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Characterization of Infrequent Samples from the Concentration, Storage, and Transfer Facility: Leak Detection Box (LDB) Drain Cell Sample: February 26, 2023, Sample

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EXECUTIVE SUMMARY

Savannah River Mission Completion Engineering (SRMC-E) requested that the Savannah River National Laboratory (SRNL) analyze the Concentration, Storage, and Transfer Facility (CSTF) samples from the following Tank Farm areas: the sump encasement, catch tank, drain cell, and waste tank annulus. In general, these CSTF samples will be analyzed on an infrequent basis and analyses will include detection for total beta/gamma activities, total alpha activity, free hydroxide, and pH measurements.

This report presents characterization results for the leak detection box (LDB) February 26, 2023, drain cell sample. The sample was clear and colorless with no visible particulates. The results are measurements for total gamma, total alpha, total beta, free hydroxide, pH, and density.

These analyses were performed in triplicate. A summary of the average analytical results for the LDB sample includes the following.

The directly measured pH for the LDB February 26, 2023 "as-received" drain cell sample range was 7.12-7.16, and the free hydroxide concentration was <0.02 M. The density of the "as-received" drain cell sample determined at 25 ºC was 1.02 ± 0.00 g/mL. The total alpha activity for the LDB February 26, 2023, sample is reported as a less than value (Upper Limit) because of possible spectral interferences.Thus, the total alpha activity averaged <3.52E+02 dpm/mL. This value is less than 4.83E+03 dpm/mL, which is the procedural limit for non-waste determination.

The total beta activity in the LDB February 26, 2023, drain cell sample is above the instrument detection limits and averaged 9.76E+03 ± 5.94E+02 dpm/mL.

The average measured cesium-137 activity (dominant beta emitter) in the LDB February 26, 2023, drain cell sample is 7.76E+03 ± *2.35E+02* dpm/mL. The corresponding Ba-137m (dominant gamma emitter) activity, calculated as 94.6% of the Cs-137 values, is 7.34E+03 ± 2.23E+02 dpm/mL.

The total empirical activity of the beta and gamma emitting (represented by the sum of total beta and Ba-137m activities) averaged 1.71E+04 ± 8.18E+02 dpm/mL. This value is less than 8.69E+05 dpm/mL, which is the procedural limit for non-waste determination.

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CSTF	Concentration, Storage and Transfer Facility
LDB	Leak Detection Box
LSC	Liquid Scintillation Counting
MDA	Minimum Detectable Activity
ND	Not Detected
PMP	Polymethyl pentene
SRNL	Savannah River National Laboratory
SRMC-E	Savannah River Mission Completion-Engineering
TTQAP	Task Technical and Quality Assurance Plan
TTR	Technical Task Request

1.0 Introduction

On occasion, Savannah River Mission Completion Engineering (SRMC-E) will request Savannah River National Laboratory (SRNL) to perform analysis on Concentration, Storage, and Transfer Facility (CSTF) samples originating from the sump encasement, catch tank, drain cell, or waste tank annulus per the Technical Task Request (TTR) or email. In February 2023, SRMC-E sent SRNL a sample identified as LDB from a leak detection box. Following the specified TTR[1]. Task Technical and Quality Assurance Plan (TTQAP)[2], and updated request by SRMC-E through email, SRNL tested the sample for Total Alpha and Total Beta by liquid scintillation counting (LSC), Cs-137 by Gamma scan, free hydroxide, and pH.

2.0 Experimental Procedure

The leak detection box (LDB) drain cell sample was received on February 26, 2023, at SRNL. As the "as-received" sample radiation dose rate was Not Detected (ND) mrem/hr extremity and skin and whole body, the container was moved to a radiological hood for inspection. Less than 100 mL of sample was collected from the stainless-steel receipt vessel and was transferred into a clear polymethyl pentene (PMP) beaker for visual inspection, as shown in Figure 2.1.

The sample appearance was clear and colorless with no visible particulates. The sample was not filtered. Aliquots of the sample were directly transferred into shielded bottles and submitted in triplicate preparations each for total gamma/beta/alpha, free hydroxide, and pH analyses by direct measurement using a pH probe.

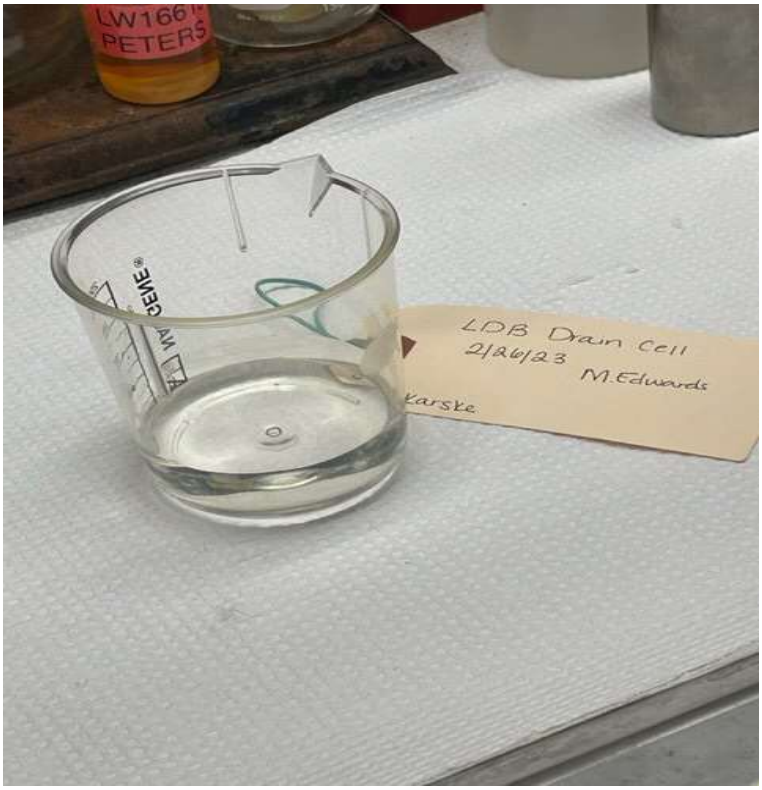

Figure 2-1. Photograph of the LDB drain cell Sample in a beaker

The density of the "as-received" LDB sample was determined in triplicate, at laboratory hood temperature of ~25 °C, using a commercial 2.0 mL reference glass tube. In this method, the weight of 2.0 mL of the LDB sample was determined and based on this weight data, and the reference volume of 2.0 ml, the density of the sample was calculated.

3.0 Results and Discussion

Separate samples were submitted in triplicate for analysis by each of the following methods: 1) radiochemical analysis (total gamma, beta and alpha by liquid scintillation counting), 2) free hydroxide, and 3) pH. These results are provided in Table 3-1.

The directly measured pH for the LDB February 26, 2023 "as-received" drain cell sample range was 7.12-7.16, and the free hydroxide concentration was <0.02 M. The density of the "as-received" drain cell sample determined at 25 ºC was 1.02 ± 0.00 g/mL. The total alpha activity for the LDB February 26, 2023, sample is reported as a less than value (Upper Limit) because of possible spectral interferences. Thus, the total alpha activity averaged < 3.52E+02 dpm/mL. This value is less than 4.83E+03 dpm/mL, which is the procedural limit for non-waste determination[3].

The total beta activity in the LDB February 26, 2023, drain cell sample is above the instrument detection limits and averaged 9.76E+03 ± 5.94E+02 dpm/mL.

The average measured cesium-137 activity (dominant beta emitter) in the LDB February 26, 2023, drain cell sample is 7.76E+03 ± 2.35E+02 dpm/mL. The corresponding Ba-137m (dominant gamma emitter) activity, calculated as 94.6% of the Cs-137 values, is 7.34E+03 ± 2.23E+02 dpm/mL.

The total empirical activity of the beta and gamma emitting (represented by the sum of total beta and Ba-137m activities) averaged 1.71E+04 ± 8.18E+02 dpm/mL. This value is less than 8.69E+05 dpm/mL, which is the procedural limit for non-waste determination[3].

Table 3-1. Results for the February 26, 2023, LDB drain cell sample: Total Alpha, Total Beta, Total Gamma scan, pH, Free Hydroxide, and density.

Analytes	Replicate 1	Replicate 2	Replicate 3	Average	1 sigma anal. Uncertainty, %	%RSD
*Total alpha, dpm/mL	< 3.28E+02	<3.72E+02	< 3.57E+02	< 3.52E+02	Upper Limit	N/A
Total beta, dpm/mL	1.04E+04	9.64E+03	9.23E+03	9.76E+03 ± *5.94E+02*	12	6.08
Cs-137, dpm/mL	7.53E+03	7.74E+03	8.00E+03	7.76E+03 ± *2.35E+02*	5	3.04
**Ba-137^{m}, dpm/mL	7.12E+03	7.32E+03	7.57E+03	7.34E+03 ± *2.23E+02*	5	3.04
**Sum of Total beta and Ba-137^{m} dpm/mL (empirical)	1.64E+04	1.70E+04	1.80E+04	1.71E+04 ± *8.18E+02*	13	4.79
***pH	7.16	7.12	7.12	7.12-7.16	10	N/A
Free Hydroxide, M	< 0.02	< 0.02	< 0.02	< 0.02	10	N/A
Density, g/mL	1.021	1.024	1.019	1.02 ± 0.00	N/A	0.29

*Note: Upper limit results are above detectable limit for quantification by method, however activity of blank signal is greater than 10% of sample signal. Therefore, result is caveated as an upper limit due to expectation of being biased high. Thus, the average value reported is the highest "<" result. All one sigma % uncertainties are as reported with the analytical methods. **Note: Ba-137m activity is calculated as 94.6% of the Cs-137 activity. ***Note: pH is given as a range since it is a logarithmic term and thus cannot be averaged.

4.0 Conclusions

The LDB drain cell sample characterization indicated low to moderate gamma and beta activity in the sample. The pH range was 7.12-7.16, and the free hydroxide was <0.02 M. Total alpha (<3.52E+02 dpm/mL) and total beta/gamma activities (1.71E+04 ± 8.18E+02 dpm/mL) are less than the respective values of 4.83E+03 dpm/ml and 8.69E+05 dpm/mL for non-waste determination.

4.1 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60[4]. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2[5]. This review, a design verification done by document review, meets the acceptance criteria to comply with the TTR[1] requesting this work with a functional classification of Safety Class and per guidance in the TTQAP[2]. Data are recorded in the electronic laboratory notebook system as Experiment ID M0869-00537-13[6].

5.0 References

(1) Technical Task Request, "Infrequent CSTF Samples", X-TTR-H-0101, Rev. 1, June 2021.
(2) L. N. Oji, S. C. Lucatero, "Task Technical and Quality Assurance Plan for the Analysis of Infrequent Samples from the Concentration, Storage, and Transfer Facility", SRNL-RP-2020-00565, Rev.1, July 2021.
(3) "Tank Farm Transfer Control Program, Pump Tank Transfer Jet Control Program, and Waste Tank Chemical Cleaning Program", WSRC-TR-2002-00403, Rev. 34, March 2023.
(4) "Technical Reviews," E7 Manual, Procedure 2.60, Rev. 18, 2019.
(5) "Savannah River National Laboratory Technical Report Design Check Guidelines", WSRC-IM-2002-00011, Rev.2, 2004.
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