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To: E. J. Freed
From: C. L. Crawford

Results for the Second Quarter Calendar Year 2016 Tank 50H Salt Solution Sample

Approved by: ____
A. D. Cozzi, Technical Reviewer, per E7, 2.60 Date

____
E. N. Hoffman, EPD Manager Date

SUMMARY

In this memorandum, the chemical and radionuclide contaminant results from the Second Quarter Calendar Year 2016 (CY16) sample of Tank 50H salt solution are presented in tabulated form. The Second Quarter CY16 Tank 50H samples (a 200 mL sample obtained 6" below the surface and a 1 L sample obtained 66" from the tank bottom) were obtained on April 6, 2016 and received at Savannah River National Laboratory (SRNL) on the same day.[1] Prior to obtaining the samples from Tank 50H, a single pump was run at least 4.4 hours and the samples were pulled immediately after pump shut down.[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 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 Second Quarter CY16 sampling of Tank 50H were requested by Savannah River Remediation (SRR) personnel[4] and details of the testing are presented in the SRNL TTQAP.[5]

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

- WAC targets or limits were met for all analyzed chemical and radioactive contaminants for which the detection limits are below the WAC targets or limits.

- Norpar 13 and Isopar L have higher detection limits[6] compared with the Saltstone WAC. The data provided in this memorandum is based upon the Norpar 13 and Isopar L concentrations from the sample obtained 6” below the surface, and due to the limited solubility of these materials in aqueous solution and the limited mixing of the tank by a single pump for 4.4 hours before sampling, may not represent the overall concentrations of the analytes in Tank 50H.

- Minimum detection limits are reported for ^{94}Nb, ^{247}Cm, ^{249}Cf, and ^{251}Cf 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, the reported minimum detection limits reported for the Second Quarter CY16 Tank 50H sample for these four radionuclides are all lower than the estimated detection limits initially established by SRNL in 2009.[8] Thus per guidance from SRR,[7] SRNL continues to achieve as low as practical detection limits for these radionuclides.

- The measured values for ^{90}Sr and the plutonium isotopes of ^{238}Pu, ^{239}Pu and ^{240}Pu for the Second Quarter CY16 Tank 50H sample are higher than the previous First Quarter CY16 Tank 50H sample[9] by 76X, 40X, 29X and 29X, respectively. This increase is due to the discontinued use of monosodium titanate (MST) in the actinide removal process (ARP) near the start of 2016.

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 Second Quarter CY16 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. If only one value out of the triplicate analysis is above the detection limit, then that single value is reported and noted in the tables. Also, if only two values out of the triplicate analysis are above the detection limit, then the average of those two values is reported and noted in the tables. Data reported for atomic absorption (AA), cold-vapor atomic absorption (CVAA), inductively coupled plasma emission spectroscopy (ICP-ES) and inductively coupled plasma mass spectroscopy (ICP-MS) are derived from the digested Tank 50H supernates by the aqua regia method. All analytical methods shown by the acronyms in the tables for this memorandum have been previously defined in the TTQAP.[5]

Mercury (Hg) speciation data shown in Table 1, Table 2 and Table 5 are taken from previous work.[10] These species include elemental Hg (Hg(0)), monomethyl mercury, ethyl mercury and dimethyl mercury. The concentration values shown for monomethyl mercury, ethyl mercury and dimethyl mercury represent the concentrations of these organomercury species. They are calculated from the reported values for monomethyl mercury, ethyl mercury and dimethyl mercury on a 'mg Hg/L' basis from the Hg speciation memorandum.[10] As a sample calculation, from reference 10, the reported monomethyl concentration on a mg Hg/L basis is 56.2 mg Hg/L. This value is then multiplied by the formula weight of monomethyl mercury from the WAC[2] (215.62 g monomethyl mercury/mol) divided by the molecular weight of Hg (200.6 g Hg/mol). Thus the calculated concentration of the species monomethyl mercury is 56.2 mg Hg/L x (215.62 g monomethyl mercury/mol / 200.6 g Hg/mol) = 60.4 mg monomethyl mercury/L.

Table 1. Chemical Contaminants from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Attachment 8.1 Limits[2]

Chemical Name (Formula)	Method	Average Concentration (mg/L)	Std. Dev.	WAC Limit (mg/L)
Aluminate ($Al(OH)_4^-$)	ICP-ES	1.25E+04 [a]	8.69E+01	**4.08E+05**
Ammonium (NH_4^+)	IC	< 1.00E+01	NA	**2.12E+02**
Carbonate (CO_3^{2-})	TIC	1.64E+04 [b]	5.00E+01	**1.20E+05**
Chloride (Cl^-)	IC	2.95E+02	1.66E+01	**7.95E+03**
Fluoride (F^-)	IC	< 1.00E+02	NA	**4.07E+03**
Free Hydroxide (OH^-)	Total Base	3.07E+04 [b]	5.97E+02	**1.58E+05**
Nitrate (NO_3^-)	IC	1.10E+05	5.58E+03	**4.37E+05**
Nitrite (NO_2^-)	IC	2.60E+04	3.34E+03	**2.14E+05**
Oxalate ($C_2O_4^{2-}$)	IC	2.81E+02	4.73E+00	**2.72E+04**
Phosphate (PO_4^{3-})	IC	3.86E+02	2.67E+01	**2.94E+04**
Sulfate (SO_4^{2-})	IC	4.38E+03	9.60E+02	**5.69E+04**
Arsenic (As)	AA	< 1.12E-01	NA	**2.30E+01**
Barium (Ba)	ICP-ES	< 5.76E-01	NA	**6.19E+02**
Cadmium (Cd)	ICP-ES	5.87E+00	5.56E-01	**3.10E+02**
Chromium (Cr)	ICP-ES	4.70E+01	1.05E+00	**1.24E+03**
Lead (Pb)	ICP-MS	3.74E-01	8.66E-03	**6.19E+02**
Total Mercury (Hg)	CVAA	1.05E+02	1.48E+00	**3.25E+02**
Elemental Mercury (Hg(0))	CVAFS	1.13E+00	4.75E-02	**1.82E+01**
Monomethyl Mercury (CH_3Hg)	CVAFS w/ Distillation	6.04E+01	4.50E+00	**3.50E+02**
Ethyl Mercury (C_2H_5Hg)	CVAFS w/ Distillation	< 2.06E-01	NA	**3.73E+02**
Selenium (Se)	AA	8.51E-02	1.79E-03	**4.46E+02**
Silver (Ag)	ICP-ES	< 1.90E+00	NA	**6.19E+02**
Aluminum (Al)	ICP-ES	3.55E+03	2.47E+01	**1.16E+05**
Potassium (K)	AA	3.14E+02	8.03E+00	**3.03E+04**
n-Butanol (C_4H_9OH)	VOA	< 5.00E-01 [c]	NA	**7.73E+00**
i-Butanol (C_4H_9OH)	VOA	< 5.00E-01 [c]	NA	**7.73E+00**
i-Propanol (C_3H_7OH)	VOA	< 2.50E-01 [c]	NA	**1.88E+00**
Phenol (C_6H_5OH)	SVOA	< 1.00E+01 [c]	NA	**7.50E+02**
Isopar L (----)	SVOA	< 2.67E+01 ppm [c,d]	NA	**1.10E+01 ppm**
Total Organic Carbon (----)	TOC	2.83E+02 [b]	2.31E+00	**5.00E+03**
Tetraphenylborate [TPB anion] ($B(C_6H_5)_4^-$)	HPLC	< 5.00E+00	NA	**5.00E+00**

a. Result is calculated from the measured Al concentration assuming all the Al is present as the OH compound.
b. Measurement performed on filtered supernate samples.
c. Measurement performed on duplicate samples rather than triplicate samples.
d. Result is calculated from the reported concentration of < 33 mg/L and the density of the slurry sample listed in Table 8.

Table 2. Chemical Contaminants from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Attachment 8.2 Targets[2]

Chemical Name (Formula)	Method	Average Concentration (mg/L)	Std. Dev.	WAC Target (mg/L)
Boron (B)	ICP-ES	5.16E+01	8.40E-01	**7.43E+02**
Cobalt (Co)	ICP-MS	< 2.03E-02	NA	**1.75E+02**
Copper (Cu)	ICP-ES	< 1.89E+00	NA	**7.43E+02**
Iron (Fe)	ICP-ES	6.43E+00	4.85E-01	**4.95E+03**
Lithium (Li)	ICP-ES	1.49E+01 [a]	8.73E-02	**7.43E+02**
Manganese (Mn)	ICP-ES	1.75E+00	2.14E-02	**7.43E+02**
Molybdenum (Mo)	ICP-ES	1.21E+01	9.89E-01	**7.43E+02**
Nickel (Ni)	ICP-ES	< 2.05E+01	NA	**7.43E+02**
Silicon (Si)	ICP-ES	3.23E+01	7.44E-01	**1.07E+04**
Strontium (Sr)	ICP-ES	< 1.72E-01	NA	**7.43E+02**
Zinc (Zn)	ICP-ES	9.28E+00	3.78E-01	**8.03E+02**
Benzene (C_6H_6)	VOA	< 1.50E-01 [a]	NA	**3.10E+02**
Methanol (CH_3OH)	VOA	b	NA	**1.88E+00**
Dibutylphosphate [DBP] ($C_8H_{19}O_4P$)	IC	< 2.50E+02	NA	**3.47E+02**
Tributyl Phosphate [TBP] ($(C_4H_9O)_3PO$)	SVOA	< 7.50E-01 [a]	NA	**7.50E+00**
Toluene ($C_6H_5CH_3$)	VOA	< 1.50E-01 [a]	NA	**3.10E+02**
EDTA ($C_{10}H_{12}N_2O_8^{4-}$)	HPLC	< 1.00E+02	NA	**3.10E+02**
NORPAR 13 ($C_nH_{2\cdot n}$)	SVOA	< 7.50E-01 [a]	NA	**7.5E-01**
Dimethyl Mercury ($(CH_3)_2Hg$)	CVAFS	3.01E-02	1.41E-03	**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).

Table 3. Radionuclide Contaminants from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Attachment 8.3 Limits[2]

Radionuclide	Method	Average Concentration (pCi/mL)	Std. Dev.	WAC Limit (pCi/mL)
Tritium (^{3}H)	Tritium counting	1.22E+03	6.11E+01	**5.63E+05**
Carbon-14 (^{14}C)	C-14 Liquid scintillation	7.39E+02	2.81E+01	**1.13E+05**
Nickel-63 (^{63}Ni)	Ni-59/63	1.67E+01	5.41E+00	**1.13E+05**
Strontium-90 (^{90}Sr)	Sr-90 Liquid scintillation	1.31E+05	5.39E+04	**3.15E+06**
Technetium-99 (^{99}Tc)	Tc-99 Liquid scintillation	3.24E+04	1.27E+03	**2.11E+05**
Iodine-129 (^{129}I)	I-129 (w/ separation) Liquid scintillation	2.35E+01	2.93E+00	**6.30E+01**
Cesium-137 (^{137}Cs)	Gamma Scan	6.49E+05	3.15E+04	**3.96E+06**
Uranium-233 (^{233}U)	ICP-MS	< 1.96E+02	NA	**1.13E+04**
Uranium-235 (^{235}U)	ICP-MS	2.71E-01	5.34E-03	**1.13E+02**
Plutonium-241 (^{241}Pu)	Pu238/241 Liquid scintillation	5.98E+03	3.20E+02	**8.38E+05**
Total Alpha	Liquid Scintillation Counting	< 1.56E+04	NA	**2.13E+05**

Table 4. Radionuclide Contaminants from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Attachment 8.4 Targets[2]

Radionuclide	Method	Average Concentration (pCi/mL)	Std. Dev.	WAC Target (pCi/mL)
Aluminum-26 (^{26}Al)	Gamma scan (Cs removed)	< 1.74E-01	NA	**2.88E+03**
Cobalt-60 (^{60}Co)	Gamma scan (Cs removed)	5.72E+00	2.38E-01	**9.75E+02**
Potassium-40 (^{40}K)	Gamma scan (Cs removed)	< 2.98E+00	NA	**1.00E+02**
Nickel-59 (^{59}Ni)	Ni-59/63	< 2.29E+00	NA	**1.13E+03**
Selenium-79 (^{79}Se)	Se-79	2.80E+01	3.17E+00	**1.90E+04**
Yttrium-90 (^{90}Y)	Secular Equilibrium w/ Sr-90	1.31E+05	5.39E+04	**3.15E+06**
Zirconium-93 (^{93}Zr)	ICP-MS	< 5.10E+01	NA	**1.00E+05**
Niobium-94 (^{94}Nb)	Nb-94	< 3.83E-01	NA	**1.53E+02**
Rhodium-106 (^{106}Rh)	Secular Equilibrium w/ Ru-106	< 4.23E+00	NA	**1.13E+06**
Ruthenium-106 (^{106}Ru)	Gamma scan (Cs removed)	< 4.23E+00	NA	**1.13E+06**
Antimony-125 (^{125}Sb)	Gamma scan (Cs removed)	1.17E+01	6.80E-01	**7.99E+03**
Tellurium-125m (^{125m}Te)	Secular Equilibrium w/ Sb-125	1.17E+01	6.80E-01	**1.83E+03**
Tin-126 (^{126}Sn)	Gamma scan (Cs removed)	3.10E+02	7.70E+00	**1.80E+04**
Cesium-134 (^{134}Cs)	Gamma Scan	< 8.20E+01	NA	**1.82E+04**
Cesium-135 (^{135}Cs)	ICP-MS	< 2.33E+01	NA	**2.50E+02**
Barium-137m (^{137m}Ba)	Calculation (Secular Equilibrium w/ 94.6% of Cs-137)	6.14E+05	2.98E+04	**3.75E+06**
Cerium-144 (^{144}Ce)	Gamma scan (Cs removed)	< 8.60E+00	NA	**1.13E+05**
Promethium-147 (^{147}Pm)	Pm-147/Sm-151 Liquid scintillation	<5.81E+01	NA	**5.63E+06**
Samarium-151 (^{151}Sm)	Pm-147/Sm-151 Liquid scintillation	<4.34E+01	NA	**2.25E+04**
Europium-154 (^{154}Eu)	Gamma scan (Cs removed)	< 6.49E-01	NA	**1.62E+03**
Europium-155 (^{155}Eu)	Gamma scan (Cs removed)	< 3.82E+00	NA	**1.13E+04**
Radium-226 (^{226}Ra)	Ra-226	<3.06E+00	NA	**1.00E+03**
Radium-228 (^{228}Ra)	Gamma scan (Cs removed)	< 2.08E+00	NA	**1.00E+04**
Actinium-227 (^{227}Ac)	Th-229/230	<2.26E-02	NA	**1.00E+04**
Thorium-229 (^{229Th})	Th-229/230	<7.07E-02	NA	**1.63E+05**
Thorium-230 (^{230Th})	Th-229/230	<3.20E-02	NA	**6.26E+03**
Thorium-232 (^{232}Th)	ICP-MS	< 2.22E-03	NA	**2.88E+03**
Protactinium-231 (^{231}Pa)	Pa-231	< 7.16E-01	NA	**1.00E+03**
Uranium-232 (^{232}U)	U-232	1.21E+00 [a]	9.56E-02 [a]	**9.06E+03**
Uranium-234 (^{234}U)	ICP-MS	< 1.27E+02	NA	**1.13E+04**
Uranium-236 (^{236}U)	ICP-MS	< 1.31E+00	NA	**1.13E+04**
Uranium-238 (^{238}U)	ICP-MS	5.76E+00	4.46E-02	**1.13E+04**
Neptunium-237 (^{237}Np)	ICP-MS	<1.43E+01	NA	**1.00E+04**

Table 4. Radionuclide Contaminants from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Attachment 8.4 Targets[2], continued

Radionuclide	Method	Average Concentration (pCi/mL)	Std. Dev.	WAC Target (pCi/mL)
Plutonium-238 (^{238}Pu)	Pu238/241 Pu alpha PHA	1.59E+04	6.31E+02	**2.13E+05**
Plutonium-239 (^{239}Pu)	Pu238/241 Pu alpha PHA	3.81E+02	2.95E+01	**2.13E+05**
Plutonium-240 (^{240}Pu)	Pu238/241 Pu alpha PHA	3.81E+02	2.95E+01	**2.13E+05**
Plutonium-242 (^{242}Pu)	ICP-MS	< 7.74E+01	NA	**2.13E+05**
Plutonium-244 (^{244}Pu)	ICP-MS	< 3.60E-01	NA	**7.02E+04**
Americium-241 (^{241}Am)	Am/Cm	7.64E+00	3.00E-01	**2.13E+05**
Americium-242m (^{242m}Am)	Am/Cm	<1.01E-01	NA	**4.50E+05**
Americium-243 (^{243}Am)	Am/Cm	<9.91E-01	NA	**2.13E+05**
Curium-242 (^{242}Cm)	Am/Cm	<8.33E-02	NA	**1.13E+04**
Curium-244 (^{244}Cm)	Am/Cm	3.51E+01	1.87E+01	**2.13E+05**
Curium-245 (^{245}Cm)	Am/Cm	<2.77E+00	NA	**2.25E+05**

a. Measurement represents data from only two samples with detectable values, rather than triplicate samples.

Table 5. Chemical Contaminants Impacting Saltstone Disposal Unit (SDU) Flammability from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Table 2 Limits and Targets[2]

Chemical Name	Method	Average Concentration (mg/L)	Std. Dev.	WAC Limit/Target
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	1.05E+02	1.48E+00	**3.25E+02 mg/L (Limit)**
Monomethyl Mercury	CVAFS w/ Distillation	6.04E+01	4.50E+00	**3.25E+02 mg/L (Limit)**
Dimethyl Mercury	CVAFS	3.01E-02	1.41E-03	**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 Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Table 3 Concentrations[2]

Chemical Name	Method	Average Concentration (mg/L)	Std. Dev.	WAC Concentrations (mg/L)
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	**0.75**

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

Table 7. Processing Constituents from Second Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 16, Table 4 Limits[2]

Processing Constituents	Method	Value	Std. Dev.	WAC Limit
pH	Calculated	> 13	NA	**> 10**
Sodium Concentration	ICP-ES / AA	4.76 M	4.21E-01	**2.5 M < [Na^+] < 7.0 M**
Total Insoluble Solids	Calculated	~0 wt%	NA	**< 15 wt%**

Table 8. Additional Measured Constituents[3]

Constituent	Method	Average Value	Std. Dev.
Density (slurry)	Measured (20.9ºC)	1.2342 g/mL	0.0005
Specific Gravity	a	1.2371	0.0005
Total Solids	Measured	27.39 wt%	0.12
Total Beta	LSC	9.79E+05 pCi/mL	1.45E+04
Total Gamma	b	6.14E+05 pCi/mL	1.72E+04 [c]
Thorium-228 (^{228}Th)	Gamma scan (Cs removed)	< 2.23E+01 pCi/mL	NA
Curium-247 (^{247}Cm) [d]	Am/Cm	< 4.09E+00 pCi/mL	NA
Californium-249 (^{249}Cf) [d]	Am/Cm	< 4.35E+00 pCi/mL	NA
Californium-251 (^{251}Cf) [d]	Am/Cm	< 3.13E+00 pCi/mL	NA
Beryllium (Be) [e]	ICP-ES	< 1.72E-01 mg/L	NA

a. Calculated from the measured density of slurry and density of water at 22.4 °C.[11]
b. Calculated from the sum of gamma emitters (Co-60, Sb-126, Sn-126, Sb-125, 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. Reported values are all below the estimated detection limits of 90.1 pCi/mL established by SRNL.[8]
e. Beryllium requested by DWPF & Saltstone Facility Engineering personnel.[1]

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