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

Results for the First 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 First Quarter Calendar Year 2016 (CY16) sample of Tank 50H salt solution are presented in tabulated form. The First 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 January 13, 2016 and received at Savannah River National Laboratory (SRNL) on January 14, 2016.[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 First 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, relative to the estimated detection limits initially established by SRNL in 2009,[8] the reported minimum detection limits for ^{247}Cm, ^{249}Cf and ^{251}Cf are all lower. The reported minimum detection limit for ^{94}Nb is < 4.64E-01 pCi/mL which is very similar, i.e., only ~ 6% higher than the estimated ^{94}Nb detection limit of 4.38E-01 pCi/mL. Thus per guidance from SRR,[7] SRNL continues to achieve as low as practical detection limits for these radionuclides.

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 First 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.[9,10] These species include elemental Hg (Hg(0)), monomethyl mercury and dimethyl mercury. The concentration values shown for both monomethyl mercury and dimethyl mercury represent the concentrations of these organomercury species. They are calculated from the reported values for monomethyl mercury and dimethyl mercury on a 'mg Hg/L' basis from the Hg speciation memorandum.[9]

Table 1. Chemical Contaminants from First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, 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	1.03E+04 [a]	6.92E+02	**4.08E+05**
Ammonium (NH_4^+)	IC	< 1.00E+00	NA	**2.12E+02**
Carbonate (CO_3^{2-})	TIC	1.59E+04 [b]	1.53E+02	**1.20E+05**
Chloride (Cl^-)	IC	2.46E+02	1.15E+00	**7.95E+03**
Fluoride (F^-)	IC	< 1.00E+02	NA	**4.07E+03**
Free Hydroxide (OH^-)	Total Base	2.67E+04 [b]	1.18E+03	**1.58E+05**
Nitrate (NO_3^-)	IC	1.23E+05	5.77E+02	**4.37E+05**
Nitrite (NO_2^-)	IC	2.40E+04 [c]	0.00E+00 [c]	**2.14E+05**
Oxalate ($C_2O_4^{2-}$)	IC	4.24E+02	7.02E+00	**2.72E+04**
Phosphate (PO_4^{3-})	ICP-ES / IC	4.28E+02 [d]	6.23E+01	**2.94E+04**
Sulfate (SO_4^{2-})	IC	5.48E+03	6.03E+01	**5.69E+04**
Arsenic (As)	AA	< 1.12E-01	NA	**2.30E+01**
Barium (Ba)	ICP-ES	< 1.20E-01	NA	**6.19E+02**
Cadmium (Cd)	ICP-ES	< 2.60E+00	NA	**3.10E+02**
Chromium (Cr)	ICP-ES	3.30E+01	2.14E+00	**1.24E+03**
Lead (Pb)	ICP-MS	1.84E-01	3.14E-02	**6.19E+02**
Total Mercury (Hg)	CVAA	7.86E+01	4.89E+00	**3.25E+02**
Elemental Mercury (Hg(0))	CVAFS	8.82E-01	1.06E-01	**8.92E+01**
Selenium (Se)	AA	< 4.07E-02	NA	**4.46E+02**
Silver (Ag)	ICP-ES	< 3.57E+00	NA	**6.19E+02**
Aluminum (Al)	ICP-ES	2.94E+03	1.96E+02	**1.16E+05**
Potassium (K)	AA	2.19E+02	1.47E+01	**3.03E+04**
Nickel Hydroxide ($Ni(OH)_2$)	ICP-ES	< 2.86E+01 [e]	NA	**1.17E+03**
n-Butanol (C_4H_9OH)	VOA	< 5.00E-01 [f]	NA	**7.73E+00**
i-Butanol (C_4H_9OH)	VOA	< 5.00E-01 [f]	NA	**7.73E+00**
i-Propanol (C_3H_7OH)	VOA	< 2.50E-01 [f]	NA	**1.88E+00**
Phenol (C_6H_5OH)	SVOA	< 1.00E+01 [f]	NA	**7.50E+02**
Isopar L (----)	SVOA	< 2.68E+01 ppm [f,g]	NA	**1.10E+01 ppm**
Total Organic Carbon (----)	TOC	3.56E+02 [b]	3.79E+00	**5.00E+03**
Tetraphenylborate [TPB anion] ($B(C_6H_5)_4^-$)	HPLC	< 5.00E+00	NA	**5.00E+00**
Monomethyl Mercury (CH_3Hg)	CVAFS w/ Distillation	3.36E+01	1.38E+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. All replicates are of equal value.
d. ICP-ES result is calculated from the measured P concentration assuming all of the P is present as the O compound.
e. Result is calculated from the measured Ni concentration assuming all of the Ni is present as the OH compound.
f. Measurement performed on duplicate samples rather than triplicate samples.
g. 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 First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, Attachment 8.2 Targets[2]

Chemical Name (Formula)	Method	Average Concentration (mg/L)	Std. Dev.	WAC Target (mg/L)
Boron (B)	ICP-ES	4.08E+01	2.71E+00	**7.43E+02**
Cobalt (Co)	ICP-MS	<2.05E-02	NA	**1.75E+02**
Copper (Cu)	ICP-ES	< 1.90E+00	NA	**7.43E+02**
Iron (Fe)	ICP-ES	5.96E+00	3.76E-01	**4.95E+03**
Lithium (Li)	ICP-ES	< 1.44E+01	NA	**7.43E+02**
Manganese (Mn)	ICP-ES	2.24E+00	9.85E-02	**7.43E+02**
Molybdenum (Mo)	ICP-ES	6.33E+00 [a]	NA [a]	**7.43E+02**
Nickel (Ni)	ICP-ES	< 1.81E+01	NA	**7.43E+02**
Silicon (Si)	ICP-ES	3.11E+01	3.05E+00	**1.07E+04**
Strontium (Sr)	ICP-ES	< 1.53E-01	NA	**7.43E+02**
Zinc (Zn)	ICP-ES	1.03E+01	5.26E-01	**8.03E+02**
Benzene (C_6H_6)	VOA	< 1.50E-01 [b]	NA	**3.10E+02**
Methanol (CH_3OH)	VOA	c	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 [b]	NA	**7.50E+00**
Toluene ($C_6H_5CH_3$)	VOA	< 1.50E-01 [b]	NA	**3.10E+02**
EDTA (----)	HPLC	< 1.00E+02	NA	**3.10E+02**
NORPAR 13 (----)	SVOA	< 7.50E-01 [b]	NA	**1.0E-01**
Dimethyl Mercury ($(CH_3)_2Hg$)	CVAFS	1.98E-01	2.41E-02	**1.00E+00**

a. Measurement represents data from a single sample with a detectable value, rather than triplicate samples.
b. Measurement performed on duplicate samples rather than triplicate samples.
c. Currently, a routine method for detecting this species does not exist in Analytical Development (AD).

Table 3. Radionuclide Contaminants from First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, Attachment 8.3 Limits[2]

Radionuclide	Method	Average Concentration (pCi/mL)	Std. Dev.	WAC Limit (pCi/mL)
Tritium (^{3}H)	Tritium counting	6.96E+02	2.01E+01	**5.63E+05**
Carbon-14 (^{14}C)	C-14 Liquid scintillation	4.86E+02	3.15E+01	**1.13E+05**
Nickel-63 (^{63}Ni)	Ni-59/63	< 3.77E+00	NA	**1.13E+05**
Strontium-90 (^{90}Sr)	Sr-90 Liquid scintillation	1.73E+03	1.90E+02	**3.15E+06**
Technetium-99 (^{99}Tc)	Tc-99 Liquid scintillation	1.96E+04	5.19E+02	**2.11E+05**
Iodine-129 (^{129}I)	I-129 (w/ separation) Liquid scintillation	1.44E+01	5.67E-01	**6.30E+01**
Cesium-137 (^{137}Cs)	Gamma Scan	1.26E+06	2.38E+05	**3.96E+06**
Uranium-233 (^{233}U)	ICP-MS	< 1.97E+02	NA	**1.13E+04**
Uranium-235 (^{235}U)	ICP-MS	2.22E-01	1.87E-02	**1.13E+02**
Plutonium-241 (^{241}Pu)	Pu238/241 Liquid scintillation	1.60E+02	1.33E+01	**8.38E+05**
Total Alpha	Liquid Scintillation Counting	< 3.75E+02	NA	**2.13E+05**

Table 4. Radionuclide Contaminants from First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, 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)	< 1.76E-01	NA	**2.88E+03**
Cobalt-60 (^{60}Co)	Gamma scan (Cs removed)	1.26E+01	5.26E-01	**9.747E+02**
Potassium-40 (^{40}K)	Gamma scan (Cs removed)	< 2.70E+00	NA	**1.00E+02**
Nickel-59 (^{59}Ni)	Ni-59/63	< 6.22E+00	NA	**1.13E+03**
Selenium-79 (^{79}Se)	Se-79	1.91E+01 [a]	5.22E+00 [a]	**1.90E+04**
Yttrium-90 (^{90}Y)	Secular Equilibrium w/ Sr-90	1.73E+03	1.90E+02	**3.15E+06**
Zirconium-93 (^{93}Zr)	ICP-MS	< 5.11E+01	NA	**1.00E+05**
Niobium-94 (^{94}Nb)	Nb-94	< 4.64E-01	NA	**1.53E+02**
Rhodium-106 (^{106}Rh)	Secular Equilibrium w/ Ru-106	< 4.12E+00	NA	**1.13E+06**
Ruthenium-106 (^{106}Ru)	Gamma scan (Cs removed)	< 4.12E+00	NA	**1.13E+06**
Antimony-125 (^{125}Sb)	Gamma scan (Cs removed)	7.33E+00	6.56E-01	**7.988E+03**
Tellurium-125m (^{125m}Te)	Secular Equilibrium w/ Sb-125	7.33E+00	6.56E-01	**1.828E+03**
Tin-126 (^{126}Sn)	Gamma scan (Cs removed)	1.76E+02	7.16E+00	**1.80E+04**
Cesium-134 (^{134}Cs)	Gamma Scan	< 1.05E+02	NA	**1.82E+04**
Cesium-135 (^{135}Cs)	ICP-MS	< 2.34E+01	NA	**2.50E+02**
Barium-137m (^{137m}Ba)	Calculation (Secular Equilibrium w/ 94.6% of Cs-137)	1.19E+06	2.25E+05	**3.75E+06**
Cerium-144 (^{144}Ce)	Gamma scan (Cs removed)	< 4.73E+00	NA	**1.13E+05**
Promethium-147 (^{147}Pm)	Pm-147/Sm-151 Liquid scintillation	< 4.73E+01	NA	**5.63E+06**
Samarium-151 (^{151}Sm)	Pm-147/Sm-151 Liquid scintillation	< 3.68E+01	NA	**2.25E+04**
Europium-154 (^{154}Eu)	Gamma scan (Cs removed)	< 7.97E-01	NA	**1.615E+03**
Europium-155 (^{155}Eu)	Gamma scan (Cs removed)	< 2.52E+00	NA	**1.13E+04**
Radium-226 (^{226}Ra)	Ra-226	< 1.87E+00	NA	**1.00E+03**
Radium-228 (^{228}Ra)	Gamma scan (Cs removed)	< 1.75E+00	NA	**1.00E+04**
Actinium-227 (^{227}Ac)	Th-229/230	< 3.04E-02	NA	**1.00E+04**
Thorium-229 (^{229}Th)	Th-229/230	< 4.68E-03	NA	**1.63E+05**
Thorium-230 (^{230}Th)	Th-229/230	< 3.32E-02	NA	**6.26E+03**
Thorium-232 (^{232}Th)	ICP-MS	< 2.23E-03	NA	**2.88E+03**
Protactinium-231 (^{231}Pa)	Pa-231	< 6.98E-01	NA	**1.00E+03**
Uranium-232 (^{232}U)	U-232	2.18E+00	2.99E-01	**9.06E+03**
Uranium-234 (^{234}U)	ICP-MS	< 1.27E+02	NA	**1.13E+04**
Uranium-236 (^{236}U)	ICP-MS	< 1.32E+00	NA	**1.13E+04**
Uranium-238 (^{238}U)	ICP-MS	4.79E+00	3.23E-01	**1.13E+04**
Neptunium-237 (^{237}Np)	ICP-MS	<1.43E+01	NA	**1.00E+04**

Table 4. Radionuclide Contaminants from First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, 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	3.99E+02	4.32E+01	**2.13E+05**
Plutonium-239 (^{239}Pu)	Pu238/241 Pu alpha PHA	1.32E+01	6.22E+00	**2.13E+05**
Plutonium-240 (^{240}Pu)	Pu238/241 Pu alpha PHA	1.32E+01	6.22E+00	**2.13E+05**
Plutonium-242 (^{242}Pu)	ICP-MS	< 7.76E+01	NA	**2.13E+05**
Plutonium-244 (^{244}Pu)	ICP-MS	< 3.61E-01	NA	**7.02E+04**
Americium-241 (^{241}Am)	Am/Cm	4.20E+00	1.31E+00	**2.13E+05**
Americium-242m (^{242m}Am)	Am/Cm	< 8.87E-02	NA	**4.50E+05**
Americium-243 (^{243}Am)	Am/Cm	< 4.55E-01	NA	**2.13E+05**
Curium-242 (^{242}Cm)	Am/Cm	< 7.34E-02	NA	**1.13E+04**
Curium-244 (^{244}Cm)	Am/Cm	2.37E+01	9.41E+00	**2.13E+05**
Curium-245 (^{245}Cm)	Am/Cm	< 1.02E+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 First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, Table 2 Limits and Targets[2]

Chemical Name	Method	Average Concentration (mg/L)	Std. Dev.	WAC Limit/Target
Isopar L	SVOA	< 2.68E+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+00	NA	**2.12E+02 mg/L (Limit)**
Total Mercury	CVAA	7.86E+01	4.89E+00	**3.25E+02 mg/L (Limit)**
Monomethyl Mercury	CVAFS w/ Distillation	3.36E+01	1.38E+00	**3.25E+02 mg/L (Limit)**
Dimethyl Mercury	CVAFS	1.98E-01	2.41E-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 First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, 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	**0.1**

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

Table 7. Processing Constituents from First Quarter CY16 Tank 50H Samples and Saltstone WAC, Revision 15, Table 4 Limits[2]

Processing Constituents	Method	Value	Std. Dev.	WAC Limit
pH	Calculated	> 13	NA	**> 10**
Sodium Concentration	ICP-ES / AA	4.70 M	3.45E-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 (20.5ºC)	1.2319 g/mL	0.0129
Specific Gravity	a	1.2342	0.0129
Total Solids	Measured	26.69 wt%	0.059
Total Beta	LSC	1.29E+06 pCi/mL	1.31E+05
Total Gamma	b	1.19E+06 pCi/mL	1.30E+05 [c]
Thorium-228 (^{228}Th)	Gamma scan (Cs removed)	< 1.67E+01 pCi/mL	NA
Curium-247 (^{247}Cm)	Am/Cm	<1.41E+00 pCi/mL	NA
Californium-249 (^{249}Cf)	Am/Cm	<1.49E+00 pCi/mL	NA
Californium-251 (^{251}Cf)	Am/Cm	<1.14E+00 pCi/mL	NA
Beryllium (Be) [d]	ICP-ES	< 1.72E-01 mg/L	NA

a. Calculated from the measured density of slurry and density of water at 20.5 °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 personnel.[1]

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