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11 January 2016

SRNL-L3100-2015-00227 Rev.0

To: E. J. Freed

From: C. L. Crawford

Results for the Fourth Quarter Calendar Year 2015 Tank 50H Salt Solution Sample

Approved by: _____
D. H. Miller, Technical Reviewer Date

E. N. Hoffman, EPD Manager Date

SUMMARY

In this memorandum, the chemical and radionuclide contaminant results from the Fourth Quarter Calendar Year 2015 (CY15) sample of Tank 50H salt solution are presented in tabulated form. The Fourth Quarter CY15 Tank 50H samples were obtained on October 29, 2015 and received at Savannah River National Laboratory (SRNL) on October 30, 2015.¹ The information from this characterization will be used by Defense Waste Processing Facility (DWPF) & Saltstone Facility Engineering for the transfer of aqueous waste from Tank 50H to the Salt Feed Tank in the Saltstone Production Facility, where the waste will be treated and disposed of in the Saltstone Disposal Facility. This memorandum compares results, where applicable, to Saltstone Waste Acceptance Criteria (WAC) limits and targets.² Data pertaining to the regulatory limits for Resource Conservation and Recovery Act (RCRA) metals will be documented at a later time per the Task Technical and Quality Assurance Plan (TTQAP) for the Tank 50H saltstone task.³ The chemical and radionuclide contaminant results from the characterization of the Fourth Quarter Calendar Year 2015 (CY15) sampling of Tank 50H were requested by SRR personnel⁴ and details of the testing are presented in the SRNL Task Technical and Quality Assurance Plan.⁵

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The following facts pertaining to the WAC are drawn from the analytical results provided in this memorandum:

- Savannah River Remediation (SRR) WAC targets or limits were met for all analyzed chemical and radioactive contaminants unless noted in this section.
- Norpar 13 and Isopar L have higher detection limits⁶ compared with the Saltstone WAC. The data provided in this report is based upon the concentrations in the sub-sample, and due to the limited solubility of these materials in aqueous solution, may not represent the concentrations of the analytes in Tank 50H.

Additional conclusions are:

- The low insoluble solids content increases the measurement uncertainty for insoluble species.
- Minimum detection limits are reported for ⁵⁹Ni, ⁹⁴Nb, ²⁴⁷Cm, ²⁴⁹Cf, and ²⁵¹Cf as determined from the minimum detectable activity associated with the radiochemical methods used for these radionuclides. The reported detection limits are above the requested SRR target minimum detection limit concentrations.⁷ However, they are below or very near the estimated detection limits initially established by SRNL in 2009.⁸

TABLES CONTAINING RESULTS

Unless otherwise stated, all of the concentrations presented in the tables (except upper limits) are averages based on triplicate analyses of the Fourth Quarter CY15 Tank 50H samples. The standard deviation of each average is also presented. Several of the contaminants were either not detected in the slurry samples or detected at values below the method reporting limit (MRL). For contaminants not detected or detected below the MRL, the result is preceded by a “<”, which indicates the result is an upper limit based on the sensitivity of the method used to analyze the individual analyte. Mercury (Hg) speciation data shown in Table 1 and Table 2 are taken from previous work.^{9,10}

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Table 1. Chemical Contaminants from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Attachment 8.1 Limits²

<u>Chemical Name (Formula)</u>	<u>Method</u>	<u>Average Concentration (mg/L)</u>	<u>Std. Dev.</u>	<u>WAC Limit (mg/L)</u>
Aluminate (Al(OH)₄⁻)	ICP-ES	1.01E+04 ^a	1.40E+02	4.08E+05
Ammonium (NH₄⁺)	IC	<1.00E+01	NA	2.12E+02
Carbonate (CO₃²⁻)	TIC	1.53E+04 ^b	5.00E+01	1.20E+05
Chloride (Cl⁻)	IC	2.18E+02	4.58E+00	7.95E+03
Fluoride (F⁻)	IC	<1.00E+02	NA	4.07E+03
Free Hydroxide (OH⁻)	Total Base	2.59E+04 ^b	5.10E+02	1.58E+05
Nitrate (NO₃⁻)	IC	1.28E+05	2.23E+03	4.37E+05
Nitrite (NO₂⁻)	IC	2.40E+04	1.11E+02	2.14E+05
Oxalate (C₂O₄²⁻)	IC	4.65E+02	7.57E+00	2.72E+04
Phosphate (PO₄³⁻)	ICP-ES	4.86E+02 ^c	1.33E+01	2.94E+04
Sulfate (SO₄²⁻)	IC	6.21E+03	1.44E+02	5.69E+04
Arsenic (As)	AA	<1.13E-01	NA	2.30E+01
Barium (Ba)	ICP-ES	< 5.84E-01	NA	6.19E+02
Cadmium (Cd)	ICP-ES	< 2.63E+00	NA	3.10E+02
Chromium (Cr)	ICP-ES	3.04E+01	2.47E-01	1.24E+03
Lead (Pb)	ICP-MS	1.68E-01	1.20E-02	6.19E+02
Total Mercury (Hg)	CVAA	9.32E+01	1.01E+00	3.25E+02
Elemental Mercury (Hg(0))	CVAFS	8.78E-01	4.21E-02	8.92E+01
Selenium (Se)	AA	4.43E-02	8.65E-04	4.46E+02
Silver (Ag)	ICP-ES	<1.93E+00	NA	6.19E+02
Aluminum (Al)	ICP-ES	2.88E+03	3.97E+01	1.16E+05
Potassium (K)	AA	1.87E+02	9.99E+00	3.03E+04
Nickel Hydroxide (Ni(OH)₂)	ICP-ES	< 2.89E+01 ^d	NA	1.17E+03
n-Butanol (C₄H₉OH)	VOA	< 5.00E-01 ^e	NA	7.73E+00
i-Butanol (C₄H₉OH)	VOA	< 5.00E-01 ^e	NA	7.73E+00
i-Propanol (C₃H₇OH)	VOA	< 2.50E-01 ^e	NA	1.88E+00
Phenol (C₆H₅OH)	SVOA	< 1.00E+01 ^e	NA	7.50E+02
Isopar L (----)	SVOA	<2.67E+01 ppm ^{e,f}	NA	1.10E+01 ppm
Total Organic Carbon (----)	TOC	3.39E+02 ^b	1.15E+00 ^e	5.00E+03
Tetraphenylborate [TPB anion] (B(C₆H₅)₄⁻)	HPLC	< 5.00E+00	NA	5.00E+00
Monomethyl Mercury (CH₃Hg)	CVAFS w/ Distillation	4.28E+01	1.80E+00	3.25E+02

a. Result is calculated from the measured Al concentration assuming all of the Al is present as the OH compound.

b. Measurement performed on filtered supernate samples.

c. Result is calculated from the measured P concentration assuming all of the P is present as the O compound.

d. Result is calculated from the measured Ni concentration assuming all of the Ni is present as the OH compound.

e. Measurement performed on duplicate samples rather than triplicate samples.

f. Result is calculated from the reported concentration of < 33 mg/L and the density of the slurry sample listed in Table 8.

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Table 2. Chemical Contaminants from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Attachment 8.2 Targets²

<u>Chemical Name (Formula)</u>	<u>Method</u>	<u>Average Concentration (mg/L)</u>	<u>Std. Dev.</u>	<u>WAC Target (mg/L)</u>
Boron (B)	ICP-ES	< 4.47E+01	NA	7.43E+02
Cobalt (Co)	ICP-MS	<2.06E-02	NA	1.75E+02
Copper (Cu)	ICP-ES	< 1.91E+00	NA	7.43E+02
Iron (Fe)	ICP-ES	6.81E+00	2.01E+00	4.95E+03
Lithium (Li)	ICP-ES	< 1.46E+01	NA	7.43E+02
Manganese (Mn)	ICP-ES	1.41E+00	1.24E-02	7.43E+02
Molybdenum (Mo)	ICP-ES	< 5.82E+00	NA	7.43E+02
Nickel (Ni)	ICP-ES	< 1.83E+01	NA	7.43E+02
Silicon (Si)	ICP-ES	3.27E+01	1.52E+00	1.07E+04
Strontium (Sr)	ICP-ES	< 1.73E-01	NA	7.43E+02
Zinc (Zn)	ICP-ES	7.40E+00	1.92E-01	8.03E+02
Benzene (C₆H₆)	VOA	< 1.50E-01 ^a	NA	3.10E+02
Methanol (CH₃OH)	VOA	b	NA	1.88E+00
Dibutylphosphate [DBP] (C₈H₁₉O₄P)	IC	< 2.50E+02	NA	3.47E+02
Tributyl Phosphate [TBP] ((C₄H₉O)₃PO)	SVOA	< 7.50E-01 ^a	NA	7.50E+00
Toluene (C₆H₅CH₃)	VOA	< 1.50E-01 ^a	NA	3.10E+02
EDTA (----)	HPLC	< 1.00E+02	NA	3.10E+02
NORPAR 13 (----)	SVOA	< 7.50E-01 ^a	NA	1.00E-01
Dimethyl Mercury ((CH₃)₂Hg)	CVAFS	5.26E-02	3.16E-02	1.00E+00

a. Measurement performed on duplicate samples rather than triplicate samples.

b. Currently, a routine method for detecting this species does not exist in Analytical Development (AD).

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Table 3. Radionuclide Contaminants from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Attachment 8.3 Limits²

<u>Radionuclide</u>	<u>Method</u>	<u>Average Concentration (pCi/mL)</u>	<u>Std. Dev.</u>	<u>WAC Limit (pCi/mL)</u>
Tritium (³H)	Tritium counting	3.43E+02	3.61E+01	5.63E+05
Carbon-14 (¹⁴C)	C-14 Liquid scintillation	5.29E+02	2.03E+01	1.13E+05
Nickel-63 (⁶³Ni)	Ni-59/63	< 1.53E+02	NA	1.13E+05
Strontium-90 (⁹⁰Sr)	Sr-90 Liquid scintillation	1.11E+03	2.67E+02	3.15E+06
Technetium-99 (⁹⁹Tc)	Tc-99 Liquid scintillation	1.54E+04	8.79E+02	2.11E+05
Iodine-129 (¹²⁹I)	I-129 (w/ separation) Liquid scintillation	1.11E+01	1.78E+00	6.30E+01
Cesium-137 (¹³⁷Cs)	Gamma Scan	5.14E+05	4.50E+03	3.96E+06
Uranium-233 (²³³U)	ICP-MS	< 1.99E+02	NA	1.13E+04
Uranium-235 (²³⁵U)	ICP-MS	2.35E-01	9.89E-04	1.13E+02
Plutonium-241 (²⁴¹Pu)	Pu238/241 Liquid scintillation	< 1.04E+02	NA	8.38E+05
Total Alpha	Liquid Scintillation Counting	< 3.59E+02	NA	2.13E+05

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Table 4. Radionuclide Contaminants from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Attachment 8.4 Targets²

<u>Radionuclide</u>	<u>Method</u>	<u>Average Concentration (pCi/mL)</u>	<u>Std. Dev.</u>	<u>WAC Target (pCi/mL)</u>
Aluminum-26 (²⁶Al)	Gamma scan (Cs removed)	< 6.94E-02	NA	2.88E+03
Cobalt-60 (⁶⁰Co)	Gamma scan (Cs removed)	4.80E+00	3.00E-01	9.747E+02
Potassium-40 (⁴⁰K)	Gamma scan (Cs removed)	< 2.02E+00	NA	1.00E+02
Nickel-59 (⁵⁹Ni)	Ni-59/63	< 7.52E+00	NA	1.13E+03
Selenium-79 (⁷⁹Se)	Se-79	3.85E+01	1.31E+01	1.90E+04
Yttrium-90 (⁹⁰Y)	Secular Equilibrium w/ Sr-90	1.11E+03	2.67E+02	3.15E+06
Zirconium-93 (⁹³Zr)	ICP-MS	< 7.73E+01	NA	1.00E+05
Niobium-94 (⁹⁴Nb)	Nb-94	< 1.71E-01	NA	1.53E+02
Rhodium-106 (¹⁰⁶Rh)	Secular Equilibrium w/ Ru-106	< 1.15E+00	NA	1.13E+06
Ruthenium-106 (¹⁰⁶Ru)	Gamma scan (Cs removed)	< 1.15E+00	NA	1.13E+06
Antimony-125 (¹²⁵Sb)	Gamma scan (Cs removed)	6.62E+00	1.19E-01	7.988E+03
Tellurium-125m (^{125m}Te)	Secular Equilibrium w/ Sb-125	6.62E+00	1.19E-01	1.828E+03
Tin-126 (¹²⁶Sn)	Gamma scan (Cs removed)	1.12E+02	2.38E+00	1.80E+04
Cesium-134 (¹³⁴Cs)	Gamma Scan	< 4.86E+01	NA	1.82E+04
Cesium-135 (¹³⁵Cs)	ICP-MS	< 2.36E+01	NA	2.50E+02
Barium-137m (^{137m}Ba)	Calculation (Secular Equilibrium w/ 94.6% of Cs-137)	4.86E+05	4.26E+03	3.75E+06
Cerium-144 (¹⁴⁴Ce)	Gamma scan (Cs removed)	< 1.35E+00	NA	1.13E+05
Promethium-147 (¹⁴⁷Pm)	Pm-147/Sm-151 Liquid scintillation	<4.28E+01	NA	5.63E+06
Samarium-151 (¹⁵¹Sm)	Pm-147/Sm-151 Liquid scintillation	<3.26E+01	NA	2.25E+04
Europium-154 (¹⁵⁴Eu)	Gamma scan (Cs removed)	< 2.61E-01	NA	1.615E+03
Europium-155 (¹⁵⁵Eu)	Gamma scan (Cs removed)	< 7.25E-01	NA	1.13E+04
Radium-226 (²²⁶Ra)	Ra-226	<6.49E+00	NA	1.00E+03
Radium-228 (²²⁸Ra)	Gamma scan (Cs removed)	< 6.53E-01	NA	1.00E+04
Actinium-227 (²²⁷Ac)	Th-229/230	<1.25E-02	NA	1.00E+04
Thorium-229 (²²⁹Th)	Th-229/230	3.36E-02 ^a	NA	1.63E+05
Thorium-230 (²³⁰Th)	Th-229/230	<4.08E-02	NA	6.26E+03
Thorium-232 (²³²Th)	ICP-MS	< 5.63E-03	NA	2.88E+03
Protactinium-231 (²³¹Pa)	Pa-231	< 7.25E-01	NA	1.00E+03
Uranium-232 (²³²U)	U-232	2.00E+00	6.44E-01	9.06E+03
Uranium-234 (²³⁴U)	ICP-MS	< 1.28E+02	NA	1.13E+04
Uranium-236 (²³⁶U)	ICP-MS	< 1.33E+00	NA	1.13E+04
Uranium-238 (²³⁸U)	ICP-MS	5.30E+00	4.14E-02	1.13E+04
Neptunium-237 (²³⁷Np)	ICP-MS	<1.45E+01	NA	1.00E+04

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Table 4. Radionuclide Contaminants from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Attachment 8.4 Targets², continued

<u>Radionuclide</u>	<u>Method</u>	<u>Average Concentration (pCi/mL)</u>	<u>Std. Dev.</u>	<u>WAC Target (pCi/mL)</u>
Plutonium-238 (²³⁸Pu)	Pu238/241 Pu alpha PHA	3.71E+02	3.98E+01	2.13E+05
Plutonium-239 (²³⁹Pu)	Pu238/241 Pu alpha PHA	1.45E+01	2.77E+00	2.13E+05
Plutonium-240 (²⁴⁰Pu)	Pu238/241 Pu alpha PHA	1.45E+01	2.77E+00	2.13E+05
Plutonium-242 (²⁴²Pu)	ICP-MS	< 7.83E+01	NA	2.13E+05
Plutonium-244 (²⁴⁴Pu)	ICP-MS	< 3.64E-01	NA	7.02E+04
Americium-241 (²⁴¹Am)	Am/Cm	2.59E+00	2.21E-01	2.13E+05
Americium-242m (^{242m}Am)	Am/Cm	1.44E-01 ^a	NA	4.50E+05
Americium-243 (²⁴³Am)	Am/Cm	<3.77E-01	NA	2.13E+05
Curium-242 (²⁴²Cm)	Am/Cm	1.19E-01 ^a	NA	1.13E+04
Curium-244 (²⁴⁴Cm)	Am/Cm	1.31E+01	1.13E+00	2.13E+05
Curium-245 (²⁴⁵Cm)	Am/Cm	<1.35E+00	NA	2.25E+05

a. Measurement represents data from a single sample rather than triplicate samples.

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Table 5. Chemical Contaminants Impacting Saltstone Disposal Unit (SDU) Flammability from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Table 3 Limits and Targets²

<u>Chemical Name</u>	<u>Method</u>	<u>Average Concentration (mg/L)</u>	<u>Std. Dev.</u>	<u>WAC Limit/Target</u>
Isopar L	SVOA	<2.67E+01 ppm ^{a,b}	NA	1.10E+01 ppm (Limit)
Tetraphenylborate (TPB)	HPLC	< 5.00E+00	NA	5.00E+00 mg/L (Limit)
Ammonium	IC	<1.00E+01	NA	2.12E+02 mg/L (Limit)
Total Mercury	CVAA	9.32E+01	1.01E+00	3.25E+02 mg/L (Limit)
Monomethyl Mercury	CVAFS w/ Distillation	4.28E+01	1.80E+00	3.25E+02 mg/L (Limit)
Dimethyl Mercury	CVAFS	5.26E-02	3.16E-02	1.00E+00 mg/L (Target)

a. Measurement performed on duplicate samples rather than triplicate samples.

b. Result is calculated from the reported concentration of < 33 mg/L and the density of the slurry sample listed in Table 8.

Table 6. Other Organics Impacting SDU Flammability from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Table 4 Concentrations²

<u>Chemical Name</u>	<u>Method</u>	<u>Average Concentration (mg/L)</u>	<u>Std. Dev.</u>	<u>WAC Concentrations (mg/L)</u>
Butanol	VOA	< 5.00E-01	NA	0.75
Tributylphosphate	SVOA	< 7.50E-01	NA	1.0
Isopropanol	VOA	< 2.50E-01	NA	0.25
Methanol	a	NA	NA	0.05
NORPAR 13	SVOA	< 7.50E-01	NA	0.1

a. Currently, a routine method for detecting this species does not exist in AD.

Table 7. Processing Constituents from Fourth Quarter CY15 Tank 50H Samples and Saltstone WAC, Revision 14, Table 5 Limits²

<u>Processing Constituents</u>	<u>Method</u>	<u>Value</u>	<u>Std. Dev.</u>	<u>WAC Limit</u>
pH	Calculated	> 13	NA	> 10
Sodium Concentration	ICP-ES / AA	4.77 M	1.99E-01	2.5 M < [Na+] < 7.0 M
Total Insoluble Solids	Calculated	~0 wt%	NA	< 15 wt%

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Table 8. Additional Measured Constituents³

<u>Constituent</u>	<u>Method</u>	<u>Average Value</u>	<u>Std. Dev.</u>
Density (slurry)	Measured (22.2°C)	1.2353 g/mL	0.0086
Specific Gravity	a	1.2381	0.0086
Total Solids	Measured	28.25 wt%	1.297
Total Beta	LSC	6.23E+05 pCi/mL	2.60E+03
Total Gamma	b	4.86E+05	2.46E+03 ^c
Thorium-228 (²²⁸ Th)	Gamma scan (Cs removed)	< 4.59E+00	NA
Curium-247 (²⁴⁷ Cm)	Am/Cm	<1.60E+00	NA
Californium-249 (²⁴⁹ Cf)	Am/Cm	<1.76E+00	NA
Californium-251 (²⁵¹ Cf)	Am/Cm	<1.62E+00	NA
Beryllium (Be) ^d	ICP-ES	< 1.74E-01	NA

a. Calculated from the measured density of slurry and density of water at 22.2 °C.¹¹

b. Calculated from the sum of gamma emitters (Co-60, Sb-126, Sn-126, Sb-125, Eu-154, Am-241 and Ba-137m).

c. Value is the “standard error of the mean” rather than the standard deviation of the measurements since its calculation involves multiple radionuclides.

d. Beryllium requested by DWPF & Saltstone Facility Engineering personnel¹

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