WSRC-TR-2000-00299
SRT-RPP-2000-00009
Revision 0

CHARACTERIZATION OF MELTER OFF GAS CONDENSATE FROM THE DURATEK LAW PILOT MELTER OFF GAS SYSTEM

August 25, 2000

T. B. Calloway, Jr.

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Official: _____
H. F. Sturm, SRTC Project Manager

Date: _____

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

SUMMARY

The off gas condensate generated from the River Protection Project Waste Treatment Plant (RPP-WTP) LAW melter systems is recycled to the pretreated LAW evaporator system. The recycled condensate is combined with the pretreated LAW from the technetium ion exchange columns and evaporated in the pretreated LAW evaporator. The concentrated LAW solution is stored in the LAW melter feed lag storage vessels before transfer to the LAW vitrification building. Characterization of the melter off gas condensate is essential to completing the design of the pretreated LAW evaporator. Additionally, characterization of the condensate is necessary for the overall development of the RPP-WPT flow sheet.

Characterization of the off gas condensate from the Duratek LAW Pilot scale melter located in Columbia Maryland was completed and the results are contained in this report. The condensate was obtained during the initial Envelope A (AW101/AN105 waste simulant) pilot tests. The condensate contains a significant quantity of dissolved (2%) and insoluble solids (1.21 g solids/L condensate). The condensate is composed of glass formers, AW101/AN105 simulant and trace amounts of LAW glass. The condensate is approximately 0.2M sodium and has a pH of 6.8. Insoluble solids formed when the AW101/AN105 LAW melter off gas condensate was mixed with a simulant of pretreated AN105 solution. The expected amount of precipitate formed is less than 0.2wt% insoluble solids.

This quantity of solids should not challenge the design basis for the LAW melter feed lag storage vessels[1]. The LAW melter feed lag storage vessels are each equipped with pulsed-jet mixing units that are capable of suspending this small quantity of solids. The LAW melter feed will be transferred from the lag storage vessels to the LAW vitrification building using centrifugal pumps that are to be designed to suspend solids and prevent settling in the underground pipeline.

[1] System Description for the LAW Melter Feed Lag Storage System (LP-140), SD-W375LP-PR00001, revision 3, April 3, 2000, BNFL Inc., Richland Washington.

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INTRODUCTION

The baseline low activity waste (LAW) flow sheet for the River Protection Project (RPP) Waste Treatment Plant (WTP) includes pretreatment of Envelope A, B and C supernate by removing strontium/TRU, cesium, and technetium via a series of precipitation[2] and ion-exchange steps. The decontaminated LAW is concentrated in the pretreated LAW evaporator. Glass formers are added to the pretreated LAW evaporator concentrate and fed to joule-heated, refractory-lined melters (3) that are designed to operate nominally at 1,150 °C. The surface area of each melter is approximately 10 m^2. The off gas from the LAW melter is quenched in a submerged bed scrubber[3]. The scrubber contains water and no reagents are added to the scrubber during operation. The condensate from the submerged bed scrubber is neutralized, if necessary, with 5M sodium hydroxide and recycled back to the pretreatment facilities where the condensate is combined with fresh technetium ion exchange effluent and fed to the pretreated LAW evaporator.

As part of the BNFL/WSRC Part B1 contract, SRTC is charged with characterizing the expected Melter off gas condensate that will be transferred back to the Pretreatment building[4]. The test specification/test plan for this work is contained in reference 4.

This report focuses on characterization of an off gas condensate sample from the Duratek LAW pilot melter located in Columbia, MD. The LAW pilot melter is a 1/3 section of a full size RPP-WPT LAW Melter. The LAW pilot melter is a joule heated, slurry fed, ceramic lined melter with submerged metallic electrodes. The distance between the electrodes is identical to the full-scale RPP-WPT LAW melters. The pilot melter glass pool cross sectional area is 3.3 m^2. The glass pool is agitated with a patented air sparging system to increase waste processing rates. Nominal processing rates for the pilot melter rage from 1.0 – 2.0 tons/day/m^2. The pilot melter glass pool holds approximately 7000 kg of glass.

EXPERIMENTAL

Characterization

Approximately three liters of melter off gas condensate from the Duratek pilot melter off gas system were collected on 6/21/99[5]. The sample was collected after feeding a 7 molar

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[2] Currently, the Sr/TRU precipitation process is conducted on Envelope C wastes only. Cs/Tc ion exchange resins are used to decontaminate all wastes.

[3] Schmidt, A. J., Final Technical Report Submerged Bed Scrubber Evaluation, PNL-8163, Pacific Northwest Laboratory, Richland, WA, June 1992

[4] WFO-98-003, Work for Other Agreement between Westinghouse Savannah River Company Operating Under Prime Contract No. DE-AC09-96SR18500 for the Department of Energy and BNFL, Inc., 6/30/98

[5] At the time the sample was taken the glass pool temperature was 1150 °C and the production rate was 1.5 ton/day/m^2.

sodium, simulated LAW Envelope A melter feed for six days at about 90% melter availability. The composition of the simulant, glass formers, and melter feed is shown in Table 1. GTS Duratek, Inc. provided the analysis of the simulant, glass formers, and LAW melter feed.

The simulant was a composite selected from Hanford tanks 241-AN105 and 241-AW101. The pre-fix "241" is common to all Hanford underground storage tanks and is not used further in this report. The analytical data used to formulate the simulant came from the tank sample analysis reports[6,7]. The selection was primarily based on tank AN105 with the exception of potassium, nitrate, nitrite, and phosphate. These analytes were found to be in a higher concentration in the AW-101 waste than AN105 and were selected as a basis for the simulant. Sulfate was also increased to reflect the potentially higher concentration tanks[8]. Cesium and technetium were omitted from the simulant because the planned waste treatment process removes these radionuclides and their contribution to the total waste oxides is negligible. The Vitreous State Laboratory (VSL, Catholic University of America) formulated the simulant and glass composition in cooperation with GTS Duratek, Inc. The sodium oxide loading in the simulant LAW glass was targeted to be 20%.

[6] Winters, W. et. al., Part A Tank Waste Remediation System (TWRS) Privatization Contractor Sample LAW Envelope (B) Tank 241-AN105 Final Analytical Report, HNF-SD-WM-218 Rev. 1, Fluor-Daniel Inc., Richland WA, 5/30/97

[7] Winters, W. et. al., Part A Tank Waste Remediation System (TWRS) Privatization Contractor Sample LAW Envelope (B) Tank 241-AW101 Final Analytical Report, HNF-SD-WM-204 Rev. 1, Fluor-Daniel Inc., Richland WA, 11/20/96

[8] Mullar, I., Re: Composition of First Duratek Pilot Melter Run – Envelope A Hanford Tank ? Email to T. B. Calloway, Vitreous State Laboratory, Catholic University of America, 620 Michigan Ave. Washington DC 20064, 5/19/00

Table 1 – Composition of Duratek LAW Pilot Melter Feed During Sampling of Melter Off Gas Condensate[9]

		AW101/AN105 SIMULANT @ 8M NA	AW101/AN105 SIMULANT @ 7M NA	GLASS FORMERS		MELTER FEED ANALYSIS
Analyte	**Formula**	**mg/L**	**mg/L**	**Oxide[10]**	**wt. %**	**wt. %**
Aluminum	Al	31360	27440	Al_2O_3	10.11	11.972
Antimony	Sb	NA	NA	Sb_2O_3	NA	NR
Arsenic	As	NA	NA	As_2O_3	NA	NR
Barium	Ba	NA	NA	BaO	NA	NR
Beryllium	Be	NA	NA	BeO	NA	NR
Boron	B	NA	NA	B_2O_3	12.1	8.640
Cadmium	Cd	NA	NA	CdO	NA	NR
Calcium	Ca	14.2	12.4	CaO	4.1	2.922
Chromium	Cr	145.6	127.4	Cr_2O_3	NA	0.017
Cobalt	Co	NA	NA	CoO	NA	NR
Copper	Cu	NA	NA	CuO	NA	NR
Iron	Fe	18.8	16.5	Fe_2O_3	8.1	5.772
Lanthanum	La	18.8	16.5	La_2O_3	NA	NR
Lead	Pb	51.1	44.7	PbO	NA	NR
Lithium	Li	NA	NA	Li_2O	NA	0.001
Magnesium	Mg	NA	NA	MgO	2.79	1.994
Manganese	Mn	20.1	17.6	MnO	NA	NR
Molybdenum	Mo	NA	NA	MoO_3	NA	NR
Nickel	Ni	9.1	8.0	NiO	NA	0.001
Potassium	K	31920	27930	K_2O	NA	3.101
Selenium	Se	NA	NA	SeO_2	NA	NR
Silicon	Si	NA	NA	SiO_2	53.31	37.993
Silver	Ag	13	11.4	Ag_2O	5.99	0.0011
Sodium	Na	184000	161000	Na_2O	NA	20.000
Sodium, M		8.00	7.00			
Thallium	Th	NA	NA	Th_2O	NA	NR
Titanium	Ti	2.7	2.4	TiO_2	NA	0.0004
Vanadium	V	NA	NA	V_2O_5	NA	NR
Zinc	Zn	NA	NA	ZnO	NA	4.275
Zirconium	Zr	NA	NA	ZrO_2	3.5	2.496
			Sum of Oxides		100	99.18
Acetate	CH_3COO	NR	NR		NR	NR

[9] Smith, E., Re: Off-Gas Sample, Email to T. B. Calloway, GTS Duratek, Columbia, MD, 6/21/99

[10] The oxide composition reported in Table 1 assumes that each element has only one oxidation state in the glass. Other oxidation states could form in the glass depending on the amount of organic and other reductants present in the simulant.

		AW101/AN105 SIMULANT @ 8M NA	AW101/AN105 SIMULANT @ 7M NA	GLASS FORMERS		MELTER FEED ANALYSIS
Analyte	**Formula**	**mg/L**	**mg/L**	**Oxide[10]**	**wt. %**	**wt. %**
Ammonium	NH4	NR	NR		NR	NR
Bromide	Br	NR	NR		NR	NR
Carbonate	CO3	NA	NR		NR	NR
Chloride	Cl	7176	6279		NR	NR
Fluoride	F	448	392		NR	NR
Formate	COOH	NR	NR		NR	NR
Glycolate	OCH_2COOH	NR	NR		NR	NR
Hydroxide	OH	NR	NR		NR	NR
Nitrate	NO_3	160800	140700		NR	NR
Nitrite	NO_2	79840	69860		NR	NR
Oxalate	C_2O_4	NR	NR		NR	NR
Phosphate	PO_4	1288	1127		NR	NR
Sulfate	SO_4	1520	1330		NR	NR
Cyanide						
Cyanide, Reactive	HCN	NA	NA		NR	NR
Cyanide, Total	HCN	NA	NA		NR	NR
TOC		2880	2520		NR	NR
TIC		NA	NA			
% Total Solids Balance is water		NR	NR		NR	NR
% Soluble Solids		NR	NR		NR	NR
% Insoluble Solids		NR	NR		NR	NR
Density, g/ml			≈1.5			≈1.56
pH		NR	NR		NR	NR
NA - Analyte not Added						
NR/NM - Analysis not reported/measured						

The total organic carbon content in the simulant (as-batched basis) is composed of 12% EDTA, ethylenediaminetetraacetic acid, $(HOOCCH_2)_2NCH_2CH_2N(CH_2COOH)_2$ (0.03 wt. % of surrogate), 38% Acetic Acid CH_3CO_2H (0.1 wt. % of simulant), 38% Formic Acid, HCOOH (0.1 wt. % of simulant), and 12% Glycolic acid, $C_2H_4O_3$ (0.03 wt. % of simulant). The simulant and melter feed used in the pilot melter tests has a density of approximately 1.50 and 1.56 g/ml, respectively. The ratio of glass formers added to total mass was 0.45. No inorganic carbon was added to the feed[11].

The three liters of melter off gas condensate were received at SRTC's 772-T laboratory and composited into a four-liter vessel. The sample was weighed and sub-samples were

[11] Smith, E., Re: Pilot Melter Surrogate and Feed Composition, Email to T. B. Calloway, GTS Duratek, Columbia, MD, 8/02/00

taken and submitted for solids (gravimetric-microwave, total, soluble and insoluble), density (pycnometer), pH, elementals (inductively coupled plasma-mass spectroscopy), anions (ion chromatography), and cyanide analyses (total and reactive). General Engineering Laboratory, an EPA certified laboratory, (See Table 2) conducted the elementals, anions and cyanide analyses using EPA SW-846 methods. All other analyses were done in SRTC analytical laboratories using standard SRTC methods and procedures. All solids and density analyses were performed in duplicate and the results averaged for this report.

The composite off gas condensate sample was vacuum filtered through a 0.42 micron Whitman filter and the solids were collected and dried in an oven at 105°C until a constant weight was obtained. The dry solids were analyzed using X-ray diffraction, scanning electron microscopy, energy dispersive spectrometry, and elemental content (inductively coupled plasma-emission spectroscopy). The filtrate was analyzed for anions and elemental content (inductively coupled plasma-emission spectroscopy).

The mass of the composite sample, sub-samples, and dry solids were obtained to maintain a mass balance during the characterization. The insoluble solids concentration was calculated from the difference between the total solids analysis and the soluble solids analysis. Additionally, the insoluble solids analysis was calculated by weighing the total dry solids filtered from the composite sample and dividing by the original composite sample weight.

Table 2– EPA Methods Used to Analyze Duratek Off Gas Sample

PROCEDURE	METHOD	ANALYTE
EPA 300.0 Total Anions in Liquids	Ion Chromatography	All anions, except Formate
SW846 6020 Inductively coupled plasma-mass spectroscopy (Prep Method 3005A, Acid Digestion of Waters for Total Recoverable Metals for Analysis by ICP)	Inductively coupled plasma-mass spectroscopy, Acid Digestion HNO_3 & HCL	Elementals
SW846 7.3.3 Reactive Cyanide, Test Method to Determine Hydrogen Cyanide Release from Wastes, Method 9014, Titrametric and Manual Spectrophotometric Determinative Methods for Cyanide	Colorimetric, Automated UV	Reactive Cyanide[12]
EPA 335.3 Total Cyanide	Colorimetric, Automated UV	Total Cyanide

[12] The definition of reactive cyanide is given in SW-846 7.3.2. A cyanide bearing waste is considered characteristic of reactivity under RCRA and DOT regulations if the waste generates toxic gases, vapors or fumes in excess of 250 mg HCN/kg waste when exposed to pH conditions between 2.5 and 12.5. See also RCRA-40 CFR 261.21, DOT-49 CFR 173.300 and 173.151

Mixing Study

Since the RPP-WTP melter off gas condensate will be recycled and mixed with fresh pretreated LAW evaporator feed, a scoping study was initiated to determine if solids would form after mixing the AN105/AW101 melter off gas condensate with a simulant of AN105. The composition of the simulant is presented in Table 4. The simulant was based upon a recipe developed by SRTC[13] for the B1 R&D program. The simulant recipe was recalculated to make a simulant with a final density of 1.2 g/ml. The target density was selected based upon the results from the BNFL ion exchange development program.[14] Ion exchange resins used in the BNFL development program have been shown to float in salt solutions with densities above 1.2 g/ml. The sodium molarity of the AN-105 simulant is approximately 4.4M. The simulant was filtered through Whitman 0.2 µm filters prior to these experiments. All chemicals used were of reagent grade and deionized water was used to prepare the solutions.

The Al, Mo, K, Na (AA), Cl, COOH, NO_3 and NO_2 evaporator feed analyses are within the expected analytical error of 10%. The reported Na (ICP-ES) concentration in the simulant was 85600 mg/L vs. a targeted concentration of 100400 mg/L. The laboratory reported that the ICP-ES QC results for sodium were out of specification by 9%. The analytical results for B, Cd, Ca, Pb, Mg, and Zn are all outside the expected analytical error. Reference[15] indicates that Ca and Mg were precipitated from the simulant during the make-up process. The as-batched values for B, Cd, Pb, and Zn are very low, and it is likely that the high dilution factors used for these analyses increased the analytical error for these elements. The analytical results for some of the anions (F, OH, CO_3, C_2O_4, PO_4, and SO4) were also outside the expected analytical error. The carbonate analysis is greater than five times higher then the expected value (34000 vs. 5000 mg/L) and is likely due to CO_2 absorption during the make-up (agitation) and vacuum filtration process.

At the time the mixing study was conducted, the condensate recycle from the LAW Vitrification facility was mixed with the Tc ion exchange effluent in approximately a 1:1 ratio[16]. Therefore, approximately 200 g of Duratek condensate was mixed with 200 g of AN105 simulant.

Since the time of this study the RPP-WTP flow sheet has been changed to neutralize the SBS recycle (if necessary) and then mix the recycle with the pretreated LAW effluent from the Tc ion exchange columns. The current flow sheet values are shown in Table 3.

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[13] Johnson, M. E., Approval of LAW Envelope A and B Simulants, Letter No. 001696, BNFL, Inc. Richland, WA 99352, 2/16/99

[14] Verbal conversation (& email) between T. B. Calloway and D. McCabe, Savannah River Technology Center, 6/18/99

[15] T. B. Calloway, Evaporation of Hanford Envelope A Simulant (AN105), BNF-003-98-0254, Westinghouse Savannah River Company, Aiken SC, August 2000.

[16] Verbal conversation with between M. E. Johnson and T. B. Calloway, 9/99. The recycle from LAW vitrification represents approximately 45% of the total feed to the pretreated LAW Melter Feed Evaporator on a mass basis. The effluent from the Tc ion exchange accounted for the other 55%.

The current RPP-WTP pretreatment B2 development plan will further address the mixing of vitrification off gas recycle condensate with pretreated LAW feeds. SRTC recommends that these studies use the RPP-WTP flow sheet as a basis.

Table 3 – LAW Melter Feed Evaporator – Expected Sources of Evaporator Feed[17]

	m^3/day	Density	MT/day	Wt. % (mass basis)
Neutralized SBS Off Gas Condensate	38.4	1.037	39.828	29.2%
Tc IX Effluent	79.7	1.210	96.469	70.8%
Combined Evaporator Feed	118.287	1.152	136.297	

[17] R. Carter & V. B. Ashley, Flowsheet Results for Envelope A/D at 60 t/d LAW Glass, RPT-W375-TE00019, Rev 0, BNFL, Inc. Richland WA. 99352, 3/17/2000

Table 4 - AN105 (Envelope A) Simulant Composition used in Mixing Study – As-Batched vs. As-Measured Composition

		AN105 SIMULANT			
Analyte	Formula	As-Batched Concentration, mg/L		Measured Concentration, mg/L	% Difference[18]
Aluminum	Al	12990		11900	9.0%
Antimony	Sb	NA		NM	
Arsenic	As	NA		NM	
Barium	Ba	NA		NM	
Beryllium	Be	NA		NM	
Boron	B	21		25.1	-18.8%
Cadmium	Cd	1	<	0.1	171%
Calcium	Ca	16	<	0.6	186%
Chromium	Cr	552		486	12.8%
Cobalt	Co	NA		NM	
Copper	Cu	NA		NM	
Iron	Fe	NA		NM	
Lanthanum	La	NA		NM	
Lead	Pb	22		16.7	26.5%
Lithium	Li	NA		NM	
Magnesium	Mg	2	<	0.05	190%
Manganese	Mn	NA		NM	
Molybdenum	Mo	34		31.9	5.34%
Nickel	Ni	NA		NM	
Potassium	K	3066		3080	-0.29%
Selenium	Se	0.3		NM	
Silicon	Si	86		78	11%
Silver	Ag	NA		NM	
Sodium, ICP-ES	Na	100431		85600	15.9%
Sodium, M ICP-ES		4.37		3.72	
Sodium, M AA		4.37		4.02	8.21%
Thallium	Th	NA		NM	
Titanium	Ti	NA		NM	
Vanadium	V	NA		NM	
Zinc	Zn	4		5.1	-22%
Zirconium	Zr	NA		NM	
Acetate	CH_3COO	846		NM	
Ammonium	NH_4	49		NM	
Bromide	Br	NA		NM	
Carbonate	CO_3	5129		34200	-148%
Chloride	Cl	3716		3870	-4.10%
Fluoride	F	78		49	45%

[18] % Difference = (Value 1 – Value 2)/ (Average of Value 1 & 2)

		AN105 SIMULANT		
Analyte	Formula	As-Batched Concentration, mg/L	Measured Concentration, mg/L	% Difference[18]
Formate	COOH	1180	1290	-8.90%
Glycolate	OCH_2COOH	470	NM	
Hydroxide	OH	24916	21500	14.7%
Nitrate	NO_3	67415	70500	-4.50%
Nitrite	NO_2	45381	46900	-3.30%
Oxalate	C_2O_4	249	152	48.9%
Phosphate	PO_4	233	293	-22.8%
Sulfate	SO_4	315	466	-38.6%
% Total Solids (Balance is water)		25.96%	26.5%	-2.00%
% Soluble Solids, measured		NA	26.6%	
% Insoluble Solids, measured		NA	0.00%	
Density, g/ml		1.200	1.197	0.20%
pH		NM	NM	
Viscosity @ 25°C, cp			2.2	
Viscosity @ 50°C, cp			1.7 (approx.)	

RESULTS AND DISCUSSION

Characterization

The sample analysis summary for the composite sample is given in Table 5 and Table 6. A detailed analytical report of the EPA sample analyses preformed is contained in Appendix A.

Table 5 – AW101/AN105 Duratek Off Gas Condensate Composite Sample - Chemical Analysis

ANALYTE	FORMULA	ANALYSIS FLAG	Detection Limit, µg/L	Reporting Limit, µg/L	Concentration	
					µg/L	mg/L
Aluminum	Al		31.2	150	121000	121
Antimony	Sb		1.11	20.0	57.5	0.0575
Arsenic	As		1.45	30.0	34.5	0.0345
Barium	Ba		1.58	20.0	207	0.207
Beryllium	Be		0.340	2.00	2.41	0.0024
Boron	B				NM	
Cadmium	Cd		0.500	10.0	46.2	0.0462
Calcium	Ca		55.4	1000	185000	160
Chromium	Cr		6.45	30.0	22400	22.4
Cobalt	Co	J	0.180	10.0	2.15	0.0022
Copper	Cu		11.8	20.0	222	0.222
Iron	Fe		79.2	250	24100	24.1
Lanthanum	La				NM	
Lead	Pb		0.770	20.0	580	0.58
Lithium					NM	
Magnesium	Mg		5.21	100.0	29400	29.4
Manganese	Mn		6.55	50.0	1760	1.76
Molybdenum	Mo		1.96	5.00	123	0.123
Nickel	Ni		0.720	20.0	190	0.19
Potassium	K		3530.0	30000	2870000	2870
Selenium	Se		2.18	30.0	80.9	0.0809
Silicon	Si				NM	
Silver	Ag		1.01	10.0	1160	1.16
Sodium	Na		41	250000	4930000	4930
Sodium, M						0.214
Thallium	Tl		0.140	5.00	19.2	0.0192
Titanium	Ti				NM	
Vanadium	V	J	3.30	100.0	99.3	0.0993
Zinc	Zn		9.74	100.0	144000	144
Zirconium					NM	
			mg/L	mg/L	µg/L	mg/L
Acetate					NM	

ANALYTE	FORMULA	ANALYSIS FLAG	Detection Limit, µg/L	Reporting Limit, µg/L	Concentration µg/L	Concentration mg/L
Ammonium	NH4				NM	
Bromide	Br	U	0.16	0.50	0	0.00
Chloride	Cl		10.40	40.00	5440000	5440
Formate	COOH				NM	
Fluoride	F		0.17	0.50	83300	83.3
Glycolate					NM	
Hydroxide					NM	
Nitrate	NO_3		2.00	5.00	551000	551
Nitrite	NO_2		2.00	5.00	1680000	1680
Oxalate	C_2O_4	J	1.13	6.00	2250	2.25
Phosphate	PO_4	U	4.00	10.00	0	0.00
Sulfate	SO_4		0.79	2.00	210000	210
Cyanide			µg/L	µg/L	µg/L	mg/L
Cyanide, Reactive	HCN	J	13.8	2.5E08	43.3	0.0433
Cyanide, Total	HCN		69.0	125	1160	1.16
J - Below Reporting Limit but above Detection Limit, U - Below Detection Limit, NR/NM – Not Reported/Not Measured						

Table 6 - AW101/AN105 Duratek Off Gas Condensate Composite Sample - Chemical Analysis (Continued)

Analysis	Result
% Total Solids	2.16%
% Soluble Solids	2.05%
% Insoluble Solids	0.10%
Density, g/ml	1.02
pH	6.79

Table 5 analyses were performed by General Engineering Laboratory (GEL), Inc. by SW-846 protocol. Solids, density, and pH analyses were performed by SRTC. All results reported in Table 5 were conducted on the composite (unfiltered) sample from GTS Duratek with the exception of the cyanide analyses. The original sample sent on 4-12-00 to GEL was not a large enough volume to perform the cyanide analyses. Since the entire remaining sample from GTS Duratek had been filtered, a filtered Duratek sample (Collection Date 4-20-00) was sent to GEL for cyanide analyses.

GTS Duratek / SRTC personnel did not add any reagents to the melter off gas sample. As stated previously, the composite sample (≈2900 g) was filtered to obtain a solid

sample for analysis and to obtain the most accurate measurement of the % insoluble solids in the sample. After filtration and drying in an oven (@ 105°C for 24 hrs), the % insoluble solids was measured to be 0.12 wt. % (1.21 g dry solids/L of condensate) which compares favorably with the gravimetric microwave analysis of a 10 ml sub-sample presented in Table 6.

The filtered solids and filtrate were submitted to SRTC laboratories for ICP-ES analysis. The solids samples were dissolved using two methods: 1) Microwave assisted acid (HNO_3 with HF) dissolution and 2) Na_2O_2-HNO_3 fusion. The filtered solids were submitted for XRD and SEM analysis.

Table 7 – Sample Results - Filtered Solids & Filtrate - Duratek Off Gas Sample

ANALYTE	FORMULA		FILTERED SOLIDS			FILTRATE
			weight %	mg/Kg		mg/L
Aluminum	Al		11.8	117000		3.6
Antimony	Sb	<	0.011	110	<	0.1
Arsenic	As	<	0.03	300	<	0.3
Barium	Ba		0.01	105	<	0.02
Beryllium	Be	<	0.001	10	<	0.003
Boron	B		1.0	10000		638
Cadmium	Cd	<	0.002	20	<	0.06
Calcium	Ca		2.1	20800		152
Chromium	Cr		0.03	280		23
Cobalt	Co		NM			NM
Copper	Cu		NM			NM
Iron	Fe		3.4	33700	<	0.06
Lanthanum	La	<	0.014	140	<	0.14
Lead	Pb	<	0.06	600	<	0.5
Lithium	Li		NM			NM
Magnesium	Mg		0.19	1860		31
Manganese	Mn		0.12	1160		0.5
Molybdenum	Mo		NM			NM
Nickel	Ni	<	0.008	80		0.6
Potassium	K		NM			NM
Selenium	Se	<	0.04	400	<	0.4
Silicon	Si		14.9	149000		10
Silver	Ag	<	0.03	300		0.9
Sodium	Na		1.8	17900		4300
Thallium	Tl	<	0.05	500	<	0.5
Titanium	Ti		0.01	134	<	0.05
Vanadium	V	<	0.012	120	<	0.12
Zinc	Zn		8.3	82800		38
Zirconium	Zr		1.5	14500		0.3

NR/NM – Analyte not added/measured

Table 5, Table 6, and Table 7 indicate the presence of both glass forming chemicals and unreacted simulants that were used to feed the Duratek LAW pilot melter.

Several analytes (e.g. Si, Zr) known to be present were not reported in the composite sample results reported in Table 5. The sample preparation method (SW846 Method 3005A) used for the composite sample did not adequately dissolve these components. Method 3005A calls for the sample to be acidified with concentrated nitric acid, heated, and then filtered. The filtrate is analyzed for the metals reported in Table 5. Therefore, calculated values based upon the filtered solids and filtrate analysis, for B, La, Si, Ti, Zr are reported in Table 8.

Table 8 – Composite Sample Results for Selected Analytes – Calculated from Filtered Solids and Filtrate Analyses

			COMPOSITE SAMPLE RESULTS CALCULATED (MG/L)
Boron	B		1880
Lanthanum	La	<	17
Silicon	Si		18300
Titanium	Ti	<	17
Zirconium	Zr		1790

Figure 1 shows the crystalline make-up of the filtered solids. As expected, glass-forming chemicals are present in the filtered solids. Additionally, two forms of aluminum phosphate compounds were also detected. Most likely these compounds are reaction products that formed in the off gas system or during make-up of the melter feed simulant. Additionally, an amorphous component (presumably LAW glass) was also identified. SEM Energy Dispersive Spectrometry analysis of the filtered solids is shown in Figure 2 – 4. Figure 4 confirms that significant portions of the filtered solids are less than 1.25 μ in size.

Particle size analysis for the filtered solids is shown in Figure 5. Table 9 provides a summary of the particle size analysis.

Table 9 – Summary Particle Size Analysis of Filtered Duratek Condensate Solids

MEASUREMENT	DESCRIPTION	VALUE (MICRON)
Mv	Mean Diameter based on Particle Volume	5.147
Mn	Mean Diameter of the Number Distribution	1.382
Ma	Mean Diameter of the Area Distribution	3.005

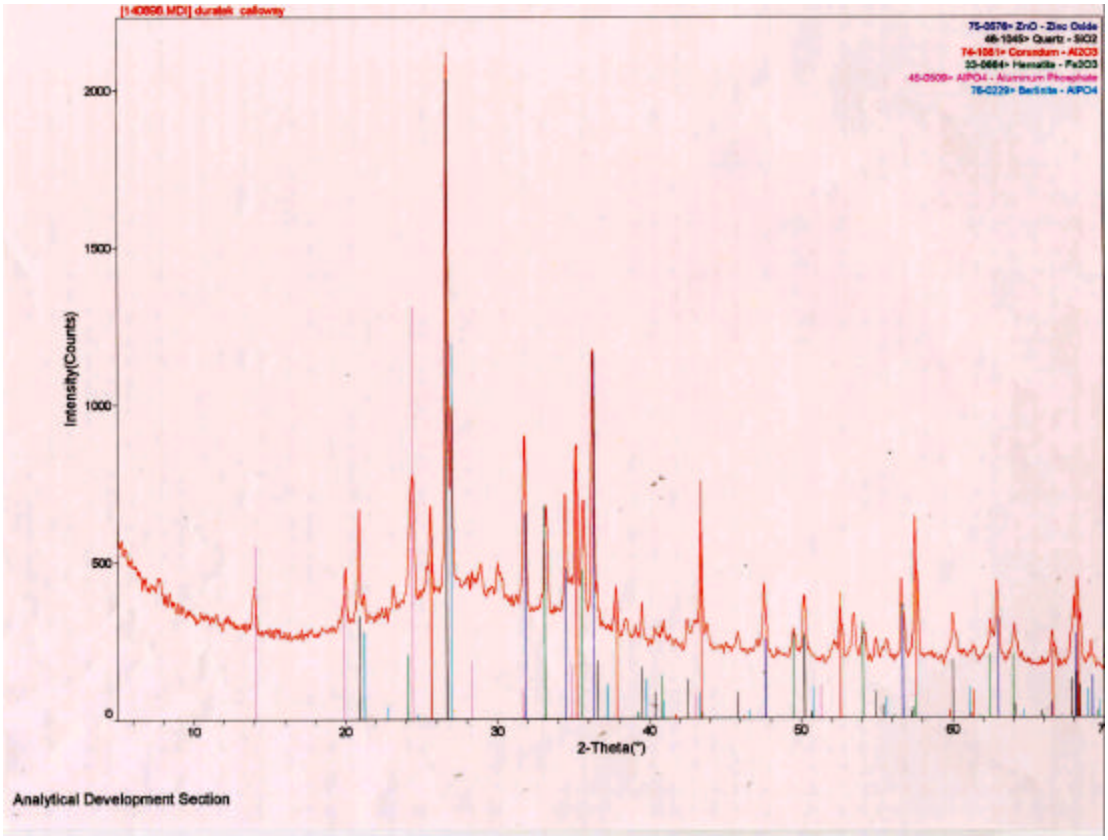

Figure 1 – X-Ray Diffraction Analysis of Filtered Solids from Duratek Off Gas

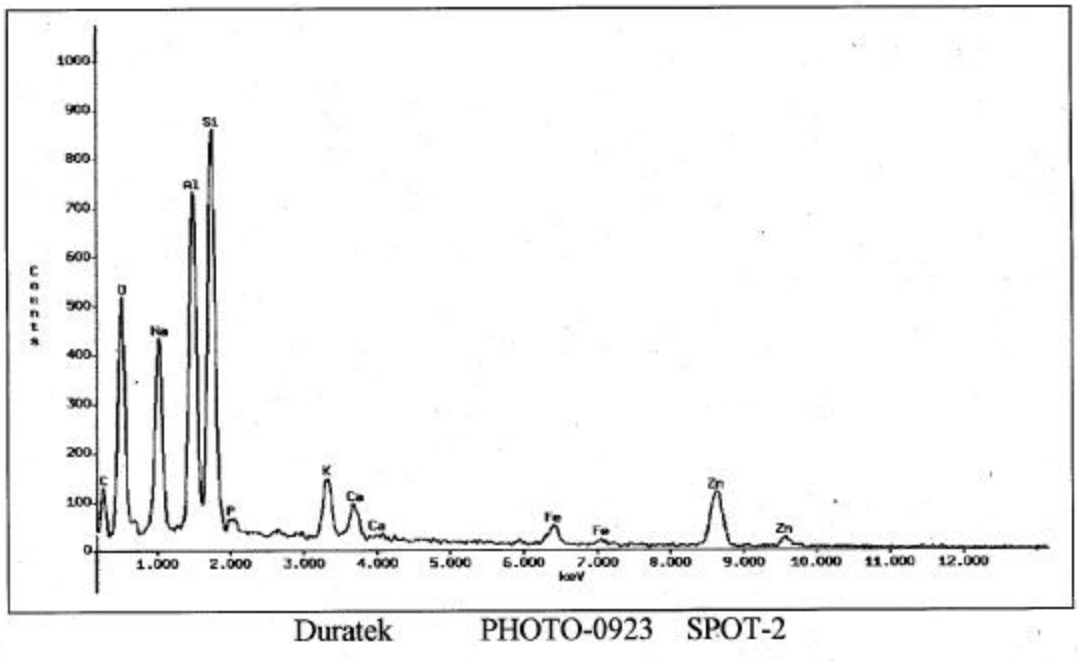

Figure 2 – SEM/EDS Analysis of Filtered Solids from Duratek Off Gas

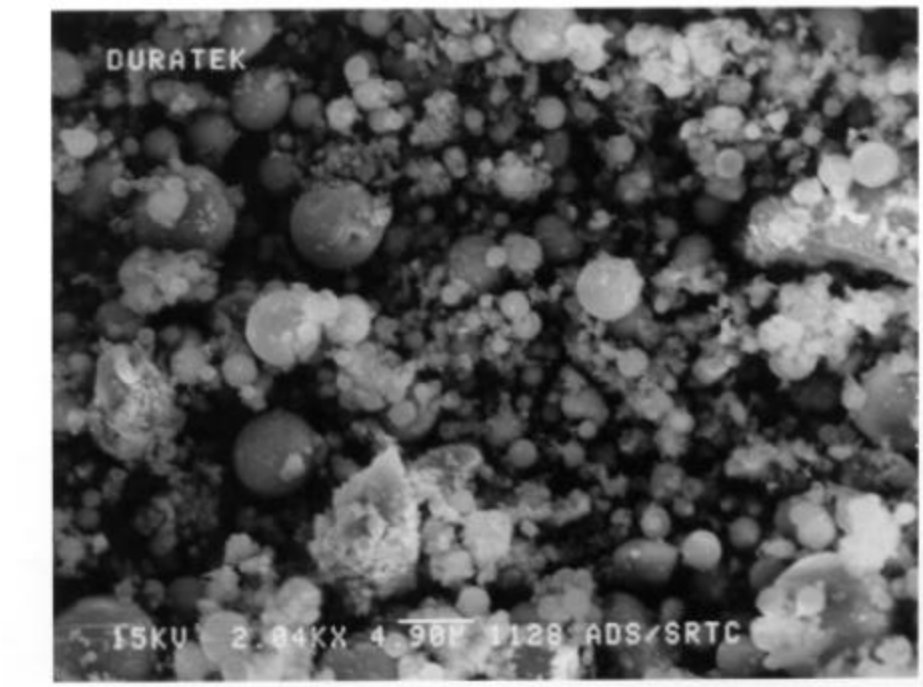

Figure 3 – SEM of Filtered Duratek Solids – Scale shown is 4.9 µm

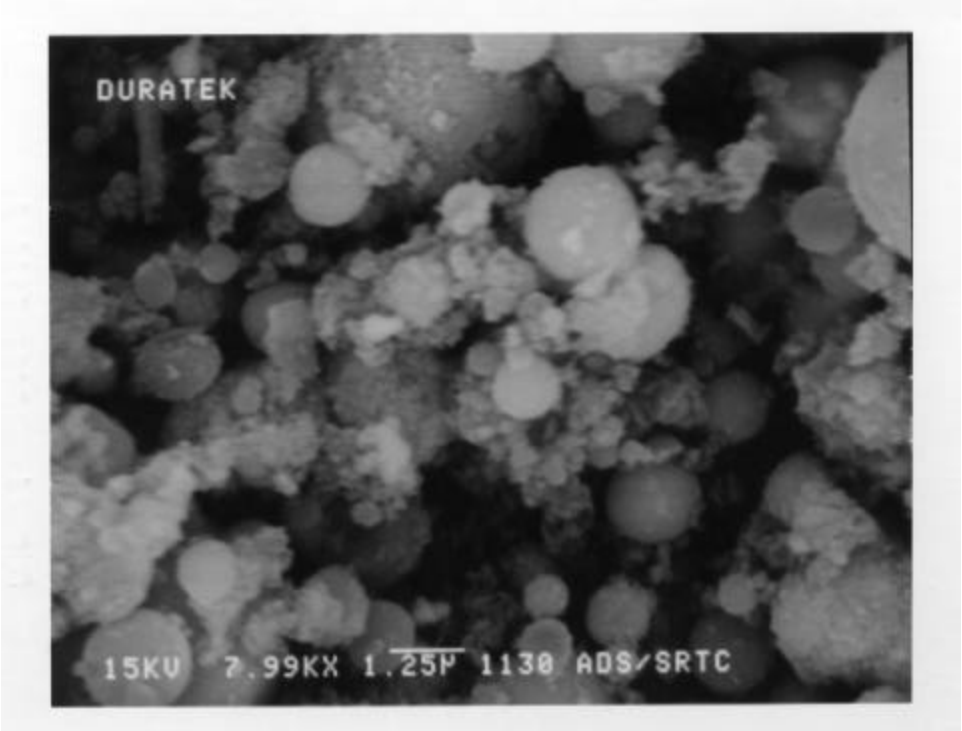

Figure 4 – SEM of Filtered Duratek Solids – Scale Shown is 1.25 µm

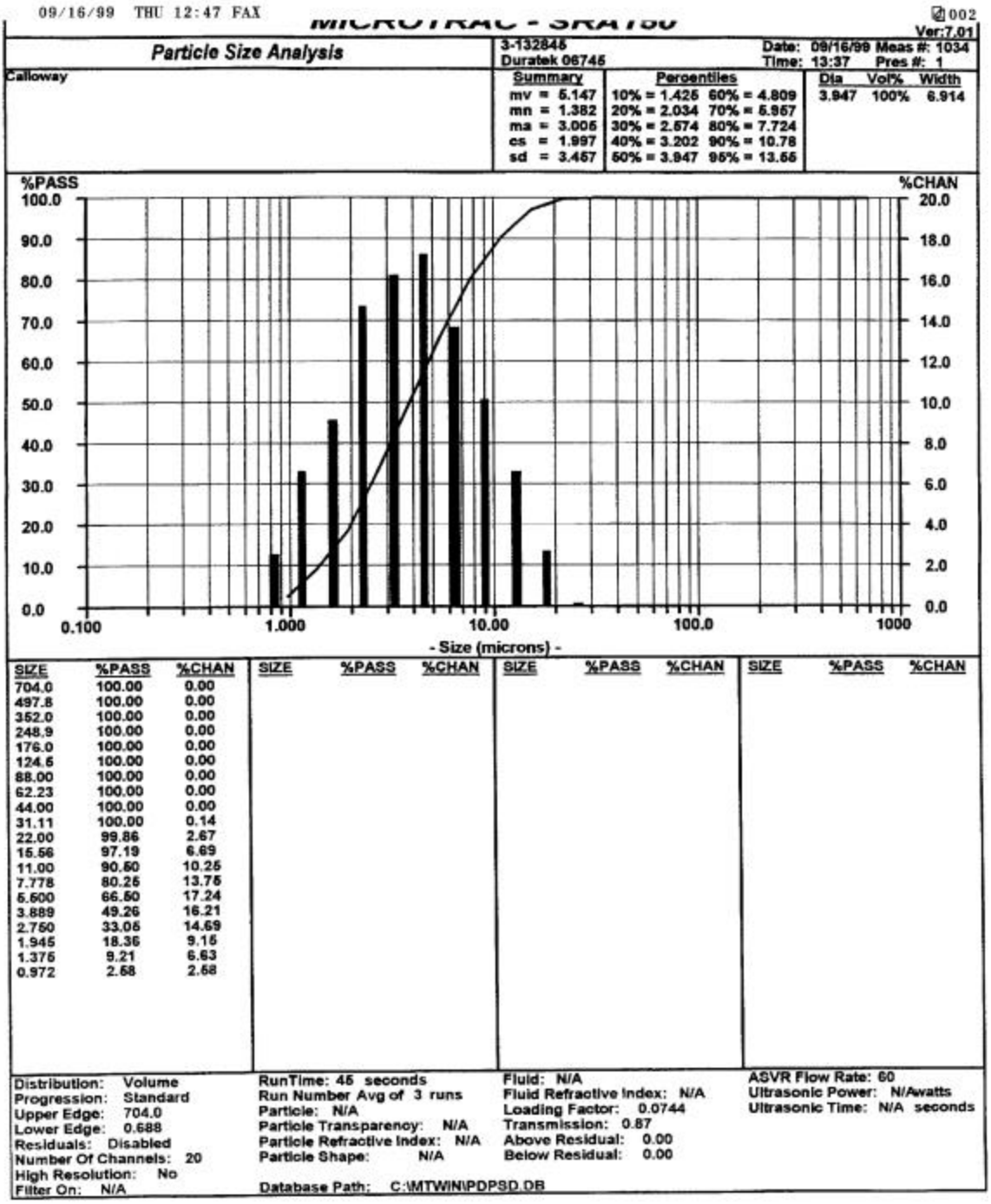

Figure 5 – Particle Size Analysis for Filtered Duratek Off Gas Solids

Mixing Study

As stated previously, a scoping study was initiated to determine if solids would form after mixing the AN105/AW101 melter off gas condensate with a simulant of AN105. The AN105 simulant was mixed with the filtered Duratek condensate in a 1:1 mass ratio. The envelope A simulant (AN105) was translucent before mixing and immediately became

cloudy upon mixing with the filtered Duratek sample indicating the presence of solids. The mixture was stored in the SRTC 772-T laboratory for approximately two months prior to analysis by XRD. Hydrocalumite, ($Ca_8Al_4(OH)_{24}(CO_3)Cl_2(H_2O)1.6(H_2O)_8$) was identified by the XRD scan along with other unidentified compounds.

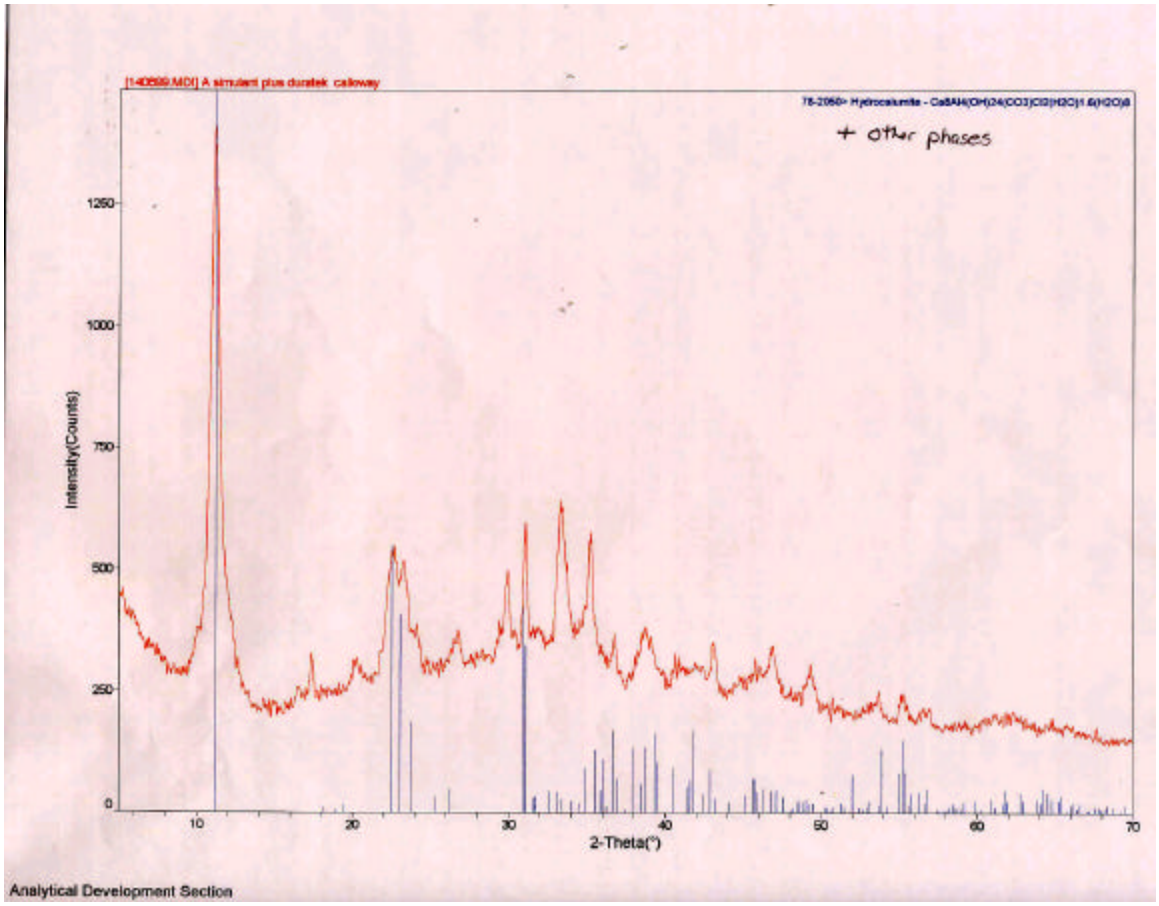

Figure 6 – Solids Formed After Mixing Duratek Condensate with AN105 Simulant

One other possible component was tentatively identified as Maricite ($NaFe_9PO_4$). The identification of Maricite was inconclusive and needs to be confirmed in future studies.

A sample of the mixture was submitted for solids and turbidity analysis to quantify the insoluble solids present in the mixture. The analysis is presented in Table 10.

Table 10 – Analysis of Simulated AN105 Mixed with AW101/105 Melter Off Gas Condensate

Analysis	Result
% Total Solids	15.56%
% Soluble Solids	15.40%
% Insoluble Solids[19]	0 - 0.16%
Density, g/ml	1.10
Turbidity, NTU[20]	115

CONCLUSIONS/FUTURE STUDIES

The characterization of the off gas condensate from the LAW Pilot scale melter was completed. The condensate contains a significant quantity of dissolved (~2wt%) and insoluble solids (0.12 wt. % or 1.21 g/L). The condensate is composed of unreacted glass formers, AW101/AN105 simulant, and trace amounts of LAW glass. The condensate is approximately 0.2M sodium and has a pH of approximately 6.8. A very small quantity of very fine insoluble solids formed when the AW101/AN105 LAW melter off gas condensate was mixed with pretreated AN105 simulant.

SRTC recommends that the RPP investigate potential design changes that would decontaminate the LAW Melter Off gas condensate to meet the Hanford site, 200 East Area Liquid Effluent Treatment Facility (LETF) waste acceptance criteria. These design changes have several benefits: 1) Purge halides from the RPP-WPT LAW melter off gas in order to reduce the potential build-up of corrosive species in the pretreated LAW evaporator and LAW Melter systems 2) Reduce the overall water load on the RPP-WPT pretreatment evaporator.

The current RPP-WTP pretreatment R&D plans call for additional characterization, mixing, and evaporation studies using HLW and LAW Melter Gas condensate derived from experiments using simulants. These studies are planned for fiscal years 2001 through 2003. It is recommended that additional condensate from Duratek and VSL pilot melters be obtained and characterized for use in additional pretreatment studies.

[19] Insoluble solids measurements are reported as a range since the values reported by the lab are very low and somewhat inconsistent. All other measurements in the table are duplicate measurements that are averaged

[20] Nephelometer Turbidity Unit. Drinking water is approximately 20 NTUs

APPROVALS

_____ _____
T. B. Calloway, Jr. Date
Author

_____ _____
D. C. Koopman Date
Technical Review

_____ _____
C. T. Randall Date
Management Review

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APPENDIX A – GEL Sample Analysis - Detail Report

WSRC-TR-2000-00299
SRT-RPP-2000-00009
Revision 0

Environmental Geochemistry Group

EGG-RSG-00188

Date: May 16, 2000

To: Ed Mann, 735-18A
Bond Calloway, 704-1T

From: Richard S. Groseclose, 735-16A

Job 00188

Attached is the final report from General Engineering Laboratories for one (1) aqueous Job 00188.

If you have any questions, please give me a call at 5-5687.

Reviewed by: R S Groseclose
Richard S. Groseclose, Environmental Geochemistry Group

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

CASE NARRATIVE REPORT
for
Westinghouse Savannah River Site
Subcontract No. AB93796N
Job# 00188

May 11, 2000

Laboratory Identification:

General Engineering Laboratories, Inc.

Summary:

Sample receipt

One liquid sample for Westinghouse Savannah River Site arrived at General Engineering Laboratories, Inc., (GEL) Charleston, South Carolina on April 13, 2000 for analysis. The sample listed on the chain arrived to the laboratory with a cooler temperature of 6° C. A ten-day turnaround was requested on the chain. The total and amenable cyanide and the reactive cyanide tests were cancelled because there was not a sufficient amount of sample to run them.

The sample was stored properly according to SW-846 procedures and GEL Standard Operating Procedures (SOP).

The laboratory received the following sample:

Description	Sample Number
24358001	00188-1

Case Narrative

Sample analyses were conducted using methodology as outlined in General Engineering Laboratories (GEL) Standard Operating Procedures. Any technical or administrative problems during analysis, data review, and reduction are written by analytical fraction in the enclosed narratives.

Data Package:

The enclosed data package contains the following sections: Case Narrative, Level II Certificate of Analysis, QC Sample Summaries, Chain of Custody, Sample Tracking Report, Nonconformance Reports if applicable & Electronic Data Hardcopy Report.

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

The Level II Certificate of Analysis contains the following headings:

Sample ID:	Sample Identification
Lab ID:	This is the laboratory identification number
Matrix:	Sample matrix
Date Collected:	Date of sample collection
Date Received:	Date of sample receipt by the laboratory
Priority:	Internal status of sample turnaround
Collector:	Party responsible for sample collection.

The detail on the Certificate includes the following:

Parameter:	Analyte or characteristic tested for in the sample
Qualifier:	Qualifier used for data interpretation
Result:	Final result of each parameter.
DL:	Method Detection Limit
RL:	Reporting Limit
Units:	Units of final result
DF:	Dilution factor
Analyst:	Initials of analyst who performed the test
Date:	Date of analysis
Time:	Time of analysis
Batch:	Analytical batch in which the sample was analyzed
Method:	Analytical method used for the analysis of the sample. Identified on the report numerically with a corresponding table.
Surrogate Recovery:	Provided for organic analysis only. Surrogate compound identified.
Test:	Analytical test associated with surrogate compound.
Percent%:	Surrogate percent recovery
Acceptable Limits:	Limits established for surrogate recoveries based upon the method requirements.

The QC Summary Report contains the following headings:

Sample Parameter:	Analyte or characteristic tested for in the QC sample
Type:	Type of QC sample (i.e., blank, dup, LCS, LCS dup, MS, MSD)
Batch:	Analytical batch in which the QC sample was analyzed
NOM:	Nominal concentration of the spiking compound
Sample:	Amount of compound found in the sample associated with the QC sample.
QC:	Amount of compound found in the QC sample.
Units:	Units of final result

RPD%:	Relative percent difference between LCS/LCS dup, MS/MSD, and Sample/Sample duplicate
REC%:	Recovery for the control samples
Range:	Acceptance limits for control samples
Analyst:	Initials of analyst who performed the test
Date:	Date of analysis
Time:	Time of analysis

Types of QC samples that may be found on the QC Summary Report are:

Blank:	Results of the blank analysis for the sample batch
Dup:	Duplicate analysis of sample
LCS:	Lab control sample
LCS dup:	Lab control sample duplicate
MS:	Matrix spike
MSD:	Matrix spike duplicate

The following are definitions of reporting limits used at General Engineering Laboratories:

DL — Detection Limit: The minimum level of an analyte that can be determined (identified not quantified) with 99% confidence. The values are normally achieved by preparing and analyzing seven aliquots of laboratory water spiked 1 to 5 times the estimated MDL, taking the standard deviation and multiplying it against the one-tailed t-statistic at 99%. This computed value is then verified for reasonableness by repeating the study using the concentration found in the initial study, calculating an F-ratio, and computing the final limit. Sample specific preparation and dilution factors are applied to these limits when they are reported.

The detection limit is the minimum concentration of a substance that can be identified, measured, and reported with 99% confidence that the analyte concentration is above zero. It answers the question "Is It Present".

QL — Quantitation Limit: The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The QL is generally 5 to 10 times the MDL. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes the QL analyte concentration is selected as the lowest non-zero standard in the calibration curve. Sample QL's are highly matrix-dependent. Sample specific preparation and dilution factors are applied to these limits when they are reported.

The QL is always $\geq$ DL

RL — Reporting Limit: Same as the QL except where driven by contract or client specifications. If the sample specific preparation and dilution factors cause the QL to be elevated above the RL, then the QL is used as the RL.

The quantitation limit is the lowest level at which a chemical may be accurately and reproducibly quantitated. It answers the question "HOW MUCH IS PRESENT".

Interpretation of RESULT column on the Certificate of Analysis:

If the final concentration in the sample was found to be above the RL, then the value reported is reported without a flag;

If the final concentration in the sample was found to be below the RL but above the DL, then the value reported is flagged with a "J";

If the final concentration in the sample was found to be below the DL, the value reported is flagged with a "U".

Quality Control Flags

General Engineering Laboratories maintains acceptance criteria for QC samples through use of statistical process control (SPC). The SPC limits are used to qualify data usability. The flagging criterion identified in WSRC AN98 Format does not necessarily coincide with the laboratory SPC criteria. There may be instances where the Electronic Data Deliverable (EDD) has flagged data based on the AN98 criteria and the lab has not identified the data to be outside of established control limits.

Those instances where the QC has not met laboratory SPC established criteria will be noted in the section case narratives that are included in this package.

This data package, to the best of my knowledge, is in compliance with technical and administrative requirements.

Amanda White for Stacy Griffin

Stacy L. Griffin
Project Manager

GENERAL ENGINEERING LABORATORIES
PO Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(803) 556-8171 • Fax (803) 766-1178

Case Narrative for
WSRC
SDG# 00188

ION CHROMATOGRAPHY

Sample Analysis

The following samples were analyzed for nitrate, nitrite, and ortho-phosphate using the analytical protocol as established in EPA 300.0 as specified in the "Method/Analysis Information" section of this narrative.

Lab ID	Client ID	Lab SDG	Client SDG
1000045779	MB for HBN 20985		
1000045780	LCS for HBN 20985		
1000045781	DUP of 24343001		
24358001	00188-1	24358	00188
1000045827	DUP of 24358001		
1000045828	PS of 24358001PS		
1000045782	PS of 24343001		

Method/Analysis Information:

Batch #: 20985

Procedure: EPA 300.0 Total Anions in Liquid(48hours)

Analytical Method: EPA 300.0

Lab Group: Ion Chromatography Federal

SOP Reference

Procedures for preparation, analysis and reporting of analytical data are controlled by General Engineering Laboratories, Inc. (GEL) as Standard Operating Procedures (SOP). The data discussed in this narrative has been prepared and analyzed in accordance with GEL SOP GL-GC-E-086.

Calibration Information:

Initial Calibration

Initial calibration was performed using a Dionex DX300 Ion Chromatograph instrument equipped with a Dionex AS9-HC general purpose anion column. All initial calibration requirements have been met for this analysis. Last calibration of IC#2 was 04/10/00.

CCAL Requirements

All continuing calibration (CCAL) criteria have been met for this sample set.

Quality Control (QC) Information:

Blank Acceptance

All of the blanks analyzed with this sample set met the established report acceptance criteria.

LCS/LCSD Recovery Statement

All LCS spike recoveries for this sample set were within the required acceptance limits.

QC Sample Designation

The following samples were designated for Quality Control analysis:

MS/MSD Recovery Statement

The PS/PSD spike recoveries for this sample set were within the required acceptance limits.

Duplicate RPD Statement

Duplicate results are evaluated for RPD when both the sample and its duplicate have concentrations greater than 5X the PQL. When both values fall between the PQL and 5X the PQL, the duplicate analysis is considered acceptable as long as the values are less than 1 PQL value apart. All duplicate RPDs for this sample set were within the required acceptance limits.

Technical Information:

Holding Time Specifications

GEL assigns holding times based on the date and time of sample collection. Those holding times expressed in hours are calculated in the GELIMS system by hours. Those holding times expressed as days expire at midnight on the day of expiration. The following samples were received out of holding for o-PO4, NO2, and NO3.

Sample ID	Comments
1000045781	Received out of holding
1000045782	Received out of holding

Sample Re-prep/Re-analysis

None of the samples had multiple analyses for reasons other than dilution.

Sample Dilutions

The sample was diluted to be within the calibration range and to minimize the matrix interferences.

Sample ID	Comments
1000045827	1:100 for NO2, NO3 1:10 for o-PO4
1000045828	1:100 for NO2, NO3 1:10 for o-PO4
24358001	1:100 for NO2, NO3, 1:10 for o-PO4

Miscellaneous Information:

NCR Documentation

There were no Nonconformance Reports associated with this batch.

ION CHROMATOGRAPHY

Sample Analysis

The following samples were analyzed for anions using the analytical protocol as established in EPA 300.0 as specified in the "Method/Analysis Information" section of this narrative.

Lab ID	Client ID	Lab SDG	Client SDG
1000046024	MB for HBN 21106		
1000046025	LCS for HBN 21106		
1000046026	DUP of 24358001		
24358001	00188-1	24358	00188
1000046027	PS of 24358001		

Method/Analysis Information:

Batch #: 21106

Procedure: EPA 300.0 Total Anions in Liquid

Analytical Method: EPA 300.0

Lab Group: Ion Chromatography Federal

SOP Reference

Procedures for preparation, analysis and reporting of analytical data are controlled by General Engineering Laboratories, Inc. (GEL) as Standard Operating Procedures (SOP). The data discussed in this narrative has been prepared and analyzed in accordance with GEL SOP GL-GC-E-086.

Calibration Information:

Initial Calibration

Initial calibration was performed using a Dionex DX300 Ion Chromatograph instrument equipped with a Dionex AS9-HC general purpose anion column. All initial calibration requirements have been met for this analysis. Last calibration of IC#2 was 04/10/00.

CCAL Requirements

All continuing calibration (CCAL) criteria have been met for this sample set.

Quality Control (QC) Information:

Blank Acceptance

All of the blanks analyzed with this sample set met the established report acceptance criteria.

LCS/LCSD Recovery Statement

All LCS spike recoveries for this sample set were within the required acceptance limits.

QC Sample Designation

The following samples were designated for Quality Control analysis:

Sample ID	Comments
24358001	Sample Duplicate and Post Spike

MS/MSD Recovery Statement

The MS/MSD spike recoveries for this sample set were within the required acceptance limits.

Duplicate RPD Statement

Duplicate results are evaluated for RPD when both the sample and its duplicate have concentrations greater than 5X the PQL. When both values fall between the PQL and 5X the PQL, the duplicate analysis is considered acceptable as long as the values are less than 1 PQL value apart. All duplicate RPDs for this sample set were within the required acceptance limits.

Technical Information:

Holding Time Specifications

GEL assigns holding times based on the date and time of sample collection. Those holding times expressed in hours are calculated in the GELIMS system by hours. Those holding times expressed as days expire at midnight on the day of expiration. All samples in this sample set met the specified holding time requirements.

Sample Re-prep/Re-analysis

None of the samples had multiple analyses for reasons other than dilution.

Sample Dilutions

The following samples were diluted to bring values within the calibration range for F, Cl, and SO4, and to minimixe matrix interference for Br.

Sample ID	Comments
1000046026	1:10 for F, Br & SO4; 1:400 for Cl
1000046027	1:10 for F, Br & SO4; 1:400 for Cl
24358001	1:10 for F, Br & SO4; 1:400 for Cl

Miscellaneous Information:

NCR Documentation

There were no Nonconformance Reports associated with this batch.

OXALATE BY ION CHROMATOGRAPHY

Sample Analysis

The following samples were analyzed for oxalate using the analytical protocol as established in EPA 300.0 as specified in the "Method/Analysis Information" section of this narrative.

Lab ID	Client ID	Lab SDG	Client SDG
1000047314	MB for HBN 21675		
1000047315	LCS for HBN 21675		
24358001	00188-1	24358	00188
1000047316	DUP of sample 24500001 for HBN 21676		
1000047317	PS of sample 24500001 for HBN 21676		

Method/Analysis Information:

Batch #: 21675

Procedure: EPA 300.0 Oxalate liquid Federal

Analytical Method: EPA 300.0

Lab Group: Ion Chromatography Federal

SOP Reference

Procedures for preparation, analysis and reporting of analytical data are controlled by General Engineering Laboratories, Inc. (GEL) as Standard Operating Procedures (SOP). The data discussed in this narrative has been prepared and analyzed in accordance with GEL SOP GL-GC-E-086.

Calibration Information:

Initial Calibration

Initial calibration was performed using a Dionex DX300 Ion Chromatograph instrument equipped with a Dionex AS9-HC general purpose anion column. All initial calibration requirements have been met for this analysis. Last calibration of IC#1 was 04/19/00.

CCAL Requirements

All continuing calibration (CCAL) criteria have been met for this sample set.

Quality Control (QC) Information:

Blank Acceptance

All of the blanks analyzed with this sample set met the established report acceptance criteria.

LCS/LCSD Recovery Statement

All LCS spike recoveries for this sample set were within the required acceptance limits.

QC Sample Designation

The following samples were designated for Quality Control analysis:

Sample ID	Comments
24500001	Sample Duplicate and Post Spike

MS/MSD Recovery Statement

The MS/MSD spike recoveries for this sample set were within the required acceptance limits.

MS/MSD RPD Statement

The relative percent difference (RPD) between the MS and MSD was within the required acceptance limits.

Duplicate RPD Statement

Duplicate results are evaluated for RPD when both the sample and its duplicate have concentrations greater than 5X the PQL. When both values fall between the PQL and 5X the PQL, the duplicate analysis is considered acceptable as long as the values are less than 1 PQL value apart. All duplicate RPDs for this sample set were within the required acceptance limits.

Technical Information:

Holding Time Specifications

GEL assigns holding times based on the date and time of sample collection. Those holding times expressed in hours are calculated in the GELIMS system by hours. Those holding times expressed as days expire at midnight on the day of expiration. All samples in this sample set met the specified holding time requirements.

Sample Re-prep/Re-analysis

None of the samples had multiple analyses for reasons other than dilution.

Sample Dilutions

The following sample was diluted due to lack of sample volume.

Sample ID	Comments
24358001	1:10 for oxalate

Miscellaneous Information:

NCR Documentation

There were no Nonconformance Reports associated with this batch.

Review/Validation:

GEL requires all analytical data to be verified by a qualified data validator.

The data presented in this sample set has been verified by the following qualified data validator:

Reviewer: _____ **Date:** 04/24/00

INORGANIC ANALYSIS

Case Narrative for
WSRC
SDG#00188
Metals Analysis by ICPMS

Sample Analysis:
The following samples were prepared and analyzed according to analytical protocol established in Environmental Protection Agency (EPA) methods as specified in the "Method/Analysis Information" section of this narrative:

Lab ID	Client ID	Batch #	Client SDG
1000046582	Method Blank (PBW)		
1000046585	Laboratory Control Sample (LCSW)		
24358001	00188-1	21745	00188

Method/Analysis Information:

Batch #:	21745
Prep Batch #:	21358
Procedure:	ICP-MS 6020 IN WATER
Analytical Method:	SW846 6020
Prep Method:	SW846 3005A
Lab Group:	Metals Analysis - ICPMS Federal

System Configuration
A Hewlett Packard 4500 Series inductively coupled plasma mass spectrometer (ICP-MS) was employed to analyze the ICP-MS samples. It is equipped with a cross-flow nebulizer, quadrupole mass spectrometer, and electron multiplier detector. Internal standards of scandium, yttrium, indium, and lutetium were utilized to cover the mass spectrum. Operating conditions are set at 1300W power and argon flows of 16 L/min, 1.0 L/min, and 1.0 L/min for the plasma, auxiliary, and carrier gases, respectively.

Sample Preparation
All samples were prepared in accordance with the referenced SW-846 procedure.

Calibration Information:
Initial Calibration
All instruments' calibrations are conducted using method and instrument manufacturer's specifications. All initial calibration requirements have been met for this analysis.

Continuing Calibration Verification (CCV) Requirements
All CCV criteria have been met for this SDG.

Quality Control (QC) Information:
Blank Acceptance
The preparation and instrument calibration blanks analyzed with this SDG met the established report acceptance criteria.

LCS Recovery Statement
All LCS spike recoveries for this SDG were not within the required acceptance limits.

Technical Information:
Holding Time Specifications
All samples in this SDG met the specified holding time requirements.

Sample Dilutions
Dilutions are performed to minimize matrix interferences resulting from elevated mineral element concentrations present in soil samples and/or to bring over range target analyte concentrations into the linear calibration range of the instruments. The sample was diluted 1:100 to bring potassium and sodium into linear range.

Miscellaneous Information:

NCR Documentation
Nonconformance reports are generated to document procedural anomalies that may deviate from referenced SOP or contractual documents. No nonconformance report (NCR) has been generated to document procedural deviations that occurred with this SDG.

Additional Comments
The additional comments field is used to address special issues associated with each analysis, clarify method/contractual issues pertaining to the analysis and to list any report documents generated as a result of sample analysis or review. The following comments were required for this sample set:

The flagging conventions demonstrated in this package are assigned based on IDL and CRDL values. All qualifiers assigned for samples in this SDG, except for serial dilutions, have been corrected for prep and dilution factors.

Review/Validation:
GEL requires all analytical data to be verified by a qualified data validator.

The following qualified data validator has verified data presented in this sample set:

Reviewer: J. R. Willey

Date: 5/8/00

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Westinghouse Savannah Rivr Co.
Address : Building 735-16A, Rm 5
P.O. Box 616
Aiken, SC 29802
Contact: Mr. Richard Groseclose
Project: HazWaste Contract

Report Date: May 11, 2000

Client Sample ID: 00188-1
Sample ID: 24358001
Matrix: Misc Liquid
Collect Date: 12-APR-00
Receive Date: 13-APR-00
Collector: Client

Project: WSRC00497
Client ID: WSRC006

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Ion Chromatography Federal										
EPA 300.0 Oxalate Liquid Feder										
Oxalate	J	2.52	1.13	6.00	mg/L	10	RWS 04/19/00	1225	21675	1
EPA 300.0 o-Phosphate (PO4)										
Nitrate		551	2.00	5.00	mg/L	100	RWS 04/14/00	0807	20985	3
Nitrite		1680	2.00	5.00	mg/L	100				
Ortho-phosphate	U	0.00	4.00	10.0	mg/L	100				
EPA300.0 Sulfate in Liquid										
Chloride		5440	10.4	40.0	mg/L	400	RWS 04/14/00	1049	21106	5
Bromide	U	0.00	0.160	0.500	mg/L	10	JBK 04/14/00	0950	21106	6
Fluoride		83.3	0.170	0.500	mg/L	10				
Sulfate		210	0.790	2.00	mg/L	10				
Metals Analysis-ICPMS Federal										
6020 ICP SCAN Metals Liquid										
Antimony, total recoverable		57.5	1.1	20.0	ug/L	1	JSS 04/20/00	1856	21745	7
Arsenic, total recoverable		34.5	1.45	30.0	ug/L	1				
Barium. total recoverable		207	1.58	20.0	ug/L	1				
Beryllium, total recoverable		2.41	0.340	2.00	ug/L	1				
Cadmium, total recoverable		46.2	0.500	10.0	ug/L	1				
Calcium, total recoverable		185000	55.4	1000	ug/L	1				
Chromium, total recoverable		22400	6.45	30.0	ug/L	1				
Cobalt, total recoverable	J	2.15	0.180	10.0	ug/L	1				
Copper, total recoverable		222	11.8	20.0	ug/L	1				
Iron, total recoverable		24100	79.2	250	ug/L	1				
Lead, total recoverable		580	0.770	20.0	ug/L	1				
Magnesium, total recoverable		29400	5.21	100	ug/L	1				
Manganese, total recoverable		1760	6.55	50.0	ug/L	1				
Molybdenum		123	1.96	5.00	ug/L	1				
Nickel, total recoverable		190	0.720	20.0	ug/L	1				
Selenium, total recoverable		80.9	2.18	30.0	ug/L	1				
Silver, total recoverable		1160	1.01	10.0	ug/L	1				
Thallium, total recoverable		19.2	0.140	5.00	ug/L	1				
Vanadium, total recoverable	J	99.3	3.30	100	ug/L	1				
Zinc, total recoverable		144000	9.74	100	ug/L	1				
Potassium, total recoverable		2870000	3530	300000	ug/L	100	JSS 04/20/00	1935	21745	8
Sodium, total recoverable		4930000	20800	250000	ug/L	100				
Aluminum, total recoverable		121000	31.2	150	ug/L	1	JSS 04/19/00	1402	21745	9

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GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Westinghouse Savannah Rivr Co.
Address : Building 735-16A, Rm 5
P.O. Box 616
Aiken, SC 29802
Contact: Mr. Richard Groseclose
Project: HazWaste Contract

Report Date: May 11, 2000

Client Sample ID: 00188-1
Sample ID: 24358001

Project: WSRC00497
Client ID: WSRC006

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
SW846 3005A	ICP-MS 3005 PREP	AJM	04/17/00	1930	21358

The following Analytical Methods were performed

Method	Description
1	EPA 300.0
2	EPA 300.0
3	EPA 300.0
4	EPA 300.0
5	EPA 300.0
6	EPA 300.0
7	SW846 6020
8	SW846 6020
9	SW846 6020

Notes:
The Qualifiers in this report are defined as follows :

J EPA Functional Guideline Code:Result > MDA and result < 2 * Error
J EPA Functional Guideline Code:Result >= MDL but result < PQL/RDL
R4 EPA Functional Guideline Code:Data Rejected
U EPA Functional Guideline Code:Result < 5 * blank result
U EPA Functional Guideline Code:Result < MDL

The above sample is reported on an "as received" basis.

This data report has been prepared and reviewed in accordance with General Engineering Laboratories, Inc. standard operating procedures. Please direct any questions to your Project Manager, Stacy L. Griffin at 843-556-8171 Ext. 4264.

Anna K White

Reviewed by

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Environmental Geochemistry Group

EGG-RSG-00188

Date: June 1, 2000

To: Bond Calloway, 704-1T

From: Richard S. Groseclose, 735-16A

Job 00188

Attached is the revised Certificate of Analysis from General Engineering Laboratories for one (1) liquid sample, No. 00188, on Job 00188. The units for Reactive Releasable Cyanide have been changed from ug/L to mg/L. I don't have a copy of SW846 7.3.3 to check, but the lab reports units for solid samples are mg/kg and units for liquid samples are mg/L.

If you have any questions, please give me a call at 5-5687.

Reviewed by: RS Groseclose

Richard S. Groseclose, Environmental Geochemistry Group

Note: Original sample was supernate. Solids had been filtered out of sample by SRTC.

T.B. Calloway
6/3/00

GENERAL ENGINEERING LABORATORIES

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Certificate of Analysis

Company : Westinghouse Savannah Rivr Co.
Address : Building 735-16A, Rm 5
P.O. Box 616
Aiken, SC 29802
Contact: Mr. Richard Groseclose
Project: HazWaste Contract

Report Date: June 1, 2000

Client Sample ID: 00188
Sample ID: 24785001
Matrix: Misc Liquid
Collect Date: 20-APR-00
Receive Date: 24-APR-00
Collector: Client

Project: WSRC00497
Client ID: WSRC006

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Ion Chromatography Federal											
EPA 300.0 Nitrate in Liquid											
Nitrate		566	2.00	5.00	mg/L	100	RWS	04/25/00	1206	22475	1
Nitrite		1710	2.00	5.00	mg/L	100					
Ortho-phosphate	U	0.00	0.400	1.00	mg/L	10	RWS	04/25/00	1247	22475	2
EPA 300.0 Oxalate Liquid Feder											
Oxalate	J	2.05	0.452	2.40	mg/L	4	RWS	04/27/00	1139	22853	3
EPA300.0 Sulfate in Liquid											
Chloride		5530	10.4	40.0	mg/L	400	RWS	04/25/00	1342	22502	4
Bromide	U	0.00	0.160	0.500	mg/L	10	RWS	04/25/00	1247	22502	5
Fluoride		53.2	0.170	0.500	mg/L	10					
Sulfate		218	0.790	2.00	mg/L	10					
Metals Analysis-ICPMS Federal											
6020 ICP SCAN Metals Liquid											
Aluminum, total recoverable		5180	31.2	150	ug/L	1	JSS	04/28/00	0016	22762	6
Antimony, total recoverable		47.4	1.11	20.0	ug/L	1					
Arsenic, total recoverable	U	-12.6	1.45	30.0	ug/L	1					
Barium, total recoverable		121	1.58	20.0	ug/L	1					
Beryllium, total recoverable	J	1.14	0.340	2.00	ug/L	1					
Cadmium, total recoverable	J	0.540	0.500	10.0	ug/L	1					
Calcium, total recoverable		160000	55.4	1000	ug/L	1					
Chromium, total recoverable		25300	6.45	30.0	ug/L	1					
Cobalt, total recoverable	J	2.01	0.180	10.0	ug/L	1					
Copper, total recoverable		43.5	11.8	20.0	ug/L	1					
Iron, total recoverable	J	171	79.2	250	ug/L	1					
Lead, total recoverable	J	8.28	0.770	20.0	ug/L	1					
Magnesium, total recoverable		35200	5.21	100	ug/L	1					
Manganese, total recoverable		545	6.55	50.0	ug/L	1					
Nickel, total recoverable		109	0.720	20.0	ug/L	1					
Selenium, total recoverable		56.6	2.18	30.0	ug/L	1					
Silver, total recoverable		1050	1.01	10.0	ug/L	1					
Thallium, total recoverable		16.2	0.140	5.00	ug/L	1					
Vanadium, total recoverable	U	-333	3.30	100	ug/L	1					
Zinc, total recoverable		36300	9.74	100	ug/L	1					
Molybdenum		108	1.96	5.00	ug/L	1	JSS	04/26/00	1819	22762	7
Potassium, total recoverable						1					
Sodium, total recoverable						1					
Potassium, total recoverable		2740000	706	60000	ug/L	20	JSS	04/26/00	2125	22762	8

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Certificate of Analysis

Company : Westinghouse Savannah Rivr Co.
Address : Building 735-16A, Rm 5
P.O. Box 616
Aiken, SC 29802
Contact: Mr. Richard Groseclose
Project: HazWaste Contract

Report Date: June 1, 2000

Client Sample ID: 00188
Sample ID: 24785001

Project: WSRC00497
Client ID: WSRC006

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICPMS Federal											
6020 ICP SCAN Metals Liquid											
Sodium, total recoverable		5270000	4160	50000	ug/L	20					
Rapid Flow Analysis Federal											
EPA 335.3 Cyanide, Total Feder											
Cyanide, Total		1160	69.0	125	ug/L	10	HSC	05/01/00	2214	22608	9
SW 7.3.3 Reactivity, Releasabl											
Reactive Releasable Cyanide	J	0.0433	0.0138	250000	mg/L	1	ADF	04/28/00	1011	22607	10

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
EPA 335.3	EPA 335.3 Total Cyanide	HSC	04/25/00	1445	22413
SW846 3005A	ICP-MS 3005 PREP	FDG	04/25/00	1150	22423
SW846 7.3.3 Pr	SW 7.3.3 Reactivity, Releasable Cyanide-	HSC	04/25/00	1515	22411

The following Analytical Methods were performed

Method	Description
1	EPA 300.0
2	EPA 300.0
3	EPA 300.0
4	EPA 300.0
5	EPA 300.0
6	SW846 6020
7	SW846 6020
8	SW846 6020
9	EPA 335.3
10	SW846 7.3.3

Notes:
The Qualifiers in this report are defined as follows :

J EPA Functional Guideline Code:Result > MDA + 2 * Error
J EPA Functional Guideline Code:Result >= MDL but result < PQL/RDL
R4 EPA Functional Guideline Code:Data Rejected
U EPA Functional Guideline Code:Result < 5 * blank result
U EPA Functional Guideline Code:Result < MDL

The above sample is reported on an "as received" basis.

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Certificate of Analysis

Company : Westinghouse Savannah Rivr Co.
Address : Building 735-16A, Rm 5
P.O. Box 616
Aiken, SC 29802
Contact: Mr. Richard Groseclose
Project: HazWaste Contract

Report Date: June 1, 2000

Client Sample ID: 00188
Sample ID: 24785001

Project: WSRC00497
Client ID: WSRC006

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method

This data report has been prepared and reviewed in accordance with General Engineering Laboratories, Inc. standard operating procedures. Please direct any questions to your Project Manager, Stacy L. Griffin at 843-556-8171 Ext. 4264.

Reviewed by

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QC Summary

Report Date: May 11, 2000
Page 1 of 3

Client : Westinghouse Savannah Rivr Co.
Building 735-16A, Rm 5
P.O. Box 616
Aiken, SC 29802
Contact: Mr. Richard Groseclose

Workorder: 24358

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Ion Chromatography Federal										
Batch 20985										
QC1000045827 24358001 DUP										
Nitrate		551		550	mg/L	0		(0%-13%)	RWS	04/14/00 08:22
Nitrite		1680		1680	mg/L	0		(0%-17%)		
Ortho-phosphate	U	0.00	U	0.00	mg/L	N/A		(0%-20%)		
QC1000045780 LCS										
Nitrate				4.97	mg/L		99	(90%-110%)		04/13/00 23:32
Nitrite				9.88	mg/L		99	(90%-110%)		
Ortho-phosphate				9.43	mg/L		94	(90%-110%)		
QC1000045779 MB										
Nitrate			U	0.00	mg/L					04/13/00 23:46
Nitrite			U	0.00	mg/L					
Ortho-phosphate			U	0.00	mg/L					
QC1000045828 24358001 PS										
Nitrate		551		1110	mg/L		112	(80%-120%)		04/14/00 08:36
Nitrite		1680		2680	mg/L		100	(80%-120%)		
Ortho-phosphate	U	0.00		1040	mg/L		104	(80%-120%)		
Batch 21106										
QC1000046026 24358001 DUP										
Bromide	U	0.00	U	0.00	mg/L	N/A		(0%-20%)	JBK	04/14/00 10:05
Chloride		5440		5300	mg/L	3		(0%-13%)	RWS	04/14/00 11:04
Fluoride		83.3		84.8	mg/L	2		(0%-15%)	JBK	04/14/00 10:05
Sulfate		210		208	mg/L	1		(0%-15%)		
QC1000046025 LCS										
Bromide				10.1	mg/L		101	(90%-110%)	RWS	04/14/00 11:33
Chloride				9.67	mg/L		97	(90%-110%)		
Fluoride				10.2	mg/L		102	(90%-110%)		
Sulfate				19.4	mg/L		97	(90%-110%)		
QC1000046024 MB										
Bromide			U	0.00	mg/L					04/14/00 11:48
Chloride			U	0.00	mg/L					
Fluoride			U	0.00	mg/L					
Sulfate			U	0.00	mg/L					
QC1000046027 24358001 PS										
Bromide	U	0.00		106	mg/L		106	(80%-120%)	JBK	04/14/00 10:20
Chloride		5440		9850	mg/L		110	(80%-120%)	RWS	04/14/00 11:19
Fluoride		83.3		171	mg/L		88	(80%-120%)	JBK	04/14/00 10:20
Sulfate		210		417	mg/L		103	(80%-120%)		
Batch 21675										
QC1000047315 LCS										
Oxalate				9.00	mg/L		100	(90%-110%)	RWS	04/19/00 14:19
QC1000047314 MB										
Oxalate			U	0.00	mg/L					04/19/00 14:37
Metals Analysis-ICPMS Federal										

QC Summary

Workorder: 24358

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Metals Analysis-ICPMS Federal											
Batch 21745											
QC1000046585 LCS											
Aluminum, total recoverable	1000			962	ug/L		96	(73%-133%)	JSS	04/19/00	13:56
Antimony, total recoverable	50.0			49.1	ug/L		98	(70%-126%)		04/20/00	18:49
Arsenic, total recoverable	50.0			49.4	ug/L		99	(78%-119%)			
Barium. total recoverable	50.0			49.7	ug/L		99	(91%-111%)			
Beryllium, total recoverable	50.0			54.6	ug/L		109	(75%-121%)			
Cadmium, total recoverable	50.0			51.8	ug/L		104	(87%-110%)			
Calcium, total recoverable	1000			1070	ug/L		107	(92%-143%)			
Chromium, total recoverable	50.0			54.9	ug/L		110	(75%-120%)			
Cobalt, total recoverable	50.0			49.3	ug/L		99	(82%-114%)			
Copper, total recoverable	50.0			51.2	ug/L		102	(82%-128%)			
Iron, total recoverable	50.0			63.3	ug/L		127	(63%-158%)			
Lead, total recoverable	50.0			49.6	ug/L		99	(80%-120%)			
Magnesium, total recoverable	500			521	ug/L		104	(83%-120%)			
Manganese, total recoverable	50.0			48.2	ug/L		96	(80%-118%)			
Molybdenum	50.0			49.2	ug/L		98	(89%-111%)			
Nickel, total recoverable	50.0			49.1	ug/L		98	(86%-118%)			
Potassium, total recoverable	1000			1070	ug/L		107	(71%-125%)			
Selenium, total recoverable	50.0			48.2	ug/L		96	(66%-130%)			
Silver, total recoverable	50.0			32.5	ug/L		65	(47%-158%)			
Sodium, total recoverable	1000			1050	ug/L		105	(80%-120%)			
Thallium, total recoverable	50.0			43.0	ug/L		86	(29%-158%)			
Vanadium, total recoverable	50.0			57.2	ug/L		114	(79%-116%)		04/19/00	13:56
Zinc, total recoverable	50.0			48.8	ug/L		98	(62%-151%)		04/20/00	18:49
QC1000046582 MB											
Aluminum, total recoverable			U	-0.167	ug/L					04/19/00	13:49
Antimony, total recoverable			J	0.180	ug/L					04/20/00	18:43
Arsenic, total recoverable			J	0.864	ug/L						
Barium. total recoverable			U	-0.095	ug/L						
Beryllium, total recoverable			U	0.009	ug/L						
Cadmium, total recoverable			U	-0.435	ug/L						
Calcium, total recoverable			J	16.8	ug/L						
Chromium, total recoverable			J	1.31	ug/L						
Cobalt, total recoverable			U	-0.248	ug/L						
Copper, total recoverable			U	-0.264	ug/L						
Iron, total recoverable			U	4.10	ug/L						
Lead, total recoverable			U	-0.163	ug/L						
Magnesium, total recoverable			J	0.762	ug/L						
Manganese, total recoverable			U	0.127	ug/L						
Molybdenum			J	0.239	ug/L						
Nickel, total recoverable			U	-0.131	ug/L						
Potassium, total recoverable			U	2.33	ug/L						
Selenium, total recoverable			J	1.33	ug/L						
Silver, total recoverable			U	0.091	ug/L						
Sodium, total recoverable			U	-14.2	ug/L						
Thallium, total recoverable			U	-0.221	ug/L						
Vanadium, total recoverable			J	6.48	ug/L						
Zinc, total recoverable			J	1.79	ug/L						

QC Summary

Workorder: 24358

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

Notes:
The Qualifiers in this report are defined as follows:

J	EPA Functional Guideline Code:Result > MDA and result < 2 * Error
J	EPA Functional Guideline Code:Result >= MDL but result < PQL/RDL
R4	EPA Functional Guideline Code:Data Rejected
U	EPA Functional Guideline Code:Result < 5 * blank result
U	EPA Functional Guideline Code:Result < MDL

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more.

FEDERAL SAMPLE RECEIPT REVIEW

Client WSRC Received by PAD Date 4/13/00

GEL COOLER____ GEL POLY COOLER____ CLIENT COOLER____ OTHER____

SAMPLE REVIEW CRITERIA	YES	NO	COMMENTS/QUALIFIERS
1. Were shipping containers received intact and sealed? If no, notify Project Manager	✓		
2. Was the Shipment screened following the radiochemistry survey procedure (EPI SOP S-007)?	✓		
Were the survey results negative? If no, notify Project Manager	✓		
Are any of the samples identified by the client as radioactive? If yes, did client provide RAD activity?		✓	
3. Were chain of custody documents included?	✓		
4. Were chain of custody documents completed correctly? (Ink, signed, match containers)	✓		
5. Were all sample containers properly labeled?	✓		
6. Were proper sample containers received?	✓		
7. Preserved samples checked for pH?		/	
8. Were samples preserved correctly? If no, list samples & tests	/		NA
9. Shipping container temperature checked?	✓		
10. Was shipping conatiner temperature within specifications (4°± 2° C) If no, notify Project Manager		✓	
11. Is temperature documented on the Chain of Custody?		✓	
12. Were samples received within holding time? if No, notify Project Manger	✓		
13. Were VOA vials free of headspace?		/	
14. ARCOC# IF REQUIRED	/		
15. SDG# IF REQUIRED	✓		00188

REVIEW Patricia Bower DATE 4/13/00 (SA) - SEALS ATTACHED NSA - NO SEALS ATTACHED