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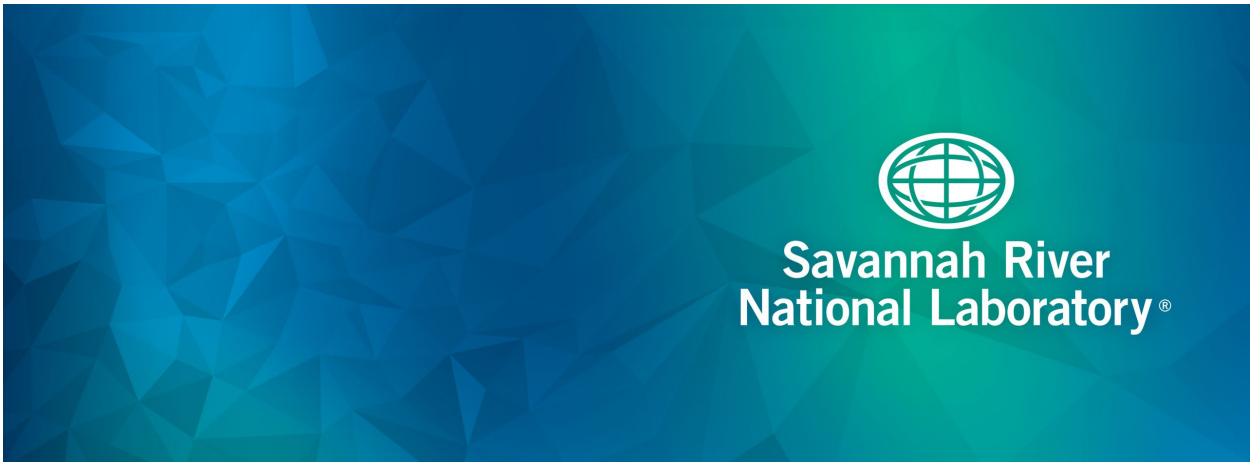

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Characterization Results for the August 2025 Tank Farm 2H Evaporator Overhead Sample

E. J. Craig

October 2025

SRNL-STI-2025-00683, Revision 0

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Prepared for
U.S. Department of Energy

SRNL-STI-2025-00683
Revision 0

Keywords: *Waste-Acceptance Criteria (WAC), Cesium-137, Strontium-90, Iodine-129.*

Retention: *Permanent*

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Savannah River National Laboratory is operated by Battelle Savannah River Alliance for the U.S. Department of Energy under Contract No. 89303321CEM000080.

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PREFACE OR ACKNOWLEDGEMENTS

The author acknowledges assistance in the completion of sample transfer and handling tasks by Shirley McCollum and Grayson Johnston and the completion of sample analyses tasks by the Nuclear Measurements group.

EXECUTIVE SUMMARY

On an annual basis, Savannah River Mission Completion (SRMC) provides 2H and 3H evaporator overhead samples to Savannah River National Lab (SRNL) to be analyzed per Section 5.2 of the Effluent Treatment Project (ETP) Waste Compliance Plan (WCP) and the Waste Acceptance Criteria (WAC).

This report presents the average characterization results for the August 2025 2H evaporator overhead sample. The sample was clear and colorless with no visible solids. The results provide measurements for cesium-137 (^{137}Cs), strontium-90 (^{90}Sr), and iodine-129 (^{129}I) with the radionuclide concentration limits specified by the WAC.

These analyses were performed in duplicate, and all three measured radionuclide concentrations were within ETP WAC limits. A summary of the analytical results for this 2H evaporator overhead sample includes the following:

The measured cesium-137 activity in the 2H evaporator overhead sample averaged 3.02E+02 dpm/mL, which is below the ETP WAC limit of 1.30E+03 dpm/mL. The strontium-90 activity in the 2H evaporator overhead sample averaged 3.33E+00 dpm/mL, which is below the ETP WAC limit of 1.76E+02 dpm/mL. The iodine-129 activity in the 2H evaporator overhead sample averaged 1.20E-01 dpm/mL, which is below the ETP WAC limit of 1.00E+00 dpm/mL.

Although the measurements for Cs-137 and Sr-90 are lower compared to previous years, the results remain within a similar range to past measurements and are well below the WAC limits. Iodine-129 indicates detectable results compared to previous years, which can be attributed to recent salt batch processing trending close to the WAC limit for saltstone production. However, these results are still below the ETP WAC limit.

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LIST OF ABBREVIATIONS

ETF	Effluent Treatment Facility
ETP	Effluent Treatment Project
HPGe	High Purity Germanium
MDA	Minimum Detectable Activity
ND	Not Detected
SRMC	Savannah River Mission Completion
SRNL	Savannah River National Laboratory
TTQAP	Task Technical and Quality Assurance Plan
TTR	Technical Task Request
WAC	Waste Acceptance Criteria
WCP	Waste Compliance Plan

1.0 Introduction

To minimize and reduce the large volume of high-level liquid waste at the Savannah River Site (SRS), the 2H and 3H evaporators were constructed and began operations in H Area in 1982 and 2000, respectively. The evaporation process is performed through boiling the liquid waste in the evaporator cell, cooling and condensing the overhead vapors in the condenser cell, followed by collecting the condensate in the overhead cell. The low-level liquid waste is further treated at the Effluent Treatment Facility (ETF) prior to release into the environment.

On an annual basis, Savannah River Mission Completion (SRMC) provides 2H and 3H evaporator overhead samples to Savannah River National Laboratory (SRNL) for select radionuclide (^{137}Cs, ^{90}Sr, and ^{129}I) characterizations to ensure that the Effluent Treatment Project (ETP) Waste Acceptance Criteria (WAC) for these radionuclides are met as specified in Section 5.2 of the ETP Waste Compliance Plan (WCP) and the WAC.[1,2] In this report, following the specified Technical Task Request (TTR) and Task Technical and Quality Assurance Plan (TTQAP), the August 2025 2H evaporator overhead sample was analyzed for cesium-137 (^{137}Cs), strontium-90 (^{90}Sr), and iodine-129 (^{129}I) with the radionuclide concentration limits specified by the WAC.[3,4]

2.0 Experimental Procedure

Two 250 mL capacity containers holding the 2H evaporator overhead sample were received on August 12th, 2025, at SRNL. Since the "as-received" sample radiation dose rate was low (i.e. extremity, skin, and whole body were below instrument detection limit (ND)), the labeled containers, Overhead TK #1 and Overhead TK #2, were moved to a radiological hood for inspection. Approximately 250 mL of sample (i.e. total combined sample volume of 500 mL) was collected from each receipt vessel and transferred into a clear plastic beaker, as separate aliquots, for visual inspection and subsequent analyses. Two distilled/deionized water blank samples were prepared in parallel at SRNL with the 2H evaporator overhead sample to evaluate sample cross contamination during transfer and sampling for analysis.

Two 2H evaporator overhead sample replicates and two distilled/deionized water blank samples were submitted for: 1) gamma spectroscopy (^{137}Cs) and 2) chemical separations followed by beta counting (^{129}I and ^{90}Sr).

Cesium-137 (Cs-137) Method: Cesium-137 (Cs-137) concentrations were determined by gamma spectrometry. A 50-milliliter aliquot of sample was analyzed/counted directly for a period of at least 4 hours. The sample was analyzed by shielded, high purity germanium (HPGe) gamma spectrometers.

I-129 and Sr-90 were determined by radiochemistry methods. These analytical methods involved separation techniques that enabled radionuclides at low concentrations to be measured more accurately and with lower detection limits. The techniques and methodology for these separations are summarized here.

Strontium-90 (Sr-90) Method: A 20-milliliter aliquot of each sample was spiked with a stable Sr carrier, and a stable cerium (Ce) carrier. The Sr carrier was used for separation yielding purposes, and the Ce carrier was used to enhance the separation rates of undesirable isotopes such as Y-90, the lanthanides or the actinides. The spiked sample aliquot was acidified with nitric acid, evaporated to dryness and re-dissolved in 8M nitric acid. The Sr in the sample was then extracted using a commercially available Sr extraction resin. This resin also extracts some of the Pu under the conditions used to extract the Sr. The plutonium on the resin was washed from the resin using an oxalic acid/nitric acid mixture. The Sr was eluted from the resin, and the resulting solution concentrated. A portion of the purified Sr solution was activated with neutrons in a californium-252 (Cf-252) neutron activation facility at SRNL to determine the total Sr in order to calculate the fraction of Sr isolated by the procedure. A second portion of each of the separated fractions was stored for five to seven days to allow Y-90 to grow in. Each fraction was then counted by liquid

scintillation analysis using a Low-Level Perkin Elmer Tri-Carb Liquid scintillation counter to determine the Y-90 activity in a high energy beta window free of interferences from Sr-90 or any residual beta interferences from isotopes such as Cs-137. The Sr-90 beta activity in each case was calculated from the Y-90 activity. The yields of the stable Sr carriers were applied to the Sr-90 beta activity results to determine Sr-90 activities in the original aliquots of the solutions.

Iodine-129 (I-129) Method: A 50-milliliter aliquot of sample was spiked with a known amount of stable potassium iodide (KI) to act as an iodine tracer/carrier. The sample was acidified with nitric acid. The sample was decontaminated with a resin treatment to enhance removal of the actinide elements. The iodine in the sample was then reduced to iodide. The solution was then treated with silver nitrate ($AgNO_3$) in order to precipitate the iodide ion as silver iodide (AgI). The precipitate was analyzed by low energy photon spectrometry to determine the amount of I-129 present. Iodine-129 is detected by its characteristic gamma and x-ray emissions. The precipitate was then neutron activated in a Cf-252 neutron source to determine the total amount of iodine present in order to calculate the recovery of I-129 in the radiochemical separation.

2.1 Quality Assurance

This work was requested via a TTR and directed by a TTQAP.[3,4] Requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60.[5] SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.[6] This review, a design check done by document review, meets the acceptance criteria to comply with the TTR requesting this work with a functional classification of Production Support and per guidance in the TTQAP.[3,4] Data are recorded in the electronic laboratory notebook system as Experiment ID K6349-00614-13.[7]

3.0 Results and Discussion

A photograph of the "as-received" 2H evaporator overhead samples in two 250 mL capacity plastic containers is provided in Figure 3-1. The appearance of both samples was clear and colorless with no visible solids.

The analytical results for the characterization of the 2H evaporator overhead and the water blanks are provided in Table 3-1. The ^{137}Cs activity in the 2H evaporator overhead sample was below the ETP WAC limit of 1.30E+03 dpm/mL, with one sigma percent uncertainty of 5.00%. The ^{90}Sr activity in the 2H evaporator overhead sample was below the ETP WAC limit of 1.76E+02 dpm/mL, with one sigma percent uncertainty of 25.6%. The ^{129}I activity in the 2H evaporator overhead sample was below the ETP WAC limit of 1.00E+00 dpm/mL, with one sigma percent uncertainty of 24.7%. It is important to note that I-129 was a measured value and not below detection limit. In recent salt batch processing, I-129 has been trending close to the WAC limit for saltstone production.[8] This trend, seen in salt batch processing, indicates to the higher concentrations measured in the 2H Evaporator Overhead sample. All radionuclides were below detectable limit in the blank sample. Historical results for 2H evaporator overhead samples are also provided in Table 3-2 and a survey of the historical results demonstrates that ^{137}Cs activity has generally tracked below the ETP WAC limit.

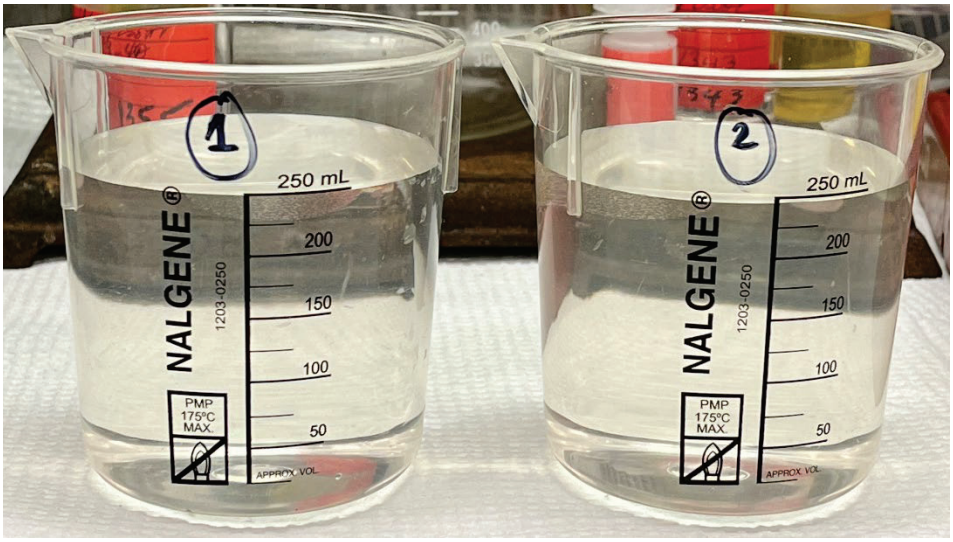

Figure 3-1. Photograph of the 2H Evaporator Overhead Samples in 250mL Plastic Beakers.

Table 3-1. Average Duplicate Results for August 2025 2H Evaporator Overhead and Blank samples: ^{137}Cs, ^{129}I, and ^{90}Sr.

Analyte	Activity (dpm/mL)	Activity (pCi/mL)	Blank Sample (dpm/mL)	ETP WAC limits (dpm/mL)
^{137}Cs	3.02E+02 (%RSD: 5.39E+00)[a]	1.36E+02	<3.86E-01 (MDA)[d]	1.30E+03
^{90}Sr	3.33E+00 (%RSD: 4.63E+01)[b]	1.50E+00	<2.25E+00 (MDA)[d]	1.76E+02
^{129}I	1.20E-01 (%RSD: 5.92E-01)[c]	5.38E-02	<7.84E-02 (MDA)[d]	1.00E+00

[a] One Sigma % uncertainty of 5.00% for analytical method.
[b] One Sigma % uncertainty of 25.6% for analytical method.
[c] One Sigma % uncertainty of 24.7% for analytical method.
[d] MDA = Minimum Detectable Activity

Table 3-2. Historical Analytical Results for 2H Evaporator Overhead Samples: ^{137}Cs, ^{129}I, and ^{90}Sr.

Analyte	^{137}Cs (dpm/mL)	^{90}Sr (dpm/mL)	^{129}I (dpm/mL)
ETP WAC limits	1.30E+03	1.76E+02	1.00E+00
August 2025 2H Evaporator Overhead Sample	3.02E+02	3.33E+00	1.20E-01
March 2024 2H Evaporator Overhead Sample[9]	3.62E+02	5.75E+00	<8.48E-02
March 2023 2H Evaporator Overhead Sample[10]	3.56E+02	<3.76E+01	<3.52E-01
April 2022 2H Evaporator Overhead Sample[11]	4.18E+02	<2.05E+00	<2.14E-02
December 2020 2H Evaporator Overhead Sample[12]	1.58E+02	<9.49E+00	<2.32E-01
July 2018 2H Evaporator Overhead Sample[13]	9.13E+01	<4.99E+00	<2.74E-02
January 2017 2H Evaporator Overhead Sample[14]	6.97E+01	<5.35E+01	<6.66E-01
March 2016 2H Evaporator Overhead Sample[15]	7.04E+01	<1.00E+01	5.83E-02

4.0 Conclusions

The August 12th, 2025, evaporator overhead sample characterization result for ^{137}Cs activity averaged 3.02E+02 dpm/mL (5.39E+00 %RSD), which is below the ETP WAC limit of 1.30E+03 dpm/mL. The ^{129}I activity was 1.20E-01 dpm/mL and ^{90}Sr activity was 3.33E+00 dpm/mL, which are both below the ETP WAC limits. Although the measurements for Cs-137 and Sr-90 are lower compared to previous years, the results remain within a similar range to past measurements and are well below the WAC limits. Iodine-129 indicates detectable results compared to previous years, which can be attributed to recent salt batch processing trending close to the WAC limit for saltstone production. However, these results are still below the ETP WAC limit.

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