelength	RL	CRDL
Total Cyanide	575 nm	0.00500	0.0100

Columns	
RL	- SwRI Reporting Limit
CRDL	- Contract Req. Det. Limit

WetChem Report - Form XII

Analysis Run Log

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5
Analytical Batch: 20170705-A003
Analysis Method:

SDG: 616432
SRR: 59851
Instrument: Konelab

Case: 17031
Project: 17995.24.001
Start Date: 06/21/2017
End Date: 06/21/2017

Lab Sample ID	Client Sample ID	Time	DF	TCN
CN-0	CN-0	14:08	1	X
CN-0.005	CN-0.005	14:08	1	X
CN-0.01	CN-0.01	14:08	1	X
CN-0.05	CN-0.05	14:08	1	X
CN-0.1	CN-0.1	14:08	1	X
CN-0.25	CN-0.25	14:08	1	X
CN-0.5	CN-0.5	14:08	1	X
CN-ICV	CN-ICV	16:48	2	X
CN-ICB	CN-ICB	16:48	1	X
CN-LLC	NA	16:48	1	X
LCS17F21JH2	NA	16:48	2	X
LCS17F21SW2	NAD	16:48	2	X
LCS17F21JH3	NA	16:48	1	X
LCS17F21JH4	NA	16:48	1	X
CN-CCV	CN-CCV	17:46	2	X
CN-CCB	CN-CCB	17:46	1	X
CN-CCV2	CN-CCV2	19:03	2	X
CN-CCB2	CN-CCB2	19:03	1	X
616432	W-17031-00001	19:03	10	X
616432D	W-17031-00001D	19:03	10	X
616432S	W-17031-00001MS	19:03	10	X
616432SD	W-17031-00001MSD	19:03	10	
616433	W-17031-00002	19:03	50	X
PB17F21PB1	NA	19:03	1	X
CN-CCV3	CN-CCV3	19:30	2	X
CN-CCB3	CN-CCB3	19:30	1	X
616434	W-17031-00003	19:30	10	
616435	W-17031-00004	19:30	10	
616436	W-17031-00005	19:30	10	
616434	W-17031-00003	20:14	100	
616435	W-17031-00004	20:14	1	
616436	W-17031-00005	20:14	1	
616432SD	W-17031-00001MSD	20:14	10	
CN-CCV4	CN-CCV4	20:14	2	X
CN-CCB4	CN-CCB4	20:15	1	X
616434	W-17031-00003	20:39	250	X
616435-R	W-17031-00004	20:39	1	X
616436-R	W-17031-00005	20:39	1	X
CN-CCV5	CN-CCV5	20:39	2	X
CN-CCB5	CN-CCB5	20:39	1	X

WetChem Report - Form XVIII

Preparation/Digestion Summary

Client: Savannah River Nuclear Solutions, LLC
Task Order: 170609-5

SDG: 616432
SRR: 59851

Case: 17031
Project: 17995.24.001

Prep Batch	Method	Preparation Date
20170621-P002	CN prep	06/21/2017

Digestion Log

010034

Southwest Research Institute
San Antonio, Texas 78228

Batch: 20170621-P002 (Ver. 2)
Status: WORKING

Client(s): Savannah River Nuclear Solutions, LLC
Task Order(s): 170620-3, 170609-5
SDG(s): 616635, 616432
Project(s): 17995.23.001, 17995.24.001
Method(s): CN prep (TAP: 01-0406-134)
Matrix(s): Solid, Aqueous
Reagent(s): (CN) 2.5M MgCl2 #135-02-WCS13, (CN) H2SO4 #76373, (CN) 0.25N NaOH #185-01-WCS13, 0.35M Calcium Hypochlorite #48-02-WCS13, 0.1N Sodium Arsenite #140-02-WCS13, KI #85038
Balance(s): #135
Pipette(s): 5000-M, 1000-1, 200-2
Heating Device: MIDI-STIL Temperature (C): 125C
Time In: 06/21/2017 09:16:52 Time Out: NA

Sample Identification	Client Identification	Initial Weight (g)	Final Volume (mL)
PB17F21JH1 Ⓐ	NA	1.0771	50
LCS17F21JH1 ①Ⓐ	NA	1.1281	50
616635	W-17030-00001	1.0291	50
616635D	W-17030-00001	1.0206	50
616635MS ②	W-17030-00001	1.0416	50
616635MSD ②	W-17030-00001	1.0479	50
616636	W-17030-00002	1.1034	50
616637	W-17030-00003	1.0422	50
LCS17F21JH2 ③Ⓑ	NA	50 (mL)	50
LCS17F21JH3 ②Ⓒ	NA	50 (mL)	50
LCS17F21JH4 ④Ⓓ	NA	50 (mL)	50
616635-CL	W-17030-00001	1.0902	50
616635D-CL	W-17030-00001	1.0276	50
616635S-CL ②	W-17030-00001	1.0242	50
616635SD-CL ②	W-17030-00001	1.0947	50
616636-CL	W-17030-00002	1.0287	50
616637-CL	W-17030-00003	1.0641	50
PB17F21JH2	NA	1.0502	50
LCS17F21SW2 ③Ⓔ	NA	50 (mL)	50
PB17F21PB1 Ⓑ	NA	50 (mL)	50
616432	W-17031-00001	10 (mL)	50
616432D	W-17031-00001	10 (mL)	50
616432S ②	W-17031-00001	10 (mL)	50
616432SD ②	W-17031-00001	10 (mL)	50
616433	W-17031-00002	50 (mL)	50
616434	W-17031-00003	50 (mL)	50
616435	W-17031-00004	50 (mL)	50
616436	W-17031-00005	50 (mL)	50

Prepared by: HERRERA, JUDY Date: 06/21/2017

Reviewed by: MOKEN, JAMES Date: 06/30/2017

Disposal Int/Date/Loc: _____

Program version(8/11/2011)

Digestion Log

010035

Southwest Research Institute
San Antonio, Texas 78228

Batch: 20170621-P002 (Ver. 2)
Status: WORKING

Client(s): Savannah River Nuclear Solutions, LLC
Task Order(s): 170620-3, 170609-5
SDG(s): 616635, 616432
Project(s): 17995.23.001, 17995.24.001
Method(s): CN prep (TAP: 01-0406-134)
Matrix(s): Solid, Aqueous
Reagent(s): (CN) 2.5M MgCl2 #135-02-WCS13, (CN) H2SO4 #76373, (CN) 0.25N NaOH #185-01-WCS13, 0.35M Calcium Hypochlorite #48-02-WCS13, 0.1N Sodium Arsenite #140-02-WCS13, KI #85038
Balance(s): #135
Pipette(s): 5000-M, 1000-1, 200-2
Heating Device: MIDI-STIL Temperature (C): 125C
Time In: 06/21/2017 09:16:52 Time Out: NA

Sample Identification	Client Identification	Initial Weight (g)	Final Volume (mL)

① spiked 1.1281 g of CI# 67469 Cyanide in Soil (Lot# D088-541, Source: ERA, Exp: 07/31/2018)
② spiked 0.250 mL of 113-02-WCS13 (Lot# 83333, Source: ERA, Exp: 02/01/2018)
③ spiked 50 mL of CI# 83495 Total Cyanide (Lot# P261-502, Source: ERA, Exp: 07/31/2019)
④ spiked 0.025 mL of 113-02-WCS13 (Lot# 83333, Source: ERA, Exp: 02/01/2018)

Ⓐ Solid
Ⓑ Water
Ⓒ High
Ⓓ Low
Ⓔ Water Dup

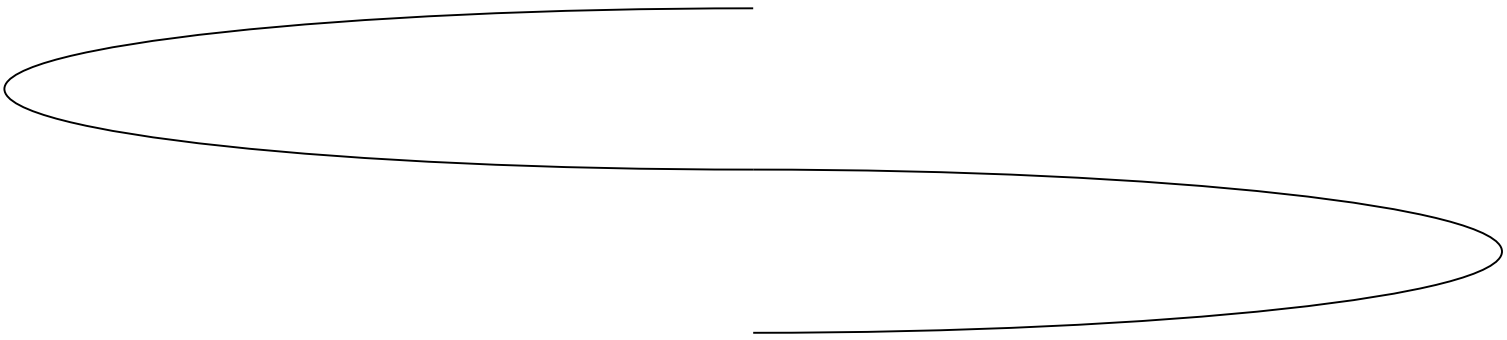
Comments:
PB #76031

1-Distillation
Start: 10:30 a.m.
Stop: 12:30 p.m.

2-Distillation
Start: 3:30 p.m.
Stop: 5:30 p.m.

3-Distillation
Start: 6:00 p.m.
Stop: 8:00 p.m.

LCS17F21JH1 and LCS17F21SW2 prepared by taking 0.25mL of concentrated ERA std (#83495) to FV 50mL with DI H2O and 1mL 0.25N NaOH (185-01-WCS13)
TV = 0.680 mg/L



Prepared by: HERRERA, JUDY Date: 06/21/2017

Reviewed by: MOKEN, JAMES Date: 06/30/2017

Disposal Int/Date/Loc: _____

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

Sample Calculations

Client: *Savannah River Nuclear Solutions, LLC*
SDG: *616432*
SwRI Project Number *17995.24.001*
SwRI Task Order Number(s): *170609-5*

Sample Calculation Sheet

CN 9012B

A = Analyte Result (mg/L)
B = Final Volume (mL)
C = Initial Volume (mL)
Final Results (mg/L) = A X (B/C)

#616432

$$2.62\ \frac{mg}{L} \times \frac{50mL}{10mL} = 13.1\ \frac{mg}{L}$$

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

SW-846 Method 9012

Raw Data

CN SW846 9012

Southwest Research Institute
San Antonio, Texas 78228

Batch: 20170705-A003 (Ver. 3)
Status: CONSUMED

Analyte Test: CN SW846 9012
Instrument: Konelab
Data File Name: WATERS SAV.xls
Start Time: 06/21/2017 14:08:00
Stop Time: 06/21/2017 20:39:00
Customer: Savannah River Nuclear Solutions, LLC
Qualifier Set: SavRiver
Task Order: 170609-5
SDG: 616432
Project: 17995.24.001
Limit: Savannah CN water
Reagent: Phosphate Buffer #106-03-WCS13, Pyridine #135-03-WCS13, Chloramine-T #185-02-WCS13, 0.25N NaOH #185-01-WCS13
Pipette: 5000-M, 1000-1, 200-2

			Total Cyanide				
Sample Identification	Client Identification	DF	Cyanide result water (mg/L)	Final Result (mg/L)	RL (mg/L)	Rec (%)	RPD (%)
CN-0	NA		0.000610 U	0.00500 U	0.00500		
CN-0.005	NA		0.00505	0.00505	0.00500		
CN-0.01	NA		0.00993	0.00993	0.00500		
CN-0.05	NA		0.0490	0.0490	0.00500		
CN-0.1	NA		0.100	0.100	0.00500		
CN-0.25	NA		0.250	0.250	0.00500		
CN-0.5	NA		0.500	0.500	0.00500		
CN-ICV ①	NA	2	0.702 D	0.702 D	0.0100 D	103 D	
CN-ICB	NA		0.000870 U	0.00500 U	0.00500		
CN-LLC	NA		0.00394 U	0.00500 U	0.00500	100	
LCS17F21JH2 ①	NA	2	0.710 D	0.710 D	0.0100 D	104 D	
LCS17F21SW2 ①	NA	2	0.721 D	0.721 D	0.0100 D	106 D	
LCS17F21JH3 ①	NA		0.472	0.472	0.00500	94.4	
LCS17F21JH4 ①	NA		0.0476	0.0476	0.00500	95.2	
CN-CCV ①	NA	2	0.686 D	0.686 D	0.0100 D	101 D	
CN-CCB	NA		0.00176 U	0.00500 U	0.00500		
CN-CCV2 ①	NA	2	0.681 D	0.681 D	0.0100 D	100 D	
CN-CCB2	NA		0.00131 U	0.00500 U	0.00500		
616432 ①	W-17031-00001	10	2.62 D	13.1 D	0.250 D		
616432D ①	W-17031-00001	10	2.83 D	14.2 D	0.250 D		7.71 D
616432S ①	W-17031-00001	10	3.18 D	15.9 D	0.250 D	112 D	
616432SD ①	W-17031-00001	10	*2.00 D*	*10.0 D*	*0.250 D*	*124 D*	
616433 ①	W-17031-00002	50	15.4 D	15.4 D	0.250 D		
PB17F21PB1 ①	NA		0.00169 U	0.00500 U	0.00500		
CN-CCV3 ①	NA	2	0.688 D	0.688 D	0.0100 D	101 D	
CN-CCB3	NA		0.00335 U	0.00500 U	0.00500		
616434 ①	W-17031-00003	10	*78.5 DH*	*78.5 DH*	*0.0500 D*		
616435 ①	W-17031-00004	10	*0.280 D*	*0.280 D*	*0.0500 D*		
616436 ①	W-17031-00005	10	*0.242 D*	*0.242 D*	*0.0500 D*		
616434 ①	W-17031-00003	100	*51.6 D*	*51.6 D*	*0.500 D*		
616435 ①	W-17031-00004		*2.56 H*	*2.56 H*	*0.00500*		
616436 ①	W-17031-00005		*0.227*	*0.227*	*0.00500*		
616432SD ①	W-17031-00001	10	*2.03 D*	*10.2 D*	*0.250 D*	*116 D*	
CN-CCV4 ①	NA	2	0.709 D	0.709 D	0.0100 D	104 D	
CN-CCB4	NA		0.00108 U	0.00500 U	0.00500		
616434 ①	W-17031-00003	250	56.4 D	56.4 D	1.25 D		
616435-R ①	W-17031-00004		0.222	0.222	0.00500		

U - Result is less than the SwRI Reporting Limit (RL)

Prepared by: HERRERA, JUDY Date: 06/21/2017

Reviewed by: MOKEN, JAMES Date: 07/05/2017

CN SW846 9012

Southwest Research Institute
San Antonio, Texas 78228

Batch: 20170705-A003 (Ver. 3)
Status: CONSUMED

Analyte Test: CN SW846 9012
Instrument: Konelab
Data File Name: WATERS SAV.xls
Start Time: 06/21/2017 14:08:00
Stop Time: 06/21/2017 20:39:00
Customer: Savannah River Nuclear Solutions, LLC
Qualifier Set: SavRiver
Task Order: 170609-5
SDG: 616432
Project: 17995.24.001
Limit: Savannah CN water
Reagent: Phosphate Buffer #106-03-WCS13, Pyridine #135-03-WCS13, Chloramine-T #185-02-WCS13, 0.25N NaOH #185-01-WCS13
Pipette: 5000-M, 1000-1, 200-2

			Total Cyanide				
Sample Identification	Client Identification	DF	Cyanide result water (mg/L)	Final Result (mg/L)	RL (mg/L)	Rec (%)	RPD (%)
616436-R ①	W-17031-00005		0.235	0.235	0.00500		
CN-CCV5 ①	NA	2	0.719 D	0.719 D	0.0100 D	106 D	
CN-CCB5	NA		0.00147 U	0.00500 U	0.00500		

+ all samples prepared in batch 20170621-P002

Comments:
Calibration Curve:

1 ppm CN std was prepared from 100 ppm CN std, 200uL of #113-02-WCS13 to final volume 20 mL with 0.25N NaOH (136-02-WCS13).

point (mg/L)	1 ppm (mL)	0.25N NaOH (mL)
0.5	5.0	5.0
0.25	2.5	7.5
0.1	1.0	9.0
0.05	0.5	9.5
0.01	0.1	9.9
0.005	0.05	9.95

pH > 12, KI = negative, Lead Acetate = negative
for the following samples:
616432
616433
616434
616435
616436

pH Lot#208515 #62596
KI #85038
Lead Acetate #85205

U - Result is less than the SwRI Reporting Limit (RL)

Prepared by: HERRERA, JUDY Date: 06/21/2017

Reviewed by: MOKEN, JAMES Date: 07/05/2017

010041

Southwest Research Institute®
Logbook: Konelab Aqua20
Serial #: S4119353
(CE032101)

Book I.D. # 17-0406-009

Analysis/ Method: CN SW846 9012 Project # 17995.23.001; 179952.00
Client: Savannah River Nuclear TO# 170620-3; 170609-5

Standard Source: 113-02-WS13 Stock TV: 100 ppm
ICV: #83495 ICV TV: 0.680 ppm
CCV: #83495 CCV TV: 0.680 ppm

Solutions Prepared for Analysis:

1. Phosphate Buffer # 106-03-WS13
2. Pyridine # 135-03-WS13
3. Chloramine-T # 185-02-WS13
4.
5.

Wash Solution: 0.25N NaOH # 185-01-WS13
Cuvettes Refilled? Yes

Additional Comments: Ep: 5000-M
1000-1
200-2

Solids non-rad (3)
Waters w/Cr (6) (5)

Analyst Signatur Date: 6/21/17
Reviewed by: Date: 6/30/17

Logbook#/ Page# 16 0017

Work continued from Page

SWRI

ID	Vol.(mL)/Wt.(g)	
PBS		
LCSS		
LCSW	50	Start: 10:30 a.m.
LCSWD	50	Stop: 12:30 p.m.
LCSH	50	
LCSL	50	
L0166635		
L0166635D		
L0166635S		
L0166635SD		
L0166636		
L0166637		
PB-Cl		
L0166635-Cl		Start: 3:30 p.m.
L0166635D-Cl		Stop: 5:30 p.m.
L0166635S-Cl		
L0166635SD-Cl		
L0166636-Cl		
L0166637-Cl		
L0164432	10	
L0164432D	10	
L0164432S	10	
L0164432SD	10	
L0164433	50	
L0164434	50	
L0164435	50	Start: 6:00 p.m
L0164436	50	Stop: 8:00 p.m.
PBW	50	

Work continued to Page

SIGNA

DISCL ... AND UNDERSTOOD BY DATE WITNESS DATE 4/21/17

DATE 7/5/17

0.35M Calcium Hypochlorite # 48-02-WCS13

0.1N Sodium Arsenite #140-02-WCS13

KI # 85038

H_2SO_4 # 76373

100ppm # 113-02-WCS13

LCSW # 83495

$MgCl_2$ # 135-02-WCS13

LCSS # 67469

pH 6+ # 208515 # 62596

EP: 5000-M
1000-1
200-2

Lead Acetate #85205

0.25N # 185-01-WCS13

Lot 64432
Lot 64433
Lot 64434
Lot 64435
Lot 64436

pH > 12, KI = neg., Lead Acetate Sulfides = Neg.

Calibration results AquaKem 6.5 Page: 1

Laboratory
Konelab User

21.06.2017 15:08

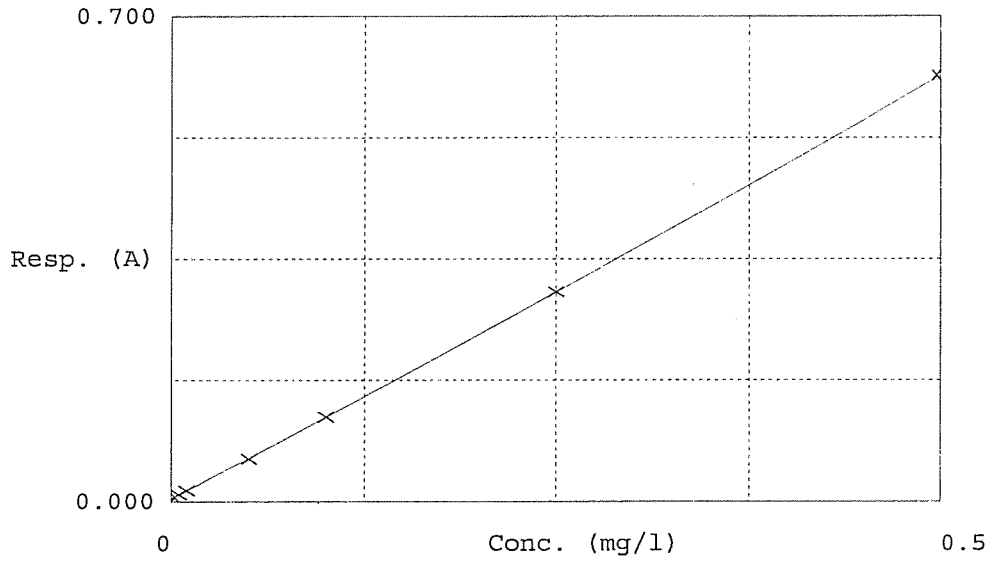
Test Cyanide

Accepted 21.06.2017 15:08

Resp. = A * Conc. ^ 2 + B * Conc. + C
A = 0.121
B = 1.16
C = 0.005

Coeff. of det. 0.999993

Errors



	Calibrator	Response	Calc. con.	Conc.	Errors
1	CN-0	0.005	0.00061	0.00000	
2	CN-0.005	0.010	0.00505	0.00500	
3	CN-0.01	0.016	0.00993	0.01000	
4	CN-0.05	0.062	0.04895	0.05000	
5	CN-0.1	0.122	0.10034	0.10000	
6	CN-0.25	0.302	0.25016	0.25000	
7	CN-0.5	0.615	0.49996	0.50000	

#20170705-A003

#20170621-P002 ✓

20170629-A001

20170629-A002

Test results AquaKem 6.5 Page: 1

Laboratory
Konelab User

Printed:

22.06.2017 07:11

Analyzed on: 6/21/17

Test: Cyanide

Sample Id	Result	Dil. 1 +	Response	Errors
CN-ICV DF2	0.7021	0.0	0.427	
CN-ICB	0.0009	0.0	0.006	
CN-LLC	0.0039	0.0	0.009	
PBS	0.0012	0.0	0.006	
LCSS DF10	1.7558	0.0	0.212	
LCSW DF2	0.7096	0.0	0.431	
LCSWD DF2	0.7214	0.0	0.439	
LCSH	0.4723	0.0	0.579	
LCSL	0.0476	0.0	0.060	
616635	0.4572	0.0	0.560	
616635D	0.4329	0.0	0.529	
616635S DF2	0.8656	0.0	0.529	
CN-CCV DF2	0.6861	0.0	0.417	
CN-CCB	0.0018	0.0	0.007	
616635SD DF2	1.0063	0.0	0.619	
616636	0.8439	0.0	1.055	
616637	0.8393	0.0	1.049	
PB-CL	0.0019	0.0	0.007	
616635-CL	0.2751	0.0	0.333	
616635D-CL	0.2542	0.0	0.307	
616635S-CL	0.2334	0.0	0.282	
616635SD-CL	0.2816	0.0	0.341	
616636-CL	0.4448	0.0	0.544	
616637-CL	0.5735	0.0	0.709	
CN-CCV2 DF2	0.6806	0.0	0.413	
CN-CCB2	0.0013	0.0	0.006	
616432 df10	2.6203	0.0	0.317	
616432D df10	2.8301	0.0	0.342	
616432S df10	3.1814	0.0	0.386	
616432SD df10	1.9976	0.0	0.241	
616433 df50	15.3875	0.0	0.373	
616635SD DF5	1.0158	0.0	0.245	
616636 DF5	0.8615	0.0	0.208	
616637 DF5	0.8897	0.0	0.215	
616637-CL DF2	0.5751	0.0	0.348	
PBW	0.0017	0.0	0.006	
CN-CCV3 DF2	0.6875	0.0	0.417	
CN-CCB3	0.0033	0.0	0.008	
616434 df10	78.5066	0.0	10.027	Abs. high
616435 df10	0.2796	0.0	0.037	
616436 df10	0.2421	0.0	0.033	
616434 DF100	51.5550	0.0	0.635	
616435	2.5618	0.0	0.310	
616436	0.2268	0.0	0.274	
616432SD DF10	2.0294	0.0	0.245	
CN-CCV4 DF2	0.7086	0.0	0.431	
CN-CCB4	0.0011	0.0	0.006	
616434 DF250	56.4430	0.0	0.273	
616435-R	0.2218	0.0	0.268	
616436-R	0.2354	0.0	0.284	
CN-CCV5 DF2	0.7191	0.0	0.437	
CN-CCB5	0.0015	0.0	0.006	

Laboratory
Konelab User

22.06.2017 07:11

Test: Cyanide

Sample Id	Result	Dil. 1 +	Response

N	52
Mean	4.5400
SD	14.83670
CV%	326.80

SOUTHWEST RESEARCH INSTITUTE
CLIENT: Savannah River Nuclear
SwRI PROJECT#: 17995.24.001
SwRI TASK ORDER: 170609-5
SwRI SRR: 59851
SDG: 616432
CONTRACT: 78769
ORDER: SWR-17-W-17031
RECEIVED: 06/09/2017

SW-846 Method 9012

Standard Logs & Certificates

Chemical Information Sheet

Total Cyanide

#83495

Grade:	Analytical
Type:	Neat
CAS:	143-33-9
Lot:	P261-502
Received:	10/01/2016
Expiration:	07/31/2019
Location:	- No Data -
Current Lab:	Lab 42 Bldg 70
Original Amount:	15 mL
Amount Remaining:	15
Supplier:	ERA
Concentration:	
Project:	- No Data -
PO Number:	PE sample
Internal Lab ID:	- No Data -
Density:	- No Data -
Storage Requirement:	- No Data -
Measuring Device ID:	- No Data -
Date Disposed:	- No Data -
Notes:	

Component Table

Compound	Conc/Activity	CAS
cyanide	0.680 mg/L	143-33-9

Reference Materials

▪ Certificate of Analysis ▪

Product: WatR™ Pollution Total Cyanide
Catalog Number: 502
Lot No. P261-502
Certificate Issue Date: February 24, 2017
Expiration Date: July 31, 2019
Revision Number: 1.0
Revision Date: February 24, 2017

CERTIFICATION

Parameter	Certified Value[1]	Uncertainty[2]	QC Performance Acceptance Limits[3]	PT Performance Acceptance Limits[4]
	mg/L	%	mg/L	mg/L
Phenol	0.958	0.404	0.718 - 1.20	-
Cyanide, total	0.680	5.30	0.515 - 0.836	0.442 - 0.918
Amenable Cyanide	0.214	10.1	0.162 - 0.263	0.139 - 0.289

ANALYTICAL VERIFICATION

Parameter	Certified Value[1]	Proficiency Testing Study			NIST Traceability	
		Mean	Recovery[5]	n	SRM Number	Recovery
	mg/L	mg/L	%			%
Phenol	0.958	-	-	-	-	-
Cyanide, total	0.680	0.732	108	83	-	-
Amenable Cyanide	0.214	0.263	123	29	-	-

16341 Table Mountain Pkwy ▪ Golden, CO 80403 ▪ T: 800.372.0122 ▪ 303.431.8454 ▪ www.eraqc.com

Reference Materials

▪ Certificate of Analysis ▪

1. The **Certified Values** are the actual "made-to" concentrations confirmed by ERA analytical verification. The certified values are monitored and purchasers will be notified of any significant changes resulting in recertification or withdrawal of this certified reference material during the period of validity of this certificate.

2. The **Uncertainty** is the total propagated uncertainty at the 95% confidence interval. The uncertainty is based on the preparation and internal analytical verification of the product by ERA, multiplied by a coverage factor. The uncertainty applies to the product as supplied and does not take into account any required or optional dilution and/or preparations the laboratory may perform while using this product.

3. The **QC Performance Acceptance Limits (QC PALs™)**are based on actual historical data collected in ERA's Proficiency Testing program. The QC PALs™ reflect any inherent biases in the methods used to establish the limits and closely approximate a 95% confidence interval of the performance that experienced laboratories should achieve using accepted environmental methods. Use the QC PALs™ to realistically evaluate your performance against your peers.

4. The **PT Performance Acceptance Limits (PT PALs™)** are calculated using the regression equations and fixed acceptance criteria specified in the NELAC proficiency testing requirements. Use the PT PALs™ when analyzing this QC standard alongside USEPA and NELAC compliant PT standards. Please note that many PT study acceptance limits are concentration dependent (some non-linearly) and, therefore, the acceptance limits of this QC standard and any PT standard may differ relative to their difference in concentrations.

5. The **PT Data/Traceability** data include the mean value, percent recovery and number of data points reported by the laboratories in our Proficiency Testing study compared to the Certified Values. In addition, where NIST Standard Reference Materials (SRMs) are available, each analyte has been analytically traced to the NIST SRM listed. This product is traceable to the lot numbers of its starting materials. All gravimetric and volumetric measurements related to its manufacture are traceable to NIST through an unbroken chain of comparisons.
Traceability Recovery (%) = [(% recovery certified standard)/(% recovery NIST SRM)]*100
The traceability data shown were compiled by analyzing the ERA standards or their associated stock solutions against the applicable NIST SRMs.

6. For additional information on this product such as intended use, instructions for use, level of homogeneity, and safety information, please refer to the provided Instruction Sheet

If you have any questions or need technical assistance, please call ERA technical assistance at 1-800-372-0122 or send an email to info@eraqc.com.

Certifying Officer	Quality Officer
Brian Miller	Patrick Larson

16341 Table Mountain Pkwy ▪ Golden, CO 80403 ▪ T: 800.372.0122 ▪ 303.431.8454 ▪ www.eraqc.com

Chemical Information Sheet

Cyanide in Soil

#67469

Grade:	Analytical
Type:	Commercial Stock
CAS:	- No Data -
Lot:	D088-541
Received:	10/01/2014
Expiration:	07/31/2018
Location:	Bldg 70 Lab 42
Current Lab:	Lab 42 Bldg 70
Original Amount:	50 g
Amount Remaining:	50
Supplier:	ERA
Concentration:	
Project:	- No Data -
PO Number:	PE sample
Internal Lab ID:	- No Data -
Density:	- No Data -
Storage Requirement:	Ambient
Measuring Device ID:	- No Data -
Date Disposed:	- No Data -
Notes:	

Component Table

Compound	Conc/Activity	CAS
Total Cyanide	53.9 mg/kg	

Reference Material

▪ Certificate of Analysis ▪

Product: Cyanide in Soil
Catalog Number: 541
Lot No. D088-541
Certificate Issue Date: January 13, 2015
Expiration Date: July 31, 2018
Revision Number: Original

CERTIFICATION

Parameter	Total Concentration	Certified Value[1]	Uncertainty[2]	QC Performance Acceptance Limits[3]	PT Performance Acceptance Limits[4]
	mgKg	mgKg	%	mg/Kg	mg/Kg
Cyanide, Total	105	59.9	10.4	D.L - 122	23.1 - 116
Amenable Cyanide	< 25.0	< 25.0	10.4	-	0.00 - 25.0

PT DATA/TRACEABILITY

Parameter	Certified Value[1]	Proficiency Testing Study[5]			NIST Traceability	
		Mean	Recovery	n	SRM Number	Recovery
	mg/Kg	mg/Kg	%			%
Cyanide, Total	59.9	59.9	57.1	63	-	-
Amenable Cyanide	< 25.0	-	-	5	-	-

ERA
A Waters Company

Reference Material

▪ Certificate of Analysis ▪

1. The **Certified Values** are equal to the mean recoveries for the parameters as determined in an interlaboratory round robin study. The Certified Values are based on an "as received" basis, assuming 100% solids content. The certified values are monitored and the purchasers will be notified of any significant changes resulting in recertification or withdrawal of this certified reference material during the period of validity of this certificate.

2. The stated **Uncertainty** is the total propagated uncertainty at the 95% confidence interval. The uncertainty is based on the preparation and internal analytical verification of the product by ERA, multiplied by a coverage factor. The uncertainty applies to the product as supplied and does not take into account any required or optional dilution and/or preparations the laboratory may perform while using this product.

3. The **QC Performance Acceptance Limits (QC PALs™)** are based on actual historical data collected in ERA's Proficiency Testing program. The QC PALs™ reflect any inherent biases in the methods used to establish the limits and closely approximate a 95% confidence interval of the performance that experienced laboratories should achieve using accepted environmental methods. Use the QC PALs™ to realistically evaluate your performance against your peers.

4. The PT **Performance Acceptance Limits (PT PALs™)** are calculated using the regression equations and fixed acceptance criteria specified in the NELAC proficiency testing requirements. Use the PT PALs™ when analyzing this QC standard alongside USEPA and NELAC compliant PT standards. Please note that many PT study acceptance limits are concentration dependent (some non-linearly) and, therefore, the acceptance limits of this QC standard and any PT standard may differ relative to their difference in concentrations.

5. The **PT Data/Traceability** data include the mean value, percent recovery and number of data points reported by the laboratories in our Proficiency Testing study compared to the Certified Values. In addition, where NIST Standard Reference Materials (SRMs) are available, each analyte has been analytically traced to the NIST SRM listed.
Traceability Recovery (%) = [(% recovery certified standard)/(% recovery NIST SRM)]*100
The traceability data shown were compiled by analyzing the ERA standards or their associated stock solutions against the applicable NIST SRMs.

6. The Total Concentrations are equal to the background concentrations in the blank soil matrix (measured using EPA Method 9010, followed by colorimetric analysis), plus the amount of each analyte spiked onto the soil.

7. For additional information on this product such as intended use, instructions for use, level of homogeneity, and safety information, please refer to the provided Instruction Sheet.

If you have any questions or need technical assistance, please call ERA technical assistance at 1-800-372-0122 or send an email to info@eraqc.com.

Certifying Officer
Tom Widera

Quality Officer
Kristina Sanchez

ACCREDITED

ACCREDITED

Chemical Information Sheet

Free Cyanide

#83333

Grade:	Analytical
Type:	Commercial Stock
CAS:	- No Data -
Lot:	140217
Received:	03/13/2017
Expiration:	02/01/2018
Location:	Fridge
Current Lab:	Lab 47 Bldg 70
Original Amount:	125 mL
Amount Remaining:	125
Supplier:	Environmental Resource Associate
Concentration:	1000 mg/L
Project:	- No Data -
PO Number:	K47829MM
Internal Lab ID:	- No Data -
Density:	- No Data -
Storage Requirement:	Ambient
Measuring Device ID:	- No Data -
Date Disposed:	- No Data -
Notes:	Cat Log 048

Component Table

Compound	Conc/Activity	CAS

ERA

A Waters Company

Certificate of Analysis

PRODUCT:	1000 mg/L Free Cyanide
CATALOG NUMBER:	048 – 125 mL; 997 – 500 mL
LOT NUMBER:	140217
ISSUE DATE:	February 13, 2017
REVISION DATE:	Original
STARTING MATERIAL:	Potassium Cyanide (KCN)
CERTIFIED CONCENTRATION[1]:	1000 mg/L
UNCERTAINTY[2]:	0.6%
MATRIX:	18 megohm deionized water and 0.5% (v/v) NaOH
DENSITY:	1.0075 ± 0.0008 g/mL at 21.5°C and 756 mm Hg
TRACEABILITY[3]:	See Footnote 3
NIST/SRM:	-
VERIFICATION METHOD:	Spectrophotometry
STORAGE:	Store at 20-25°C

1. The **Certified Concentration** is the actual made-to concentration confirmed by ERA analytical verification.

2. The stated **Uncertainty** is the total propagated uncertainty at the 95% confidence interval. The uncertainty is based on the preparation of the product and includes uncertainty related to the starting material used and the volumetric and gravimetric measurements made. The method of calculating uncertainty is taken from the ISO Guide to the Expression of Uncertainty in Measurement (current version). The uncertainty applies to the product as supplied and does not take into account any required or optional dilutions and/or preparations the laboratory may perform while using this product.

3. Traceability ((% Recovery Certified Standard)/(% Recovery NIST SRM))* 100.

The traceability data shown were compiled by analyzing the ERA standards or their associated stock solutions against the applicable NIST SRMs. Where a NIST SRM is not available, the product is metrologically traceable through an unbroken chain of calibrations to NIST weights, each having stated uncertainties and utilizing measurement standards that are appropriate for the physical and/or chemical property being measured.

This standard **expires 2/2018**. The certified values are monitored and purchasers will be notified of any significant changes resulting in recertification or withdrawal of this certified reference material during the period of validity of this certificate.

This product is intended to be used as either a calibration standard or a quality control check of the entire analytical process for the analytes/matrix included in the standard.

If you have any questions or need technical assistance, please call ERA technical assistance at 1-800-372-0122 or email to info@eraqc.com

Certifying Officer: Brian Miller - Product Line Manager

ISO/IEC GUIDE 34:2009

ACCREDITED

REFERENCE MATERIAL PRODUCER
CERTIFICATE NO. 1539.03

ISO/IEC 17025:2005

ACCREDITED

CHEMICAL TESTING LABORATORY
CERTIFICATE NO. 1539.02

16341 Table Mtn Pkwy, Golden, CO 80403 800-372-0122 fax: 303-421-0159 www.eraqc.com

Distribution:

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A.M. Howe, 999-W
C.A. Langton, 773-42A
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D.L. McClane, 999-W
F.R. Miera, SRNL Tri-Cities Office
M.M. Reigel, 773-42A
W.G. Ramsey, 999-W
A.A. Ramsey, 999-W
M.E. Stone, 999-W